ADDENDUM NO. 1

May 4, 2022

Engineer:
Parametrix
1019 39th Avenue SE
Suite 100
Puyallup, Washington 98374

Owner:
Tulalip Tribes of Washington
6406 Marine Drive
Tulalip, Washington 98271

PAVEMENT REHABILITATION AND SAFETY IMPROVEMENTS PROJECTS 28TH DRIVE NW – 81ST STREET NE HOUSING AREA ROADS – TOTEM BEACH ROAD

To: All Holders of the Bidding Documents, Contract Specifications, and Construction Drawings

This Addendum forms a part of the Contract Documents and modifies the Bidding Documents, Contract Specifications, and Construction Drawings for the opening date of May 19, 2022.

Acknowledge receipt of this addendum on the Bid Proposal Form. Failure to do so may subject the Bidder to disqualification. This addendum consists of:

4	Pages of text (including this cover sheet)
5	Bid Proposal Forms, Bid Schedules A-C
4	Contract Forms
77	Appendix A: Final Geotechnical Reports

DMITRI VICTOROVIC SUSLIKOV
38390

5/4/2022

Prepared by: ______________________
Dmitri Victorovic Suslikov, PE

Checked by: ______________________
Austin Fisher, PE

Approved by: ______________________
Happy Longfellow, PE

ADDENDUM NO. 1

PAVEMENT REHABILITATION AND SAFETY IMPROVEMENTS PROJECTS
28TH DRIVE NW – 81ST STREET NE HOUSING AREA ROADS – TOTEM BEACH ROAD

REVISIONS TO CONTRACT DOCUMENTS

DIVISION 0 BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF CONTRACT

1. Bid Proposal Forms

a. Bid Schedules A, B, and C attached hereto and labeled Addendum No. 1 are revised to reflect Bid Items labeled Minor Change in each schedule, No. A-29, B-23, and C-39, respectively, the unit is revised from Lum Sum to Force Account, and the unit price is $25,000 for each.

b. Bid Schedule C, Totem Beach Road, attached hereto and labeled Addendum No. 1, Bid Item No. C-38, Resolution of Utility Conflicts, is revised to reflect the F.A. unit price is $45,000.

2. Contract Forms

a. Replace the Interim Waiver and Release of Claims with the attached Interim Waiver and Release of Claims labeled Addendum No. 1. All highlights have been removed.

b. Replace the Final Waiver and Release of Claims with the attached Final Waiver and Release of Claims labeled Addendum No. 1. All highlights have been removed.

SPECIAL PROVISIONS

1. Division 2 – Earthwork, Section 2-02, Removal of Structures and Obstructions

a. Add Section 2-02.1, Description, as follows::

“**2-02.1 Description**

Section 2-02.1 is supplemented with the following:

(******)

This work shall consist of removing and disposing of existing structures and obstructions as shown on the Plans.

Other work shall also include removing of existing bollards and water main where shown in the Plans.”

2. Division 8 – Miscellaneous Construction, Section 8-02, Roadside Restoration

a. Supplement Section 8-02.2, Materials, with the following:

“Biorention Soil Medium

Section 8-02.2 is supplemented with the following:

Bioretention Soil Medium shall meet the following requirements:

Bioretention Soil Medium shall consist of 35 – 40 percent Special Compost by volume meeting the requirements of Section 9-14.5(8) of the Standard Specifications and 60 – 65 percent Mineral Aggregate for Bioretention Soil by volume meeting the requirements of Section 9-14.2(4) of these Special Provisions. The mixture shall be well blended to produce a homogeneous mix.”

b. Add Section 8-02.4, Measurement, as follows:

“**8-02.4 Measurement**

Section 8-02.4 is supplemented with the following:

(******)

Bioretention Swale will be measured per linear foot along the center of the swale.”

3. Section 8-02.5, Payment

a. Section 8-02.5 is supplemented with the following:

“Bioretention Swale”, per linear foot.

The unit Contract price per linear foot for “Bioretention Swale” shall be full pay for constructing the swale as shown in the plans including but not limited to excavation, material placement and compaction, plantings, underdrain pipe, connection to structures, surface restoration and cleaning of adjacent structures.”

4. Division 9 – Materials, Section 9-14, Erosion Control and Roadside Planting

a. Section 9-14, Erosion Control and Roadside Planting, is added as follows:

“**9-14 Erosion Control and Roadside Planting**

9-14.2 Topsoil

Section 9-14.2 is supplemented with the following new section:

(******)

“**9-14.2(4) Mineral Aggregate for Bioretention Soil Medium** **New Section**

Mineral Aggregate for bioretention soil shall meet the following gradation:

Sieve Size	Percent Passing
3/8" inch	100
No. 4	95-100
No. 10	75-90
No. 40	25-40
No. 100	4-10
No. 200	2-5

Mineral Aggregate for bioretention soil shall meet the following gradation coefficients:

Coefficient of Uniformity (Cu = D60/D10) equal to or greater than 4; and Coefficient of Curve (Cc = (D302)/D60*D10) greater than or equal to 1 and less than or equal to 3.

Fines passing the #200 sieve shall not exceed 5 percent as measured using ASTM D422.”

APPENDICES

1. Appendix A, Geotechnical Reports

a. Replace the Draft HWA GeoSciences Inc. Geotechnical Engineering Report Pavement Improvement Project – 81st Street NE, Tulalip, Washington, with the attached Final Geotechnical Engineering Report, Pavement Improvement Project – 81st Street NE, Tulalip, Washington.

b. Replace the Draft HWA GeoSciences Inc. Geotechnical Engineering Report Pavement Improvement Project – Totem Beach Road Improvements, Tulalip, Washington, with the attached Final Geotechnical Engineering Report, Pavement Improvement Project – Totem Beach Road Improvements, Tulalip, Washington.

ATTACHMENTS

a. Bid Schedules A, B, and C

b. Interim Waiver and Release of Claims

c. Final Waiver and Release of Claims

d. Final HWA GeoSciences Inc. Geotechnical Engineering Report: pavement Improvement Project – 81st Street NE, Tulalip, Washington;

e. Final HWA GeoSciences Inc. Geotechnical Engineering Report: pavement Improvement Project – Totem Beach Road Improvements, Tulalip, Washington;

BID SCHEDULE

TULALIP TRIBES

PAVEMENT REHABILITATION AND SAFETY IMPROVEMENTS PROJECTS 28TH DRIVE NW – 81ST STREET NE HOUSING AREA ROADS – TOTEM BEACH ROAD

SCHEDULE OF PRICES

SCHEDULE A – 28th Dr NW

SCHEDULE B – 81st St NE

SCHEDULE C – Totem Beach Road

**(Work Within Tribal Reservation Boundary
Washington State Sales Tax Does Not Apply)**

Schedule A: 28th Dr. NW – BASE BID					
ITEM NO.	ITEM DESCRIPTION	UNIT	APPROX. QTY.	UNIT PRICE DOLLAR CENTS	AMOUNT DOLLAR CENTS
A-1	MOBILIZATION	L.S.	1	$	$
A-2	CLEARING AND GRUBBING	ACRE	0.3	$	$
A-3	REMOVING DRAINAGE STRUCTURE	EACH	3	$	$
A-4	REMOVING STORM SEWER PIPE	L.F.	25	$	$
A-5	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	L.S.	1	$	$
A-6	REMOVING CEMENT CONC. SIDEWALK	S.Y.	60	$	$
A-7	REMOVING CEMENT CONC. CURB AND GUTTER	L.F.	990	$	$
A-8	REMOVING ASPHALT CONC. PAVEMENT	S.Y.	1,650	$	$
A-9	ROADWAY EXCAVATION INCL. HAUL	C.Y.	710	$	$
A-10	PVC UNDERDRAIN PIPE 6 IN. DIAM.	L.F.	200	$	$
A-11	EXTRA EXCAVATION	C.Y.	50	$	$
A-12	FOUNDATION MATERIAL	TON	90	$	$
A-13	STORMWATER TREATMENT VAULT	EACH	1	$	$
A-14	CATCH BASIN TYPE 1	EACH	10	$	$
A-15	CORRUGATED POLYETHYLENE STORM SEWER PIPE 12 IN. DIAM.	L.F.	470	$	$
A-16	DUCTILE IRON SEWER PIPE 12 IN. DIAM	L.F.	25	$	$
A-17	LEVEL SPREADER TRENCH	L.S.	1	$	$
A-18	RESETTING EXISTING HYDRANTS	EACH	1	$	$
A-19	CRUSHED SURFACING BASE COURSE	TON	830	$	$
A-20	CEMENT CONC. DRIVEWAY	S.Y.	180	$	$
A-21	HMA CL. 1/2 IN. PG 58H-22	TON	270	$	$
A-22	SILT FENCE	L.F.	200	$	$
A-23	TOP SOIL TYPE A	ACRE	0.1	$	$
A-24	SEEDING AND FERTILIZING	S.Y.	230	$	$
A-25	INLET PROTECTION	EACH	7	$	$
A-26	EROSION CONTROL AND WATER POLLUTION PREVENTION	L.S.	1	$	$

Schedule A: 28th Dr. NW – BASE BID					
ITEM NO.	**ITEM DESCRIPTION**	**UNIT**	**APPROX. QTY.**	**UNIT PRICE DOLLAR CENTS**	**AMOUNT DOLLAR CENTS**
A-27	CEMENT CONC. TRAFFIC CURB AND GUTTER	L.F.	990	$	$
A-28	PROJECT TEMPORARY TRAFFIC CONTROL	L.S.	1	$	$
A-29	MINOR CHANGE	F.A.	1	$ 25,000	$ 25,000
A-30	DEWATERING	L.S.	1	$	$
A-31	RESOLUTION OF UTILITY CONFLICTS	F.A.	1	$ 45,000	$ 45,000
A-32	POTHOLING	EACH	10	$	$
A-33	RECORD DRAWINGS (MINIMUM BID $1,000)	L.S.	1	$	$
A-34	SHORING OR EXTRA EXCAVATION CLASS B	L.S.	1	$	$
A-35	ROADWAY SURVEYING	L.S.	1	$	$
A-36	BOLLARD TYPE	EACH	2	$	$
A-37	ADA FEATURES SURVEYING	L.S.	1	$	$
A-38	CEMENT CONC. CURB RAMP TYPE PERPENDICULAR A	EACH	2	$	$
			Subtotal:	$	
			TERO (1.75%):	$	
			TOTAL (Including TERO):	$	

Schedule A: 28th Dr. NW – BID ADDITIVE					
ITEM NO.	**ITEM DESCRIPTION**	**UNIT**	**APPROX. QTY.**	**UNIT PRICE DOLLAR CENTS**	**AMOUNT DOLLAR CENTS**
AD-1	REMOVING ASPHALT CONC. PAVEMENT	S.Y.	350	$	$
AD-2	ROADWAY EXCAVATION INCL. HAUL	C.Y.	40	$	$
AD-3	CRUSHED SURFACING BASE COURSE	TON	40	$	$
AD-4	CEMENT CONC. DRIVEWAY	C.Y.	320	$	$
AD-5	ROADWAY SURVEYING	L.S.	1	$	$
			Subtotal:	**$**	
			TERO (1.75%):	**$**	
			TOTAL (Including TERO):	**$**	

SCHEDULE B: 81st St NE					
ITEM NO.	**ITEM DESCRIPTION**	**UNIT**	**APPROX. QTY.**	**UNIT PRICE DOLLAR CENTS**	**AMOUNT DOLLAR CENTS**
B-1	MOBILIZATION	L.S.	1	$	$
B-2	REMOVING CEMENT CONC. PAVEMENT	S.Y.	500	$	$
B-3	REMOVING CEMENT CONC. CURB AND GUTTER	L.F.	530	$	$
B-4	REMOVING ASPHALT CONC. PAVEMENT	S.Y.	4,000	$	$
B-5	ROADWAY EXCAVATION INCL. HAUL	C.Y.	900	$	$
B-6	STORMWATER TREATMENT CATCH BASIN	EACH	1	$	$
B-7	CHAMBER SYSTEM	L.S.	1	$	$
B-8	CATCH BASIN TYPE 1	EACH	2	$	$
B-9	CORRUGATED POLYETHYLENE STORM SEWER PIPE 12 IN. DIAM.	L.F.	26	$	$
B-10	DUCTILE IRON SEWER PIPE 12 IN. DIAM.	L.F.	22	$	$
B-11	CRUSHED SURFACING BASE COURSE	TON	1,300	$	$
B-12	SPEED HUMPS	EACH	8	$	$
B-13	HMA CL. 1/2 IN. PG 58H-22	TON	760	$	$
B-14	SILT FENCE	L.F.	90	$	$
B-15	TOPSOIL TYPE A	ACRE	0.2	$	$
B-16	SEEDING AND FERTILIZING	S.Y.	800	$	$
B-17	INLET PROTECTION	EACH	11	$	$
B-18	MEDIUM COMPOST	S.Y.	75	$	$
B-19	EROSION CONTROL AND WATER POLLUTION PREVENTION	L.S.	1	$	$
B-20	CEMENT CONC. TRAFFIC CURB AND GUTTER	L.F.	560	$	$
B-21	ILLUMINATION SYSTEM MODIFICATIONS, COMPLETE	L.S.	1	$	$
B-22	PROJECT TEMPORARY TRAFFIC CONTROL	L.S.	1	$	$
B-23	MINOR CHANGE	F.A.	1	$ 25,000	$ 25,000
B-24	ADJUST CATCH BASIN	EACH	1	$	$
B-25	DEWATERING	L.S.	1	$	$
B-26	RESOLUTION OF UTILITY CONFLICTS	F.A.	1	$ 40,000	$ 40,000
B-27	POTHOLING	EACH	2	$	$
B-28	RECORD DRAWINGS (MINIMUM $1,000)	L.S.	1	$	$
B-29	ROADWAY SURVEYING	L.S.	1	$	$
B-30	GRAVEL BACKFILL FOR DRAIN	C.Y.	50	$	$
			Subtotal:	**$**	
			TERO (1.75%):	**$**	
			TOTAL (Including TERO):	**$**	

SCHEDULE C: Totem Beach Road

ITEM NO.	SECTION ITEM DESCRIPTION	UNIT	APPROX. QTY.	UNIT PRICE DOLLAR CENTS	AMOUNT DOLLAR CENTS
C-1	MOBILIZATION	L.S.	1	$	$
C-2	REMOVING CEMENT CONC. SIDEWALK	S.Y.	1,500	$	$
C-3	REMOVING CEMENT CONC. CURB AND GUTTER	L.F.	2,740	$	$
C-4	REMOVING ASPHALT CONC. PAVEMENT	S.Y.	5,800	$	$
C-5	REMOVING GUARDRAIL	L.F.	100	$	$
C-6	REMOVING GUARDRAIL ANCHOR	EACH	2	$	$
C-7	REMOVING PAINT LINE	L.F.	20	$	$
C-8	REMOVING STORM SEWER PIPE	L.F.	150	$	$
C-9	ROADWAY EXCAVATION INCL. HAUL	C.Y.	2,200	$	$
C-10	BIORETENTION SWALE	L.F.	180	$	$
C-11	PVC UNDERDRAIN PIPE 6 IN. DIAM.	L.F.	250	$	$
C-12	EXTRA EXCAVATION	C.Y.	50	$	$
C-13	FOUNDATION MATERIAL	TON	90	$	$
C-14	CATCH BASIN TYPE 1	EACH	4	$	$
C-15	SOLID WALL PVC STORM SEWER PIPE 12 IN. DIAM.	L.F.	230	$	$
C-16	CRUSHED SURFACING BASE COURSE	TON	2,200	$	$
C-17	PLANING BITUMINOUS PAVEMENT	S.Y.	2,510	$	$
C-18	HMA CL. 1/2 PG 58H-22	TON	2,400	$	$
C-19	HMA CL. 1/2 IN. PG 58H-22 FOR OVERLAY	TON	300	$	$
C-20	HMA CL. 1/2 IN. PG 58H-22 FOR PAVEMENT REPAIR	S.Y.	500	$	$
C-21	TOPSOIL TYPE A	ACRE	0.2	$	$
C-22	SEEDING, FERTILIZING, AND MULCHING	L.S.	1	$	$
C-23	CHECK DAM	L.F.	15	$	$
C-24	INLET PROTECTION	EACH	26	$	$
C-25	WATTLE	L.F.	1,400	$	$
C-26	EROSION CONTROL AND WATER POLLUTION PREVENTION	L.S.	1	$	$
C-27	CEMENT CONC. TRAFFIC CURB AND GUTTER	L.F.	2,900	$	$
C-28	BEAM GUARDRAIL TYPE 31	L.F.	180	$	$
C-29	BEAM GUARDRAIL ANCHOR TYPE 10	EACH	2	$	$
C-30	PAINT LINE	L.F.	4,300	$	$
C-31	PLASTIC CROSSWALK LINE	S.F.	180	$	$
C-32	PLASTIC STOP LINE	L.F.	40	$	$
C-33	PERMANENT SIGNING	L.S.	1	$	$
C-34	PUD CONDUIT INSTALLATION, COMPLETE	L.S.	1	$	$
C-35	PROJECT TEMPORARY TRAFFIC CONTROL	L.S.	1	$	$
C-36	POTHOLING	EACH	5	$	$
C-37	DEWATERING	L.S.	1	$	$
C-38	RESOLUTION OF UTILITY CONFLICTS	F.A.	1	$ 45,000	$ 45,000

SCHEDULE C: Totem Beach Road					
ITEM NO.	SECTION ITEM DESCRIPTION	UNIT	APPROX. QTY.	UNIT PRICE DOLLAR CENTS	AMOUNT DOLLAR CENTS
C-39	MINOR CHANGE	F.A.	1	$ 25,000	$ 25,000
C-40	RECORD DRAWING (MINIMUM BID $1,000)	L.S.	1	$	$
C-41	ROADWAY SURVEYING	L.S.	1	$	$
C-42	ADJUST MANHOLE	EACH	3	$	$
C-43	ADJUST VALVE BOX	EACH	10	$	$
C-44	SHORING OR EXTRA EXCAVATION CLASS B	L.S.	1	$	$
C-45	CEMENT CONC. SIDEWALK	S.Y.	1,400	$	$
C-46	CEMENT CONC. DRIVEWAY ENTRANCE TYPE	S.Y.	80	$	$
			Subtotal:	**$**	
			TERO (1.75%):	**$**	
			TOTAL (Including TERO):	**$**	

BID SUMMARY

Schedule A Total (including 1.75% TERO):	**$**
Schedule B Total (including 1.75% TERO):	**$**
Schedule C Total (including 1.75% TERO):	**$**
TOTAL BASE BID (Schedule A + Schedule B + Schedule C):	**$**
Schedule A – Bid Additive (including 1.75% TERO)	**$**
TOTAL BID (TOTAL BASE BID + Schedule A – Bid Additive):	**$**

INTERIM WAIVER AND RELEASE OF CLAIMS

TO THE TULALIP TRIBES OF WASHINGTON ("OWNER"):

____ (the "Releasing Party") has furnished labor or services, or supplied materials or equipment (collectively, the "Work") for construction on Pavement Rehabilitation and Safety Improvements Projects 28th Drive NW – 81st Street NE Housing Area Roads – Totem Beach Road Project (the "Project"), located at _____________________, Tulalip, WA 98271.

Upon receipt of payment by the Releasing Party of **$**____________________, whether in cash, by check or by joint check, the Releasing Party represents and certifies to Owner that: (i) Releasing Party and all of its subcontractors are in compliance with the terms of their respective contracts; (ii) all due and payable bills with respect to the Work have been paid to date or are included in the amount requested in the current Application for Payment and there is no known basis for the filing of any claim in respect of the Work except for (a) any claim that the Releasing Party has previously provided written notice to Owner about such claim, and (b) amounts owed to Releasing Party and/or any subcontractor or supplier that are considered Cost of the Work but have been withheld by the Owner; and (iii) waivers and releases from all Subcontractors and/or Suppliers being billed under a Releasing Party Subcontract Agreement or Purchase Agreement have been obtained in form substantially similar hereto as to constitute an effective waiver and release of all known claims. Notwithstanding the foregoing, this Interim Waiver and Release of Claims shall not apply to any amounts owed for Work which has been provided to the Project during a billing period prior to the date hereof where Releasing Party and/or any subcontractor or supplier has not yet requested reimbursement for the cost of the Work provided to the Project.

If any claim covered by this Interim Waiver and Release of Claims is made or filed by the Releasing Party or any of its lower tier consultants, subcontractors, suppliers, vendors or materialmen at any tier against or with respect to Owner or the Project then the Releasing Party (1) shall immediately release and discharge, or secure the release or discharge of, such claim and (2) shall indemnify, defend and hold harmless Owner and the Project from and against any and all costs, damages, expenses, court costs and attorney fees arising from such claim or any litigation resulting from such claim.

____
(the Releasing Party)

DATED:_______________________________

By:____

Printed Name: _______________________________

Its:____

[Notary Seal]

State of: ___________________________________ County of: _______________________________

Subscribed and sworn to before me this __________ day of __________

Notary Public: _______________________________

My Commission expires: ______________________

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The Tulalip Tribes of Washington

The Pavement Rehabilitation and Safety Improvements Projects 28th Drive NW – 81st Street NE Housing Area Roads – Totem Beach Road Project

FINAL WAIVER AND RELEASE OF CLAIMS

TO THE TULALIP TRIBES OF WASHINGTON ("OWNER"):

Upon receipt of payment of $___________, whether in cash, by check or by joint check, _____________________________ (the "Releasing Party") has furnished labor or services, or supplied materials or equipment for construction on Pavement Rehabilitation and Safety Improvements Projects 28th Drive NW – 81st Street NE Housing Area Roads – Totem Beach Road Project (the "Project"), located at located at _________________________________, Tulalip, WA 98271.

The Releasing Party hereby unconditionally waives and releases any and all claims, stop notices, rights to submit stop notices, suits, demands, protests, damages, losses and expenses of any nature whatsoever (whether under statute, in equity or otherwise and whether received through assignment or otherwise) (each, individually, a "Claim") against or with respect to The Tulalip Tribes of Washington, which is referred to as the Owner in the Contract Documents, or any other party holding an interest in the Property (collectively, the "Released Parties"), or against or with respect to the Project, the Property, improvements to the Property and materials, fixtures, apparatus and machinery furnished for the Property (collectively, the "Released Properties").

Upon the receipt of the aforesaid amount, the Releasing Party expressly acknowledges that it has been paid all amounts due and owing to it for work, services, material or equipment in connection with the Work and the Releasing Party represents and warrants that all amounts due and owing to consultants, subcontractors and suppliers below the Releasing Party in connection with this Project have been paid, unless noted herewith as approved by Owner.

If any Claim is made or filed by the Releasing Party or any of its lower tier consultants, subcontractors, suppliers or laborers at any tier against or with respect to any of the Released Parties or any of the Released Properties, then the Releasing Party (1) shall immediately release and discharge, or secure the release or discharge of such Claim and (2) shall indemnify, defend and hold harmless the Released Parties from and against any and all costs, damages, expenses, court costs and attorney fees arising from such Claim or any litigation resulting from such Claim.

____
(the Releasing Party)

DATED:______________________________

By:____

Printed Name: ______________________________

Its:____

[Notary Seal]

State of: __________________________________ County of: ______________________________

Subscribed and sworn to before me this __________ day of __________

Notary Public: ______________________________

My Commission expires: _____________________

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GEOTECHNICAL REPORT
Pavement Improvement Project
81st Street NE/29th Drive NE/30th Drive NE
Tulalip, Washington

HWA Project No. 2021-036

Prepared for

Parametrix

&

Tulalip Tribes of Washington

May 2, 2022

HWA GeoSciences Inc.
DBE/MWBE

HWA GeoSciences Inc.
DBE/MWBE

May 2, 2022
HWA Project No. 2021-036-21

Parametrix
719 2nd Avenue, Suite 200
Seattle, WA 98104

Attention: Austin Fisher, P.E.

Subject: **Final Geotechnical Engineering Report**
Pavement Improvement Project – 81st Street NE/29th Drive NE/30th Drive NE
Tulalip, Washington

Dear Mr. Fisher:

As requested, HWA GeoSciences Inc. (HWA) has completed a geotechnical investigation for the proposed improvements along 81st Street NE, 29th Drive NE, and 30th Drive NE on the Tulalip Indian Reservation in Snohomish County, Washington. This report presents the results of our field explorations and laboratory testing along with our recommendations pertaining to stormwater infiltration, luminaire/signal pole foundations and pavement design.

We appreciate the opportunity to provide geotechnical engineering services on this project. If you have any questions regarding this report or require additional information or services, please contact us at your convenience.

Sincerely,

HWA GeoSciences Inc.

Bryan Hawkins, P.E.
Senior Geotechnical Engineer

FINAL GEOTECHNICAL ENGINEERING REPORT
PAVEMENT IMPROVEMENT PROJECT – 81ST STREET NE
TULALIP, WASHINGTON

1. INTRODUCTION

1.1 GENERAL

This report summarizes the results of the geotechnical engineering investigation performed by HWA GeoSciences Inc. (HWA) in support of the proposed improvements along 81st Street NE, east of Donald Campbell Road and extending to 30th Drive NE, including 29th Drive NE and 30th Drive NE, on the Tulalip Indian Reservation in Snohomish County, Washington. The approximate location of the project site is shown on the Site and Vicinity Map, Figure 1, and on the Site and Exploration Plan, Figure 2. Our field work included logging the drilling of five boreholes and logging the excavation of three hand borings to evaluate existing pavement thickness, subsurface soil, and groundwater conditions. Laboratory tests were conducted on select soil samples to determine relevant engineering properties of the subsurface soils.

1.2 PROJECT UNDERSTANDING

It is our understanding that the proposed project improvements include full depth pavement reconstruction, stormwater treatment and infiltration facilities (30th Drive NE), curb and gutter replacement (30th Drive NE) and new luminaires (on 81st Street NE, 29th Drive NE, and 30th Drive NE). Our investigation was performed to evaluate subsurface conditions along the project alignment to provide design recommendation for the proposed improvements.

2. FIELD INVESTIGATION

2.1 SUBSURFACE EXPLORATIONS

2.1.1 Pavement Conditions

The pavement structure (HMA pavement, aggregate base, and subgrade conditions) of the existing roadways was assessed during site reconnaissance and while performing five geotechnical borings (designated BH-07 through BH-11). A Standard Penetration Test (SPT) was performed at each location just below the layer of HMA to assess subgrade support. Drilling equipment and SPT procedures are described in Section 2.1.2. Table 1 summarizes the pavement structures encountered in the pavement core explorations.

Table 1. Thickness of Pavement Layers

Designation	Location	HMA Thickness (in.)	Pervious Concrete Pavement Thickness (in.)	Crushed Base Thickness (in.)	Subgrade Conditions
BH-07	81st St. NE	2	---	---	Medium dense, slightly silty sand
BH-08	30th Dr. NE	2	---	---	Medium dense, slightly silty sand
BH-09	30th Dr. NE	---	6	5	Medium dense sand
BH-10	81st St. NE	1	---	---	Medium dense, slightly silty sand
BH-11	29th Dr. NE	1	---	---	Medium dense, slightly silty sand

Pavement distresses visible at the surface along the alignments consist of medium to high severity alligator cracking and potholing, particularly in the wheel paths.

As indicated in Table 1, the existing Hot Mix Asphalt (HMA) thickness typically varied from 1 to 2 inches and consisted of 1 lift of HMA. Crushed base was not observed below any the payment areas except at the cul-du-sac at the end of 30th Drive NE which is paved with pervious concrete. At that location the pervious Portland cement concrete layer was 5 inches thick and with a 6-inch-thick layer of crushed rock base below.

2.1.2 Geotechnical Borings

HWA logged the drilling of five machine-drilled borings, designated BH-07 through BH-11, to assess subsurface conditions along the alignment. The locations of the explorations are shown on the Site Exploration Plan, Figure 2. The borings were drilled on August 5 and 6, 2021 using a Diedrich D-90 truck-mounted drill rig operated by Holocene Drilling, of Puyallup, Washington, under subcontract to HWA. Borehole depths varied between approximately 11½ and 21½ feet.

In each boring, Standard Penetration Test (SPT) sampling was performed using a 2-inch outside diameter split-spoon sampler driven by a 140-pound automatic hammer. During the SPT, samples were obtained by driving the sampler 18 inches into the soil with the hammer free-falling 30 inches. The numbers of blows required for each 6 inches of penetration were recorded. The Standard Penetration Resistance ("N-value") of the soil is calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides an indication of relative density of granular soils and the relative consistency of cohesive soils; both indicators of soil strength.

A geologist from HWA logged the explorations and recorded all pertinent information. Soil samples obtained from the boreholes were classified in the field and representative portions were sealed in plastic bags. Pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence was recorded. These soil samples were then taken to our Bothell, Washington, laboratory for further examination and testing.

The stratigraphic contacts shown on the individual exploration logs represent the approximate boundaries between soil types; actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific date and location reported and, therefore, are not necessarily representative of other locations and times. A legend of the terms and symbols used on the exploration logs is presented in Appendix A, Figure A-1. Summary logs of the borehole explorations are presented in Figures A-2 through A-6.

2.1.3 Hand Borings

HWA logged the excavation of three hand borings on August 9, 2021, designated HH-1 through HH-3, to depths of about 6 to 9 feet. The purpose of the hand borings was to retrieve soil samples from proposed receptor soils for evaluation of infiltration potential. Groundwater seepage was not observed in any of the hand borings.

The hand borings were excavated by an HWA Geologist, who logged the borings and obtained representative soil samples. Soil samples obtained from the hand borings were classified in the field and representative portions were placed in plastic bags and taken to our Bothell, Washington laboratory for further examination and testing.

Hand boring exploration logs are presented in Appendix A, Figures A-7 through A-9. It should be noted that the stratigraphic contacts shown on the individual exploration logs represent the approximate boundaries between soil types; actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific date and locations reported and, therefore, are not necessarily representative of other locations and times.

2.2 LABORATORY TESTING

Geotechnical laboratory tests were conducted on selected samples obtained from the explorations to characterize relevant engineering and index parameters of the soils encountered. The tests included visual classification, natural moisture content determination, organic content and grain size distribution. The tests were conducted in the HWA laboratory in general accordance with appropriate American Society of Testing and Materials (ASTM) standards and are discussed in further detail in Appendix B. In addition, selected samples representing potential infiltration receptor soils were sent to Soiltest Services of Moses Lake, Washington for Cation Exchange capacity (CEC) determinations. The test results are presented in Appendix B, and displayed on the exploration logs in Appendix A, as appropriate.

3. SITE CONDITIONS

3.1 GENERAL GEOLOGIC CONDITIONS

The project alignment is located within the Puget Lowland. The Puget Lowland has repeatedly been occupied by a portion of the continental glaciers that developed during the ice ages of the Quaternary period. During at least four periods, portions of the ice sheet advanced south from British Columbia into the lowlands of Western Washington. The southern extent of these glacial advances was near Olympia, Washington. Each major advance included numerous local advances and retreats, and each advance and retreat resulted in its own sequence of erosion and deposition of glacial lacustrine, outwash, till, and drift deposits. Between and following these glacial advances, sediments from the Olympic and Cascade Mountains accumulated in the Puget Lowland. As the most recent glacier retreated, it uncovered a sculpted landscape of elongated, north-south trending hills and valleys between the Cascade and Olympic Mountain ranges, composed of a complex sequence of glacial and interglacial deposits.

Geologic information for the project site was obtained from the published geologic maps for the area; *Geologic map of the Tulalip Quadrangle, Island and Snohomish Counties, Washington* (Minard, 1985) and the *Surficial Geology, Selected Wells, and Hydrogeologic Units and Sections – Plate 1* from *Water Resources of the Tulalip Indian Reservation and adjacent areas, Snohomish County, Washington 2001-2003* (Frans and Kresch, 2004). These maps indicate that the surficial geology within the vicinity of the subject roadway consists of Vashon recessional outwash, a unit of mostly clean sand with some gravel, and some beds of silts and clay that were deposited by glacial meltwater behind the retreating Puget Lobe of the Cordilleran Ice Sheet during the latest glaciation. A portion of the geologic map depicting the project location is shown on Figure 3.

3.2 SUBSURFACE SOIL CONDITIONS

Below the thin pavement section or shallow topsoil layer, subsurface conditions consisted of recessional outwash deposits as described below.

Vashon Recessional Outwash: Vashon recessional outwash was encountered immediately below the pavement layer or topsoil in all explorations and each exploration was terminated in this deposit. The Vashon recessional outwash encountered consisted of loose to medium dense, clean to silty sands and gravels. A layer of stiff silt approximately 2.5 feet in thickness was encountered in BH-09 from a depth of 7.5 to 9 feet. The recessional outwash layer was not fully penetrated in any of our borings and appears to be more than 20 feet thick.

Recessional outwash was deposited by glacial meltwater during ice retreat away from the ice margin, consequently this unit is not glacially overridden and therefore typically permeable and a good receptor for infiltration purposes.

3.3 GROUNDWATER CONDITIONS

Groundwater seepage was encountered in borings BH-07 and BH-08 at a depth of about 16½ feet, and in boring BH-09 at a depth of about 16 feet. Groundwater seepage was not encountered in the hand borings, which extended to a maximum depth of about 9 feet. We anticipate that groundwater levels vary seasonally, with the highest water levels in the wet winter months.

3.4 INFILTRATION

3.4.1 General

Below the pavement section and shallow topsoil, the native subgrade soils along throughout the project area consist of non-glacially consolidated recessional outwash deposits. The thickness of the recessional outwash soils appears to be more than 20 feet based on our borings.

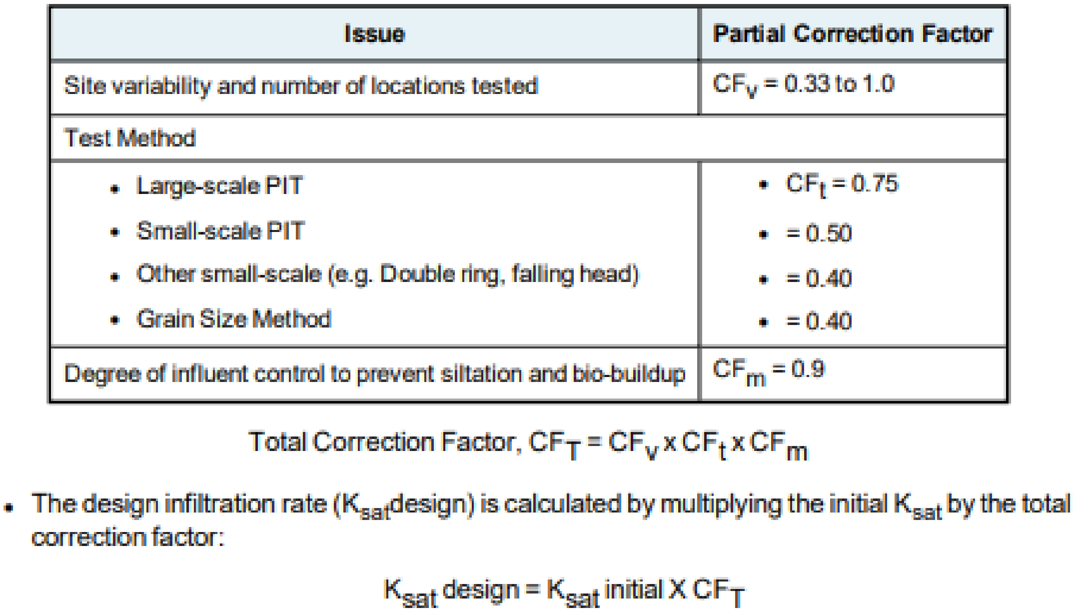
Laboratory testing consisting of particle size analyses was performed on four select recessional outwash soil samples to estimate infiltration rates, as described below.

3.4.2 Calculated Infiltration Rates

Design infiltration rates were evaluated in general accordance with the *Stormwater Management Manual for Western Washington* (SWMMWW, 2019), published by the Washington State Department of Ecology. The Washington State Department of Ecology, Stormwater Management Manual for Western Washington (SWMMWW, 2019) recommends the following relationship may be used to determine initial infiltration rates using the results of soil grain size analyses for soils unconsolidated by glacial advance, such as recessional outwash:

$$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$$

Once the initial saturated hydraulic conductivity (Ksat) is obtained, the manual recommends using the following correction factors to estimate the design infiltration rate:



Issue	Partial Correction Factor
Site variability and number of locations tested	$CF_v = 0.33$ to 1.0
Test Method	
Large-scale PIT Small-scale PIT Other small-scale (e.g. Double ring, falling head) Grain Size Method	$CF_t = 0.75$ $= 0.50$ $= 0.40$ $= 0.40$
Degree of influent control to prevent siltation and bio-buildup	$CF_m = 0.9$

Total Correction Factor, $CF_T = CF_v \times CF_t \times CF_m$

- The design infiltration rate (K_{sat}design) is calculated by multiplying the initial K_{sat} by the total correction factor:

$$K_{sat} \text{ design} = K_{sat} \text{ initial X } CF_T$$

For the site variability correction factor (CF_v), a value of 0.9 was used. Because the grain size method was used in the analyses, a value of 0.4 was used for the uncertainty of test method correction factor (CF_t). A value of 0.9 was used for the degree of influent control to prevent siltation and bio-buildup correction factor (CF_m). Multiplying these three correction factors together resulted in a Total Correction Factor value of 0.324. Figure 4 presents the results of the Massmann analysis, and the design infiltration rates for the four samples tested.

3.4.3 Soil Suitability for Treatment

The potential receptor soils were tested to determine their potential suitability for physical and chemical treatment of infiltrating water to remove target pollutants as required by Section V-5.6 the SWMWW and Section 3.3.7 of the Snohomish County Drainage Manual. Potential receptor soil's ability to treat infiltrating water is assessed by determination of the soils organic content and cation exchange capacity (CEC). Soils considered to be suitable for infiltration treatment are those that contain at least 1 percent organic material by weight and exhibit a cation exchange capacity (CEC) of greater than or equal to 5 meq / 100 g. None of the potential receptor soils meet the minimum requirement for cation exchange capacity. Therefore, Snohomish County will require an engineered soil pre-treatment layer be incorporated into the design of the infiltration facilities. The results for the target receptor soils for this project are presented in Table 2 below.

Table 2. Soil Physical and Chemical Suitability for Treatment

Sample Designation	**Sample Depth (feet)**	**Soil Classification**	**Design Infiltration Rate (in/hr.)**	**Organic Content (%)**	**CEC meq / 100 g**
BH-08, S-1	2.5 - 4	SP	20.7	1.2	4.4
HH-1, S-2	2.5 - 5	SP	24.4	1.3	1.7
HH-2, S-1	1 - 3	SM	4.8	4.3	4.6
HH-3, S-2	1.7 – 6.8	SP	25.5	1.2	1.6

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

The explorations performed throughout the project area indicate that the subsurface surface soils in the upper 20 feet consist of non-glacially consolidated recessional outwash deposits. The soils appear suitable for the proposed improvements, including new luminaires, stormwater infiltration and subsurface utilities. Based on the results of laboratory testing, the recessional outwash soils will be suitable for stormwater infiltration, although an engineered soil pre-treatment layer will need be incorporated into the design.

The existing pavement thickness is very thin (2 inches thick or less) and heavily distressed and will need to be reconstructed.

Design recommendations for stormwater infiltration, luminaire pole foundations, earthwork, pavement design and general earthwork are presented in the following sections.

4.2 INFILTRATION RECOMMENDATIONS

4.2.1 General

Our infiltration analyses indicate that infiltration is feasible along the alignment of 30th Drive NE within the recessional outwash soils, with calculated design infiltration rates in the range of 4.8 to 25.5 in/hr, as indicated in Figure 4.

4.2.2 Construction Considerations for Infiltration Facilities

Prior to the installation of infiltration facilities, the subgrade should be cut to the depth of proposed receptor soils. A flat subgrade is preferred for the bottom of the infiltration facilities. The subgrade soils under areas used for infiltration should NOT be compacted or subjected to excessive construction equipment traffic prior to coarse aggregate bed placement. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum depth of 8 inches. Subsurface conditions should be monitored and verified during construction by a qualified earthworks inspector.

Construction of the proposed infiltration facilities will require excavations within recessional outwash soils that could potentially contain cobbles and or boulders. Therefore, perspective contractors should be prepared to encounter and remove cobbles and bounders during excavations for the proposed infiltration facilities.

4.3 LUMINAIRE POLE FOUNDATION RECOMMENDATIONS

Table 17-2 of the *WSDOT Geotechnical Design Manual* (WSDOT, 2019), provides allowable lateral bearing pressures based on Standard Penetration Test (SPT) Resistance N-values (blows/foot). Table 3 summarizes the proposed luminaire pole foundation recommendations by depth for each borehole location in the vicinity of proposed luminaires.

Table 3. Recommended Standard for Luminaire Pole Foundations

Relevant Boring	Depth (ft)	Average SPT N-Value in Depth Interval	Design Allowable Lateral Bearing Pressure (psf)
BH-07	0-6½	13	2.100
BH-07	6½-21½	23	3,900
BH-08	0-6½	10	1,500
BH-08	6½-21½	24	4,100
BH-09	0-6½	20	3,500
BH-09	6½-21½	17	2,900

Luminaire pole foundations can likely be constructed using conventional drilled shaft methods using flighted augers. Cobbles were not encountered in the subsurface soils; however, they are common in glacial soils and boulders could also be present. Per the Unified Soil Classification System (USCS), cobbles are defined as a rock with a dimension between 3 and 12 inches; boulders are defined as rock with a minimum dimension of 12 inches. The contractor should be prepared to encounter cobbles and boulders during drilling of shafts.

Groundwater seepage was encountered in all three borings conducted for luminaire foundations (BH-07, BH-08, and BH-09) at a minimum depth of about 16 feet at the time of drilling; however, explorations were conducted in summer when the groundwater levels are anticipated to be at their lowest. Higher groundwater levels should be anticipated if work is conducted at wetter times of year or after heavy precipitation events. The contractor should be prepared to control ground water and prevent caving of the drilled shaft sidewalls, which will require use of temporary casing. The concrete should be placed using a tremie pipe from the bottom of the shaft if groundwater inside the casing is over a depth of 6 inches.

A qualified geotechnical engineer should observe shaft excavation and concrete placement. This will also provide the opportunity to confirm conditions assumed in the design and provide corrective recommendations as necessary to adapt to conditions observed during construction.

4.4 PAVEMENT DESIGN

The existing pavement section is very thin, less than about 2 inches thick, and highly distressed. No crushed base layer was present below the pavement except in BH-09, where it was beneath a section of pervious concrete pavement. Although these streets experience residential traffic only, the existing pavement section is insufficient to handle the traffic loads in this area as evidenced by the distresses observed. We recommend that the pavement be reconstructed. The following sections provide our pavement design recommendations.

4.4.1 New HMA Pavement Design

Table 4 provides our HMA design recommendations, assuming residential traffic loading with occasional garbage truck and emergency vehicle loads.

Table 4. Structure Requirements for New HMA Pavement

Material Description	Pavement Minimum Layer Thickness (inches)	WSDOT Standard Specification
HMA	3	5-04
CSBC	4	9-03.9(3)

HMA: Hot Mix Asphalt
CSBC: Crushed Surfacing Base Course

We recommend that the HMA consist of Class ½-inch and the binder consist of PG 58H-22. Recommendations are presented below for subgrade preparation and structural fill placement and compaction for pavement reconstruction. The longitudinal joint in the HMA wearing course should coincide with the centerline of the roadway and not within a travel lane.

Placement of HMA

Placement of HMA should be in accordance with Section 5-04 of the WSDOT *Standard Specifications* (WSDOT, 2021). Particular attention should be paid to the following:

- HMA should not be placed until the engineer has accepted the previously constructed pavement layers.
- HMA should not be placed on any frozen or wet surface.
- HMA should not be placed when precipitation is anticipated before the pavement can be compacted, or before any other weather conditions which could prevent proper handling and compaction of HMA.
- HMA should not be placed when the average surface temperatures are less than 45^o F.
- HMA temperature behind the paver should be in excess of 240^o F. Compaction should be completed before the mix temperature drops below 180^o F. Comprehensive temperature records should be kept during the HMA placement.
- For cold joints, tack coat should be applied to the edge to be joined and the paver screed should be set to overlap the first mat by 1 to 2 inches.

Drainage

It is essential to the satisfactory performance of the roadway that good drainage is provided to prevent water ponding on or alongside, or accumulating beneath, the pavement. Water ponding can cause saturation of the pavement and subgrade layers and lead to premature failure. The surface of the pavement should be sloped to convey water from the pavement to appropriate drainage facilities.

4.5 EARTHWORK

4.5.1 Subgrade Preparation

Subgrade preparation for the proposed improvements should begin with the removal of all existing pavement, topsoil, organic-rich soils, debris and vegetation. The soils should be excavated to the design elevation and thoroughly compacted.

The exposed subgrade soils should be evaluated to assess their suitability for support of the improvements. Areas accessible to fully-loaded dump trucks, or similar heavy, wheeled equipment, should be proof-rolled prior to placement of structural fill. Any areas exhibiting pumping or heaving should be delineated and over-excavated to reach competent soils, as determined by the geotechnical engineer. Areas inaccessible to large equipment should be evaluated by the geotechnical engineer using a T-handle probe, or other suitable method. Areas found to be soft/loose, or unsuitable, should be over-excavated to reach competent soils.

Backfill of any over-excavated areas should consist of structural fill, placed and compacted as described below.

4.5.2 Structural Fill Materials and Compaction

Any material used to support the pavement should consist of Crushed Surfacing Base Course (CSBC) as specified in Section 9-03.9(3) of the WSDOT Standard Specifications (WSDOT, 2021). Structural fill used to raise site grades, or backfill utility trench excavations, should consist of granular materials such as Gravel Borrow, meeting the requirements of Section 9-03.14(1) of the WSDOT Standard Specifications. Based on our subsurface explorations, we do not anticipate the on-site soils will be suitable for reuse as structural fill.

A sufficient number of modified Proctor tests should be performed on the materials to be used as structural fill to properly evaluate the compaction characteristics of the materials. A Geotechnical Engineer, or their representative, should perform full-time construction monitoring of all fill placement and compaction operations. If the on-site soils are placed either too wet or too dry of optimum moisture content, or if the soils are inadequately compacted, significant settlement should be anticipated.

Structural fill soils should be moisture conditioned, placed in loose horizontal lifts less than 8-inches thick, and compacted to at least 95% of the maximum dry density (MDD) as determined using test method ASTM D1557 (modified Proctor). Achievement of proper density of a compacted fill depends on the size and type of compaction equipment, the number of passes, thickness of the layer being compacted and soil moisture-density properties. In areas where limited space restricts the use of heavy equipment, smaller equipment can be used, but the soil must be placed in thin enough layers to achieve the required relative compaction. Generally, loosely compacted soils result from poor construction technique and/or improper moisture content. Soils with high fines contents are particularly susceptible to becoming too wet, and coarse-grained materials easily become too dry for proper compaction.

4.5.3 Temporary Excavations

Any temporary excavations deeper than 4 feet should be sloped or shored in accordance with Part N of the Washington Administrative Code (WAC) 296-155 or shored. The near-surface soils classify as Type C soils. Temporary excavations in Type C soils may be no steeper than 1.5H:1V to meet safety requirements for worker access during construction. The recommended maximum allowable temporary slope cut inclinations are applicable to temporary excavations above the water table only. Flatter slopes may be required where ground water seepage is present.

The contractor should monitor the stability of the temporary cut slopes and adjust the construction schedule and slope inclination accordingly. The contractor should be responsible for control of ground and surface water and should employ sloping, slope protection, ditching, sumps, dewatering, and other measures as necessary to prevent sloughing of soils.

4.5.4 Wet Weather Earthwork

Some of the soils encountered contained a high fines content and will likely be difficult to place/compact or traverse with construction equipment during periods of wet weather. General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement of concrete or placement and compaction of structural fill material. The size and type of construction equipment used may need to be limited to prevent soil disturbance.
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water.
- The ground surface within the construction area should be sealed by a smooth drum roller, or equivalent, and under no circumstances should soil be left uncompacted and exposed to moisture infiltration.
- Excavation and placement of fill material should be monitored to determine that the work is being accomplished in accordance with the project specifications and that the weather conditions do not adversely impact the quality of work.

4.6 UTILITY PIPE BEDDING AND BACKFILL

General recommendations relative to pipe bedding and utility trench backfill are presented below:

- Pipe bedding material, placement, compaction and shaping should be in accordance with the project specifications and the pipe manufacturer’s recommendations. As a minimum, the pipe bedding should meet the gradation requirements for Gravel Backfill for Pipe Zone Bedding, Section 9.03.12(3) of the WSDOT *Standard Specifications* (WSDOT, 2021).
- Pipe bedding materials should be placed on relatively undisturbed native soils, or compacted fill soils. If the native subgrade soils are disturbed, the disturbed material should be removed and replaced with compacted bedding material.
- Although unlikely, the possibility may arise that in areas the trench bottom may encounter very soft or organic-rich subgrade soils, and it will be necessary to over-excavate the unsuitable material and backfill with pipe bedding material. We recommend that crushed rock meeting the requirements for Crushed Surfacing Top Course, as described in Section 9-03.9(3) of the WSDOT *Standard Specifications* (WSDOT, 2021), be used to backfill the over-excavated portions of the trench bottom.
- Pipe bedding should provide a firm, uniform, cradle for support of the pipe. We recommend that a minimum 4-inch thickness of bedding material beneath the pipe be provided. Greater

thicknesses may be necessary to prevent loosening and softening of the natural soils during pipe placement.

- Pipe bedding material and/or backfill around the pipe should be placed in layers and tamped to obtain complete contact with the pipe.
- During placement of the initial lifts, the trench backfill material should not be bulldozed into the trench or dropped directly on the pipe. Furthermore, heavy equipment should not be permitted to operate directly over the pipe until a minimum of 2 feet of backfill has been placed. Trench backfill should be placed in 8-inch (maximum) thick lifts and compacted using mechanical equipment to at least 95% of its maximum dry density, as determined by testing in general accordance with ASTM D1557 (modified Proctor).

5. CONDITIONS AND LIMITATIONS

We have prepared this report for Parametrix and the Tulalip Tribe for use in design of this project. The conclusions and interpretations presented in this report should not be construed as our warranty of the subsurface conditions. Experience has shown that soil and ground water conditions can vary significantly over small distances.

Inconsistent conditions can occur between explorations and may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HWA should be notified for review of the recommendations of this report, and revision of such if necessary.

Within the limitations of scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology in the area at the time the report was prepared. No warranty, express or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

◆

We appreciate the opportunity to provide geotechnical services on this project. Should you have any questions or comments, or if we may be of further service, please do not hesitate to call.

Sincerely,

HWA GEOSCIENCES INC.

BRYAN KEITH HAWKINS
39862

1704
STEVEN ELLIOTT GREENE

Bryan Hawkins, P.E.
Senior Geotechnical Engineer

Steven E. Greene, L.G., L.E.G
Principal Engineering Geologist

LIST OF FIGURES (FOLLOWING TEXT)

Appendices

Appendix A: Field Investigation

Appendix B: Laboratory Testing

6. REFERENCES

Department of Ecology, 2019, *Stormwater Management Manual for Western Washington*, State of Washington, Publication Number 19-10-021, dated July 2019.

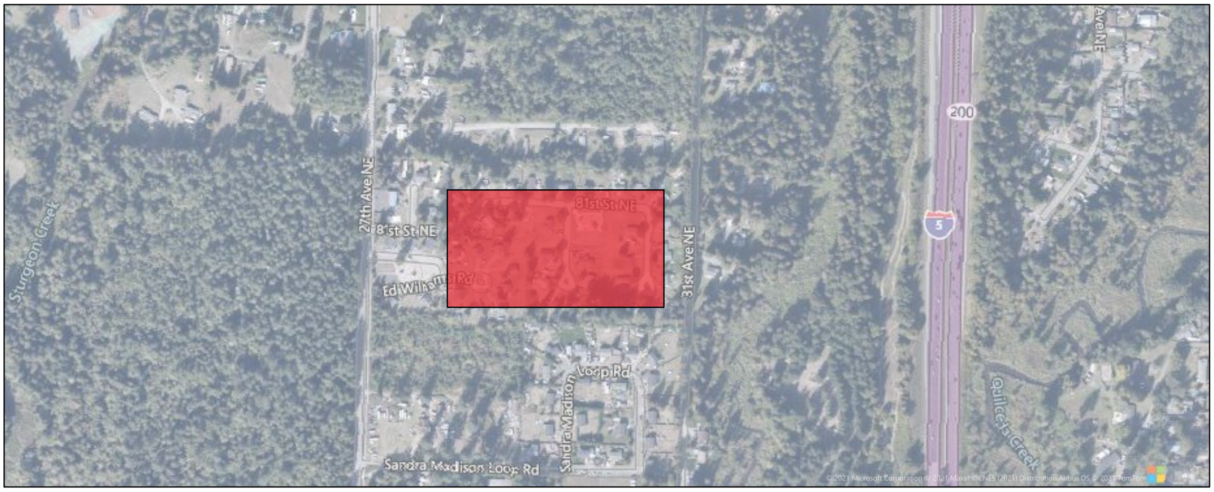
Frans, L.M., and Kresch, D.L., 2004, *Water resources of the Tulalip Indian Reservation and adjacent area, Snohomish County, Washington*, 2001–03: U.S. Geological Survey Scientific Investigations Report 2004–5166, 86 p.

Minard, J.P, 1985, *Geologic Map of the Tulalip Quadrangle, Island and Snohomish Counties, Washington*, U S Geological Survey Misc. Field Studies Map MF-1744.

Snohomish County, 2016, Snohomish County Drainage Manual.

WSDOT, 2019, *Geotechnical Design Manual*, Washington State Department of Transportation, dated July 1, 2019.

WSDOT, 2021, *Standard Specifications for Road, Bridge, and Municipal Construction*, M 41-10.

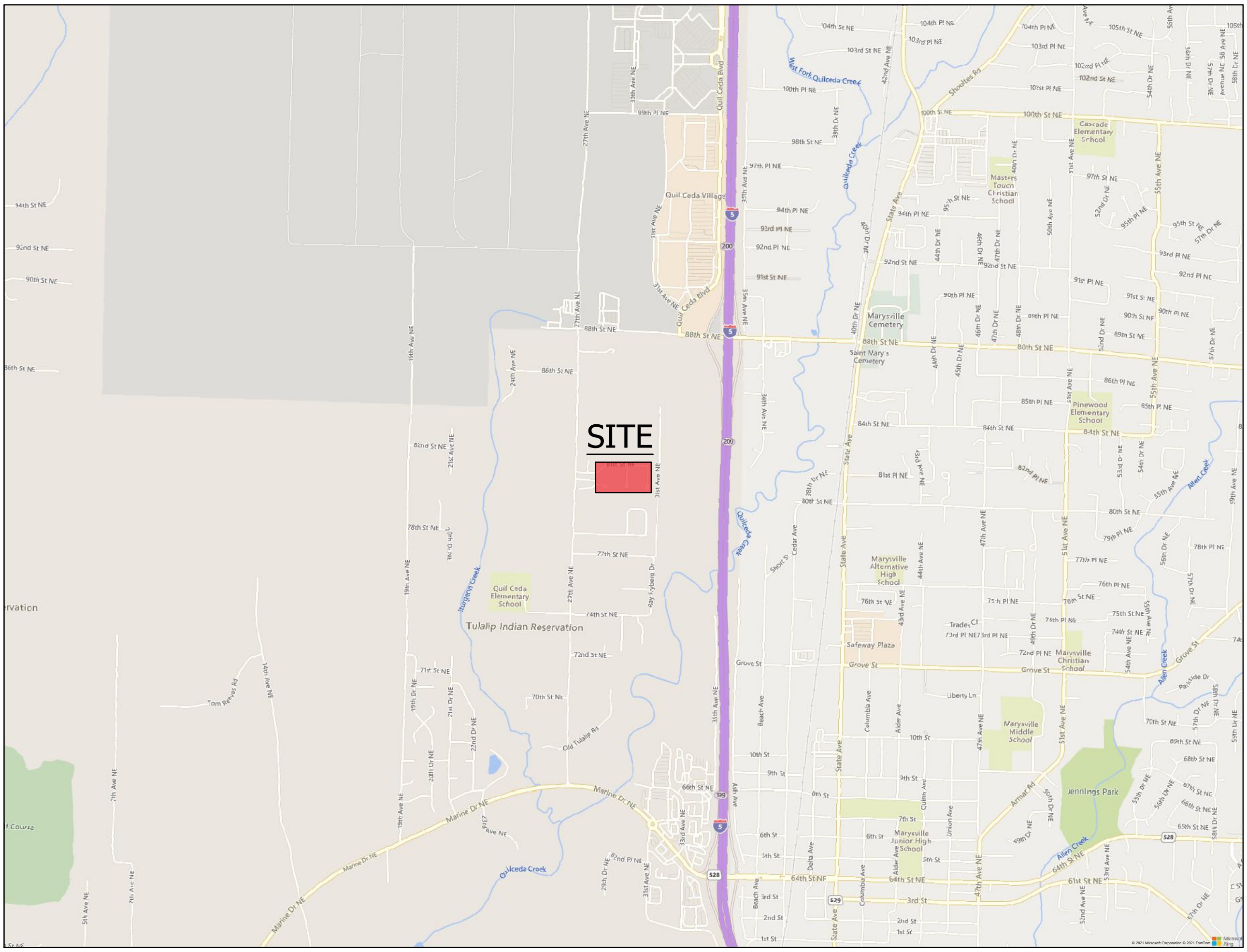


SITE MAP

0 400' 800' 1200' 1600'

SCALE: 1" = 800'

N



VICINITY MAP

0 1500' 3000' 4500' 6000'

SCALE: 1" = 3000'

N

HWA GEOSCIENCES INC.
DBE/MWBE

SITE AND VICINITY MAP

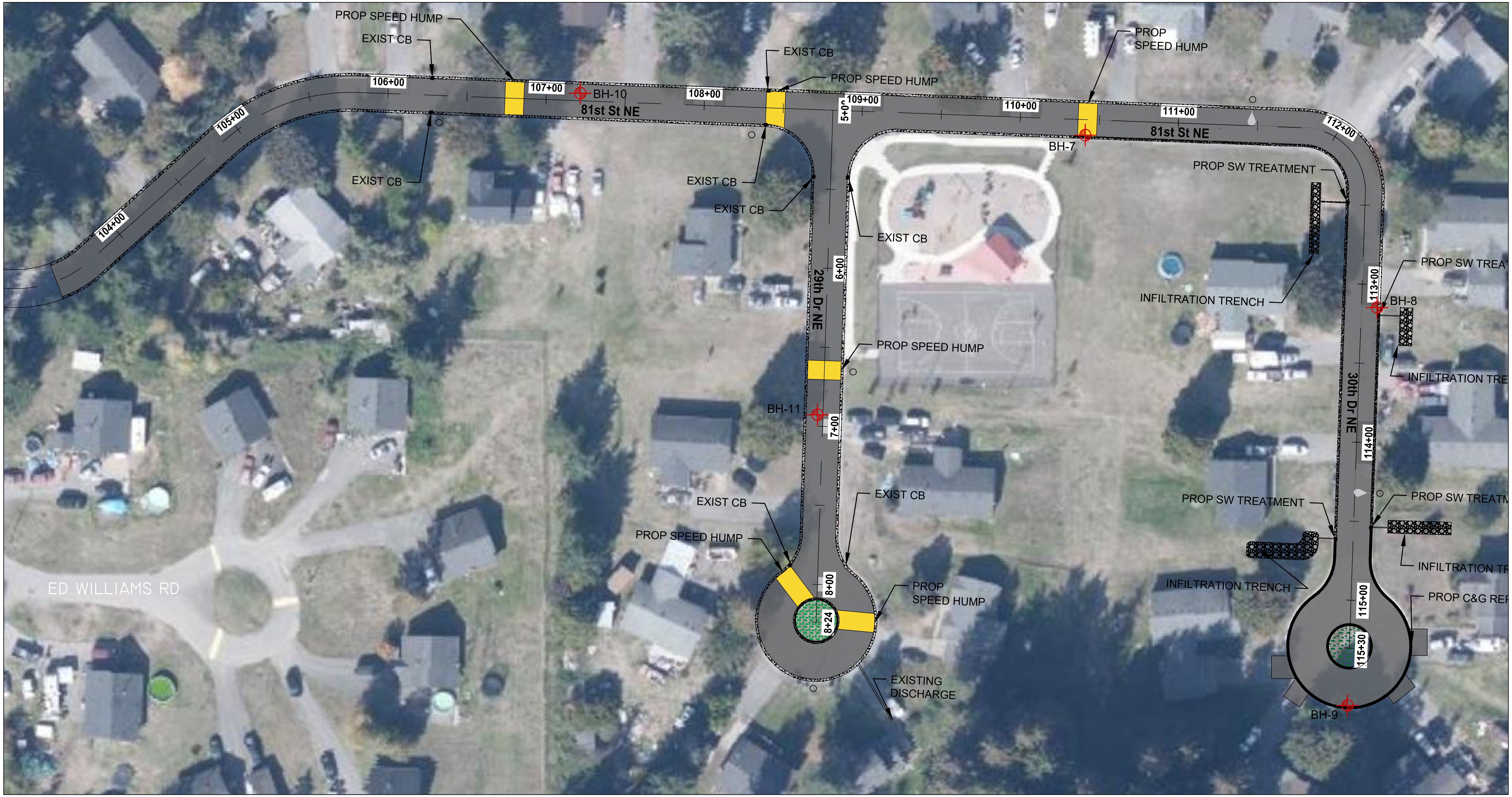
TULALIP ROAD PRESERVATION
81ST STREET NE
TULALIP, WASHINGTON

FIGURE NO.: 1

DRAWN BY:	CHECK BY:
CF	SEG

PROJECT # 2021-036-21

C:\USERS\CFRY\DESKTOP\2021-036-21 TULALIP ROAD PRESERVATION\81ST ST NE\2021-036-21 TULALIP ROAD PRESERVATION - 81ST STREET NE.DWG <1> Plotted: 7/6/2021 1:03 PM



EXPLORATION LEGEND

BH-7 ⌖ BOREHOLE DESIGNATION AND APPROXIMATE LOCATION

81ST STREET NE

Scale: 1" = 60'-0"

N

0 30 60 90 120

SCALE: 1" = 60'

HWA GEOSCIENCES INC.
DBE/MWBE

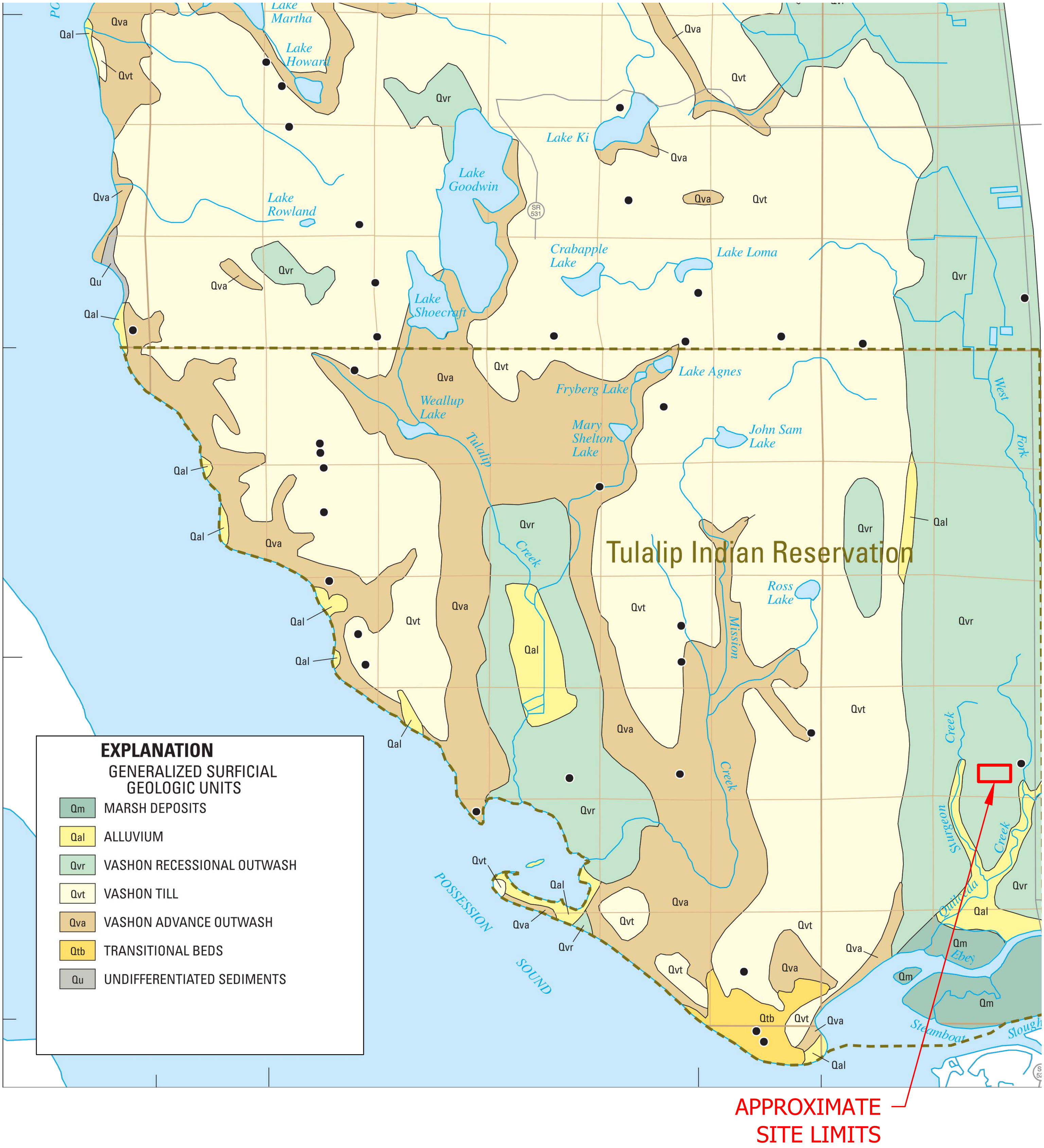
TULALIP ROAD PRESERVATION
81ST STREET NE
TULALIP, WASHINGTON

SITE &
EXPLORATION PLAN

DRAWN BY: CF	FIGURE NO.: 2
CHECK BY: SEG	PROJECT NO.: 2021-036-21

BASE MAP PROVIDED BY: BING AND PARAMETRIX 6.22.21

S:\2021 PROJECTS\2021-036-21 TULALIP ROAD PRESERVATION\CAD\81ST ST NE\2021-036-21 TULALIP ROAD PRESERVATION - 81ST STREET NE.DWG <2> Plotted: 7/14/2021 9:53 AM



BASE MAP PROVIDED BY: SCIENTIFIC INVESTIGATIONS REPORT 2004-5166, SURFICIAL GEOLOGY, SELECTED WELLS, AND HYDROGEOLOGIC UNITS AND SECTIONS - PLATE 1, FRANS, L.M., AND KRESCH D.L., 2004, WATER RESOURCES OF THE TULALIP INDIAN RESERVATION AND ADJACENT AREA, SNOHOMISH COUNTY, WASHINGTON, 2001-03

NOT TO SCALE

HWA GEOSCIENCES INC.
DBE/MWBE

GEOLOGIC MAP

TULALIP ROAD PRESERVATION
81ST STREET NE
TULALIP, WASHINGTON

FIGURE NO.:	3
DRAWN BY: CF	CHECK BY: SEG
PROJECT #	2021-036-21

MASSMANN INFILTRATION ANALSIS SUMMARY

FIGURE 4

												Ksat_initial	Correction Factors			Total Correction Factor	Ksat_design
Exploration Designation	Top Depth (ft)	Bottom Depth (ft)	Moisture Content (%)	ASTM Classification	D10 (mm)	D60 (mm)	D90 (mm)	fines (%)	fines (fraction)	LOG10 (Ks)	Ks (cm/sec)	Ks (in/hr)	CFv	CFt	CFm	CFT	Ks (in/hr)
BH-08, S-2	2.5	4	5	SP	0.17	0.36	0.64	4.6	0.046	-1.3456	0.04512321	63.95	0.9	0.4	0.9	0.324	20.72
HH-1, S-2	2.5	9	3	SP	0.18	0.37	0.6	2.1	0.021	-1.27393	0.0532194	75.43	0.9	0.4	0.9	0.324	24.44
HH-2, S-1	1	6.5	9	SM	0.023	0.26	0.56	21.8	0.218	-1.98312	0.01039633	14.73	0.9	0.4	0.9	0.324	4.77
HH-3, S-2	1.67	14	3	SP	0.19	0.46	1.05	1.9	0.019	-1.25527	0.05555588	78.74	0.9	0.4	0.9	0.324	25.51

APPENDIX A

SUBSURFACE EXPLORATIONS

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density(%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

USCS SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils More than 50% Retained on No. 200 Sieve Size	Gravel and Gravelly Soils More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
		Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
	Sand and Sandy Soils 50% or More of Coarse Fraction Passing No. 4 Sieve	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
		Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils 50% or More Passing No. 200 Sieve Size	Silt and Clay	Liquid Limit Less than 50%	ML	SILT
			CL	Lean CLAY
			OL	Organic SILT/Organic CLAY
	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY
			OH	Organic SILT/Organic CLAY
Highly Organic Soils			PT	PEAT

TEST SYMBOLS

%F	Percent Fines
AL	Atterberg Limits: PL = Plastic Limit, LL = Liquid Limit
CBR	California Bearing Ratio
CN	Consolidation
DD	Dry Density (pcf)
DS	Direct Shear
GS	Grain Size Distribution
K	Permeability
MD	Moisture/Density Relationship (Proctor)
MR	Resilient Modulus
OC	Organic Content
pH	pH of Soils
PID	Photoionization Device Reading
PP	Pocket Penetrometer (Approx. Comp. Strength, tsf)
Res.	Resistivity
SG	Specific Gravity
CD	Consolidated Drained Triaxial
CU	Consolidated Undrained Triaxial
UU	Unconsolidated Undrained Triaxial
TV	Torvane (Approx. Shear Strength, tsf)
UC	Unconfined Compression

SAMPLE TYPE SYMBOLS

☒	2.0" OD Split Spoon (SPT) (140 lb. hammer with 30 in. drop)
I	Shelby Tube
▣	Non-standard Penetration Test (3.0" OD Split Spoon with Brass Rings)
○	Small Bag Sample
▚	Large Bag (Bulk) Sample
▮	Core Run
⧄	3-1/4" OD Split Spoon

GROUNDWATER SYMBOLS

▽	Groundwater Level (measured at time of drilling)
▼	Groundwater Level (measured in well or open hole after water level stabilized)

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

COMPONENT PROPORTIONS

PROPORTION RANGE	DESCRIPTIVE TERMS
< 5%	Clean
5 - 12%	Slightly (Clayey, Silty, Sandy)
12 - 30%	Clayey, Silty, Sandy, Gravelly
30 - 50%	Very (Clayey, Silty, Sandy, Gravelly)
Components are arranged in order of increasing quantities.	

NOTES: Soil classifications presented on exploration logs are based on visual and laboratory observation. Soil descriptions are presented in the following general order:

Density/consistency, color, modifier (if any) GROUP NAME, additions to group name (if any), moisture content. Proportion, gradation, and angularity of constituents, additional comments. (GEOLOGIC INTERPRETATION)

Please refer to the discussion in the report text as well as the exploration logs for a more complete description of subsurface conditions.

MOISTURE CONTENT

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.

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LEGEND OF TERMS AND SYMBOLS USED ON EXPLORATION LOGS

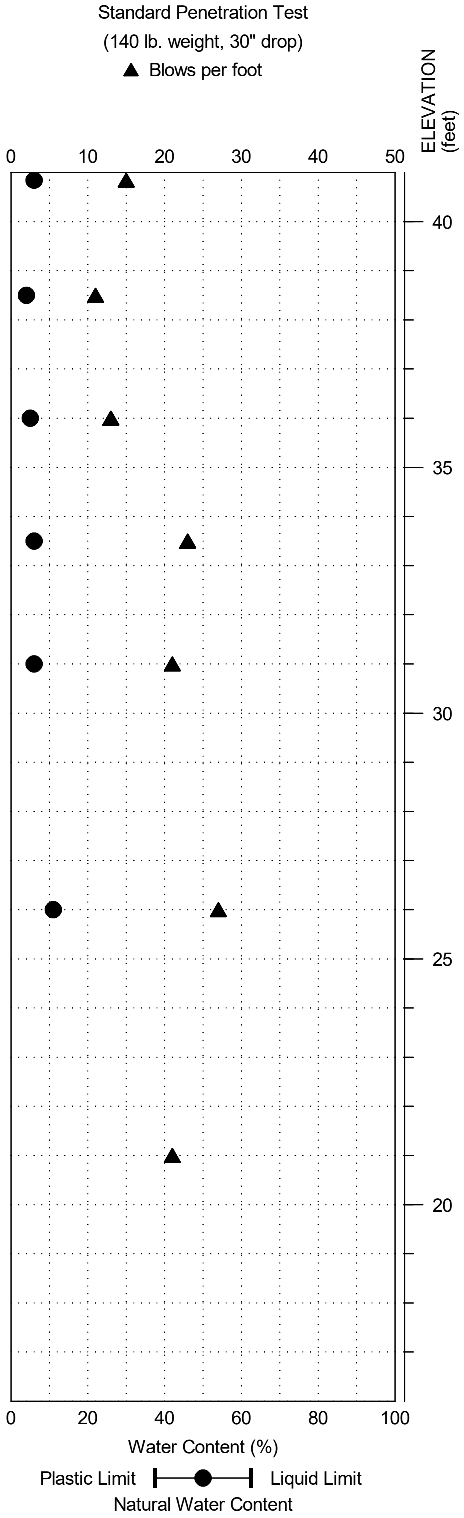
PROJECT NO.: 2021-036-21
FIGURE: A-1

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: HSA, Diedrich D-90 Truck Rig
SAMPLING METHOD: SPT w/Autohammer
LOCATION: 48.06990783, -122.19074279, See Figure 2.

DATE STARTED: 8/6/2021
DATE COMPLETED: 8/6/2021
LOGGED BY: M.A. Benson
SURFACE ELEVATION: 41.0 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		SP SM	A.C.P., about 2 inches thick, no base course. Medium dense, yellowish-brown, slightly silty, SAND, moist. **(RECESSIONAL OUTWASH)** Grades to olive brown.	☒	S-1	7-8-7		
		SP	Medium dense, olive brown, clean SAND, moist. Trace gravel.	☒	S-2	7-5-6		
5			Contains no gravel.	☒	S-3	4-6-7		
			Grades to grayish-brown.	☒	S-4	7-9-14		
10		SP SM	Medium dense, grayish-brown, slightly silty, fine to medium SAND, moist. Silt lens, about 1 inch thick.	☒	S-5	9-12-9		
15		SP	Medium dense, grayish-brown, fine SAND, moist to wet.	☒	S-6	7-13-14		
			Becomes wet.					∇
20		SM	Medium dense, grayish-brown, silty, fine SAND, wet.	☒	S-7	4-8-13		
25								

BH-7 terminated at approximately 21.5 feet below ground surface.
Groundwater observed during drilling at about 16.5 feet.
Brorhole abandoned with 3/8" bentonite chips.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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BORING:
BH-07

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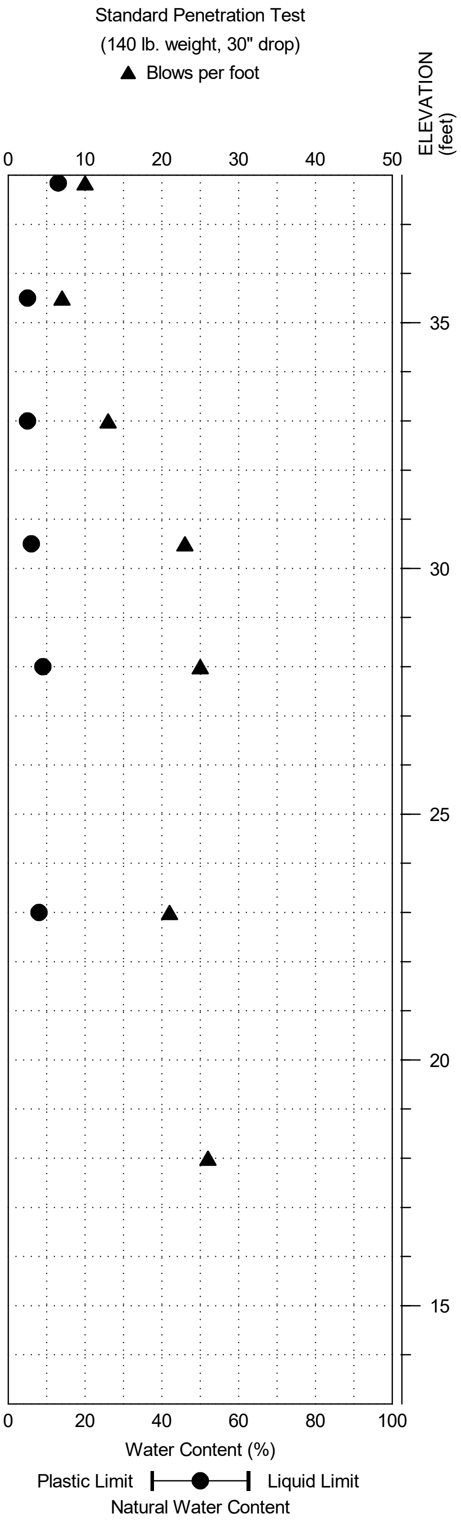
PROJECT NO.: 2021-036-21 FIGURE: A-2

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: HSA, Diedrich D-90 Truck Rig
SAMPLING METHOD: SPT w/Autohammer
LOCATION: 48.06959160, -122.18994469, See Figure 2.

DATE STARTED: 8/6/2021
DATE COMPLETED: 8/6/2021
LOGGED BY: M.A. Benson
SURFACE ELEVATION: 38.0 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0	SP SM	A.C.P., about 2 inches thick, no base course. Medium dense, reddish-brown, slightly silty, fine SAND, moist. Bedded, wood and organics on bedding planes. **(RECESSIONAL OUTWASH)** Grades to yellowish-brown.	S-1	5-4-6	OC CEC	
	SP	Loose, yellowish-brown, fine to medium SAND, moist.	S-2	3-3-4	GS	
5		Becomes medium dense.	S-3	5-4-9		
		Grades to olive brown.				
		Medium dense, olive brown, clean to slightly silty, fine SAND, moist.	S-4	7-11-12		
10	SP SM	Medium dense, olive brown, slightly silty, fine SAND, moist. Interbedded with silt, becomes rust-mottled.	S-5	7-11-14		
15	SP	Medium dense, olive gray, fine SAND, moist to wet.	S-6	6-9-12		
		Becomes wet.				▽
20	SP SM	Medium dense, gray brown, slightly silty, SAND, wet.	S-7	8-11-15		
25						

BH-8 terminated at approximately 21.5 feet below ground surface.
Groundwater observed at about 16.5 feet during drilling.
Borehole abandoned with 3/8" bentonite chips.



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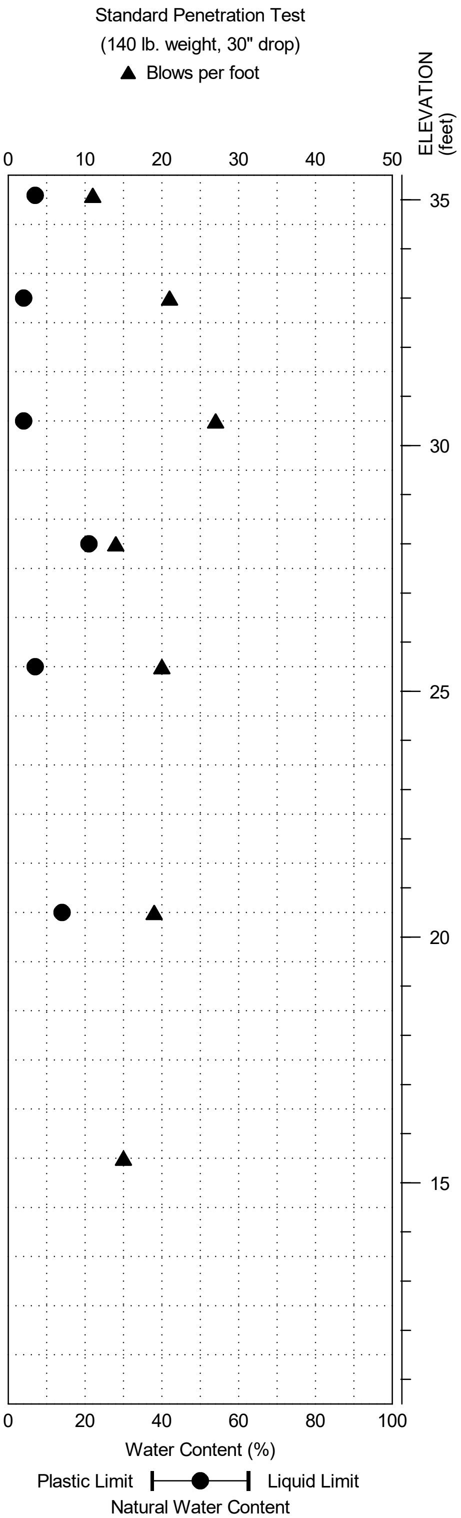
PROJECT NO.: 2021-036-21 FIGURE: A-3

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: HSA, Diedrich D-90 Truck Rig
SAMPLING METHOD: SPT w/Autohammer
LOCATION: 48.06894126, -122.19002323, See Figure 2.

DATE STARTED: 8/6/2021
DATE COMPLETED: 8/6/2021
LOGGED BY: M.A. Benson
SURFACE ELEVATION: 35.5 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		Pervious concrete, about 5 inches thick.				
		Crushed rock base course, about 6 inches thick.	S-1	5-6-5		
	SP	Medium dense, reddish-brown, fine to medium SAND, moist. **(RECESSIONAL OUTWASH)** Grades to yellowish-brown. Medium dense, olive brown, fine to coarse SAND, moist. Trace gravel.	S-2	5-10-11		
5	SP SM	Medium dense, olive-brown, slightly gravelly, slightly silty, fine to coarse SAND, moist.	S-3	8-13-14	GS	
	ML	Stiff, olive brown, sandy, SILT, moist. Contains sand interbeds.	S-4	3-6-8		
10	SP SM	Medium dense, olive brown, slightly silty, fine SAND, moist.	S-5	6-9-11		
15			S-6	8-8-11		
		Becomes wet.				▽
20	SM	Medium dense, olive brown, silty, fine SAND, wet. some silt lenses.	S-7	4-4-11		
25						

BH-9 terminated at approximately 21.5 feet below ground surface.
Groundwater observed at about 16 feet during drilling.
Borehole abandoned with 3/8" bentonite chips.



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BORING:
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FIGURE: A-4

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: HSA, Diedrich D-90 Truck Rig
SAMPLING METHOD: SPT w/Autohammer
LOCATION: 48.06996521, -122.19203242, See Figure 2.

DATE STARTED: 8/5/2021
DATE COMPLETED: 8/5/2021
LOGGED BY: M.A. Benson
SURFACE ELEVATION: 41.0 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		SP SM	A.C.P., about 1 inch thick. No base course. Medium dense, yellowish-brown, slightly silty, fine SAND, moist. **(RECESSIONAL OUTWASH)**	☒	S-1	9-8-6	GS	
		SP	Medium dense, olive brown, fine to medium SAND, moist.	☒	S-2	4-5-5		
5			Grades to olive gray, contains some bedding with oxidation on bedding planes. Trace gravel.	☒	S-3	4-8-10		
			Medium dense, olive gray, fine SAND, moist. Massive.	☒	S-4	7-10-12		
10				☒	S-5	9-10-12		

BH-10 terminated at approximately 11.5 feet below ground surface.
No groundwater observed during drilling.
Borehole abandoned with 3/8" benonite chips.

15

20

25

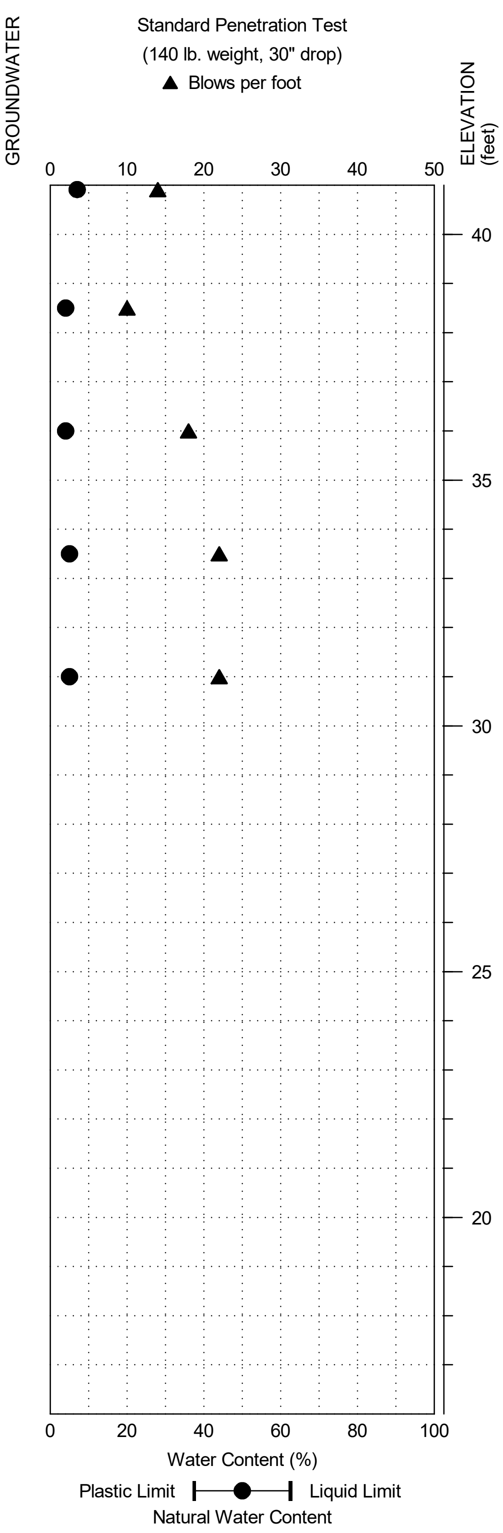

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FIGURE: A-5

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: HSA, Diedrich D-90 Truck Rig
SAMPLING METHOD: SPT w/Autohammer
LOCATION: 48.06941508, -122.19140437, See Figure 2.

DATE STARTED: 8/5/2021
DATE COMPLETED: 8/5/2021
LOGGED BY: M.A. Benson
SURFACE ELEVATION: 40.5 ± feet

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		SP SM	A.C.P., about 1 inch thick, no base course. Medium dense, yellowish-brown, fine SAND, moist. **(RECESSIONAL OUTWASH)**	☒	S-1	8-10-8	GS	
		SP	Medium dense, olive brown, poorly graded SAND, moist. Grades to brownish-gray.	☒	S-2	4-5-6		
5				☒	S-3	3-5-5		
			Medium dense, gray, fine SAND, moist.	☒	S-4	6-8-9		
10				☒	S-5	6-9-9		

BH-11 terminated at approximately11.5 feet below ground surface.
No groundwater observed during drilling.
Borehole abandoned with 3/8" benonite chips.

15

20

25

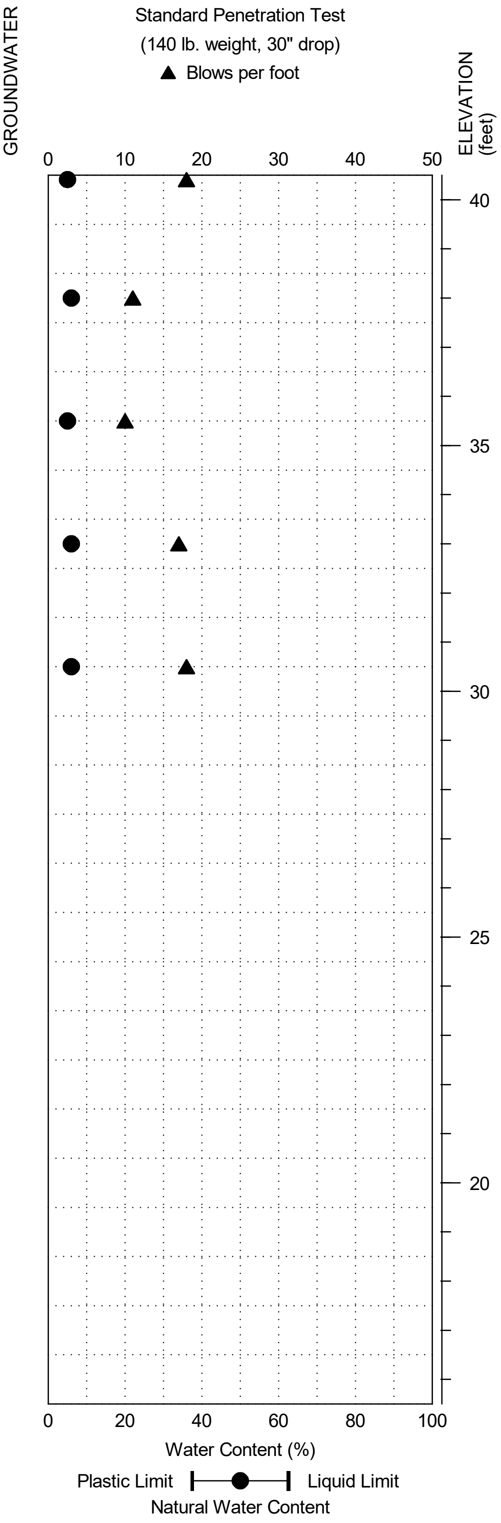

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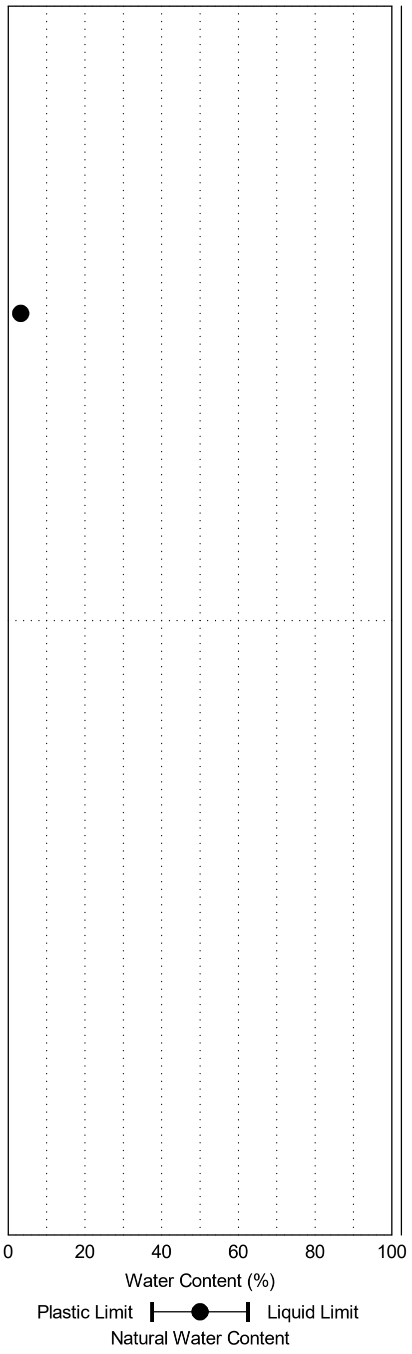
FIGURE: A-6

DRILLING COMPANY: HWA GeoSciences Inc.
DRILLING METHOD: Hand Auger
SAMPLING METHOD: Grab
LOCATION: See Figure 2

DATE STARTED: 8/9/2021
DATE COMPLETED: 8/9/2021
LOGGED BY: V. Oskierko

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER	ELEVATION (feet)
0		SP SM SP SM	Medium dense, brown, fine SAND, with silt and organics, moist. **(TOPSOIL)** Medium dense, light yellow brown, fine SAND, with silt, moist. **(RECESSIONAL OUTWASH)**		S-1				
		SP	Medium dense, olive brown, fine to medium SAND, moist. Slight rust mottling. Becomes light gray. Medium dense, gray to brown, gravelly, fine to medium SAND, moist.		S-2		GS OC CEC		
5		SM	Medium dense, silty, fine SAND, moist.						
10			Exploration terminated at 6.0 feet below ground surface. No groundwater seepage was encountered.						



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HAND HOLE:
HH-1

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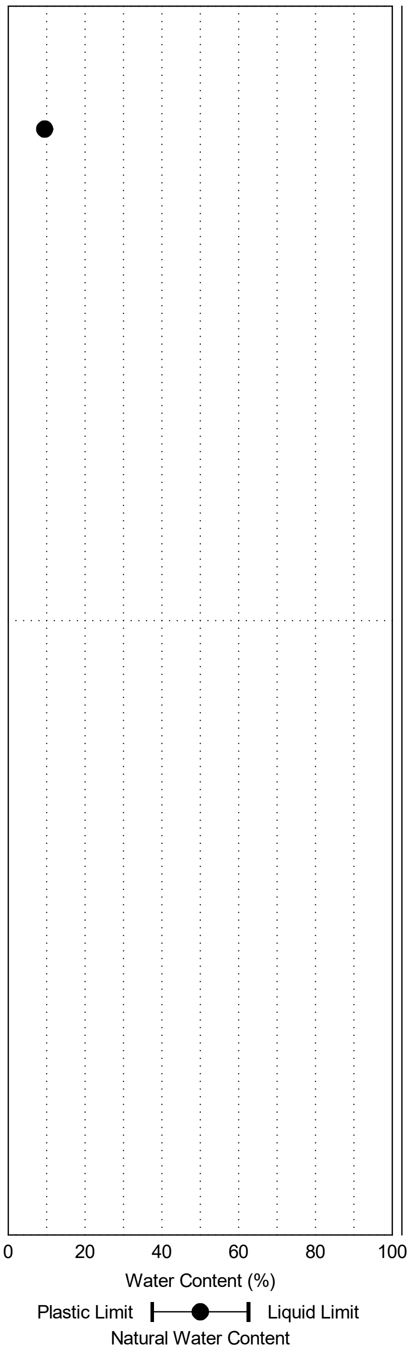
PROJECT NO.: 2021-036-21 FIGURE: A-7

DRILLING COMPANY: HWA GeoSciences Inc.
DRILLING METHOD: Hand Auger
SAMPLING METHOD: Grab
LOCATION: See Figure 2

DATE STARTED: 8/9/2021
DATE COMPLETED: 8/9/2021
LOGGED BY: V. Oskierko

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER	ELEVATION (feet)
0		SM	Medium dense, brown, silty, fine SAND, with scattered gravel and organics, moist. **(TOPSOIL)**						
		SM	Medium dense, reddish brown, silty fine SAND, moist. **(RECESSIONAL OUTWASH)** Becomes orange-brown.		S-1		GS OC CEC		
		SP	Medium dense, olive gray, fine to medium SAND, with scattered fine gravel, moist.		S-2				
5			Medium dense, gray to brown, gravelly, fine to medium SAND, moist. Becomes light gray. Scattered coarse gravel.						
		SP SM	Medium dense, gray, silty, fine SAND, moist.						
10									

Exploration terminated at 9.0 feet below ground surface. No groundwater seepage was encountered.



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HAND HOLE:
HH-2

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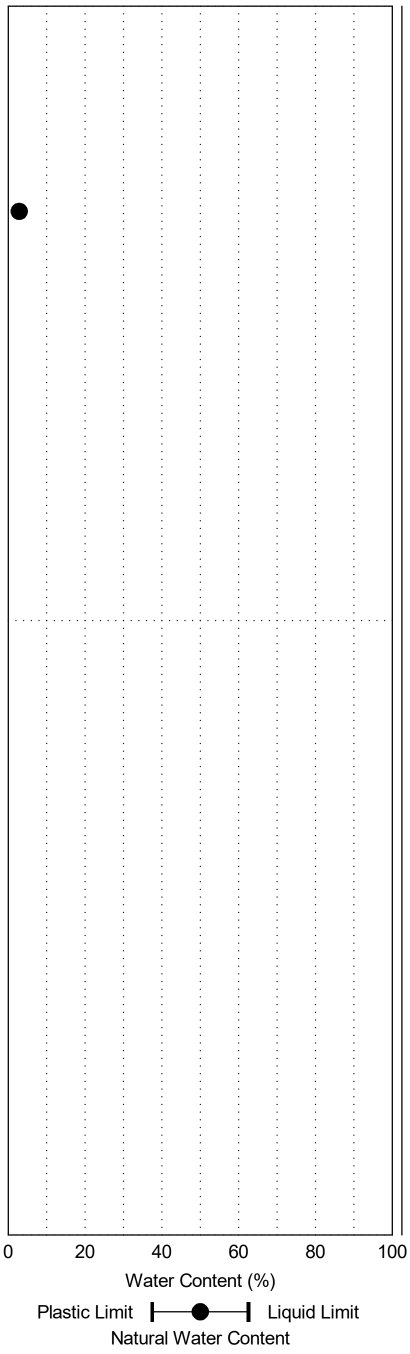
PROJECT NO.: 2021-036-21 FIGURE: A-8

DRILLING COMPANY: HWA GeoSciences Inc.
DRILLING METHOD: Hand Auger
SAMPLING METHOD: Grab
LOCATION: See Figure 2

DATE STARTED: 8/9/2021
DATE COMPLETED: 8/9/2021
LOGGED BY: V. Oskierko

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER	ELEVATION (feet)
0		SM	Medium dense, brown, silty, fine SAND, with scattered gravel and organics, moist. **(TOPSOIL)**						
		SM	Medium dense, olive brown, silty, fine SAND, moist. **(RECESSIONAL OUTWASH)**		S-1				
		SP	Medium dense, olive gray, fine to medium SAND, with scattered fine gravel, moist.		S-2		GS OC CEC		
5			Becomes light gray.						
		SP SM	Medium dense, olive brown, silty, fine SAND, moist.		S-3				
		SM	Medium dense, olive brown, silty, fine SAND, moist.						
			Exploration terminated at 8.0 feet below ground surface. No groundwater seepage was encountered.						
10									



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HAND HOLE:
HH-3

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PROJECT NO.: 2021-036-21

FIGURE: A-9

APPENDIX B

LABORATORY TEST RESULTS

APPENDIX B

LABORATORY TESTING

Representative soil samples obtained from the explorations were placed in plastic bags to prevent loss of moisture and transported to HWA's laboratory in Bothell, Washington, for further examination and testing. Laboratory tests were conducted on selected soil samples to characterize relevant engineering and index properties of the site soils. Laboratory testing was conducted as described below:

MOISTURE CONTENT OF SOIL: The moisture content of selected soil samples (percent by dry mass) was determined in general accordance with ASTM D 2216. The results are shown at the sampled intervals on the appropriate summary logs in Appendix A and the Summary of Material Properties report, Figures B-1and B-2.

PARTICLE SIZE ANALYSIS OF SOILS: Selected samples were tested to determine the particle (grain) size distribution of material in general accordance with ASTM D 6913 using either the wet sieve or wet sieve and hydrometer methods. The results are summarized on the attached Particle Size Analysis of Soils reports, Figures B-3 through B-5, which also provide information regarding the classification of the sample, and the moisture content at the time of testing.

MOISTURE CONTENT, ASH, AND ORGANIC MATTER: Selected samples were tested in general accordance with method ASTM D 2974, using moisture content method 'A' (oven dried at 105^0 C) and ash content method 'C' (burned at 440^0 C). The test results are summarized below and reported within the relevant report section. The results are percent by weight of dry soil and provided below.

Moisture Content, Ash, and Organic Matter			
Sample	**Moisture Content (%)**	**Ash Content (%)**	**Organic Content (%)**
BH-08, S-2	4.8	98.8	1.2
HH-1, S-2	3.2	98.7	1.3
HH-2, S-1	10.2	95.7	4.3
HH-3, S-2	3.0	98.8	1.2

CATION EXCHANGE CAPACITY (CEC); Selected samples were delivered to SoilTest Farm Consultants of Moses Lake, Washington for determination of Cation Exchange Capacity. The test results are summarized below and reported within the relevant report section. The individual data reports are attached below.

Cation Exchange Capacity of Soils	
Sample	**Cation Exchange Capacity (meq / 100 g)**
BH-08, S-2	4.4
HH-1, S-2	1.7
HH-2, S-1	4.6
HH-3, S-2	1.6

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT(%) (440° C)	ORGANIC CONTENT (%) (750° C)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% SILT	% CLAY	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI						
BH-07	0.2	1.7	6.0										SP-SM	Dark olive-brown, poorly graded SAND with silt
BH-07	2.5	4.0	4.3										SP-SM	Dark olive-brown, poorly graded SAND with silt and gravel
BH-07	5.0	6.5	4.7										SP-SM	Dark olive-brown, poorly graded SAND with silt
BH-07	7.5	9.0	6.0										SP-SM	Olive-brown, poorly graded SAND with silt
BH-07	10.0	11.5	6.3										SP-SM	Olive-brown, poorly graded SAND with silt and gravel
BH-07	15.0	16.5	11.4										SP-SM	Olive-brown, poorly graded SAND with silt
BH-08	0.2	1.7	13.3										SP-SM	Dark reddish-brown, poorly graded SAND with silt
BH-08	2.5	4.0	5.2	1.2					1.8	93.6			SP	Olive-brown, poorly graded SAND
BH-08	5.0	6.5	5.0										SP-SM	Olive-brown, poorly graded SAND with silt
BH-08	7.5	9.0	6.4										SP-SM	Light olive-brown, poorly graded SAND with silt
BH-08	10.0	11.5	9.3										SP-SM	Olive-brown, poorly graded SAND with silt
BH-08	15.0	16.5	8.1										SP-SM	Dark grayish-brown, poorly graded SAND with silt
BH-09	0.4	1.9	7.2										SP-SM	Reddish-brown, poorly graded SAND with silt and gravel
BH-09	2.5	4.0	3.6										SP-SM	Dark olive-brown, poorly graded SAND with silt
BH-09	5.0	6.5	4.1						20.0	75.0			SP-SM	Olive-brown, poorly graded SAND with silt and gravel
BH-09	7.5	9.0	21.2										SM	Olive-brown, silty SAND
BH-09	10.0	11.5	7.2										SP-SM	Grayish-brown, poorly graded SAND with silt
BH-09	15.0	16.5	13.7										SP-SM	Dark grayish-brown, poorly graded SAND with silt
BH-10	0.1	1.6	7.4						1.2	88.5			SP-SM	Yellowish-brown, poorly graded SAND with silt
BH-10	2.5	4.0	4.2										SP-SM	Olive-brown, poorly graded SAND with silt

Notes:
1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report text, other graphs and tables, and the exploration logs.
2. The classification of soils in this table is based on ASTM D2487 and D2488 as applicable.

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SUMMARY OF MATERIAL PROPERTIES

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PROJECT NO.: 2021-036-21 FIGURE: B-1

EXPLORATION DESIGNATION	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	MOISTURE CONTENT (%)	ORGANIC CONTENT(%) (440° C)	ORGANIC CONTENT (%) (750° C)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% SILT	% CLAY	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
						LL	PL	PI						
BH-10	5.0	6.5	3.9										SP-SM	Grayish-brown, poorly graded SAND with silt and gravel
BH-10	7.5	9.0	5.4										SP-SM	Grayish-brown, poorly graded SAND with silt
BH-10	10.0	11.5	5.2										SP-SM	Grayish-brown, poorly graded SAND with silt
BH-11	0.1	1.6	5.5						0.9	91.4			SP-SM	Yellowish-brown, poorly graded SAND with silt
BH-11	2.5	4.0	5.6										SP-SM	Olive-brown, poorly graded SAND with silt
BH-11	5.0	6.5	5.3										SP-SM	Olive-brown, poorly graded SAND with silt
BH-11	7.5	9.0	5.7										SP-SM	Olive-brown, poorly graded SAND with silt
BH-11	10.0	11.5	6.1										SP-SM	Dark olive-brown, poorly graded SAND with silt
HH-1	2.5	5.0	3.2	1.3					0.2	97.6			SP	Olive-brown, poorly graded SAND
HH-2	1.0	3.0	9.5	4.3					0.0	78.2	20.6	1.2	SM	Dark reddish-brown, silty SAND
HH-3	1.7	6.7	2.8	1.2					5.5	92.6			SP	Olive-brown, poorly graded SAND

Notes:
1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report text, other graphs and tables, and the exploration logs.
2. The classification of soils in this table is based on ASTM D2487 and D2488 as applicable.

HWA GEOSCIENCES INC.

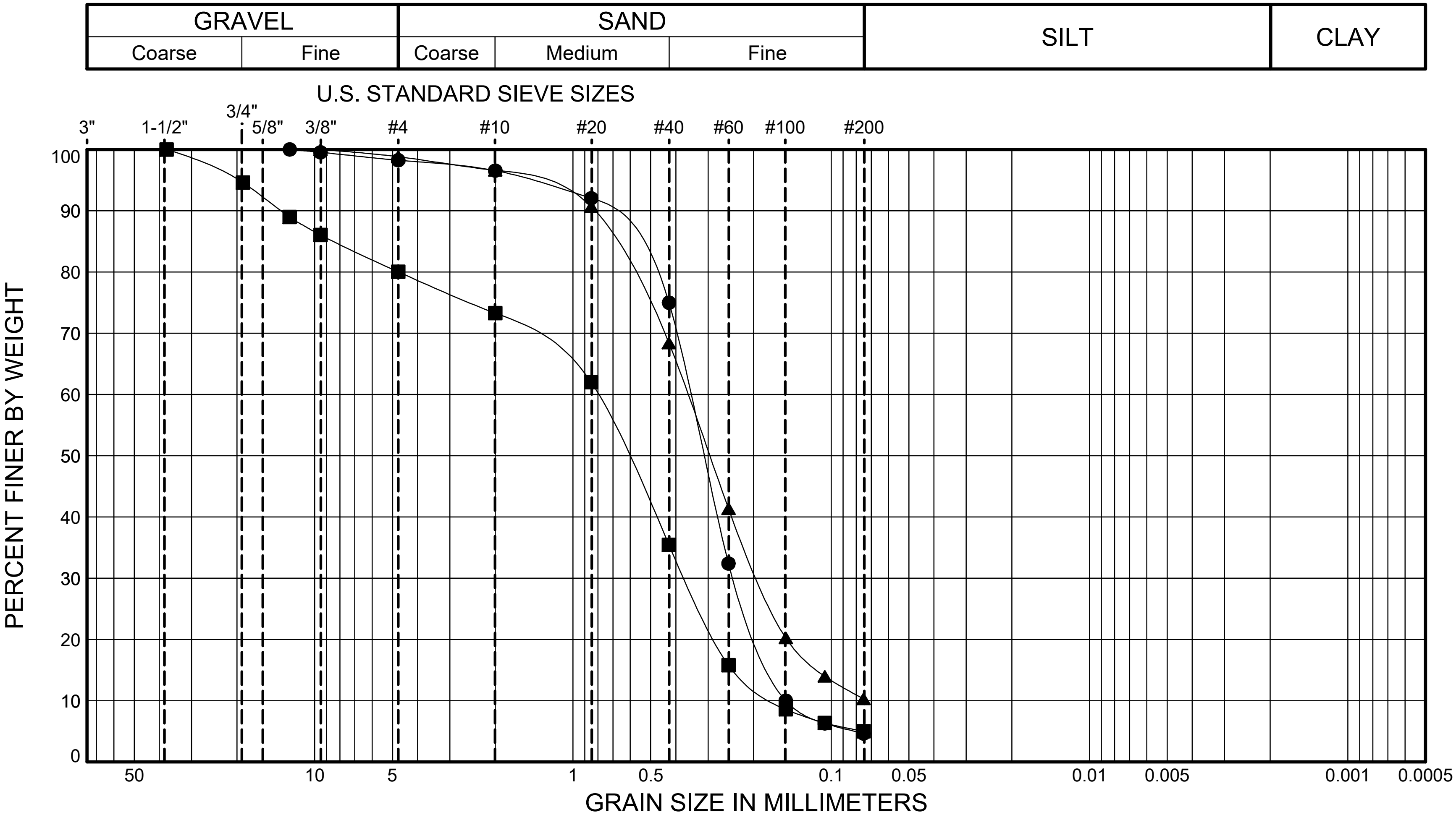
Tulalip Pavement Preservation
Geotechnical Investigation
81st Street NE, 29th and 30th Drive NE
Tulailp, Washington

SUMMARY OF
MATERIAL PROPERTIES

PAGE: 2 of 2

PROJECT NO.: 2021-036-21

FIGURE: B-2



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	BH-08	S-2	2.5 - 4.0	(SP) Olive-brown, poorly graded SAND					1.8	93.6	4.6
■	BH-09	S-3	5.0 - 6.5	(SP-SM) Olive-brown, poorly graded SAND with silt and gravel					20.0	75.0	5.0
▲	BH-10	S-1	0.1 - 1.6	(SP-SM) Yellowish-brown, poorly graded SAND with silt					1.2	88.5	10.3

HWA
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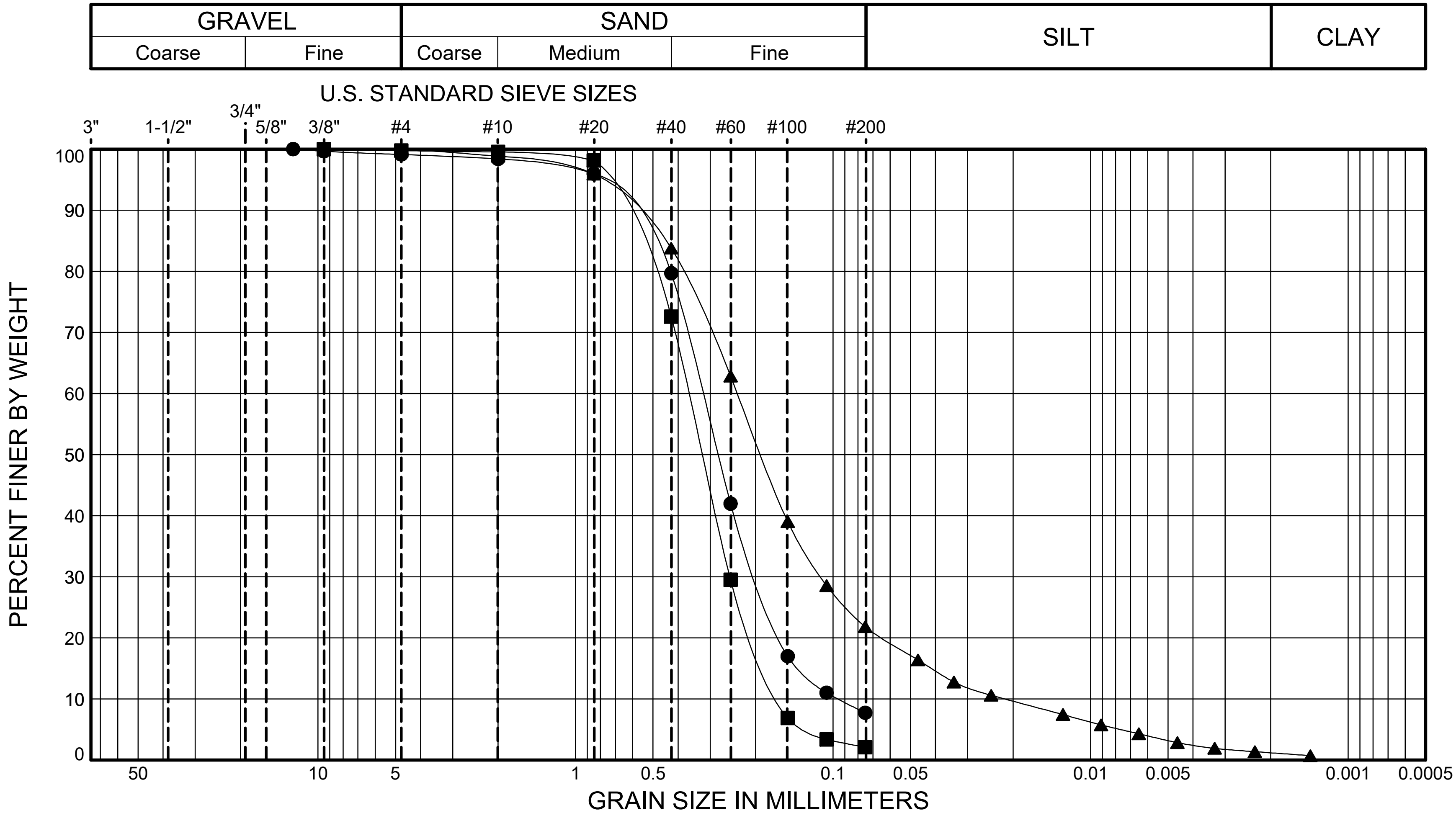
Tulalip Pavement Preservation
Geotechnical Investigation
81st Street NE, 29th and 30th Drive NE
Tulalip, Washington

PARTICLE-SIZE ANALYSIS OF SOILS
METHOD ASTM D422

PROJECT NO.: 2021-036-21 FIGURE: B-3

HWAGRSZMC 2021-036-21.GPJ 9/25/21



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	BH-11	S-1	0.1 - 1.6	(SP-SM) Yellowish-brown, poorly graded SAND with silt					0.9	91.4	7.7
■	HH-1	S-2	2.5 - 5.0	(SP) Olive-brown, poorly graded SAND					0.2	97.6	2.1
▲	HH-2	S-1	1.0 - 3.0	(SM) Dark reddish-brown, silty SAND					0.0	78.2	21.8

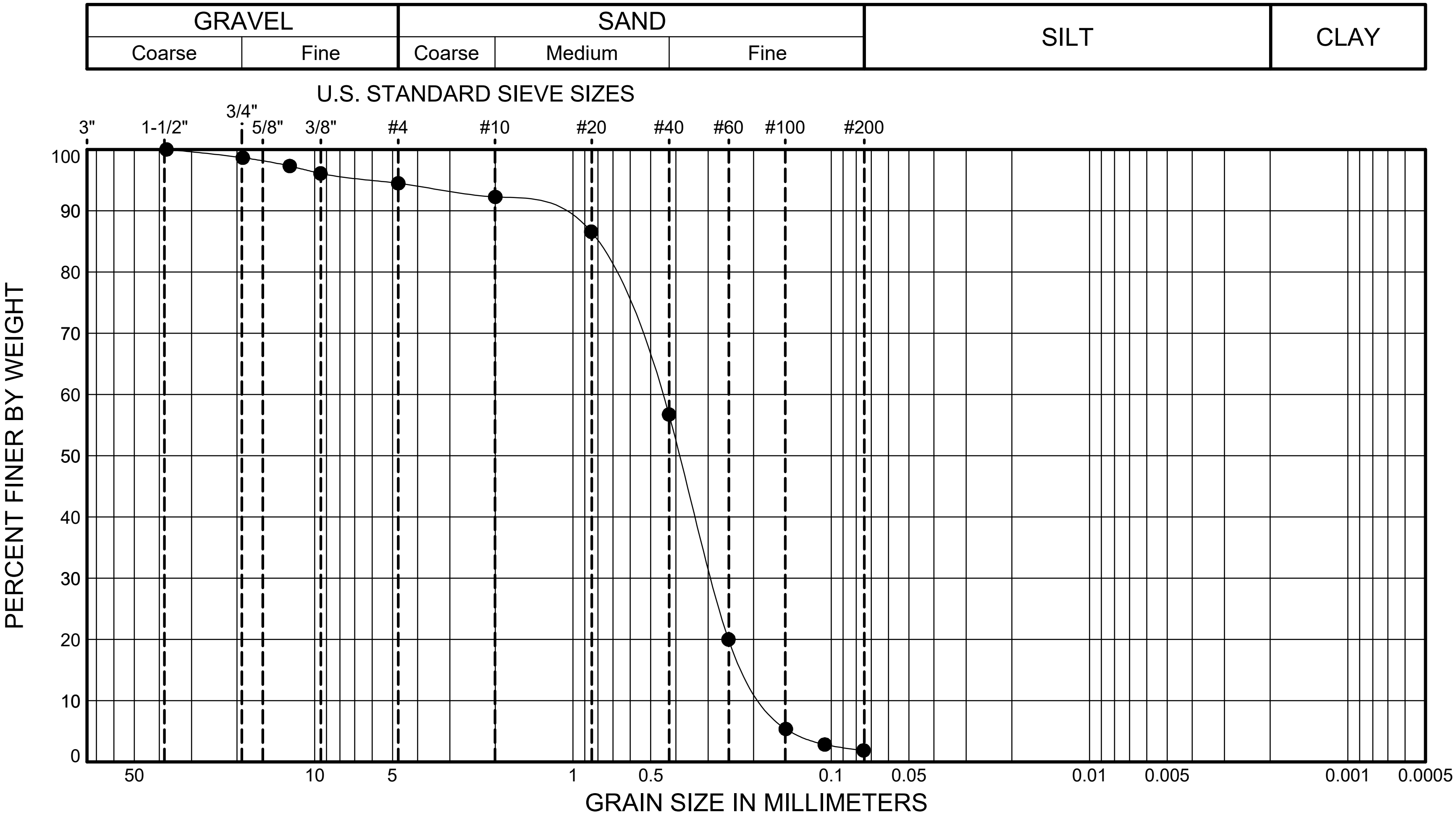
HWA
GEOSCIENCES INC.

Tulalip Pavement Preservation
Geotechnical Investigation
81st Street NE, 29th and 30th Drive NE
Tulalip, Washington

PARTICLE-SIZE ANALYSIS OF SOILS
METHOD ASTM D422

PROJECT NO.: 2021-036-21 FIGURE: B-4

HWAGRSZMC 2021-036-21.GPJ 9/25/21



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	HH-3	S-2	1.7 - 6.7	(SP) Olive-brown, poorly graded SAND					5.5	92.6	1.9

GEOSCIENCES INC.

Tulalip Pavement Preservation
Geotechnical Investigation
81st Street NE, 29th and 30th Drive NE
Tulalip, Washington

PARTICLE-SIZE ANALYSIS OF SOILS METHOD ASTM D422

PROJECT NO.: 2021-036-21 FIGURE: B-5

FINAL GEOTECHNICAL REPORT
Tulalip Road Preservation
Totem Beach Road Improvements
Tulalip, Washington
HWA Project No. 2021-036
Prepared for

Parametrix

&

Tulalip Tribes of Washington

May 2, 2022

HWA GEOSCIENCES INC.
DBE/MWBE

HWA GeoSciences Inc.
DBE/MWBE

May 2, 2022
HWA Project No. 2021-036-21

PARAMETRIX
719 2nd Ave, Suite 200
Seattle, WA 98104

Attn: Austin Fisher, P.E.

Subject: **Tulalip Road Preservation – Totem Beach Road Improvements**
Final Geotechnical Investigation Report
Tulalip, Washington

Mr. Fisher:

In accordance with your request, HWA GeoSciences Inc. (HWA) completed a field investigation consisting of performing pavement coring in 6 locations and logging the drilling of 3 boreholes along Totem Beach Road in the Tulalip Reservation in Tulalip, Washington. In addition, we performed laboratory testing on select samples retrieved from the boreholes. This report summarizes the results of our field investigation, laboratory testing, and provides recommendations for the design of seepage interceptor trench (French drain) and pavement reconstruction/rehabilitation.

PROJECT DESCRIPTION

The project alignment consists of approximately 2,500 feet of Totem Beach Road, between 76th Place NW and 70th Street NW (Alphonsus Bob Road). The alignment consists of one travel lane in each direction. The northernmost 1,570 feet of roadway, extending from 76th Place NW to the north entrance to the Senior Residential apartments, is surfaced with a thin layer of Hot Mix Asphalt (HMA) that is in poor condition and will be reconstructed. Improvements along this portion of the alignment will also include adding three new curb ramps, sidewalk replacement, three new catch basins, guardrail replacement and extension, and new curb and gutter. In addition, a French drain is proposed along the east side of the roadway within the middle of the reconstructed alignment to collect and convey groundwater seepage before it migrates under the roadway and softens the subgrade. An existing bioswale located at the northeast end of the proposed new French drain will be re-established.

The southern approximately 930 feet of the alignment, extending from the Senior Residential apartments to 70th Street NW, will be rehabilitated by grinding and construction of a new HMA overlay. The general location of the project alignment is shown on Figure 1, Site and Vicinity

Map. Figures 2A through 2C, Site and Exploration Plans, show the proposed improvements and locations of our explorations.

SITE CONDITIONS

Totem Beach Drive is a thoroughfare located adjacent to Tulalip Bay. The project alignment extends approximately 2,500 feet from 76th Place NW to 70th Street NW. Review of the USGS topographic map of the Tulalip Quadrangle indicates that the roadway traverses a shoreline facing slope, descending towards Tulalip bay from the north for approximately 0.3 miles, then roughly paralleling the slope, and gently ascending, for approximately 0.2 miles. Relief in the descending and ascending sections appear to be approximately 40 feet and 10 feet respectively. Currently the road has one travel lane in each direction. In general, the pavement along the northern 1,570 feet of the alignment is in poor condition exhibiting considerable amounts of high severity alligator cracking and rutting. We understand that seasonal groundwater seepage emanating along the uphill side of the roadway (east side) from approximate Sta 108+75 to 110+50 (See Figures 2A and 2B) has softened the road subgrade. The pavement along the southern 930 feet of the alignment exhibits minor longitudinal and transverse cracking, utility patching and surficial weathering.

SUBSURFACE INVESTIGATION

Geotechnical Borings

HWA GeoSciences Inc. (HWA) logged the drilling of three machine-drilled borings to assess subsurface conditions along the area of the proposed French drain. The borings, designated BH-1 through BH-3, were drilled on August 9, 2021, using a Bobcat mini track drill rig equipped with hollow stem augers, owned, and operated by Geologic Drill Partners Inc., of Bellevue, Washington, under subcontract to HWA. The borings were each drilled to depths of about 11.5 feet below ground surface (bgs). The locations of the borings were determined in the field by using a handheld GPS measuring device and are shown on Figures 2A and 2B.

In each boring, Standard Penetration Test (SPT) sampling was performed using a 2-inch outside diameter split-spoon sampler driven by a 140-pound automatic hammer. During the SPT, samples were obtained by driving the sampler 18 inches into the soil with the hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration were recorded. The Standard Penetration Resistance ("N-value") of the soil is calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides an indication of relative density of granular soils and the relative consistency of cohesive soils, both indicators of soil strength.

A geologist from HWA logged the explorations and recorded all pertinent information. Soil samples obtained from the boreholes were classified in the field and representative portions were sealed in plastic bags. Pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence was recorded. These soil samples were then taken to our Bothell, Washington, laboratory for further examination and testing.

The stratigraphic contacts shown on the individual exploration logs represent the approximate boundaries between soil types; actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific date and location reported and, therefore, are not necessarily representative of other locations and times. A legend of the terms and symbols used on the exploration logs is presented in Appendix A, Figure A-1. Summary logs of the borehole explorations are presented in Figures A-2 through A-4.

Pavement Cores

HWA GeoSciences Inc. (HWA) performed six, 4-inch diameter pavement cores, designated Core-1 through Core-6, along the project alignment to assess pavement layer thicknesses and shallow subgrade support conditions. Shallow subsurface explorations were performed in each pavement core hole using hand augers and hand digging tools. The coring and subsurface explorations were performed by geologists from HWA on August 10, 2021. All core holes were backfilled with compacted gravel and patched with Aquaphalt. A legend of the terms and symbols used on exploration logs is presented in Appendix A, Figure A-1. Photographic logs of the pavement cores are presented in Figures A-5 through A-10. Table 1 summarizes the pavement structures encountered in the pavement core explorations.

Table 1. Thickness of Pavement Layers

Designation	Location	HMA Thickness (in.)	Crushed Base Thickness (in.)	General Notes
Core-1	SB Lane - See Figure 2A	3.0	-	2 lifts of HMA, cracking extends through both lifts.
Core-2	NB Lane - See Figure 2A	2.25	-	2 lifts of HMA, cracking extends through both lifts.
Core-3	SB Lane -See Figure 2B	2.25	-	2 lifts of HMA, no cracking at this location.
Core-4	WB Lane - See Figure 2B	2.0	-	2 lifts of HMA, cracking extends through both lifts.
Core-5	WB Lane - See Figure 2C	8.0	-	4 lifts of HMA, no cracking at this location. Lifts 3 and 4 are not bonded.
Core-6	EB Lane - See Figure 2C	8.5	1.0	5 lifts of HMA, no cracking at this location. Lifts 4 and 5 are not bonded.

From Approximately Sta 100+00 to 115+30, the HMA pavement section is very thin (2 to 3 inches) and was placed over a thin section of fill or directly on native soils. No crushed base was encountered below the HMA. The HMA consisted of two lifts and cracking extended full-depth of the HMA where cores were performed over cracked pavement. Pavement distresses visible at the surface along this portion of the alignment consist of medium to high severity longitudinal cracking, alligator cracking, transverse cracking, rutting and potholing, particularly in the wheel paths. Some crack sealing and pothole patching has been performed in the past.

From approximately Sta 115+30 to 125+50, the HMA pavement section was considerably thicker (8 to 8.5 inches) and was comprised of 4 to 5 lifts of HMA. Crushed aggregate base was only encountered in Core-6 where it was about 1 inch thick.

LABORATORY TESTING

Representative soil samples obtained from the drilled boreholes were taken to the HWA geotechnical laboratory for examination and testing. Laboratory tests were conducted on selected soil samples to characterize engineering properties of the soils. Laboratory tests, as described in Appendix B, included moisture content determination, grain size distribution, and Atterberg Limits. The tests were conducted in general accordance with appropriate American Society of Testing and Materials (ASTM) standards and are discussed in further detail in Appendix B. The test results are also presented in Appendix B, and/or displayed on the exploration logs in Appendix A, as appropriate.

GEOLOGY

The project alignment is located within the Puget Lowland. The Puget Lowland has repeatedly been occupied by a portion of the continental glaciers that developed during the ice ages of the Quaternary period. During at least four periods, portions of the ice sheet advanced south from British Columbia into the lowlands of Western Washington. The southern extent of these glacial advances was near Olympia, Washington. Each major advance included numerous local advances and retreats, and each advance and retreat resulted in its own sequence of erosion and deposition of glacial lacustrine, outwash, till, and drift deposits. Between and following these glacial advances, sediments from the Olympic and Cascade Mountains accumulated in the Puget Lowland. As the most recent glacier retreated, it uncovered a sculpted landscape of elongated, north-south trending hills and valleys between the Cascade and Olympic Mountain ranges, composed of a complex sequence of glacial and interglacial deposits.

Geologic information for the project site was obtained from the published geologic maps for the area; Geologic Map of the Tulalip Quadrangle, Island and Snohomish Counties, Washington (Minard, 1985) and the Surficial Geology, Selected Wells, and Hydrogeologic Units and Sections - Plate 1 from Water Resources of the Tulalip Indian Reservation and adjacent areas, Snohomish County, Washington 2001-2003 (Frans and Kresch, 2004). These maps indicate that the surficial geology within the vicinity of the project alignment consists of Vashon recessional outwash, a unit of mostly clean sand with some gravel, and some beds of silts and clay that was deposited by glacial meltwater behind the retreating Puget Lobe of the Cordilleran Ice Sheet during the latest glaciation. The geologic map depicting the project location is shown on Figure 3.

SUBSURFACE CONDITIONS

The subsurface conditions encountered vary by location and consist primarily of recessional outwash overlying advance outwash. All borings contained a 2 to 4-foot-thick silt (BH-1 and BH-2) or elastic silt (see BH-3) layer, within the upper five feet of each boring in the recessional outwash deposit.

In general, where encountered beneath pavement at shallow depths, the fine-grained silts soils are considered to be moisture sensitive and susceptible to frost heave.

The following units were observed in the explorations performed for this study. Each major soil unit is described below, with materials interpreted as being youngest in origin and nearest to the surface described first.

Topsoil: Topsoil was encountered at the surface at the locations BH-1 and BH-3, which were drilled in the grass area on the north side of the sidewalk. The topsoil layer was about 6 inches thick at both locations and consisted of medium dense, dark brown, silty sand that contained scattered organic matter and roots.

Fill: Fill soils were encountered immediately below topsoil at the location of BH-1, comprised of medium dense, orange brown, silty, gravelly sand. The fill was likely native soils that were re-graded during site development. Fill was also observed directly beneath the HMA at the locations of Core-1 and Core-4 through Core-6.

Vashon Recessional Outwash: Vashon recessional outwash was encountered near surface (below the topsoil or shallow layer of fill) in all three borings and extended to depths of 7.5 feet, 8 feet and 3.5 feet in borings BH-1 through BH-3, respectively. At the location of BH-1, the recessional outwash consisted of about 2 feet of very stiff silt over 3.5 feet of medium dense silty sand. At the location of BH-2, the recessional outwash consisted of about 3.5 feet of medium dense sand over 4 feet of medium stiff silt. At the location of BH-3, the recessional outwash consisted of about 3 feet of very stiff elastic silt over 1.5 feet of dense, silty sand.

The explorations at the pavement core locations all encountered recessional outwash, comprised of clean to silty sand and silt, below the HMA or thin layer of fill.

Recessional outwash was deposited by glacial meltwater during ice retreat away from the ice margin, consequently this unit is not glacially overridden and therefore, typically permeable and a good receptor for infiltration purposes. The silt encountered in our borings is not a good receptor for infiltration purposes and may serve as a confining layer over the underlying advance outwash or as a perching layer for shallow seepage.

Vashon Advance Outwash: Vashon advance outwash was encountered immediately below the recessional outwash in all three borings, extending to the terminal depths of all borings. The advance outwash encountered consisted of medium dense to very dense, poorly graded sand with gravel to silty sand with gravel, to silty gravel.

Advance outwash was deposited in front of an advancing glacier and subsequently overridden by glacial ice. This unit is typically over-consolidated due to being glacially overridden and not conducive to infiltration given its dense consistency. This unit serves as the regional aquifer.

GROUNDWATER CONDITIONS

Groundwater seepage was encountered during drilling in all three borings, which were drilled during dry summer conditions. In boring BH-1, groundwater was encountered during drilling at a depth of 4 feet but rose to a depth of 2 feet when the augers were removed. In boring BH-2, groundwater was encountered at a depth of 8 feet during drilling but rose to a depth of 2.3 feet when the augers were removed. In boring BH-3, groundwater was encountered at a depth of 4 feet during drilling but rose to a depth of 2.5 feet when the augers were removed. The groundwater level rises observed appear to indicate artesian groundwater conditions are present, with the Vashon recessional silt acting as a confining layer. We anticipate that groundwater levels vary seasonally, with the highest water levels in the wet winter months.

CONCLUSIONS & RECOMMENDATIONS

The results of our field investigation and laboratory testing indicate that the northern section of the existing roadway pavement structure (approximately Sta 100+00 to 115+30) is very thin (2 to 3 inches of HMA) with no crushed base course below. The pavement throughout this area exhibits high severity alligator cracking. Pavement distresses in this area are likely related to shallow perched or springing groundwater conditions that facilitate softening of the roadway subgrade. The pavement in this section needs to be reconstructed with a sufficient thickness of HMA over crushed base course. We recommend that the shallow seepage is intercepted along the eastern (uphill) side of the road and conveyed to a suitable discharge point downhill.

Although, the SPT blow counts indicate the subgrade is stiff when undisturbed, the native fine-grained subgrade soils when exposed during reconstruction should be considered moisture sensitive and can lose strength and become unstable and subject to rutting and pumping under construction traffic loads. Given the moisture susceptibility of the silty subgrade soils, we recommend that reconstruction activities only occur during the dry summer months.

The remainder of the alignment (Sta 115+30 to 125+25) appears to be paved with about 8 to 8.5 inches of HMA placed either directly over fill or a thin venerer of crushed aggregate base. The road surface exhibits minor, widely spaced traverse cracking, trench patching and environmental deterioration. An overlay is planned for this roadway section. The use of engineered fibers (such as ACE Fibers) could be considered in the HMA overlay to prolong the pavement life and delay the onset of distress.

The following sections present our new drainage and pavement design recommendations.

INTERCEPTOR DRAIN

We recommend design provisions include an interceptor drain along the east side of the roadway as currently proposed from approximately Sta 108+75 to at least Sta 110+50. The drain should consist of 6-inch diameter, perforated pipe encapsulated in pervious gravel backfill, meeting the requirements for Gravel Backfill for Drains per Section 9-03.12(4) of the WSDOT *Standard Specification*s (WSDOT 2021). The gravel envelopment should be at least 6 inches thick in all directions around the pipe. The gravel backfill material should be encapsulated in a layer of non-woven geotextile meeting the requirements of WSDOT *Standard Specifications* Section 9-33.2(1) Table 1 for Moderate Survivability and Table 2 Class B. The pipe invert should be set at a depth of at least 2.5 feet and sloped to drain toward connection with an outlet for off-site disposal at the lower end of the project. The trench should be backfilled with Gravel Borrow, meeting the requirements of Section 9-03.14(1) of the WSDOT *Standard Specifications*.

Seepage collection and conveyance should not be combined with local stormwater conveyance unless suitable catch basin connections eliminate the ability of the stormwater to surcharge the seepage collection system. We recommend that construction of the interceptor trench be conducted during the dry summer months. We recommend that construction of the interceptor trench and conveyance proceed uphill so that if seepage is encountered during construction the conveyance and disposal system or suitable temporary outlet is already in place.

NEW HMA PAVEMENT DESIGN

Pavement Design

The existing Hot Mix Asphalt (HMA) section from approximately 76th Place NW south and east to entrance to the Senior Apartments (Sta 115+30) is very thin with no crushed base course and exhibits high severity distresses. We understand that the pavement in this section will be reconstructed. From about Sta 115+30 to the south/east end of the alignment, our pavement cores encountered about 8 to 8.5 inches of HMA with only minor distresses. We understand that this portion of the alignment will be rehabilitated by grinding and overlay. The following sections provide our pavement design recommendations.

Design Traffic

Current design traffic parameters were provided by Parametrix, consisting of three days of traffic counts (7/19/16 through 7/21/16) for the northbound (NB) and southbound (SB) directions at three locations along the alignment. We used the highest 24-hour count for the NB traffic for design, and ADT of 1,292 vehicles. We were also provided an annual traffic volume growth rate of 2% and 4% heavy truck traffic. Assuming 2 Equivalent Single Axle Loads (ESALs) per heavy truck and 0.008 ESALs for all other vehicles, we calculate a 20-year design life ESAL value of 1,005,000, which was used for design.

The pavement recommendations presented in this report are based on these traffic calculations. If additional traffic count information is obtained that varies appreciably from these values, the recommendations given in this report should be reviewed and revised as necessary.

New HMA Pavement Design

Table 2 provides our HMA design recommendations, assuming the traffic loading input described above. This pavement design is based on the design method given in the 1993 AASHTO Design Guide (AASHTO, 1993) using the following parameters:

- Reliability = 90%
- Initial Serviceability = 4.5

- Terminal Serviceability = 3.0
- Overall Standard Deviation = 0.5
- Subgrade Resilient Modulus = 7.5 ksi

These values result in a required AASHTO Structural Number (SN) of 3.80.

Table 2. Structure Requirements for New HMA Pavement – 20-Year Design Life

Material Description	Minimum Layer Thickness (inches)	WSDOT Standard Specification
HMA	7	5-04
CSBC	6	9-03.9(3)

HMA: Hot Mix Asphalt
CSBC: Crushed Surfacing Base Course

We recommend that the asphaltic layers consist of HMA Class ½-inch. Recommendations are presented below for subgrade preparation and structural fill placement and compaction for pavement reconstruction. The use of engineered fibers (such as ACE Fibers) could be considered in the HMA overlay to prolong the pavement life and delay the onset of distress.

PAVEMENT OVERLAY AREA DESIGN

We understand that an HMA overlay is planned for the portion of the alignment east of the Senior Apartment Center (approximate Sta 115+30) to the project terminus at the intersection of Totem Beach Road and 70th Street NW (approximate Sta 125+50).

For areas where pavement repairs are not required we recommend that 3 inches be ground from the existing surface and a new 3-inch thick HMA overlay be constructed. We did not identify any repair areas during our walkthrough or pavement coring; however, we recommend that a representative from HWA evaluate the HMA surface after grinding to determine if any areas require repair.

HMA Design Considerations

The following design considerations should be noted and implemented:

- The longitudinal joints in the HMA wearing course should coincide with a lane line or an edge line.
- The pavement will likely require a functional overlay after about 10 to 12 years because of non-structural associated distress caused by environmental factors such as degradation of the asphalt surface and rutting.
- HMA pavements are susceptible to shoving and rutting from heavy vehicles, such as buses and heavy delivery trucks, particularly at intersections. In these areas, more frequent maintenance and even premature reconstruction of the pavement may be required.

HMA Binder Selection

The selection of the optimum asphalt binder type for the prevailing climate is critical to ensure long-term pavement performance. Use of the wrong binder can result in low temperature cracking or permanent deformation at high temperatures.

Based on the climate in the project vicinity, we recommend Superpave Performance Grade binder PG 58H-22 be used for pavement reconstruction and pavement overlays in order to provide greater resistance to potential pavement distresses.

Placement of HMA

Placement of HMA should be in accordance with Section 5-04 of the WSDOT Standard Specifications (WSDOT, 2021). Particular attention should be paid to the following:

- HMA should not be placed until the engineer has accepted the previously constructed pavement layers.
- HMA should not be placed on any frozen or wet surface.
- HMA should not be placed when precipitation is anticipated before the pavement can be compacted, or before any other weather conditions which could prevent proper handling and compaction of HMA.
- HMA should not be placed when the average surface temperatures are less than 45^o F.
- HMA temperature behind the paver should be in excess of 240^o F. Compaction should be completed before the mix temperature drops below 180^o F. Comprehensive temperature records should be kept during the HMA placement.
- Sufficient tack coat must be applied uniformly and allowed to break and set before placing HMA above an existing HMA layer in order to create a strong bond between layers. The surface of the pavement should be thoroughly cleaned prior to tack coat application. Improper tack coat application can cause unbonded layers and will lead to premature pavement distress/failure.
- For cold joints, tack coat should be applied to the edge to be joined and the paver screed should be set to overlap the first mat by 1 to 2 inches.

Drainage

It is essential to the satisfactory performance of the roadway that good drainage is provided to prevent water ponding on or alongside, or accumulating beneath, the pavement. Water ponding can cause saturation of the pavement and subgrade layers and lead to premature failure. The surface of the pavement should be sloped to convey water from the pavement to appropriate drainage facilities.

EARTHWORK

Subgrade Preparation

Subgrade preparation for the proposed improvements should begin with the removal of all existing topsoil, organic-rich soils, debris and vegetation. The soils should be excavated to the design elevation and thoroughly compacted. In areas of pavement reconstruction, excavation should extend to design subgrade elevation (below new HMA and crushed base course thickness).

The exposed subgrade soils should be evaluated to assess their suitability for support of the improvements. Areas accessible to fully-loaded dump trucks, or similar heavy wheeled equipment should be proof-rolled prior to placement of structural fill. Any areas exhibiting pumping or heaving should be delineated and over-excavated to reach competent soils, as determined by the geotechnical engineer. Areas inaccessible to large equipment should be evaluated by the geotechnical engineer using a T-handle probe, or other suitable method. Soils found to be soft/loose, or unsuitable for support of the proposed improvements, should be over-excavated to reach competent soils. Backfill of any over-excavated areas should consist of structural fill, placed and compacted as described below.

Structural Fill Materials and Compaction

Any material used to support the pavement should consist of Crushed Surfacing Base Course (CSBC) as specified in Section 9-03.9(3) of the WSDOT *Standard Specifications* (WSDOT, 2021). Structural fill used to raise site grades, or backfill utility trench excavations, should consist of granular materials such as Gravel Borrow, meeting the requirements of Section 9-03.14(1) of the WSDOT *Standard Specifications* (WSDOT, 2021). Based on our subsurface explorations, we do not anticipate that native soils can be re-used as structural fill.

Structural fill soils should be moisture conditioned, placed in loose horizontal lifts less than 8-inches thick, and compacted to at least 95% of the maximum dry density (MDD) as determined using test method ASTM D1557 (modified Proctor). Achievement of proper density of a compacted fill depends on the size and type of compaction equipment, the number of passes, thickness of the layer being compacted and soil moisture-density properties. In areas where limited space restricts the use of heavy equipment, smaller equipment can be used, but the soil must be placed in thin enough layers to achieve the required relative compaction. Generally, loosely compacted soils result from poor construction technique and/or improper moisture content. Soils with high fines contents are particularly susceptible to becoming too wet, and coarse-grained materials easily become too dry for proper compaction.

Temporary Excavations

Any temporary excavations deeper than 4 feet should be sloped or shored in accordance with Part N of the Washington Administrative Code (WAC) 296-155 or shored. The near-surface soils classify as Type C soils. Temporary excavations in Type C soils may be no steeper than 1.5H:1V to meet safety requirements for worker access during construction. The recommended maximum allowable temporary slope cut inclinations are applicable to temporary excavations above the water table only. Flatter slopes may be required where groundwater seepage in present.

The contractor should monitor the stability of the temporary cut slopes and adjust the construction schedule and slope inclination accordingly. The contractor should be responsible for control of ground and surface water and should employ sloping, slope protection, ditching, sumps, dewatering, and other measures as necessary to prevent sloughing of soils.

Wet Weather Earthwork

Some of the soils encountered contained a high fines content and will likely be difficult to place/compact or traverse with construction equipment during periods of wet weather. General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement of concrete or placement and compaction of structural fill material. The size and type of construction equipment used may need to be limited to prevent soil disturbance.
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water.
- The ground surface within the construction area should be sealed by a smooth drum roller, or equivalent, and under no circumstances should soil be left uncompacted and exposed to moisture infiltration.
- Excavation and placement of fill material should be monitored to determine that the work is being accomplished in accordance with the project specifications and that the weather conditions do not adversely impact the quality of work.

Utility Pipe Bedding and Backfill

General recommendations relative to pipe bedding and utility trench backfill are presented below:

- Pipe bedding material, placement, compaction and shaping should be in accordance with the project specifications and the pipe manufacturer’s recommendations. As a minimum, the pipe bedding should meet the gradation requirements for Gravel Backfill for Pipe Zone Bedding, Section 9.03.12(3) of the WSDOT *Standard Specifications* (WSDOT, 2021).

- Pipe bedding materials should be placed on relatively undisturbed native soils, or compacted fill soils. If the native subgrade soils are disturbed, the disturbed material should be removed and replaced with compacted bedding material.
- Although unlikely, the possibility may arise that in areas the trench bottom may encounter very soft or organic-rich subgrade soils, and it will be necessary to over-excavate the unsuitable material and backfill with pipe bedding material. We recommend that crushed rock meeting the requirements for Crushed Surfacing Top Course, as described in Section 9-03.9(3) of the WSDOT *Standard Specifications* (WSDOT, 2021), be used to backfill the over-excavated portions of the trench bottom.
- Pipe bedding should provide a firm, uniform, cradle for support of the pipe. We recommend that a minimum 4-inch thickness of bedding material beneath the pipe be provided. Greater thicknesses may be necessary to prevent loosening and softening of the natural soils during pipe placement.
- Pipe bedding material and/or backfill around the pipe should be placed in layers and tamped to obtain complete contact with the pipe.
- During placement of the initial lifts, the trench backfill material should not be bulldozed into the trench or dropped directly on the pipe. Furthermore, heavy equipment should not be permitted to operate directly over the pipe until a minimum of 2 feet of backfill has been placed. Trench backfill should be placed in 8-inch (maximum) thick lifts and compacted using mechanical equipment to at least 95% of its maximum dry density, as determined by testing in general accordance with ASTM D1557 (modified Proctor).

CONDITIONS AND LIMITATIONS

We have prepared this report for Parametrix and the Tulalip Tribe for use in design of this project. The conclusions and interpretations presented in this report should not be construed as our warranty of the subsurface conditions. Experience has shown that soil and groundwater conditions can vary significantly over small distances.

Inconsistent conditions can occur between explorations and may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HWA should be notified for review of the recommendations of this report, and revision of such if necessary.

Within the limitations of scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology in the area at the time the report was prepared. No warranty, express or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

* * *

We appreciate this opportunity to provide geotechnical and pavement engineering services on this project. If you have any questions or if we may be of further assistance, please contact the undersigned at (425) 774-0106.

Sincerely,

HWA GEOSCIENCES INC.

BRYAN KEITH HAWKINS
39862

Engineering Geologist
1704
STEVEN ELLIOTT GREENE

Bryan K. Hawkins, P.E.
Senior Geotechnical Engineer

Steven E. Greene, L.G., L.E.G.
Principal Engineering Geologist

ATTACHMENTS:

Figure 1	Vicinity Map
Figure 2	Site and Exploration Plan
Figure 3	Geologic Map
Figure 4	Generalized Geologic Cross Section A – A'
Appendix A	Subsurface Exploration
Appendix B	Laboratory Test Results

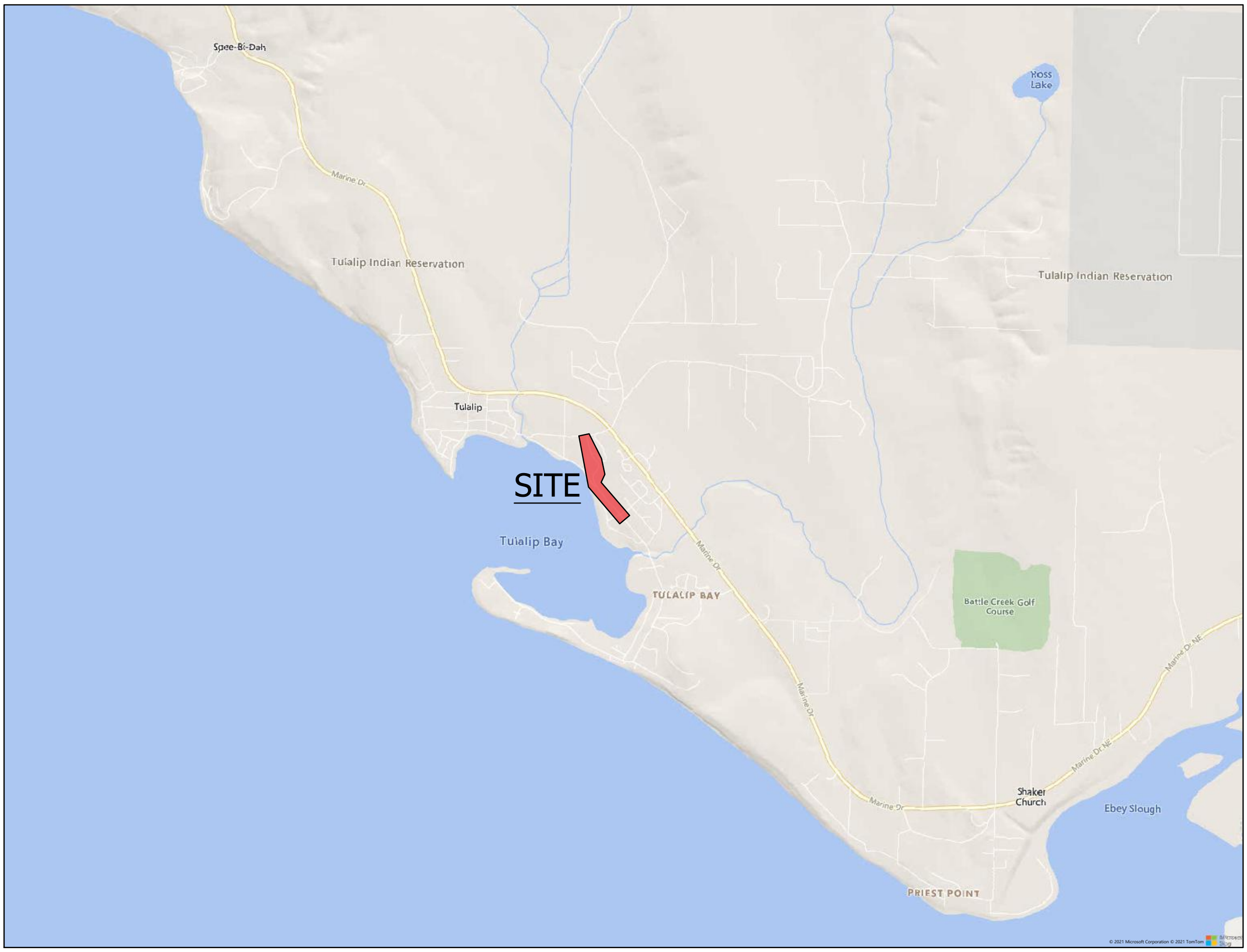
REFERENCES:

Frans, L.M., and Kresch, D.L., 2004, *Water resources of the Tulalip Indian Reservation and adjacent area, Snohomish County, Washington, 2001–03*: U.S. Geological Survey Scientific Investigations Report 2004–5166, 86 p.

Minard, J.P, 1985, *Geologic Map of the Tulalip Quadrangle, Island and Snohomish Counties, Washington,* U S Geological Survey Misc. Field Studies Map MF-1744.

WSDOT, 2021, *Standard Specifications for Road, Bridge, and Municipal Construction*.

SITE MAP



VICINITY MAP

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SITE AND VICINITY MAP

TULALIP ROAD PRESERVATION
TOTEM BEACH ROAD
TULALIP, WASHINGTON

FIGURE NO.: 1

DRAWN BY: CF
CHECK BY: SEG
PROJECT # 2021-036-21

C:\USERS\CFRY\DESKTOP\2021-036-21 TULALIP ROAD PRESERVATION\2021-036-21 TULALIP ROAD PRESERVATION - TOTEM BEACH ROAD.DWG <1> Plotted: 7/6/2021 12:02 PM

TOTEM BEACH ROAD

Scale: 1" = 60'-0"

0 30 60 90 120

SCALE: 1" = 60'

EXPLORATION LEGEND

BH-3 BOREHOLE DESIGNATION AND APPROXIMATE LOCATION

C-1 PAVEMENT CORE DESIGNATION AND APPROXIMATE LOCATION

A A' GEOLOGIC CROSS SECTION

BASE MAP PROVIDED BY: BING AND PARAMETRIX 06.22.2021

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DBE/MWBE

TULALIP ROAD PRESERVATION
TOTEM BEACH ROAD
TULALIP, WASHINGTON

SITE &
EXPLORATION PLAN

DRAWN BY: CF	FIGURE NO.: 2A
CHECK BY: SEG	PROJECT NO.: 2021-036-21

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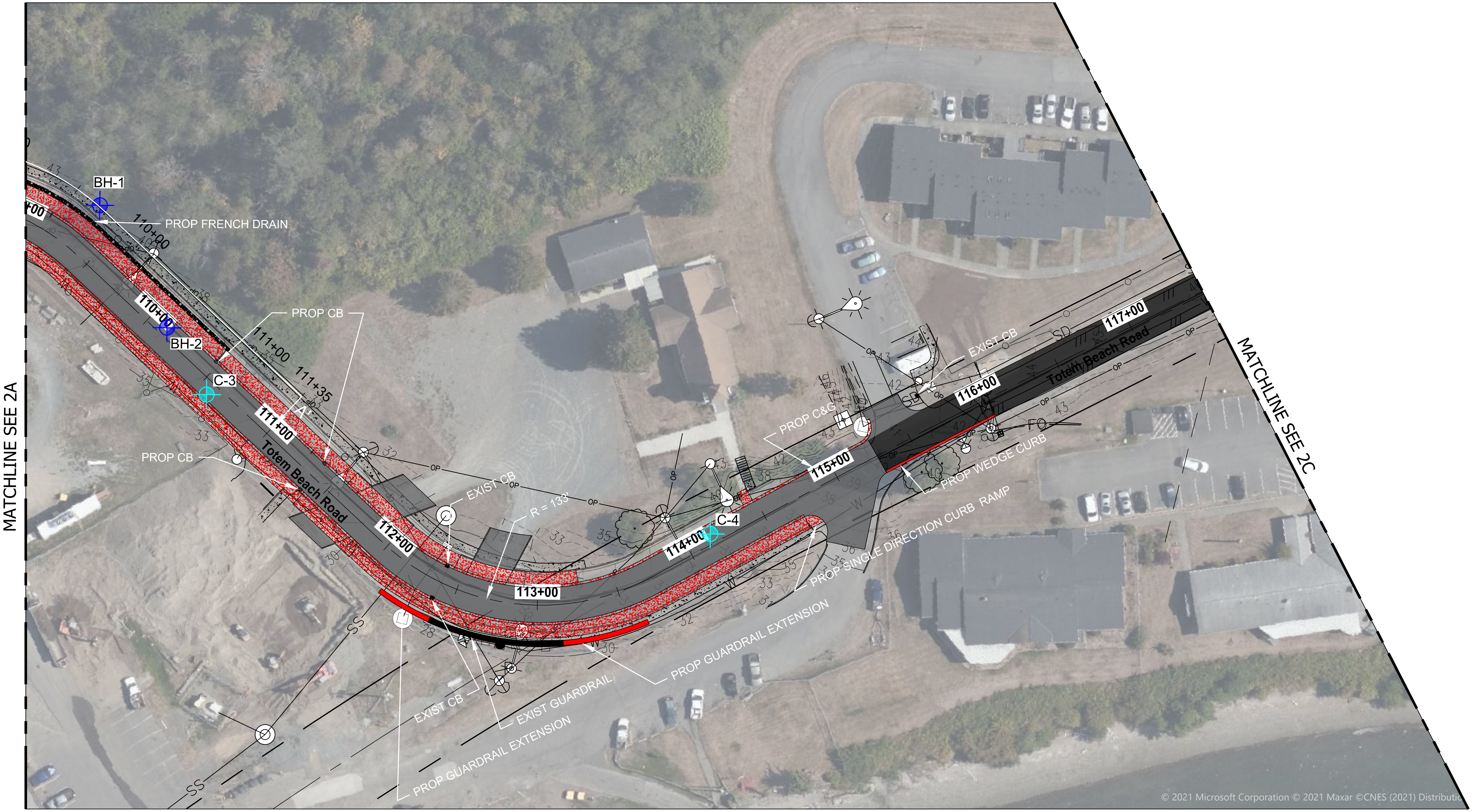

TOTEM BEACH ROAD

Scale: 1" = 60'-0"

0 30 60 90 120

SCALE: 1" = 60'

EXPLORATION LEGEND

BH-1 BOREHOLE DESIGNATION AND APPROXIMATE LOCATION

C-3 PAVEMENT CORE DESIGNATION AND APPROXIMATE LOCATION

A A' GEOLOGIC CROSS SECTION

BASE MAP PROVIDED BY: BING AND PARAMETRIX 06.22.2021

HWA GEOSCIENCES INC.
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TULALIP ROAD PRESERVATION
TOTEM BEACH ROAD
TULALIP, WASHINGTON

SITE &
EXPLORATION PLAN

DRAWN BY:	FIGURE NO.:
CF	2B
CHECK BY:	PROJECT NO.:
SEG	2021-036-21

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TOTEM BEACH ROAD
Scale: 1" = 60'-0"

EXPLORATION LEGEND

C-5 ⌖ PAVEMENT CORE DESIGNATION AND APPROXIMATE LOCATION

0 30 60 90 120
SCALE: 1" = 60'

HWA GEOSCIENCES INC.
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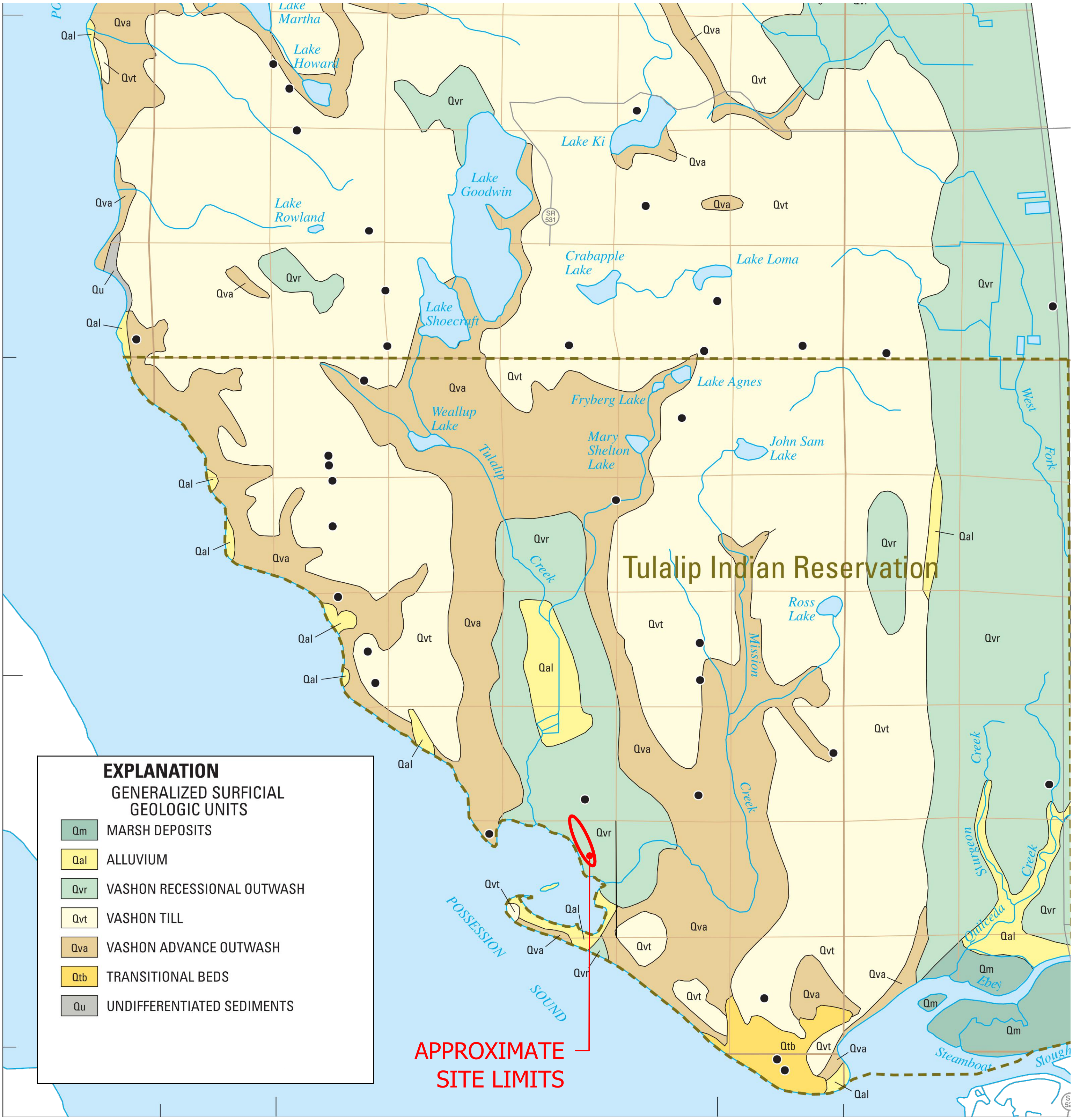
TULALIP ROAD PRESERVATION
TOTEM BEACH ROAD
TULALIP, WASHINGTON

SITE &
EXPLORATION PLAN

DRAWN BY: CF
CHECK BY: SEG
FIGURE NO.: 2C
PROJECT NO.: 2021-036-21

BASE MAP PROVIDED BY: BING AND PARAMETRIX 06.22.2021

S:\2021 PROJECTS\2021-036-21 TULALIP ROAD PRESERVATION\CAD\TOTEM BEACH ROAD\2021-036-21 TULALIP ROAD PRESERVATION - TOTEM BEACH ROAD.DWG <2C> Plotted: 10/25/2021 12:01 PM



BASE MAP PROVIDED BY: SCIENTIFIC INVESTIGATIONS REPORT 2004-5166, SURFICIAL GEOLOGY, SELECTED WELLS, AND HYDROGEOLOGIC UNITS AND SECTIONS - PLATE 1, FRANS, L.M., AND KRESCH D.L., 2004, WATER RESOURCES OF THE TULALIP INDIAN RESERVATION AND ADJACENT AREA, SNOHOMISH COUNTY, WASHINGTON, 2001-03

NOT TO SCALE

HWA GEOSCIENCES INC.
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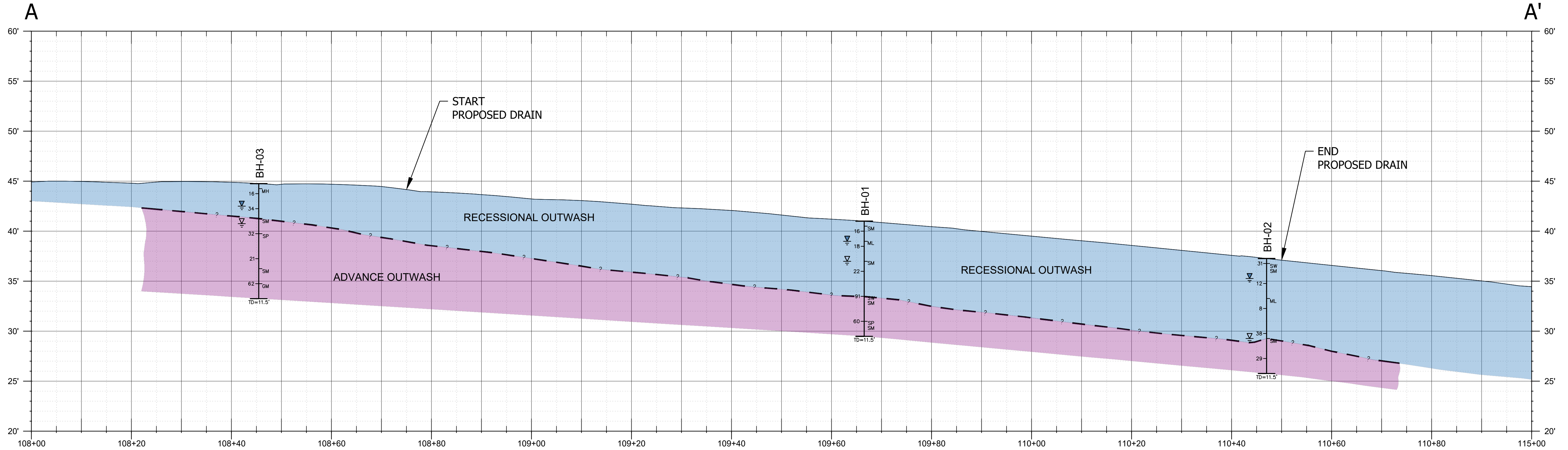
GEOLOGIC MAP

TULALIP ROAD PRESERVATION
TOTEM BEACH ROAD
TULALIP, WASHINGTON

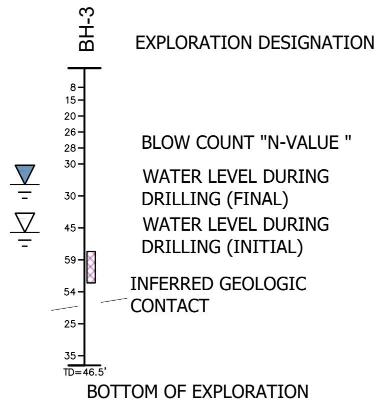
FIGURE NO.:
3

DRAWN BY: CF
CHECK BY: SEG

PROJECT #
2021-036-21



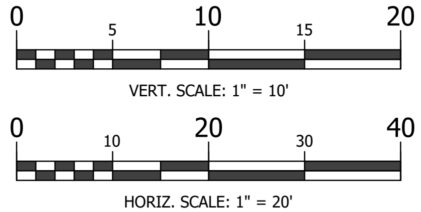
BORING LEGEND



SOILS LEGEND

🟦 RECESSIONAL OUTWASH

🟪 ADVANCE OUTWASH



NOTE: THE SUBSURFACE CONDITIONS SHOWN ARE BASED ON WIDELY SPACED BORINGS AND SHOULD BE CONSIDERED APPROXIMATE. FURTHERMORE, THE CONTACT LINES SHOWN BETWEEN UNITS ARE INTERPRETIVE IN NATURE AND MAY VARY LATERALLY OR VERTICALLY OVER RELATIVELY SHORT DISTANCES ON SITE. ELEVATIONS OF BORINGS ARE APPROXIMATE.

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TULALIP ROAD PRESERVATION
TOTEM BEACH ROAD
TULALIP, WASHINGTON

GENERALIZED
GEOLOGIC CROSS
SECTION

DRAWN BY:	FIGURE NO.:
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MAB/SEG	2021-036-21

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APPENDIX A

SUBSURFACE EXPLORATION

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density(%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

USCS SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils More than 50% Retained on No. 200 Sieve Size	Gravel and Gravelly Soils More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
		Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
	Sand and Sandy Soils 50% or More of Coarse Fraction Passing No. 4 Sieve	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
		Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils 50% or More Passing No. 200 Sieve Size	Silt and Clay	Liquid Limit Less than 50%	ML	SILT
			CL	Lean CLAY
			OL	Organic SILT/Organic CLAY
	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY
			OH	Organic SILT/Organic CLAY
Highly Organic Soils			PT	PEAT

TEST SYMBOLS

%F	Percent Fines
AL	Atterberg Limits: PL = Plastic Limit, LL = Liquid Limit
CBR	California Bearing Ratio
CN	Consolidation
DD	Dry Density (pcf)
DS	Direct Shear
GS	Grain Size Distribution
K	Permeability
MD	Moisture/Density Relationship (Proctor)
MR	Resilient Modulus
OC	Organic Content
pH	pH of Soils
PID	Photoionization Device Reading
PP	Pocket Penetrometer (Approx. Comp. Strength, tsf)
Res.	Resistivity
SG	Specific Gravity
CD	Consolidated Drained Triaxial
CU	Consolidated Undrained Triaxial
UU	Unconsolidated Undrained Triaxial
TV	Torvane (Approx. Shear Strength, tsf)
UC	Unconfined Compression

SAMPLE TYPE SYMBOLS

☒	2.0" OD Split Spoon (SPT) (140 lb. hammer with 30 in. drop)
I	Shelby Tube
▣	Non-standard Penetration Test (3.0" OD Split Spoon with Brass Rings)
○	Small Bag Sample
▚	Large Bag (Bulk) Sample
▮	Core Run
⧄	3-1/4" OD Split Spoon

GROUNDWATER SYMBOLS

▽	Groundwater Level (measured at time of drilling)
▼	Groundwater Level (measured in well or open hole after water level stabilized)

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

COMPONENT PROPORTIONS

PROPORTION RANGE	DESCRIPTIVE TERMS
< 5%	Clean
5 - 12%	Slightly (Clayey, Silty, Sandy)
12 - 30%	Clayey, Silty, Sandy, Gravelly
30 - 50%	Very (Clayey, Silty, Sandy, Gravelly)
Components are arranged in order of increasing quantities.	

NOTES: Soil classifications presented on exploration logs are based on visual and laboratory observation. Soil descriptions are presented in the following general order:

Density/consistency, color, modifier (if any) GROUP NAME, additions to group name (if any), moisture content. Proportion, gradation, and angularity of constituents, additional comments. (GEOLOGIC INTERPRETATION)

Please refer to the discussion in the report text as well as the exploration logs for a more complete description of subsurface conditions.

MOISTURE CONTENT

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.

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Tulailp, Washington

LEGEND OF TERMS AND SYMBOLS USED ON EXPLORATION LOGS

PROJECT NO.: 2021-036-21

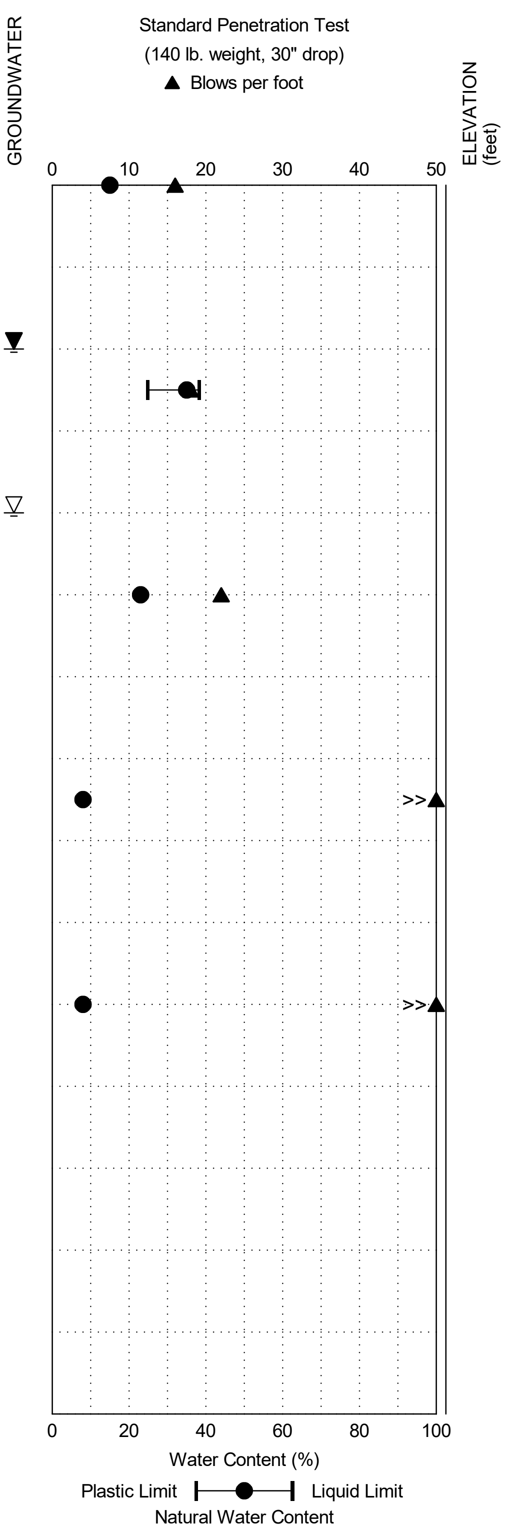
FIGURE: A-1

DRILLING COMPANY: Geologic Drill, Inc.
DRILLING METHOD: HSA, Bobcat Mini Track Rig
SAMPLING METHOD: SPT w/Rope & Cathead
LOCATION: See Figure 2B

DATE STARTED: 8/9/2021
DATE COMPLETED: 8/9/2021
LOGGED BY: S. Pemble

USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
	Medium dense, dark brown, silty SAND with rootlets. **(TOPSOIL)**	S-1	6-7-9	
SM	Medium dense, orange brown and olive brown mottled, gravelly, silty, SAND, moist. **(FILL/DISTURBED NATIVE SOIL)**			
ML	Very stiff, gray, gravelly, SILT, with scattered peaty organics, moist. **(VASHON RECESSIONAL OUTWASH)**	S-2	7-8-10	AL
SM	Medium dense, gray, gravelly, silty, SAND, wet. Gradational contact with silt above.	S-3	6-7-15	
SW SM	Very dense, dark gray, slightly silty, well graded SAND, wet. Composed of interlayered fine to coarse sand with fine gravel, wet. **(VASHON ADVANCE OUTWASH)**	S-4	37-41-50	GS
SP SM	Very dense, dark gray, slightly silty, gravelly, SAND, wet.	S-5	17-26-34	

Borehole was terminated at approximately 11.5-feet below ground surface. Groundwater was observed at 4.0-feet below ground surface and rose to 2.0-feet below ground surface when auger was removed from the hole.



DEPTH (feet): 0, 5, 10, 15

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

GEOSCIENCES INC.

Tulalip Pavement Preservation
Geotechnical Investigation
Totem Beach Road
Tulalip, Washington

BORING:
BH-1

PAGE: 1 of 1

PROJECT NO.: 2021-036-21
FIGURE: A-2

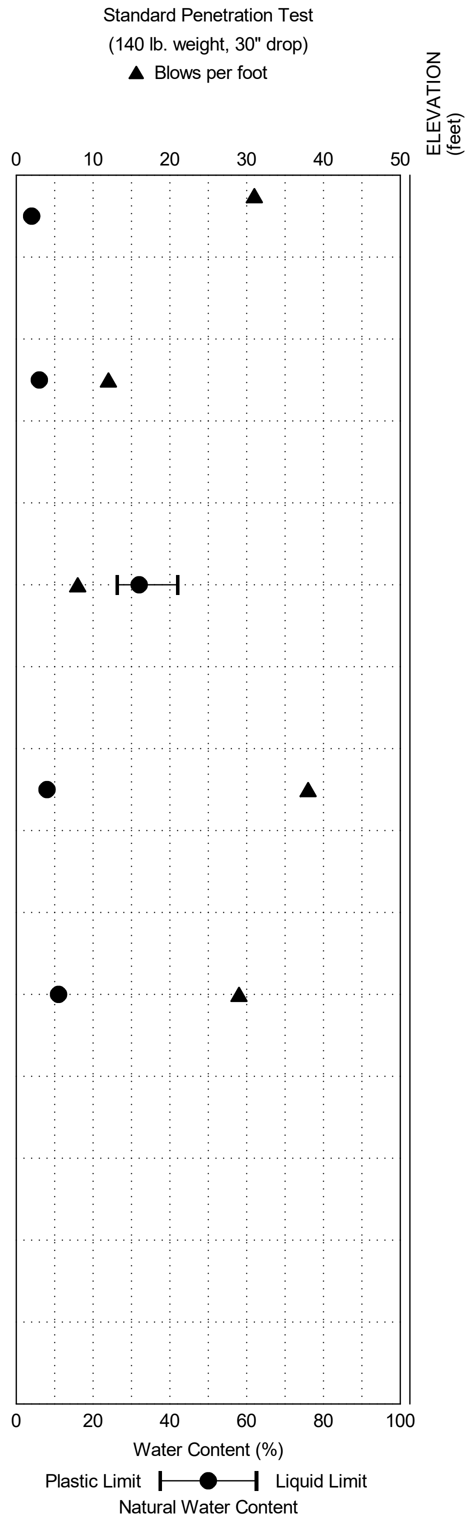
DRILLING COMPANY: Geologic Drill, Inc.
DRILLING METHOD: HSA, Bobcat Mini Track Rig
SAMPLING METHOD: SPT w/Rope & Cathead
LOCATION: See Figure 2B

DATE STARTED: 8/9/2021
DATE COMPLETED: 8/9/2021
LOGGED BY: S. Pemble

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		3.0-inches Hot Mix Asphalt. **(HMA)**	S-1a	17-16-15		
	SW SM	3.0-inches Crushed Base. Dense, brown, sandy, fine crushed GRAVEL, moist. 50% fractured aggregate. **(CRUSHED BASE)**	S-1b			
		Medium dense, olive brown, slightly silty, gravelly, well graded SAND, moist. **(VASHON RECESSIONAL OUTWASH)**	S-2	14-7-5	GS	▼
	ML	Medium stiff, gray, SILT, moist.				
5			S-3	3-3-5	AL	
		Moisture content increases to wet at 5.5-feet below ground surface.				
			S-4	7-21-17		▽
	SM	Dense, gray, gravelly, silty, coarse SAND, wet. **(ADVANCE OUTWASH)**				
10		Becomes medium dense, very silty, fine SAND, wet.	S-5	9-12-17		

Borehole was termianted at approximately 11.5-feet below ground surface. Groundwater was observed at 8.0-feet below ground surface during drilling and rose to 2.3-feet below ground surface after auger was removed from the hole.

15



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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Geotechnical Investigation
Totem Beach Road
Tulalip, Washington

BORING:
BH-2
PAGE: 1 of 1

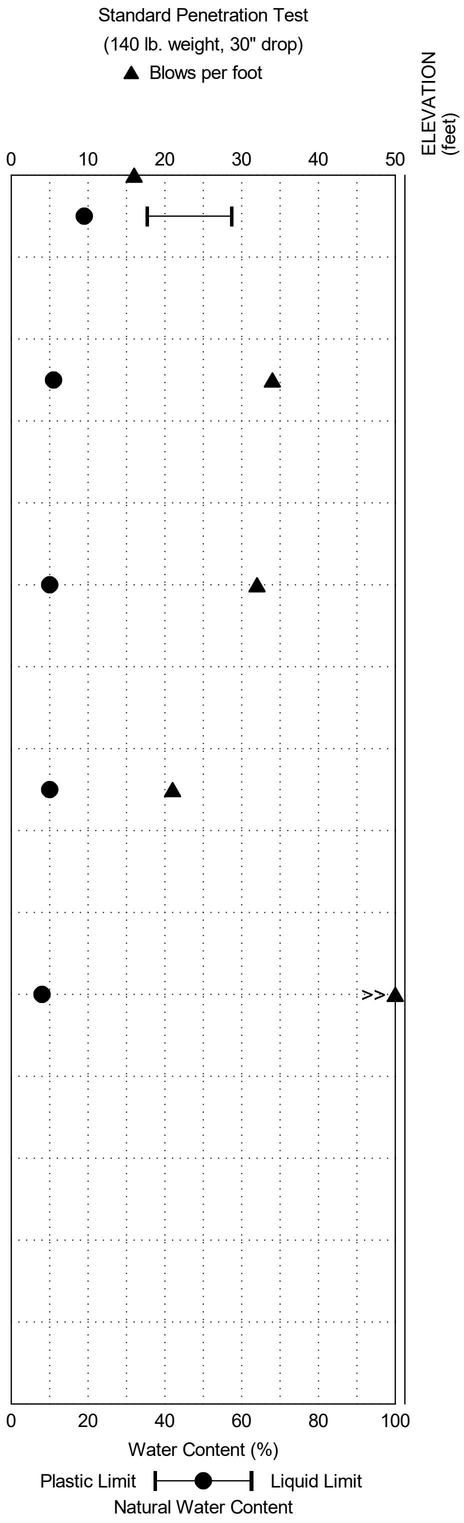
PROJECT NO.: 2021-036-21
FIGURE: A-3

DRILLING COMPANY: Geologic Drill, Inc.
DRILLING METHOD: HSA, Bobcat Mini Track Rig
SAMPLING METHOD: SPT w/Rope & Cathead
LOCATION: See Figure 2A

DATE STARTED: 8/9/2021
DATE COMPLETED: 8/9/2021
LOGGED BY: S. Pemble

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		Medium dense, dark brown, silty SAND with rootlets, moist. **(TOPSOIL)**	S-1a	8-10-6		
	MH	Very stiff, orange brown and gray mottled, elastic SILT, moist. **(VASHON RECESSIONAL OUTWASH)**	S-1b		AL	
			S-2	18-16-18		▼
	SM	Dense, gray, gravelly, silty SAND, moist. Tip of sampler was wet. **(ADVANCE OUTWASH)** Gravelly drilling at 4.0-feet below ground surface.				▽
5	SP	Dense, gray, gravelly, medium SAND, wet. Few silty SAND lenses throughout.	S-3	36-15-17	GS	
			S-4	13-12-9		
	SM	Medium dense to very dense, gray, gravelly, silty SAND, wet.				
10	GM	Very dense, gray, sandy, silty GRAVEL, wet.	S-5	17-33-29		
15						

Borehole was terminated at approximately 11.5-feet below ground surface. Groundwater was observed at 4.0-feet below ground surface during drilling and rose to 2.5-feet below ground surface after the auger was removed from the hole.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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Tulalip Pavement Preservation
Geotechnical Investigation
Totem Beach Road
Tulalip, Washington

BORING:
BH-3

PAGE: 1 of 1

PROJECT NO.: 2021-036-21 FIGURE: A-4

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 4-inch Diameter Core Barrel
STREET: Totem Beach Road, Southbound, 8' from curb

LOCATION: See Figure 2A
DATE COMPLETED: 8/10/21
LOGGED BY: S. Pemble

DEPTH (feet)	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0		3.0-inches Hot Mix Asphalt. 2 Lifts: 1.5" x 1.5" Cored on high severity alligator cracking. Cracked through full depth. Lifts are bonded. **(HMA)**				
	GP	Dense, brown, sandy GRAVEL, moist. **(FILL)**				
	ML	Stiff, gray with brown mottling, SILT, moist. **(VASHON RECESSIONAL OUTWASH)**				
		Becomes silty and sandy.				
		Corehole was terminated at 2.5-feet below ground surface. No groundwater seepage was observed during the exploration.				
3						

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

Tulalip Pavement Preservation
Geotechnical Investigation
Totem Beach Road
Tulalip, Washington

PAVEMENT CORE
Core-1

PAGE: 1 of 1

PROJECT NO.: 2021-036-21 FIGURE: A-5

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 4-inch Diameter Core Barrel
STREET: Totem Beach Road, Northbound, 6.5' from curb

LOCATION: See Figure 2A
DATE COMPLETED: 8/10/21
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0	■		2.25-inches Hot Mix Asphalt. 2 Lifts: 1.0" x 1.25" Cored on high severity alligator and longitudinal cracking. Cracked through full depth. Lifts are bonded. **(HMA)**				
	⁘	SP	Dense, brown, SAND, with gravel and cobbles, moist. **(VASHON RECESSIONAL OUTWASH)**				
			Corehole was terminated at 1.0-feet below ground surface. No groundwater seepage was observed during the exploration.				
3							

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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Tulalip Pavement Preservation
Geotechnical Investigation
Totem Beach Road
Tulalip, Washington

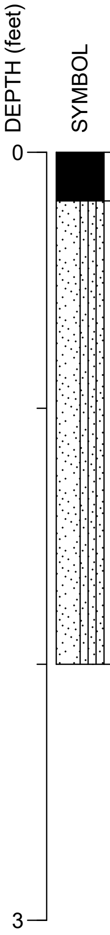
PAVEMENT CORE
Core-2

PAGE: 1 of 1

PROJECT NO.: 2021-036-21 FIGURE: A-6

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 4-inch Diameter Core Barrel
STREET: Totem Beach Road, Southbound, 5' from curb

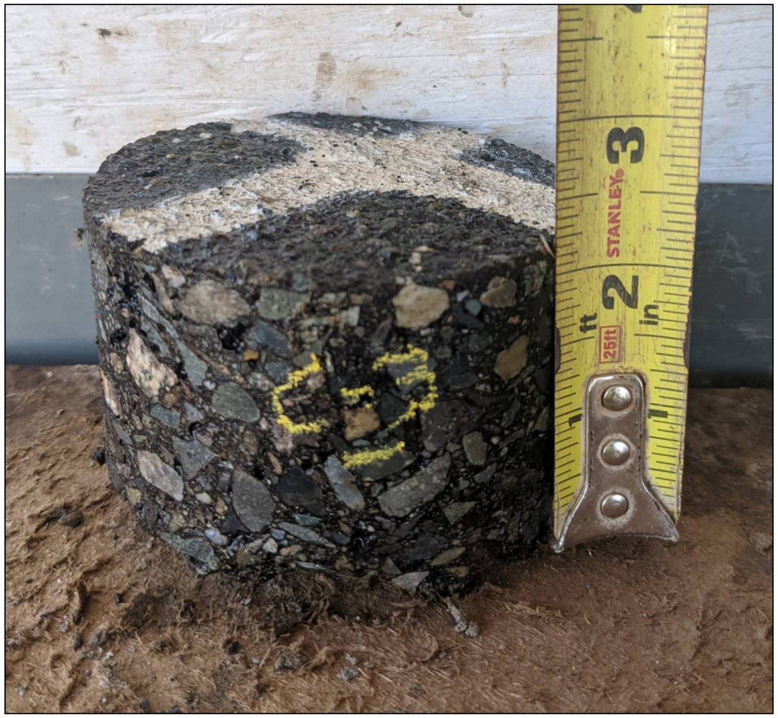
LOCATION: See Figure 2B
DATE COMPLETED: 8/10/21
LOGGED BY: S. Pemble



USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
	2.25-inches Hot Mix Asphalt. 2 Lifts: 1.125" x 1.125" No cracking at core location. Lifts are bonded. **(HMA)**				
SP SM	Dense, brown, SAND, with silt and gravel, moist. **(VASHON RECESSIONAL OUTWASH)**				

Corehole was terminated at 2.0-feet below ground surface. No groundwater seepage was observed during the exploration.

PAVEMENT CORE PHOTO



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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PAVEMENT CORE
Core-3

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PROJECT NO.: 2021-036-21 FIGURE: A-7

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 4-inch Diameter Core Barrel
STREET: Totem Beach Road, Westbound, 10' from edge of pavement

LOCATION: See Figure 2B
DATE COMPLETED: 8/10/21
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			2.0-inches Hot Mix Asphalt. 2 Lifts: 1.125" x 0.875" Cored on high severity alligator cracking. Cracked through full depth. Lifts are bonded. **(HMA)**				
		GP	Dense, brown, sandy, fine GRAVEL, moist. **(FILL)**				
		SM	Dense, brown, silty SAND, with gravel, moist. **(VASHON RECESSIONAL OUTWASH)** Becomes medium dense to dense and gray. Becomes dense and brown.				
3							

Corehole was terminated at 1.6-feet below ground surface. No groundwater seepage was observed during the exploration.

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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PAVEMENT CORE
Core-4

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PROJECT NO.: 2021-036-21 FIGURE: A-8

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 4-inch Diameter Core Barrel
STREET: Totem Beach Road, Westbound, 4.5' from edge of pavement

LOCATION: See Figure 2C
DATE COMPLETED: 8/10/21
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0	■		8.0-inches Hot Mix Asphalt. 4 Lifts: 1.75" x 1.5" x 2.0" x 2.75" No cracking at core location. Third and fourth lifts are unbonded. **(HMA)**				
	░	SM	Medium dense, brown, silty SAND, with gravel and slightly plastic fines, moist. **(FILL)** Very dense, gray, silty SAND, with gravel, moist.				
			Corehole was terminated at 1.1-feet below ground surface. No groundwater seepage was observed during the exploration.				
3							

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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PAVEMENT CORE
Core-5

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PROJECT NO.: 2021-036-21 FIGURE: A-9

EXCAVATION COMPANY: HWA GeoSciences Inc.
EXCAVATING EQUIPMENT: 4-inch Diameter Core Barrel
STREET: Totem Beach Road, Eastbound, 7.6' from edge of pavement

LOCATION: See Figure 2C
DATE COMPLETED: 8/10/21
LOGGED BY: S. Pemble

DEPTH (feet)	SYMBOL	USCS SOIL CLASS.	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT(%)	OTHER TESTS
0			8.25-inches Hot Mix Asphalt. 5 Lifts: 1.75" x 1.25" x 1.25" x 1.5" x 2.5" No cracking at core location. Fourth and fifth lifts are unbonded. **(HMA)**				
			1.0-inch Crushed Surfacing Base Course. Dense, brown, fine to coarse crushed GRAVEL, with sand, moist. **(CSBC)**				
		SM	Dense, brown and gray, silty SAND, with gravel, moist. **(FILL)**				
		ML	Stiff, gray, sandy SILT, with gravel, moist. **(VASHON RECESSIONAL OUTWASH)** Scattered peat like organics.				
			Corehole was terminated at 2.4-feet below ground surface. No groundwater seepage was observed during the exploration.				
3							

PAVEMENT CORE PHOTO

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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PAVEMENT CORE
Core-6

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PROJECT NO.: 2021-036-21 FIGURE: A-10

APPENDIX B

LABORATORY TEST RESULTS

APPENDIX B

LABORATORY TESTING

Representative soil samples obtained from the drilled borings were taken to the HWA laboratory in Bothell, Washington for examination and testing. Laboratory tests were conducted on selected soil samples to characterize engineering properties of the soils. Laboratory tests, as described below, included moisture content determination, grain size distribution, and Atterberg Limits. The results of the laboratory testing are presented in Appendix B.

Moisture Content of Soil: The moisture content (percent by dry mass) of select samples was determined in general accordance with ASTM D 2216. The results are shown at the sampled intervals on the appropriate exploration logs in Appendix A and on the Summary of Material Properties, Figure B-1.

Particle Size Analysis of Soils: The particle size distribution of select samples was determined in general accordance with ASTM D6913 (wet sieve and hydrometer method). The results are summarized on the attached Particle-Size Analysis of Soils report, Figure B-2, which also provides information regarding the classification of the samples and the moisture content at the time of testing.

Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits): The Atterberg limits of select samples were determined using method ASTM D 4318, multi-point method. The results are reported on the attached Liquid Limit, Plastic Limit, and Plasticity Index report, Figure B-3.

EXPLORATION DESIGNATION	SAMPLE NUMBER	TOP DEPTH (feet)	BOTTOM DEPTH (feet)	PENETRATION RESISTANCE (blows/6")	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			% GRAVEL	% SAND	% FINES	PROCTOR MAXIMUM DRY DENSITY (pcf)	OPTIMUM WATER CONTENT (%)	ASTM SOIL CLASSIFICATION	SAMPLE DESCRIPTION
							LL	PL	PI							
BH-01	S-1	0.0	1.5	6-7-9		15									SM	Dark reddish-brown, silty SAND
BH-01	S-2	2.5	4.0	7-8-10		35	38	25	13						ML	Dark gray, SILT
BH-01	S-3	5.0	6.5	6-7-15		23									SM	Very dark gray, silty SAND
BH-01	S-4	7.5	9.0	37-41-50		8				41.7	52.9	5.4			SW-SM	Very dark gray, well-graded SAND with silt and gravel
BH-01	S-5	10.0	11.5	17-26-34		8									SP-SM	Very dark gray, poorly graded SAND with silt and gravel
BH-02	S-1a	0.3	0.5	17-16-15											GP	Brown, sandy fine crushed GRAVEL
BH-02	S-1b	0.5	1.8			4									SM	Dark olive-brown, silty SAND with gravel
BH-02	S-2	2.5	4.0	14-7-5		6				25.2	64.6	10.2			SW-SM	Olive-brown, well-graded SAND with silt and gravel
BH-02	S-3	5.0	6.5	3-3-5		32	42	26	16						ML	Dark gray, SILT
BH-02	S-4	7.5	9.0	7-21-17		8									SM	Dark gray, silty SAND with gravel
BH-02	S-5	10.0	11.5	9-12-17		11									ML	Dark gray, sandy SILT with gravel
BH-03	S-1a	0.0	0.5	8-10-6											SM	Dark brown, silty SAND. contains rootlets and organic matter.
BH-03	S-1b	0.5	1.5			19	57	35	22						MH	Olive-brown, elastic SILT
BH-03	S-2	2.5	4.0	18-16-18		11									SM	Olive-gray, silty SAND with gravel
BH-03	S-3	5.0	6.5	36-15-17		10				41.9	53.9	4.1			SP	Dark gray, poorly graded SAND with gravel
BH-03	S-4	7.5	9.0	13-12-9		10									SM	Olive-gray, silty SAND with gravel
BH-03	S-5	10.0	11.5	17-33-29		8									GM	Olive-gray, silty GRAVEL with sand

Notes:
1. This table summarizes information presented elsewhere in the report and should be used in conjunction with the report text, other graphs and tables, and the exploration logs.
2. "Penetration Resistance" may represent the results of standard (SPT) or non-standard penetration tests. See exploration logs.

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SUMMARY OF MATERIAL PROPERTIES

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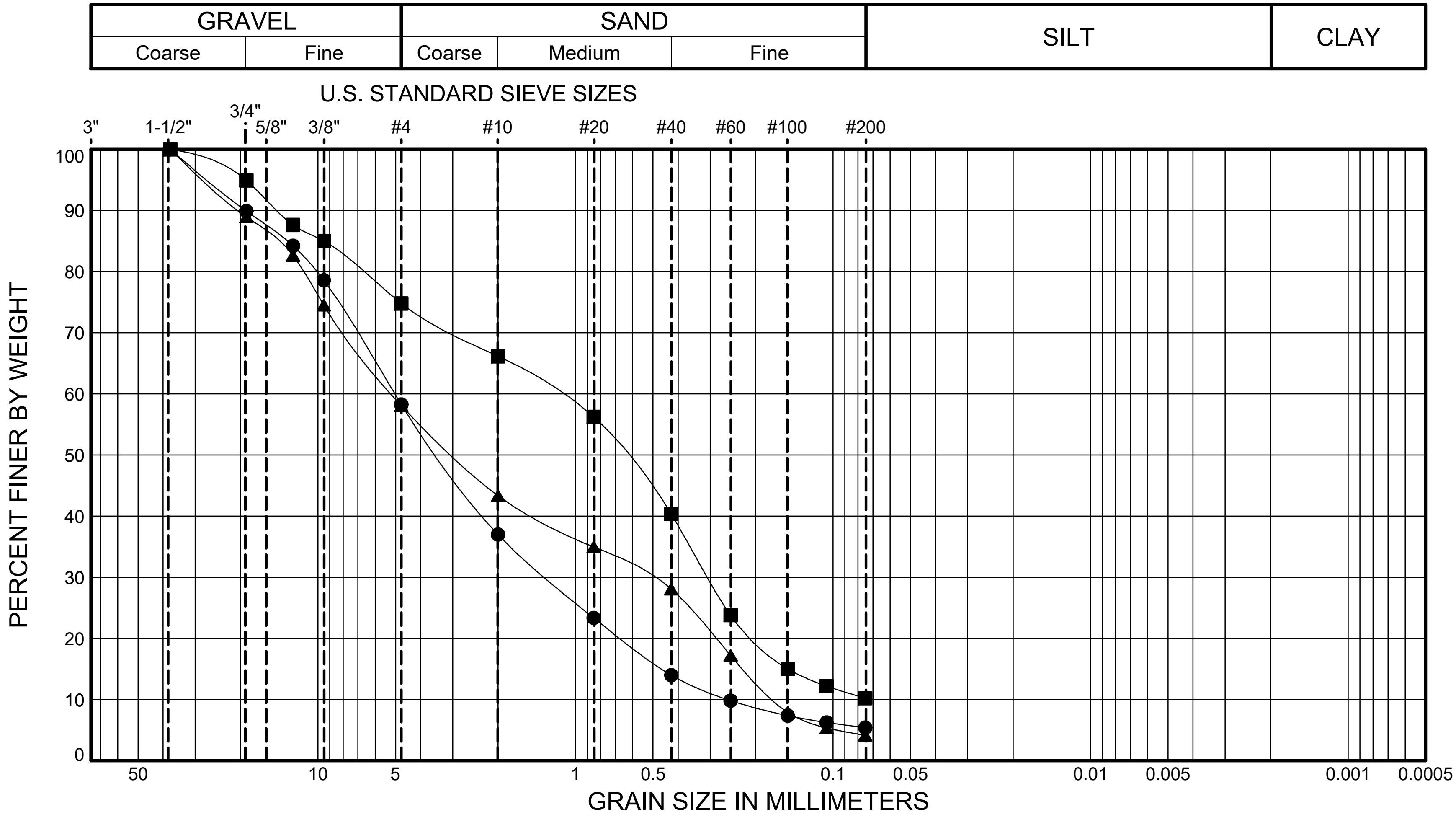
FIGURE: B-1



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	BH-01	S-4	BH-01,7.5	(SW-SM) Very dark gray, well-graded SAND with silt and gravel	8				41.7	52.9	5.4
■	BH-02	S-2	BH-02,2.5	(SW-SM) Olive-brown, well-graded SAND with silt and gravel	6				25.2	64.6	10.2
▲	BH-03	S-3	BH-03,5	(SP) Dark gray, poorly graded SAND with gravel	10				41.9	53.9	4.1

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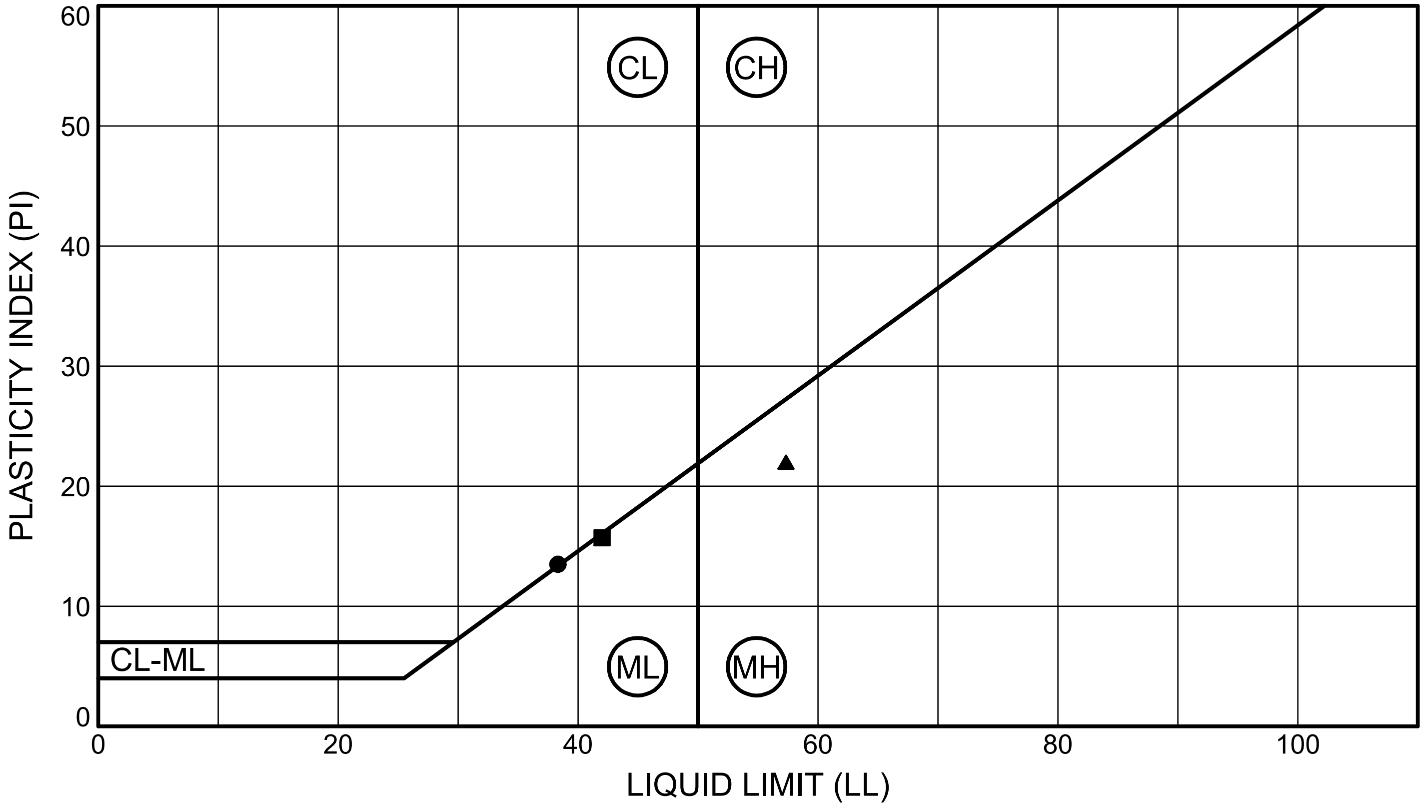
PARTICLE-SIZE ANALYSIS OF SOILS METHOD ASTM D422

PROJECT NO.: 2021-036-21 FIGURE: B-2



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	BH-01	S-2	2.5 - 4.0	(ML) Dark gray, SILT	35	38	25	13	
■	BH-02	S-3	5.0 - 6.5	(ML) Dark gray, SILT	32	42	26	16	
▲	BH-03	S-1b	0.5 - 1.5	(MH) Olive-brown, elastic SILT	19	57	35	22	

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS METHOD ASTM D4318

PROJECT NO.: 2021-036-21 FIGURE: B-3