Marine Drive Pedestrian/Bike Improvements
Phase 1: 64th Street NW to 7th Drive NW
Stormwater Site Plan

Prepared for
The Tulalip Tribes

March 2016

Prepared by
Parametrix

Marine Drive Pedestrian/Bike Improvements Phase 1: 64th Street NW to 7th Drive NW Stormwater Site Plan

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CITATION

Parametrix. 2016. Marine Drive Pedestrian/Bike Improvements
Phase 1: 64th Street NW to 7th Drive NW
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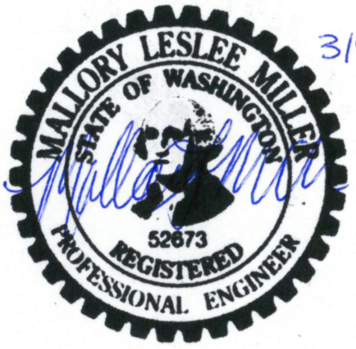
Washington. March 2016.

CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.



3/9/2016

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3-9-16

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KEY TERMS

BMPs	Best Management Practices
NRCS	Natural Resource Conservation Service Soils
PGIS	pollution-generating impervious surface
SEPA	State Environmental Policy Act
SF	square feet
SWPPP	Stormwater Pollution Prevention Plan
TDA	threshold discharge area

1. PROJECT OVERVIEW

The Marine Drive Pedestrian/Bike Improvements – 64th Street NW to 7th Drive NW Project aims to improve pedestrian safety and mobility from 64th Street NW to 7th Drive NW (approximately 7,750 feet), which connects The Tulalip Tribes' Administration Building to several Tribal housing developments. Current conditions consist of two through lanes and a left-turn lane at 12th Avenue NW with existing pedestrian access limited to narrow shoulders on both sides of Marine Drive. The proposed project will maintain the existing corridor layout – two through lanes and left-turn lane – with the addition of a widened shoulder along the north/east side of Marine Drive. The widened shoulder will improve non-motorized mobility and safety along Marine Drive between 64th Street NW and 7th Drive NW. Other project elements will include illumination, structural earth walls, and a wood boardwalk located near the intersection of 64th Street NW and Marine Drive.

The Natural Resource Conservation Service Soils (NRCS) survey identifies the soils in the project area as Alderwood gravelly sandy loam, Bellingham silty clay loam, Kitsap silt loam, Ragnar fine sandy loam, and Sulsavar gravelly loam. Alderwood gravelly sandy loam and Kitsap silt loam are classified as moderately well drained, Bellingham silty clay loam is classified as poorly drained, and Ragnar fine sandy loam and Sulsavar gravelly loam are classified as well drained. A full geotechnical analysis and report will be provided upon completion.

The 2005 Ecology *Stormwater Management Manual for Western Washington* was used for this project. The 2005 Ecology Manual is the current adopted Manual for The Tulalip Tribes. In existing conditions, surface runoff sheet flows off of Marine Drive into natural ditches and depressions on adjacent properties. There are also numerous culverts along the length of the project reach that convey the collected runoff across Marine Drive to adjacent properties where it disperses and infiltrates. There are approximately 5.9 acres of impervious surfaces in existing conditions. The developed conditions will consist of approximately .15 acre of new asphalt concrete pavement. Less than 5,000 square feet (SF) of impervious surfaces are being added to each threshold discharge area (TDA); therefore, added flow control and runoff treatment are not necessary. Existing site conditions will be maintained, allowing runoff to naturally disperse through existing soils and adjacent properties.

2. EXISTING SITE HYDROLOGY

The existing site is generally flat (0 to 8 percent slopes), but also has two small locations with moderate slopes of 8 to 15 percent and 15 to 30 percent. Types A and B soils are present throughout the project site and Type D soil is present near the intersection of Marine Drive and 64th Street NW. Marine Drive relies on sheet flow and natural dispersion into adjacent properties for stormwater management. The properties to the north and south of Marine Drive are residential and are located within The Tulalip Tribes' jurisdiction.

There are five distinct TDAs that exist in the project limits. TDA 1 is located on the north/east side of the road, TDA 2 is located on the south/west side, and TDAs 3, 4, and 5 cover all of Marine Drive within the right-of-way. Besides the culverts that cross Marine Drive, there is no additional constructed conveyance systems or flow control within the project area. All existing runoff sheet flows into adjacent properties and naturally disperses and infiltrates into the ground. There are several wetlands within the project limits but no known flooding problems.

A summary of the land cover within each TDA is included in Table 1.

Table 1. Existing Threshold Discharge Areas

Threshold Discharge Area	Existing Impervious Area (acres)	Existing Pervious Area (acres)	Total Area (acres)
TDA 1	0.70	0.61	1.31
TDA 2	1.08	4.03	5.11
TDA 3	1.03	0.96	1.98
TDA 4	2.38	2.00	4.38
TDA 5	0.74	0.61	1.34

3. DEVELOPED SITE HYDROLOGY

The project is designed to mitigate for all stormwater runoff within the right-of-way. There is no proposed conveyance system or flow control for the project because less than 5,000 SF of impervious surfaces are being added. The project allows existing runoff conditions to be maintained through natural dispersion into existing soils and adjacent properties.

A summary of the developed site land cover conditions for each TDA is included in Table 2.

Table 2. TDA Developed Site Land Cover Conditions

Threshold Discharge Area	Impervious Area (acres)	Pervious Landscape (acres)	Total Area (acres)
TDA 1	0.74	0.57	1.31
TDA 2	1.09	4.02	5.11
TDA 3	1.05	0.94	1.98
TDA 4	2.44	1.94	4.38
TDA 5	0.76	0.59	1.34

4. PERFORMANCE STANDARDS AND GOALS

The performance standards for the project are that each TDA within the project will meet the minimum technical requirements required by the 2005 Ecology *Stormwater Management Manual for Western Washington*. Further discussion of the minimum requirements and how the requirements apply to the project as a whole and within each TDA is included in Section 5.

5. MINIMUM TECHNICAL REQUIREMENTS

The minimum technical requirements in the 2005 Ecology *Stormwater Management Manual for Western Washington* were applied to both the project and each TDA. At the project level, the amount of pollution generating effective impervious area is 6,391 square feet (.15 acres). The amount of new impervious area within each of the five TDAs, however, is less than 5,000 square feet. Therefore, no additional water quality or flow control mitigation is necessary.

5.1 Minimum Requirement No. 1 – Preparation of Stormwater Site Plans

The Marine Drive Pedestrian/Bike Improvements – Phase 1 project adds more than 2,000 square feet of impervious surface and disturbs more than 7,000 square feet of land. A full stormwater site plan has been prepared for this project in accordance with Minimum Requirement No. 1. See Appendix D for project plans for the proposed improvements.

5.2 Minimum Requirement No. 2 – Construction Stormwater Pollution Prevention

A separate Construction Stormwater Pollution Prevention Plan (SWPPP) has been prepared for the project. See Appendix A for the SWPPP prepared for the Marine Drive Pedestrian/Bike Improvements – Phase 1 project. Through the preparation of a SWPPP and eventual application for the Ecology Construction Stormwater General Permit, this minimum technical requirement has been addressed. The SWPPP will address the 12 elements of Construction Stormwater Pollution Prevention which are:

1. Mark clearing limits.
2. Establish construction access.
3. Control flow rates.
4. Install sediment controls.
5. Stabilize soils.
6. Protect slopes.
7. Protect drain inlets.
8. Stabilize channels and outlets.
9. Control pollutants.
10. Control dewatering.
11. Maintain Best Management Practices (BMPs).
12. Manage the project.

5.3 Minimum Requirement No. 3 – Source Control of Pollution

The source control BMPs listed below give a broad overview of measures that will be taken to prevent stormwater from coming into contact with pollutants on site. Other applicable BMPs can be found in Volume IV of Ecology's 2005 *Stormwater Management Manual for Western Washington*.

To minimize dust generation during construction, the soil should be wet down with water prior to ground disturbance. All generated waste must be properly disposed.

Loose aggregate chunks and dust must be swept or shoveled and collected (not hosed down a storm drain) for recycling or proper disposal at the end of each workday.

A Spill Prevention Countermeasures and Control Plan will be required from the Contractor to mitigate for any potential spills or leaks from construction materials and equipment during construction.

5.4 Minimum Requirement No. 4 – Preservation of Natural Drainage Systems and Outfalls

In existing conditions, runoff from the Marine Drive corridor primarily sheet flows to roadside lawns, undeveloped properties, and wetlands which provides infiltration into native soils. There are also locations in TDAs 4 and 5 where the natural topography does not promote dispersion, so runoff is conveyed through culverts to the undeveloped properties on the other side of the road. The developed project shall maintain the natural drainage patterns, and discharges from the site shall continue to occur at existing locations of the discharge. The developed project will continue to allow stormwater to maintain the natural drainage paths and infiltrate into the native soils via interflow and groundwater.

5.5 Minimum Requirement No. 5 – On-Site Stormwater Management

The purpose of the project is to improve pedestrian safety by widening the existing shoulder along Marine Drive. The objective of Minimum Technical Requirement No. 5 (Section 2.5.5 of the 2005 Ecology Manual) is, "To use inexpensive practices on individual properties to reduce the amount of disruption of the natural hydrologic characteristics of the site." Since the project construction will not include individual properties, this requirement is not applicable to the project.

5.6 Minimum Requirement No. 6 – Runoff Treatment

Per Section 2.5.6 of the 2005 Ecology Manual, projects only require construction of stormwater treatment facilities when the total of effective, pollution-generating impervious surface (PGIS) is 5,000 square feet or more in a threshold discharge area. For this redevelopment project, the effective PGIS only applies to the new impervious surfaces added to each TDA. Table 3 presents the amount of new PGIS in each TDA in the project area.

Table 3. New Impervious Surface per TDA

TDA No.	New Impervious Surface, sf
1	1,743
2	279
3	912
4	2,648
5	809

There is no proposed runoff treatment for the project. Existing runoff conditions shall be maintained through natural dispersion into existing soils and adjacent properties.

5.7 Minimum Requirement No. 7 – Flow Control

Per Section 2.5.7 of the 2005 Ecology Manual, projects require construction of flow control facilities when the total of effective impervious surfaces is 10,000 square feet or more in a threshold discharge area. As shown in Table 3, the new impervious surfaces added to each TDA fall below this threshold. Therefore, no flow control system is proposed for this project.

5.8 Minimum Requirement No. 8 – Wetlands Protection

Per Section 2.5.8 of the 2005 Ecology Manual, the thresholds identified for Minimum Requirements No. 6 and No. 7 shall also be applied for discharges to wetlands. The project is below these thresholds, but measures will be taken during construction to protect the eight potential wetland areas to which the project discharges. All of the potential wetland areas will be delineated with a high visibility silt fence. The natural hydrology will be maintained via interflow and groundwater.

5.9 Minimum Requirement No. 9 – Basin/Watershed Planning

The project is not located in an area with an established Basin Plan. This Drainage Report and SWPPP (included in Appendix A) have been prepared in accordance with the Ecology Manual; therefore, the stormwater requirements for The Tulalip Tribes have been met.

5.10 Minimum Requirement No. 10 – Operation and Maintenance

The project does not exceed the thresholds described in Minimum Requirements 6 and 7; therefore, no stormwater facilities are proposed for the project. Maintenance standards for the BMPs used during project construction are included in the SWPPP.

6. FLOW CONTROL SYSTEM

There is no proposed flow control system for the project. Less than 5,000 SF of impervious surfaces are being added, allowing existing runoff conditions to be maintained through natural dispersion into existing soils and adjacent properties.

7. WATER QUALITY SYSTEM

Less than 5,000 square feet of new impervious surface will be added to each TDA in the project area. Therefore, no treatment facilities or structural source control BMPs are proposed.

8. CONVEYANCE SYSTEM ANALYSIS

The stormwater conveyance method for the project is sheet flow to adjacent properties. The project will not be changing the existing site hydrology and no downstream impacts are anticipated due to the amount of added impervious areas totaling less than 5,000 square feet per TDA.

9. OFF-SITE ANALYSIS

The natural drainage path for the stormwater under the existing conditions is dispersion or infiltration to the subsurface. No downstream drainage problems have been identified by The Tulalip Tribes, and no future drainage problems are anticipated to be caused by the project.

10. ANALYSIS OF THE FLOODPLAIN

The project area is not located within a floodplain. FEMA FIRM maps of the project area are included in Appendix B.

11. SPECIAL REPORTS AND STUDIES

A SWPPP and Geotechnical Report have been prepared for this project and are included in Appendices A and C, respectively.

12. OTHER PERMITS

Due to the funding sources and size of project, there are multiple permits that are required for this project. These permits include, but are not limited to:

- State Environmental Policy Act (SEPA).
- Construction Stormwater General Permit from Ecology.

Figures

Date: 9/29/2015 Path: P:\1598_MarineDrivePedBikeImprovement\MapDocs\Figure1_VicinityMap.mxd

Parametrix

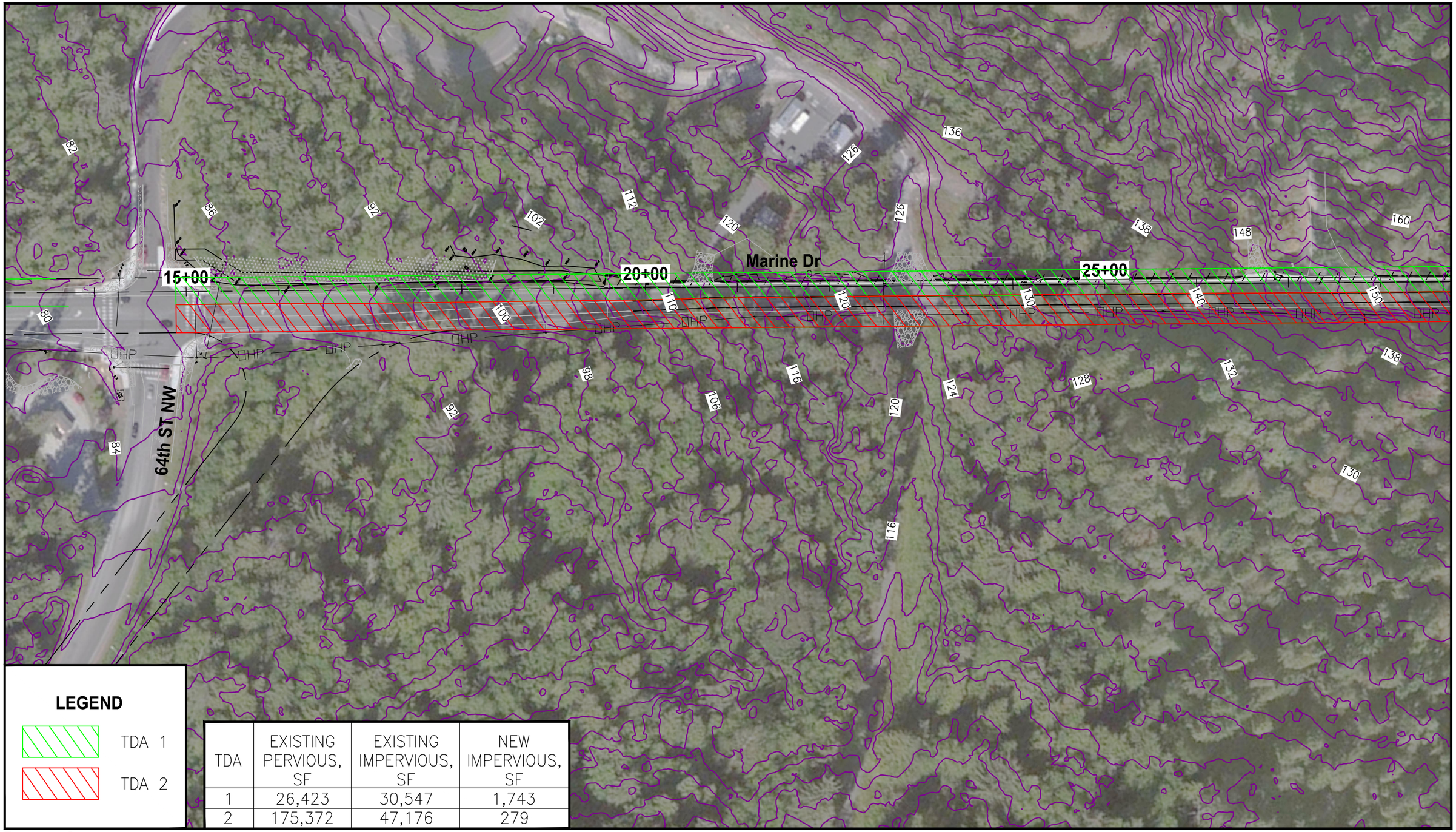
N

0 0.5 1 2 Miles

Alignment

Figure 1
Vicinity Map

Marine Drive
7th Drive NW to 64th St NW



LEGEND

TDA 1

TDA 2

TDA	EXISTING PERVIOUS, SF	EXISTING IMPERVIOUS, SF	NEW IMPERVIOUS, SF
1	26,423	30,547	1,743
2	175,372	47,176	279

Parametrix DATE: March 4, 2016 FILE: TDAFIGS

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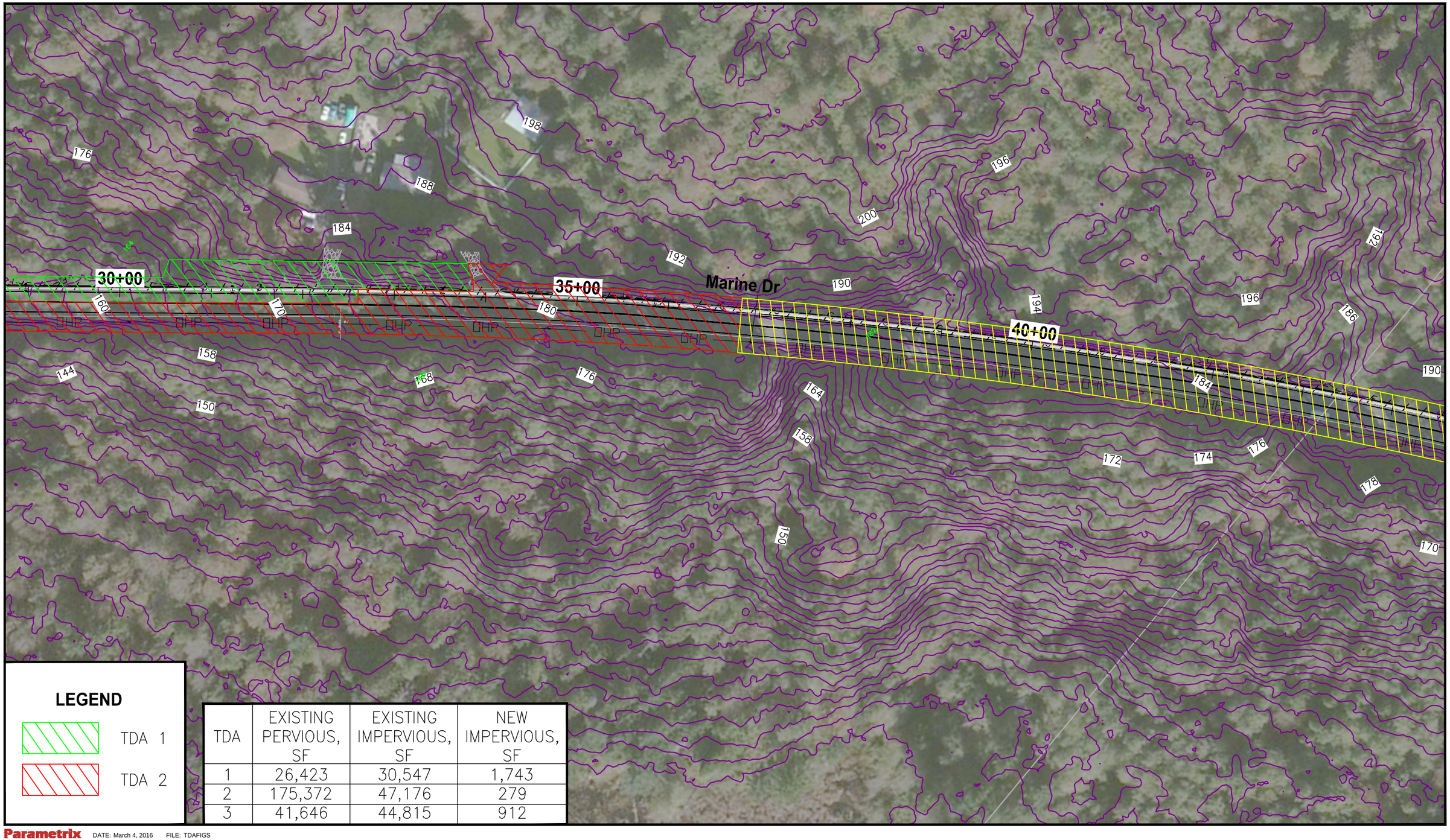
SCALE IN FEET

Figure 2A
Threshold Discharge Areas

Marine Drive Ped/Bike Improvements



LEGEND

TDA 1

TDA 2

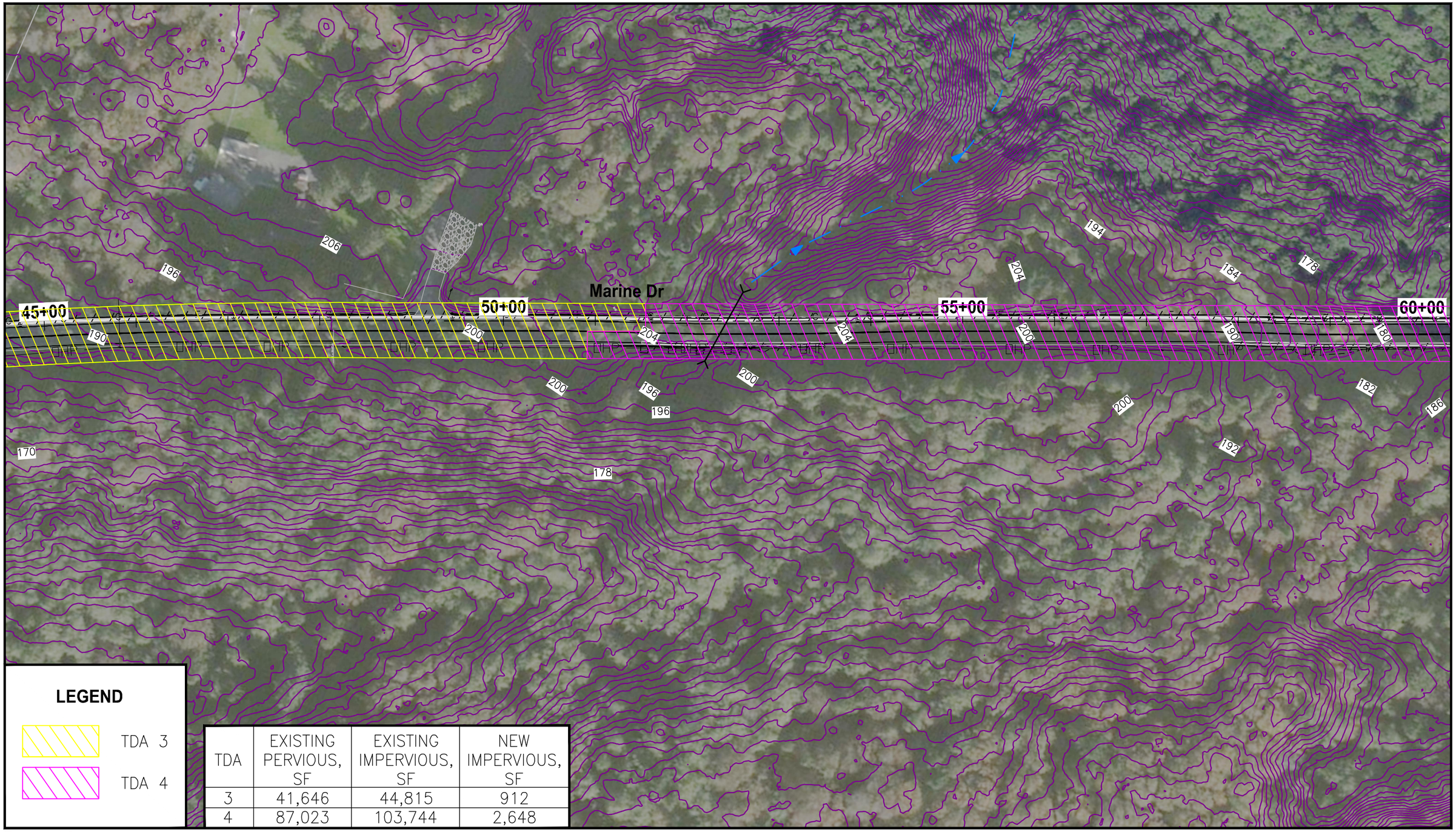
TDA	EXISTING PERVIOUS, SF	EXISTING IMPERVIOUS, SF	NEW IMPERVIOUS, SF
1	26,423	30,547	1,743
2	175,372	47,176	279
3	41,646	44,815	912

Parametrix DATE: March 4, 2016 FILE: TDAFIGS

0 N

SCALE IN FEET

Figure 2B
Threshold Discharge Areas
Marine Drive Ped/Bike Improvements



LEGEND

TDA 3

TDA 4

TDA	EXISTING PERVIOUS, SF	EXISTING IMPERVIOUS, SF	NEW IMPERVIOUS, SF
3	41,646	44,815	912
4	87,023	103,744	2,648

Parametrix DATE: March 4, 2016 FILE: TDAFIGS

0 N

SCALE IN FEET

Figure 2C
Threshold Discharge Areas

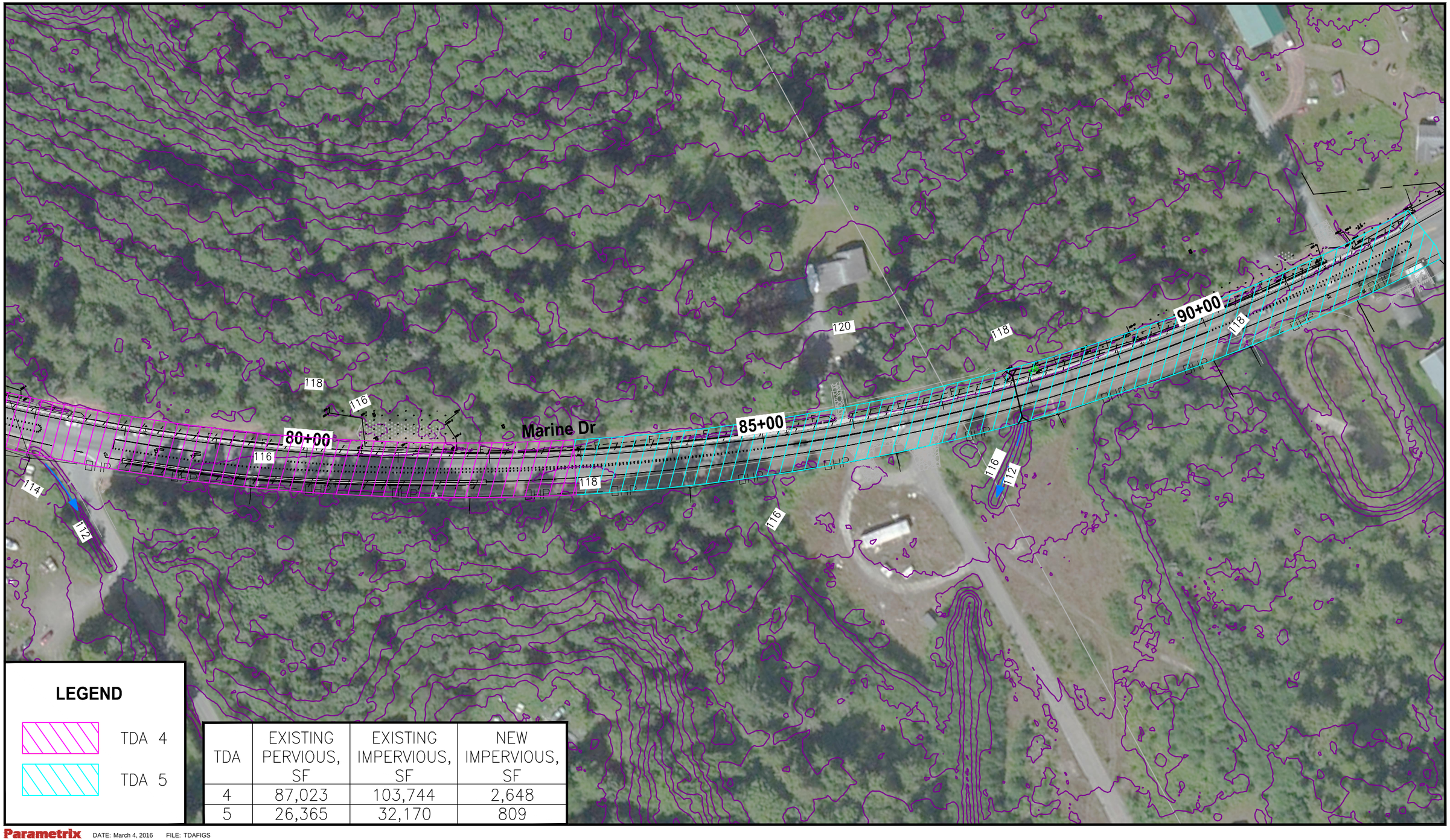
Marine Drive Ped/Bike Improvements

TDA	EXISTING PERVIOUS, SF	EXISTING IMPERVIOUS, SF	NEW IMPERVIOUS, SF
4	87,023	103,744	2,648

Parametrix DATE: March 4, 2016 FILE: TDAFIGS

0 N SCALE IN FEET

Figure 2D
Threshold Discharge Areas
Marine Drive Ped/Bike Improvements



LEGEND

TDA 4

TDA 5

TDA	EXISTING PERVIOUS, SF	EXISTING IMPERVIOUS, SF	NEW IMPERVIOUS, SF
4	87,023	103,744	2,648
5	26,365	32,170	809

Parametrix DATE: March 4, 2016 FILE: TDAFIGS

N

0

SCALE IN FEET

Figure 2E
Threshold Discharge Areas

Marine Drive Ped/Bike Improvements

Soil Map—Snohomish County Area, Washington
(Marine Drive Pedestrian Improvements)

Map Scale: 1:11,900 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 150 300 600 900

Feet
0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 12, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 9, 2010—Aug 28, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Snohomish County Area, Washington (WA661)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1	Alderwood gravelly sandy loam, 0 to 8 percent slopes	17.8	39.8%
2	Alderwood gravelly sandy loam, 8 to 15 percent slopes	6.9	15.5%
3	Alderwood gravelly sandy loam, 15 to 30 percent slopes	4.8	10.8%
7	Bellingham silty clay loam	2.3	5.1%
27	Kitsap silt loam, 0 to 8 percent slopes	7.0	15.6%
39	Norma loam	0.1	0.3%
57	Ragnar fine sandy loam, 0 to 8 percent slopes	5.5	12.3%
65	Sulsavar gravelly loam, 0 to 8 percent slopes	0.3	0.7%
Totals for Area of Interest		**44.9**	**100.0%**

Appendix A

Construction Stormwater
Pollution Prevention Plan

Marine Drive Pedestrian/Bike Improvements
Phase 1: 64th Street NW to 7th Drive NW
Stormwater Pollution Prevention Plan

Prepared for
The Tulalip Tribes

March 2016

Prepared by
Parametrix

Marine Drive Pedestrian/Bike Improvements Phase 1: 64th Street NW to 7th Drive NW Stormwater Pollution Prevention Plan

Prepared for

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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

3/9/2016

Prepared by Mallory Leslee Miller, P.E.

3-9-16

Checked by Austin R. Fisher, P.E.

Approved by Austin R. Fisher, P.E.

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APPENDICES

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B Spill Prevention, Contamination, Control, and Cleanup Plan (SPCCCP)

C BMP Inspection and Maintenance Forms

KEY TERMS

BMPs	best management practices
CESCL	Certified Erosion and Sediment Control Lead
CGP	Construction General Permit
CWA	Clean Water Act
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FWPCA	Federal Water Pollution Control Act
NPDES	National Pollutant Discharge Elimination System
SPCCCP	Spill Prevention, Containment, Control, and Cleanup Plan
SWPPP	Stormwater Pollution Prevention Plan
TESC	Temporary Erosion and Sediment Control
TMDL	Total Maximum Daily Load
WAC	Washington Administrative Code
WQA	Water Quality Act
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

1.1 Background

In 1972, Congress passed the Federal Water Pollution Control Act (FWPCA), also known as the Clean Water Act (CWA), to restore and maintain the quality of the nation's waterways. The ultimate goal was to make sure rivers and streams were fishable, swimmable, and drinkable. In 1987, the Water Quality Act (WQA) added provisions to the CWA that allowed the United States Environmental Protection Agency (EPA) to govern stormwater discharges from construction sites. Since that time, EPA issued a general permit that authorizes the discharge of pollutants in stormwater discharges associated with construction activity (also known as the National Pollutant Discharge Elimination System [NPDES] Construction General Permit [CGP]). The most current version of the CGP became effective on January 1, 2016. This CGP requires development of a Stormwater Pollution Prevention Plan (SWPPP) to maximize the potential benefits of pollution prevention and sediment and erosion control measures at construction sites. This SWPPP was prepared in accordance with Volume II of the 2005 *Stormwater Management Manual for Western Washington* (Washington State Department of Ecology [Ecology] 2005).

1.2 SWPPP Content

Development, implementation, and maintenance of the SWPPP provides the Contractor with the framework for reducing soil erosion and minimizing pollutants in stormwater during project construction. The SWPPP defines the characteristics of the site and the type of work to occur, and includes the following information:

- Identification of potential sources of pollution that may reasonably be expected to affect the quality of stormwater discharges from the construction site.
- Identification of the operators for the project site.
- Nature of construction activity, including the function of the project, the intended sequence and timing of activities that disturb soils at the site, and estimates of the total area expected to be disturbed by excavation, grading, or other construction activities.
- General location map (see Figure 1-1) and description of project and project features.
- Plan drawings showing all Temporary Erosion and Sedimentation Control (TESC) measures.
- Description of all pollution control measures (best management practices [BMPs]) that will be implemented as part of the construction activity to control pollutants in stormwater discharges.
- Description of interim and permanent stabilization practices for the site.
- Forms for maintaining dates when major grading activities occur and when construction activities temporarily or permanently cease on a portion of the site and dates when stabilization measures are initiated.
- Description of all post-construction stormwater management measures.
- Non-stormwater discharge management.

- Maintenance of erosion and sediment control measures.
- Reference to documentation of permit eligibility related to endangered species.
- Copy of the NPDES CGP.
- BMP inspection and maintenance forms.

Date: 9/29/2015 Path: P:\1598_MarineDrivePedBikeImprovement\MapDocs\Figure1_VicinityMap.mxd

Parametrix

N

0 0.5 1 2 Miles

Alignment

Figure 1
Vicinity Map

Marine Drive
7th Drive NW to 64th St NW

2. SWPPP COORDINATOR AND DUTIES

The Certified Erosion and Sediment Control Lead (CESCL) for the project will be designated by the Contractor after the contract has been awarded. Their duties include the following:

- Implement the SWPPP with the aid of the SWPPP team.
- Oversee maintenance practices identified as BMPs in the SWPPP.
- Implement and oversee employee training.
- Conduct or provide for inspection and monitoring activities.
- Identify other potential pollutant sources and make sure these sources are added to the plan.
- Identify any deficiencies in the SWPPP and make sure the deficiencies are corrected.
- Ensure that any changes in project plans are addressed in the SWPPP.

To aid in the implementation of the SWPPP, the key member of the project team is Debra Bray with The Tulalip Tribes.

3. SITE AND ACTIVITY DESCRIPTION

3.1 Site Location and Project Description

The Tulalip Tribes is proposing to construct a widened shoulder along the north/east side of Marine Drive between 64th Street NW and 7th Drive NW. The shoulder will also be widened at four locations along the south/west side of Marine Drive. Marine Drive consists of two through lanes and a left-turn lane at 12th Avenue NW.

The project goal is to improve pedestrian and bicycle safety and mobility along the corridor. The shoulder widening will increase the existing north/east shoulder width from approximately 2 feet to 6 feet. The project will also include new illumination, a wood boardwalk near at the intersection of 64th Street NW and Marine Drive, and retaining walls at several locations.

The illumination installation for the project will include the installation of 30 new LED streetlights along the north/east shoulder.

The wood boardwalk is 12-feet wide and approximately 475 feet in length. Construction of the wood boardwalk will occur in Category III wetlands.

The retaining walls for the project will be structural earth walls and will be located at five different locations. The purpose of the walls is to keep the cut and fill limits of the project within the right-of-way, and to protect existing culverts that cross Marine Drive.

3.2 Existing Site Conditions

Runoff currently sheet flows off the road into adjacent properties bordering the road and naturally disperses to the subsurface. No flow control exists within the project limits.

The project area is completely within the road right-of-way. Vegetation in the right-of-way is characterized by grass, shrubs, and deciduous trees. Based on aerial photos and ground investigations, there are several wetlands within or nearby the project limits. Seven Category III wetlands are within the project limits and one Category II wetland is located outside of the edge of rights-of-way (outside the project limits).

Site information is summarized in Table 3-1.

Table 3-1. Site Information

	Marine Drive
Location:	Marine Drive, Tulalip, WA
Body of Water that May Receive Water from the Project Site:	Wetlands
Site Area:	Approximately 6.5 acres
Construction Schedule:	Construction is scheduled to begin in 2016.
Site Activities:	Activities include clearing and grubbing, grading, construction, roadway embankment, paving, and planting.

3.3 Project Construction Work

Project construction work consists of widening an existing shoulder, installing a new illumination system, construction of a wood boardwalk within a Category III wetland, and construction of structural earth walls at multiple locations. Work activities will include clearing and grubbing, grading, paving with asphalt concrete, striping, constructing and installing temporary erosion control BMPs, planting, mitigation, and performing traffic control.

3.4 Temporary Erosion and Sedimentation Control

The Temporary Erosion and Sediment Control (TESC) plans for this project are included in the contract plans on Sheets DM1 through DM9. Copies of these drawings are included in Appendix A of this SWPPP.

4. IDENTIFICATION OF POTENTIAL STORMWATER CONTAMINANTS

4.1 Significant Material Inventory

Table 4-1 lists the pollutants that result from clearing, grading, excavation, and building materials that have the potential to be present in stormwater runoff. This table includes information regarding material type, chemical and physical description, and the specific regulated stormwater pollutants associated with each material.

Table 4-1. Potential Project Site Stormwater Pollutants

Trade Name Material	Chemical/Physical Description	Stormwater Pollutants
Pesticides (insecticides, fungicides, herbicides, rodenticides)	Various colored to colorless liquid, powder, pellets, or grains	Chlorinated hydrocarbons, organophosphates, carbonates, arsenic
Fertilizer	Liquid or solid grains	Nitrogen, phosphorous
Plaster	White granules or powder	Calcium sulphate, calcium carbonate, sulfuric acid
Cleaning solvents	Colorless, blue, or yellow-green	Perchloroethylene, methylene liquid chloride, trichloroethylene, petroleum distillates
Asphalt	Black solid	Oil, petroleum distillates
Concrete	White solid	Limestone, sand
Glue, adhesives	White or yellow liquid	Polymers, epoxies
Paints	Various colored liquid	Metal oxides, Stoddard solvent, talc, calcium carbonate, arsenic
Curing compounds	Creamy white liquid	Naphtha
Wastewater from construction	Water	Soil, oil and grease, solids equipment washing
Wood preservatives	Clear amber or dark brown liquid	Stoddard solvent, petroleum distillates, arsenic, copper, chromium
Hydraulic oil/fluids	Brown oily petroleum hydrocarbon	Mineral oil
Gasoline	Colorless, pale brown or pink petroleum hydrocarbon	Benzene, ethyl benzene, toluene, xylene, MTBE
Diesel fuel	Clear, blue-green to yellow liquid	Petroleum distillate, oil and grease naphthalene, xylenes
Kerosene	Pale yellow liquid petroleum hydrocarbon	Coal oil, petroleum distillates
Antifreeze/coolant	Clear green-yellow liquid	Ethylene glycol, propylene glycol, heavy metals (copper, lead, zinc)
Erosion	Solid particles	Soil, sediment

4.2 Potential Areas for Stormwater Contamination

The project includes embankment construction to accommodate shoulder widening; however, all stormwater runoff will infiltrate in the nearby soils and there is little to no risk of contamination from soil erosion. Existing pavement will be removed and grading will occur near wetlands. Any potential sources of stormwater contamination in this area will be addressed through appropriate mitigation measures during the shoulder widening construction, such as plastic protection, erosion control blankets, and geotextile mats (see Table 4-2 below).

Table 4-2. Locations of Potential Sources of Stormwater Contamination

Drainage Area	Potential Stormwater Contamination Point	Potential Pollutants	Potential Problem
Wetlands	Roadway Excavation/Grading/ Preparation for Paving	Soil erosion	Erosion of soils from excavated roadway and slopes prior to paving and final grading

4.3 A Summary of Available Stormwater Sampling Data

Stormwater sampling data are not available for the site.

4.4 Total Maximum Daily Load (TMDL) Information

The project does not impact the hydrology of the area. Stormwater runoff will continue to flow off of Marine Drive and disperse along the adjacent properties. In addition, there are no water bodies in the project area subject to TMDL restrictions. The EPA has approved a water quality improvement project to address fecal coliform bacteria TMDL within Quilceda Creek, which is located east of the project area. No contaminated water will be discharged into Quilceda Creek, and the project does not present a significant source of fecal coliform.

5. STORMWATER MANAGEMENT CONTROLS

The purpose of this section is to identify the types of temporary and permanent erosion and sediment controls that will be used during project activities for shoulder widening construction, boardwalk construction, and illumination installation. The controls will provide soil stabilization for disturbed areas and structural controls to divert runoff and remove sediment. This section will also address control of other potential stormwater pollutant sources such as project materials (paints, concrete dust, asphalt, solvents, etc.), waste disposal, control of vehicle traffic, and sanitary waste disposal.

5.1 Temporary and Permanent Erosion Control Practices

BMPs for the TESC elements of site construction activities are described below. The BMPs were taken from the 2005 Ecology *Stormwater Management Manual for Western Washington*. Specifications for these BMPs were taken from the Washington State Department of Transportation (WSDOT) *2016 Standard Specifications* document. A Spill Prevention, Containment, Control, and Cleanup Plan (SPCCCP) will be provided by the Contractor and will be inserted in Appendix B of this SWPPP.

5.1.1 TESC Element 1: Mark Clearing Limits

Risk Analysis (Project Construction)

Clearing limits will be delineated on the project site with silt fence (BMP C233), as shown on the plans. In general, clearing limits correspond to the perimeter of the construction site. In addition, there are multiple wetlands with associated buffers throughout the project area. The wetland boundary will be delineated with a high visibility silt fence. The silt fence and high visibility silt fence will be used to protect the existing adjacent properties, wetlands, and wetland buffers from silt and construction debris contamination during construction. No work shall be allowed beyond the limits of the fencing. Placement of both the silt fence and high visibility silt fencing will be along the contour near the right-of-way/easement line incorporating the J-Hook Method at 100-foot to 150-foot intervals to ensure no sedimentation will leave the project site.

5.1.2 TESC Element 2: Establish Construction Access

Risk Analysis (Project Construction)

The site will be accessed via existing public and private driveways. All site work shall be conducted within the existing rights-of-way and easement areas within the project limits, thereby reducing the construction disturbances to the project site limits. All identified project site access points are located within existing asphaltic impervious areas. Public roads will be cleaned, as necessary, to prevent sediment from entering waterways.

5.1.3 TESC Element 3: Control Flow Rates

Risk Analysis (Project Construction)

No flow control BMPs will be implemented for control of construction water on this project. No flow control facilities or BMPs are required for this project according to the *2005 Ecology Stormwater*

Management Manual for Western Washington. Runoff from the site will be naturally infiltrated and/or dispersed during construction and operation of the project, consistent with existing conditions.

Construction dewatering may be required for excavation and installation of the structural earth wall. Any dewatering activities shall adhere to Element 10 for control of dewatering in Volume II of the *2005 Ecology Stormwater Management Manual for Western Washington*.

5.1.4 TESC Element 4: Install Sediment Controls

Risk Analysis (Project Construction)

There are five soil types underlying the site (see Table 5-1). The Alderwood gravelly sandy loam and Kitsap silt loam are classified as moderately well-drained soils, Bellingham silty clay loam is classified as a poorly-drained soil, and Ragnar fine sandy loam and Sulsavar gravelly loam are classified as well-drained soils.

Table 5-1. On-Site Soils Information

Soil Type	Hydrologic Group	Infiltration	Location
Alderwood gravelly sandy loam	A	High	500 feet southeast of start of the project to Marine View Drive
Kitsap silt loam	B	Moderate	500 feet southeast of 12th Avenue NW to the end of the project
Bellingham silty clay loam	D	Very Low	Start of project to 500 feet southeast of 64th Street NW
Ragnar fine sandy loam	A/B	High/Moderate	Marine View Drive to 1,000 feet southeast of Marine View Drive
Sulsavar gravelly loam	A	High	500 feet north of Marine View Drive to Marine View Drive

Source: Natural Resource Conservation Service Soil Survey of Snohomish County.

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site. The silt fence and high visibility silt fence installed along the clearing limits and wetlands will be used for controlling sediment on the project.

In addition, sediment will be removed from paved areas in and adjacent to construction work areas manually or by using mechanical sweepers, as needed, to minimize tracking of sediments on vehicle tires away from the site and to minimize runoff occurring from sediments being washed off adjacent streets.

Whenever possible, sediment-laden water shall be discharged into on-site, relatively level, vegetated areas (BMP C240 paragraph 5, page 4-102).

5.1.5 TESC Element 5: Stabilize Soils

Risk Analysis (Project Construction)

Proposed project activities will disturb approximately 1.3 acres of soil within the project footprint. The project site contains Types A, B, and D soils throughout the project (see Table 5-1).

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. Construction is unscheduled at this point but is anticipated to occur in 2016. During the wet weather period, which is defined as October 1 to April 30, no soils shall remain exposed and unworked for more than 7 days. Furthermore, work performed during the wet weather period will be subject to the requirements identified in Division 8, Section 8-01.3(1) in the *2016 WSDOT Standard Specifications* (WSDOT 2016). From May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days.

Disturbed soils will be stabilized as directed by the Project Engineer using BMPs described in Section 8-01.3(2) Seeding, Fertilizing, and Mulching of the *WSDOT Standard Specifications* (WSDOT 2016). Plastic covering (BMP C123) and Dust Control (BMP C140) may also be used for soil stabilization on this project.

The project site is not exposed to persistent high winds.

5.1.6 TESC Element 6: Protect Slopes

Risk Analysis (Project Construction)

Slopes on the project site vary from flat to moderately steep and the site has a significant amount of slopes that will be exposed during construction.

All cut and fill slopes will be designed, constructed, and protected in a manner that minimizes erosion. BMP C120, Temporary and Permanent Seeding, will be used to protect slopes.

The site will be inspected in accordance with Elements 11 and 12, and any rills or erosion that form will be stabilized as directed by the Project Engineer

5.1.7 TESC Element 7: Protect Drain Inlets

Risk Analysis (Project Construction)

There are three catch basins located on the western side of Marine Drive, just northwest of 12th Avenue NW. Construction is not to occur in this area; however, inlet protection will be installed in each of these structures to protect the drainage system. Straw wattles shall also be installed at the upstream end of the culverts that cross Marine Drive.

5.1.8 TESC Element 8: Stabilize Channels and Outlets

Risk Analysis (Project Construction)

There will be no channels or outlets for drainage so this element has no risk for this project.

5.1.9 TESC Element 9: Control Pollutants

Risk Analysis (Project Construction)

Saw cutting will occur along the entire project length of Marine Drive. The project will be constructed with asphalt concrete pavement for the roadway. Application of fertilizers will occur along the entire length of Marine Drive to seed embankments. Equipment will be present for the entirety of the project timeline.

Per the conditions of Division 1, Legal Relations and Responsibilities to the Public, *WSDOT Standard Specifications* 1-07.15(1) Spill Prevention, Control and Countermeasures Plan, the Contractor shall prepare a project-specific Spill Prevention, Control, and Countermeasures Plan prior to commencement of any site work.

The following methods are proposed during saw cutting activities on the site:

- Slurry and cuttings will be vacuumed during cutting and surfacing operations.
- Slurry and cuttings will not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings will not drain to any natural or constructed drainage conveyance system.
- Slurry and cuttings will be disposed of in a manner that does not violate groundwater or surface water quality standards as identified in Washington Administrative Code (WAC) 173-200 and WAC 173-201A.

5.1.10 TESC Element 10: Control Dewatering

Risk Analysis (Project Construction)

Dewatering activities are not anticipated for construction of the shoulder widening; however, may be required for installation of the structural earth wall. Any dewatering activities shall adhere to Element 10 for control of dewatering in Volume II of the *2005 Ecology Stormwater Management Manual for Western Washington*.

The preferred method for managing dewatering water is to pump it to an upland area adjacent to the site designated by the Project Engineer and infiltrated. Alternatively, water may be pumped into a temporary stormwater treatment tank.

If dewatering activities are required, no direct discharge of the turbid water into the nearby wetlands is allowed. Any discharge from the dewatering system will pump water through a sediment bag, or into compost socks and silt fencing prior to discharging to nearby vegetated areas.

5.1.11 TESC Element 11: Maintain BMPs

Risk Analysis (Project Construction)

There are no unique foreseen circumstances that would render the WSDOT Maintenance Specification, Section 8-01.3(15), insufficient.

5.1.12 TESC Element 12: Manage the Project

Risk Analysis (Project Construction)

There are no unique foreseen circumstances that would render the WSDOT Erosion and Sediment Control Lead Specification, Section 8-01.3(1)B, insufficient.

5.2 Practices to Minimize Stormwater Contamination

All metal and general waste materials will be loaded into a truck and taken to a certified waste disposal site. Any miscellaneous trash and debris from the site will be deposited in a dumpster and emptied a

minimum of twice per week. No materials will be buried on site. All personnel will be instructed regarding the correct procedure for waste disposal. All sanitary waste will be collected from the portable units by a licensed sanitary waste management contractor. Good housekeeping and spill control practices will be followed during project activities to minimize stormwater contamination from petroleum products, fertilizers, paints, and concrete.

5.3 Coordination of BMPs with Project Activities

The BMP implementation schedule will be driven by the shoulder widening construction schedule. The following provides a sequential list of the proposed construction schedule milestones and the corresponding BMP implementation schedule. Implementation of TESC BMPs will be staged along with construction.

The BMP implementation schedule listed below is keyed to proposed phases of the construction project. The project site is located west of the Cascade Mountain Crest. As such, the dry season is considered to be from May 1 to September 30, and the wet season is considered to be from October 1 to April 30.

Estimated Roadway Construction Start Date:	June 2016
Mobilize Equipment On-Site:	June 2016
Mobilize and Store All TESC and Soil Stabilization Products:	June 2016 through project completion
Install TESC Measures:	June 2016
Substantial Completion Date:	October 2016
Complete Remaining Construction Elements:	December 2016

5.4 Post-Construction Stormwater Management Measures

The project adds less than 5,000 square feet of impervious surfaces to each threshold discharge area. No additional permanent stormwater management measures are required.

5.5 Certification of Compliance with Federal, State, and Local Regulations

This SWPPP reflects the requirements for stormwater management and erosion and sediment control, as established in The Tulalip Tribes Ordinances. To ensure compliance, this plan was prepared in accordance with the *2005 Stormwater Management Manual for Western Washington.*

6. NON-STORMWATER DISCHARGE MANAGEMENT

The following allowable sources of non-stormwater discharges from Subpart 1.3.B of the NPDES permit could potentially be combined with stormwater discharges associated with construction activities at the Marine Drive construction site:

- Water used to control dust in accordance with Subpart 3.4.G of the NPDES permit.
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and where detergents are not used.
- Uncontaminated groundwater or spring water.
- Discharge from foundation or footing drains where flows are not contaminated with process materials such as solvents.
- Uncontaminated water from excavation dewatering activities.

Measures specified in the SPCCCP (to be submitted by the Contractor and included in Appendix B) will be implemented, to the extent feasible, to eliminate or reduce these non-stormwater components of discharge from construction activities.

7. MAINTENANCE OF CONTROLS

All erosion and sediment control measures and other protective measures identified in this SWPPP will be maintained in effective operating condition for the shoulder widening and construction of the structural earth wall and boardwalk. All associated maintenance schedules/standards and procedures are located in Appendix C. If site inspections identify BMPs that are not operating effectively, maintenance will be performed as soon as possible and before the next storm event, whenever practicable, to maintain the continued effectiveness of stormwater controls.

If existing BMPs need to be modified, or if additional BMPs are necessary for any reason, implementation will be completed before the next storm event, whenever practicable. If implementation before the next storm event is impracticable, the situation will be documented in this SWPPP, and alternative BMPs will be implemented as soon as possible.

8. PERMIT ELIGIBILITY RELATED TO ENDANGERED SPECIES

There are seven federally listed threatened or endangered wildlife species that may occur in the vicinity of the project. An Environmental Assessment (Parametrix 2015) was prepared to address potential impacts of the project on these listed species. According to the document, there will be no effect on the identified endangered species in the designated project area.

9. INSPECTION PROCEDURES

9.1 Inspections

All cleared and graded areas of the project site will be visually inspected daily and within 24 hours of the end of a storm with rainfall amounts greater than 0.5 inch. The inspection will be conducted by the SWPPP coordinator or his designated stormwater team members. The inspection will verify that the structural BMPs described in Section 5 of this SWPPP are in good condition and are minimizing erosion. The inspection will also verify that the procedures used to prevent stormwater contamination from project materials and petroleum products are effective. The following inspection and maintenance practices will be used to maintain erosion and sediment controls:

- Built-up sediment will be removed from silt fencing when it has reached one-third of the fence height.
- Silt fences will be inspected for depth of sediment, any fabric tears, and to ensure the fabric is securely attached to the fence posts, and to verify that the fence posts are firmly in the ground.
- Temporary and permanent seeding will be inspected for bare spots, washouts, and healthy growth.
- Controlled dewatering on site will be inspected to ensure appropriate mitigation measures (e.g., compost socks), according to Volume II of the *2005 Stormwater Management Manual for Western Washington*, are in place and working at all times of dewatering disposal operation.

The designated CESCL will complete the maintenance inspection report form after each inspection (see Appendix C of this SWPPP for a copy of the report form). Completed forms will be maintained on-site during the entire project. Following construction, the completed forms will be retained at the general contractor's office for a minimum of 1 year.

If project activities or design modifications are made to the site plan that could affect stormwater, this SWPPP will be amended appropriately. The amended SWPPP will describe the new activities that contribute to the increased pollutant loading and the planned source control activities.

9.2 Employee Training

An employee training program will be implemented to inform employees about the requirements of the SWPPP. This educational program will provide background information on the components and goals of the SWPPP. The program will also provide hands-on training in erosion controls; spill prevention and response; good housekeeping practices; proper material handling; disposal and control of waste, equipment fueling; and proper storage, washing, and inspection procedures. All employees will be trained prior to their first day on the site.

9.3 Certification

Contractor Certification (_____)

I certify that I understand the requirements of this plan.

Name: _____

Title: _____

Date: _____

10. REFERENCES

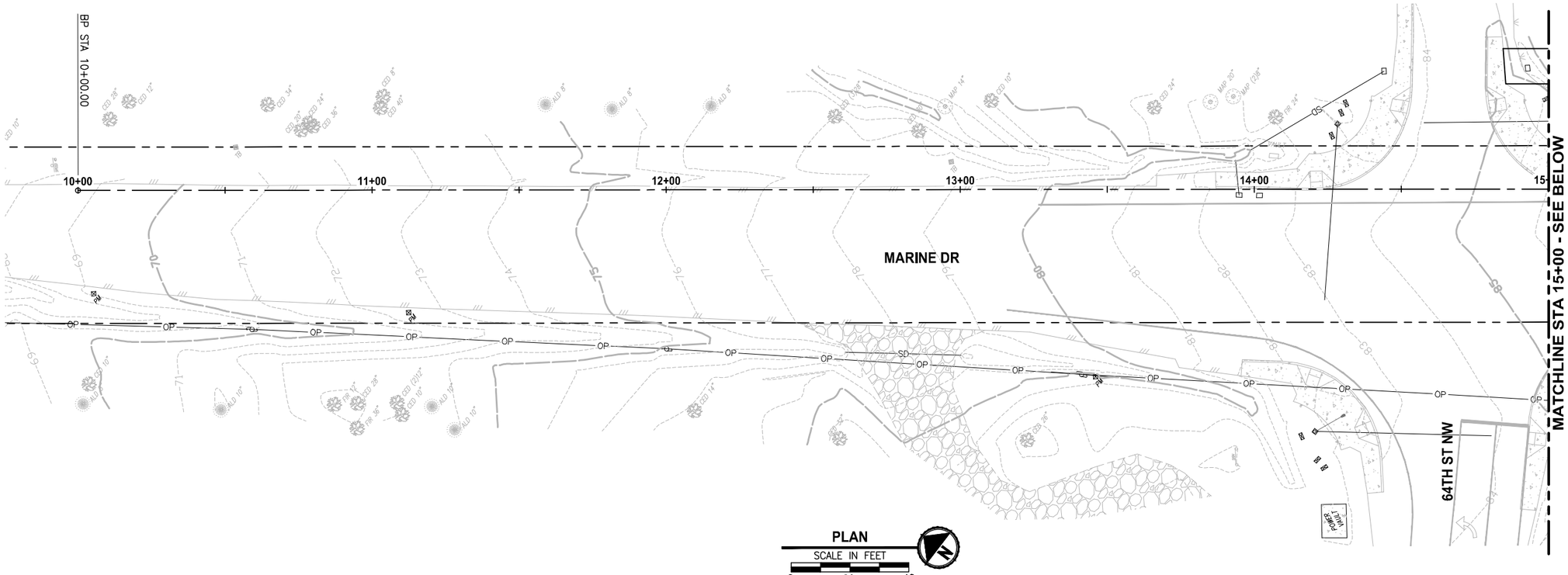
Ecology. (Washington State Department of Ecology). 2005. Water quality program. Stormwater management manual for western Washington. February 2005.

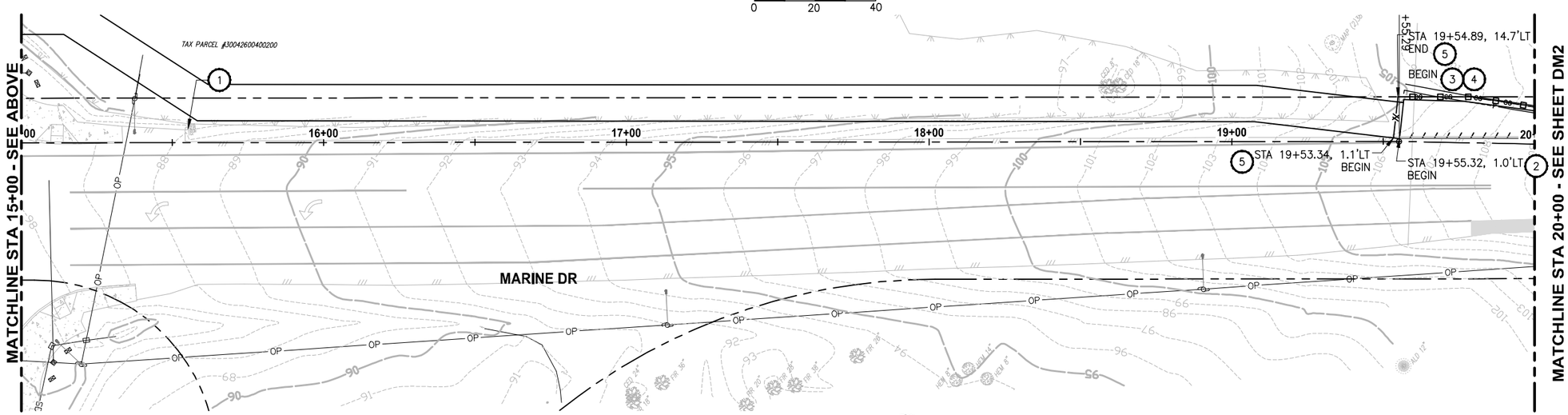
Parametrix. 2015. Marine Drive pedestrian and bicycle improvements project – Phase 1 environmental assessment. Prepared by Parametrix, Puyallup, Washington. September 2015.

WSDOT (Washington State Department of Transportation). 2016. Standard specifications for road, bridge, and municipal construction. M 41-10. Olympia, Washington.

Appendix A

Temporary Erosion and
Sedimentation Control Plan
and Revegetation Plan Drawings





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PLAN
SCALE IN FEET
0 20 40

CONSTRUCTION NOTES:

1. SEE CH SHEETS FOR SIGN MODIFICATIONS.
2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I–30.15–02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

GENERAL NOTES:

1. SILT FENCE SHALL FOLLOW CLEARING AND GRUBBING LIMITS UNLESS SHOWN OTHERWISE ON PLANS.
2. MAINTAIN ACCESS AT PRIVATE DRIVEWAYS DURING CONSTRUCTION AT ALL TIMES.
3. ALL WORK SHALL BE PERFORMED WITHIN THE EXISTING RIGHT–OF–WAY.
4. SEE CH SHEETS FOR ALIGNMENT EQUATIONS.

SNOHOMISH COUNTY
TRAFFIC ENGINEER
APPROVED FOR CONSTRUCTION
BY _____
JIM BLOODGOOD, P.E.

PERMIT SUBMITTAL
NOT FOR CONSTRUCTION

Know what's below. Call before you dig.

	REVISIONS	DATE	BY

DESIGNED B. THOMAS
DRAWN E. SOTO
CHECKED
APPROVED

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY
FILE NAME PS1598078P01T04–DM
JOB No. 554–1598–078 (01/05)
DATE MARCH 2016

AUSTIN ROY FISHER — STATE OF WASHINGTON — 41048 — REGISTERED PROFESSIONAL ENGINEER
PRELIMINARY

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES
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WWW.PARAMETRIX.COM

PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 10+00 TO STA 20+00

SHEET NO. 4 OF 35
DM1

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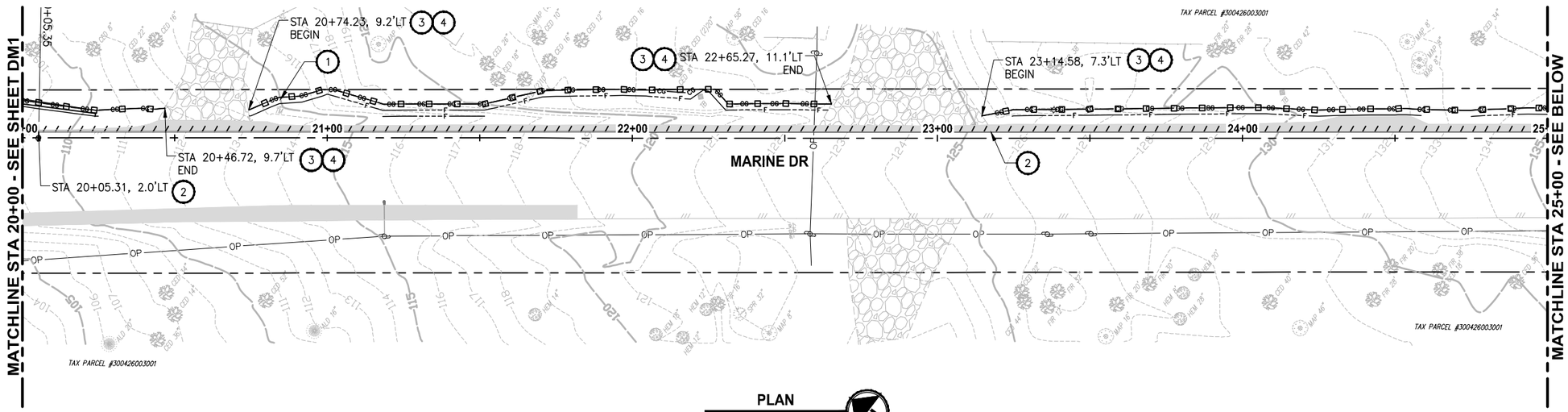

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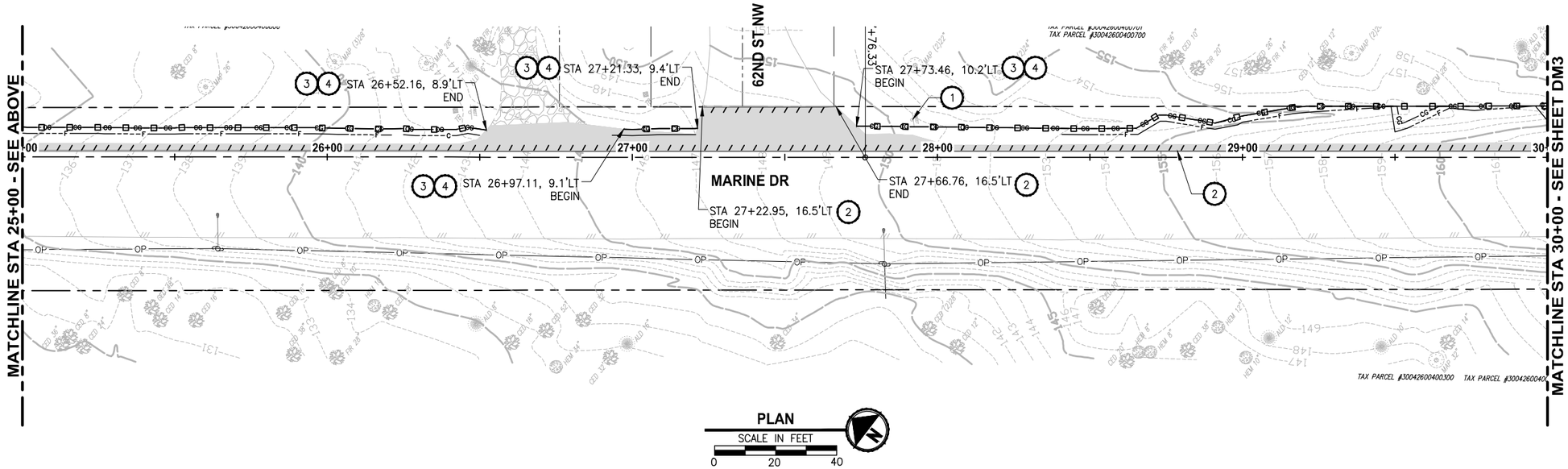

PLAN
SCALE IN FEET
0 20 40

CONSTRUCTION NOTES:

1. SEE CH SHEETS FOR SIGN MODIFICATIONS.
2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I–30.15–02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

GENERAL NOTES:

1. SILT FENCE SHALL FOLLOW CLEARING AND GRUBBING LIMITS UNLESS SHOWN OTHERWISE ON PLANS.
2. MAINTAIN ACCESS AT PRIVATE DRIVEWAYS DURING CONSTRUCTION AT ALL TIMES.
3. ALL WORK SHALL BE PERFORMED WITHIN THE EXISTING RIGHT–OF–WAY.
4. SEE CH SHEETS FOR ALIGNMENT EQUATIONS.

SNOHOMISH COUNTY
TRAFFIC ENGINEER
APPROVED FOR CONSTRUCTION
BY _____
JIM BLOODGOOD, P.E.

PERMIT SUBMITTAL
NOT FOR CONSTRUCTION

811 Know what's below. Call before you dig.

	REVISIONS	DATE	BY

DESIGNED B. THOMAS
DRAWN E. SOTO
CHECKED
APPROVED

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY
FILE NAME PS1598078P01T04–DM
JOB No. 554–1598–078 (01/05)
DATE MARCH 2016

AUSTIN ROY FISHER — STATE OF WASHINGTON — 41048 — REGISTERED PROFESSIONAL ENGINEER
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PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 20+00 TO STA 30+00

SHEET NO. 5 OF 35
DM2

PATH: U:\PSO\Projects\Clients\1598–TulalipTribes\214–1598–078 MarineDrPedBikeImprove\995\cs\CADD\Phase 01\Task 04\DWG\
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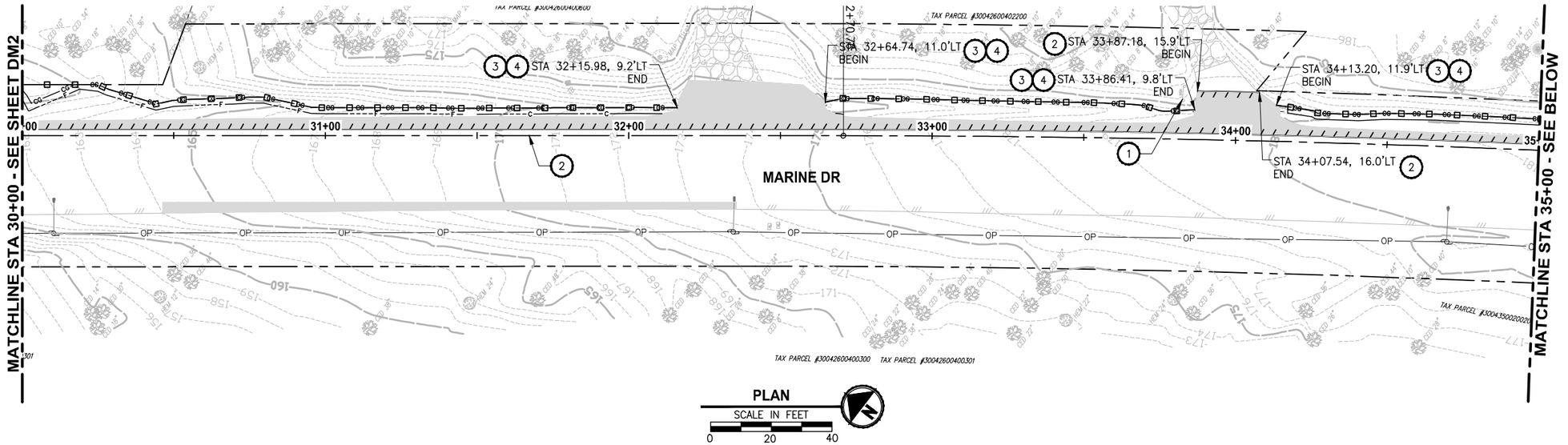
PLOTTED BY: wrighjph DATE: Wednesday, March 30, 2016 7:02:52 PM



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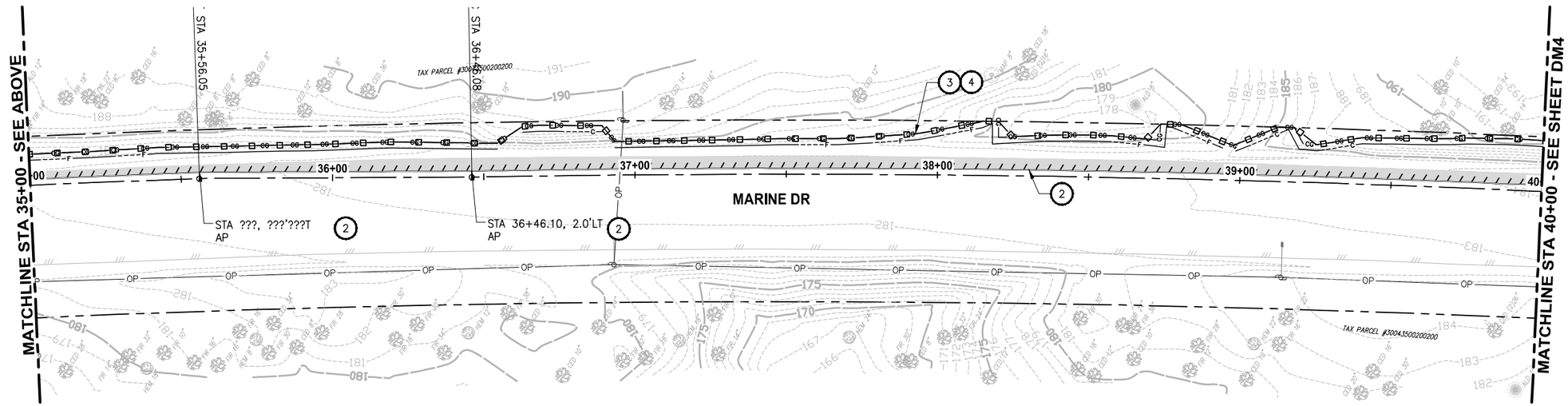

PLAN
SCALE IN FEET
0 20 40

CONSTRUCTION NOTES:

1. SEE CH SHEETS FOR SIGN MODIFICATIONS.
2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I-30.15-02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I-30.17-00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I-30.30-01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

GENERAL NOTES:

1. SILT FENCE SHALL FOLLOW CLEARING AND GRUBBING LIMITS UNLESS SHOWN OTHERWISE ON PLANS.
2. MAINTAIN ACCESS AT PRIVATE DRIVEWAYS DURING CONSTRUCTION AT ALL TIMES.
3. ALL WORK SHALL BE PERFORMED WITHIN THE EXISTING RIGHT-OF-WAY.
4. SEE CH SHEETS FOR ALIGNMENT EQUATIONS.

SNOHOMISH COUNTY
TRAFFIC ENGINEER
APPROVED FOR CONSTRUCTION
BY _____
JIM BLOODGOOD, P.E.

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NOT FOR CONSTRUCTION

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DESIGNED B. THOMAS
DRAWN E. SOTO
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APPROVED

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

FILE NAME PS1598078P01T04-DM
JOB No. 554-1598-078 (01/05)
DATE MARCH 2016

PRELIMINARY

AUSTIN ROY FISHER — STATE OF WASHINGTON — 41048 — REGISTERED PROFESSIONAL ENGINEER

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PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 30+00 TO STA 40+00

SHEET NO. 6 OF 35

DM3

PATH: U:\PSO\Projects\Clients\1598-TulalipTribes\214-1598-078 MarineDrPedBikeImprove\99Sxcs\CADD\Phase 01\Task 04\DWG\
PLOTTED BY: wrighjoh DATE: Wednesday, March 30, 2016 7:03:17 PM
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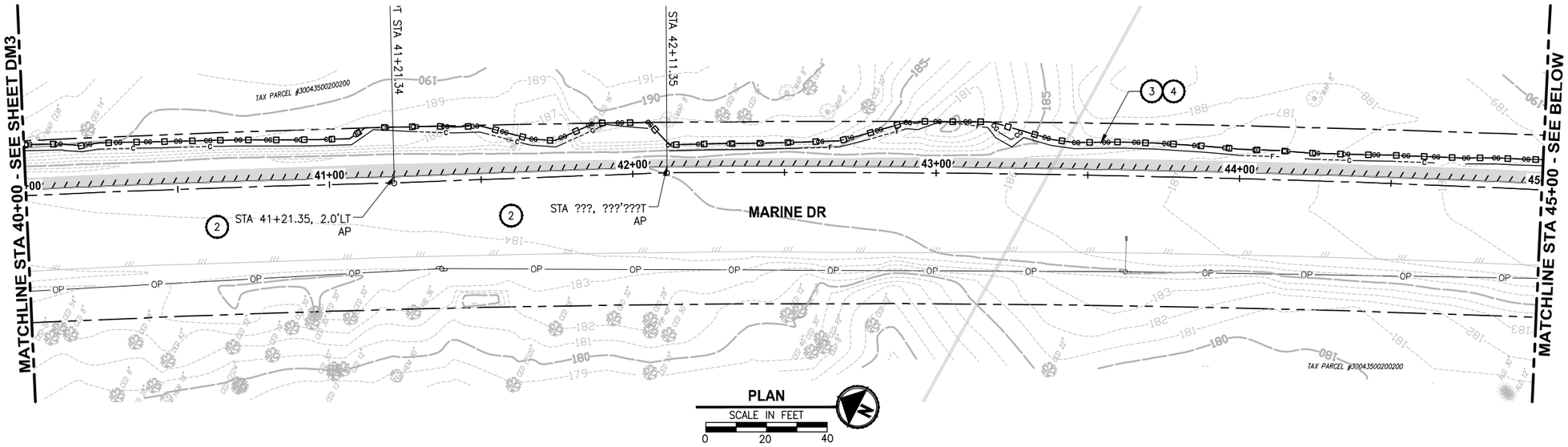

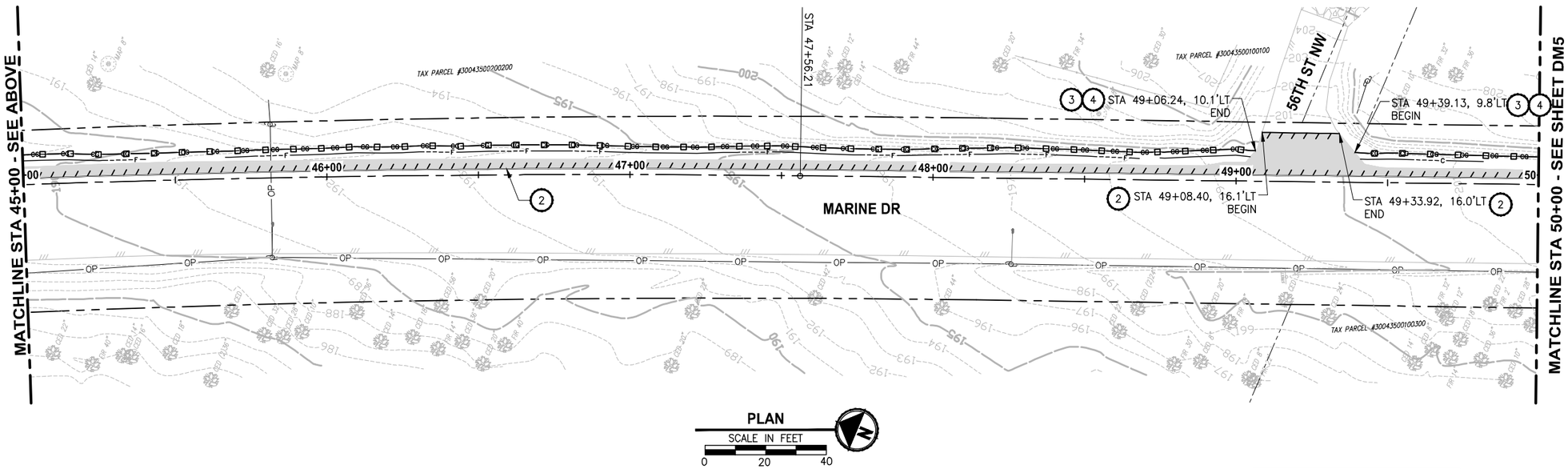

CONSTRUCTION NOTES:

1. SEE CH SHEETS FOR SIGN MODIFICATIONS.
2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I–30.15–02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CG CG — CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

GENERAL NOTES:

1. SILT FENCE SHALL FOLLOW CLEARING AND GRUBBING LIMITS UNLESS SHOWN OTHERWISE ON PLANS.
2. MAINTAIN ACCESS AT PRIVATE DRIVEWAYS DURING CONSTRUCTION AT ALL TIMES.
3. ALL WORK SHALL BE PERFORMED WITHIN THE EXISTING RIGHT–OF–WAY.
4. SEE CH SHEETS FOR ALIGNMENT EQUATIONS.

SNOHOMISH COUNTY
TRAFFIC ENGINEER
APPROVED FOR CONSTRUCTION
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PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 40+00 TO STA 50+00

SHEET NO. 7 OF 35
DM4

PATH: U:\PSO\Projects\Clients\1598–TulalipTribes\214–1598–078 MarineDrPedBikeImprove\99Sxcs\CADD\Phase 01\Task 04\DWG\
PLOTTED BY: wrighjoh DATE: Wednesday, March 30, 2016 7:04:01 PM
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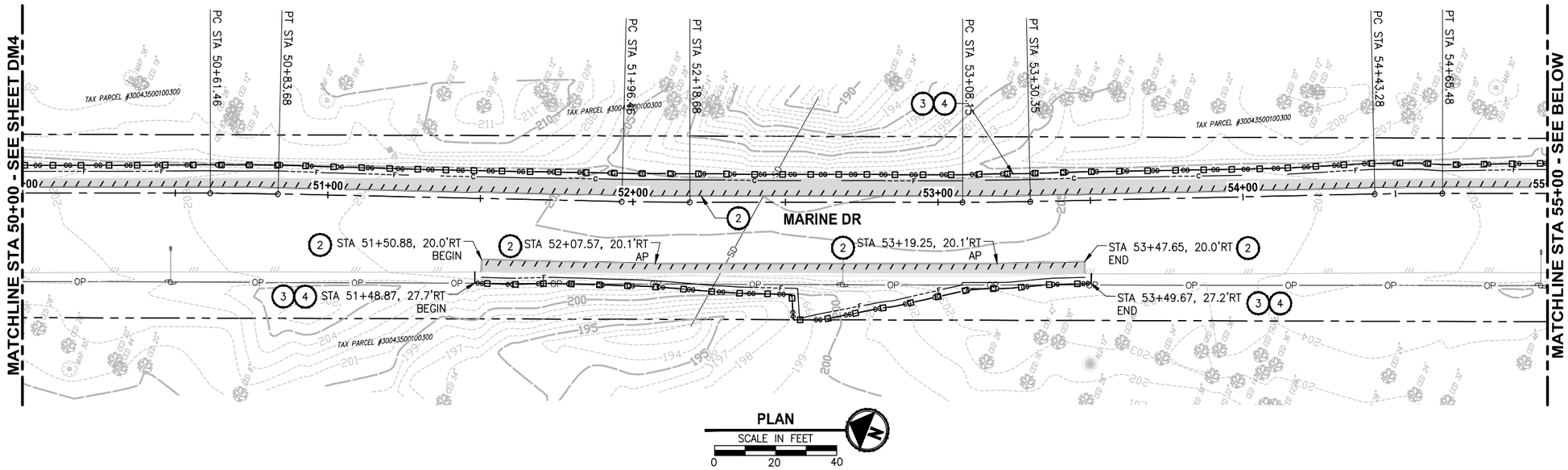

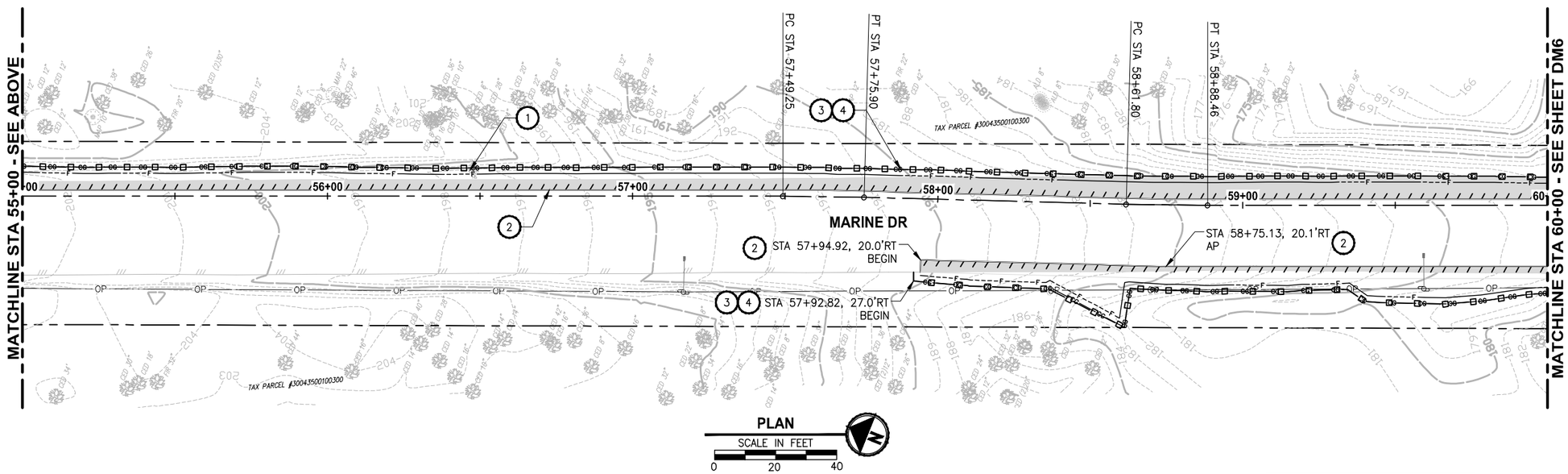

CONSTRUCTION NOTES:

1. SEE CH SHEETS FOR SIGN MODIFICATIONS.
2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I–30.15–02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CG — CG — CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

GENERAL NOTES:

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3. ALL WORK SHALL BE PERFORMED WITHIN THE EXISTING RIGHT–OF–WAY.
4. SEE CH SHEETS FOR ALIGNMENT EQUATIONS.

SNOHOMISH COUNTY
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DRAWN E. SOTO
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PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 50+00 TO STA 60+00

SHEET NO. 8 OF 35
DM5

PATH: U:\PSO\Projects\Clients\1598–TulalipTribes\214–1598–078 MarineDrPedBikeImprove\995xcs\CADD\Phase 01\Task 04\DWG\
PLOTTED BY: wrighjoh DATE: Wednesday, March 30, 2016 7:04:31 PM
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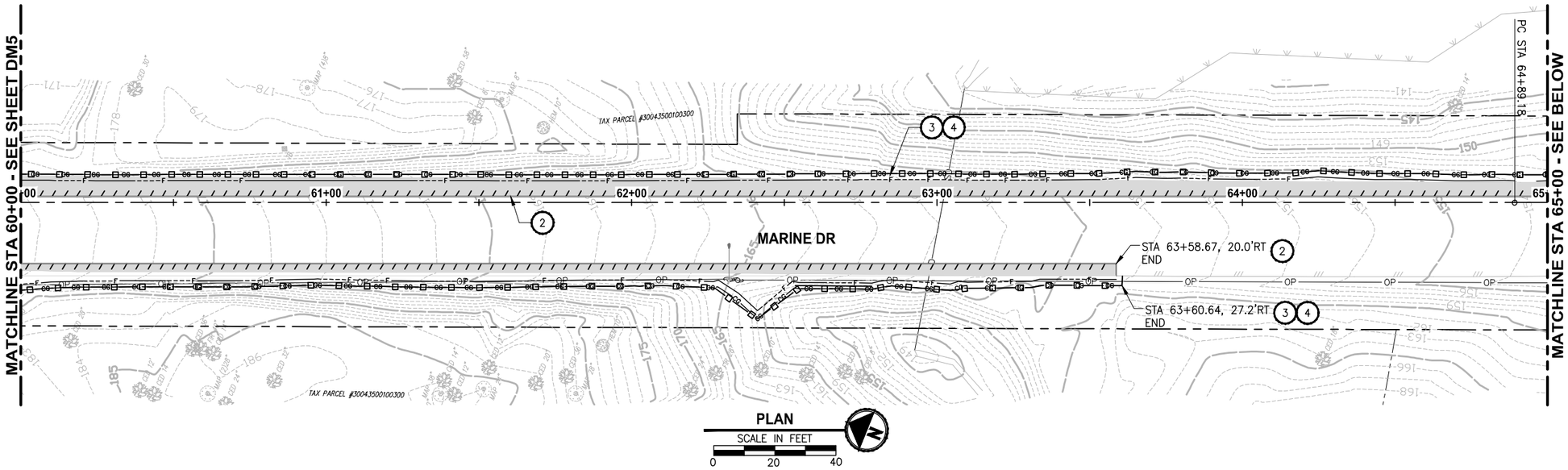

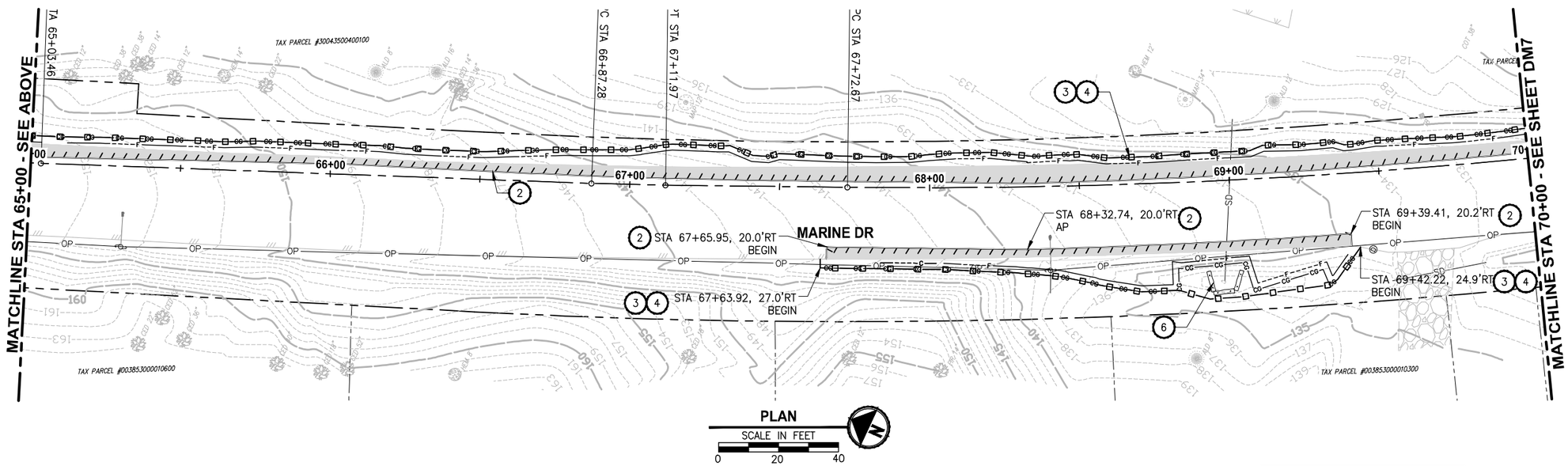

CONSTRUCTION NOTES:

1. SEE CH SHEETS FOR SIGN MODIFICATIONS.
2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I–30.15–02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

GENERAL NOTES:

1. SILT FENCE SHALL FOLLOW CLEARING AND GRUBBING LIMITS UNLESS SHOWN OTHERWISE ON PLANS.
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4. SEE CH SHEETS FOR ALIGNMENT EQUATIONS.

SNOHOMISH COUNTY
TRAFFIC ENGINEER
APPROVED FOR CONSTRUCTION
BY _____
JIM BLOODGOOD, P.E.

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DESIGNED B. THOMAS
DRAWN E. SOTO
CHECKED
APPROVED

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FILE NAME PS1598078P01T04–DM
JOB No. 554–1598–078 (01/05)
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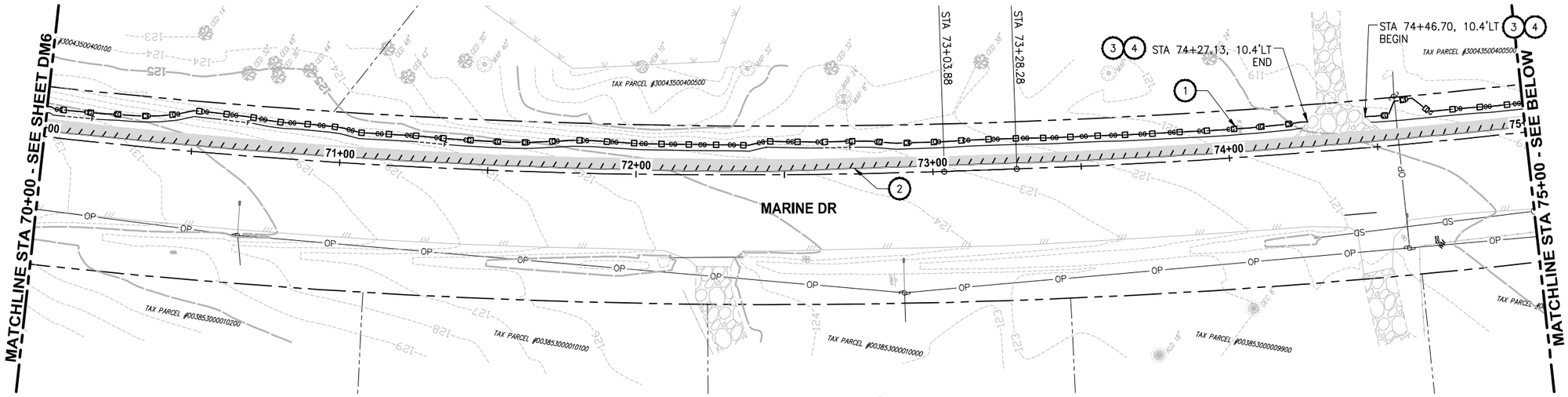
WWW.PARAMETRIX.COM

PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 60+00 TO STA 70+00

SHEET NO. 9 OF 35
DM6

LAYOUT: DM6 PATH: U:\PSO\Projects\Clients\1598–TulalipTribes\214–1598–078 MarineDrPedBikeImprove\99Svcs\CADD\Phase 01\Task 04\DWG\ PLOTTED BY: wrighjoh DATE: Wednesday, March 30, 2016 7:04:57 PM



PLAN
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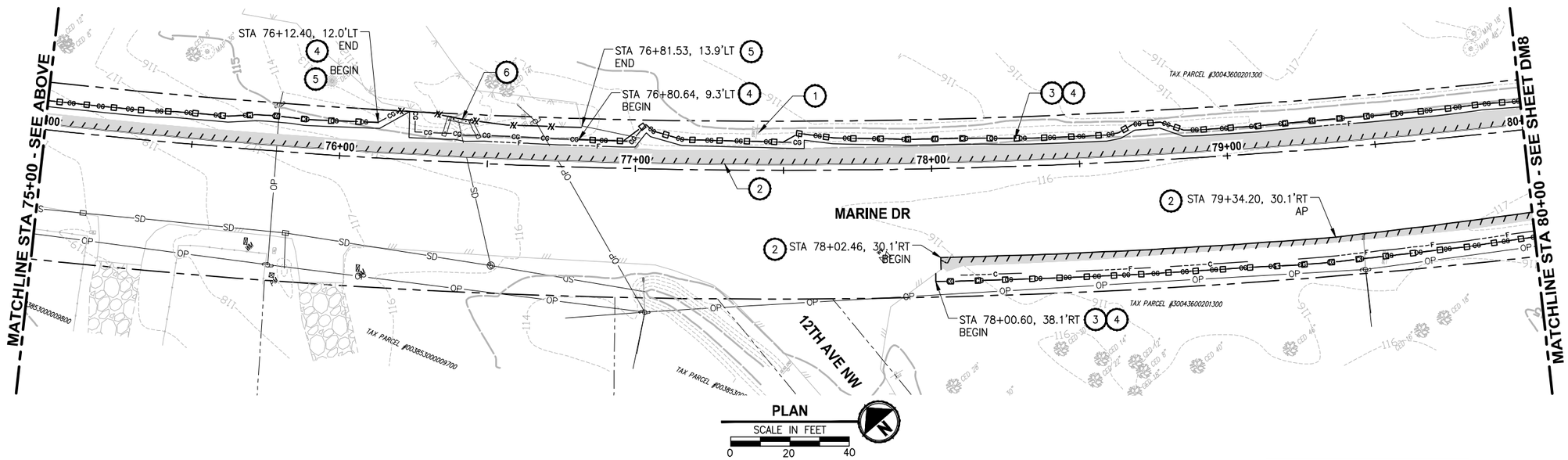

PLAN
SCALE IN FEET
0 20 40

CONSTRUCTION NOTES:

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2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I–30.15–02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

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4. SEE CH SHEETS FOR ALIGNMENT EQUATIONS.

SNOHOMISH COUNTY
TRAFFIC ENGINEER
APPROVED FOR CONSTRUCTION
BY _____
JIM BLOODGOOD, P.E.

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DESIGNED B. THOMAS
DRAWN E. SOTO
CHECKED
APPROVED

ONE INCH AT FULL SCALE. IF NOT, SCALE ACCORDINGLY
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PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS
PHASE 1: 7TH DRIVE NW TO 64TH STREET NW
THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 70+00 TO STA 80+00

SHEET NO.
10 OF 35

DM7

PATH: U:\PSO\Projects\Clients\1598–TulalipTribes\214–1598–078 MarineDrPedBikeImprove\99Sxcs\CADD\Phase 01\Task 04\DWG\
LAYOUT: DM7
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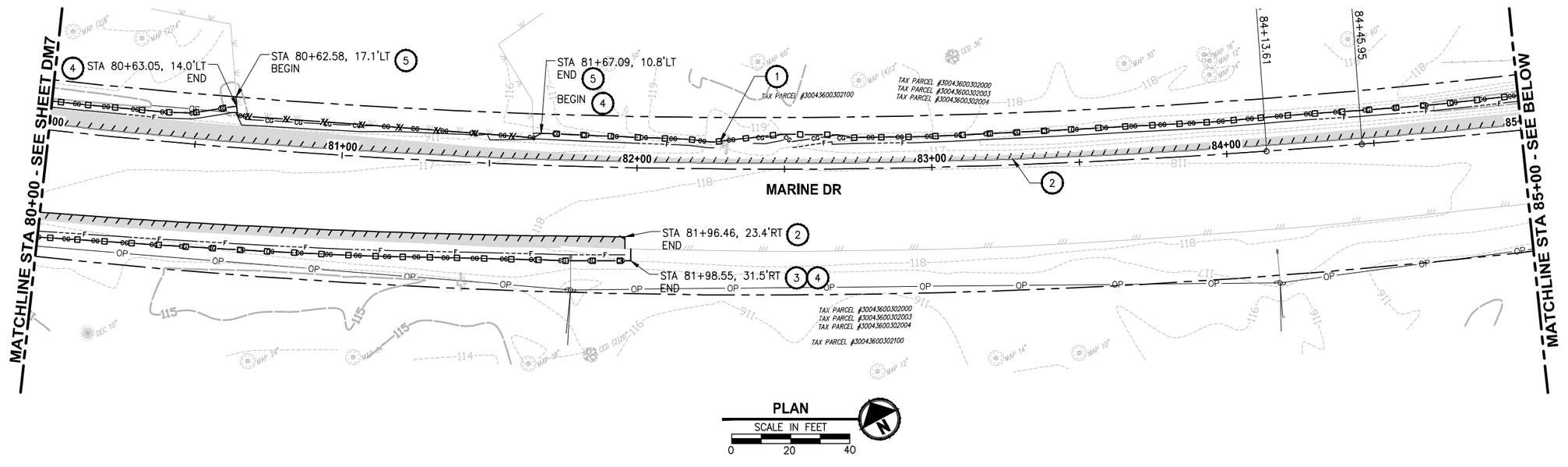

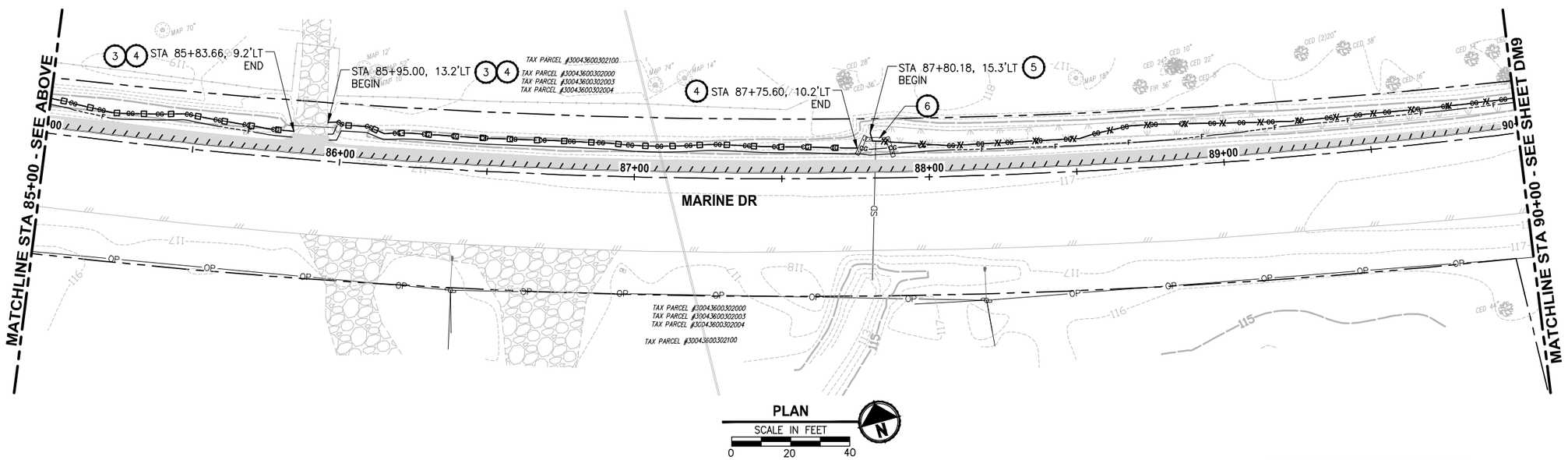

CONSTRUCTION NOTES:

1. SEE CH SHEETS FOR SIGN MODIFICATIONS.
2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
4. SILT FENCE PER WSDOT STD. PLAN I–30.15–02.
5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

- REMOVE EXISTING ASPHALT CONC. PAVEMENT
- SAWCUT
- CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

GENERAL NOTES:

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SNOHOMISH COUNTY
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DESIGNED B. THOMAS
DRAWN E. SOTO
CHECKED
APPROVED

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PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 80+00 TO STA 90+00

SHEET NO. 11 OF 35

DM8

PATH: U:\PSO\Projects\Clients\1598–Tulalip Tribes\214–1598–078 MarineDrPedBikeImprove\999vcs\CADD\Phase 01\Task 04\DWG\
PLOTTED BY: wrighjoh DATE: Wednesday, March 30, 2016 7:06:56 PM
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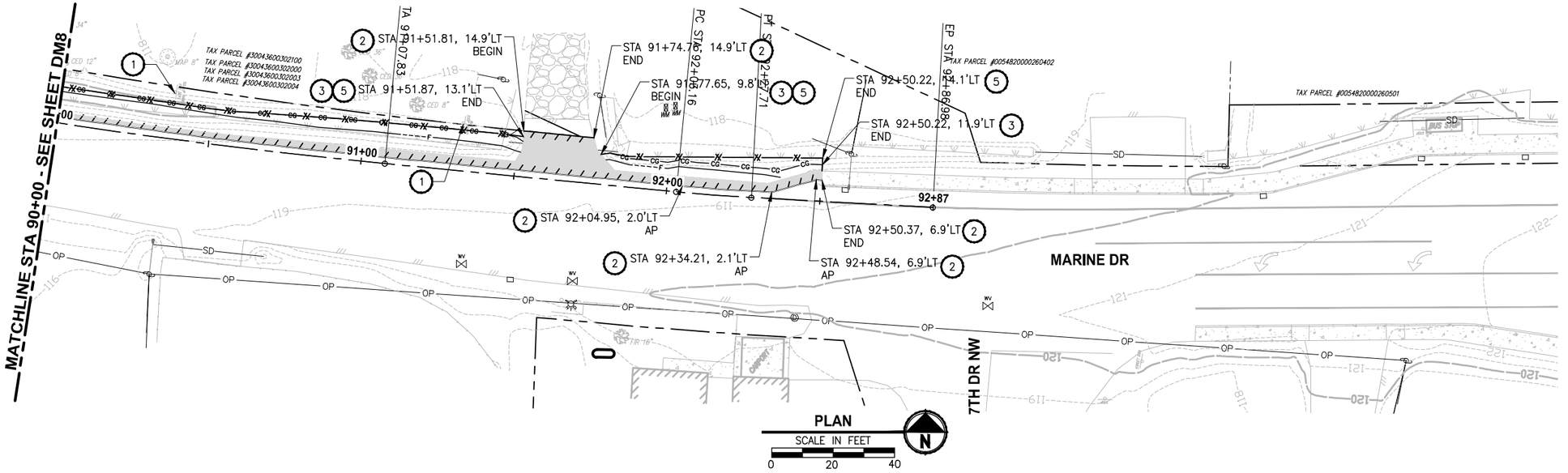

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2. SAWCUT EXISTING ASPHALT CONC. PAVEMENT AT STATION SHOWN. SEE SHEET RS1 FOR GENERAL DIMENSIONS FROM EDGE OF PAVEMENT.
3. CLEARING AND GRUBBING
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5. HIGH VISIBILITY SILT FENCE, PER WSDOT STD. PLAN I–30.17–00.
6. STRAW WATTLE, PER WSDOT STD. PLAN I–30.30–01.

LEGEND:

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- SAWCUT
- CLEARING AND GRUBBING LIMITS
- SILT FENCE
- HIGH VISIBILITY SILT FENCE
- STRAW WATTLE

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PROJECT NAME
MARINE DRIVE SHOULDER IMPROVEMENTS PHASE 1: 7TH DRIVE NW TO 64TH STREET NW THE TULALIP TRIBES
TULALIP, WASHINGTON

DEMOLITION AND TESC PLAN STA 90+00 TO END OF PROJECT

SHEET NO. 12 OF 35

DM9

LAYOUT: DM9 PATH: U:\PSO\Projects\Clients\1598–TulalipTribes\214–1598–078 MarineDrPedBikeImprove\99Svce\CADD\Phase 01\Task 04\DWG\ PLOTTED BY: wrighjoh DATE: Wednesday, March 30, 2016 7:07:34 PM

Appendix B

Spill Prevention, Contamination, Control, and Cleanup Plan (SPCCCP)

(This plan to be provided by the Construction Contractor)

Appendix C

BMP Inspection and Maintenance Forms

4.1 Source Control BMPs

BMP C101: Preserving Natural Vegetation

Purpose

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20-30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

- Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.
- As required by local governments.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.
- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Plants need protection from three kinds of injuries:

- *Construction Equipment* - This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries.
- *Grade Changes* - Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can tolerate fill of 6 inches or less. For shrubs and other plants, the fill should be less.

  When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile

system protects a tree from a raised grade. The tile system should be laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant.

- *Excavations* - Protect trees and other plants when excavating for drainfields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:

  Cut as few roots as possible. When you have to cut, cut clean. Paint cut root ends with a wood dressing like asphalt base paint.

  Backfill the trench as soon as possible.

  Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar, and Douglas fir do not readily adjust to changes in environment and special care should be taken to protect these trees.
- The windthrow hazard of Pacific silver fir and madronna is high, while that of Western hemlock is moderate. The danger of windthrow increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils less than 20 inches deep) have a low windthrow hazard.
- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and infiltration fields. On the other hand, they thrive in high moisture conditions that other trees would not.
- Thinning operations in pure or mixed stands of Grand fir, Pacific silver fir, Noble fir, Sitka spruce, Western red cedar, Western hemlock,

Pacific dogwood, and Red alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

- Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.
- If tree roots have been exposed or injured, "prune" cleanly with an appropriate pruning saw or lopers directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C107: Construction Road/Parking Area Stabilization

Purpose

Stabilizing subdivision roads, parking areas, and other onsite vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

- Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.
- Fencing (see BMPs C103 and C104) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for roadbase stabilization, pH monitoring and BMPs are necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.
- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands. If runoff is allowed to sheetflow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.
- Storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system (see BMP C220).

Maintenance Standards

- Inspect stabilized areas regularly, especially after large storm events.
- Crushed rock, gravel base, hog fuel, etc. shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded.
- Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion.

BMP C120: Temporary and Permanent Seeding

Purpose

Seeding is intended to reduce erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use

- Seeding may be used throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.
- Channels that will be vegetated should be installed before major earthwork and hydroseeded with a Bonded Fiber Matrix. The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch. With channels that will have high flows, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed in the bottom of the ditch over hydromulch and blankets.
- Retention/detention ponds should be seeded as required.
- Mulch is required at all times because it protects seeds from heat, moisture loss, and transport due to runoff.
- All disturbed areas shall be reviewed in late August to early September and all seeding should be completed by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.
- At final site stabilization, all disturbed areas not otherwise vegetated or stabilized shall be seeded and mulched. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions or geotextiles) which will prevent erosion.

Design and Installation Specifications

- Seeding should be done during those seasons most conducive to growth and will vary with the climate conditions of the region. Local experience should be used to determine the appropriate seeding periods.
- The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1. Seeding that occurs between July 1 and August 30 will require irrigation until 75 percent grass cover is established. Seeding that occurs between October 1 and March 30 will require a mulch or plastic cover until 75 percent grass cover is established.
- To prevent seed from being washed away, confirm that all required surface water control measures have been installed.

- The seedbed should be firm and rough. All soil should be roughened no matter what the slope. If compaction is required for engineering purposes, slopes must be track walked before seeding. Backblading or smoothing of slopes greater than 4:1 is not allowed if they are to be seeded.
- New and more effective restoration-based landscape practices rely on deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical the subgrade should be initially ripped to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches the rototilling process should be done in multiple lifts, or the prepared soil system shall be prepared properly and then placed to achieve the specified depth.
- Organic matter is the most appropriate form of "fertilizer" because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form. A natural system typically releases 2-10 percent of its nutrients annually. Chemical fertilizers have since been formulated to simulate what organic matter does naturally.
- In general, 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer can be used at a rate of 90 pounds per acre. Slow-release fertilizers should always be used because they are more efficient and have fewer environmental impacts. It is recommended that areas being seeded for final landscaping conduct soil tests to determine the exact type and quantity of fertilizer needed. This will prevent the over-application of fertilizer. Fertilizer should not be added to the hydromulch machine and agitated more than 20 minutes before it is to be used. If agitated too much, the slow-release coating is destroyed.
- There are numerous products available on the market that take the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal is a good source of long-term, slow-release, available nitrogen.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. Mulch may be made up of 100 percent: cottonseed meal; fibers made of wood, recycled cellulose, hemp, and kenaf; compost; or blends of these. Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide or polymers. Any mulch or tackifier product used shall be installed per manufacturer's instructions. Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.

- Mulch is always required for seeding. Mulch can be applied on top of the seed or simultaneously by hydroseeding.
- On steep slopes, Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products should be used. BFM/MBFM products are applied at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Application is made so that a minimum of 95 percent soil coverage is achieved. Numerous products are available commercially and should be installed per manufacturer's instructions. Most products require 24-36 hours to cure before a rainfall and cannot be installed on wet or saturated soils. Generally, these products come in 40-50 pound bags and include all necessary ingredients except for seed and fertilizer.

BFMs and MBFMs have some advantages over blankets:

- No surface preparation required;
- Can be installed via helicopter in remote areas;
- On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety;
- They are at least $1,000 per acre cheaper installed.

In most cases, the shear strength of blankets is not a factor when used on slopes, only when used in channels. BFMs and MBFMs are good alternatives to blankets in most situations where vegetation establishment is the goal.

- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. One way to overcome this is to increase seed quantities by up to 50 percent.
- Vegetation establishment can also be enhanced by dividing the hydromulch operation into two phases:
    1. Phase 1- Install all seed and fertilizer with 25-30 percent mulch and tackifier onto soil in the first lift;
    2. Phase 2- Install the rest of the mulch and tackifier over the first lift.

An alternative is to install the mulch, seed, fertilizer, and tackifier in one lift. Then, spread or blow straw over the top of the hydromulch at a rate of about 800-1000 pounds per acre. Hold straw in place with a standard tackifier. Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:

1. Irrigation
2. Reapplication of mulch
3. Repair of failed slope surfaces

This technique works with standard hydromulch (1,500 pounds per acre minimum) and BFM/MBFMs (3,000 pounds per acre minimum).

- Areas to be permanently landscaped shall provide a healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation. This can be accomplished in a number of ways:

  Recent research has shown that the best method to improve till soils is to amend these soils with compost. The optimum mixture is approximately two parts soil to one part compost. This equates to 4 inches of compost mixed to a depth of 12 inches in till soils. Increasing the concentration of compost beyond this level can have negative effects on vegetal health, while decreasing the concentrations can reduce the benefits of amended soils. Please note: The compost should meet specifications for Grade A quality compost in Ecology Publication 94-038.

  Other soils, such as gravel or cobble outwash soils, may require different approaches. Organics and fines easily migrate through the loose structure of these soils. Therefore, the importation of at least 6 inches of quality topsoil, underlain by some type of filter fabric to prevent the migration of fines, may be more appropriate for these soils.

  Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.

- Areas that will be seeded only and not landscaped may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Native topsoil should be re-installed on the disturbed soil surface before application.
- Seed that is installed as a temporary measure may be installed by hand if it will be covered by straw, mulch, or topsoil. Seed that is installed as a permanent measure may be installed by hand on small areas (usually less than 1 acre) that will be covered with mulch, topsoil, or erosion blankets. The seed mixes listed below include recommended mixes for both temporary and permanent seeding. These mixes, with the exception of the wetland mix, shall be applied at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used. Local suppliers or the local conservation district should be consulted for their recommendations because the appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the local authority may be used.

Table 4.1 represents the standard mix for those areas where just a temporary vegetative cover is required.

Table 4.1
Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass *Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye - *Lolium perenne*	50	98	90
Redtop or colonial bentgrass *Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover *Trifolium repens*	5	98	90

Table 4.2 provides just one recommended possibility for landscaping seed.

Table 4.2
Landscaping Seed Mix

	% Weight	% Purity	% Germination
Perennial rye blend *Lolium perenne*	70	98	90
Chewings and red fescue blend *Festuca rubra var. commutata* or *Festuca rubra*	30	98	90

This turf seed mix in Table 4.3 is for dry situations where there is no need for much water. The advantage is that this mix requires very little maintenance.

Table 4.3
Low-Growing Turf Seed Mix

	% Weight	% Purity	% Germination
Dwarf tall fescue (several varieties) *Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay) *Lolium perenne var. barclay*	30	98	90
Red fescue *Festuca rubra*	20	98	90
Colonial bentgrass *Agrostis tenuis*	5	98	90

Table 4.4 presents a mix recommended for bioswales and other intermittently wet areas.

Table 4.4
Bioswale Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	92	85
Redtop bentgrass *Agrostis alba* or *Agrostis gigantea*	5-10	90	80

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

The seed mix shown in Table 4.5 is a recommended low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Other mixes may be appropriate, depending on the soil type and hydrology of the area. Recent research suggests that bentgrass (agrostis sp.) should be emphasized in wet-area seed mixes. Apply this mixture at a rate of 60 pounds per acre.

Table 4.5
Wet Area Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	98	85
Meadow foxtail *Alepocurus pratensis*	10-15	90	80
Alsike clover *Trifolium hybridum*	1-6	98	90
Redtop bentgrass *Agrostis alba*	1-6	92	85

** Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

The meadow seed mix in Table 4.6 is recommended for areas that will be maintained infrequently or not at all and where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. The appropriateness of clover in the mix may need to be considered, as this can be a fairly invasive species. If the soil is amended, the addition of clover may not be necessary.

Table 4.6
Meadow Seed Mix

	% Weight	% Purity	% Germination
Redtop or Oregon bentgrass *Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue *Festuca rubra*	70	98	90
White dutch clover *Trifolium repens*	10	98	90

Maintenance Standards

- Any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows) shall be reseeded. If reseeding is ineffective, an alternate method, such as sodding, mulching, or nets/blankets, shall be used. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority when sensitive areas would otherwise be protected.

- After adequate cover is achieved, any areas that experience erosion shall be reseeded and protected by mulch. If the erosion problem is drainage related, the problem shall be fixed and the eroded area reseeded and protected by mulch.
- Seeded areas shall be supplied with adequate moisture, but not watered to the extent that it causes runoff.

BMP C121: Mulching

Purpose

The purpose of mulching soils is to provide immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches that can be used. Only the most common types are discussed in this section.

Conditions of Use

As a temporary cover measure, mulch should be used:

- On disturbed areas that require cover measures for less than 30 days.
- As a cover for seed during the wet season and during the hot summer months.
- During the wet season on slopes steeper than 3H:1V with more than 10 feet of vertical relief.
- Mulch may be applied at any time of the year and must be refreshed periodically.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table 4.7. Note: Thicknesses may be increased for disturbed areas in or near sensitive areas or other areas highly susceptible to erosion.

Mulch used within the ordinary high-water mark of surface waters should be selected to minimize potential flotation of organic matter. Composted organic materials have higher specific gravities (densities) than straw, wood, or chipped material.

Maintenance Standards

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be remulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area remulched.

Table 4.7
Mulch Standards and Guidelines

Mulch Material	Quality Standards	Application Rates	Remarks
Straw	Air-dried; free from undesirable seed and coarse material.	2"-3" thick; 5 bales per 1000 sf or 2-3 tons per acre	Cost-effective protection when applied with adequate thickness. Hand-application generally requires greater thickness than blown straw. The thickness of straw may be reduced by half when used in conjunction with seeding. In windy areas straw must be held in place by crimping, using a tackifier, or covering with netting. Blown straw always has to be held in place with a tackifier as even light winds will blow it away. Straw, however, has several deficiencies that should be considered when selecting mulch materials. It often introduces and/or encourages the propagation of weed species and it has no significant long-term benefits. Straw should be used only if mulches with long-term benefits are unavailable locally. It should also not be used within the ordinary high-water elevation of surface waters (due to flotation).
Hydromulch	No growth inhibiting factors.	Approx. 25-30 lbs per 1000 sf or 1500 - 2000 lbs per acre	Shall be applied with hydromulcher. Shall not be used without seed and tackifier unless the application rate is at least doubled. Fibers longer than about ¾-1 inch clog hydromulch equipment. Fibers should be kept to less than ¾ inch.
Composted Mulch and Compost	No visible water or dust during handling. Must be purchased from supplier with Solid Waste Handling Permit (unless exempt).	2" thick min.; approx. 100 tons per acre (approx. 800 lbs per yard)	More effective control can be obtained by increasing thickness to 3". Excellent mulch for protecting final grades until landscaping because it can be directly seeded or tilled into soil as an amendment. Composted mulch has a coarser size gradation than compost. It is more stable and practical to use in wet areas and during rainy weather conditions.
Chipped Site Vegetation	Average size shall be several inches. Gradations from fines to 6 inches in length for texture, variation, and interlocking properties.	2" minimum thickness	This is a cost-effective way to dispose of debris from clearing and grubbing, and it eliminates the problems associated with burning. Generally, it should not be used on slopes above approx. 10% because of its tendency to be transported by runoff. It is not recommended within 200 feet of surface waters. If seeding is expected shortly after mulch, the decomposition of the chipped vegetation may tie up nutrients important to grass establishment.
Wood-based Mulch	No visible water or dust during handling. Must be purchased from a supplier with a Solid Waste Handling Permit or one exempt from solid waste regulations.	2” thick; approx. 100 tons per acre (approx. 800 lbs. per cubic yard)	This material is often called “hog or hogged fuel.” It is usable as a material for Stabilized Construction Entrances (BMP C105) and as a mulch. The use of mulch ultimately improves the organic matter in the soil. Special caution is advised regarding the source and composition of wood-based mulches. Its preparation typically does not provide any weed seed control, so evidence of residual vegetation in its composition or known inclusion of weed plants or seeds should be monitored and prevented (or minimized).

BMP C123: Plastic Covering

Purpose

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

Conditions of Use

- Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.
- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than six months) applications.
- Clear plastic sheeting can be used over newly-seeded areas to create a greenhouse effect and encourage grass growth if the hydroseed was installed too late in the season to establish 75 percent grass cover, or if the wet season started earlier than normal. Clear plastic should not be used for this purpose during the summer months because the resulting high temperatures can kill the grass.
- Due to rapid runoff caused by plastic sheeting, this method shall not be used upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50-2.00 per square yard.
- Whenever plastic is used to protect slopes, water collection measures must be installed at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to covey clean rainwater away from bare soil and disturbed areas. At no time is clean runoff from a plastic covered slope to be mixed with dirty runoff from a project.
- Other uses for plastic include:
    1. Temporary ditch liner;
    2. Pond liner in temporary sediment pond;
    3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored;
    4. Emergency slope protection during heavy rains; and,
    5. Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
  1. Run plastic up and down slope, not across slope;
  2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet;
  3. Minimum of 8-inch overlap at seams;
  4. On long or wide slopes, or slopes subject to wind, all seams should be taped;
  5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath;
  6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and pound a wooden stake through each to hold them in place;
  7. Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil which causes extreme erosion;
  8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.
- Plastic sheeting shall have a minimum thickness of 0.06 millimeters.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced and open seams repaired.
- If the plastic begins to deteriorate due to ultraviolet radiation, it must be completely removed and replaced.
- When the plastic is no longer needed, it shall be completely removed.
- Dispose of old tires appropriately.

BMP C125: Topsoiling

Purpose

To provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling is an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Native soils should be left undisturbed to the maximum extent practicable. Native soils disturbed during clearing and grading should be restored, to the maximum extent practicable, to a condition where moisture-holding capacity is equal to or better than the original site conditions. This criterion can be met by using on-site native topsoil, incorporating amendments into on-site soil, or importing blended topsoil.
- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.
- Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. If an existing soil system is functioning properly it shall be preserved in its undisturbed and uncompacted condition.
- Depending on where the topsoil comes from, or what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.
- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Commercially available mycorrhiza products should be used when topsoil is brought in from off-site.

Design and Installation Specifications

If topsoiling is to be done, the following items should be considered:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil depth shall be at least 8 inches with a minimum organic content of 10 percent dry weight and pH between 6.0 and 8.0 or matching the pH of the undisturbed soil. This can be accomplished either by returning native topsoil to the site and/or incorporating organic amendments. Organic amendments should be incorporated to a minimum 8-inch depth except where tree roots or other natural

features limit the depth of incorporation. Subsoils below the 12-inch depth should be scarified at least 2 inches to avoid stratified layers, where feasible. The decision to either layer topsoil over a subgrade or incorporate topsoil into the underlying layer may vary depending on the planting specified.

- If blended topsoil is imported, then fines should be limited to 25 percent passing through a 200 sieve.
- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, recent practices have shown that incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.
- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.
- Allow sufficient time in scheduling for topsoil to be spread prior to seeding, sodding, or planting.
- Care must be taken not to apply to subsoil if the two soils have contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough.
- If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.
- Ripping or re-structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.
- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). Areas of natural ground water recharge should be avoided.
- Stripping shall be confined to the immediate construction area. A 4- to 6- inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2:1.
- An interceptor dike with gravel outlet and silt fence shall surround all topsoil stockpiles between October 1 and April 30. Between May 1

and September 30, an interceptor dike with gravel outlet and silt fence shall be installed if the stockpile will remain in place for a longer period of time than active construction grading.

- Erosion control seeding or covering with clear plastic or other mulching materials of stockpiles shall be completed within 2 days (October 1 through April 30) or 7 days (May 1 through September 30) of the formation of the stockpile. Native topsoil stockpiles shall not be covered with plastic.
- Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan.
- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:

  1. Topsoil is to be re-installed within 4 to 6 weeks;
  2. Topsoil is not to become saturated with water;
  3. Plastic cover is not allowed.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.

BMP C140: Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

- In areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition, if stable. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP C105).
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to the increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may actually reduce the quantity of water needed for dust control, especially in eastern Washington. Since the wholesale cost of PAM is about $ 4.00 per pound, this is an extremely cost-effective dust control method.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.

- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.
- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
- Encourage the use of alternate, paved routes, if available.
- Restrict use by tracked vehicles and heavy trucks to prevent damage to road surface and base.
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
- Pave unpaved permanent roads and other trafficked areas.
- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP.

Maintenance Standards Respray area as necessary to keep dust to a minimum.

BMP C150: Materials On Hand

Purpose

Quantities of erosion prevention and sediment control materials can be kept on the project site at all times to be used for emergency situations such as unexpected heavy summer rains. Having these materials on-site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric and steel "T" posts.
- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or developer could keep a stockpile of materials that are available to be used on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum that will cover numerous situations includes:

Material	Measure	Quantity
Clear Plastic, 6 mil	100 foot roll	1-2
Drainpipe, 6 or 8 inch diameter	25 foot section	4-6
Sandbags, filled	each	25-50
Straw Bales for mulching,	approx. 50# each	10-20
Quarry Spalls	ton	2-4
Washed Gravel	cubic yard	2-4
Geotextile Fabric	100 foot roll	1-2
Catch Basin Inserts	each	2-4
Steel "T" Posts	each	12-24

Maintenance Standards

- All materials with the exception of the quarry spalls, steel "T" posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials used as needed.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. This BMP is intended to minimize and eliminate process water and slurry from entering waters of the State.

Conditions of Use

Anytime sawcutting or surfacing operations take place, these management practices shall be utilized. Sawcutting and surfacing operations include, but are not limited to, the following:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Slurry and cuttings shall be vacuumed during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance.
- Collected slurry and cuttings shall be disposed of in a manner that does not violate groundwater or surface water quality standards.
- Process water that is generated during hydro-demolition, surface roughening or similar operations shall not drain to any natural or constructed drainage conveyance and shall be disposed of in a manner that does not violate groundwater or surface water quality standards.
- Cleaning waste material and demolition debris shall be handled and disposed of in a manner that does not cause contamination of water. If the area is swept with a pick-up sweeper, the material must be hauled out of the area to an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.

BMP C153: Material Delivery, Storage and Containment

Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in a designated area, and installing secondary containment.

Conditions of Use

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil and grease
- Soil stabilizers and binders (e.g. Polyacrylamide)
- Fertilizers, pesticides and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage on-site should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (Oct 1 – April 30), consider storing materials in a covered area.
- Materials should be stored in secondary containments, such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.

- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.

Material Storage Areas and Secondary Containment Practices:

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.
- Temporary secondary containment facilities shall provide for a spill containment volume able to contain precipitation from a 25 year, 24 hour storm event, plus 10% of the total enclosed container volume of all containers, or 110% of the capacity of the largest container within its boundary, whichever is greater.
- Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.
- Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- During the wet weather season (Oct 1 – April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.
- Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill clean-up material (spill kit).
- The spill kit should include, at a minimum:
    - 1-Water Resistant Nylon Bag
    - 3-Oil Absorbent Socks 3”x 4’
    - 2-Oil Absorbent Socks 3”x 10’
    - 12-Oil Absorbent Pads 17”x19”
    - 1-Pair Splash Resistant Goggles
    - 3-Pair Nitrile Gloves
    - 10-Disposable Bags with Ties
    - Instructions

BMP C160: Certified Erosion and Sediment Control Lead

Purpose

The project proponent designates at least one person as the responsible representative in charge of erosion and sediment control (ESC), and water quality protection. The designated person shall be the Certified Erosion and Sediment Control Lead (CESCL) who is responsible for ensuring compliance with all local, state, and federal erosion and sediment control and water quality requirements.

Conditions of Use

A CESCL shall be made available on projects one acre or larger that discharge stormwater to surface waters of the state

- The CESCL shall:
  - Have a current certificate proving attendance in an erosion and sediment control training course that meets the minimum ESC training and certification requirements established by Ecology (see details below).

    Ecology will maintain a list of ESC training and certification providers at: www.ecy.wa.gov/programs/wq/stormwater.

    OR

  - Be a Certified Professional in Erosion and Sediment Control (CPESC); for additional information go to: www.cpesc.net

Specifications

- Certification shall remain valid for three years.
- The CESCL shall have authority to act on behalf of the contractor or developer and shall be available, on call, 24 hours per day throughout the period of construction.
- The Construction SWPPP shall include the name, telephone number, fax number, and address of the designated CESCL.
- A CESCL may provide inspection and compliance services for multiple construction projects in the same geographic region.

Duties and responsibilities of the CESCL shall include, but are not limited to the following:

- Maintaining permit file on site at all times which includes the SWPPP and any associated permits and plans.
- Directing BMP installation, inspection, maintenance, modification, and removal.
- Updating all project drawings and the Construction SWPPP with changes made.

- Keeping daily logs, and inspection reports. Inspection reports should include:
    - Inspection date/time.
    - Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
    - A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:

      1) Locations of BMPs inspected,

      2) Locations of BMPs that need maintenance,

      3) Locations of BMPs that failed to operate as designed or intended, and

      4) Locations of where additional or different BMPs are required.
    - Visual monitoring results, including a description of discharged stormwater. The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
    - Any water quality monitoring performed during inspection.
    - General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.
- Facilitate, participate in, and take corrective actions resulting from inspections performed by outside agencies or the owner.

Minimum Requirements for ESC Training and Certification Courses

General Requirements

1. The course shall teach the construction stormwater pollution prevention guidance provided in the most recent version of:
    a. The Washington State Dept. of Ecology Stormwater Management Manual for Western Washington,
    b. Other equivalent stormwater management manuals approved by Ecology.

2. Upon completion of course, each attendee shall receive documentation of certification, including, at a minimum, a wallet-sized card that certifies completion of the course. Certification shall remain valid for three years. Recertification may be obtained by completing the 8-hour refresher course or by taking the initial 16-hour training course again.

3. The initial certification course shall be a minimum of 16 hours (with a reasonable time allowance for lunch, breaks, and travel to and from field) and include a field element and test.
    a. The field element must familiarize students with the proper installation, maintenance and inspection of common erosion and sediment control BMPs including, but not limited to, blankets, check dams, silt fence, straw mulch, plastic, and seeding.
    b. The test shall be open book and a passing score is not required for certification. Upon completion of the test, the correct answers shall be provided and discussed.

4. The refresher course shall be a minimum of 8 hours and include a test.
    a. The refresher course shall include:
        i. Applicable updates to the Stormwater Management Manual that is used to teach the course, including new or updated BMPs; and
        ii. Applicable changes to the NPDES General Permit for Construction Activities.
    b. The refresher course test shall be open book and a passing score is not required for certification. Upon completion of the test, the correct answers shall be provided and discussed.
    c. The refresher course may be taught using an alternative format (e.g. internet, CD ROM, etc.) if the module is approved by Ecology.

Required Course Elements

1. Erosion and Sedimentation Impacts
    a. Examples/Case studies

2. Erosion and Sedimentation Processes
    a. Definitions
    b. Types of erosion
    c. Sedimentation
        i. Basic settling concepts
        ii. Problems with clays/turbidity

3. Factors Influencing Erosion Potential
    a. Soil
    b. Vegetation
    c. Topography
    d. Climate

4. Regulatory Requirements
    a. NPDES - Construction Stormwater General Permit
    b. Local requirements and permits
    c. Other regulatory requirements

5. Stormwater Pollution Prevention Plan (SWPPP)
    a. SWPPP is a living document – should be revised as necessary
    b. 12 Elements of a SWPPP; discuss suggested BMPs (with examples)
        1. Mark Clearing Limits
        2. Establish Construction Access
        3. Control Flow Rates
        4. Install Sediment Controls
        5. Stabilize Soils
        6. Protect Slopes
        7. Protect Drain Inlets
        8. Stabilize Channels and Outlets
        9. Control Pollutants
        10. Control De-watering
        11. Maintain BMPs
        12. Manage the Project

6. Monitoring/Reporting/Recordkeeping
    a. Site inspections/visual monitoring
        i. Disturbed areas
        ii. BMPs
        iii. Stormwater discharge points
    b. Water quality sampling/analysis
        i. Turbidity
        ii. pH
    c. Monitoring frequency
        i. Set by NPDES permit
        ii. Inactive sites - reduced frequency

d. Adaptive Management
    i. When monitoring indicates problem, take appropriate action (e.g. install/maintain BMPs)
    ii. Document the corrective action(s) in SWPPP
e. Reporting
    i. Inspection reports/checklists
    ii. Discharge Monitoring Reports (DMR)
    iii. Non-compliance notification

Instructor Qualifications

1. Instructors must be qualified to effectively teach the required course elements.

2. At a minimum, instructors must have:

    a. Current certification as a Certified Professional in Erosion and Sediment Control (CPESC), or
    b. Completed a training program for teaching the required course elements, or
    c. The academic credentials and instructional experience necessary for teaching the required course elements.

3. Instructors must demonstrate competent instructional skills and knowledge of the applicable subject matter.

BMP C161: Payment of Erosion Control Work

Purpose

As with any construction operation, the contractor should be paid for erosion control work. Payment for erosion control must be addressed during project development and design. Method of payment should be identified in the SWPPP.

Conditions of Use

Erosion control work should never be "incidental" to the contract as it is extremely difficult for the contractor to bid the work. Work that is incidental to the contract is work where no separate measurement or payment is made. The cost for incidental work is included in payments made for applicable bid items in the Schedule of Unit Prices. For example, any erosion control work associated with an item called "Clearing and Grubbing" is bid and paid for as part of that item, not separately.

Several effective means for payment of erosion control work are described below. These include:

- Temporary Erosion and Sediment Control (TESC) Lump Sum.
- TESC-Force Account.
- Unit Prices.
- Lump Sum.

TESC Lump Sum

One good method for achieving effective erosion and sediment control is to set up a Progress Payment system whereby the contract spells out exactly what is expected and allows for monthly payments over the life of the contract.

For example, an Item called "TESC Lump Sum" is listed in the Bid Schedule of Unit Prices. An amount, such as $10,000, is written in both the Unit Price and Amount columns. This requires all bidders to bid $10,000 for the item. If $10,000 is not shown in the Amount column, each contractor bids the amount. Often this is under-bid, which can cause compliance difficulties later. In this example, the contractor is required to revise the project Construction SWPPP by developing a Contractor's Erosion and Sediment Control Plan (CESCP) that is specific to their operations.

Next, the following language is included in the TESC specification Payment section:

Based upon lump sum Bid Item "TESC Lump Sum", payments will be made as follows:

A. Upon receipt of the Contractor's CESCP, 25 percent.

B. After Notice To Proceed and before Substantial Completion, 50 percent will be pro rated and paid monthly for compliance with the

CESCP. Non-compliance will result in withholding of payment for the month of non-compliance.

C. At Final Payment, 25 percent for a clean site.

Payment for "TESC Lump Sum" will be full compensation for furnishing all labor, equipment, materials and tools to implement the CESCP, install, inspect, maintain, and remove temporary erosion and sediment controls as detailed in the drawings and specified herein, with the exception of those items measured and paid for separately.

TESC Force Account

One good method for ensuring that contingency money is available to address unforeseen erosion and sediment control problems is to set up an item called "TESC-Force Account". For example, an amount such as $15,000 is written in both the Unit Price and Amount columns for the item. This requires all bidders to bid $15,000 for the item.

The Force Account is used only at the discretion of the contracting agency or developer. If there are no unforeseen erosion problems, the money is not used. If there are unforeseen erosion problems, the contracting agency would direct the work to be done and pay an agreed upon amount for the work (such as predetermined rates under a Time and Materials setting).

Contract language for this item could look like this:

Measurement and Payment for "TESC-Force Account" will be on a Force Account basis in accordance with_____ (include appropriate section of the Contract Specifications). The amount entered in the Schedule of Unit Prices is an estimate.

Unit Prices

When the material or work can be quantified, it can be paid by Unit Prices. For example, the project designer knows that 2 acres will need to be hydroseeded and sets up an Item of Work for Hydroseed, with a Bid Quantity of 2, and a Unit for Acre. The bidder writes in the unit Prices and Amount.

Unit Price items can be used in conjunction with TESC-Force Account and TESC-Lump Sum.

Lump Sum

In contracts where all the work in a project is paid as a Lump Sum, erosion control is usually not paid as a separate item. In order to ensure that appropriate amounts are bid into the contract, the contracting agency can request a Schedule of Values and require that all erosion control costs be identified.

BMP C162: Scheduling

Purpose

Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

Conditions of Use

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided.

Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site vulnerable to accelerated erosion. Construction procedures that limit land clearing, provide timely installation of erosion and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

Design Considerations

- Avoid rainy periods.
- Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding in order to revegetate cut and fill slopes as the work progresses.

BMP C220: Storm Drain Inlet Protection

Purpose To prevent coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use Where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. Protection should be provided for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless the runoff that enters the catch basin will be conveyed to a sediment pond or trap. Inlet protection may be used anywhere to protect the drainage system. It is likely that the drainage system will still require cleaning.

Table 4.9 lists several options for inlet protection. All of the methods for storm drain inlet protection are prone to plugging and require a high frequency of maintenance. Drainage areas should be limited to 1 acre or less. Emergency overflows may be required where stormwater ponding would cause a hazard. If an emergency overflow is provided, additional end-of-pipe treatment may be required.

Table 4.9
Storm Drain Inlet Protetion

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/ Earthen Surfaces	Conditions of Use
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding will occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area Requirement: 30' X 30'/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No		Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with a wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap			18 month expected life.

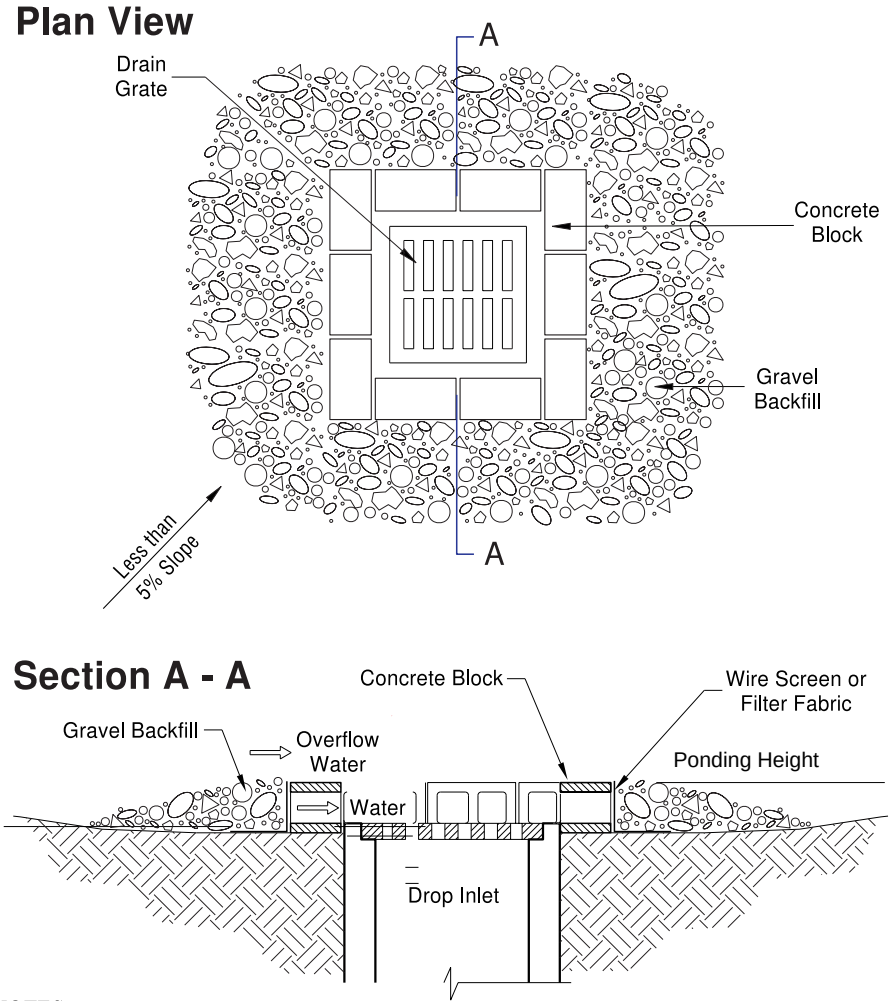
Design and Installation Specifications

Excavated Drop Inlet Protection - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- Depth 1-2 ft as measured from the crest of the inlet structure.
- Side Slopes of excavation no steeper than 2:1.
- Minimum volume of excavation 35 cubic yards.
- Shape basin to fit site with longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water problems.
- Clear the area of all debris.
- Grade the approach to the inlet uniformly.
- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.
- It may be necessary to build a temporary dike to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter - A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure 4.14.

- Height 1 to 2 feet above inlet.
- Recess the first row 2 inches into the ground for stability.
- Support subsequent courses by placing a 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel just below the top of blocks on slopes of 2:1 or flatter.
- An alternative design is a gravel donut.
- Inlet slope of 3:1.
- Outlet slope of 2:1.
- 1-foot wide level stone area between the structure and the inlet.
- Inlet slope stones 3 inches in diameter or larger.
- Outlet slope use gravel ½- to ¾-inch at a minimum thickness of 1-foot.



Notes:
1. Drop inlet sediment barriers are to be used for small, nearly level drainage areas. (less than 5%)
2. Excavate a basin of sufficient size adjacent to the drop inlet.
3. The top of the structure (ponding height) must be well below the ground elevation downslope to prevent runoff from bypassing the inlet. A temporary dike may be necessary on the dowslope side of the structure.

Figure 4.14 – Block and Gravel Filter

Gravel and Wire Mesh Filter - A gravel barrier placed over the top of the inlet. This structure does not provide an overflow.

- Hardware cloth or comparable wire mesh with ½-inch openings.
- Coarse aggregate.
- Height 1-foot or more, 18 inches wider than inlet on all sides.
- Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.
- If more than one strip of mesh is necessary, overlap the strips.
- Place coarse aggregate over the wire mesh.
- The depth of the gravel should be at least 12 inches over the entire inlet opening and extend at least 18 inches on all sides.

Catchbasin Filters - Inserts should be designed by the manufacturer for use at construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. The maintenance requirements can be reduced by combining a catchbasin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.

- 5 cubic feet of storage.
- Dewatering provisions.
- High-flow bypass that will not clog under normal use at a construction site.
- The catchbasin filter is inserted in the catchbasin just below the grating.

Curb Inlet Protection with Wooden Weir – Barrier formed around a curb inlet with a wooden frame and gravel.

- Wire mesh with ½-inch openings.
- Extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against wire/fabric.
- Place weight on frame anchors.

Block and Gravel Curb Inlet Protection – Barrier formed around an inlet with concrete blocks and gravel. See Figure 4.14.

- Wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.
- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
- Place wire mesh over the outside vertical face.
- Pile coarse aggregate against the wire to the top of the barrier.

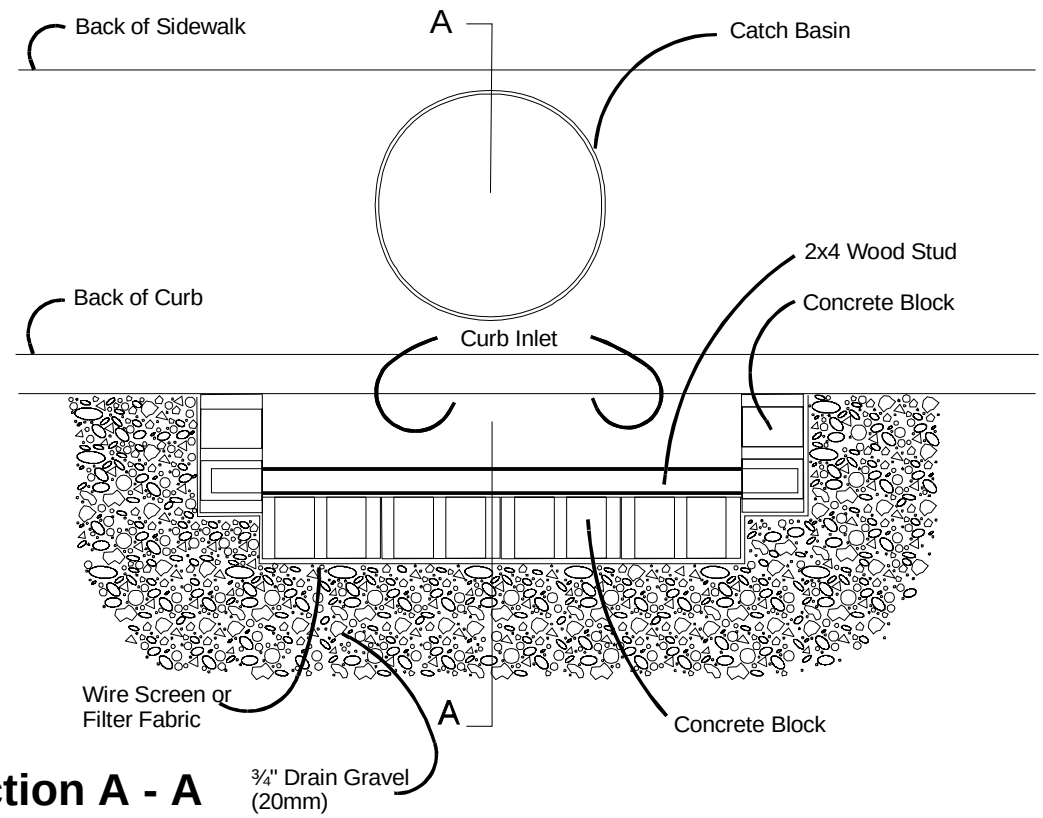
Curb and Gutter Sediment Barrier – Sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure 4.16.

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet.
- Construct a horseshoe shaped sedimentation trap on the outside of the berm sized to sediment trap standards for protecting a culvert inlet.

Maintenance Standards

- Catch basin filters should be inspected frequently, especially after storm events. If the insert becomes clogged, it should be cleaned or replaced.
- For systems using stone filters: If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

Plan View



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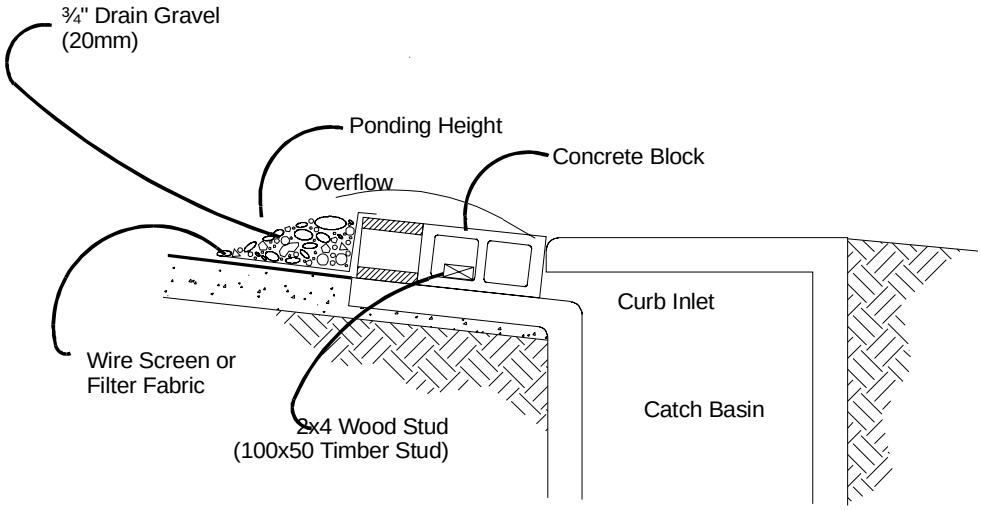
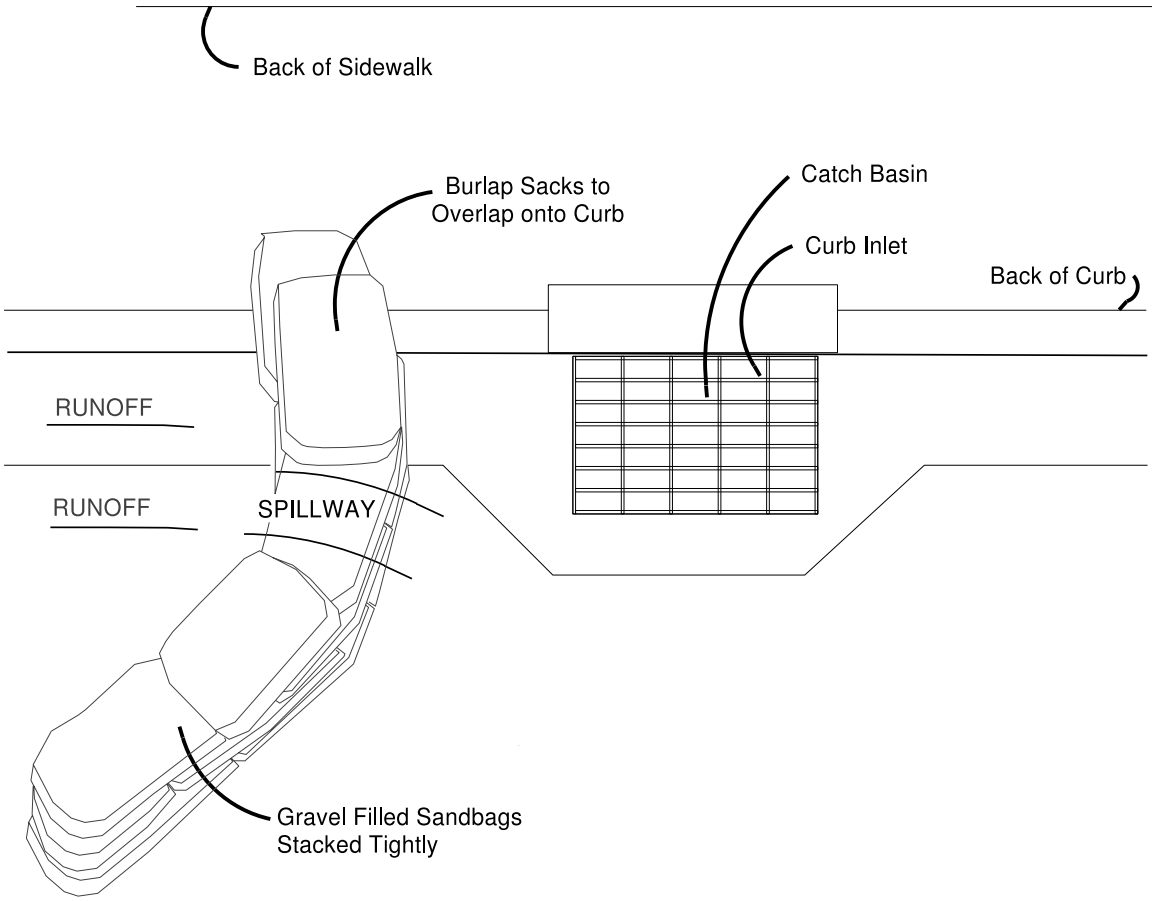


NOTES:
1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.15 – Block and Gravel Curb Inlet Protection

Plan View



NOTES:
1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven `geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.16 – Curb and Gutter Barrier

Maintenance Standards

- Any damage shall be repaired immediately.
- If concentrated flows are evident uphill of the fence, they must be intercepted and conveyed to a sediment pond.
- It is important to check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.
- Sediment deposits shall either be removed when the deposit reaches approximately one-third the height of the silt fence, or a second silt fence shall be installed.
- If the filter fabric (geotextile) has deteriorated due to ultraviolet breakdown, it shall be replaced.

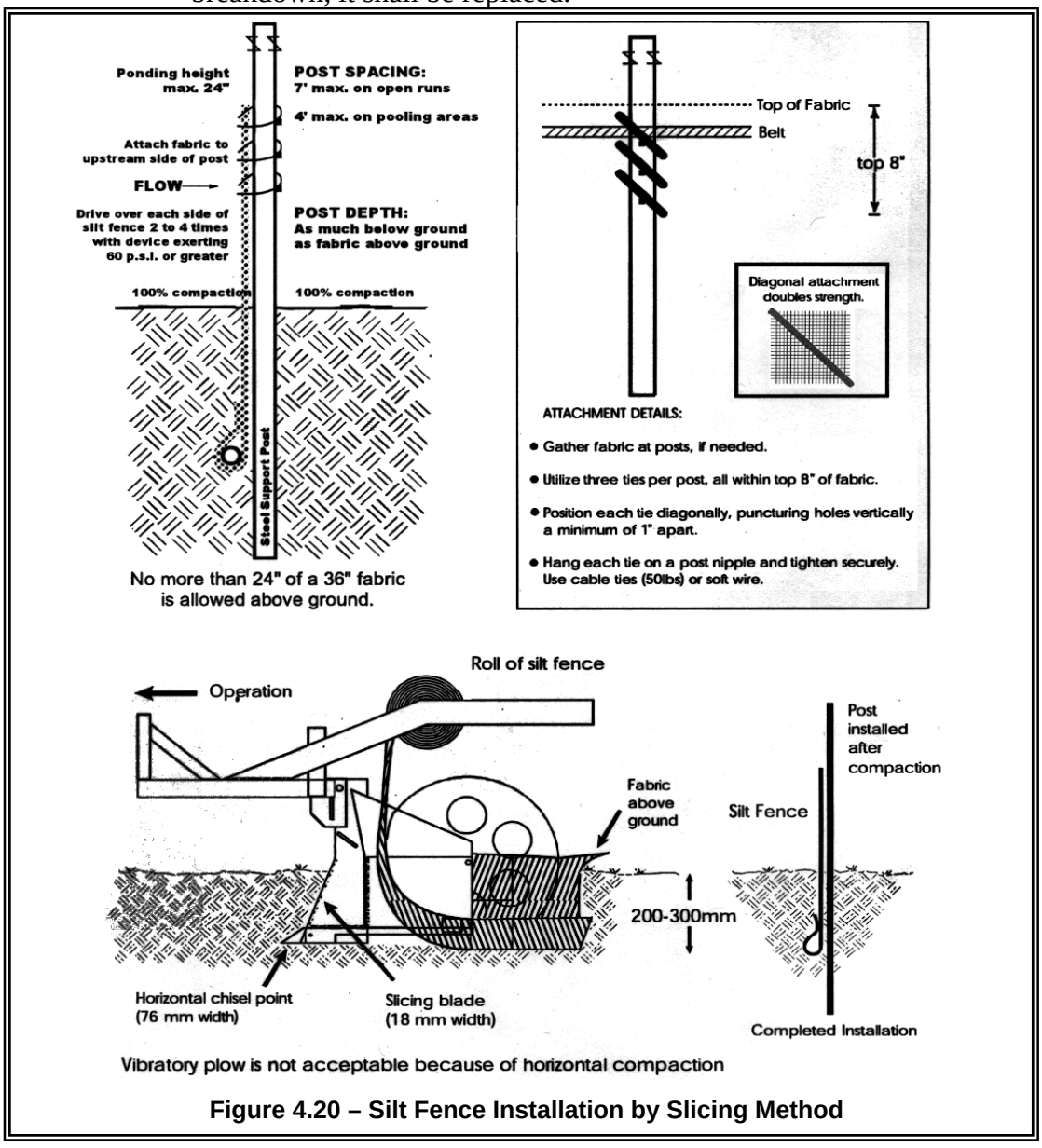


Figure 4.20 – Silt Fence Installation by Slicing Method

BMP C235: Straw Wattles

Purpose

Straw wattles are temporary erosion and sediment control barriers consisting of straw that is wrapped in biodegradable tubular plastic or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and can capture and retain sediment. Straw wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length. The wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes. See Figure 4.21 for typical construction details.

Conditions of Use

- Disturbed areas that require immediate erosion protection.
- Exposed soils during the period of short construction delays, or over winter months.
- On slopes requiring stabilization until permanent vegetation can be established.
- Straw wattles are effective for one to two seasons.
- If conditions are appropriate, wattles can be staked to the ground using willow cuttings for added revegetation.
- Rilling can occur beneath wattles if not properly entrenched and water can pass between wattles if not tightly abutted together.

Design Criteria

- It is critical that wattles are installed perpendicular to the flow direction and parallel to the slope contour.
- Narrow trenches should be dug across the slope on contour to a depth of 3 to 5 inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches should be dug to a depth of 5 to 7 inches, or 1/2 to 2/3 of the thickness of the wattle.
- Start building trenches and installing wattles from the base of the slope and work up. Excavated material should be spread evenly along the uphill slope and compacted using hand tamping or other methods.
- Construct trenches at contour intervals of 3 to 30 feet apart depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches.
- Install the wattles snugly into the trenches and abut tightly end to end. Do not overlap the ends.
- Install stakes at each end of the wattle, and at 4-foot centers along entire length of wattle.
- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.
- At a minimum, wooden stakes should be approximately 3/4 x 3/4 x 24 inches. Willow cuttings or 3/8-inch rebar can also be used for stakes.

Maintenance Standards

- Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle.
- Wattles may require maintenance to ensure they are in contact with soil and thoroughly entrenched, especially after significant rainfall on steep sandy soils.
- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles.

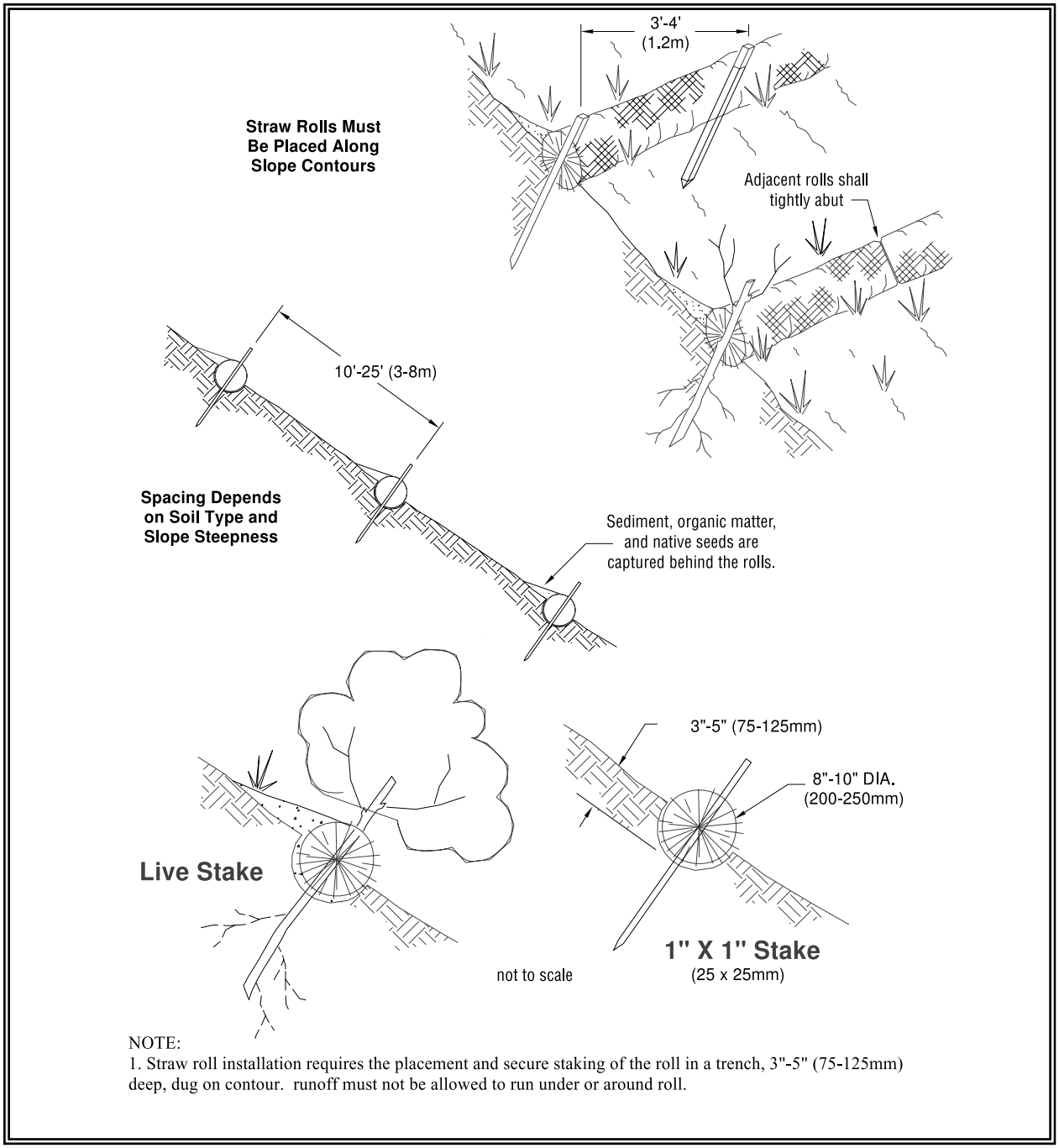
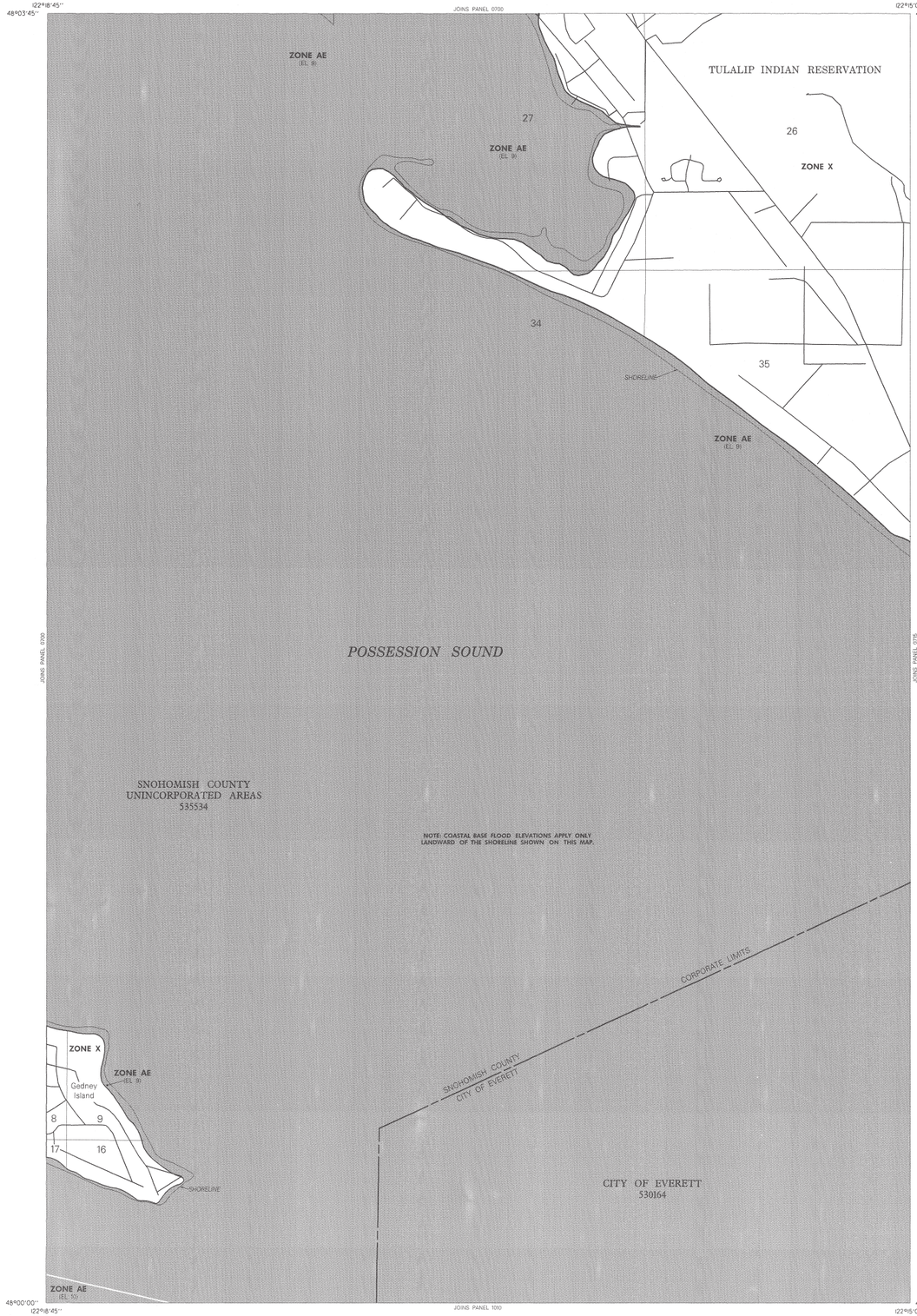


Figure 4.21 – Straw Wattles

Appendix B

FEMA Firm Maps



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction ; no base flood elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Area

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 — Elevation Reference Mark

M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas. The community map repository should be consulted for more detailed data on BFE's, and for any information on floodway delineations, prior to use of this map for property purchase or construction purposes.

Areas of Special Flood Hazard (100-year flood) include Zones A, AE, A1-A30, AH, AO, A99, V, VE and V1-V30.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Refer to Floodway Data Table where floodway width is shown at 1/20 inch.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and /or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101-591).

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:
NOVEMBER 8, 1999

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE DATE shown on this map to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

SNOHOMISH COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 695 OF 1575
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
EVERETT, CITY OF	530164	0695	E
SNOHOMISH COUNTY, UNINCORPORATED AREAS	535534	0695	E

MAP NUMBER
53061C0695 E

EFFECTIVE DATE:
NOVEMBER 8, 1999

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevation** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevation (BFEs) shown on this map apply only landward of 0.0' National Geodetic Vertical Datum (NGVD). Users of this FIRM should be aware that coastal flood elevations may also be provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this community. Elevations shown in the Summary of Stillwater Elevations table should be used for construction, and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

The **projection** used in the preparation of this map is Universal Tranverse Mercator (UTM) zone 10. The **horizontal datum** is NAD27, CLARKE1866 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242,** or visit their website at www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the Snohomish County Geographic Information Systems Department and from the City of Everett.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

An accompanying Flood Insurance Study report, Letters of Map Revision or Letters of Map Amendment revising portions of this panel, and digital versions of this PANEL may be available. Contact the **FEMA Map Service Center** at the following phone numbers and Internet address for infomation on all related products available from FEMA;

Phone: 800-358-9616
FAX: 800-358-9620
www.fema.gov/msc

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at www.fema.gov.

This map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report may reflect stream channel distances that differ from what is shown on this map.

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD EVENT

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood.

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Area of special flood hazard formerly protected from the 1% annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood event.

ZONE A99 Area to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no base flood elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the National Geodetic Vertical Datum of 1929

- A — A — Cross Section Line
- 23 — 23 — Transect Line
- 97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1927 (NAD 27)
- 4276000M — 1000-meter Universal Transverse Mercator grid values, zone 10
- 600000 FT — 5000-foot grid ticks
- DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel).
- M1.5 — River Mile

MAP REPOSITORY
Refer to Repository Listing on Index Map

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
NOVEMBER 6, 1999

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 16, 2005: to increase base flood elevations, to add special flood hazard areas, to change special flood hazard areas, to add roads and road names, and to reflect updated topographic information.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at (800) 638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

PANEL 0715F

FIRM
FLOOD INSURANCE RATE MAP
SNOHOMISH COUNTY, WASHINGTON
AND INCORPORATED AREAS

PANEL 715 OF 1575
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SNOHOMISH COUNTY, UNINCORPORATED AREAS	535534	0715	F
EVERETT, CITY OF	530164	0715	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
53061C0715F

MAP REVISED:
SEPTEMBER 16, 2005

Federal Emergency Management Agency

Appendix C

Geotechnical Report

Materials Testing & Consulting, Inc.

Geotechnical Engineering ● Materials Testing ● Special Inspection ● Environmental Consulting

March 3, 2016

Ms. Debbie Bray
Tulalip Tribes
8802 27th Ave NE
Tulalip, WA 98271

Subject: Geotechnical Investigation and Engineering Services
Marine Drive Pedestrian/Bike Improvements
Tulalip, Washington

MTC Project No.: 14B024-12

Dear Ms. Bray:

This letter transmits our Revised Geotechnical Engineering Report for the above-referenced project. Materials Testing & Consulting, Inc. (MTC) performed this geotechnical engineering study in accordance with our Proposal for Geotechnical Services, dated October 29, 2015.

We would be pleased to continue our role as your geotechnical engineering consultants during the project planning and construction. We also have a keen interest in providing materials testing and special inspection during construction of this project. We will be pleased to meet with you at your convenience to discuss these services.

We appreciate the opportunity to provide geotechnical engineering services to you for this project. If you have any questions regarding this report, or if we can provide assistance with other aspects of the project, please contact me at (360) 755-1990.

Respectfully Submitted,
MATERIALS TESTING & CONSULTING, INC.

David Rauch, P.E.
Engineering Division Manager

Attachment: Geotechnical Engineering Report - FINAL

GEOTECHNICAL ENGINEERING INVESTIGATION

MARINE DRIVE PEDESTRIAN/BIKE IMPROVEMENTS

MARINE DRIVE
TULALIP, WASHINGTON

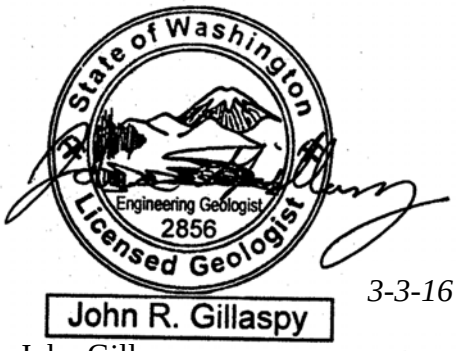
Prepared for:

Ms. Debbie Bray
Tulalip Tribes
8802 27th Ave NE
Tulalip, WA 98271

Prepared by:

3-3-16

David Rauch, P.E.
Engineering Division Manager



3-3-16

John Gillaspy
NW Region Geotechnical Manager

Meghan Hallam
Staff Geologist

MATERIALS TESTING & CONSULTING, INC. (MTC)
777 Chrysler Drive
Burlington, Washington 98233
Phone: (360) 755-1990
Fax: (360) 755-1980

March 3, 2016
MTC Project Number: **14B024-12**

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1.0 INTRODUCTION

1.1 GENERAL

This report presents the findings and recommendations of Materials Testing & Consulting, Inc.'s (MTC) geotechnical engineering study conducted for the design and construction of the proposed site development. The proposed project is located along the north side of Marine Drive between 64th Street NW and 7th Avenue NW in Tulalip, Washington. The location and aerial photo site plan of the project site is shown in Figures 1 and 2 of Appendix A.

1.2 PROJECT DESCRIPTION

It is our understanding that the project consists of designing and constructing pedestrian and bike improvements along Marine Drive from 7th Avenue NW to 64th Street NW, including a pile-supported boardwalk, channelization, lighting and signage improvements, and structural earth walls. MTC was provided a conceptual site plan for determination of study scope and discussion of proposed constructions (Figures 3, 4 Appendix B). MTC understands that the boardwalk will be approximately 475 feet in length and supported by pairs of hollow steel pipe piles spaced typically about 20 feet apart. Design of the walkway is in progress at the time of this study. Geotechnical aspects of pile design specifications are addressed in this report, based on the results of site explorations and MTC's pile analysis. Embankment and structural earth wall construction will be utilized in various locations along the boardwalk and roadway in order to safely level the subgrade through filling and cutting, respectively.

It is anticipated that loads will be typical for the type and materials and that no unusually large or vibratory loads are expected.

Roadways shown on the proposed site plan are anticipated to be installed similar to existing grade. MTC assumes the pavement sections will employ conventional flexible pavement with structural sections suitable for heavy vehicles or light traffic accesses depending on location.

MTC should be allowed to review the final plans and specifications for the project to ensure that the recommendations presented herein are appropriate. Recommendations and conclusions presented by this report will need to be re-evaluated in the event that changes to the proposed construction are made.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of our study was to explore subsurface conditions at the site and provide geotechnical engineering recommendations for design and construction of the 475- foot pile supported boardwalk, pavement improvements, and structural earth walls. Our scope of services was consistent with that presented in our Proposal for Geotechnical Engineering Services, dated October 29, 2015.

2.0 SITE EXPLORATION AND LABORATORY TESTING

2.1 SITE EXPLORATION ACTIVITIES

Our geotechnical site exploration activities for this phase of study were performed on January 6 and 7 of 2016. Field activities included advancing Hollow-Stem Auger (HSA) borings, Kessler Dynamic Cone Penetrometer (kDCP) testing, and Hand Auguring (HA). Exploration locations were generally selected by MTC prior to commencing field work based on the provided conceptual site plan and stationing requested by Austin Fisher, P.E. of Parametrix. Test locations were nominally adjusted by MTC while on site during explorations as needed for access and coverage. Additional information on the site exploration program and field methods is provided with our exploration logs in Appendix C through Appendix F of this report. Test locations are shown approximately on the exploration site plan, Figure 4 of Appendix B.

HSA boreholes were advanced on January 6 and 7, 2016. An MTC Staff Geologist directed borehole advancement and sampling procedures, logged samples, and noted SPT (Standard Penetration Test) count results. A total of seven borings were advanced to a maximum depth of 40 feet BPG within the proposed improvement zone, labeled B-1 through B-7. Samples were collected typically on 5-foot intervals with an additional shallow sample collected at 2.5 feet BPG in B-2. Borehole logs are included in Appendix D.

Kessler DCP tests were advanced by an MTC Staff Geologist at representative locations within the planned road extension and for pavement recommendation purposes. A total of three kDCP tests were extended to termination depths typically between 7 to 8 feet BPG, the maximum equipment reach. kDCP test results are provided in Appendix F.

Three HA borings were advanced by an MTC Geologist at representative locations within the planned road extension to correlate with HSA and kDCP data. Grabs samples were taken of each unit encountered. One hand auger was advanced to 5.5 feet BPG, while the other two encountered refusal upon large aggregate approximately 2.0 and 3.0 feet BPG.

2.2 LABORATORY TESTING

Laboratory tests were performed on selected soil samples in accordance with ASTM standards to determine pertinent index and engineering properties of the site soils. Tests included supplementary soil classification, grain-size distribution analysis by sieve and hydrometer methods, and Atterberg limits. Laboratory test results are presented on test reports included in Appendix H.

Laboratory results are displayed as applicable on the associated exploration boring and hand auger logs.

3.0 EXISTING SITE CONDITIONS

3.1 SURFACE DESCRIPTION

The project site consists of an existing two-lane road between 64th Street and 7th Avenue NW in Tulalip, Washington. Beginning at 64th Street, (at Station 00 + 00) the topography rises at about a 3 percent grade for approximately ¾ of a mile to a local high point, then drops by about 4 percent for approximately ½ of a mile before becoming approximately level by 7th Avenue NW. Smaller (< 10 foot) topographic variations at various localized areas were observed and included in the overall grade approximations, particularly between Station 51+25 to 51+75 and Station 62+37 to 63+09.

Apart from the existing road improvements and recent improvements at the intersection of 64th Avenue and Marine Drive during the construction of the Tulalip Tribes of Washington Administration Building located to the northwest, the site is relatively undeveloped and heavily vegetated within 10 feet on both sides of the road. Residential development near 62nd Street, 56th Street, and 7th Street was observed on the north to northeast side of the road.

Vegetation consists primarily of large evergreen and deciduous trees, to approximately 100 feet tall, with native underbrush including blackberry bushes, salal, ferns and other shrubs. A runoff ditch borders most of the roadway to the north where Frontier Communications also has buried lines set approximately 4 to 5 feet from the fog line. Southeast and southwest of the intersection at 64th Avenue NW topography is generally lower than the roadway and consists of marsh and wetland vegetation and features.

3.2 AREA GEOLOGY

The *Geologic Map of the Tulalip Quadrangle, Island & Snohomish Counties, Washington* (Minard 1985) and the *Geologic Map of the Marysville Quadrangle, Snohomish Counties, Washington* (Minard 1985) published by the USGS, indicates that geology of the site contains Quaternary Advanced Outwash (Qva), Quaternary Transitional Beds (Qtb) and possibly Quaternary Vashon Till (Qvt) of Vashon Drift (Fraser Glaciation). Qva is the primary unit expected and extends from the northwest boundary of the project area to about 280 feet northwest of 12th Avenue NW along Marine Drive. Qtb is mapped from about 280 feet northwest of 12th Avenue NW along Marine Drive East to the southeast end of the project area. Qvt is mapped very close to the transition between Qva and Qtb, on the south side of the road.

Quaternary Advance Outwash is described generally thick to massive gray gravelly sand with varying amounts of fine-grained sand and silt lenses throughout that generally becomes finer with depth. Quaternary Transitional Beds are similar in color to Qva, though have a much higher silt and clay content. Qtb also contains very fine to fine grained sand and possibly peaty sand/ gravel layers in the

lower part of the unit. Quaternary Vashon Till is described as an overconsolidated and poorly sorted light-brown to gray mixture of gravel, sand, silt and clay with varying amounts of sand, silt and gravel.

Native soil conditions encountered in the field to maximum depth explored consist of sand to silty fine and medium grained sand with locally interbedded silt and fine grained sand horizons. Near-surface conditions were observed to consist of multiple layers of asphalt overlying sandy silt to silty sand consistent with RAP and road base products. These conditions are typical of glacial outwash and transitional deposits, and are thus consistent with local geology sources.

3.3 SOIL CONDITIONS

A general characterization of on-site soil units encountered during our exploration is presented below. The exploration boring and test pit logs in Appendix D present details of soils encountered at each exploration location. This section focuses on native conditions throughout the site. For discussion of fill conditions at the southwest corner and north portion of the site, refer to subsequent sections below.

The on-site soils are generally characterized as follows in stratigraphic order to depth:

- **ASPHALT and Road Base Material - 0.0 to 2.5 feet BPG:**

  All borings except B-4 and B-7 and the 3 hand augers were advanced within the existing roadway alignment. Asphalt was cored through and logged up to 1-foot thick. Cores were individually measured as definitive layers were encountered upon retrieval. Road base material consisting of sand with varying amounts of silt and gravel to silty sand with gravel was observed beneath the asphalt including RAP and crushed aggregate. These units ranged from black to brown and were moist to medium dense.

- **Native Deposits (Topsoils, SM, ML, SP-SM, SP) – 0.0 to 40 feet BPG:**

  Soils consisting of silt to sandy silt, stiff to very stiff, or medium dense becoming very dense sand with gravel and decreasing amounts of silt were encountered at all exploration locations. These brown becoming gray soils were found beginning at approximately 0.0 feet in TP-4 and TP-7 and 5.0 feet in all other test pits and hand augers. These soils were generally moist and contained varying percentages of roots and organics in the upper 2.0 to 3.0 feet.

  Below approximately 4.0 feet BPG, soils became more coarse-grained silty sand to sand with silt, loose to medium dense and damp to moist. In some locations, another silty horizon occurred in the vicinity of 5.0 feet BPG before becoming consistently sandy below.

3.4 SURFACE WATER AND GROUNDWATER CONDITIONS

No surface water features were observed during the current site explorations conducted in the late winter season, excepting the wetland area in the vicinity of the proposed pin pile supported boardwalk. A drainage ditch, parallels Marine Drive beginning at approximately STA 22+67 on the north side of the existing roadway. Topography variance and undeveloped site conditions bordering both sides of the existing roadway, in conjunction with the engineered roadway crown likely contribute to the lack of standing water within the proposed improvements. Although as discussed below, perched water conditions may be a local factor.

During boring advancement, conditions became wet to saturated in the range of 19 feet BPG in B-5, 6 and 7 while shallower levels of very wet soils were observed at 1.8 feet BPG in HA-1, although actual conditions may have been higher if allowed to stabilize. At B-1 through B-4 and HA-2 through HA-3 no distinct groundwater or high moisture soils were observed during advancement. Water conditions may be marginally higher in the north end of the site, due to natural topographic lows and designated wetland features.

Soil mottling was observed at B-2 within a few feet of native grade and in B-3, B-4, B-6 and B-7 between 5.0 and 10.0 feet BPG. Mottled soils and low-chroma colors are indicative of a high seasonal water table and/or soil wetting and drying cycles. At this site, mottling patterns were observed to be complex and likely influenced by local variations in stratigraphy. However, impeding silt layers were observed interbedded with coarse horizons which may contribute to seasonal or temporary perched conditions related to downward stormwater infiltration and potentially fluctuating groundwater levels. It is not apparent if the groundwater table rises seasonally to meet this condition, or if perched horizons remain isolated. Low-chroma hues (gray soils, faded mottling) were more consistently onset between approximately 7.5 feet BPG where coarse grained soils are present. This may be more indicative of typical high winter season conditions, and is generally consistent with observations in the field.

MTC's scope of investigation did not include observation and monitoring of seasonal variations or conclusive measurement of groundwater elevations at the time of exploration. Water levels noted above should be considered close approximations. Given the time of this investigation in the mid to late winter, it is interpreted that measured groundwater levels represent typical wet-season condition. Actual groundwater conditions can vary locally as a consequence of complex shallow stratigraphy, especially in the winter months. It is important to note that past development of the property and adjacent sites, including stripping and drainage improvements in the vicinity, may have altered winter groundwater patterns or lowered seasonal levels since mottling was established.

Due to the more fine-grained nature of some soil horizons, pockets or layers of saturation and water seepage may be present throughout much of the year. The phenomenon of perched groundwater levels or localized pockets of saturation frequently develops where lower permeability horizons underlie or are

interbedded with coarse-grained sediment. Discovery of seepage from perched water horizons or confined coarse lenses should be anticipated during construction, especially if work is conducted in the wet season. Field observations suggest that free water will likely be encountered in excavations at the project site exceeding 19.0 BPG assuming dry season construction. If earthwork occurs in the wet season, general wet conditions and free water should be anticipated to begin by 15.0 feet BPG. Perched water lenses may be encountered locally within about 1.5 feet of the surface.

4.0 GEOTECHNICAL ANALYSIS & DISCUSSION

This section addressed the results of site-specific geotechnical analysis and review of available data. The results described below form the basis for the geotechnical engineering design recommendations presented in Section 5.0 and construction recommendations presented in Section 6.0.

4.1 SEISMIC HAZARDS

A seismic hazard presents a risk of facility and infrastructure damage due to ground rupture, liquefaction, lateral spreading, or seismically-induced slope instability associated with a seismic event. One known fault zone is mapped to the northwest 20 miles and to the southwest within 7 miles of the proposed improvements. As a result the risk for significant ground-shaking during a seismic event exists, though the risk of ground rupture is unlikely as no faults are mapped that transect the subject property. According to Johnson et al. (2003)[1], the estimated recurrence interval for seismic events on proximal faults range from 200 to 12 thousand years. MTC recommends all buildings at the site be designed to applicable building codes in consideration of the site seismic design parameters provided below.

4.2 LIQUEFACTION SUSCEPTIBILITY

The *Liquefaction Susceptibility Map of Snohomish County* (Palmer et al., 2004) indicates that there is a low to moderate (Site Class C to D) for liquefaction. All structures should be designed according to criteria outlined by the latest edition, at the time of construction, of the International Code Council® for Site Class D.

4.3 SEISMIC DESIGN AND ACCELERATION PARAMETERS

According to the Washington State Department of Natural Resources *Site Class Map of Snohomish County, Washington* (Palmer et al., 2004), the site area is mapped as Seismic Site Class C to D. For site construction, Seismic Site Class D appears appropriate for design. The *USGS Seismic Design Map Tool* was used to determine site coefficients and spectral response accelerations for the project site assuming design Site Class D after ground improvements. In this case, MTC recommends these parameters for incorporating seismic design into the proposed development:

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[1]Johnson, S.Y., Blakely, R.J., and Brocher, T.M., compilers, 2003, Fault number 573, Utsalady Point fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/regional/qfaults, accessed 12/28/2011 09:05 AM.

Table 2. Seismic Design Parameters – Site Class D

Mapped Acceleration Parameters (MCE horizontal)	S_S	1.254 g
	S_1	0.481 g
Site Coefficient Values	F_a	1.0
	F_v	1.519
Calculated Peak SRA	S_{MS}	1.254 g
	S_{M1}	0.731 g
Design Peak SRA (*2/3 of peak*)	S_{DS}	0.836 g
	S_{D1}	0.487 g
Seismic Design Category – Short Period (0.2 Second) Acceleration		D
Seismic Design Category – 1-Second Period Acceleration		D

4.4 PILE FOUNDATION

MTC understands that hollow steel pipe piles are proposed as the preferred foundation for the elevated boardwalk extending from STA 14+88 to STA 19+55. MTC has performed pile analysis using the results of our site investigation to determine recommended minimum pile size and optimum embedment depth for typical site soil conditions. It is our understanding that all other aspects of pile and walkway design will be performed by the project engineer. Relevant details are discussed below.

MTC's investigation revealed favorable dense soil conditions beginning reliably by approximately 15.0 feet BPG. MTC generally recommends a minimum 5 feet of embedment into suitably dense soils, corresponding to a target minimum embedment of 20 feet below existing grade. We recommend following installation and refusal recommendations as presented in *Section 5.1 Foundation Feasibility* or as recommended by the manufacturer, whichever is more conservative and applicable for the project. If discrepancies exist, MTC should be contacted to consult on selection of final construction criteria.

4.5 STRUCTURAL EARTH WALL DISCUSSION

MTC understands that structural earth walls are proposed to be constructed at stations extending from STA 51+25 to 51+75 and STA 62+37 to 63+09 where right of way space is constricted.

MTC anticipates that a geogrid-reinforced slope is feasible at the proposed locations assuming the recommendations for base subgrade preparations in *Section 5.2 Structural Earth Wall Construction* are followed. MTC recommends that final design elements adhere to the specifications and standards as set forth in WSDOT 2-03.3(14) for Embankment Construction and that appropriate landscape design professionals are consulted for final planting schematics.

5.0 DESIGN RECOMMENDATIONS

5.1 PILE FOUNDATION FEASIBILITY

MTC consulted with the design engineer, Ben Schlachter of Parametrix, and reviewed initial plans from June, 2015. The walkway spans approximately 475 lineal feet over existing grade. The walkway profile is within about 5 feet of present grade toward each end, reaching heights of 10 to 15 feet above grade along the middle third of the alignment. Initial components included a relatively light wood-frame walkway supported by smaller diameter pin piles with lateral wood bracing between pairs as well as longitudinally spanning pairs spaced 10 feet apart. Anticipated pile size was 6-inch diameter.

During the course of the site investigation and supplemental engineering period, the proposed walkway design elements also evolved. After draft report submittal, MTC was apprised that the walkway is proposed to be composed primarily of cast-in-place concrete, and pile pair spacings will be roughly 20 feet on-center (22.5 feet maximum). Due to the increased spacing, longitudinal bracing became infeasible. We understand the profile remains consistent with preliminary plans. Pile analysis was undertaken by MTC at the request of the client to determine a suitable pile size that will meet design requirements with only lateral bracing using steel angles as needed per the engineer. The details of MTC's pile analysis are provided as Appendix F.

Target embedment depth for analysis was retrieved from subsurface exploration data with N values of blow counts at 5-foot intervals. MTC interprets consistently medium dense sand to sand with silt conditions present by approximately 15 feet BPG throughout the elevated walkway footprint, becoming very dense with depth. In contrast, the upper 10 to 12 feet of cover soils and overburden is commonly sensitive or relatively soft or loose. A minimum embedment of 5 feet into suitably dense conditions is recommended throughout the alignment, equating to a typical total pile depth of 20 feet below present grade. Based on our understanding of site subsurface conditions and the results of pile analysis, the proposed pile-supported walkway appears feasible in terms of geotechnical engineering and typical pile construction practices.

All piles shall be driven to suitable refusal with criteria as determined by the pile contractor and approved by the geotechnical engineer and design engineer. Refusal specifications may depend on the type of machinery used for pile driving. We also recommend embedding sufficiently into dense soils. Based on MTC's site testing, pile end depths may range from at minimum 20 to 25 feet BPG along the alignment. If early pile refusal is encountered at depths less than those recorded by field exploration for a specific location, pile acceptance shall be evaluated by the geotechnical engineer in consideration of achieved depth, driving behavior, and adjacent pile conditions. If refusal is encountered at an excessively shallow depth (less than 10 feet BPG per our explorations), MTC recommends an alternative driving location be attempted at minimum 3*d (three times pile diameter) and at maximum 5*d on-center from the refused pile. Final acceptance of installed piles will be at the discretion of the

geotechnical and design engineers. MTC recommends the process of pile installation be observed and documented full-time by an MTC representative to verify adequate pile depths and refusal criteria are met and that we be contacted immediately if conditions encountered differ from those described herein.

5.2 STRUCTURAL EARTH WALL CONSTRUCTION

Based on MTC's exploration observations of near-surface deposits, structural earth wall construction at the proposed stations extending from STA 51+25 to 51+75 and STA 62+37 to 63+09 is acceptable provided the following considerations and recommendations for construction and materials are followed and at a minimum, conform to WSDOT 2-03(14) for embankment construction. MTC expressly recommends that we review final plans and specifications for retaining walls to ensure consistency with the recommendations presented herein and to provide additional geotechnical consultation and recommendations as needed for final design and construction.

- **Site Preparation and Earthwork**

  After excavations have been completed to the planned subgrade elevations, but before placing fill or structural elements, the exposed subgrade soils should be evaluated under the full-time observation and guidance of an MTC representative. Soils should be probed with a minimum ½-inch round steel T-probe or an MTC representative may use alternative methods for subgrade evaluation.

  Any loose soil should be compacted to a firm and unyielding condition and at least to 95 percent of the modified Proctor maximum dry density per ASTM D1557. Any areas that are identified as being soft or yielding during subgrade evaluation should be over-excavated to a firm and unyielding condition or to the depth determined by the geotechnical engineer. Where over-excavation is performed below a structure, the over-excavation area should extend beyond the outside of the berm base a distance equal to the depth of the over-excavation below the base. The over-excavated areas should be backfilled with properly compacted structural fill in accordance with the specifications found in *Section 6.2 for Structural Fill Materials and Compaction.*

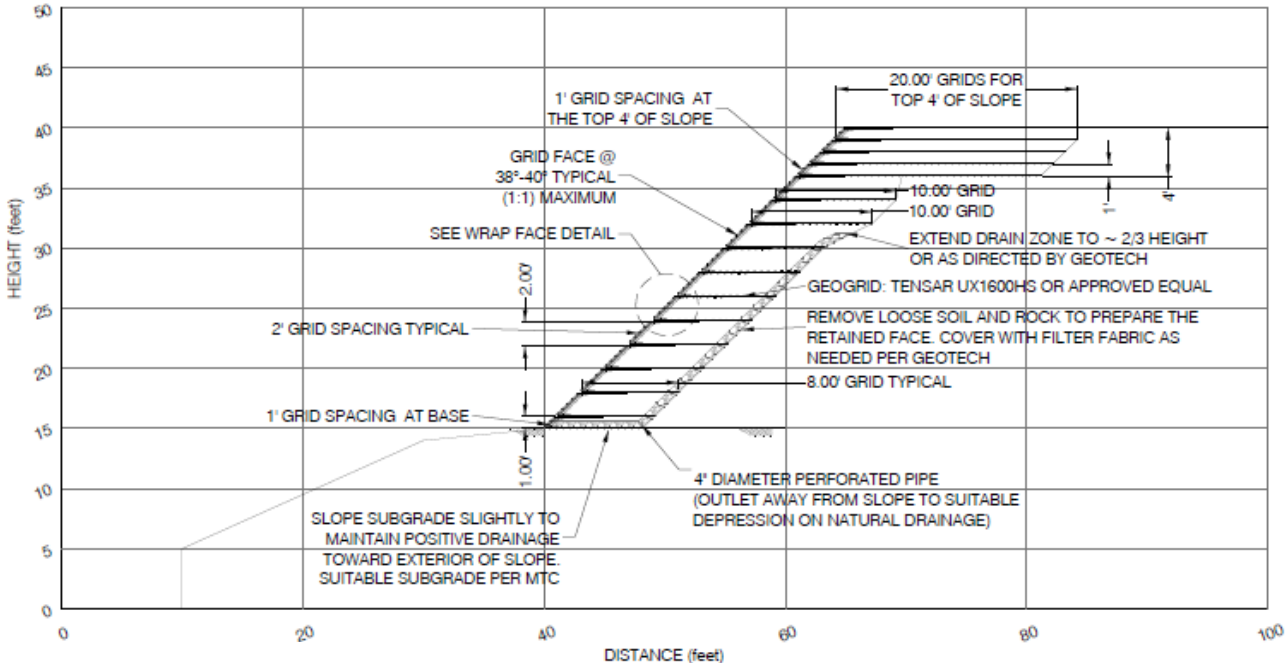
- **Foundation:**

  A foundation pad shall be constructed in the proposed areas consisting of either competent native soils at depths between 5.0 and 15.0 feet BPG, respectively. If structural fill is required then a material shall be used that conforms to WSDOT 9-03.14(1) for Gravel Borrow with a maximum particle size of 2 inches and compacted to 95% of the modified proctor maximum dry density. Foundation pads shall be terraced if the slopes exceed 2H:1V at a minimum of 1.0 to 5.0 feet vertical height and 1.0 to 3.0 feet on the horizontal with no more than a 0.05-foot incline.

- **Structural Earth Wall Construction:**

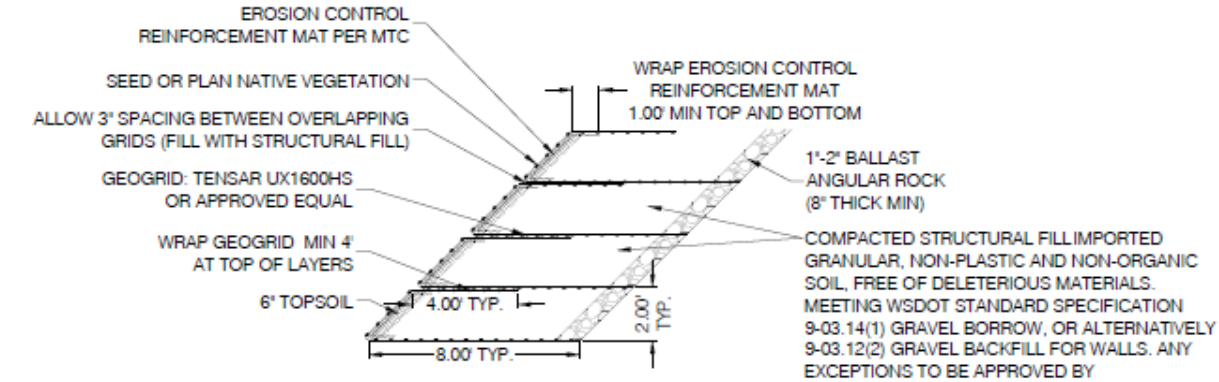
Berm erection shall be constructed in layers from the base using a wrapped geogrid pattern on 2-foot intervals and compacted imported structural infill per Figure 1. The outer edge of the slope will have planting soil and wrapped erosion control matting placed to allow for revegetation or seeding per the project plans as directed by a qualified landscape professional after construction. For drainage controls, a ballast rock base layer and 2/3 height chimney is incorporated. Plans call for a 4-inch perforated drain pipe outlet to a natural drain course away from the slope. Filter fabric should be utilized against the soil cut if needed depending on actual conditions encountered.

Figure 1. Structural Earth Wall Specifications and Installation Detail*.



* Schematic to be used for guidance of design only. Actual dimensions for height and width will vary depending upon project location and site topography.

Figure 2. Wrap Face Detail



- **Requirements and Installation:**
  Geosynthetic reinforcement (geogrid) shall consist of Tensar UX1600HS or equivalent uniaxial grid approved by the engineer. Grids shall consist of a minimum of 2.0 feet in height with a maximum length of 8.0 feet and geogrid shall embed a minimum of 4.0 feet into slope. The inclusion of a 3.0 inch layer of structural fill will provide traction between each grid layer and shall be incorporated prior to beginning each successive layer. If necessary to achieve the desired face grade, forms may be used to create uniform wrapped faces and provide stabilization during construction. Fill shall be placed in loose lifts not to exceed 8.0 inches, taking care to avoid wrinkling or disturbance of grid bedding. Fill shall be placed along the entire length and width of the lift and machinery should be restricted from traversing the grid until each lift is placed in entirety. Upon completion an erosion control wrap facing shall be placed over the structure in its entirety with a 1.0-foot embedment. A minimum of 12.0 inches of an approved topsoil material shall be placed for planting at the discretion of the client in with direction from an authorized landscape professional. MTC recommends we are retained for full-time inspections or regular inspection during installation.
- **Drainage:**
  To preclude build-up of hydrostatic pressure, we recommend a minimum width of 1 foot of clean, granular, free-draining material extend from the footing drain at the base of the wall to the ground surface immediately behind the wall. Native soils are not considered suitable as drainage material. Imported wall drain aggregate should conform to WSDOT Standard Specification 9-03.12(4) Gravel Backfill for Drains or 9-03.12(5) Gravel Backfill for Drywells. A filter fabric suitable for use in soil separation and water transmission is recommended to be placed against retained soil cuts behind the wall (if present) to limit migration of fines into the drain corridor.

5.3 PAVEMENT CONSTRUCTION PREPARATIONS

MTC recommends adhering to general site preparation guidelines addressed in Section 6.0 below prior to construction of pavement sections and flatworks. We understand finished pavement grade is anticipated to be similar to or slightly elevated compared to existing grade. In existing undeveloped or landscaped areas of the site, MTC recommends stripping organic topsoils and unsuitably loose or soft soils from road alignments and parking footprints and their annular spaces. Exposed subgrade shall be proof-rolled to confirm that the subgrade does not exhibit any soft or deflecting areas prior to pavement section construction. Areas of excessive yielding, rutting, or pumping should be excavated and backfilled with properly compacted structural fill as described in Section 6.2. The subgrade shall be approved by a representative of the geotechnical engineer using a combination of proof roll, visual inspection, and probing as deemed appropriate for the conditions encountered.

Based on MTC's observations and density testing within the existing road alignment, the existing fill appears generally suitable and well installed to serve as aggregate base material for pavement

construction. MTC recommends stripping to proposed top-of-base grade, removing any remaining plant matter and organic materials, grading and recompacting, and verifying suitability by the methods noted above as well as compaction testing of prepared base grade. In this case, the contractor must ensure adequate fill section remains to meet or exceed section requirements.

In order to perform pavement section design calculation, MTC has assigned traffic loading values (18-kip ESALs) of 1,675,558 for automobiles, buses, truck and trailer combos and other heavy trucks. Values are based on data obtained from Snohomish County Public Works Historical Traffic County for 2010-2013. Within a 24 hour period approximately 11,470 units were counted at the intersection of 7th Ave NW and Marine Drive, while 8,690 at the intersection of 64th Street NW and Marine Drive. We recommend assumed design ESALs be verified by the design team with information available later in the project to ensure the most appropriate design criteria is applied, and if necessary that pavement sections be reevaluated if anticipated traffic loads differ from the presumed.

Calculations were performed per AASHTO Flexible Pavement Design methods, with the following standard input parameters:

Input	Existing Alignment	Unimproved Alignment
Pavement Design Life	20 Years	
Terminal Serviceability Index	2.0	
Reliability	95	
Expected Growth Rate	2.0%	
Subgrade CBR Value	8	1

5.3.1 CONVENTIONAL PAVEMENT RECOMMENDATIONS

1. In all areas to receive pavements, the organic, loose or obviously compressive materials must be removed. Because the exposed subgrade soils will be moisture sensitive and rapidly degrade under construction traffic loads when wet, care should be exercised to protect subgrades until pavements have been placed.
2. The pavement and driveway subgrade shall be proof-rolled to confirm that the subgrade contains no soft or deflecting areas. Areas of excessive yielding should be excavated and backfilled with structural fill. Structural fill shall conform to WSDOT 9-03.14(1) for gravel borrow in

accordance with the latest version of the *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*[2].

3. Structural fill will most likely be required in the existing shoulder and in various locations beneath the existing roadway. Structural fill shall meet the requirements outlined above and shall be compacted to a minimum percent compaction of 95 percent based on its modified Proctor maximum dry density as determined per ASTM D1557. Where reinforcing fabric is used over soft subgrades, an initial lift of 18 inches of structural fill should be placed prior to compacting.
4. We recommend that fill placed on slopes steeper than 3:1 (H:V) be 'benched' in accordance with hillside terraces entry of section 2-03.3(14) of the latest version of the *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*[3].
5. The pavement structural sections should consist of a minimum of 6 inches of ¾ -inch HMA pavement over a minimum of 3 inches of Asphalt Treated Base (ATB) over a minimum of 6 inches of crushed surfacing base course (CSBC). Beneath the roadway prism a minimum of 6 inches of aggregate base should be apparent in the existing alignment, while a minimum of 24 inches of structural fill shall be placed as detailed above.

5.3.2 Rigid Pavements and Flatworks

Rigid pavement components are commonly utilized for portions of accesses and ancillary exterior improvements. The project civil design engineer may reevaluate the below general recommendations for pavement thicknesses and base sections if necessary to ensure proper application to a given structure and use. MTC recommends that we be contacted for further consultation if the below sections are proposed to be reduced.

Concrete driveway aprons and curb alignments, if utilized, should consist of a minimum 6-inch thickness of reinforced concrete pavement over 12 inches of aggregate base per *WSDOT standard 9-03.10 Aggregate for Gravel Base* fill. Base thickness should correspond to related location and anticipated traffic loading.

Concrete sidewalks, walkways and patios if present may consist of a minimum 4-inch section of plain concrete (unreinforced) installed over a 6-inch minimum compacted base of crushed rock. Base material directly below pavement for sidewalks should consist of ¾-inch minus crushed rock or approved equivalent, compacted to 95% of maximum dry density. At locations where grade has been

[2] *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*; Washington State Department of Transportation; 2014
[3] *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*; Washington State Department of Transportation; 2014

raised with structural fill, a 4-inch minimum crushed rock section may be used. Flatworks should employ frequent joint controls to limit cracking potential.

Specifications for concrete aprons and flatworks can be predetermined by the local municipality, and may conflict with the above. In this case, we recommend either adhering to the more stringent option, or contacting MTC for clarification.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 EARTHWORK

6.1.1 Excavation

Excavations can generally be performed with conventional earthmoving equipment such as bulldozers, scrapers, and excavators.

Where possible, excavations made within about one foot of finished subgrade level should be performed with smooth edged buckets to minimize subgrade disturbance and the potential for softening to the greatest extent practical.

6.1.2 Subgrade Evaluation and Preparation

After excavations have been completed to the planned subgrade elevations, but before placing fill or structural elements, the exposed subgrade soils should be evaluated under the full-time observation and guidance of an MTC representative. Where appropriate, the subgrade should be proof-rolled with a minimum of two passes with a fully loaded dump truck or water truck. In circumstances where this seems unfeasible, an MTC representative may use alternative methods for subgrade evaluation.

Any loose soil should be compacted to a firm and unyielding condition and at least to 95 percent of the modified Proctor maximum dry density per ASTM D1557. Any areas that are identified as being soft or yielding during subgrade evaluation should be over-excavated to a firm and unyielding condition or to the depth determined by the geotechnical engineer. Where over-excavation is performed below a structure, the over-excavation area should extend beyond the outside of the footing a distance equal to the depth of the over-excavation below the footing. The over-excavated areas should be backfilled with properly compacted structural fill.

6.1.3 Site Preparation, Erosion Control and Wet Weather Construction

The various fills and silty to silty sand native soils at anticipated excavation depth may be moisture sensitive and could become soft and difficult to compact or traverse with construction equipment when wet. During wet weather, the contractor should take measures to protect the exposed subgrades and limit construction traffic during earthwork activities.

Once the geotechnical engineer has approved a subgrade, further measures should be implemented to prevent degradation or disturbance of the subgrade. These measures could include, but are not limited to, placing a layer of crushed rock or lean concrete on the exposed subgrade, or covering the exposed subgrade with a plastic tarp and keeping construction traffic off the subgrade. Once subgrade has been approved, any disturbance because the subgrade was not protected should be repaired by the contractor at no cost to the owner.

During wet weather, earthen berms or other methods should be used to prevent runoff from draining into excavations. All runoff should be collected and disposed of properly. Measures may also be required to reduce the moisture content of on-site soils in the event of wet weather. These measures can include, but are not limited to, air drying and soil amendment, etc.

Since the silty on-site soils will be difficult to work with during periods of wet weather due to elevated soil moisture content, and frozen soil is not suitable for use as structural fill, we recommend that earthwork activities generally take place in late spring, summer or early fall. In addition, late summer may be the most preferable time for construction of subsurface elements corresponding to the period of generally lowest surface and ground water occurrences.

Dewatering efforts may be required depending on total excavation depth, season of construction, and weather conditions during earthwork. MTC recommends major earthwork activities take place during the dry season if possible to minimize the potential for encountering perched groundwater or the water table near proposed excavation depth, and to reduce the extent of surface water presence in low areas of the site. It should be understood that some amount of water seepage from shallow sources or perched lenses may be unavoidable year-round.

6.2 STRUCTURAL FILL MATERIALS AND COMPACTION

6.2.1 Materials

All material placed below structures or pavement areas should be considered structural fill. Structural fill material shall be free of deleterious material, have a maximum particle size of 6 inches, and be compactable to the required compaction level.

Stripped or excavated native soils may be suitable for or amended for other non-structural applications in the proposed development, such as for general grading fill in shoulders or for preparation of landscaping areas. If reuse of native soils is considered, MTC recommends that we be contacted for assistance in evaluating suitability and feasibility based on the findings of this study.

Imported material can be used as structural fill. Imported structural fill material should conform to Section 9-03.14(1), Gravel Borrow, of the most recent edition (at the time of construction) of the State of Washington Department of Transportation *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*.

Controlled-density fill (CDF) or lean mix concrete may be used as an alternative to structural fill materials, except in areas where free-draining materials are required or specified.

Frozen soil is not suitable for use as structural fill. Fill material may not be placed on frozen soil.

The contractor should submit samples of each of the required earthwork materials to the geotechnical engineer for evaluation and approval prior to delivery to the site. The samples should be submitted at least 5 days prior to their delivery and sufficiently in advance of the work to allow the contractor to identify alternative sources if the material proves unsatisfactory.

6.2.2 Placement and Compaction

Prior to placement and compaction, structural fill should be moisture conditioned to within 3 percent of its optimum moisture content. Loose lifts of structural fill shall not exceed 8 inches in thickness; thinner lifts will be required for walk-behind or hand operated equipment.

All structural fill shall be compacted to a dense and unyielding condition and to a minimum percent compaction based on its modified Proctor maximum dry density as determined per ASTM D1557. Structural fill placed beneath each of the following shall be compacted to the indicated percent compaction:

Foundation and Floor Slab Subgrades:	95 Percent
Impervious Pavement Subgrades (upper 2 feet):	95 Percent
Impervious Pavement Subgrades (below 2 feet):	90 Percent
Utility Trenches (upper 4 feet):	95 Percent
Utility Trenches (below 4 feet):	90 Percent
Landscaping:	85 Percent

We recommend that fill placed on slopes steeper than 3:1 (H:V) be 'benched' in accordance with hillside terraces entry of section 2-03.3(14) of the WSDOT Standard Specifications.

We recommend structural fill placement and compaction be observed on a full-time basis by an MTC representative. A sufficient number of tests shall be performed to verify compaction of each lift. The number of tests required will vary depending on the fill material, its moisture condition and the equipment being used. Initially, more frequent tests will be required while the contractor establishes the means and methods required to achieve proper compaction.

6.3 TEMPORARY EXCAVATIONS AND SLOPES

All excavations and slopes must comply with applicable local, state, and federal safety regulations. Construction site safety is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing soil type information solely as a service to our client for planning purposes. Under no circumstances should the information be interpreted to mean that MTC is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

Temporary excavations in the existing site soils should be inclined no steeper than 1.5H:1V for silty soils or 2H:1V for sandy soils, although applying lesser grades may be necessary depending on actual conditions encountered and the potential presence of localized water seepage and shallow groundwater. Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed near the top of any excavation. Where the stability of adjoining walls or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Earth retention, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Washington.

Temporary excavations and slopes should be protected from the elements by covering with plastic sheeting or some other similar impermeable material. Sheeting sections should overlap by at least 12 inches and be tightly secured with sandbags, tires, staking, or other means to prevent wind from exposing the soils under the sheeting.

Plans for excavation including temporary cut slopes and proposed shoring methods were not available to MTC at the time of report production. Assuming excavation depths of up to 10 feet from existing grade may be necessary, it is anticipated that one or both techniques will be used. MTC can provide further consultation, design, and evaluation services for cut slopes if desired prior to and during construction. If shoring is required beyond typical OSHA standards, MTC can provide geotechnical engineering services for shoring design upon request.

6.4 PERMANENT SLOPES

MTC recommends generally that new areas of permanent slopes including fill embankments be inclined no greater than 3H:1V. If steeper grades are considered outside of building and traffic loading zones as well as away from sensitive areas, they may be permissible with the use of permanent erosion control measures (such as synthetic matting and cover plantings). MTC may be contacted for recommendations of suitable erosion control measures if needed. All permanent slopes should be planted with a deep-rooted, rapid-growth vegetative cover as soon as possible after completion of slope construction. Alternatively, the slope should be covered with plastic, straw, etc. until it can be landscaped.

6.5 UTILITY TRENCHES AND EXCAVATIONS

The contractor shall be responsible for the safety of personnel working in utility trenches. Given that steep excavations in native soils may be prone to caving, we recommend all utility trenches, but particularly those greater than 4 feet in depth, be supported in accordance with state and federal safety regulations.

Pipe bedding material should conform to the manufacturer's recommendations and be worked around the pipe to provide uniform support. Cobbles exposed in the bottom of utility excavations should be covered with pipe bedding or removed to avoid inducing concentrated stresses on the pipe.

Trench backfill should be placed and compacted as structural fill as recommended in Section 5.2. Particular care should be taken to insure bedding or fill material is properly compacted to provide adequate support to the pipe. Jetting or flooding is not a substitute for mechanical compaction and should not be allowed.

Dewatering will likely be necessary for utility trench excavations approaching or exceeding 4 feet BPG in the winter or 6 feet BPG in the summer, especially if construction occurs during prolonged wet weather. General recommendations for site preparation and wet weather construction are addressed in Section 6.1.3. However, it should be noted that this study did not include a hydrogeologic evaluation necessary for accurate appraisal of site flow conditions or volume estimates and is only generally suitable for planning and design of dewatering methods.

7.0 ADDITIONAL RECOMMENDED SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during construction to verify compliance with these recommendations. Testing and observations performed during construction should include, but not necessarily be limited to, the following:

- Geotechnical plan review and engineering consultation as needed prior to construction phase,
- Observation and monitoring of ground improvements or preload construction as applicable,
- Observations and testing during site preparation, earthwork, structural fill, and pavement section placement,
- Consultation on temporary excavation cutslopes and shoring if needed,
- Testing and inspection of any concrete or masonry included in the final construction plans, and
- Consultation as may be required during construction.

We strongly recommend that MTC be retained for the construction of this project to provide these and other services. Our knowledge of the project site and the design recommendations contained herein will be of benefit in the event that difficulties arise and either modifications or additional geotechnical engineering recommendations are required or desired. We can also, in a timely fashion observe the actual soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

We further recommend that project plans and specifications be reviewed by us to verify compatibility with our conclusions and recommendations.

Also, MTC retains fully accredited, WABO-certified laboratory and inspection personnel, and is available for this project's testing, observation and inspection needs. Information concerning the scope and cost for these services can be obtained from our office.

8.0 LIMITATIONS

Recommendations contained in this report are based on our understanding of the proposed development and construction activities, our field observations and exploration and our laboratory test results. It is possible that soil and groundwater conditions could vary and differ between or beyond the points explored. If soil or groundwater conditions are encountered during construction that vary or differ from those described herein, we should be notified immediately in order that a review may be made and supplemental recommendations provided. If the scope of the proposed construction, including the proposed loads or structural locations, changes from that described in this report, our recommendations should also be reviewed.

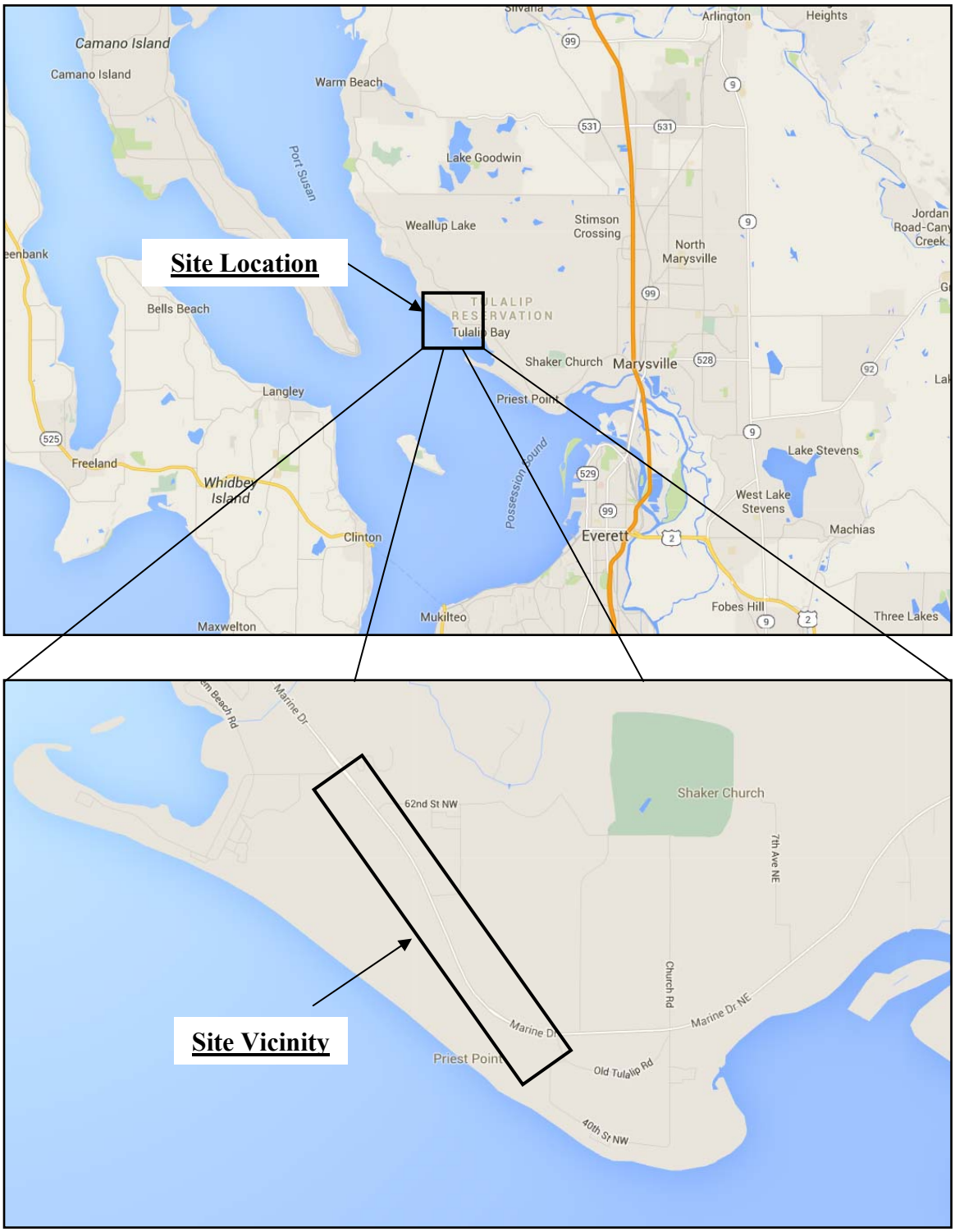
We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty, express or implied, is made. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by MTC during the construction phase in order to evaluate compliance with our recommendations. Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the author of this report, are only mentioned in the given standard; they are not incorporated into it or "included by referenced", as that latter term is used relative to contracts or other matters of law.

This report may be used only by the Tulalip Tribe and their design consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than 18 months from the date of the report. Note that if another firm assumes Geotechnical Engineer of Record responsibilities they need to review this report and either concur with the findings, conclusions, and recommendations or provide alternate findings, conclusions and recommendation under the guidance of a professional engineer registered in the State of Washington. The recommendations of this report are based on the assumption that the Geotechnical Engineer of Record has reviewed and agrees with the findings, conclusion and recommendations of this report.

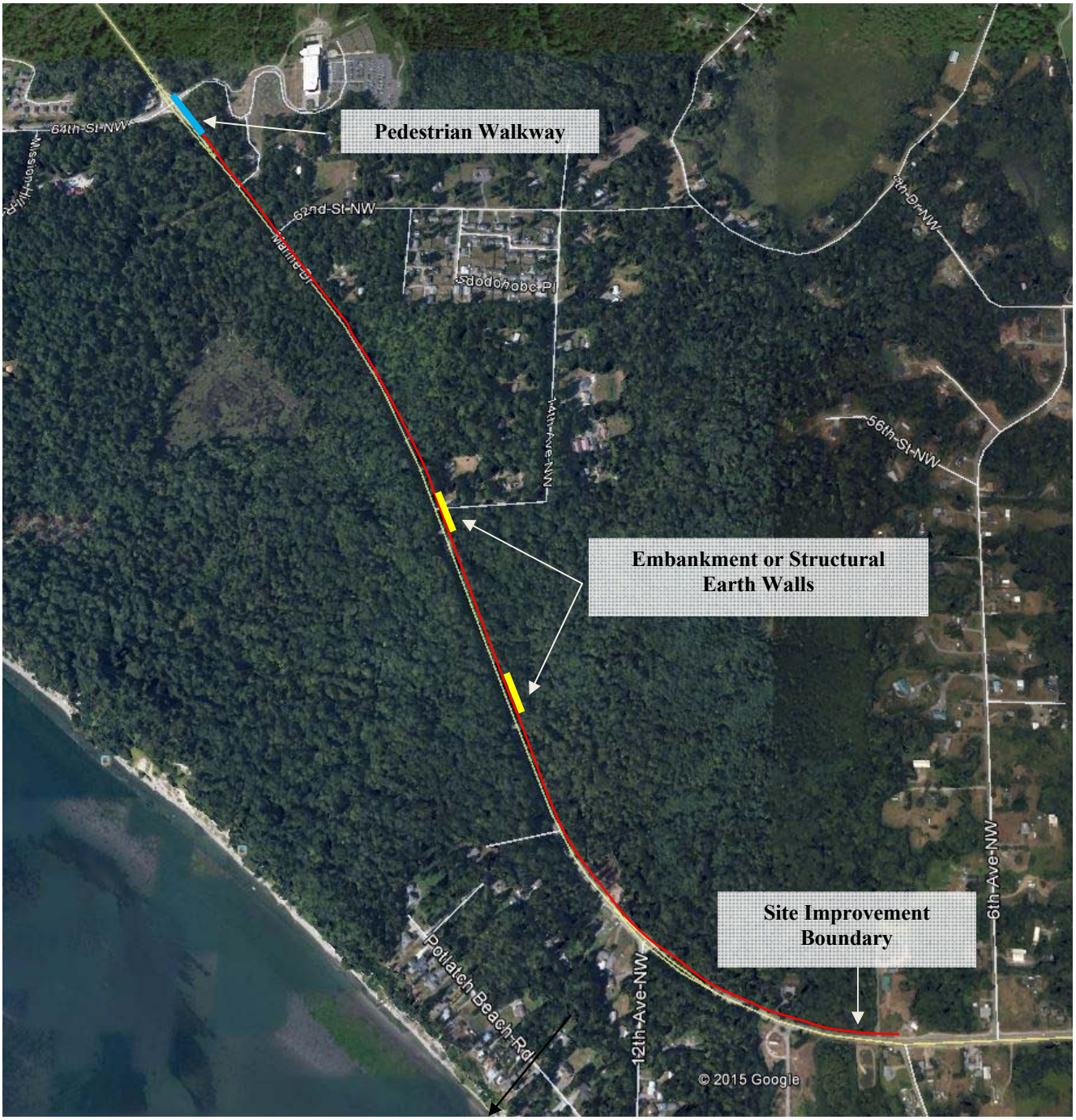
Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time. Based on the intended use of the report, MTC may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Tulalip Tribe or anyone else will release MTC from any liability resulting from the use of this report by any unauthorized party and the Tulalip Tribe agrees to defend, indemnify, and hold harmless MTC from any claim or liability associated with such unauthorized use or non-compliance. We recommend that MTC be given the opportunity to review the final project plans and specifications to evaluate if our recommendations have been properly interpreted. We assume no responsibility for misinterpretation of our recommendations.

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

Appendix A. SITE VICINITY AND AIR PHOTO



Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Location & Vicinity Map** Ped/Bike Improvements Marine Drive Tulalip, WA	**FIGURE** **1**



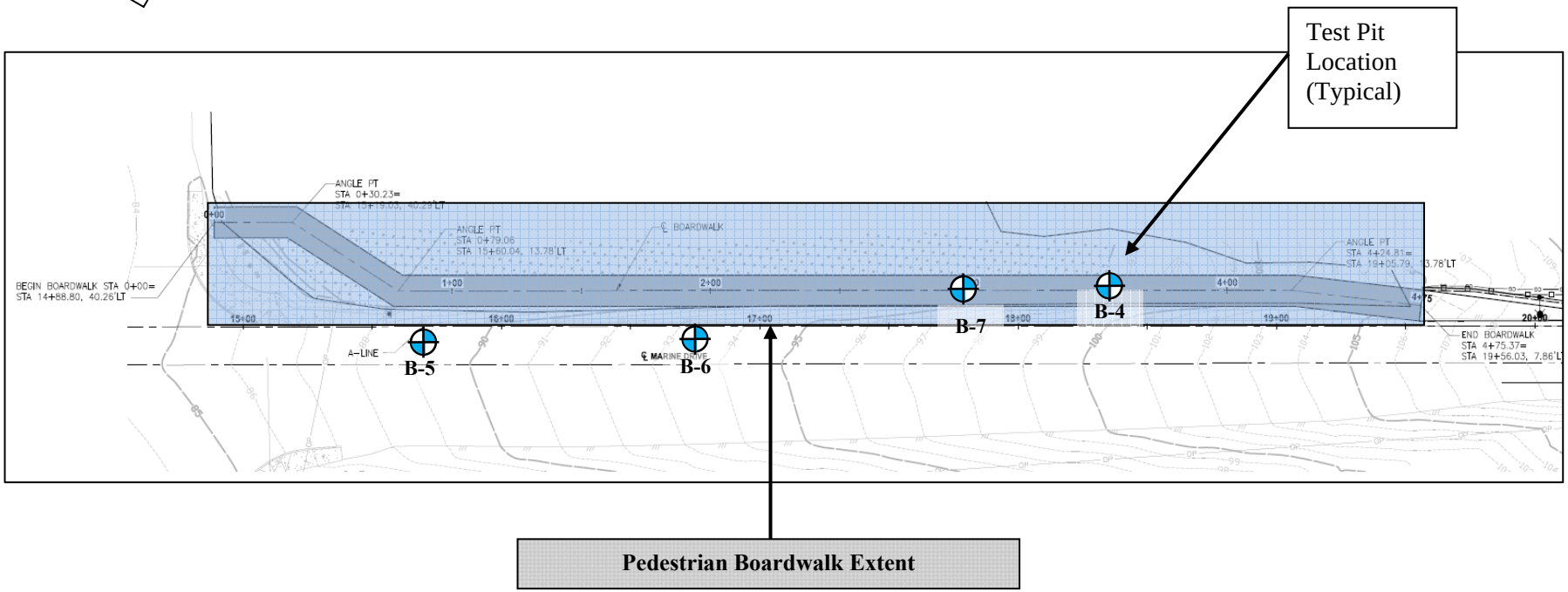
0 1000

SCALE (FEET)
Approximate

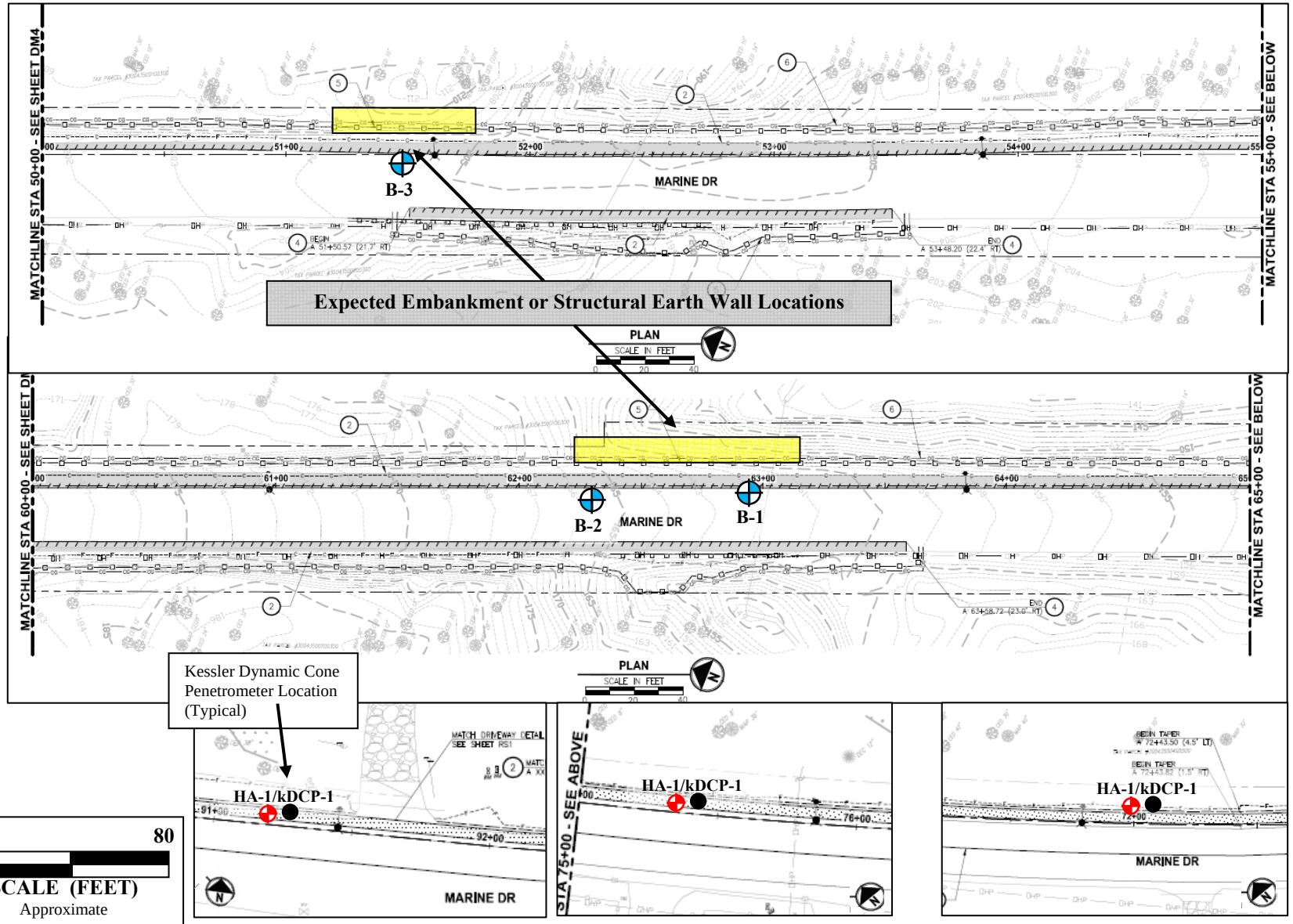
Aerial Photo from Google Imagery (2015) | All locations Approximate

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Aerial Photo – Recent Conditions** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **2**

Appendix B. SITE MAP AND TEST LOCATIONS



Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Proposed Development Map** Pedestrian Improvements Marine View Drive Tulalip, WA	Proposed Site Plan – Pedestrian Boardwalk By: Parametrix Date: 10-27-15 Modified by MTC: 12-30-15 NOT INTENDED FOR CONSTRUCTION	**FIGURE** **3**



Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Proposed Development Map** Pedestrian Improvements Marine View Drive Tulalip, WA	Proposed Site Plan – Embankment/Structural Earth By: Parametrix Date: 10-27-15 Modified by MTC: 12-30-15 NOT INTENDED FOR CONSTRUCTION	**FIGURE** **4**

Appendix C. EXPLORATION LOGS

Grab soil samples were collected from each exploration location by our field geologist during borehole advancement and test pit excavation. Soil samples collected during the field exploration were classified in accordance with ASTM D2487. All samples were placed in plastic bags to limit moisture loss, labeled, and returned to our laboratory for further examination and testing.

Exploration logs are shown in full in Appendices C & D, corresponding to boring results and test pit observations respectively. The explorations were monitored by our field geologist who examined and classified the materials encountered in accordance with the Unified Soil Classification System (USCS), obtained representative soil samples, and recorded pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence. Upon completion boreholes were backfilled with native soil and bentonite chips, and test pits were backfilled with native soil tailings.

The stratification lines shown on the individual logs represent the approximate boundaries between soil types; actual transitions may be either more gradual or more severe. The conditions depicted are for the date and location indicated only, and it should not necessarily be expected that they are representative of conditions at other locations and times.

Unified Soil Classification System Chart

Major Divisions			Graph	USCS	Typical Description
Coarse Grained Soils More Than 50% Retained On No. 200 Sieve	**Gravel** More Than 50% of Coarse Fraction Retained On No. 4 Sieve	Clean Gravels		GW	Well-graded Gravels, Gravel-Sand Mixtures
				GP	Poorly-Graded Gravels, Gravel-Sand Mixtures
		Gravels With Fines		GM	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand More Than 50% of Coarse Fraction Passing No. 4 Sieve	Clean Sands		SW	Well-graded Sands, Gravelly Sands
				SP	Poorly-Graded Sands, Gravelly Sands
		Sands With Fines		SM	Silty Sands, Sand-Silt Mixtures
				SC	Clayey Sands, Clay Mixtures
Fine Grained Soils More Than 50% Passing The No. 200 Sieve	**Silts & Clays**	Liquid Limit Less Than 50		ML	Inorganic Silts, rock Flour, Clayey Silts With Low Plasticity
				CL	Inorganic Clays of Low To Medium Plasticity
				OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts & Clays	Liquid Limit Greater Than 50		MH	Inorganic Silts of Moderate Plasticity
				CH	Inorganic Clays of High Plasticity
				OH	Organic Clays And Silts of Medium to High Plasticity
Highly Organic Soils				PT	Peat, Humus, Soils with Predominantly Organic Content

Sampler Symbol Description

- Standard Penetration Test (SPT)
- Shelby Tube
- Grab or Bulk
- California (3.0" O.D.)
- Modified California (2.5" O.D.)

Stratigraphic Contact

- Distinct Stratigraphic Contact Between Soil Strata
- Gradual Change Between Soil Strata
- Approximate location of stratagraphic change

- Groundwater observed at time of exploration
- Measured groundwater level in exploration, well, or piezometer
- Perched water observed at time of exploration

Modifiers

Description	%
Trace	>5
Some	5-12
With	>12

Soil Consistency

Granular Soils		Fine-grained Soils	
Density	***SPT Blowcount***	***Consistency***	***SPT Blowcount***
Very Loose	0-4	Very Soft	0-2
Loose	4-10	Soft	2-4
Medium Dense	10-30	Firm	4-8
Dense	30-50	Stiff	8-15
Very Dense	> 50	Very Stiff	15-30
		Hard	> 30

Grain Size

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than a basketball
Cobbles		3 - 12"	3 - 12"	Fist to basketball
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb to fist
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea to thumb
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock salt to pea
	Medium	#40 - #10	0.017 - 0.079"	Sugar to rock salt
	Fine	#200 - #40	0.0029 - 0.017"	Flour to Sugar
Fines		Passing #200	< 0.0029"	Flour and smaller

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Exploration Logs** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **5**

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Hand Auger Log HA-1

Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Grab Samples
Location : STA 91+25
Logged By : Michael Furman

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Water Level	Sample	% Finer than #200	% Moisture
0	ML		SANDY SILT with gravel, organics observed including roots and vegetative matter, soft, wet. DARK BROWN **TOPSOIL**				
	SM		SAND with silt and gravel, medium and coarse-grained sand, heavy orange mottling throughout, medium dense, moist becoming very wet with depth. GRAY-BROWN	▼			
2			0.5" thick fine-grained sand lens observed at 3.0' BPG.				
	ML		SILT with sand and trace gravel, heavy orange mottling observed throughout, medium dense, wet. GRAY **{SAND = 58.2%, SILT = 28.3%, CLAY = 13.5%}**			53.9%	32.6%
4	SM		SAND with silt, fine and medium-grained sand, medium dense, wet. GRAY				
6			T.D. = 5.5' BPG Hand Auger terminated in very dense conditions. Seepage observed beginning at 1.5' BPG. No groundwater observed.				

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Hand Auger Log HA-2

Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Grab Samples
Location : STA 75+50
Logged By : Michael Furman

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Water Level	Sample	% Finer than #200	% Moisture
0	ML		SANDY SILT with gravel, organics observed including roots and vegetative matter, soft, wet. DARK BROWN **TOPSOIL**				
	SM		SILTY SAND and gravel, gravel up to 5" in diameter, medium dense, moist. LIGHT BROWN		X		
2			T.D. = 2.0' BPG Hand Auger terminated in very dense conditions due to large rock. No groundwater observed.				
4							
6							

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Hand Auger Log HA-3

Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Grab Samples
Location : STA 72+00
Logged By : Michael Furman

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Water Level	Sample	% Finer than #200	% Moisture
0	ML		SANDY SILT with gravel, organics observed including roots and vegetative matter, soft, wet. DARK BROWN **TOPSOIL**				
	SM		SILTY SAND and gravel, gravel up to 1" in diameter, organics observed including roots and wood chips, medium dense, moist. BROWN Urban debris observed at 1.0' BPG Red wood chips observed from 1.0' to 1.8' BPG.		X		
2					X		
			T.D. = 3.3' BPG Hand Auger terminated in very dense conditions due to large rock. No groundwater observed.				
4							
6							

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Log of Boring B-1

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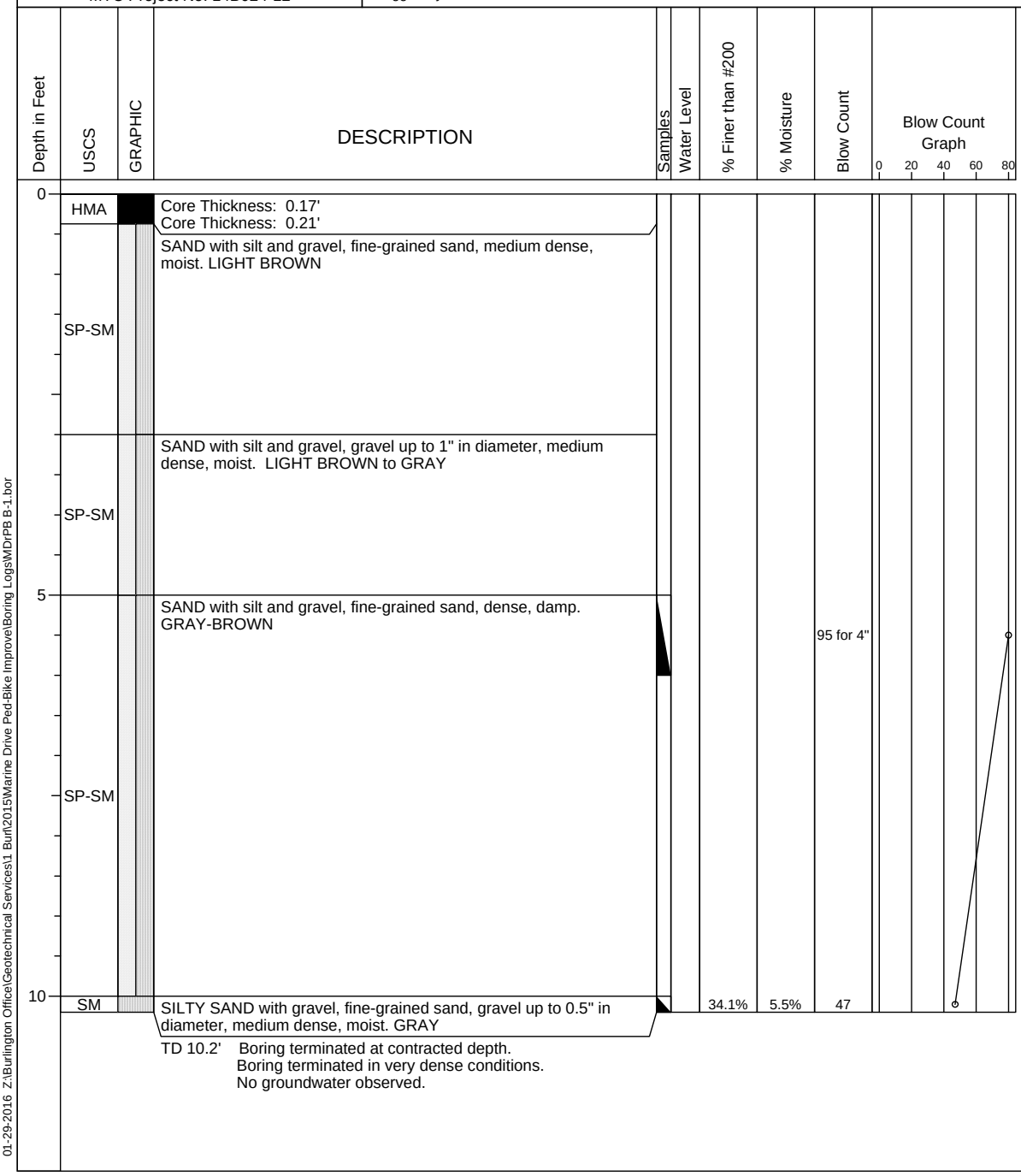
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/6/16
Date Completed : 1/6/16
Sampling Method : Split Spoon 5-ft. intervals
Location : STA 62+80
Logged By : MH



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Log of Boring B-2

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Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/6/16
Date Completed : 1/6/16
Sampling Method : Split Spoon 2.5 and 5-ft. intervals
Location : STA 62+40
Logged By : MH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level	% Finer than #200	% Moisture	Blow Count
0	HMA		Core Thickness: 0.5' Core Thickness: 0.17' Core Thickness: 0.25'					
	SM		SILTY SAND with gravel, fine-grained sand, orange mottling observed throughout, loose, moist.					4
5	ML-SM		SANDY SILT with gravel to SILTY SAND with gravel, orange mottling and organics observed, organics include wood debris and roots, loose to soft, moist. BROWN					3
10	ML-SM		SANDY SILT with gravel to SILTY SAND with gravel, orange mottling and organics throughout, organics include carbonized wood and roots, medium dense to medium stiff, moist. DARK BROWN					4
	SP-SM		SAND with silt and gravel, gravel up to 1" in diameter, some orange mottling throughout, medium dense, moist. GRAY to BROWN					
15	ML		SANDY SILT with gravel, gravel up to 3" in diameter, stiff, moist. GRAY			63.3%	16.4%	57
20			No recovery at 20.0' BPG.					100 for 5.5"
25			TD 20.5' Boring terminated at contracted depth. Boring terminated in very dense conditions. No groundwater observed.					

Blow Count Graph: 0 20 40 60 80

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Log of Boring B-3

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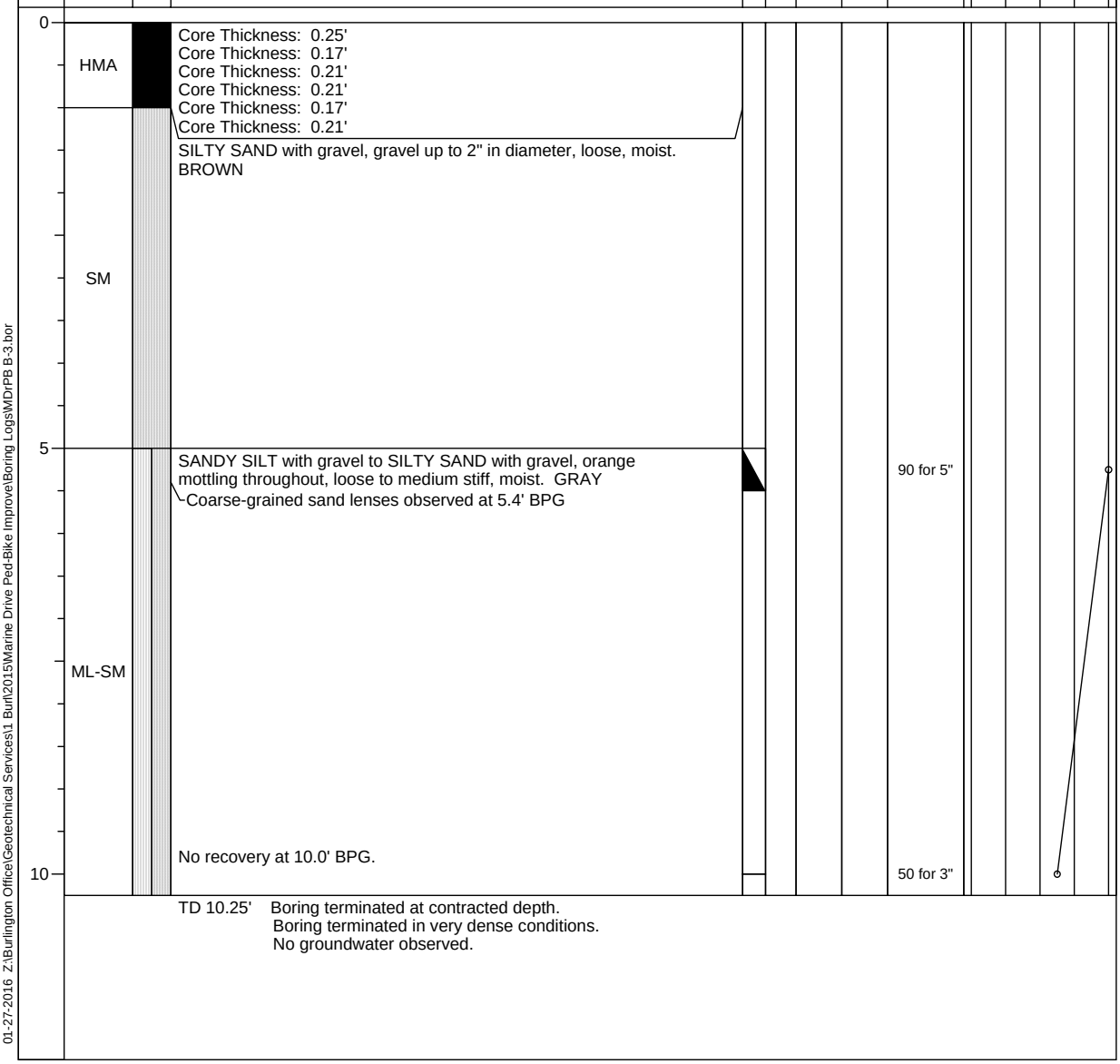
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/6/16
Date Completed : 1/6/16
Sampling Method : Split Spoon 5-ft. intervals
Location : STA 51+50
Logged By : MH



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Log of Boring B-4

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Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Split Spoon 5-ft. intervals
Location : STA 18+30
Logged By : MH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level	% Finer than #200	% Moisture	Blow Count
0	SM		SILTY SAND with gravel, loose, wet. DARK BROWN					
5	ML		SILT with sand and gravel, some organics observed, medium stiff, very wet. BROWN					19
	SP-SM		SAND with silt and some gravel, heavy orange mottling observed throughout, silt lenses 0.5" thick observed, loose, moist. GRAY					
	SP		SAND with gravel and some silt, sand is fine-grained in upper 2" becoming medium to coarse grained, dense, very wet. GRAY					
	ML		SANDY SILT with gravel, heavy orange mottling observed in upper 1", stiff, wet. ORANGE to BROWN					
10	SP-SM		SAND with silt and gravel, gravel up to 0.25" in diameter, fine and medium-grained sand, orange mottling throughout, very dense, wet. BROWN			32.8%	11.7%	63
15	SP-SM		SAND with silt and gravel, medium-grained sand, heavy orange mottling observed in upper 2" decreasing with depth, very dense, moist. GRAY					62
20	SP-SM		SAND with silt and gravel, medium and coarse-grained sand, trace orange mottling throughout, very dense, moist. GRAY					85 for 5"

TD 21.7' Boring terminated at contracted depth.
Boring terminated in very dense or hard conditions.
No groundwater observed.

Blow Count Graph: 0 20 40 60 80

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Log of Boring B-5

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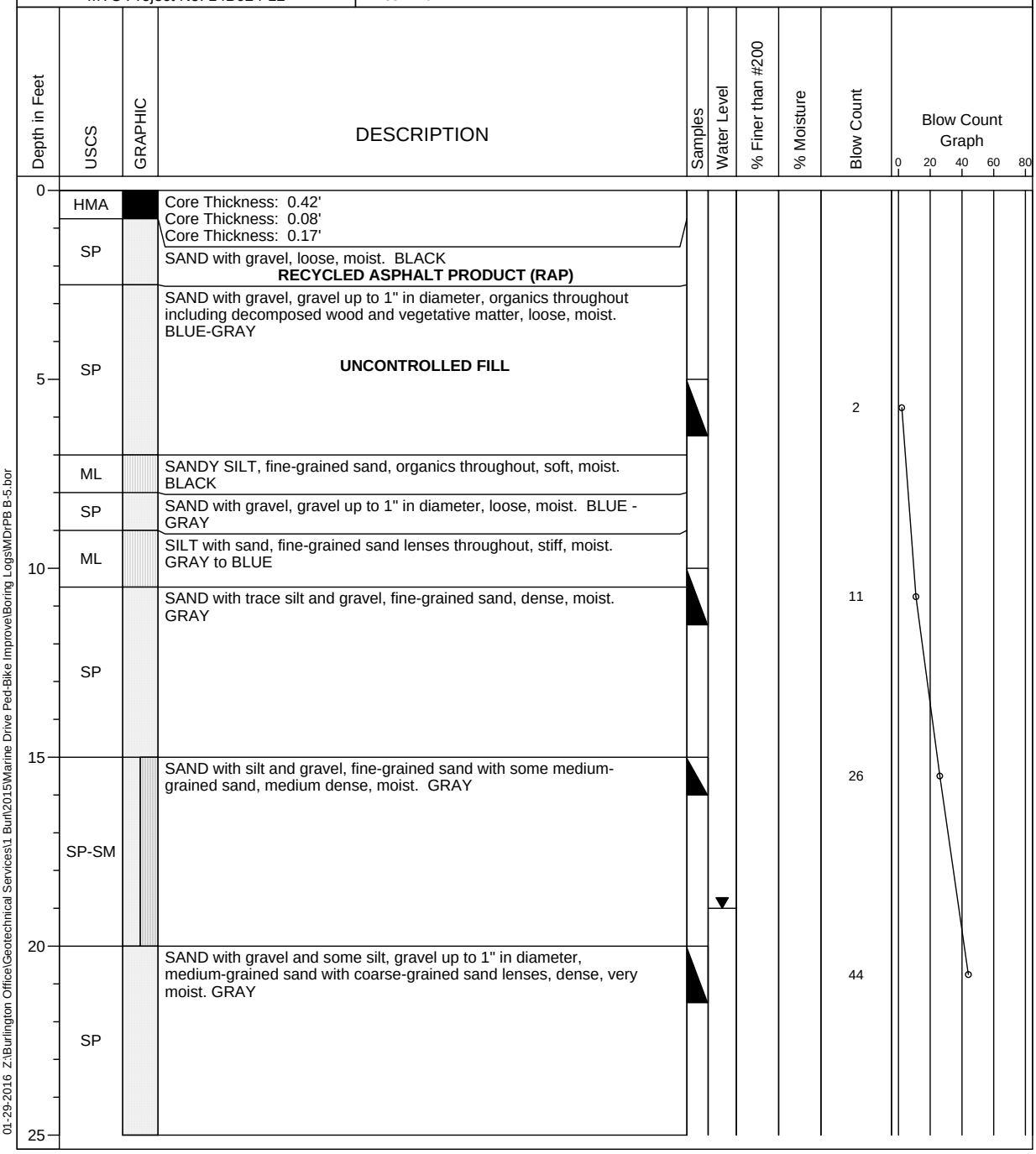
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip Bay, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Split Spoon 5-ft. intervals
Location : STA 15+75
Logged By : MH



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Log of Boring B-5

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Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip Bay, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Split Spoon 5-ft. intervals
Location : STA 15+75
Logged By : MH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level	% Finer than #200	% Moisture	Blow Count
25	SP		SAND with trace silt and gravel, fine and medium-grained sand, dense, very moist. GRAY			9.0%	22.2%	31
30	SP-SM		SAND with silt and some gravel, fine-grained sand, gravel up to 0.25" in diameter, some organics observed throughout, dense, moist. BROWN					51
35	SP		SAND with some gravel and trace silt, coarse-grained sand, dense, very moist. GRAY 1/2" thick silt lense at 35.3' BPG					55
40			TD 41.5' Boring terminated at contracted depth. Boring terminated in very dense or hard conditions. Standing water observed at 19.0' BPG.					
45								
50								

Blow Count Graph: 0 20 40 60 80

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Log of Boring B-6

(Page 1 of 1)

Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Split Spoon 5-ft. intervals
Location : STA 16+75
Logged By : MH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level	% Finer than #200	% Moisture	Blow Count	Blow Count Graph (0 20 40 60 80)
0	HMA		Core Thickness: 0.12'						
	SP		Core Thickness: 0.58'						
			Core Thickness: 0.12'						
			Core Thickness: 0.08'						
			SAND with gravel, loose, moist. BLACK						
			RECYCLED ASPHALT PRODUCT (RAP)						
	SP-SM		SAND with silt and some gravel, fine-graIned sand, trace orange mottling and organics observed in lower 0.5", loose, moist. BROWN to GRAY						
5	ML		SILT with sand, fine-grained sand, lenses of fine-grained sand throughout, organics and heavy orange mottling throughout, stiff, moist. BLUE-GRAY					7	
10	ML		SILT with sand and trace gravel, fine-grained sand, fine-grained sand lenses throughout, organics observed throughout, stiff to very stiff, moist. BLUE					10	
	SP-SM		SAND with silt and trace gravel, fine-grained sand with trace medium-grained sand, dense, moist. GRAY						
15	SP		SAND with some silt and gravel, medium-grained sand, dense, very moist. GRAY					33	
20	SP		SAND with trace silt and gravel, medium & coarse-grained sand, dense, wet. GRAY			3.9%	22.0%	38	
25			No recovery at 25.0' BPG					50 for 5"	
			TD 25.5' Boring terminated at contracted depth. Boring terminated in very dense conditions. Groundwater observed at 19.0' BPG.						

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Log of Boring B-7

(Page 1 of 1)

Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

Date Started : 1/7/16
Date Completed : 1/7/16
Sampling Method : Split Spoon 5-ft. intervals
Location : STA 17+75
Logged By : MH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level	% Finer than #200	% Moisture	Blow Count	Blow Count Graph (0 20 40 60 80)
0	SM		SILTY SAND with gravel, highly organic including wood, roots and vegetative matter, loose, moist. DARK BROWN						
	SP-SM		SAND with silt and gravel, fine-grained sand, some organics observed, medium dense, moist. LIGHT BROWN						
5	SP-SM		SAND with silt and gravel, fine and medium-grained sand, gravel up to 0.5" in diameter, coarse-grained sand lenses and orange mottling observed throughout decreasing with depth, dense, moist. LIGHT BROWN					52	
10	SP		SAND with trace silt and gravel, medium-grained sand, gravel up to 1" in diameter, very dense, moist to very wet with depth. GRAY		▼			77	
15	SM		SAND with silt and trace gravel, medium-grained sand, very dense, moist. GRAY					50 for 2"	

TD 15.8' Boring terminated at contracted depth.
Boring terminated in very dense conditions.
Groundwater observed at 12.0' BPG.

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Appendix D. KESSLER DCP LOGS

Dynamic Cone Penetrometer (DCP) tests were conducted at representative locations within parking areas and along road alignments for the proposed development. DCP test locations were correlated with adjacent or nearby test pit explorations to most accurately assess results in terms of observed stratigraphy per location.

Tests were conducted using KSE K-100 MD model DCP (Kessler) equipment to provide general soil strength data and CBR correlation for use in pavement design analysis. The kDCP is designed to generate a profile of correlative California Bearing Ratio versus depth and is operated by recording the number of blows required to advance a 0.8-inch diameter round tip probe for each successive 2-inch increment under the force of a free-falling hammer weighing 17.6 pounds and dropping 22.6 inches. The results of each kDCP test are presented in this Appendix. Accompanying blow count results is a graph of corresponding CBR values displayed by depth.

CBR Log of kDCP-1

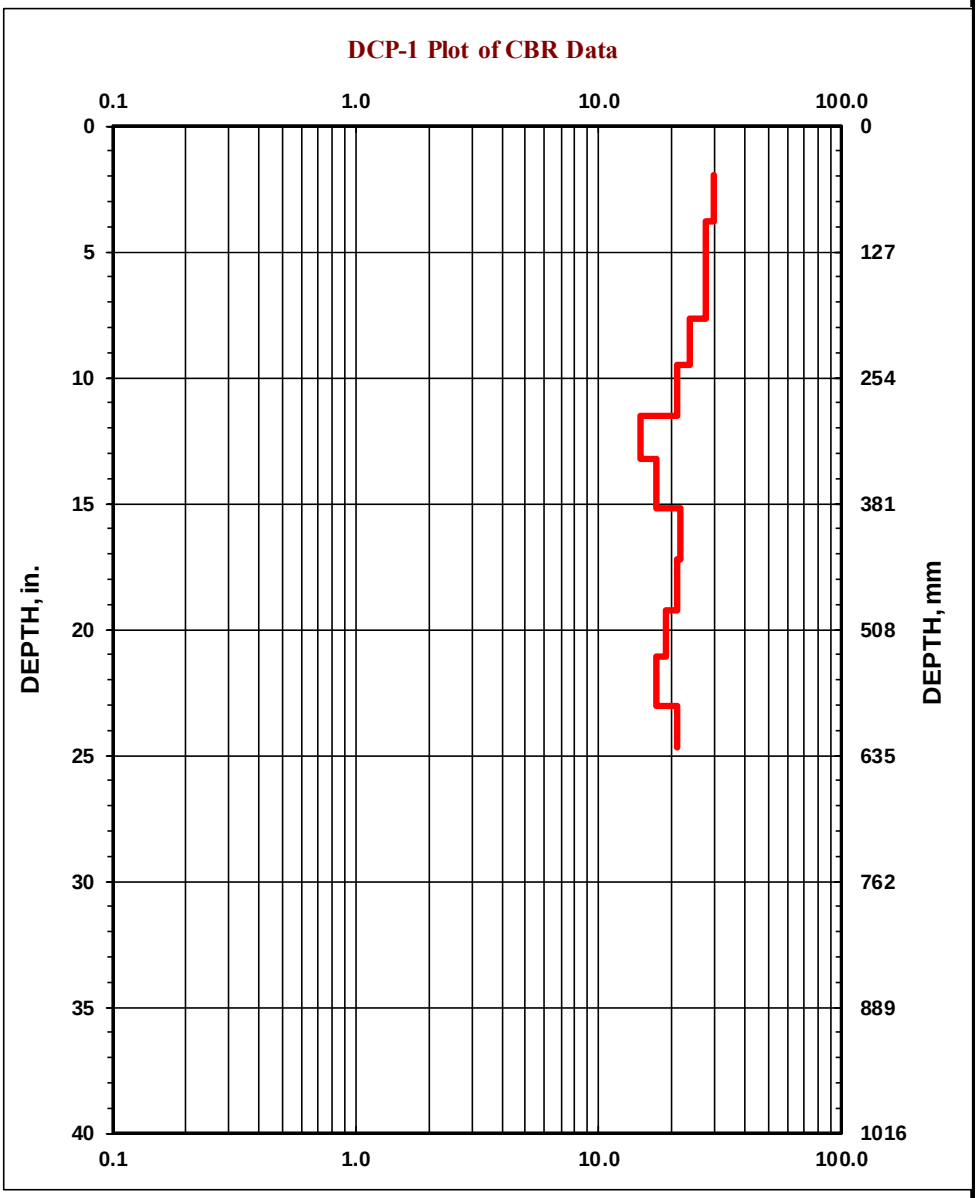
Project: *Marine Dr. Bike/Ped Improvements* **Date:** 7-Jan-16

Location: STA 91+25 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
4	50	1
6	96	1
6	145	1
6	194	1
5	241	1
5	293	1
3	336	1
4	386	1
5	437	1
5	489	1
4	535	1
4	585	1
4	627	1



CBR Log of kDCP-2

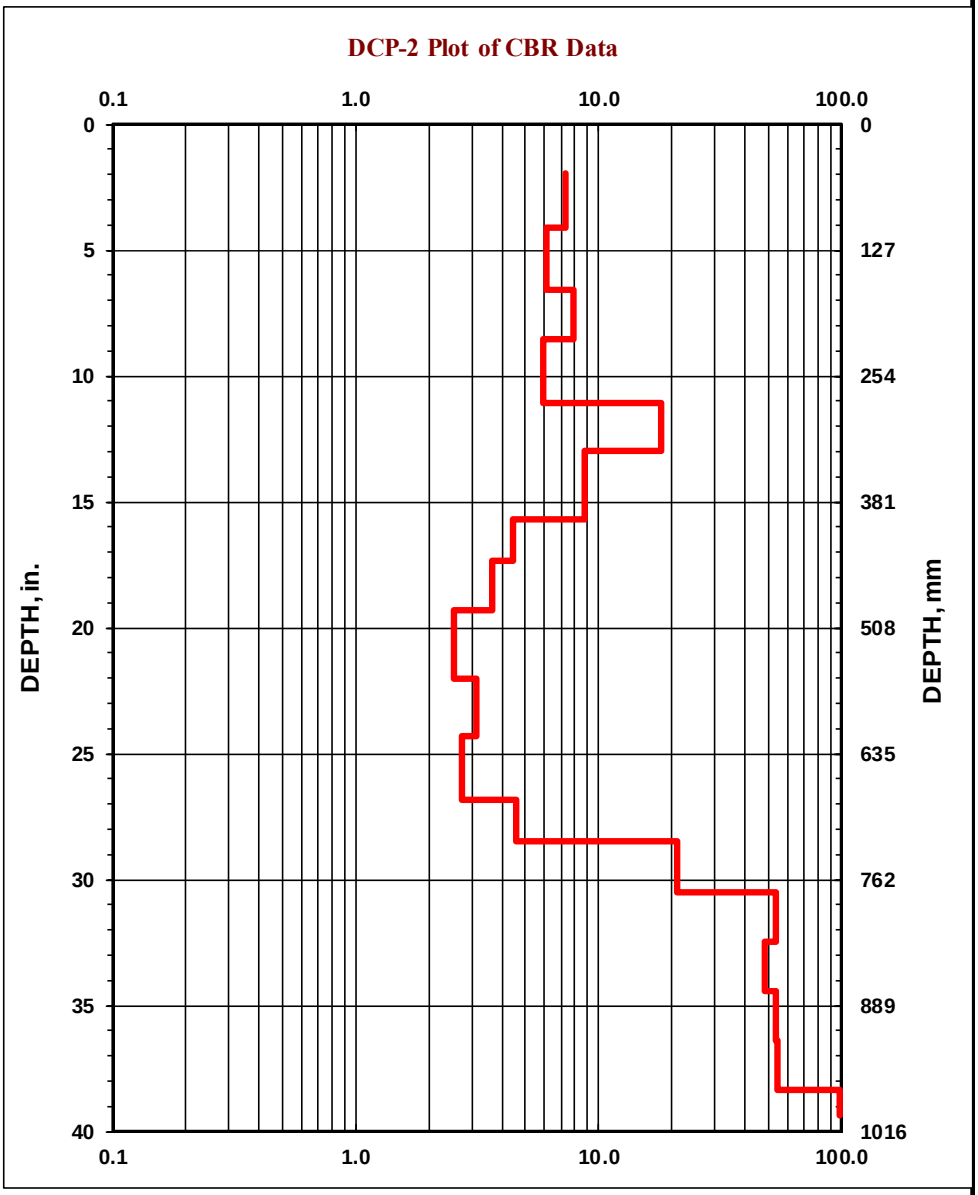
Project: *Marine Dr. Bike/Ped Improvements* **Date:** 7-Jan-16

Location: STA 75+50 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
1	50	1
2	104	1
2	167	1
2	217	1
2	282	1
4	330	1
3	399	1
1	441	1
1	491	1
1	560	1
1	617	1
1	682	1
1	723	1
5	775	1
11	825	1
10	875	1
11	925	1
11	974	1
10	1000	1



CBR Log of kDCP-3

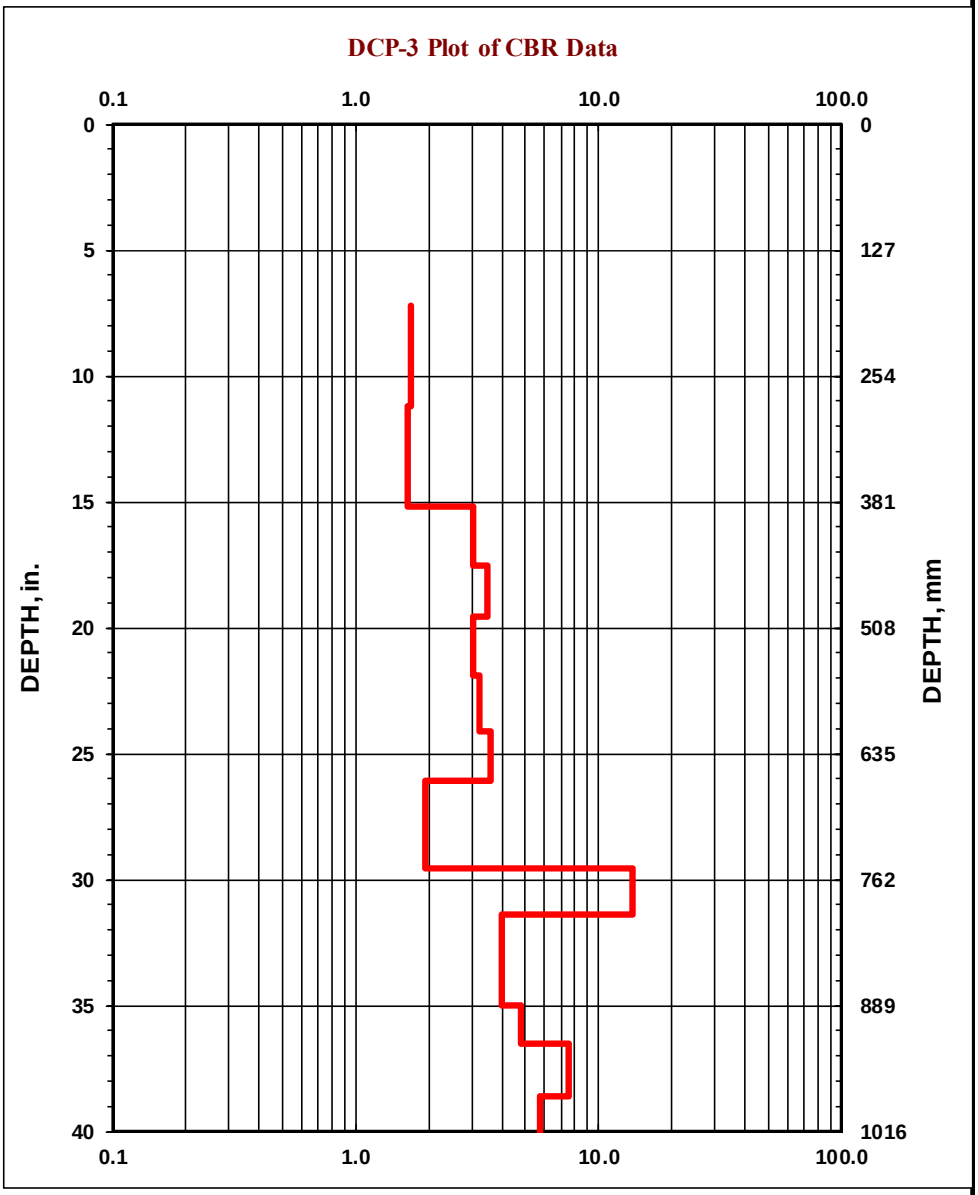
Project: *Marine Dr. Bike/Ped Improvements* **Date:** 7-Jan-16

Location: STA 72+00 **Soil Type(s):**

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
1	184	1
1	284	1
1	386	1
1	445	1
1	497	1
1	556	1
1	612	1
1	663	1
1	751	1
3	797	1
1	843	1
1	889	1
1	928	1
2	980	1
2	1047	1
2	1100	1
2	1140	1
2	1202	1
3	1251	1
3	1295	1
4	1356	1



Appendix E. LABORATORY RESULTS

Laboratory tests were conducted on representative soil samples to better identify the soil classification of the units encountered and to evaluate the material's general physical properties and engineering characteristics. A brief description of the tests performed for this study is provided below. The results of laboratory tests performed on specific samples are provided at the appropriate sample depths on the individual boring logs. However, it is important to note that these test results may not accurately represent in situ soil conditions. Our recommendations are based on our interpretation of these test results and their use in guiding our engineering judgment. MTC cannot be responsible for the interpretation of these data by others.

Soil samples for this project will be retained for a period of 3 months following completion of this report, unless we are otherwise directed in writing.

SOIL CLASSIFICATION

Soil samples were visually examined in the field by our representative at the time they were obtained. They were subsequently packaged and returned to our laboratory where they were reexamined and the original description checked and verified or modified. With the help of information obtained from the other classification tests, described below, the samples were described in general accordance with ASTM Standard D2487. The resulting descriptions are provided at the appropriate locations on the individual exploration logs, located in Appendix C, and are qualitative only.

GRAIN-SIZE DISTRIBUTION

Grain-size distribution analyses by sieve and hydrometer methods were conducted in general accordance with ASTM Standard D422 on representative soil samples to determine gradations of the on-site soils. The information gained from these analyses allows us to provide an accurate description and classification of the in-place materials per ASTM Standard D2487. In turn, this information helps us to understand engineering properties of the soil and thus how the in-place materials will react to conditions such as traffic action, loading, potential liquefaction, and so forth. The results are presented in this Appendix.

HYDROMETER ANALYSIS

Particle-size distribution analyses were conducted in general accordance with ASTM Standard D422 on these soil samples to determine the particle-size distribution for the material passing the #200 sieve of the on-site soil. The results are presented in this Appendix.

Sieve Report

Project: Marine Dr. Ped-Bike Imp.
Project #: 14B024-12
Client: Tulalip Tribes
Source: HA-1 @ 3.5'
Sample#: B16-0014

Date Received: 12-Jan-16
Sampled By: MF/MH
Date Tested: 14-Jan-16
Tested By: MBC

ASTM D-2487 Unified Soils Classification System
ML, Sandy Silt
Sample Color:
Gray

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

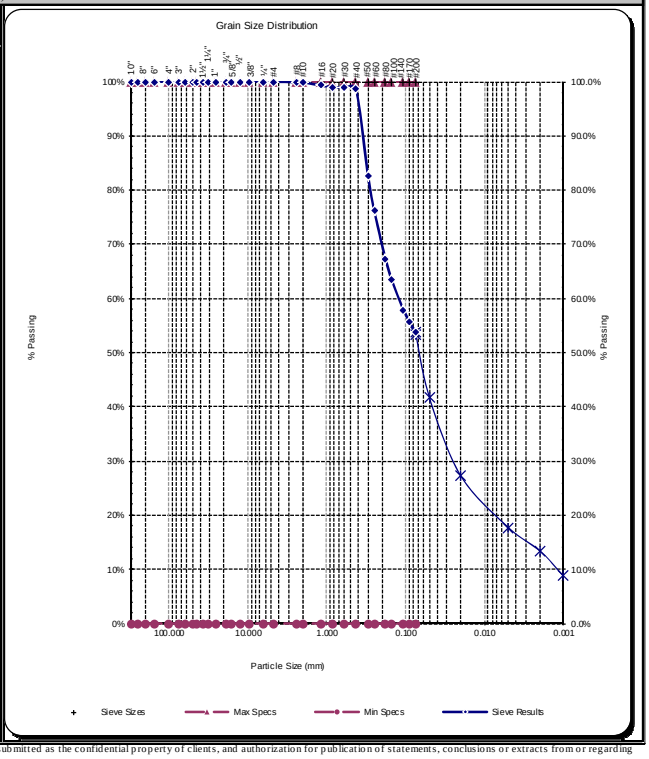
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.007 mm	% Gravel =	0.0%	Coeff. of Curvature, C_C =	1.02
$D_{(10)}$ =	0.014 mm	% Sand =	46.1%	Coeff. of Uniformity, C_U =	8.82
$D_{(15)}$ =	0.021 mm	% Silt & Clay =	53.9%	Fineness Modulus =	0.56
$D_{(30)}$ =	0.042 mm	Liquid Limit =	0.0%	Plastic Limit =	0.0%
$D_{(50)}$ =	0.070 mm	Plasticity Index =	0.0%	Moisture %, as sampled =	32.6%
$D_{(60)}$ =	0.123 mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =	
$D_{(90)}$ =	0.357 mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =	
Dust Ratio =	6/11	Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =	

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00		100%	100.0%	0.0%
3/4"	19.00		100%	100.0%	0.0%
5/8"	16.00		100%	100.0%	0.0%
1/2"	12.50		100%	100.0%	0.0%
3/8"	9.50		100%	100.0%	0.0%
1/4"	6.30		100%	100.0%	0.0%
#4	4.75	100%	100%	100.0%	0.0%
#8	2.36		100%	100.0%	0.0%
#10	2.00	100%	100%	100.0%	0.0%
#16	1.18		99%	100.0%	0.0%
#20	0.850		99%	100.0%	0.0%
#30	0.600		99%	100.0%	0.0%
#40	0.425	99%	99%	100.0%	0.0%
#50	0.300		83%	100.0%	0.0%
#60	0.250		76%	100.0%	0.0%
#80	0.180		67%	100.0%	0.0%
#100	0.150		63%	100.0%	0.0%
#140	0.106		58%	100.0%	0.0%
#170	0.090		56%	100.0%	0.0%
#200	0.075	53.9%	53.9%	100.0%	0.0%



Comments: _____

Reviewed by: _____

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Lab Sample: HA-1 @ 3.5'** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **6**

Hydrometer Report

Project:	Marine Dr. Ped-Bike Imp.	**Date Received:**	12-Jan-16
Project #:	14B024-12	**Sampled By:**	MF/MH
Client :	Tulalip Tribes	**Date Tested:**	14-Jan-16
Source:	HA-1 @ 3.5'	**Tested By:**	MBC
Sample#:	B16-0014		

ASTM D 2487 Soils Classification
ML, Sandy Silt
Sample Color
Gray

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr :	2.70	
Sample Weight:	50.13	grams
Hydroscopic Moist.:	2.60%	
Adj. Sample Wgt :	48.86	grams

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	17	34.4%	0.0349 mm
5	14	28.3%	0.0225 mm
15	12	24.3%	0.0131 mm
30	10	20.2%	0.0094 mm
60	9.5	19.2%	0.0067 mm
250	8	16.2%	0.0033 mm
1440	6	12.1%	0.0014 mm

% Gravel:	0.0%	**Liquid Limit:**	0.0 %
% Sand:	46.1%	**Plastic Limit:**	0.0 %
% Silt:	36.1%	**Plasticity Index:**	0.0 %
% Clay:	17.7%		

ASTM C-136

Sieve Analysis
Grain Size Distribution

Sieve Size	Percent Passing	Soils Particle Diameter
3.0"	100%	75.000 mm
2.0"	100%	50.000 mm
1.5"	100%	37.500 mm
1.25"	100%	31.500 mm
1.0"	100%	25.000 mm
3/4"	100%	19.000 mm
5/8"	100%	16.000 mm
1/2"	100%	12.500 mm
3/8"	100%	9.500 mm
1/4"	100%	6.300 mm
#4	100%	4.750 mm
#10	100%	2.000 mm
#20	99%	0.850 mm
#40	99%	0.425 mm
#100	63%	0.150 mm
#200	53.9%	0.075 mm
Silts	53.4%	0.074 mm
	41.7%	0.050 mm
	27.3%	0.020 mm
Clays	17.7%	0.005 mm
	13.5%	0.002 mm
Colloids	8.8%	0.001 mm

USDA Soil Textural Classification

		Particle Size
% Sand:	58.2%	2.0 - 0.05 mm
% Silt:	28.3%	0.05 - 0.002 mm
% Clay:	13.5%	< 0.002 mm

USDA Soil Textural Classification
Sandy Loam

Comments: _____

Reviewed by: _____

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Lab Sample: HA-1 @ 3.5'** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **7**

Sieve Report

Project: Marine Dr. Ped-Bike Imp.
Project #: 14B024-12
Client: Tulalip Tribes
Source: B-1 @ 10'
Sample#: B16-0009

Date Received: 12-Jan-16
Sampled By: MF/MH
Date Tested: 14-Jan-16
Tested By: MBC

ASTM D-2487 Unified Soils Classification System
SM, Silty Sand with Gravel
Sample Color:
Gray-Brown

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

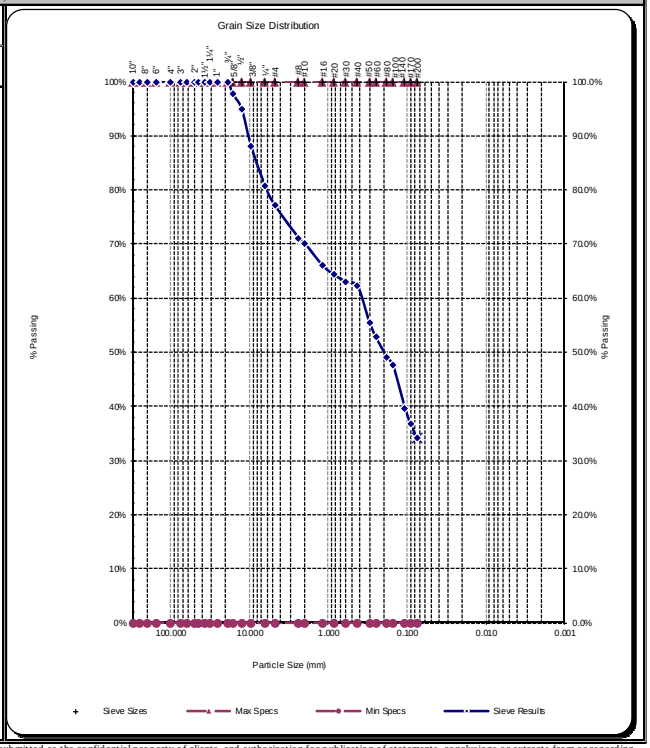
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.011 mm	% Gravel =	22.9%	Coeff. of Curvature, C_C =	0.52
$D_{(10)}$ =	0.022 mm	% Sand =	43.1%	Coeff. of Uniformity, C_U =	17.42
$D_{(15)}$ =	0.033 mm	% Silt & Clay =	34.1%	Fineness Modulus =	2.32
$D_{(30)}$ =	0.066 mm	Liquid Limit =	n/a	Plastic Limit =	n/a
$D_{(50)}$ =	0.196 mm	Plasticity Index =	n/a	Moisture %, as sampled =	5.5%
$D_{(60)}$ =	0.383 mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =	
$D_{(90)}$ =	10.361 mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =	
Dust Ratio =	23/42	Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =	

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		98%	100.0%	0.0%
1/2"	12.50	95%	95%	100.0%	0.0%
3/8"	9.50		88%	100.0%	0.0%
1/4"	6.30		81%	100.0%	0.0%
#4	4.75	77%	77%	100.0%	0.0%
#8	2.36		71%	100.0%	0.0%
#10	2.00	70%	70%	100.0%	0.0%
#16	1.18		66%	100.0%	0.0%
#20	0.850		64%	100.0%	0.0%
#30	0.600		63%	100.0%	0.0%
#40	0.425	62%	62%	100.0%	0.0%
#50	0.300		56%	100.0%	0.0%
#60	0.250		53%	100.0%	0.0%
#80	0.180		49%	100.0%	0.0%
#100	0.150	48%	48%	100.0%	0.0%
#140	0.106		40%	100.0%	0.0%
#170	0.090		37%	100.0%	0.0%
#200	0.075	34.1%	34.1%	100.0%	0.0%



Comments: _____

Reviewed by: _____

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Lab Sample: B-1 @ 10.0'** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **8**

Sieve Report

Project: Marine Dr. Ped-Bike Imp.
Project #: 14B024-12
Client: Tulalip Tribes
Source: B-2 @ 15'
Sample#: B16-0010

Date Received: 12-Jan-16
Sampled By: MF/MH
Date Tested: 14-Jan-16
Tested By: MBC

ASTM D-2487 Unified Soils Classification System
ML, Sandy Silt
Sample Color:
brown

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

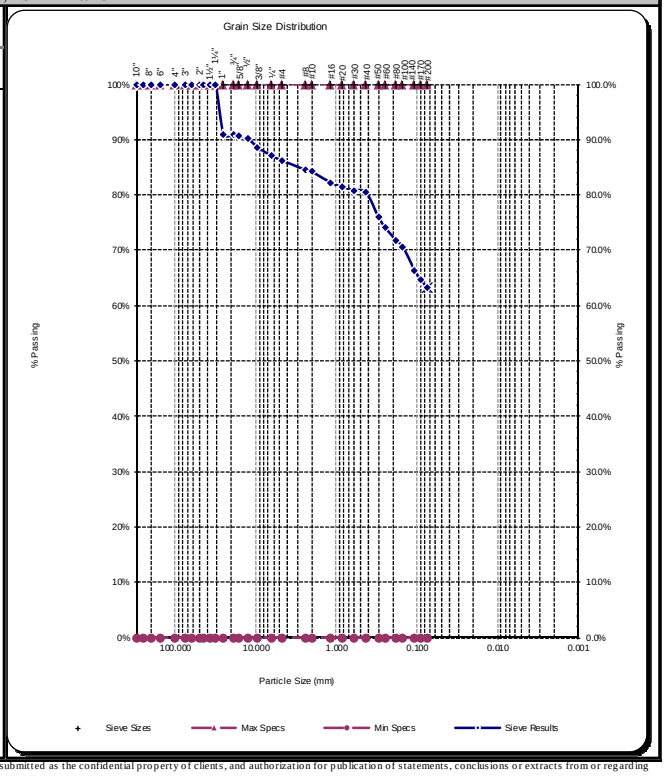
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.006 mm	% Gravel =	13.8%	Coeff. of Curvature, C_C =	1.50
$D_{(10)}$ =	0.012 mm	% Sand =	23.0%	Coeff. of Uniformity, C_U =	6.00
$D_{(15)}$ =	0.018 mm	% Silt & Clay =	63.3%	Fineness Modulus =	1.40
$D_{(30)}$ =	0.036 mm	Liquid Limit =	0.0%	Plastic Limit =	0.0%
$D_{(50)}$ =	0.059 mm	Plasticity Index =	0.0%	Moisture %, as sampled =	16.4%
$D_{(60)}$ =	0.071 mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =	
$D_{(90)}$ =	12.232 mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =	
Dust Ratio =	70/89	Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =	

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	91%	91%	100.0%	0.0%
3/4"	19.00	91%	91%	100.0%	0.0%
5/8"	16.00		91%	100.0%	0.0%
1/2"	12.50	90%	90%	100.0%	0.0%
3/8"	9.50		89%	100.0%	0.0%
1/4"	6.30		87%	100.0%	0.0%
#4	4.75	86%	86%	100.0%	0.0%
#8	2.36		84%	100.0%	0.0%
#10	2.00	84%	84%	100.0%	0.0%
#16	1.18		82%	100.0%	0.0%
#20	0.850		81%	100.0%	0.0%
#30	0.600		81%	100.0%	0.0%
#40	0.425	80%	80%	100.0%	0.0%
#50	0.300		76%	100.0%	0.0%
#60	0.250		74%	100.0%	0.0%
#80	0.180		72%	100.0%	0.0%
#100	0.150	71%	71%	100.0%	0.0%
#140	0.106		66%	100.0%	0.0%
#170	0.090		65%	100.0%	0.0%
#200	0.075	63.3%	63.3%	100.0%	0.0%



Comments: _____

Reviewed by: _____

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Lab Sample: B-2 @ 15.0'** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **9**

Sieve Report

Project: Marine Dr. Ped-Bike Imp.
Project #: 14B024-12
Client: Tulalip Tribes
Source: B-4 @ 10'
Sample#: B16-0011

Date Received: 12-Jan-16
Sampled By: MF/MH
Date Tested: 14-Jan-16
Tested By: MBC

ASTM D-2487 Unified Soils Classification System
SM, Silty Sand, Crushed
Sample Color:
brown

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

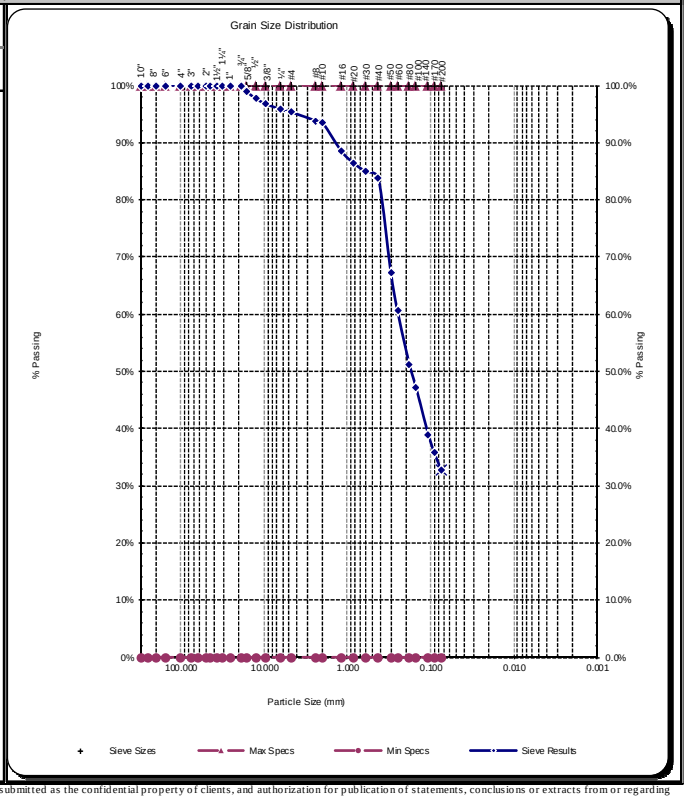
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.011 mm	% Gravel =	4.7%	Coeff. of Curvature, C_C =	0.84
$D_{(10)}$ =	0.023 mm	% Sand =	62.5%	Coeff. of Uniformity, C_U =	10.75
$D_{(15)}$ =	0.034 mm	% Silt & Clay =	32.8%	Fineness Modulus =	1.26
$D_{(30)}$ =	0.069 mm	Liquid Limit =	n/a	Plastic Limit =	n/a
$D_{(50)}$ =	0.170 mm	Plasticity Index =	n/a	Moisture %, as sampled =	11.7%
$D_{(60)}$ =	0.246 mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =	
$D_{(90)}$ =	1.422 mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =	
Dust Ratio =	9/23	Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =	

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		99%	100.0%	0.0%
1/2"	12.50	98%	98%	100.0%	0.0%
3/8"	9.50		97%	100.0%	0.0%
1/4"	6.30		96%	100.0%	0.0%
#4	4.75	95%	95%	100.0%	0.0%
#8	2.36		94%	100.0%	0.0%
#10	2.00	94%	94%	100.0%	0.0%
#16	1.18		89%	100.0%	0.0%
#20	0.850		86%	100.0%	0.0%
#30	0.600		85%	100.0%	0.0%
#40	0.425	84%	84%	100.0%	0.0%
#50	0.300		67%	100.0%	0.0%
#60	0.250		61%	100.0%	0.0%
#80	0.180		51%	100.0%	0.0%
#100	0.150	47%	47%	100.0%	0.0%
#140	0.106		39%	100.0%	0.0%
#170	0.090		36%	100.0%	0.0%
#200	0.075	32.8%	32.8%	100.0%	0.0%



Comments:

Reviewed by:

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Lab Sample: B-4 @ 10.0'** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **10**

Sieve Report

Project: Marine Dr. Ped-Bike Imp.
Project #: 14B024-12
Client: Tulalip Tribes
Source: B-5 @ 25'
Sample#: B16-0012

Date Received: 12-Jan-16
Sampled By: MF/MH
Date Tested: 14-Jan-16
Tested By: MBC

ASTM D-2487 Unified Soils Classification System
SP-SM, Poorly graded Sand with Silt
Sample Color:
Gray

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

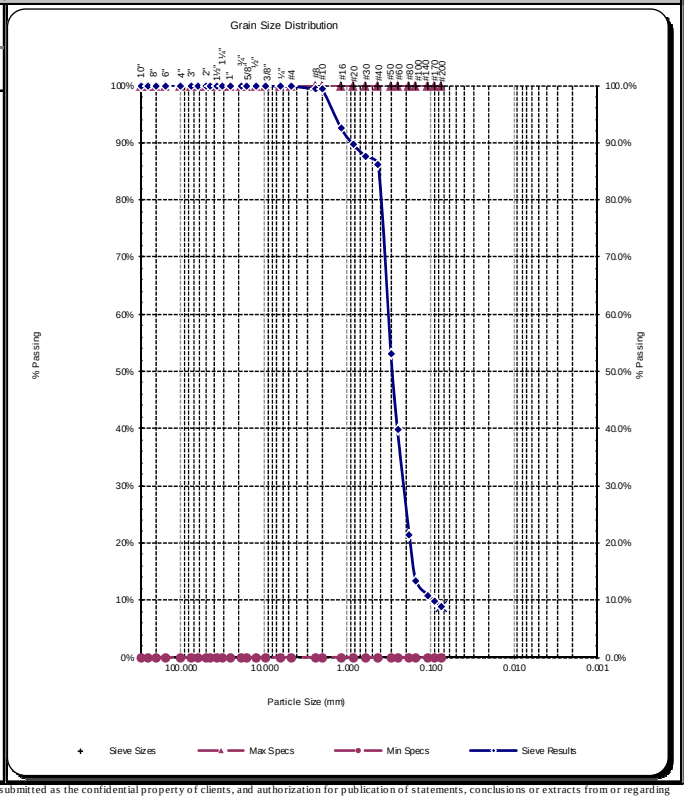
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.042 mm	% Gravel =	0.2%	Coeff. of Curvature, C_C =	1.50
$D_{(10)}$ =	0.092 mm	% Sand =	90.9%	Coeff. of Uniformity, C_U =	3.53
$D_{(15)}$ =	0.156 mm	% Silt & Clay =	9.0%	Fineness Modulus =	1.54
$D_{(30)}$ =	0.213 mm	Liquid Limit =	n/a	Plastic Limit =	n/a
$D_{(50)}$ =	0.288 mm	Plasticity Index =	n/a	Moisture %, as sampled =	22.2%
$D_{(60)}$ =	0.326 mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =	
$D_{(90)}$ =	0.890 mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =	
Dust Ratio =	5/48	Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =	

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		100%	100.0%	0.0%
1/2"	12.50	100%	100%	100.0%	0.0%
3/8"	9.50		100%	100.0%	0.0%
1/4"	6.30		100%	100.0%	0.0%
#4	4.75	100%	100%	100.0%	0.0%
#8	2.36		99%	100.0%	0.0%
#10	2.00	99%	99%	100.0%	0.0%
#16	1.18		92%	100.0%	0.0%
#20	0.850		90%	100.0%	0.0%
#30	0.600		88%	100.0%	0.0%
#40	0.425	86%	86%	100.0%	0.0%
#50	0.300		53%	100.0%	0.0%
#60	0.250		40%	100.0%	0.0%
#80	0.180		21%	100.0%	0.0%
#100	0.150	13%	13%	100.0%	0.0%
#140	0.106		11%	100.0%	0.0%
#170	0.090		10%	100.0%	0.0%
#200	0.075	9.0%	9.0%	100.0%	0.0%



Comments: _____

Reviewed by: _____

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Lab Sample: B-5 @ 25.0'** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **11**

Sieve Report

Project: Marine Dr. Ped-Bike Imp.
Project #: 14B024-12
Client: Tulalip Tribes
Source: B-6 @ 20'
Sample#: B16-0013

Date Received: 12-Jan-16
Sampled By: MF/MH
Date Tested: 14-Jan-16
Tested By: MBC

ASTM D-2487 Unified Soils Classification System
SP, Poorly graded Sand
Sample Color:
Gray

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

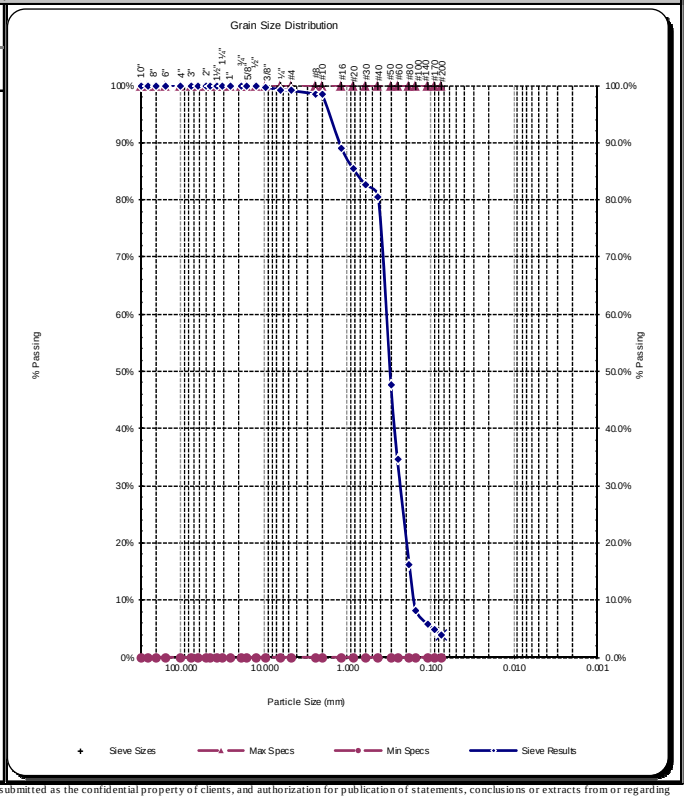
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ =	0.094 mm	% Gravel =	0.9%	Coeff. of Curvature, C_C =	1.00
$D_{(10)}$ =	0.157 mm	% Sand =	95.2%	Coeff. of Uniformity, C_U =	2.21
$D_{(15)}$ =	0.176 mm	% Silt & Clay =	3.9%	Fineness Modulus =	1.75
$D_{(30)}$ =	0.233 mm	Liquid Limit =	n/a	Plastic Limit =	n/a
$D_{(50)}$ =	0.309 mm	Plasticity Index =	n/a	Moisture %, as sampled =	22.0%
$D_{(60)}$ =	0.347 mm	Sand Equivalent =	n/a	Req'd Sand Equivalent =	
$D_{(90)}$ =	1.258 mm	Fracture %, 1 Face =	n/a	Req'd Fracture %, 1 Face =	
Dust Ratio =	2/41	Fracture %, 2+ Faces =	n/a	Req'd Fracture %, 2+ Faces =	

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		100%	100.0%	0.0%
1/2"	12.50	100%	100%	100.0%	0.0%
3/8"	9.50		100%	100.0%	0.0%
1/4"	6.30		99%	100.0%	0.0%
#4	4.75	99%	99%	100.0%	0.0%
#8	2.36		98%	100.0%	0.0%
#10	2.00	98%	98%	100.0%	0.0%
#16	1.18		89%	100.0%	0.0%
#20	0.850		85%	100.0%	0.0%
#30	0.600		83%	100.0%	0.0%
#40	0.425	81%	81%	100.0%	0.0%
#50	0.300		48%	100.0%	0.0%
#60	0.250		35%	100.0%	0.0%
#80	0.180		16%	100.0%	0.0%
#100	0.150	8%	8%	100.0%	0.0%
#140	0.106		6%	100.0%	0.0%
#170	0.090		5%	100.0%	0.0%
#200	0.075	3.9%	3.9%	100.0%	0.0%



Comments: _____

Reviewed by: _____

Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Lab Sample: B-6 @ 20.0'** Ped/Bike Improvements Marine View Drive Tulalip, WA	**FIGURE** **12**

Appendix F. PILE ANALYSIS

Following draft report submittal and consultations with the client and design engineer, MTC was retained for additional engineering services to perform pile analysis for determining final geotechnical design and construction specifications of walkway pilings. The results of our analysis are presented below along with input parameters and assumptions applied. A description of site conditions related to the pile foundation and installation recommendations is found in *Section 5.1 Foundation Feasibility* above.

Design and Analysis Criteria

The design engineer (Parametrix) supplied in-progress design parameters and anticipated dimensions for the revised walkway. Hollow steel piles are proposed to be placed as pairs with approximately 7-foot on-center lateral spacing. Piles will be embedded and affixed into the walkway concrete with pile caps and attachments to be determined by the engineer. Maximum allowable vertical deflection was specified as L/360. Allowable lateral deflection was initially discussed to be as high as 6 inches, but was later constrained to 3 inches maximum with a 1.5 lateral load factor of safety. Dead and live loads for vertical and lateral scenarios were supplied to MTC for static and seismic conditions. MTC used total loads including seismic components for pile calculations. Table F-1 below summarizes provided loads per pile pair and applied deflection criteria used in analysis.

TABLE F-1. Pile Design Loads and Deflection Criteria.

LOAD TYPE	LOAD per pile	DESIGN INPUT per pair of piles
Dead Load	17.5 kips	66 kips
Live Load	12.2 kips	
Seismic - Vertical	2.9 kips	
Seismic - Lateral	7.4 kips	15 kips
Moment	12.3 k-ft	24.6 k-ft
Maximum Allowable Deflection ^	0.67 inches	0.5 inches
Maximum Lateral Deflection ^^	2.0 inches (3.0 with 1.5 load factor)	

^ - Defined as L/360 by Design Engineer (L = pier segment length)
^^ - Assumed as maximum lateral tolerance under seismic condition.

For analysis, piles were subjected to vertical and lateral design loads under a fixed-head scenario, as construction is assumed to attach the pile head directly to the walkway structure which reduces deflection or deformation of a given single pile versus adjacent piles and the walkway. Analysis was completed for the pile pairs, providing a most realistic estimate of system response to lateral loading and walkway moment forces.

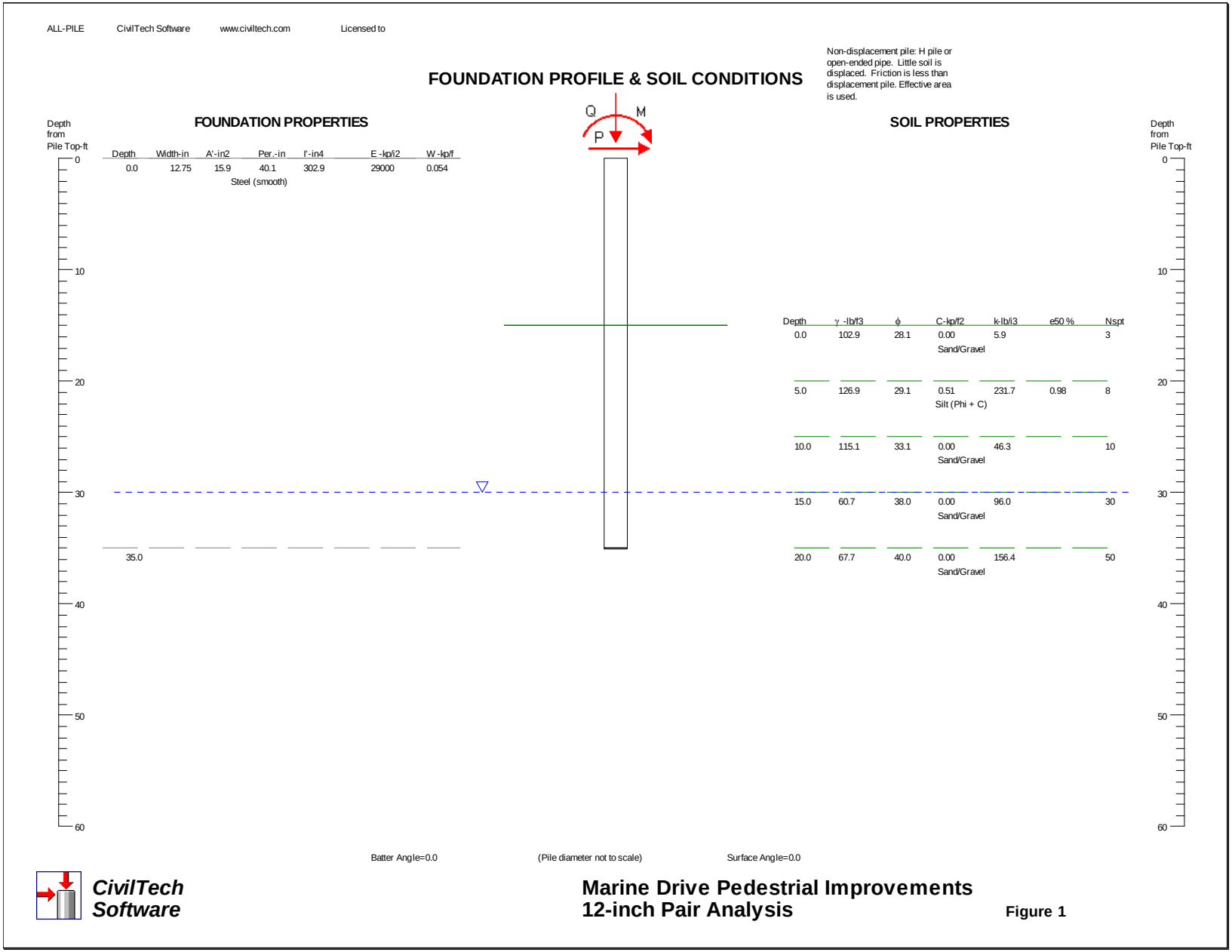
Methods and Results

Pile analysis was performed using Allpile, version 7.13g, by CivilTech Software, with output results presented at the end of Appendix F. Soil conditions were input as interpreted from SPT data and soil classifications as addressed above. Geometric values used for analysis correspond to the section of greatest free-height along the walkway, extending a maximum of approximately 15 feet above existing grade. Pile lengths and corresponding embedment depths were initially approximated based on DCP refusal results, then refined by iterative analysis to define minimum pile embedment needed to both gain required vertical capacity and adhere to allowable lateral deflection under assumed loads.

MTC understands provided loads from the engineer do not include safety factors. For pile analysis, a factor of safety of FS = 2.0 was applied to vertical bearing calculation. No safety factor was applied to lateral loads and moment forces to initially calculate anticipated deflection under seismic action. A second analysis is provided incorporating a load factor of 1.5.

Based on the below results, MTC recommends the project utilize at minimum 12-inch diameter schedule 40 hollow steel piles to achieve design load requirements and protect against excessive lateral deflection. Recommended embedment to achieve vertical design loads and provide lateral support protection corresponds directly to anticipated minimum embedment based on typical site soil conditions. The design depth of 20 feet equates to a minimum embedment of 5 feet into consistently dense soils per our exploration results.

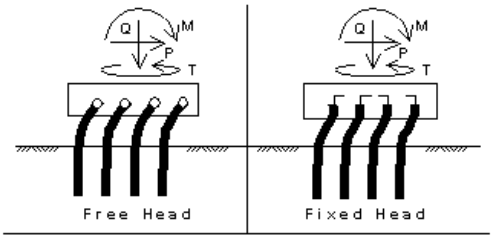
Pile Geometry and Soil Parameters



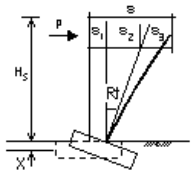
Summary of Vertical Analysis

VERTICAL ANALYSIS

Figure 1



s=s1+s2+s3
s1=Lateral Movement by AllPile
s2=Rt * Hs, Hs-Height of Structure
Rt-Rotation by AllPile
s3=Deflection of Structure by
Strucrural Engineer
x=Vertical Settlement by AllPile



Driving Steel Pile (Open end)

Loads:
Load Factor for Vertical Loads= 1.0
Load Factor for Lateral Loads= 1.0
Loads Supported by Pile Cap= 0 %
Shear Condition: Static

(with Load Factor)
Vertical Load, Q= 66.0 -kp
Shear Load, P= 15.0 -kp
Moment, M= 12.3 -kp-f

Profile:
Pile Length, L= 35.0 -ft
Top Height, H= 15 -ft
Slope Angle, As= 0.0
Batter Angle, Ab= 0.0

Group and Boundary Condition:
Fixed Head
Sx= 12.8 -in
Sy= 84 -in
Nx= 1
Ny= 2

Soil Data:

Depth -ft	Gamma -lb/f3	Phi	C -kp/f2	K -lb/i3	e50 or Dr %	Nspt
0	102.9	28.1	0.00	5.9	12.68	3
5	126.9	29.1	0.51	231.7	0.98	8
10	115.1	33.1	0.00	46.3	35.29	10
15	60.7	38.0	0.00	96.0	66.00	30
20	67.7	40.0	0.00	156.4	85.51	50

Pile Data:

Depth -ft	Width -in	Area -in2	Per. -in	I -in4	E -kp/i2	Weight -kp/f
0.0	12.75	15.9	40.1	302.9	29000	0.054
35.0						

Group Vertical capacity:
Total Ultimate Capacity (Down)= 133.894-kp Total Ultimate Capacity (Up)= 45.839-kp
Total Allowable Capacity (Down)= 66.947-kp Total Allowable Capacity (Up)= 24.809-kp
OK! Qallow > Q

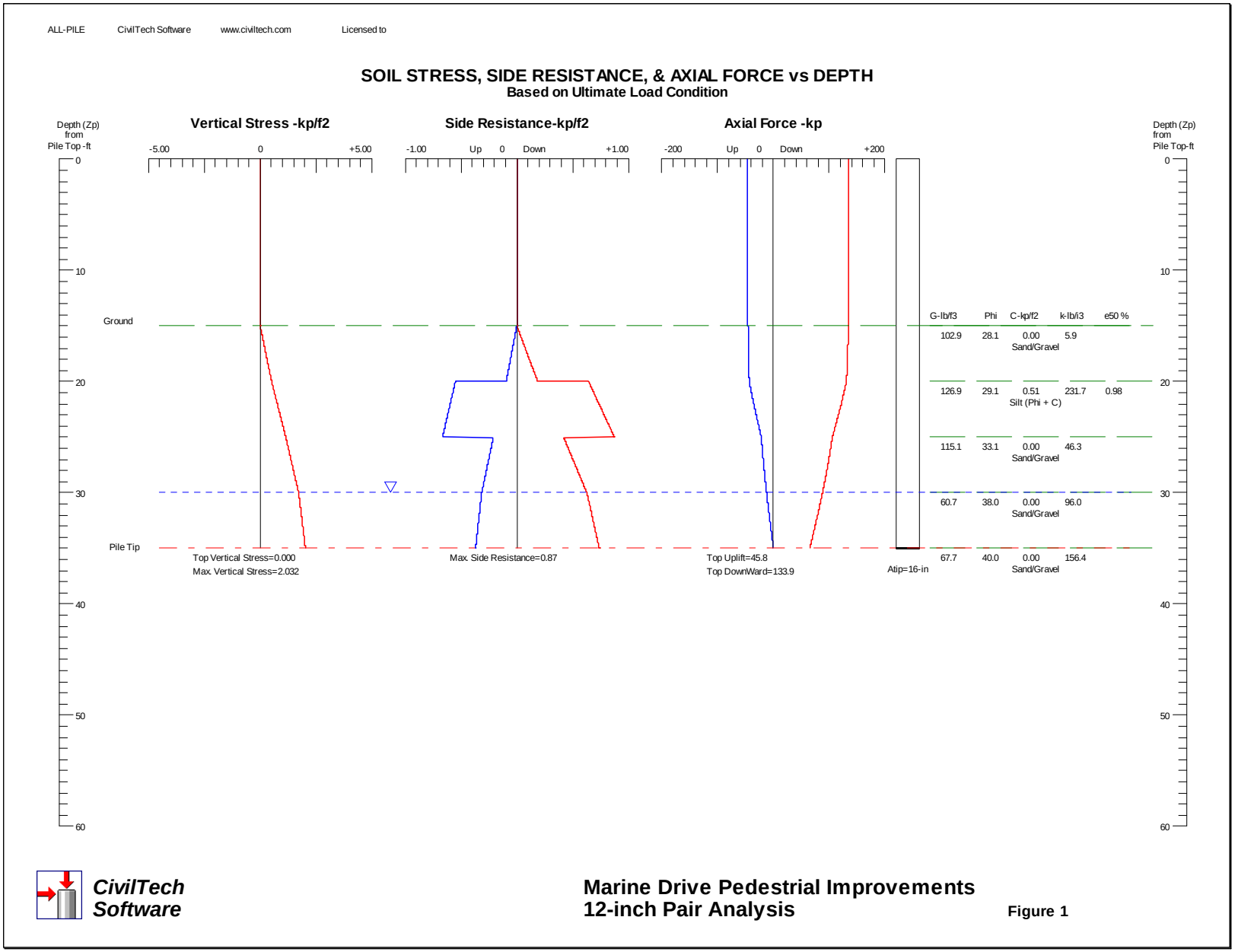
Group Settlement Calculation:
At Xallow= 0.50-in Qallow= 99999.00-kp
At Q= 66.00-kp Settlement= 0.01180-in

Note: If the program cannot find a result or the result exceeds the upper limit. The result will be displayed as 99999.

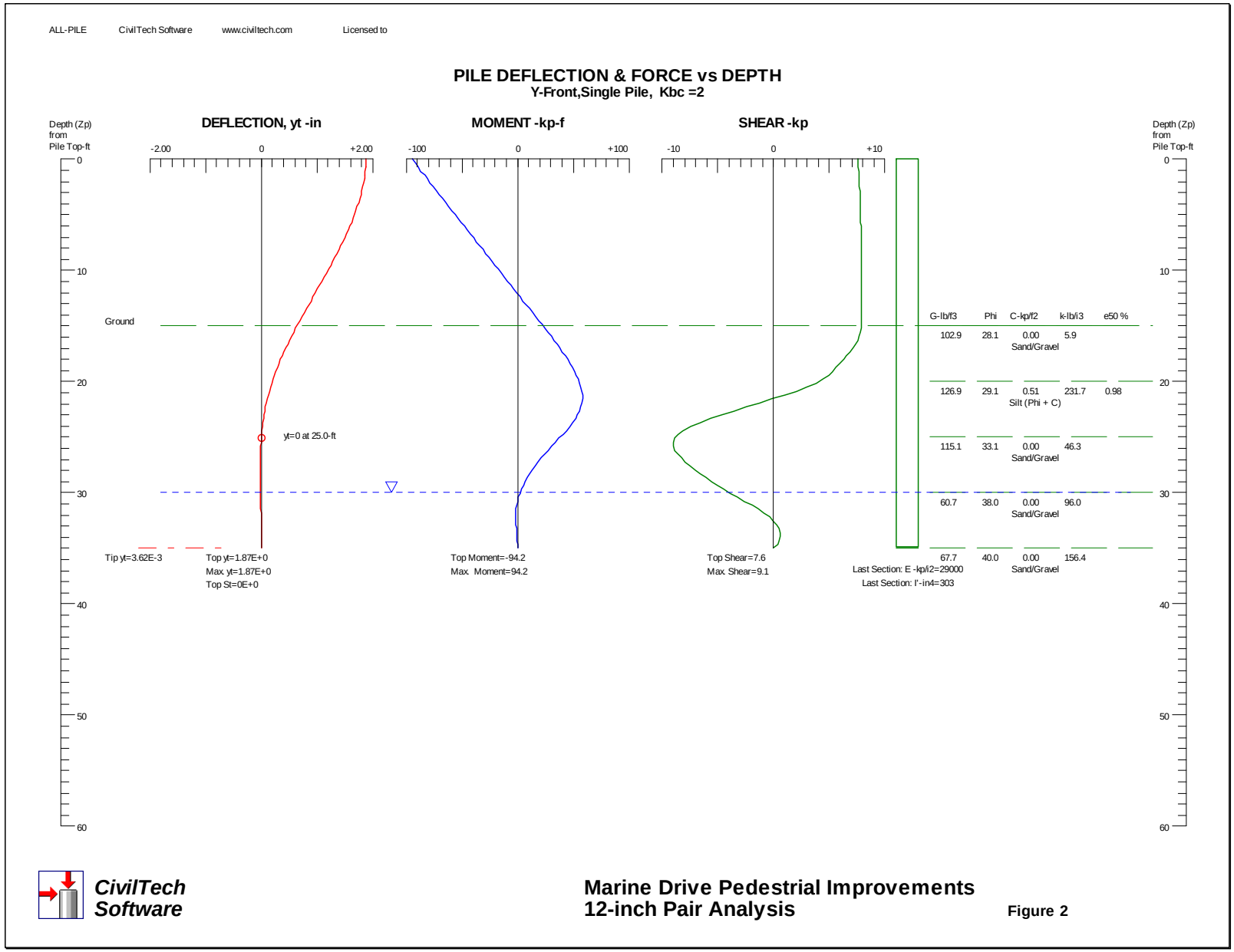
CivilTech Software

Marine Drive Pedestrial Improvements
12-inch Pair Analysis

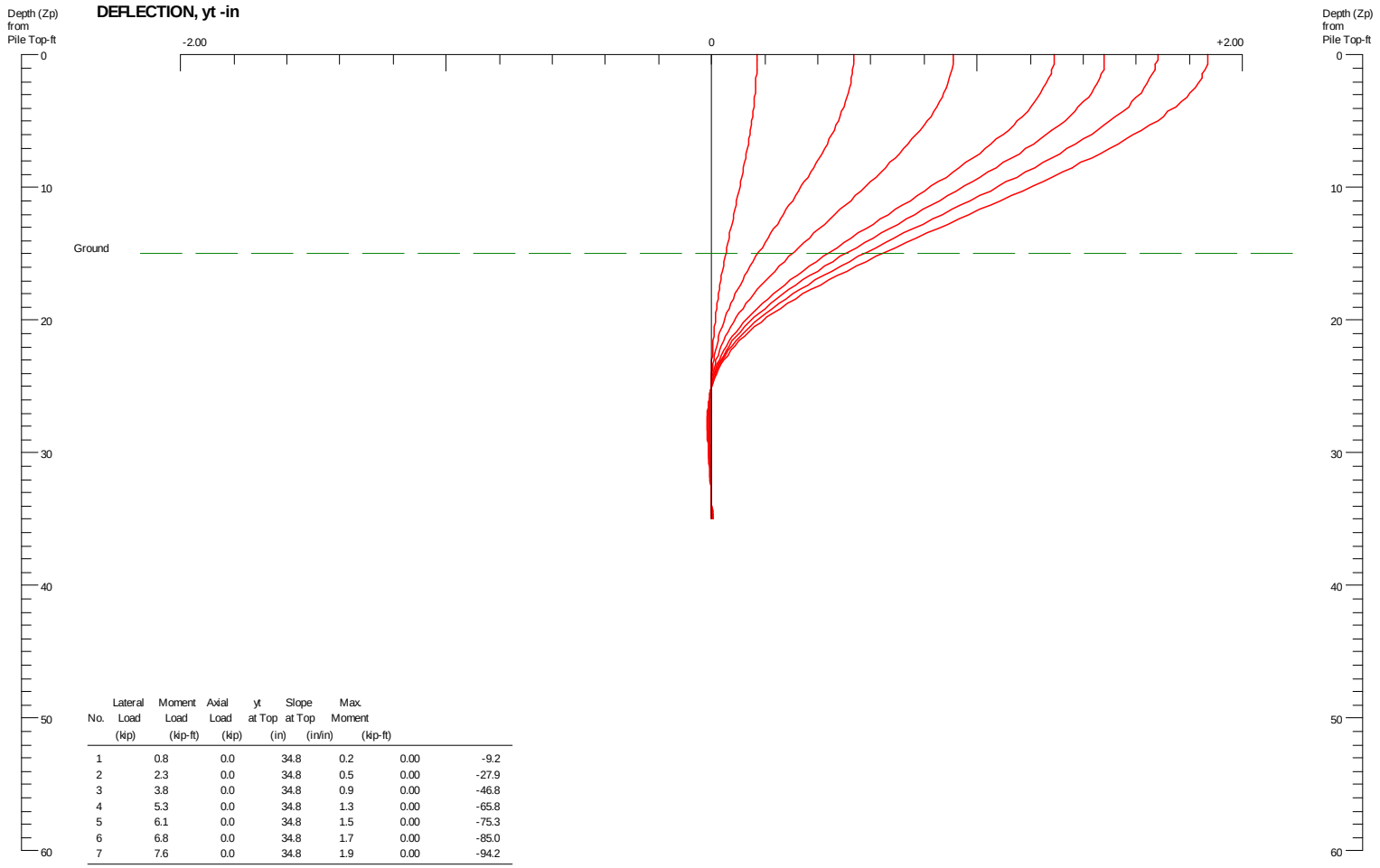
Vertical Analysis Distributions



Lateral Analysis Results - Load Factor = 1.0



Lateral Deflection versus Loading - Load Factor = 1.0



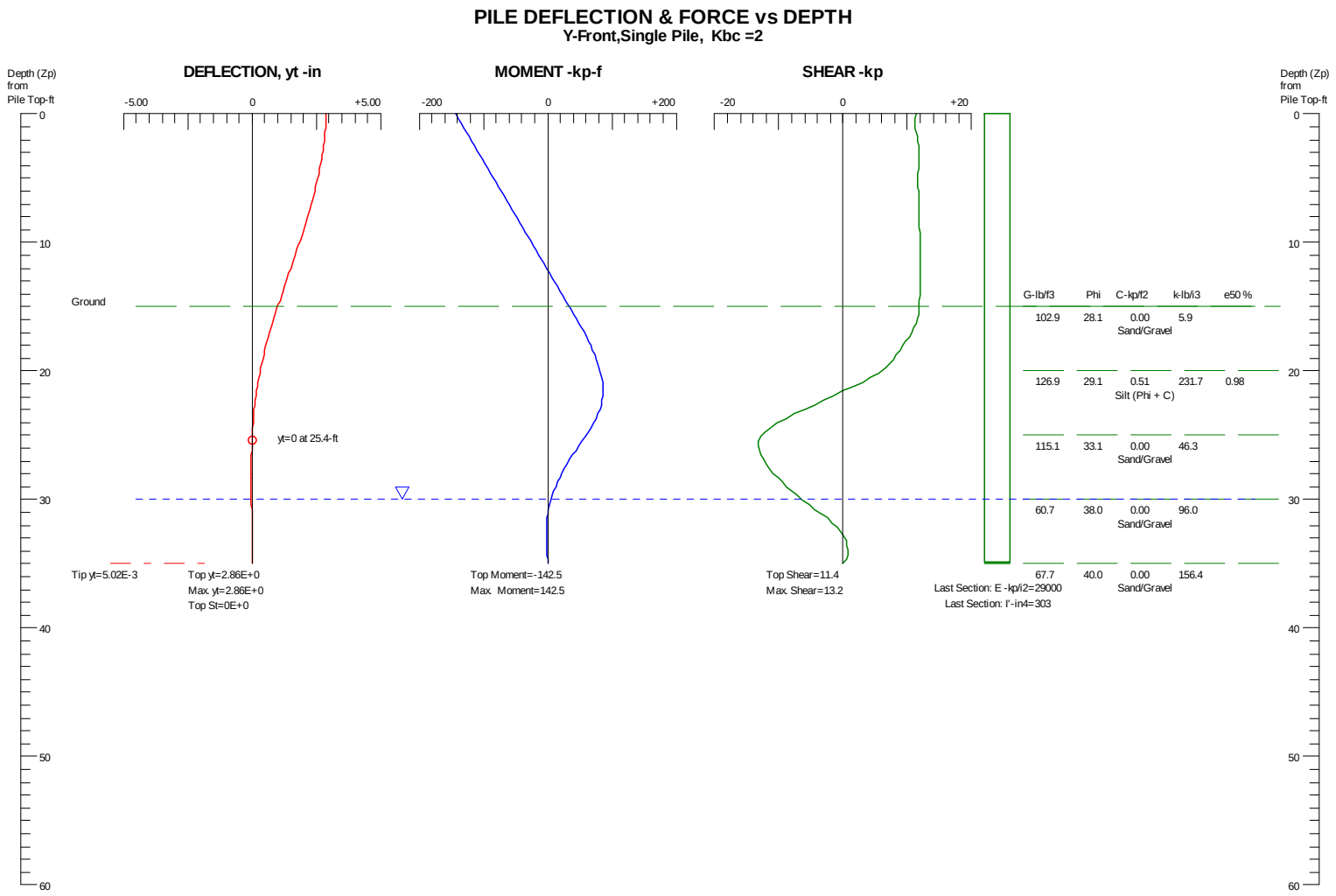
No.	Lateral Load (kip)	Moment Load (kip-ft)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	0.8	0.0	34.8	0.2	0.00	-9.2	
2	2.3	0.0	34.8	0.5	0.00	-27.9	
3	3.8	0.0	34.8	0.9	0.00	-46.8	
4	5.3	0.0	34.8	1.3	0.00	-65.8	
5	6.1	0.0	34.8	1.5	0.00	-75.3	
6	6.8	0.0	34.8	1.7	0.00	-85.0	
7	7.6	0.0	34.8	1.9	0.00	-94.2	

CivilTech Software

Marine Drive Pedestrial Improvements
12-inch Pair Analysis

Figure 2

Lateral Analysis Results - Load Factor = 1.5



CivilTech Software

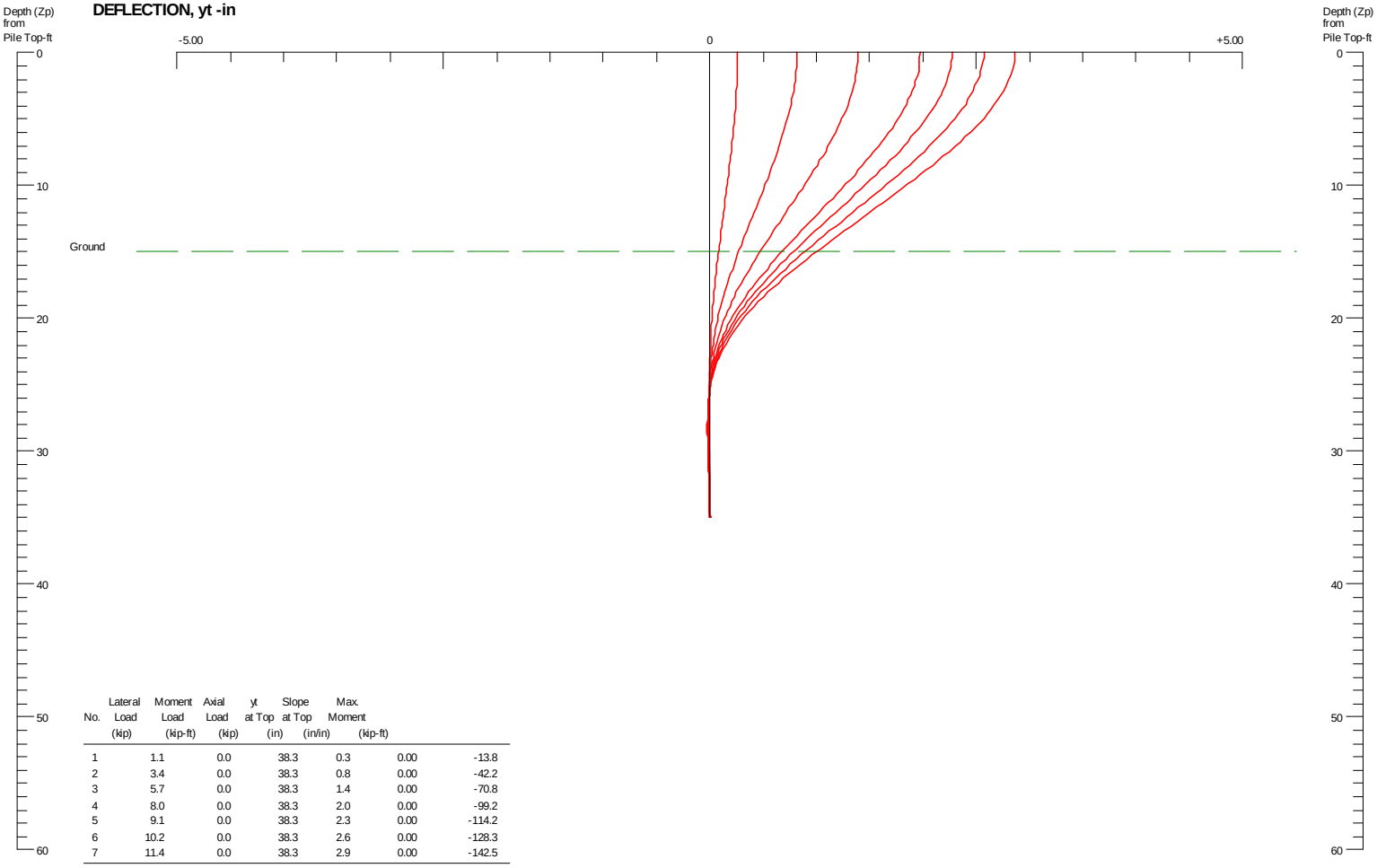
Marine Drive Pedestrial Improvements
12-inch Pair Analysis

Figure 2

Lateral Deflection versus Loading - Load Factor = 1.5

ALL-PILE CivilTech Software www.civiltech.com Licensed to

PILE DEFLECTION vs LOADING
Y-Front,Single Pile, Kbc =2



No.	Lateral Load (kip)	Moment Load (kip-ft)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)	
1	1.1	0.0	38.3	0.3	0.00	-13.8	
2	3.4	0.0	38.3	0.8	0.00	-42.2	
3	5.7	0.0	38.3	1.4	0.00	-70.8	
4	8.0	0.0	38.3	2.0	0.00	-99.2	
5	9.1	0.0	38.3	2.3	0.00	-114.2	
6	10.2	0.0	38.3	2.6	0.00	-128.3	
7	11.4	0.0	38.3	2.9	0.00	-142.5	

CivilTech Software

Marine Drive Pedestrial Improvements
12-inch Pair Analysis

Figure 2

Appendix D

Plans and Profile Drawings
(under separate cover)