The Tulalip Tribes of Washington

The Consolidated Borough of Quil Ceda Village

Marine Drive Shoulder Improvements
Phase 1: 7th Drive NW to 64th Street NW
Contract Documents

Bid Solicitation No. 2014-358

ADDENDUM NO. 2 – June 9, 2016

to

Request for Bid Proposals

ADDENDUM NO. 2 – June 21, 2016

Sealed bid proposals will be received by the Tulalip Tribes of Washington, at the Consolidated Borough of Quil Ceda Village's Office located at 8802 27th Avenue NE, Tulalip, WA 98271-9694 for the following Project:

BID SOLICITATION NUMBER 2014-358

Marine Drive Shoulder Improvements Phase 1: 7th Drive NW to 64th Street NW

until Monday, June 27, 2016 at 2:00 p.m. at which time all bids will be opened and read aloud. All required bid documentation shall be submitted to the front desk receptionist at the QCV – Administrative Office located at 8802 27th Avenue NE, Tulalip, WA by the scheduled bid date and times. ORAL, TELEPHONIC, FAXED, OR TELEGRAPHIC BIDS WILL NOT BE ACCEPTED.

This Addendum is being issue to provide clarifications to certain Bid Document related issues and or questions received from potential Bidders related to the above Project(s). Submitted Request for Bid Proposals shall conform to the requirements of this Addendum. Unless specifically changed and or amended by this Addendum all other requirements, terms and conditions of the Bid Documents and any previous addenda shall remain unchanged.

1. The following changes, additions, and or deletions to the Bid Documents dated June 1, 2016 hereby become a part of the Bid Documents.
2. Notify all Subcontractors affected by this Addendum.
3. It is essential that prospective Bidders note the contents of this Addendum and the Tulalip Tribes of Washington be made aware the Addendum has been received. Therefore, Bidder shall acknowledge receipt of this Addendum on the Request for Bid Proposal form.

REQUESTS:

It was requested that the geotechnical report be made available for review.

ATTACHMENTS

- Final Geotechnical Report prepared by Materials Testing and Consulting Inc.

END OF ADDENDUM NO. 2

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 R. Gillaspy
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**

Table of Contents

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:

---

[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*.

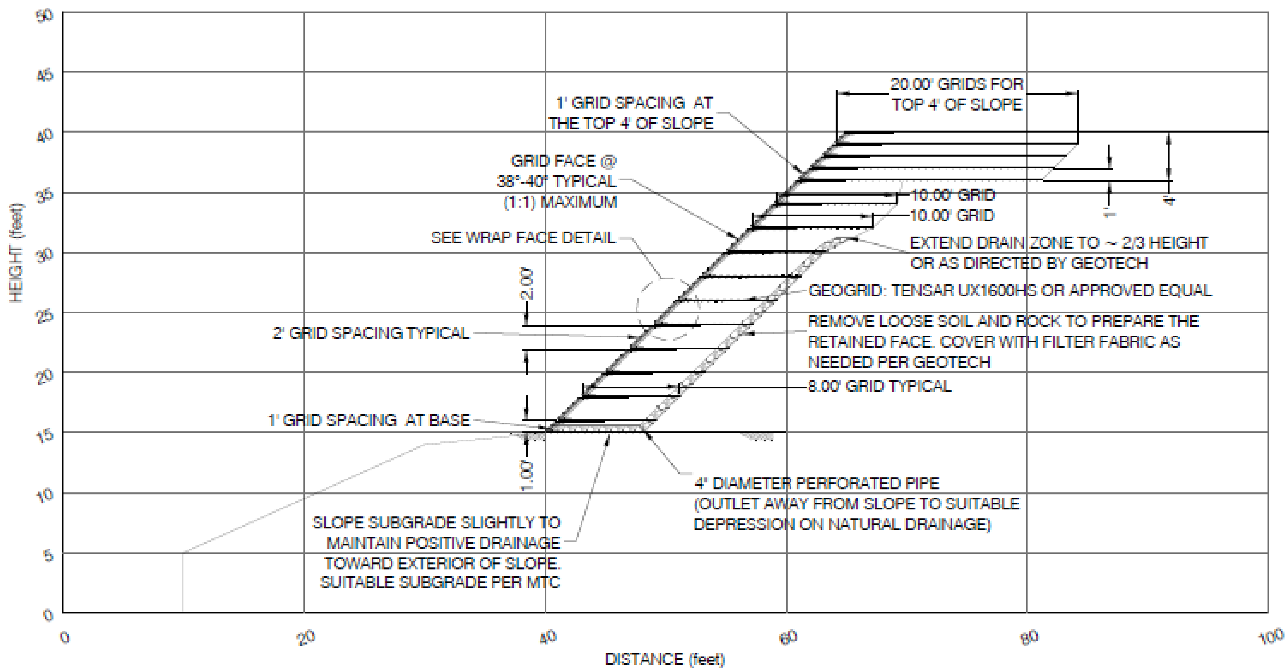
- **Foundation:**

  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:**

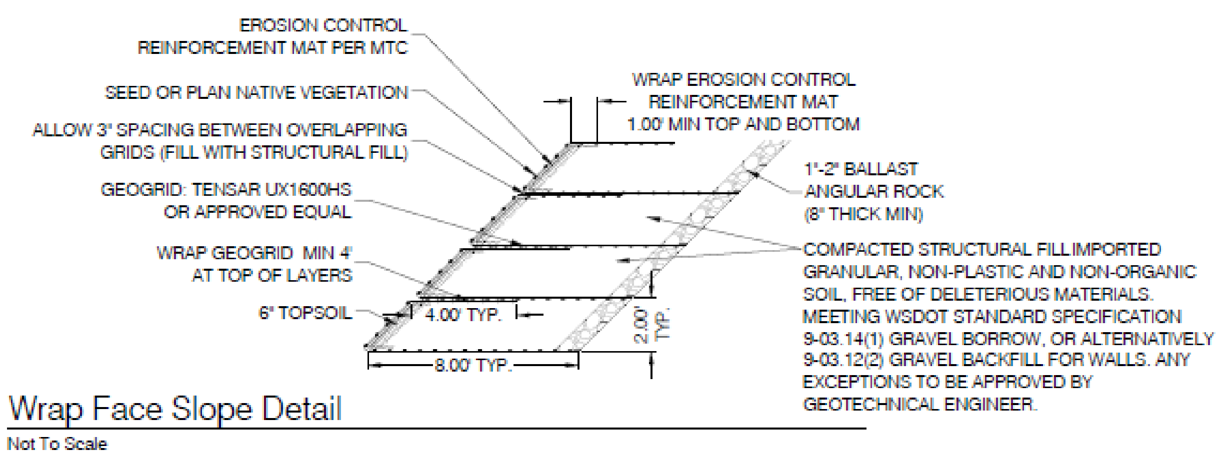
  Berm erection shall be constructed in layers from the base using a wrapped geogrid pattern on 2-foot intervals and compacted imported structural infill per Figure 1. The outer edge of the slope will have planting soil and wrapped erosion control matting placed to allow for revegetation or seeding per 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.

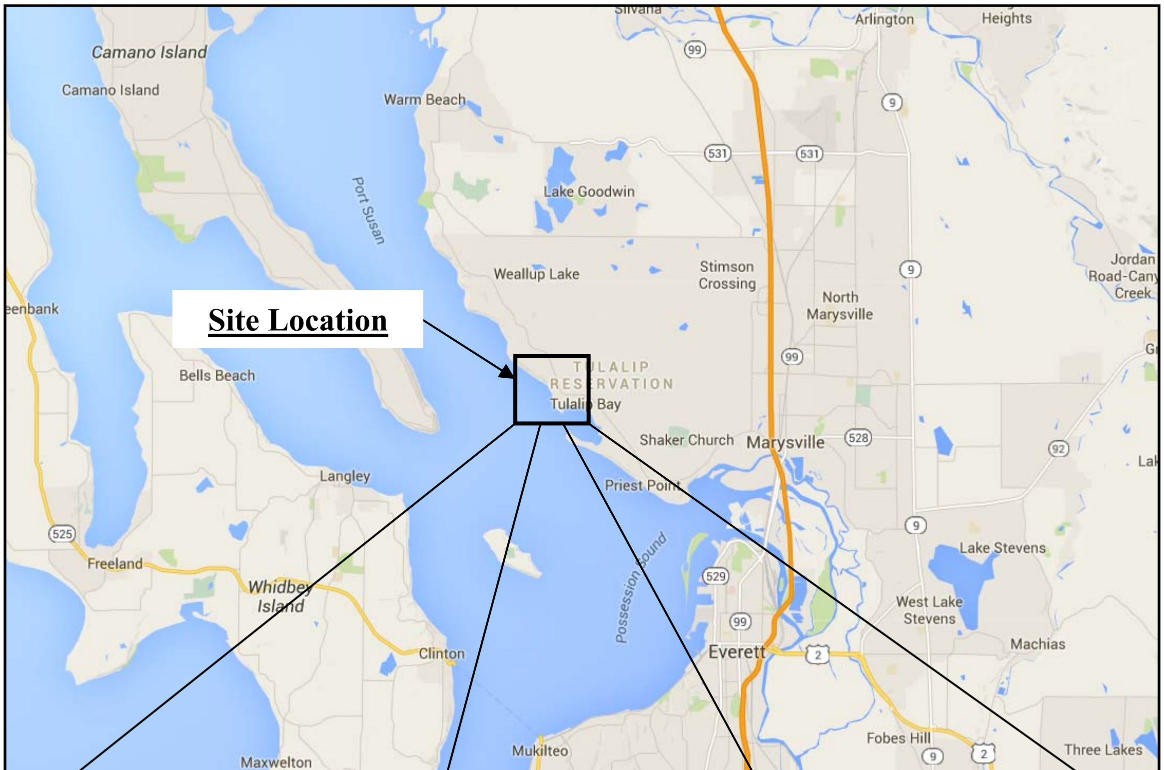
We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty, express or implied, is made. The recommendations provided in this report are based on the assumption that an adequate 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.

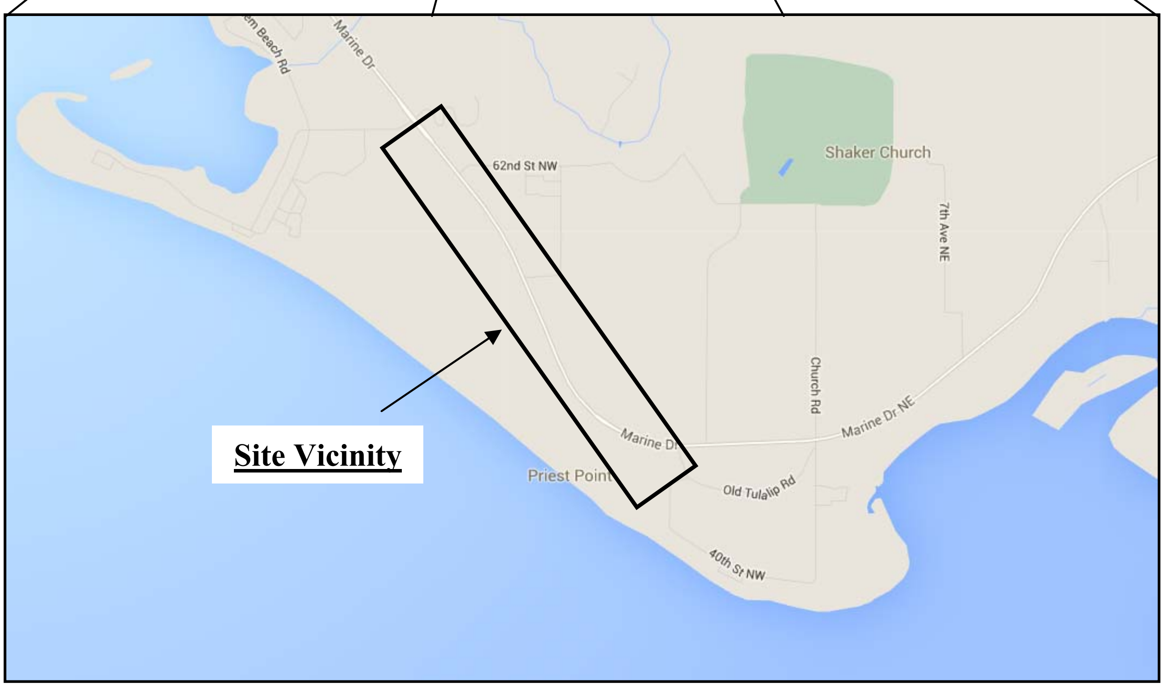
This report may be used only by the Tulalip Tribe and their design consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than 18 months from the date of the report. Note that if another firm assumes Geotechnical Engineer of Record responsibilities 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.

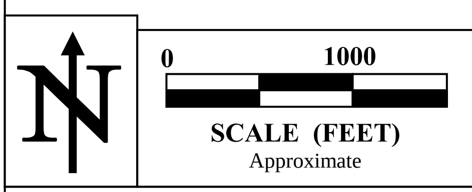
The scope of work for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

Appendix A. SITE VICINITY AND AIR PHOTO





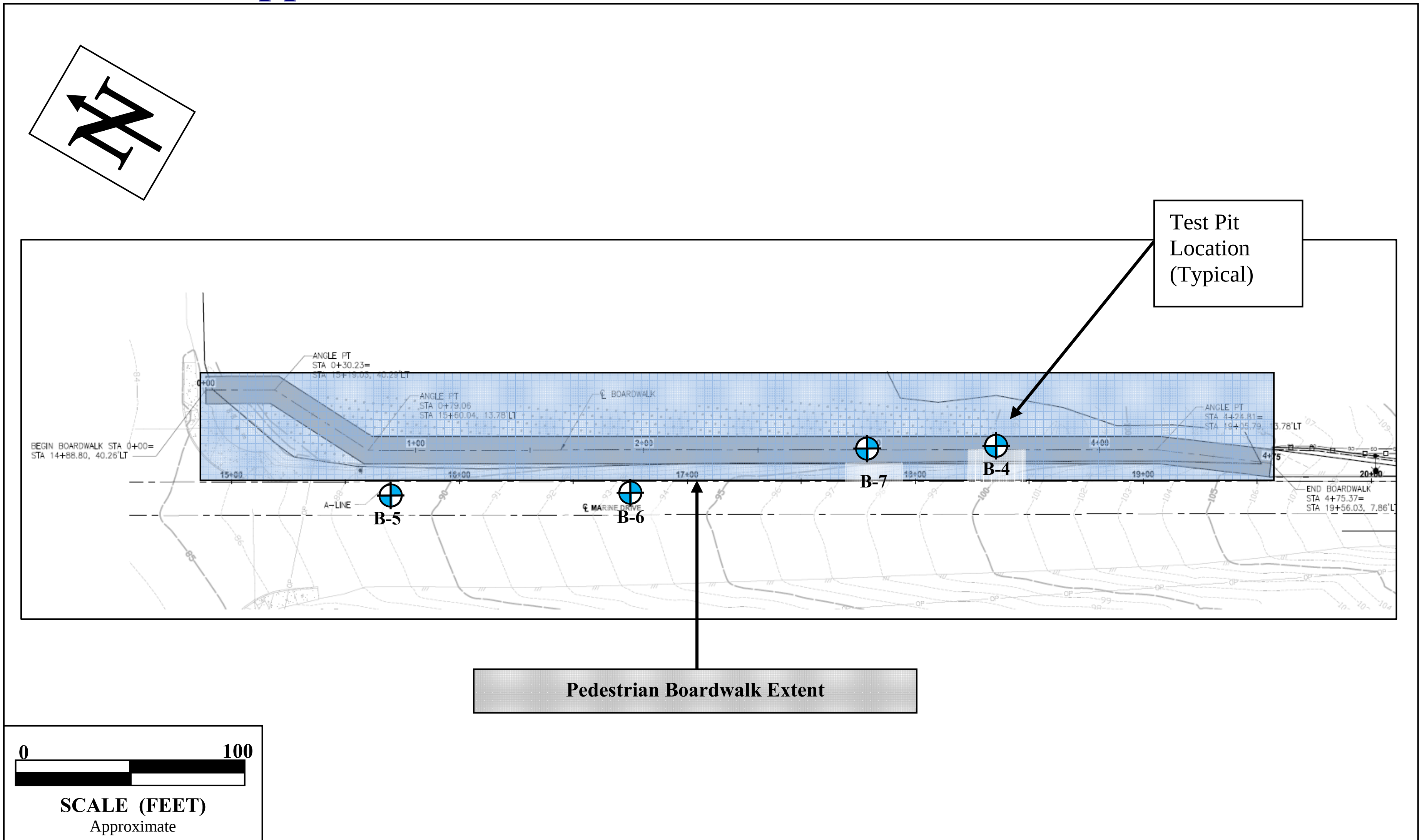
Materials Testing & Consulting, Inc. 777 Chrysler Drive Burlington, WA 98233	**Location & Vicinity Map** Ped/Bike Improvements Marine Drive Tulalip, WA	**FIGURE** **1**



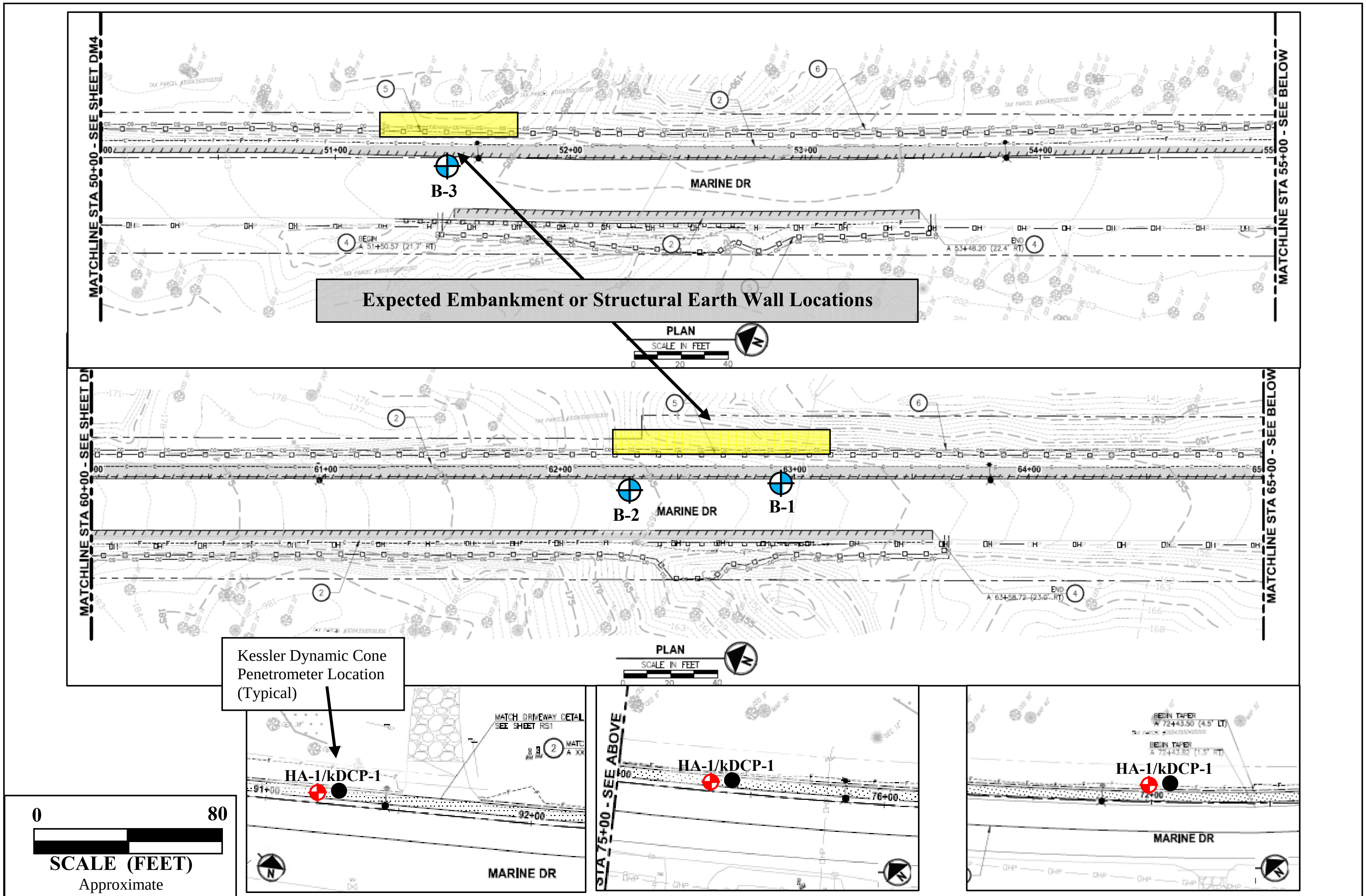
Aerial Photo from Google Imagery (2015) | All locations Approximate

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.	Exploration Logs	FIGURE
777 Chrysler Drive Burlington, WA 98233	Ped/Bike Improvements Marine View Drive Tulalip, WA	5

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

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**				
2	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 0.5" thick fine-grained sand lens observed at 3.0' BPG.	▼			
4	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%
	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.				

01-27-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\HA-1.bor

Materials Testing & Consulting, Inc. Burlington, WA Geotechnical & Environmental Engineering	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							

01-27-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\HA-2.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

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**				
2	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		
4			T.D. = 3.3' BPG Hand Auger terminated in very dense conditions due to large rock. No groundwater observed.				
6							

01-29-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\HA-3.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-1

(Page 1 of 1)

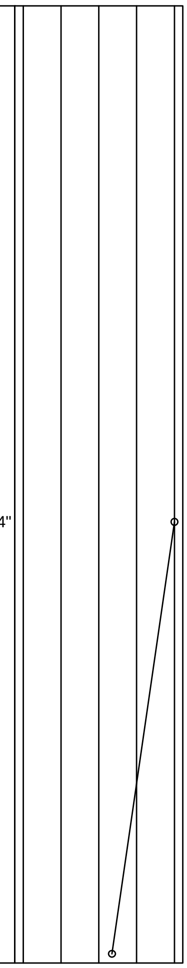
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

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

Depth in Feet	USCS	DESCRIPTION	Samples	Water Level	% Finer than #200	% Moisture	Blow Count
0	HMA	Core Thickness: 0.17' Core Thickness: 0.21'					
	SP-SM	SAND with silt and gravel, fine-grained sand, medium dense, moist. LIGHT BROWN					
	SP-SM	SAND with silt and gravel, gravel up to 1" in diameter, medium dense, moist. LIGHT BROWN to GRAY					
5	SP-SM	SAND with silt and gravel, fine-grained sand, dense, damp. GRAY-BROWN					95 for 4"
10	SM	SILTY SAND with gravel, fine-grained sand, gravel up to 0.5" in diameter, medium dense, moist. GRAY			34.1%	5.5%	47

Blow Count Graph (0, 20, 40, 60, 80)



TD 10.2' Boring terminated at contracted depth.
Boring terminated in very dense conditions.
No groundwater observed.

01-29-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\MDrPB B-1.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-2

(Page 1 of 1)

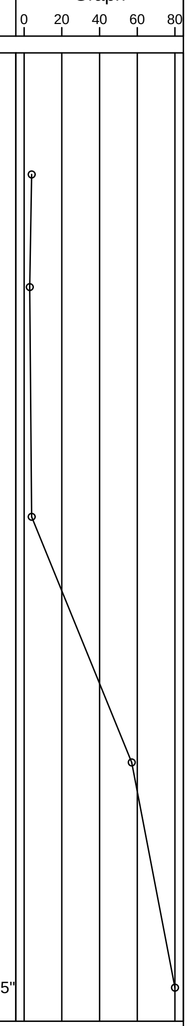
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

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	DESCRIPTION	% 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



01-29-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\MDrPB B-2.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-3

(Page 1 of 1)

Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

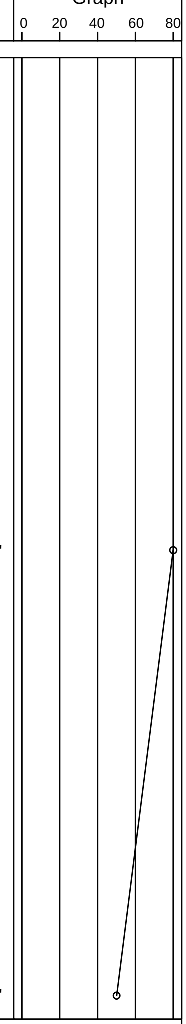
MTC Project No. 14B024-12

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

Depth in Feet	USCS	DESCRIPTION	Blow Count
0	HMA	Core Thickness: 0.25' Core Thickness: 0.17' Core Thickness: 0.21' Core Thickness: 0.21' Core Thickness: 0.17' Core Thickness: 0.21'	
	SM	SILTY SAND with gravel, gravel up to 2" in diameter, loose, moist. BROWN	
5	ML-SM	SANDY SILT with gravel to SILTY SAND with gravel, orange mottling throughout, loose to medium stiff, moist. GRAY Coarse-grained sand lenses observed at 5.4' BPG	90 for 5"
10		No recovery at 10.0' BPG.	50 for 3"

TD 10.25' Boring terminated at contracted depth.
Boring terminated in very dense conditions.
No groundwater observed.

Blow Count Graph



01-27-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\MDrPB B-3.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-4

(Page 1 of 1)

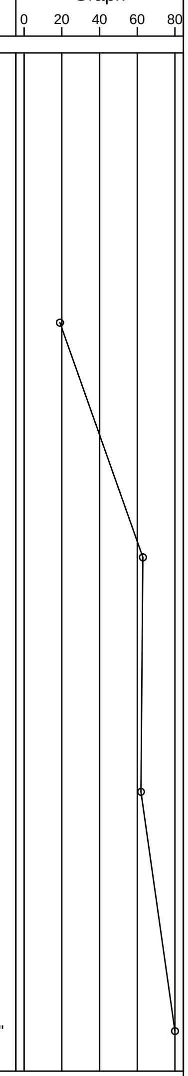
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

MTC Project No. 14B024-12

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

Depth in Feet	USCS	DESCRIPTION	% 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"

Blow Count Graph



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

01-29-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\MDrPB B-4.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-5

(Page 1 of 2)

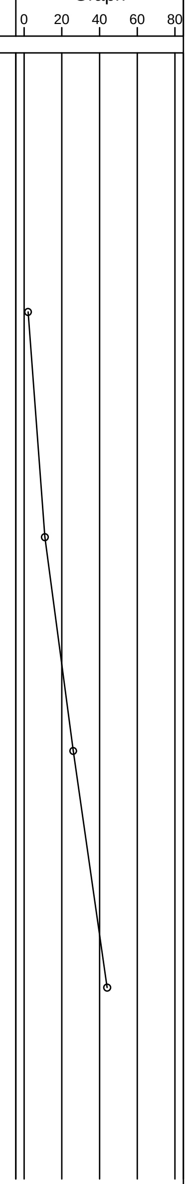
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip Bay, WA

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	DESCRIPTION	Samples	Water Level	% Finer than #200	% Moisture	Blow Count
0	HMA	Core Thickness: 0.42' Core Thickness: 0.08' Core Thickness: 0.17'					
	SP	SAND with gravel, loose, moist. BLACK **RECYCLED ASPHALT PRODUCT (RAP)**					
5	SP	SAND with gravel, gravel up to 1" in diameter, organics throughout including decomposed wood and vegetative matter, loose, moist. BLUE-GRAY **UNCONTROLLED FILL**	▼				2
	ML	SANDY SILT, fine-grained sand, organics throughout, soft, moist. BLACK					
	SP	SAND with gravel, gravel up to 1" in diameter, loose, moist. BLUE - GRAY					
10	ML	SILT with sand, fine-grained sand lenses throughout, stiff, moist. GRAY to BLUE					
	SP	SAND with trace silt and gravel, fine-grained sand, dense, moist. GRAY	▼				11
15	SP-SM	SAND with silt and gravel, fine-grained sand with some medium-grained sand, medium dense, moist. GRAY	▼	▼ (approx. 19 ft)			26
20	SP	SAND with gravel and some silt, gravel up to 1" in diameter, medium-grained sand with coarse-grained sand lenses, dense, very moist. GRAY	▼				44
25							

Blow Count Graph



01-29-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\MDrPB B-5.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-5

(Page 2 of 2)

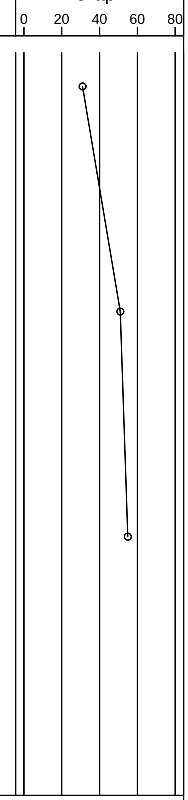
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip Bay, WA

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	DESCRIPTION	% Finer than #200	% Moisture	Blow Count
25–30	SP	SAND with trace silt and gravel, fine and medium-grained sand, dense, very moist. GRAY	9.0%	22.2%	31
30–35	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
35–41.5	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

Blow Count Graph



TD 41.5' Boring terminated at contracted depth.
Boring terminated in very dense or hard conditions.
Standing water observed at 19.0' BPG.

01-29-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\MDrPB B-5.bor

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-6

(Page 1 of 1)

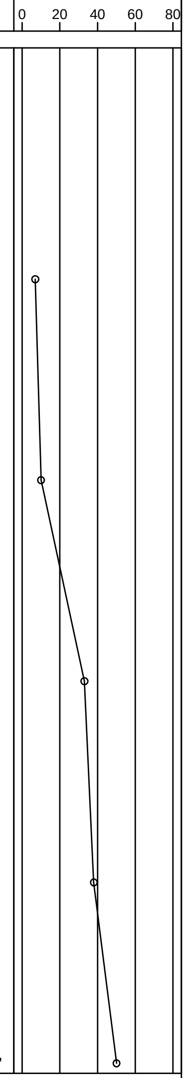
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

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	DESCRIPTION	% Finer than #200	% Moisture	Blow Count
0	HMA	Core Thickness: 0.12' Core Thickness: 0.58' Core Thickness: 0.12' Core Thickness: 0.08'			
	SP	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 No recovery at 25.0' BPG	3.9%	22.0%	38
25					50 for 5"

Blow Count Graph



TD 25.5' Boring terminated at contracted depth.
Boring terminated in very dense conditions.
Groundwater observed at 19.0' BPG.

Materials Testing & Consulting, Inc.
Burlington, WA
Geotechnical & Environmental Engineering

Log of Boring B-7

(Page 1 of 1)

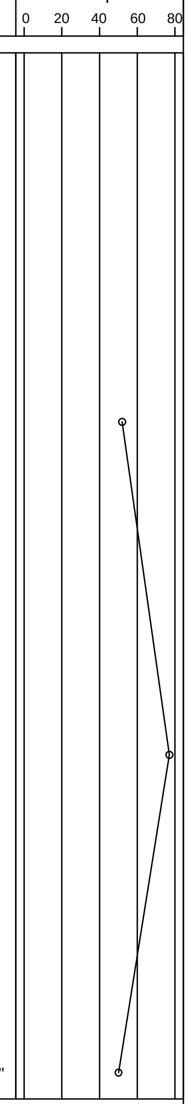
Marine Drive Ped-Bike Improvements
Marine Drive
Tulalip, WA

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
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"

Blow Count Graph



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

01-27-2016 Z:\Burlington Office\Geotechnical Services\1 Burl\2015\Marine Drive Ped-Bike Improve\Boring Logs\MDrPB B-7.bor

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

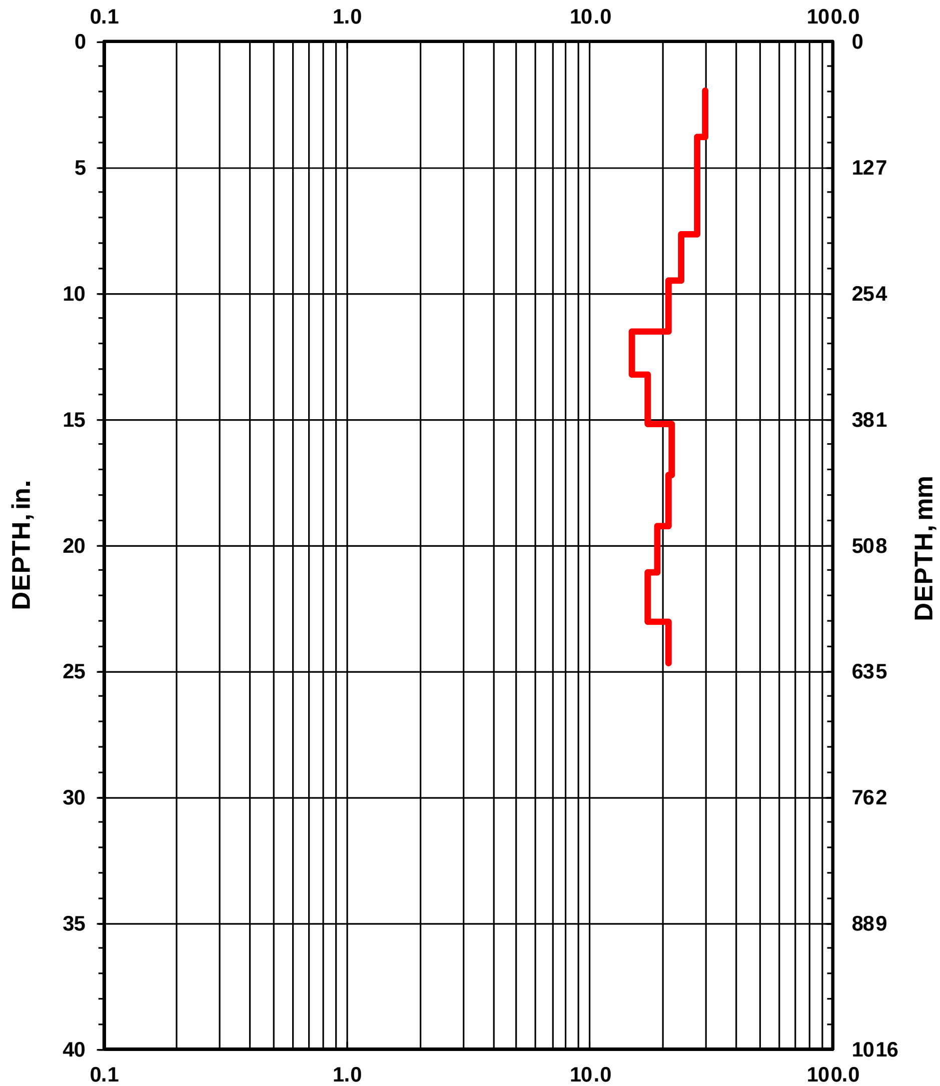
Project: *Marine Dr. Bike/Ped Improvements* **Date:** 7-Jan-16
Location: STA 91+25 **Soil Type(s):**

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

DCP-1 Plot of CBR Data



CBR Log of kDCP-2

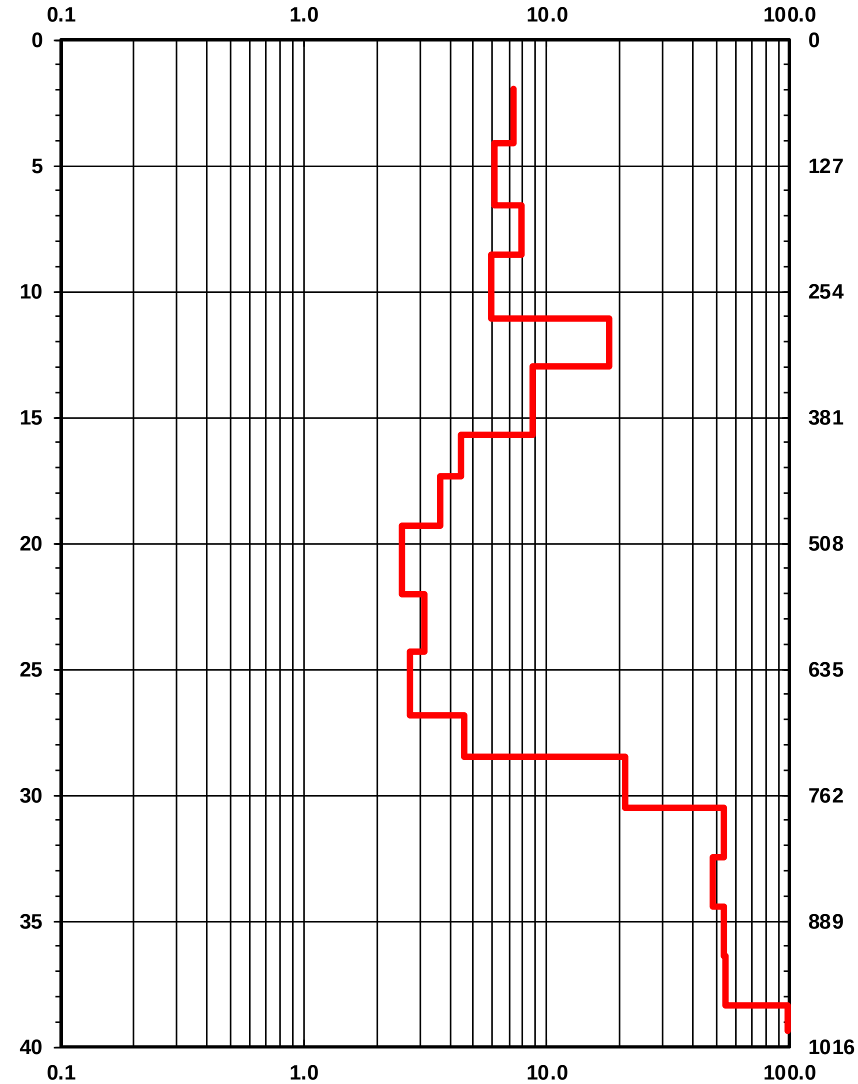
Project: *Marine Dr. Bike/Ped Improvements* **Date:** 7-Jan-16
Location: STA 75+50 **Soil Type(s):**

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

DCP-2 Plot of CBR Data



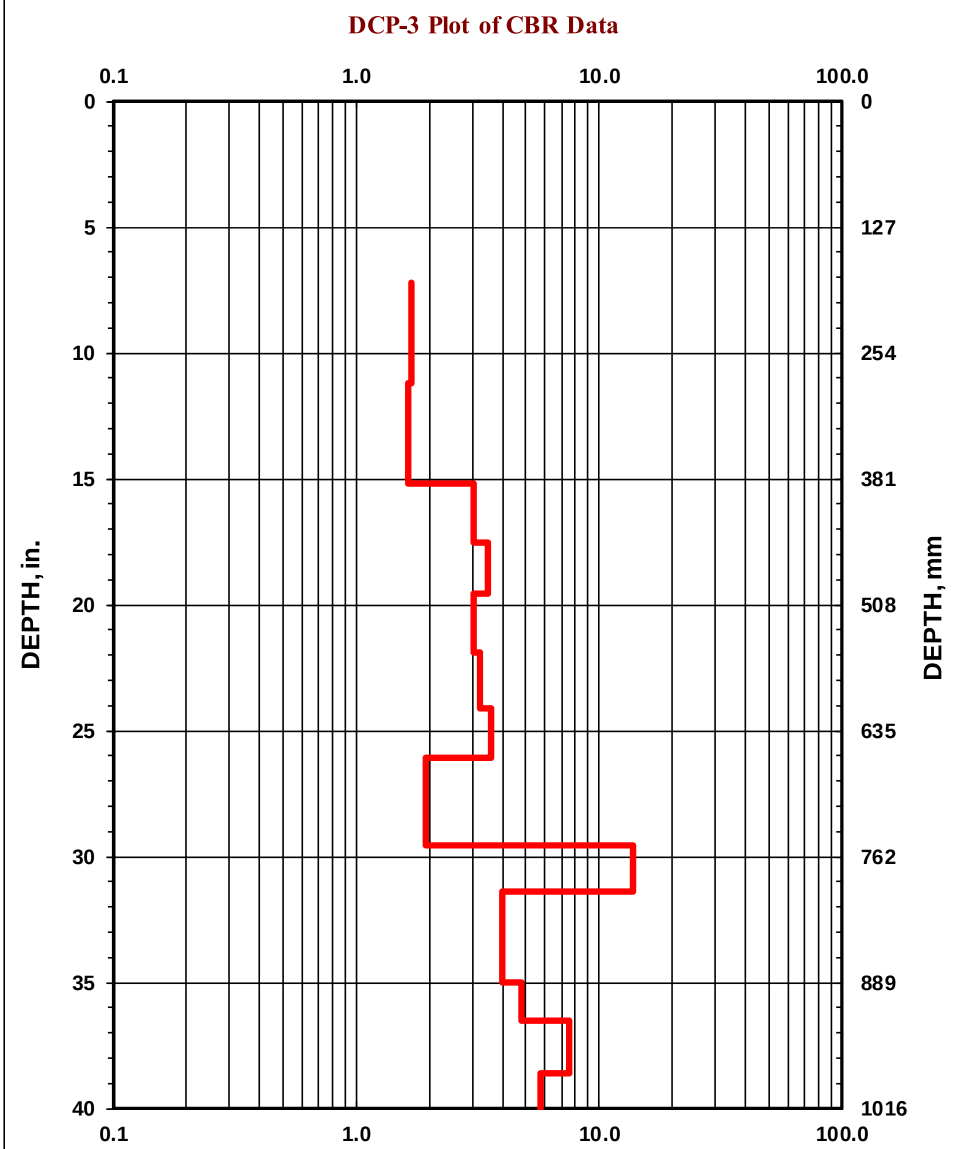
CBR Log of kDCP-3

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

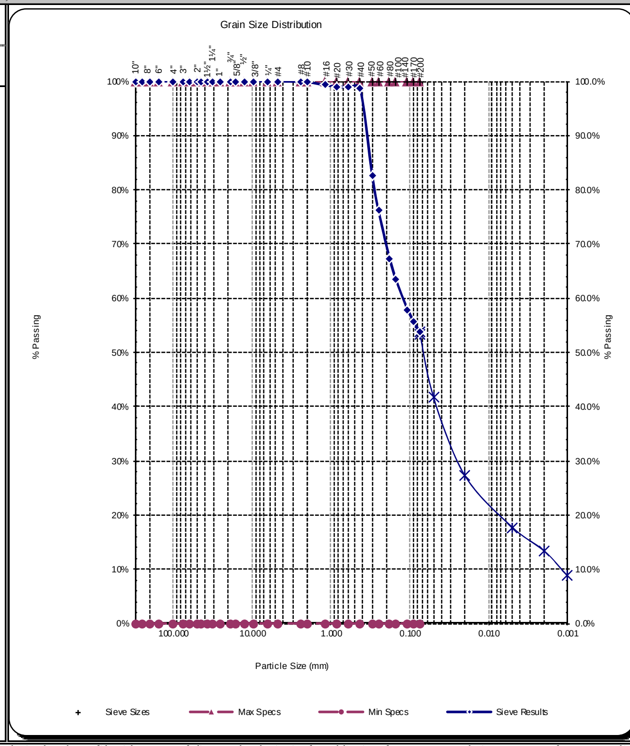
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

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

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

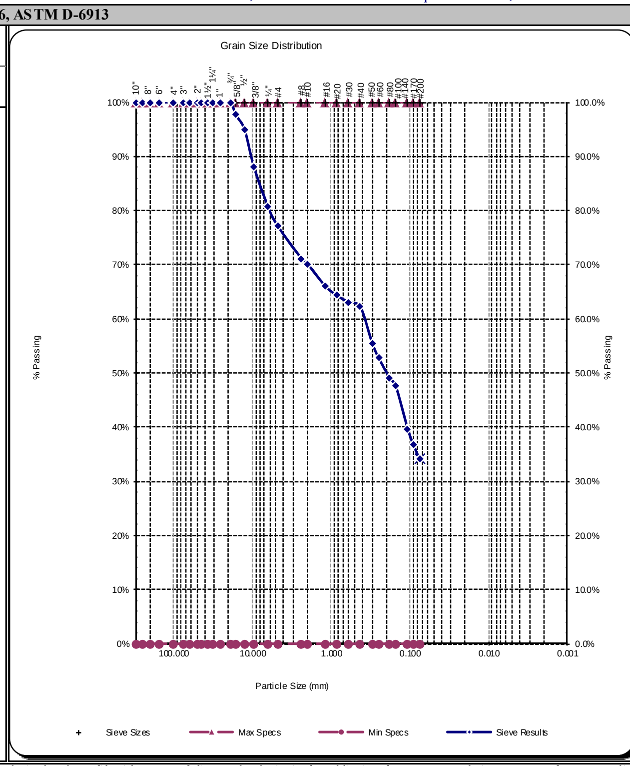
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

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

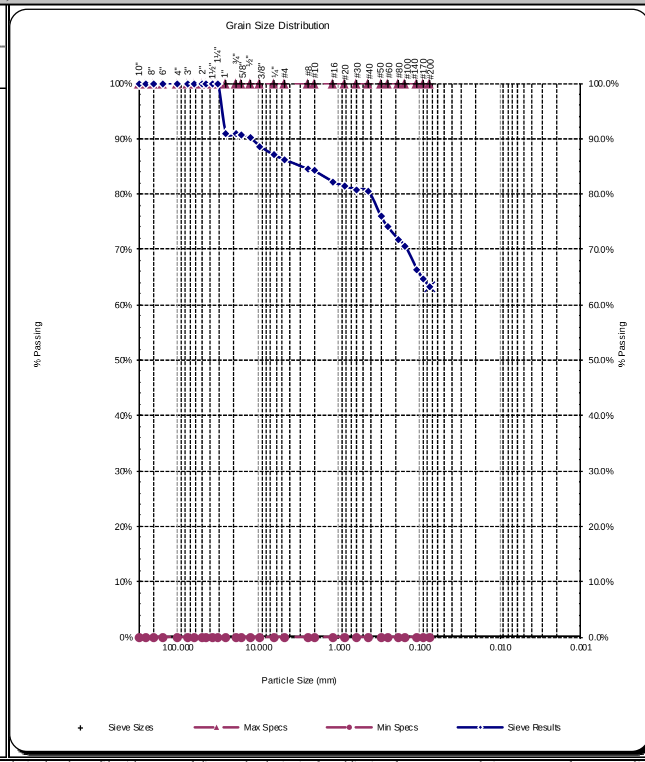
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

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: [signature]

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

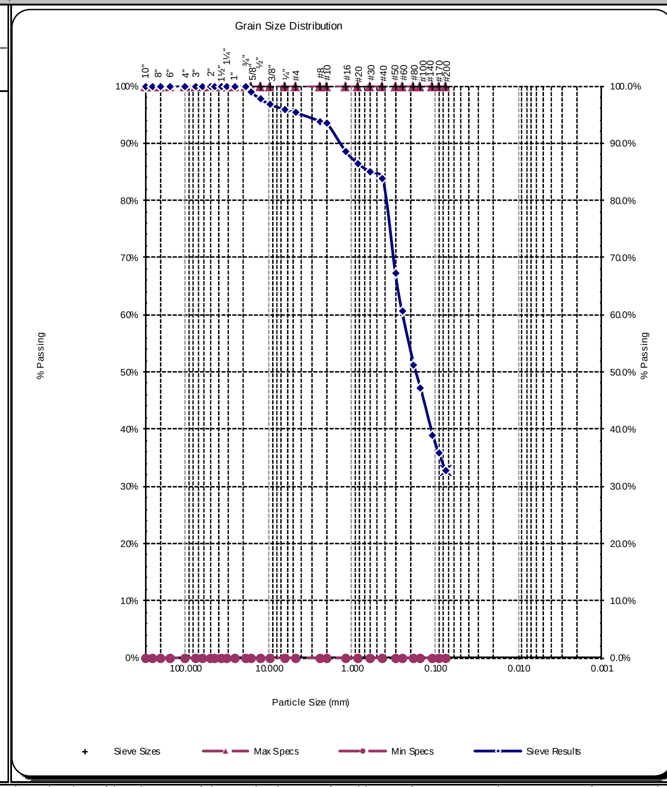
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

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

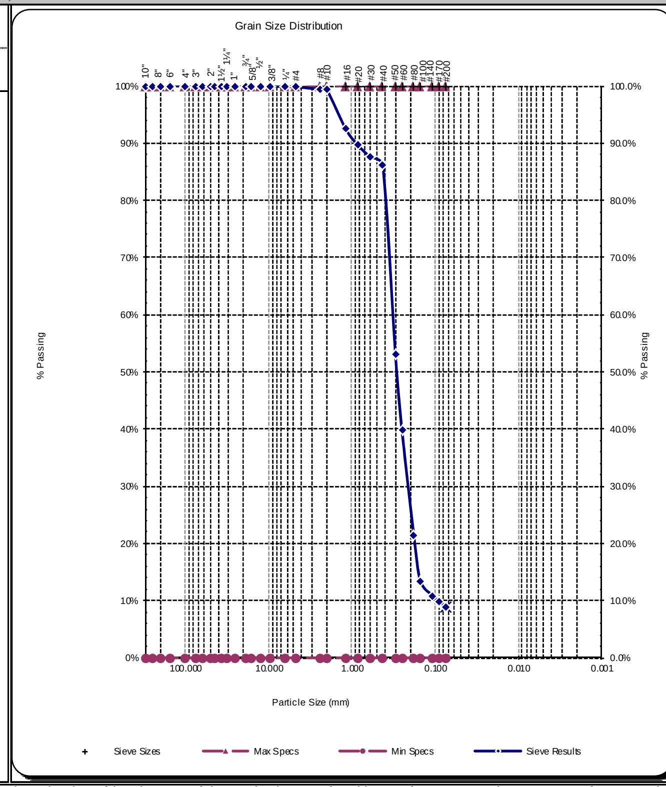
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

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

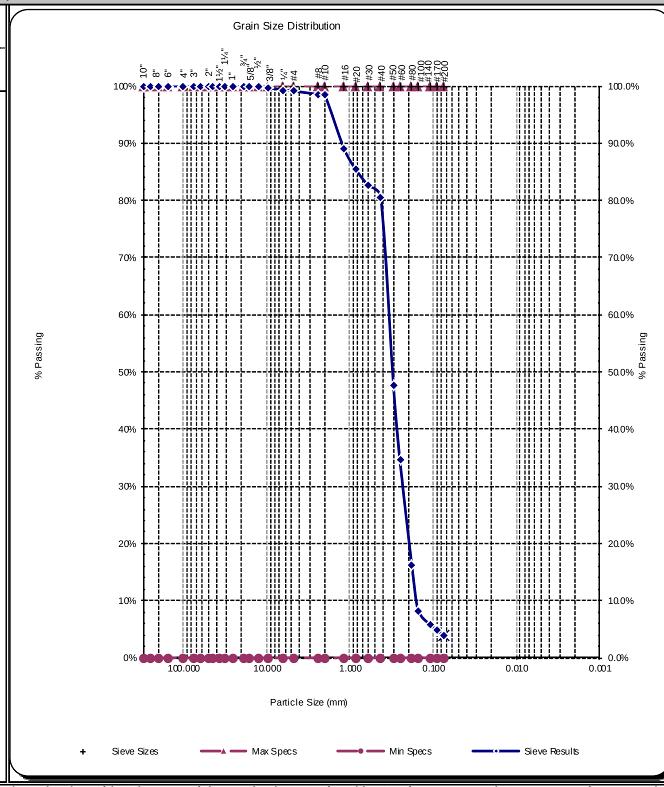
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

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.

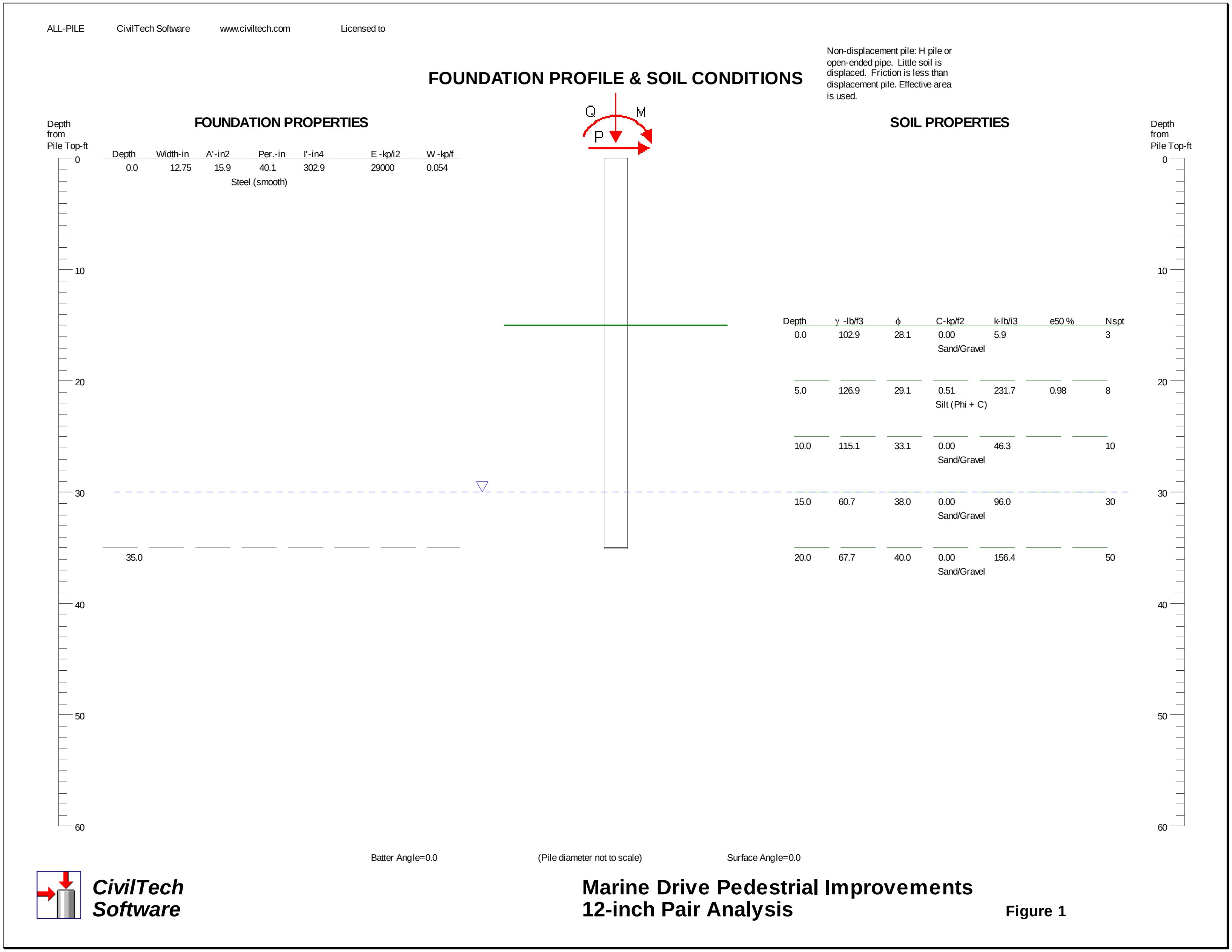
Methods and Results

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.

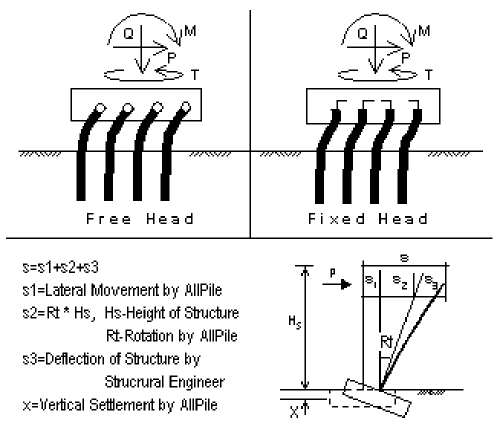
Pile Geometry and Soil Parameters



Summary of Vertical Analysis

VERTICAL ANALYSIS

Figure 1



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

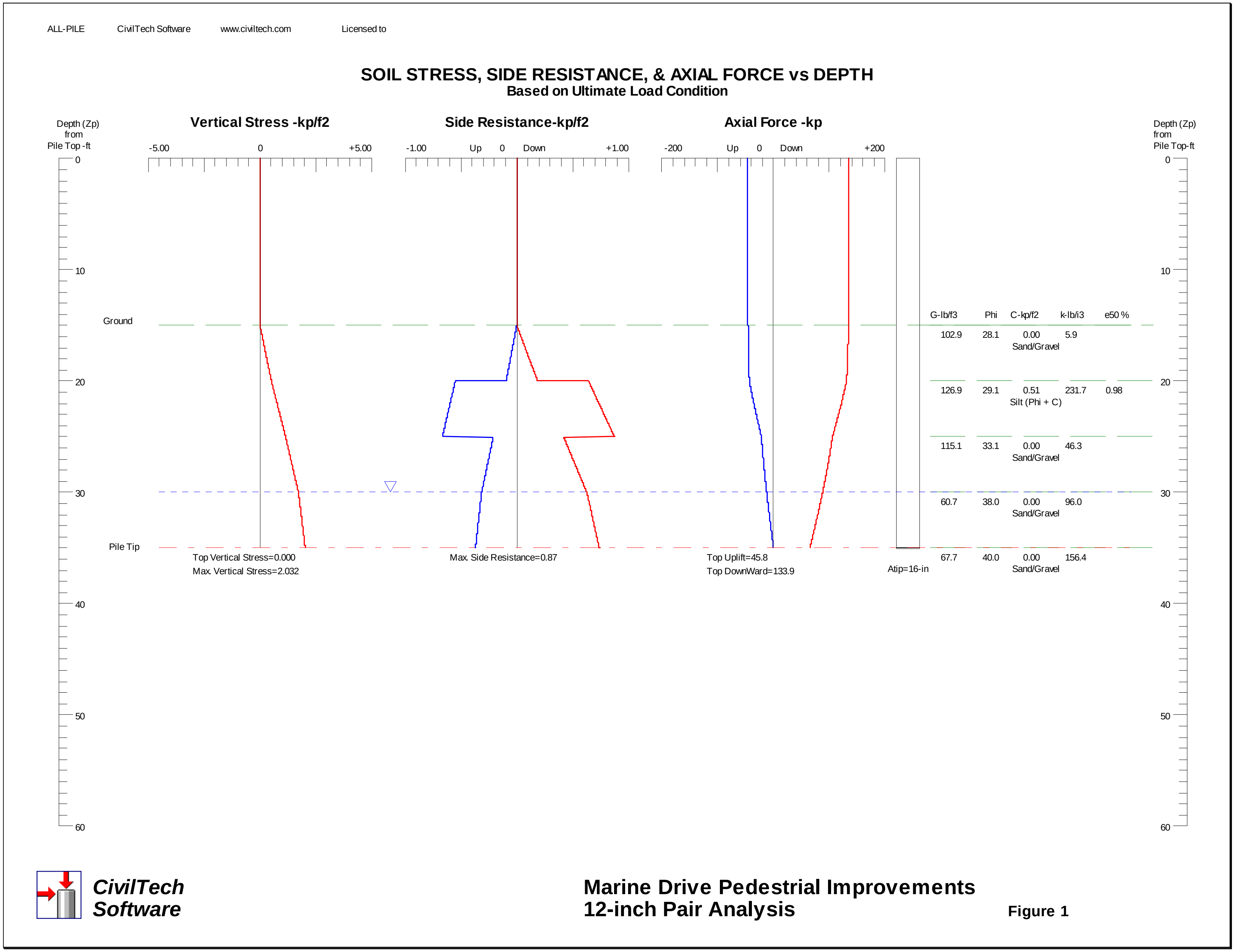
Group Settlement Calculation:
At Xallow= 0.50-in Qallow= 99999.00-kp
At Q= 66.00-kp Settlement= 0.01180-in

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

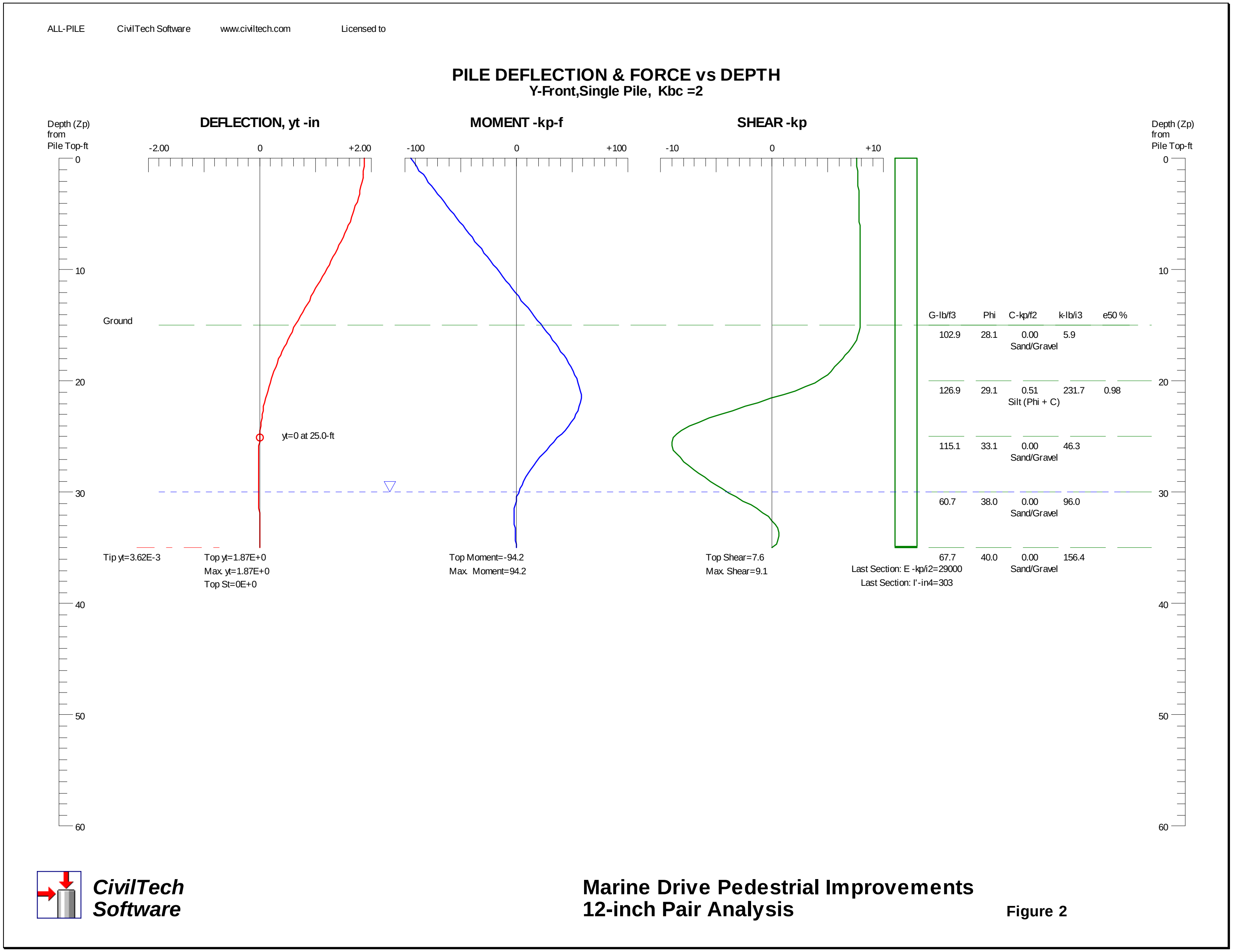
CivilTech Software

Marine Drive Pedestrial Improvements
12-inch Pair Analysis

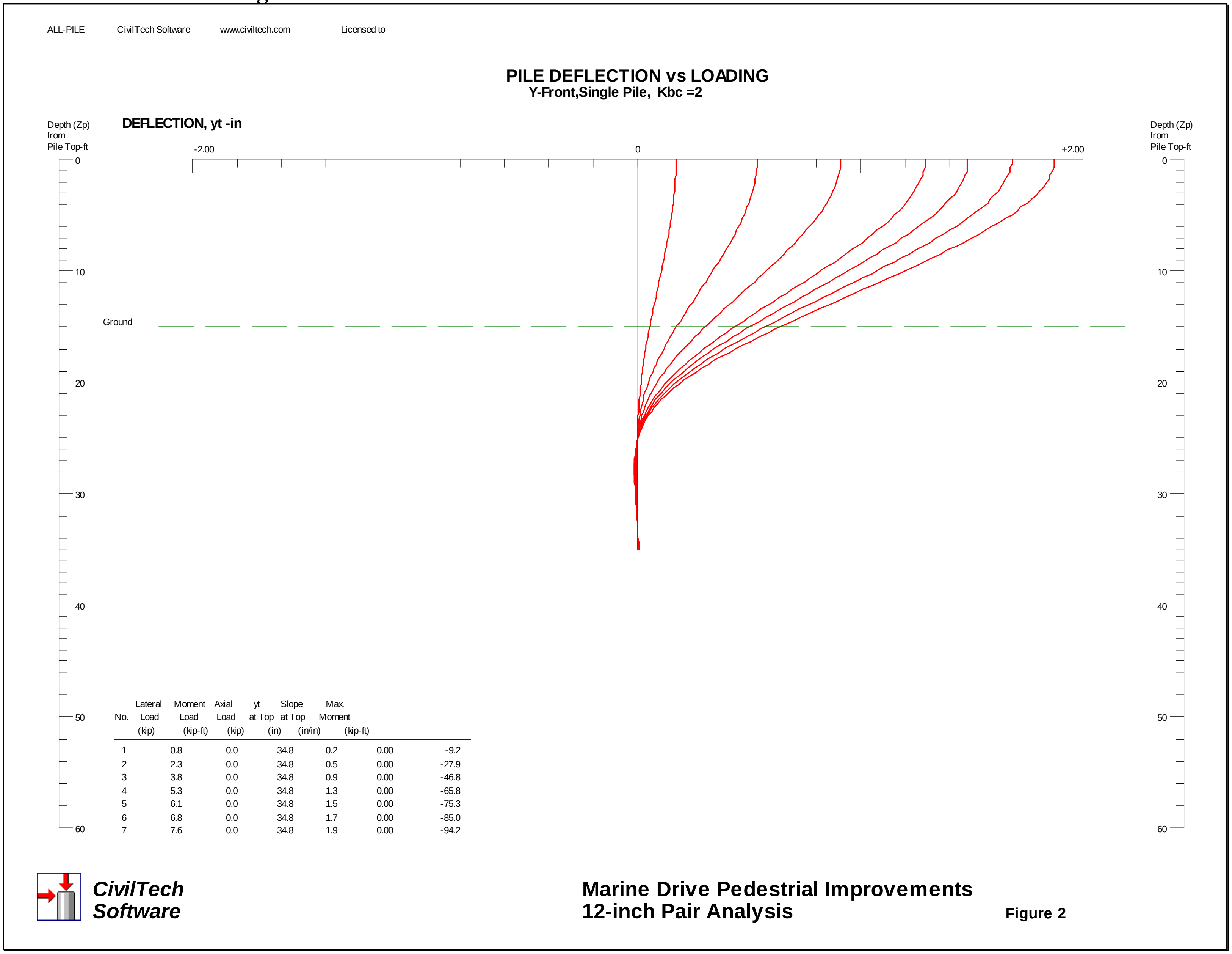
Vertical Analysis Distributions



Lateral Analysis Results - Load Factor = 1.0

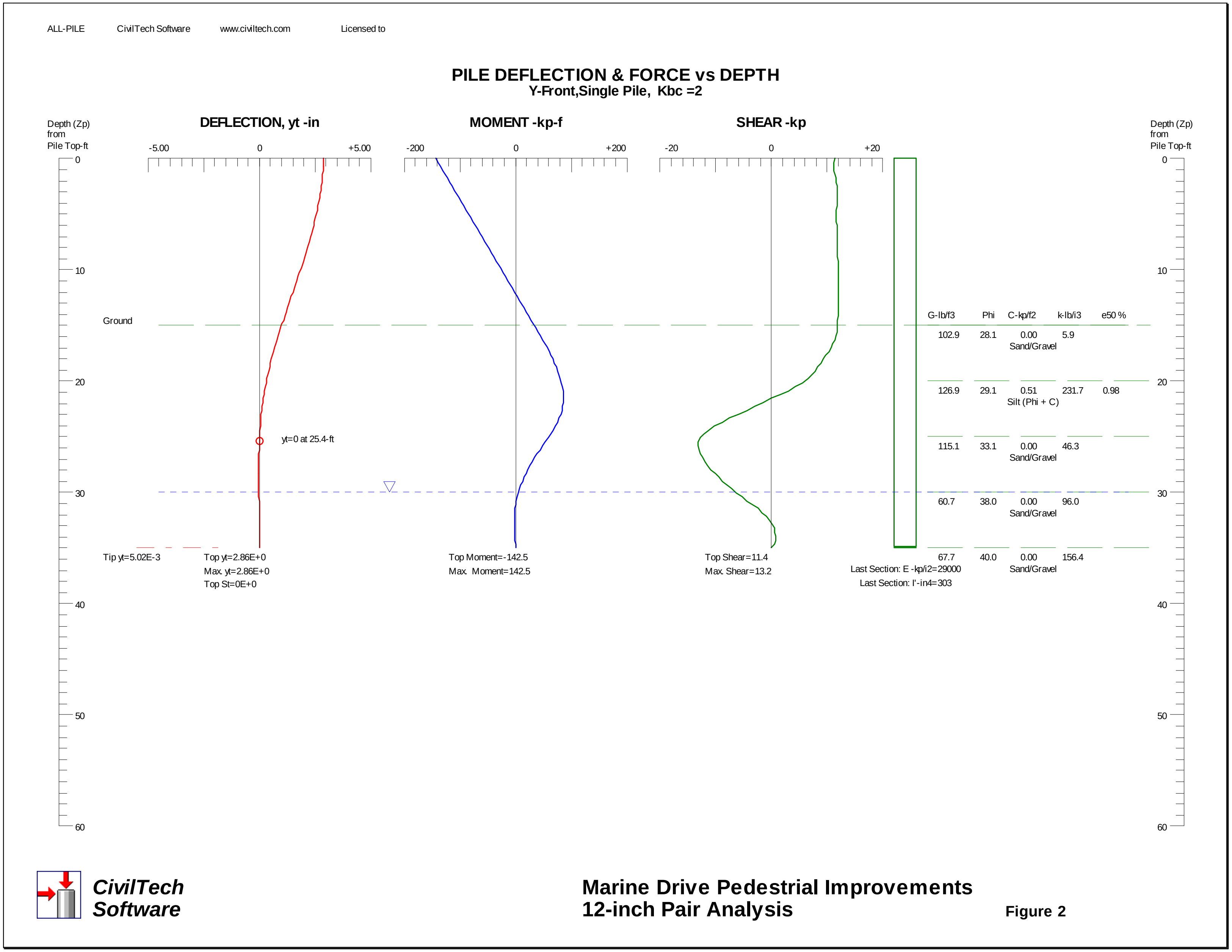


Lateral Deflection versus Loading - Load Factor = 1.0

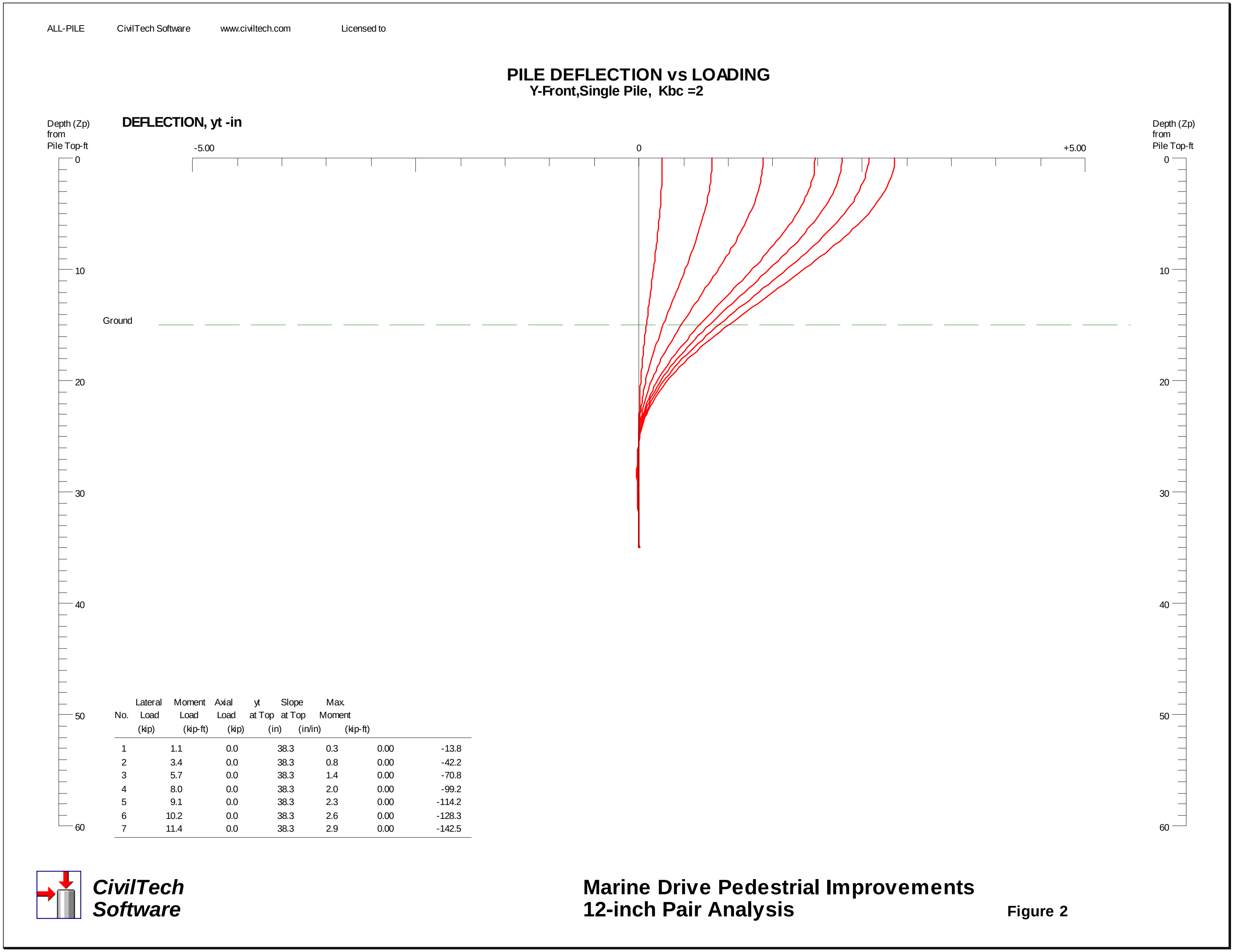


No.	Lateral Load (kip)	Moment Load (kip-ft)	Axial Load (kip)	yt at Top (in)	Slope at Top (in/in)	Max. Moment (kip-ft)
1	0.8	0.0	34.8	0.2	0.00	-9.2
2	2.3	0.0	34.8	0.5	0.00	-27.9
3	3.8	0.0	34.8	0.9	0.00	-46.8
4	5.3	0.0	34.8	1.3	0.00	-65.8
5	6.1	0.0	34.8	1.5	0.00	-75.3
6	6.8	0.0	34.8	1.7	0.00	-85.0
7	7.6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

Lateral Analysis Results - Load Factor = 1.5



Lateral Deflection versus Loading - Load Factor = 1.5



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