Appendix 4.17-A

Hockomock Swamp Stormwater Report

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Stormwater Report

Hockomock Swamp Trestle

Easton and Raynham,
Massachusetts

Prepared for

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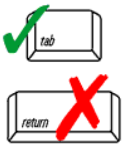
Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

☐ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☒ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☒ Use of "country drainage" versus curb and gutter conveyance and pipe

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Infiltration trenches

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

- ☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- ☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- ☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

- ☐ Soil Analysis provided.
- ☒ Required Recharge Volume calculation provided.
- ☐ Required Recharge volume reduced through use of the LID site Design Credits.
- ☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

  ☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

- ☒ Runoff from all impervious areas at the site discharging to the infiltration BMP.
- ☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- ☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- ☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
  - ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
  - ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
  - ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
  - ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- ☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- ☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☐ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

  ☐ is within the Zone II or Interim Wellhead Protection Area

  ☒ is near or to other critical areas

  ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

  ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½” or 1” Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☒ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☒ Critical areas and BMPs are identified in the Stormwater Report.

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☐ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☐ Name of the stormwater management system owners;
- ☐ Party responsible for operation and maintenance;
- ☐ Schedule for implementation of routine and non-routine maintenance tasks;
- ☐ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☐ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner’s association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and Water Quality Certification Regulations (314 CMR 9.00).

Project Description

MassDOT is proposing to construct an 8,500-foot long railroad trestle along the out-of-service portion of the Stoughton Line between Foundry Street in Easton, Massachusetts and the Raynham Park grade crossing in Raynham, Massachusetts (the Project). The trestle would be constructed in order to restore commuter rail service through this corridor while avoiding and minimizing wetland impacts in the Hockomock Swamp. The Project will involve driving piles at 50-foot intervals along the Project corridor, installing pile caps, decking, and ballasted trestle superstructure elements on top of the piles, and constructing retaining walls and embankments on either end of the trestle to return the track to grade. In order to provide stormwater management for runoff from the trestle, infiltration trenches will be constructed beneath the proposed trestle.

The project is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) as defined in 310 CMR 10.04 and 314 CMR 9.02.

Site Description

The Project site is part of an existing railroad right-of-way located between Foundry Street in Easton and the Raynham Park grade crossing in Raynham (Figures 1 and 2). Tracks and ties were removed from this segment in the 1960s and the embankment which remains through the corridor is utilized by pedestrians and all-terrain vehicles (ATVs).

The corridor is within the Hockomock Swamp Area of Critical Environmental Concern (ACEC) and is surrounded by wetland resources along most of its length. For additional information regarding the wetland resource areas present on the site see the Abbreviated Notices of Resource Area Delineation (ANRADs) for Easton and Raynham prepared by VHB dated May 2011.

The Project site consists of an earthen embankment (fill material and old railroad ballast) that rises approximately 2 to 3 feet above the adjacent wetlands. The embankment is topped by a gravel/dirt track kept relatively free from vegetation by off-road vehicles. According to the National Resources Conservation Service (NRCS), the dominant surface soil below the embankment (covering 80 percent of the area) is

Freetown muck, a soil classified as Hydrologic Soil Group (HSG) D. However, the geotechnical study of the Project corridor determined that the predominant soils within the embankment were loamy fine sands, which may be capable of higher infiltration rates. Based on the soil evaluation, the Project site is not considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour). The poorly drained soils onsite have a low potential for infiltration; According to 1982 Rawls Rates for sandy clay loam, infiltration rates for the soils will be approximately 0.17 inches per hour.

The Project corridor is located within the 100-year flood plain as shown on the FEMA Floodway Maps, Town of Easton, Massachusetts Bristol County, Community Panel Numbers 25005C00064F and 25005C0152F dated July 7, 2009. These maps are included in Appendix B.

Existing Drainage Conditions

The Project site consists of an earthen embankment that rises approximately 2 to 3 feet above the adjacent wetlands. The embankment is topped by a gravel/dirt track kept relatively free from vegetation by off-road vehicles. The sides and some sections of the top of the embankment are covered by brush and saplings. Although slight variations in cover type and soils may occur along the length of the trestle corridor, the contributing watersheds are nearly identical in terms of slope and area. Evaluating a typical or "unit" drainage area for the existing conditions analysis allows for direct comparison to be made between existing and proposed conditions. This unit drainage area would then be replicated along the length of the trestle corridor. For the existing conditions hydrologic analysis, the site was evaluated as a single design point representing runoff from a 300-foot segment of the embankment, or approximately 0.14 acres (6,000 square feet). This segment length was selected because it corresponds to a whole number of proposed spans. In addition, because the existing berm is narrow and level, the use of smaller drainage areas more closely models existing conditions.

Existing Unit Drainage Area – The existing unit drainage area of 0.14 acres was conservatively assumed to be covered with brush in fair condition, discounting the contribution from the gravel/dirt track. Under existing conditions, runoff from this area sheet flows, untreated, to the wetlands on either side of the embankment.

Figure 3 illustrates the existing drainage patterns within a typical unit drainage area. Table 1 provides a summary of the existing conditions hydrologic data.

Table 1
Existing Conditions Hydrologic Data

Drainage Area	*Discharge Location*	*Design Point*	*Area (acres)*	*Curve Number*	*Time of Concentration (min)*
EX	Adjacent Wetland	1	0.14	70	6

Proposed Drainage Conditions

The proposed trestle would be constructed on piles and would elevate the track above the existing embankment to avoid wetland impacts. Specifically, the use of a structure significantly reduces the amount of earthwork required to meet the design requirements for a safe high-speed train track while providing proper track support and ballast drainage. The structure will be designed with a minimum of 5 feet of vertical clearance to allow unimpeded movement of wildlife across the embankment. This open space beneath the structure will provide opportunities for the construction of decentralized stormwater management features that can treat runoff from the structure without impacting adjacent wetland resource areas.

Drainage for the trestle is proposed to be handled by evaluating a unit drainage area and repeating that drainage design along the length of the trestle. Minor local modifications to this treatment design may be required during final design. The following is a summary of the proposed unit drainage area and treatment design.

Proposed Unit Drainage Area – Under proposed conditions, drainage will be addressed by a unit design that treats stormwater from the 20-foot wide trestle in 300-foot segments (i.e., six 50-foot spans of trestle deck). The area of this unit design corresponds to the 6,000 square foot area previously evaluated under existing conditions. The unit design will consist of an underdrain collection system within the ballast of the trestle deck leading to downspouts. The downspouts will convey stormwater from the trestle deck and direct it to gravel-lined infiltration trenches beneath the deck. There will be one infiltration trench for each 300 feet of trestle, requiring a total of approximately 30 infiltration trenches along the length of the trestle. Each proposed infiltration trench will each be 16 feet wide by 33 feet long and will be 1 foot deep. The length of the trenches is constrained by the spacing of the pile bents and the 5-foot setback that is required from each pile bent.

Figure 4 illustrates the proposed "post construction" drainage conditions for the project. Table 2 provides a summary of the proposed conditions hydrologic data.

Table 2
Proposed Conditions Hydrologic Data

Drainage Area	*Discharge Location*	*Design Point*	*Area (acres)*	*Curve Number*	*Time of Concentration (min)*
PR	Adjacent Wetland	1	0.14	98	6

As shown on the typical plans and sections (see Figure 5, 6, and 7), the trestle will consist of a bed of ballast that supports the tracks and ties, with a concrete walkway on one side and a concrete apron on the other. The ballast is off set from the center line of the trestle in order to provide a safe zone along the walkway if workers are present when a train crosses the trestle. The narrower apron on the opposite side of the ballast is an integral part of the structural support for the ballast deck and provides support for a railing.

The surface of the trestle is assumed to be completely impervious because it will be a solid concrete structure. Any rainfall that lands on the ballast or on the exposed portions of the deck will drain through the ballast and be collected by an underdrain prior to discharge. The underdrain will run the length of the trestle and will be connected to downspouts located at intervals along the length of the trestle. These downspouts will be piped to the infiltration trenches that will be located beneath the trestle between sets of pile bents.

The ballast which supports the track within the trestle will capture coarse particulates and drippings from the trains by adsorption onto the stone and minimizes the potential to contaminate stormwater. This ballast will be periodically replaced as part of regular operations and maintenance, and any accumulated materials will be removed at that time. Because train operations do not generate suspended solids and the trestle will not be sanded during winter operations, the trestle will effectively function as a roof and runoff from the trestle is not anticipated to contain suspended solids. Any solids present due to atmospheric deposition will be managed by the infiltration trenches.

The Project site has been designed with a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook.

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include:

- Minimal disturbance to exiting trees and vegetation;
- Infiltration practices; and
- Decentralized treatment and discharge locations.

Stormwater runoff from all impervious surfaces in proposed conditions will receive treatment for stormwater quality prior to discharge to the existing design points. Under existing conditions no such treatment is provided for stormwater runoff.

By using a series of small, decentralized stormwater management features, existing drainage patterns will be maintained to the maximum extent practicable. Low impact development stormwater management techniques have been incorporated into the design, including minimizing disturbance within environmentally sensitive areas and promoting infiltration. These practices will reduce peak runoff rates, maximize groundwater recharge and treat for water quality. In addition, wetland impacts are avoided that might occur if a centralized stormwater management facility was required.

Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the Project fully complies with the MassDEP Stormwater Management Standards at 310 CMR 10.05.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The BMPs included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges would result from the Project are presented through compliance with Standards 4 through 6.

The proposed outlets from the stormwater management system have been designed to not cause erosion or scour to wetlands or receiving waters. Because of the storage volume within the ballast and infiltration trenches, discharge rates from the trestle will be less than 1 cubic foot per second (cfs) up to the 100-year storm event. Overflow outlets have been designed with stone protection to dissipate flows that may be discharged during large storm events.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to fully comply with Standard 2.

The rainfall-runoff response of the Project site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, and 100-years. The results of the analysis, as summarized in Table 3 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Table 3
Unit Drainage Area Peak Discharge Rates (cfs*)

Design Point	*2-year*	*10-year*	*100-year*
Design Point 1: Adjacent Wetland			
Existing	0.12	0.28	0.56
Proposed	0.05	0.14	0.26

*cubic foot per second

Standard 3: Stormwater Recharge

The Project has been designed to fully comply with Standard 3.

In accordance with the Stormwater Handbook, the Required Recharge Volume for each Unit Drainage Area of the Project is 127 cubic feet. Recharge of stormwater has been provided through the use of infiltration basins which have been sized using the static method. Each infiltration trench will provide 254 cubic feet of recharge and has been designed to drain completely within 72 hours.

A Geotechnical Report that describes subsurface soil conditions is included in Appendix E.

Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.

Standard 4 specifies that "Stormwater Management Systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS)." As previously noted, rail operations generate negligible quantities of TSS. Because the trestle consists of ballast placed inside a solid structure, stormwater runoff must be managed differently than that from ballast placed directly on the ground; however the TSS loading would be similarly negligible.

Each infiltration trench has been designed to meet the 0.5-inch Water Quality Volume for its contributing drainage area. Because of the trestle's configuration and setting, it is not feasible to provide the full 1-inch Water Quality Volume and the 44 percent pretreatment required to receive credit for 80 percent TSS removal under the guidelines contained in the Stormwater Handbook. However, discharges from the trestle can be considered *de minimus* under the guidance provided in Volume 3, Chapter 1 of the Handbook. The Handbook specifies the following criteria for a *de minimus* determination:

- Physical sit conditions preclude installation of a TSS treatment practice.
- The discharge is less than or equal to 1 cfs for runoff associated with the 2-year 24-hour storm.
- 80 percent TSS removal is achieved on an average weighted basis from the site as a whole using the weighted average method.

- The stormwater outlets where additional controls are used to achieve more than 80 percent TSS removal must discharge to the same reach of the same wetland or waterbody as the outlets that achieve less than 80 percent TSS removal.
- Controls are placed at the outlet to prevent erosion or scour of the wetland/stream channel and bank.
- Standard 2 and Standard 3 must be achieved on a site-wide basis.
- Source control and pollution prevention measures that mitigate the impact of the untreated or partially treated discharges are identified in the Pollution Prevention Plan.
- The size of the drainage area contributing runoff to the untreated outlet has been reduced to the maximum extent practicable.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The site is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL) as defined in 310 CMR 10.04 and 314 CMR 9.02.

Standard 6: Critical Areas

The Project would discharge treated storm water to a critical area, the Hockomock Swamp Area of Critical Environmental Concern, via overland flow during large storm events. As described above under Standard 4, physical site conditions preclude installation of treatment practices of sufficient size to meet the 1-inch Water Quality Volume and perform 44 percent TSS removal prior to infiltration. However, the trestle meets the requirements of a *de minimus* determination and is not anticipated to negatively impact water quality within the Hockomock Swamp. Proposed source controls and pollution prevention measures will be identified in the Long-Term Pollution Prevention Plan that will be required as part of final design.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff near or to critical areas, see Appendix D.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is not a redevelopment.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project is required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) would be developed and a Notice of Intent for the CGP would be submitted by the contractor and owner at least 14 days before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls were discussed in the DEIS/DEIR. Appropriate controls will be prepared and implemented by the contractor and MassDOT (MBTA) during construction in accordance with the final design and NPDES SWPPP.

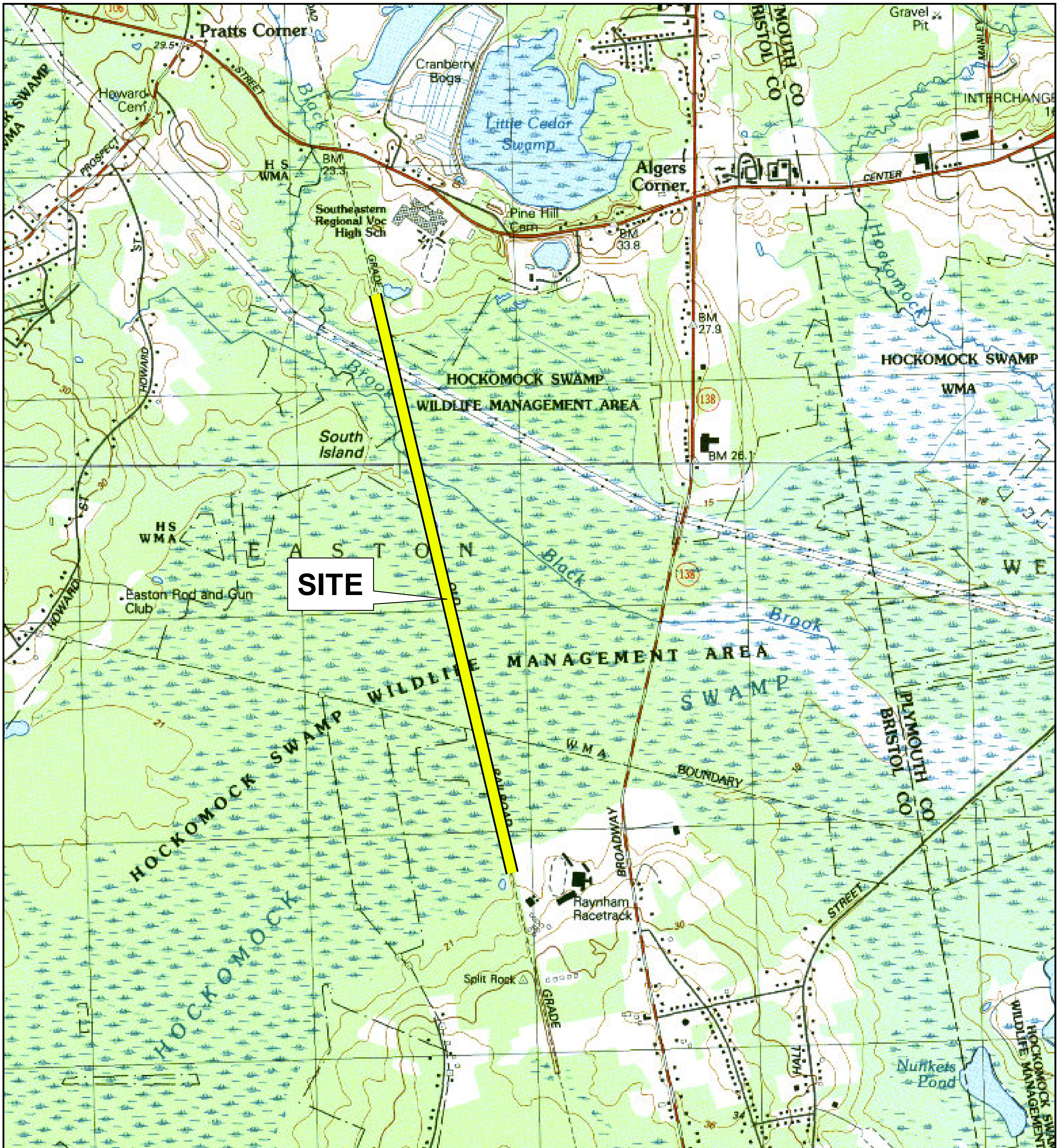
Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan will be developed by the MassDOT during final design for the Project.

Standard 10: Prohibition of Illicit Discharges

No sanitary sewer lines are known to exist in this area and no subsurface storm drainage structures or pipes are proposed to be constructed in this project area. The Long-Term Pollution Prevention Plan will include measures to prevent illicit discharges.

File Source: \\mabos\projects\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Trestle\Stormwater Figures\Figure 1



Source: USGS 2001

Vanasse Hangen Brustlin, Inc.

N

0 1,000 2,000 4,000 Feet

USGS Locus Map

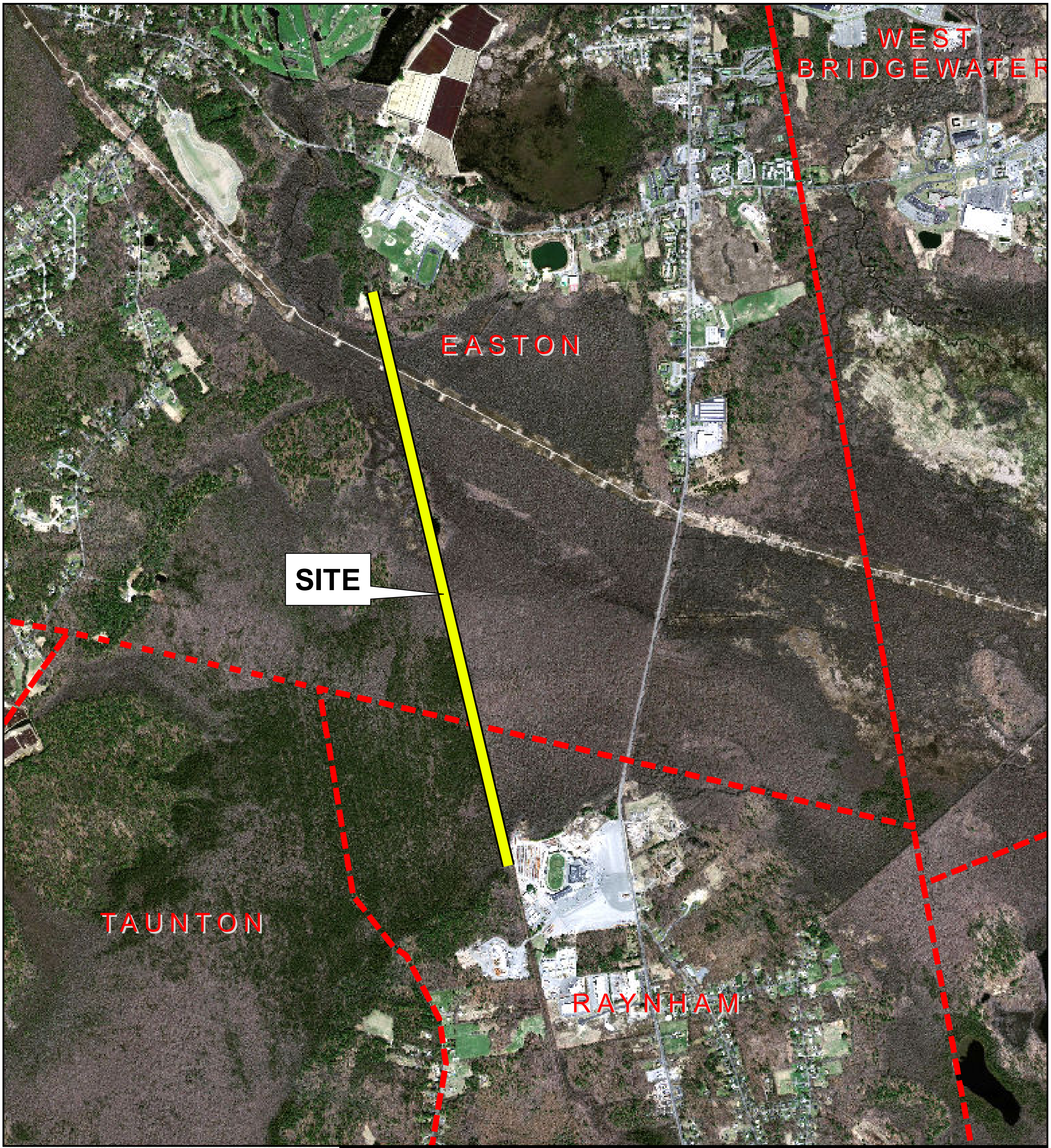
Hockomock Swamp Trestle
South Coast Rail
Easton and Raynham, Massachusetts

Figure 1

May 2012

Project Locations

File Source: \\mabos\projects\10111.00\tech\FINAL_EIS_EIR\Stormwater\Data\Trestle\Stormwater Figures\Figure 2



Source: MassGIS 2008

Vanasse Hangen Brustlin, Inc.

N

0 1,000 2,000 4,000 Feet

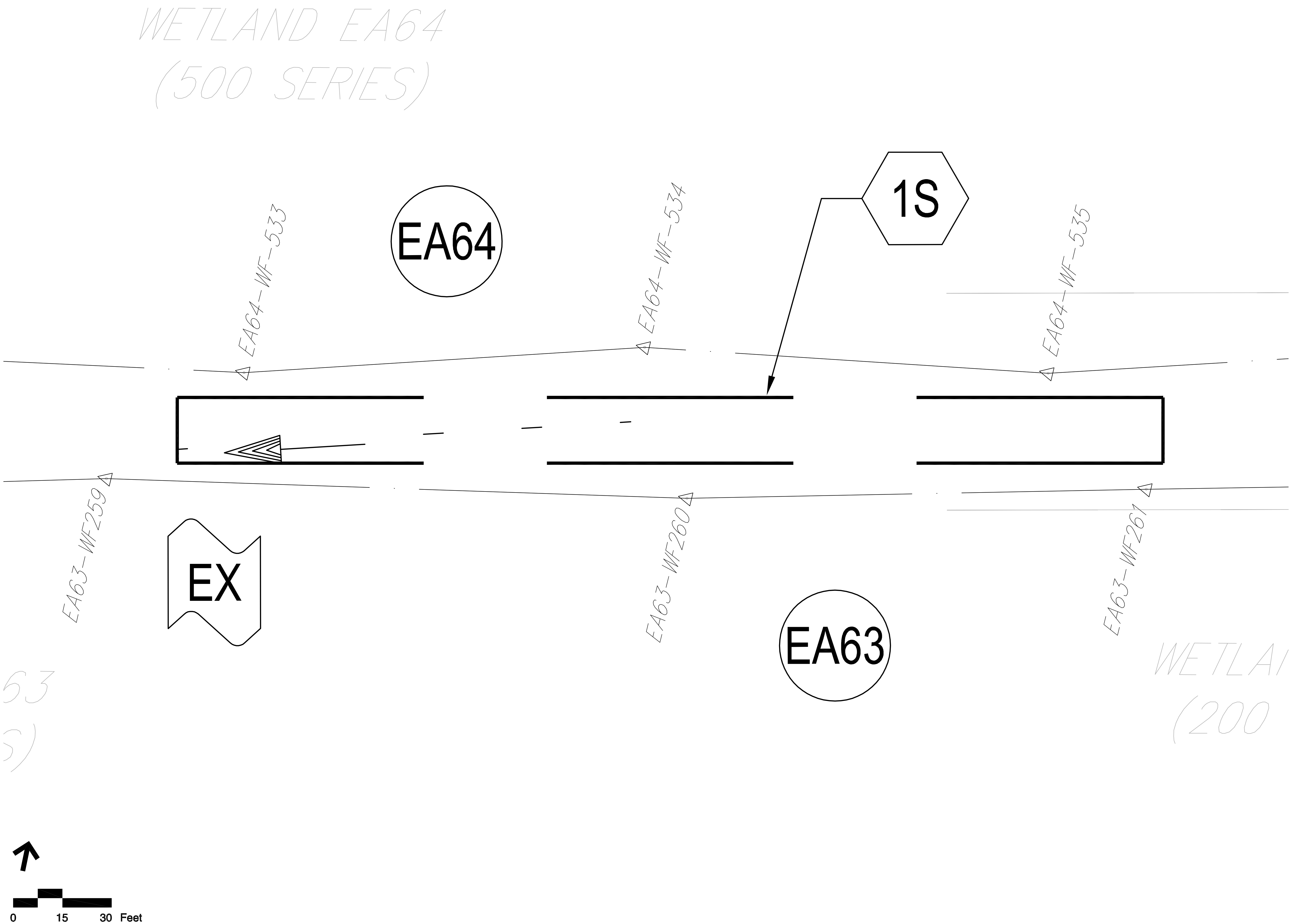
Aerial Map

Hockomock Swamp Trestle
South Coast Rail
Easton and Raynham, Massachusetts

Figure 2

May 2012

Project Locations



LEGEND

- SUBCATCHMENT DRAINAGE AREA DESIGNATION
- DESIGN POINT
- WETLAND RESOURCE AREA
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- SOIL TYPE BOUNDARY
- 100' BUFFER ZONE
- WETLAND BOUNDARY

NRCS SOIL CLASSIFICATIONS (HSG)

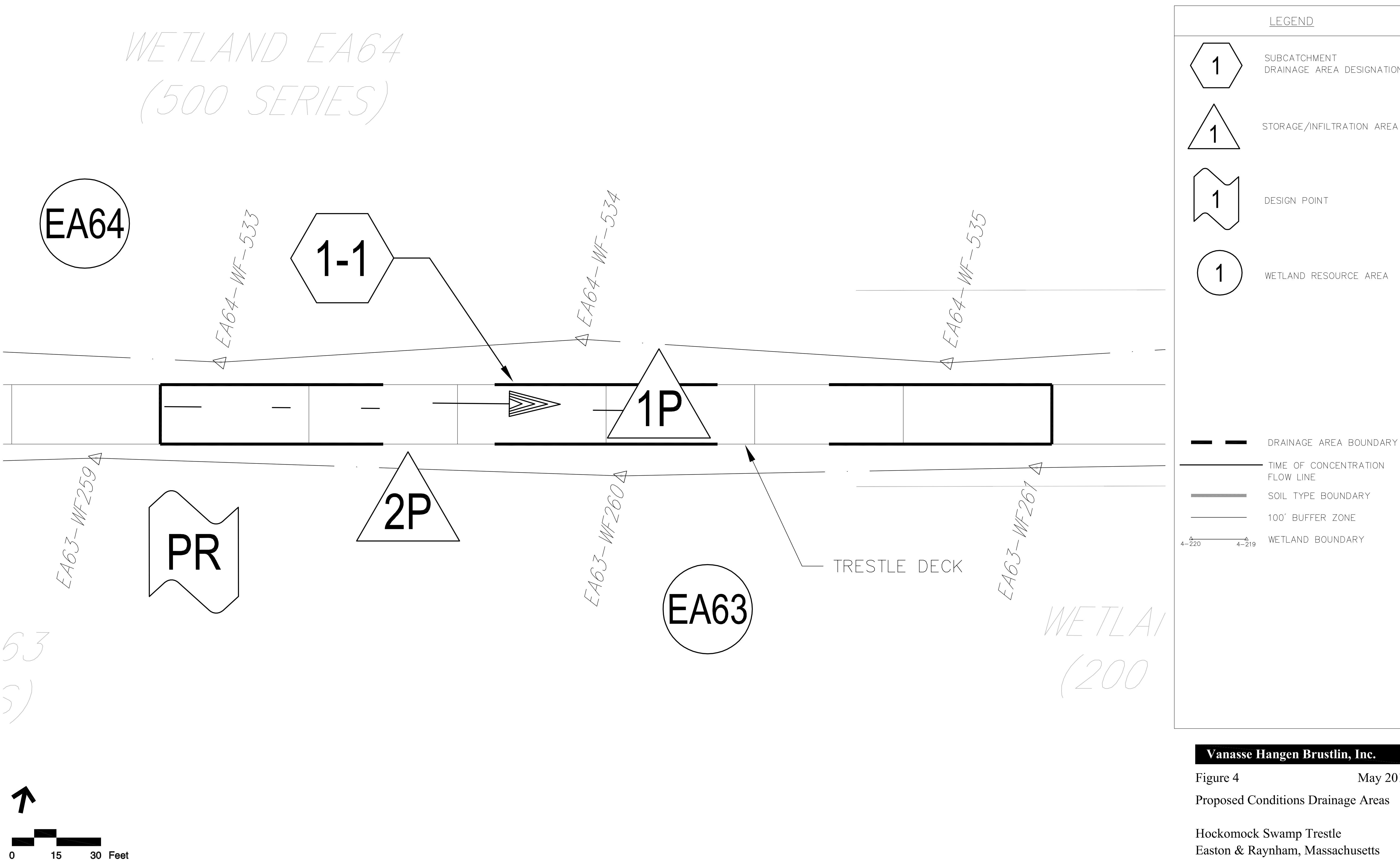
- 43A SCARBORO MUCKY SAND (D)
- 73A WHITMAN FINE SANDY LOAM (D)
- 306B PAXTON FINE SANDY LOAM (C)
- 602 URBAN LAND
- 705B CHARLTON–PAXTON FINE SANDY LOAM (B)

Vanasse Hangen Brustlin, Inc.

Figure 3 May 2012

Existing Conditions Drainage Areas

Hockomock Swamp Trestle
Easton & Raynham, Massachusetts

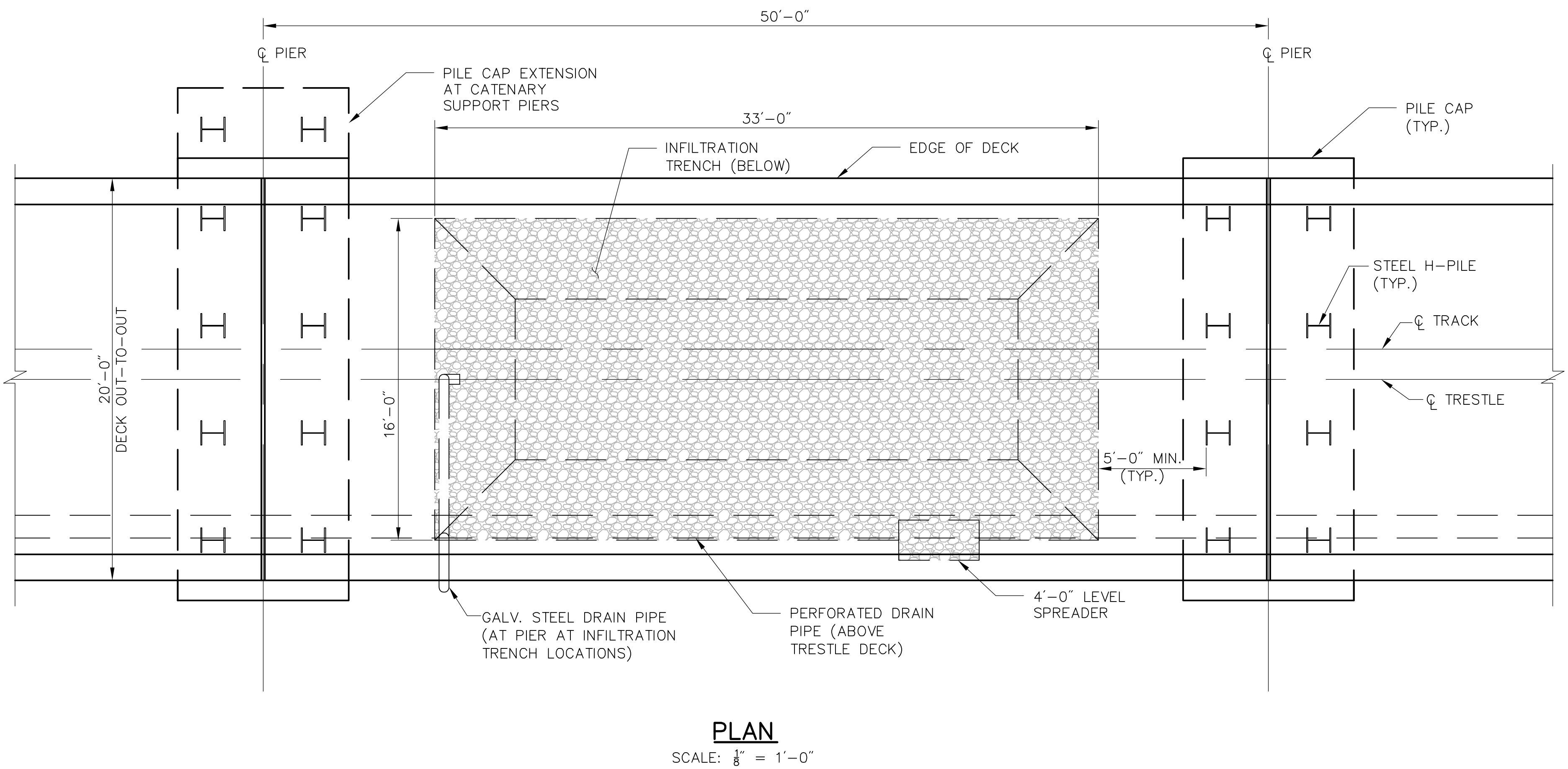


Vanasse Hangen Brustlin, Inc.

Figure 4 May 2012

Proposed Conditions Drainage Areas

Hockomock Swamp Trestle
Easton & Raynham, Massachusetts

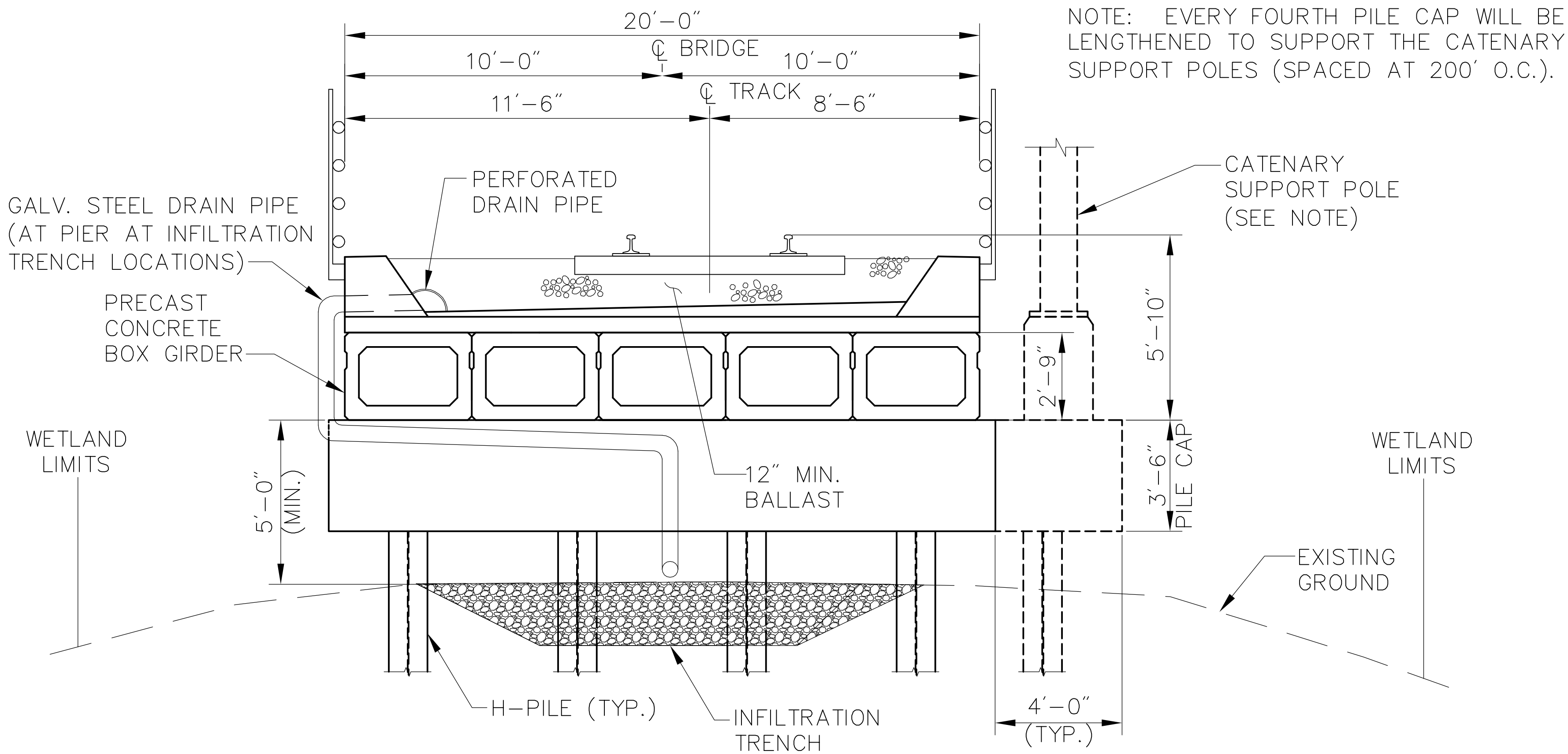


massDOT — Moving Massachusetts Forward.

SOUTH COAST RAIL

Figure 5
Trestle Through Hockomock Swamp
Typical Plan

Prepared by: VHB



TYPICAL CROSS SECTION AT PIER

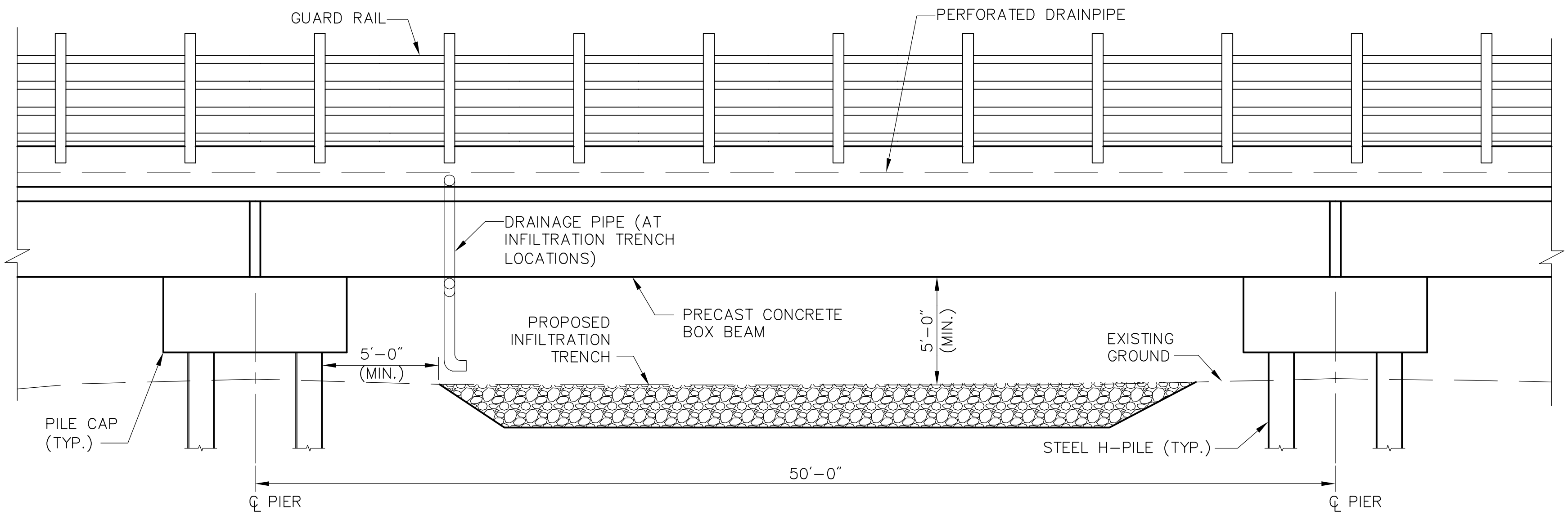
SCALE: 3/16″ = 1–0′

massDOT Moving Massachusetts Forward.

SOUTH COAST RAIL

Figure 6
Trestle Through Hockomock Swamp
Typical Section

Prepared by: VHB



ELEVATION

SCALE: 1/8" = 1'-0"

FIGURE 7
TRESTLE THROUGH HOCKOMOCK SWAMP

TYPICAL ELEVATION

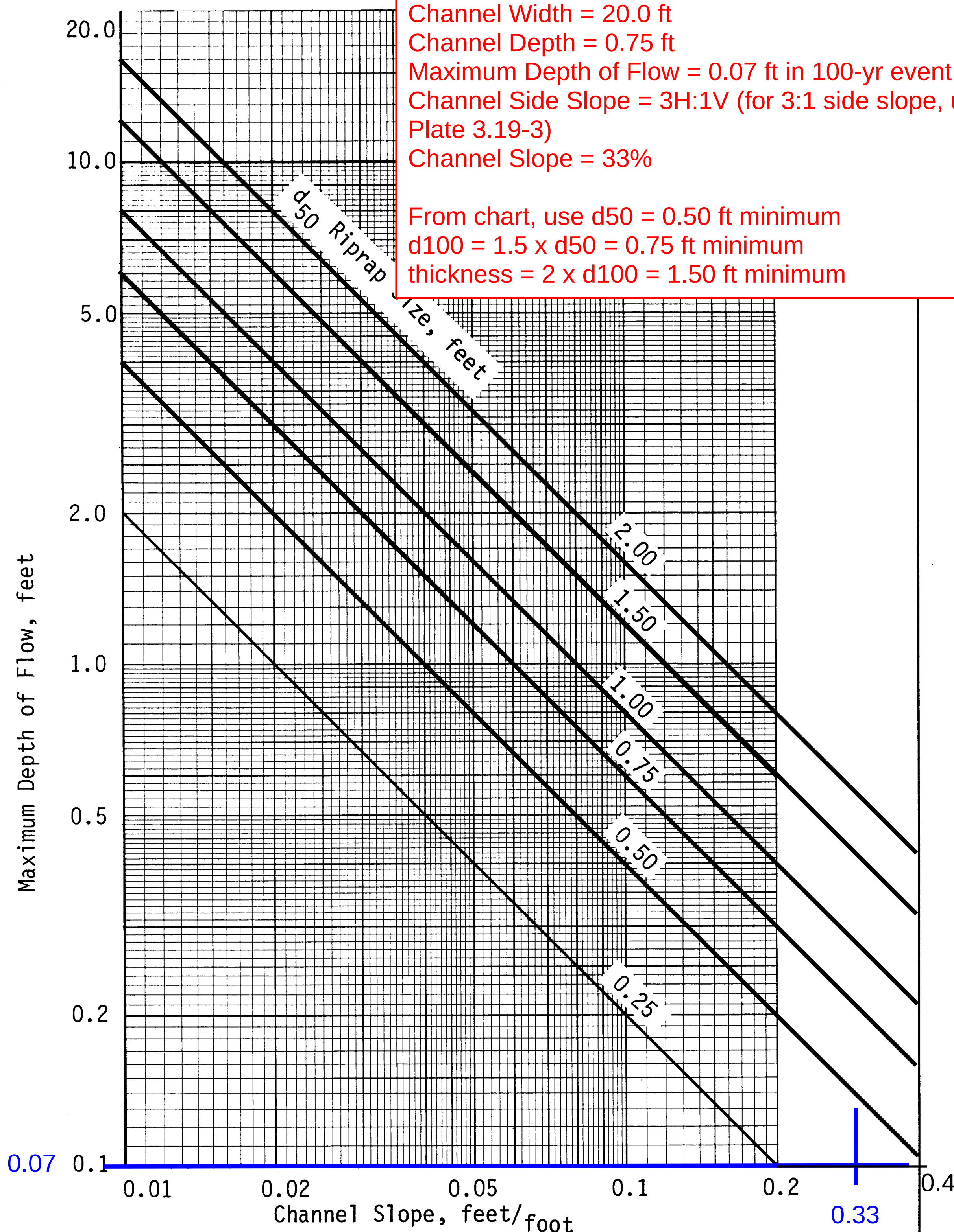
SOURCE
PREPAREDBY VHB

Appendix A
Standard 1 Computations and Supporting Information

Project No: 10111
Project Name: SCR
Date: June 2012
Location: Easton, MA
Calculated By: EJM
Re: Basin Overflow Stone Sizing

Channel Width = 20.0 ft
Channel Depth = 0.75 ft
Maximum Depth of Flow = 0.07 ft in 100-yr event
Channel Side Slope = 3H:1V (for 3:1 side slope, use Plate 3.19-3)
Channel Slope = 33%

From chart, use d50 = 0.50 ft minimum
d100 = 1.5 x d50 = 0.75 ft minimum
thickness = 2 x d100 = 1.50 ft minimum



MAXIMUM DEPTH OF FLOW FOR RIPRAP LINED CHANNELS

Source: VDOT Drainage Manual

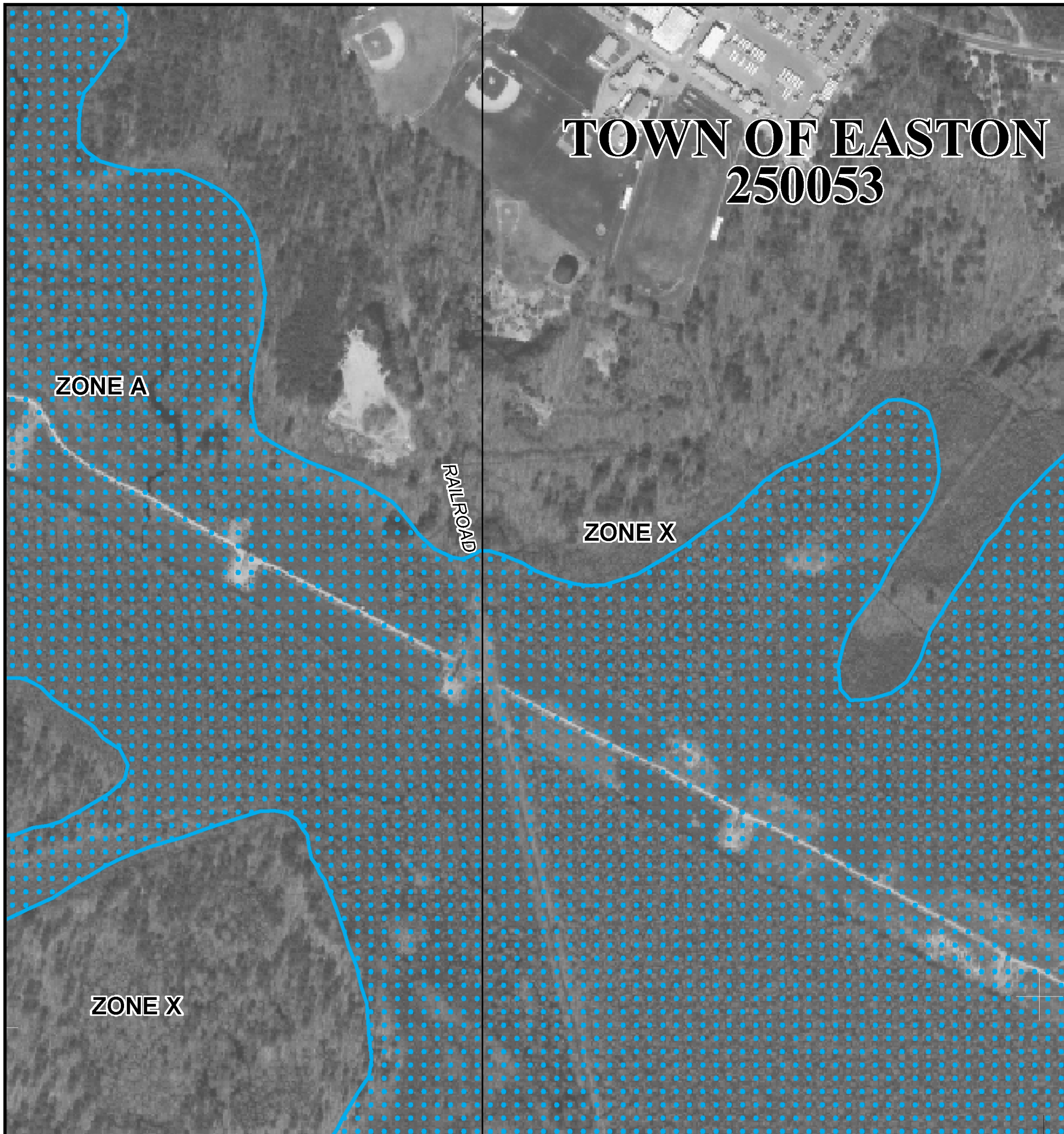
Plate 3.19-3

*Sizing calculations represent minimum stone size. Larger stone may be required per detail plans.

Appendix B
Standard 2 Computations and Supporting Information

Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Bristol County. Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

FEMA Flood Map



234524 M

JOINS PANEL 0152

MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0064F

FIRM

FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, MASSACHUSETTS

(ALL JURISDICTIONS)

PANEL 64 OF 550

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EASTON, TOWN OF	250053	0064	F

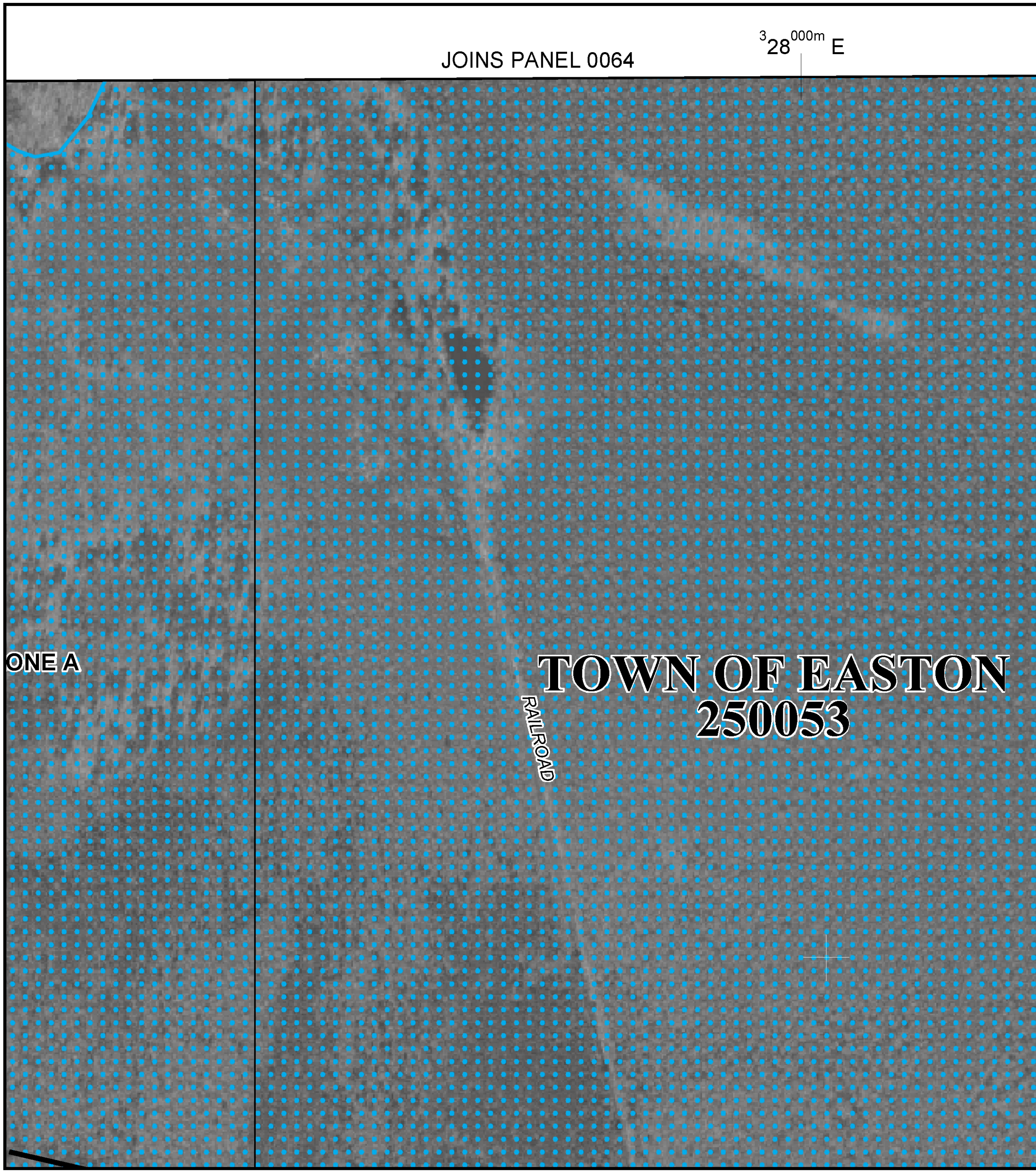
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25005C0064F

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

PANEL 0152F

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

FIRM
FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, MASSACHUSETTS
(ALL JURISDICTIONS)

PANEL 152 OF 550
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

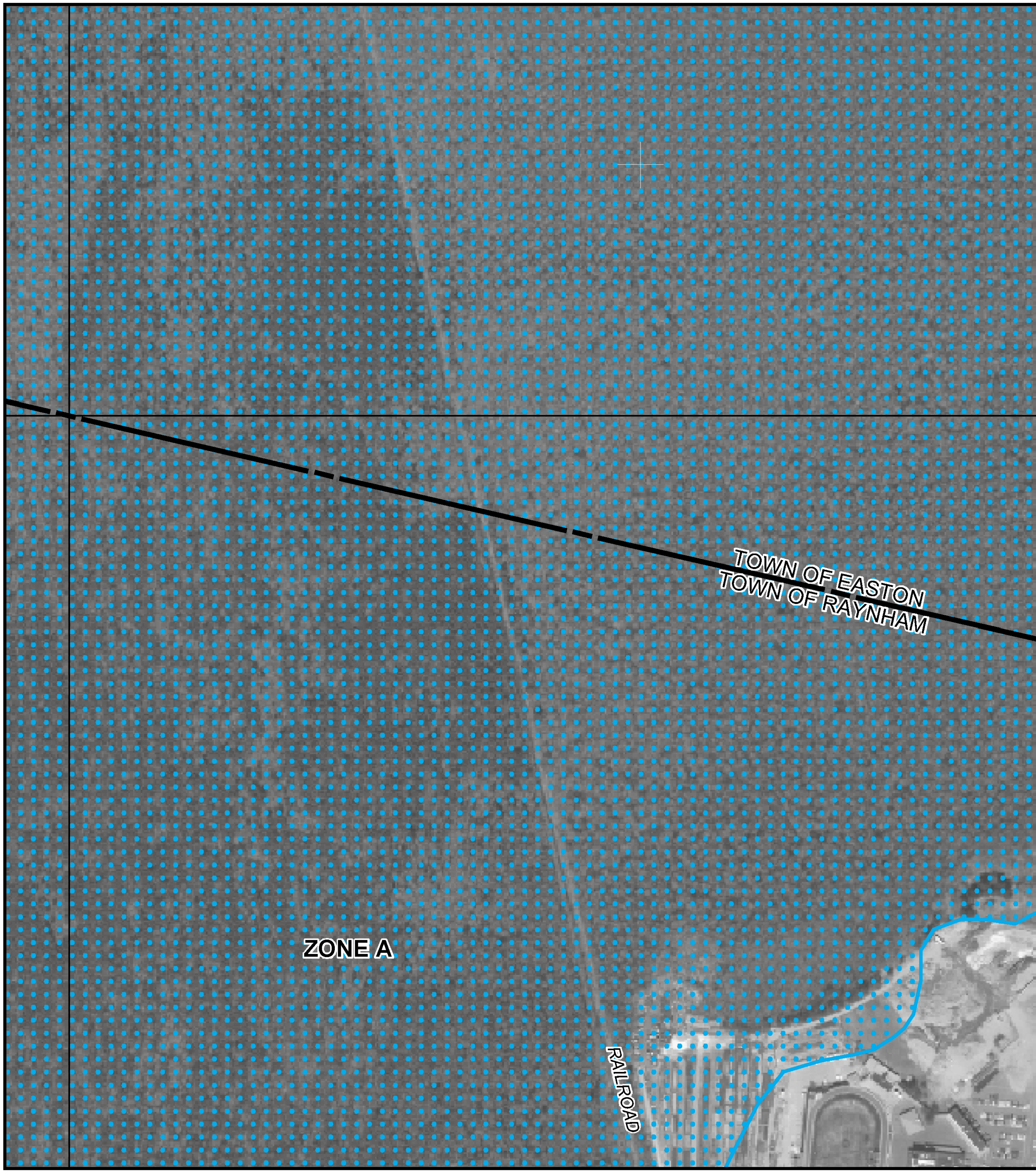
COMMUNITY	NUMBER	PANEL	SUFFIX
EASTON, TOWN OF	250053	0152	F
RAYNHAM, TOWN OF	250061	0152	F
TAUNTON, CITY OF	250066	0152	F

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

MAP NUMBER
25005C0152F

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

PANEL 0152F

FIRM
FLOOD INSURANCE RATE MAP

BRISTOL COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 152 OF 550

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EASTON, TOWN OF	250053	0152	F
RAYNHAM, TOWN OF	250061	0152	F
TAUNTON, CITY OF	250066	0152	F

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

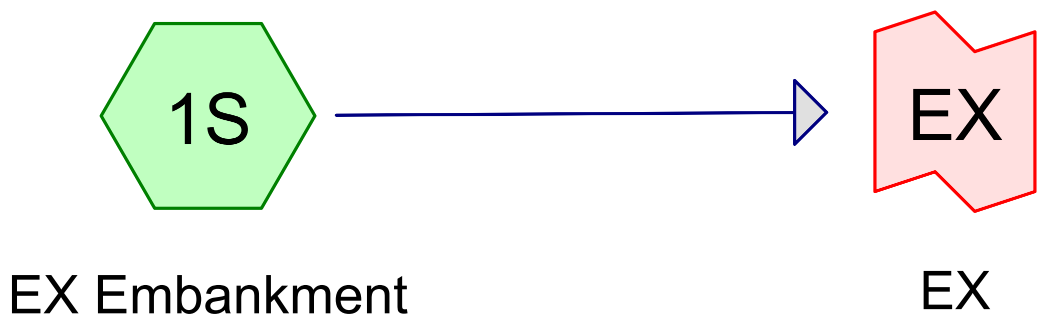
MAP NUMBER 25005C0152F

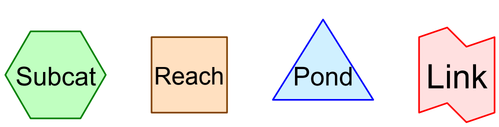
EFFECTIVE DATE JULY 7, 2009

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

HydroCAD Analysis: Existing Conditions





Routing Diagram for TrestleDrainage - 50 ft spans
Prepared by Vanasse Hangen Brustlin, Inc., Printed 6/15/2012

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.138	70	Brush, Fair, HSG C (1S)
0.138	**70**	**TOTAL AREA**

Time span=0.00-90.00 hrs, dt=0.01 hrs, 9001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: EX Embankment Runoff Area=6,000 sf 0.00% Impervious Runoff Depth=0.86"
Tc=6.0 min CN=70 Runoff=0.12 cfs 0.010 af

Link EX: EX Inflow=0.12 cfs 0.010 af
Primary=0.12 cfs 0.010 af

Total Runoff Area = 0.138 ac Runoff Volume = 0.010 af Average Runoff Depth = 0.86"
100.00% Pervious = 0.138 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: EX Embankment

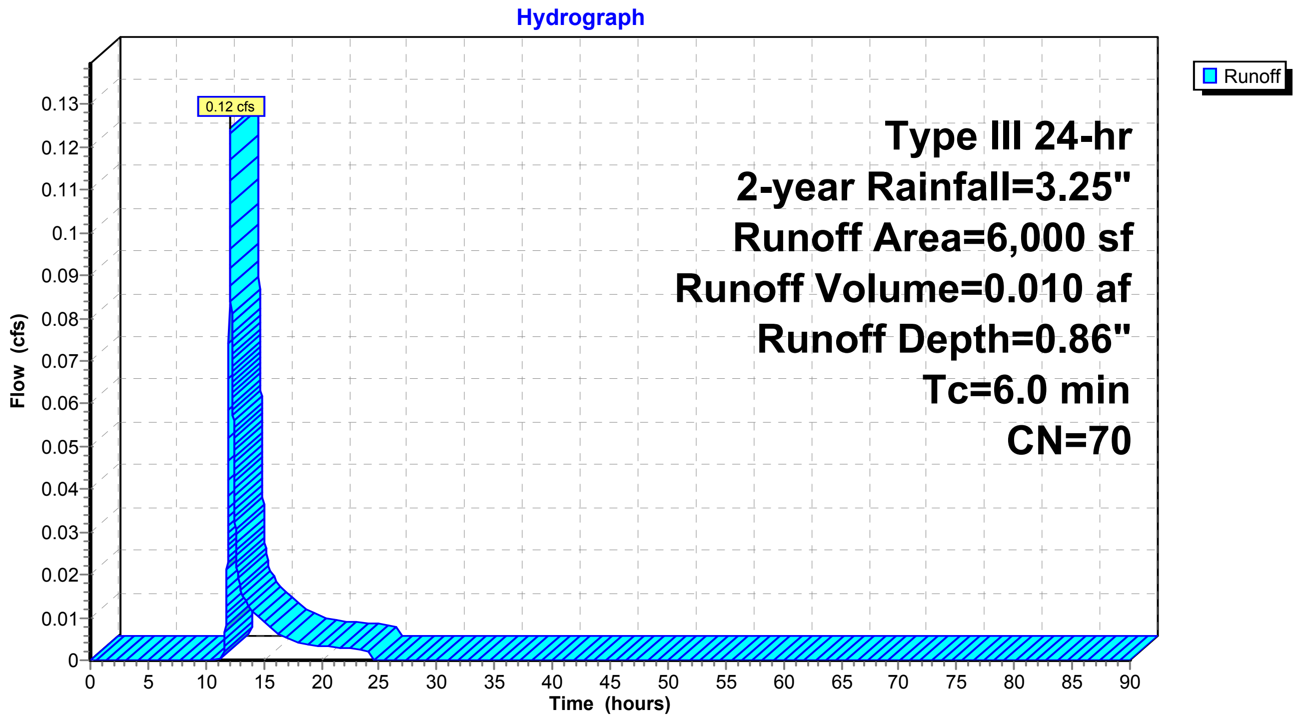
Runoff = 0.12 cfs @ 12.10 hrs, Volume= 0.010 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.25"

Area (sf)	CN	Description
6,000	70	Brush, Fair, HSG C
6,000		100.00% Pervious Area

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

Subcatchment 1S: EX Embankment

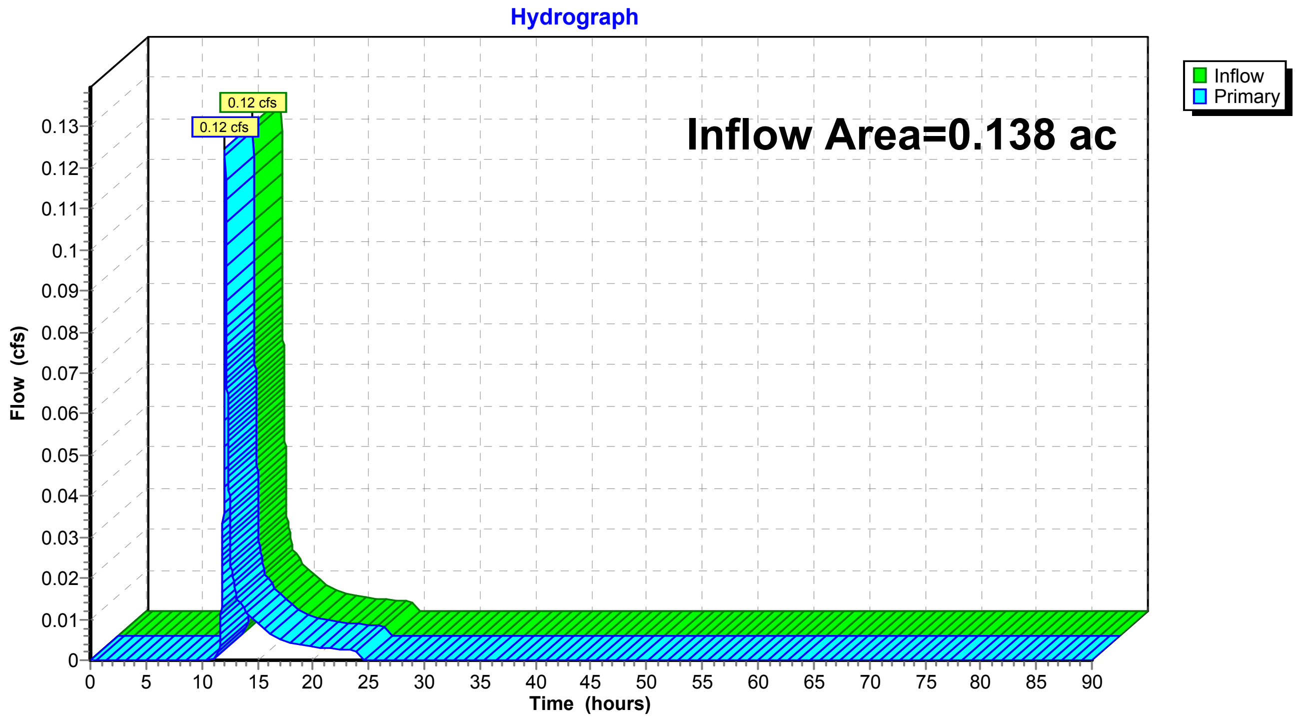


Summary for Link EX: EX

Inflow Area =	0.138 ac,	0.00% Impervious, Inflow Depth = 0.86"	for 2-year event	
Inflow =	0.12 cfs @	12.10 hrs, Volume=	0.010 af	
Primary =	0.12 cfs @	12.10 hrs, Volume=	0.010 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs

Link EX: EX



Time span=0.00-90.00 hrs, dt=0.01 hrs, 9001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: EX Embankment Runoff Area=6,000 sf 0.00% Impervious Runoff Depth=1.78"
Tc=6.0 min CN=70 Runoff=0.28 cfs 0.020 af

Link EX: EX Inflow=0.28 cfs 0.020 af
Primary=0.28 cfs 0.020 af

Total Runoff Area = 0.138 ac Runoff Volume = 0.020 af Average Runoff Depth = 1.78"
100.00% Pervious = 0.138 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: EX Embankment

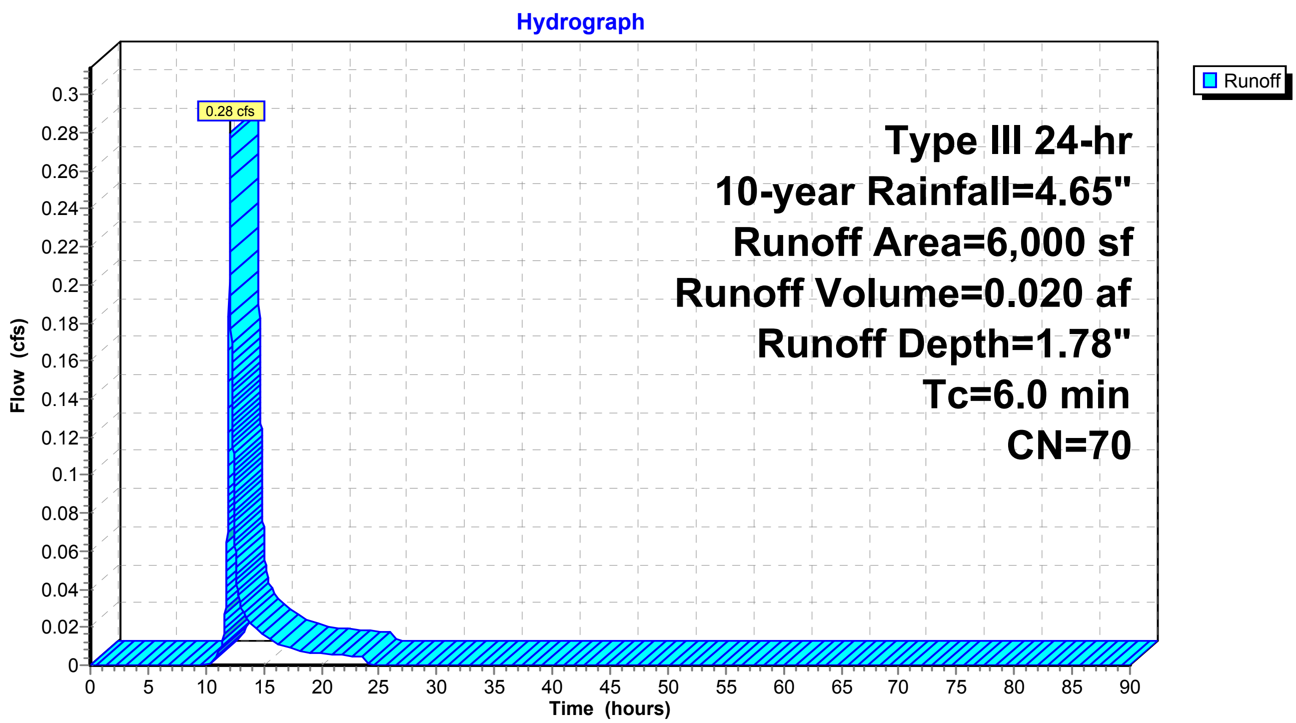
Runoff = 0.28 cfs @ 12.09 hrs, Volume= 0.020 af, Depth= 1.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.65"

Area (sf)	CN	Description
6,000	70	Brush, Fair, HSG C
6,000		100.00% Pervious Area

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

Subcatchment 1S: EX Embankment

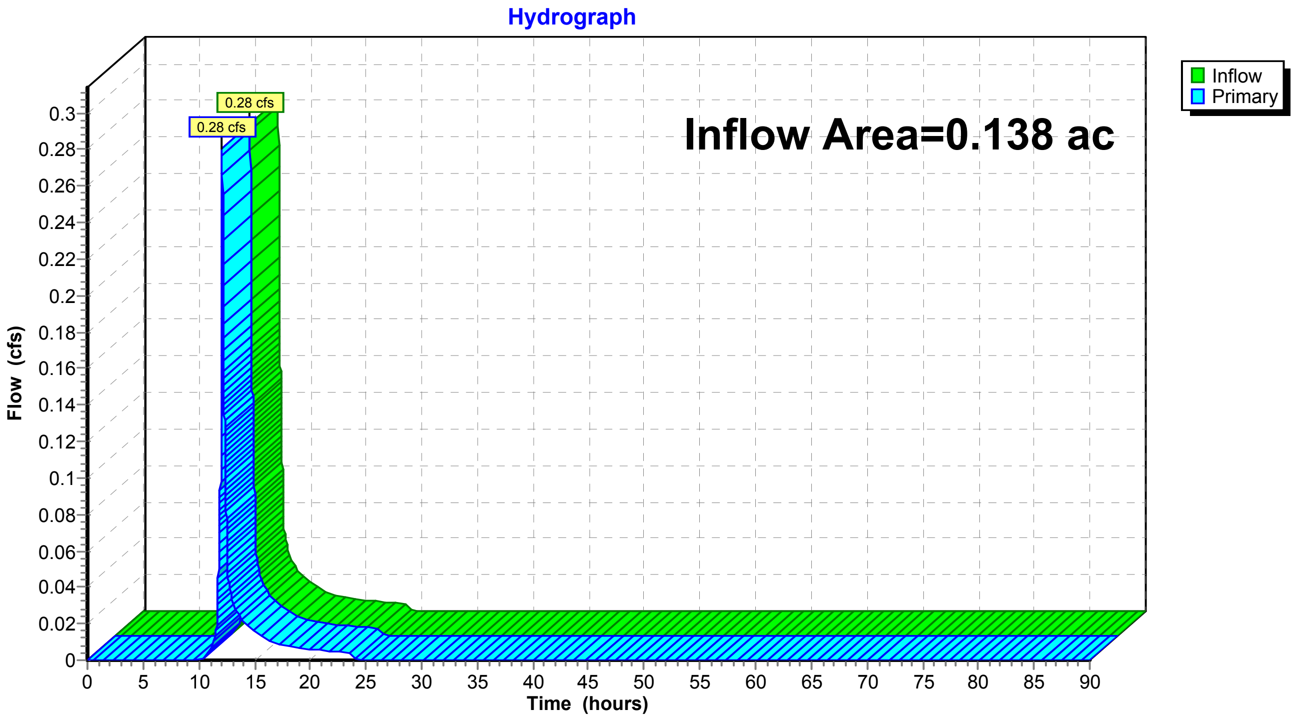


Summary for Link EX: EX

Inflow Area = 0.138 ac, 0.00% Impervious, Inflow Depth = 1.78" for 10-year event
Inflow = 0.28 cfs @ 12.09 hrs, Volume= 0.020 af
Primary = 0.28 cfs @ 12.09 hrs, Volume= 0.020 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs

Link EX: EX



Time span=0.00-90.00 hrs, dt=0.01 hrs, 9001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: EX Embankment Runoff Area=6,000 sf 0.00% Impervious Runoff Depth=3.45"
Tc=6.0 min CN=70 Runoff=0.56 cfs 0.040 af

Link EX: EX Inflow=0.56 cfs 0.040 af
Primary=0.56 cfs 0.040 af

Total Runoff Area = 0.138 ac Runoff Volume = 0.040 af Average Runoff Depth = 3.45"
100.00% Pervious = 0.138 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: EX Embankment

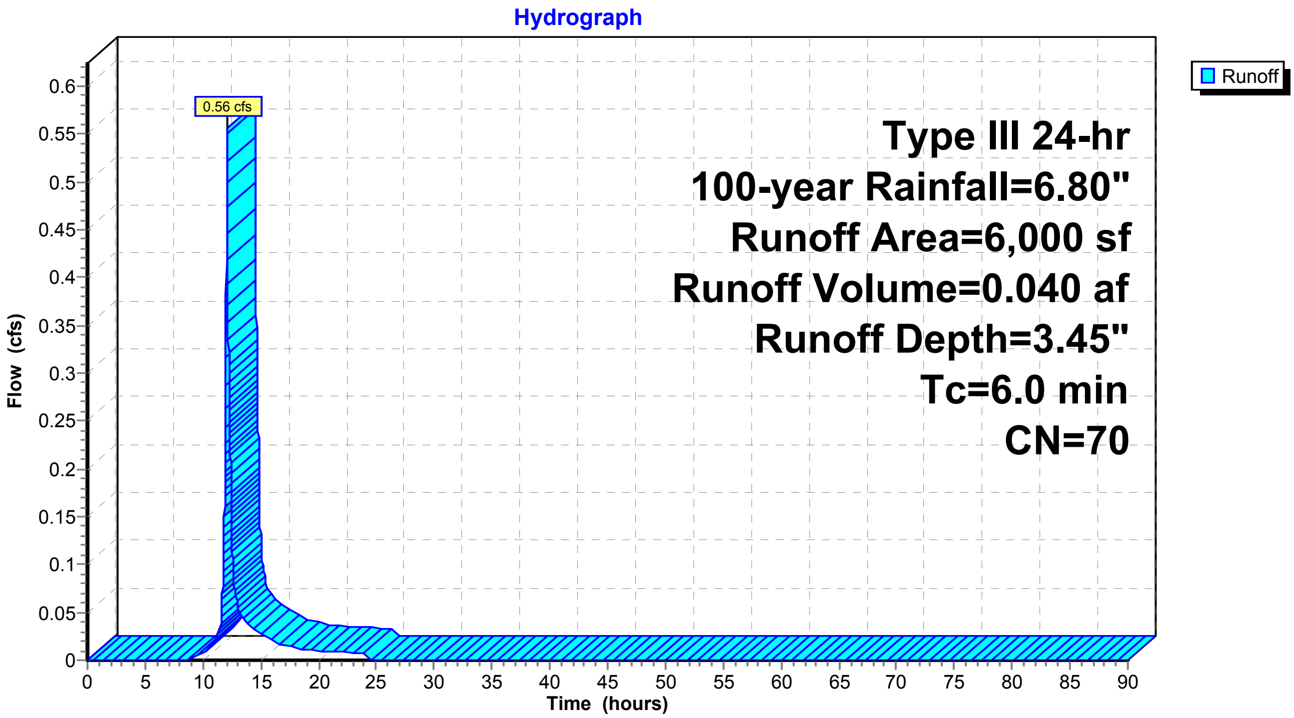
Runoff = 0.56 cfs @ 12.09 hrs, Volume= 0.040 af, Depth= 3.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
6,000	70	Brush, Fair, HSG C
6,000		100.00% Pervious Area

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

Subcatchment 1S: EX Embankment

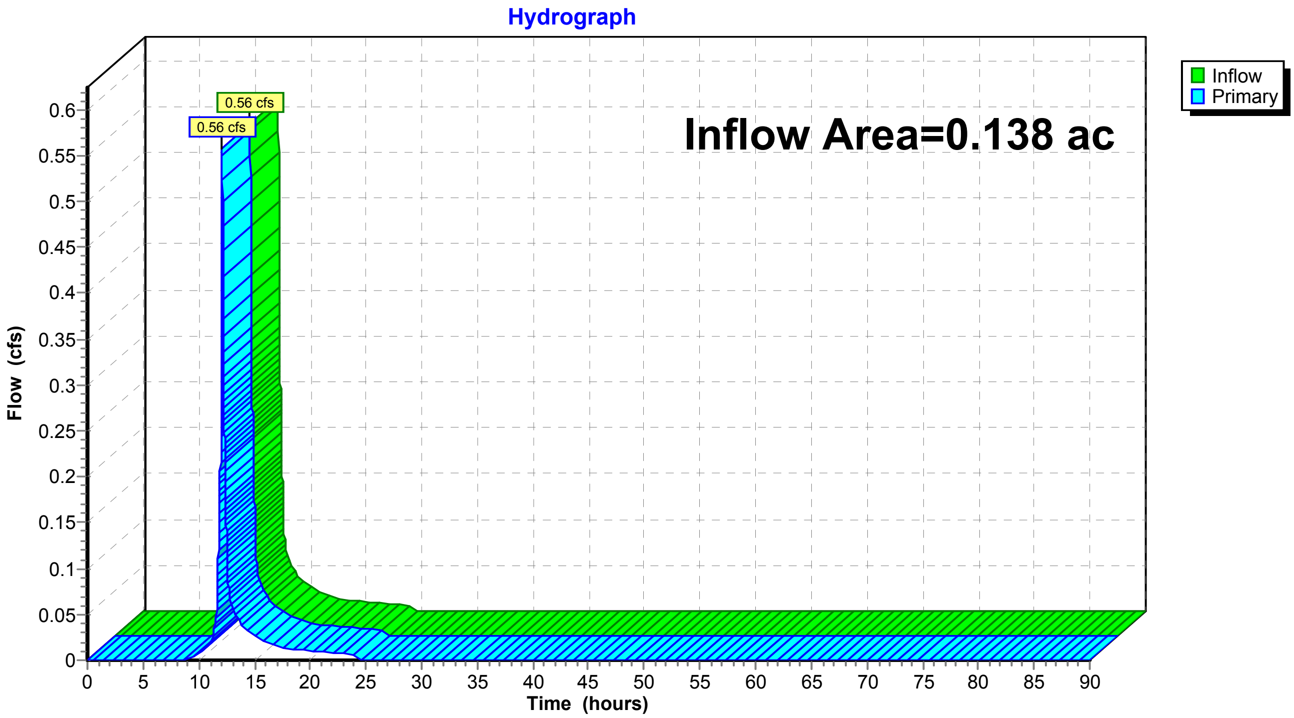


Summary for Link EX: EX

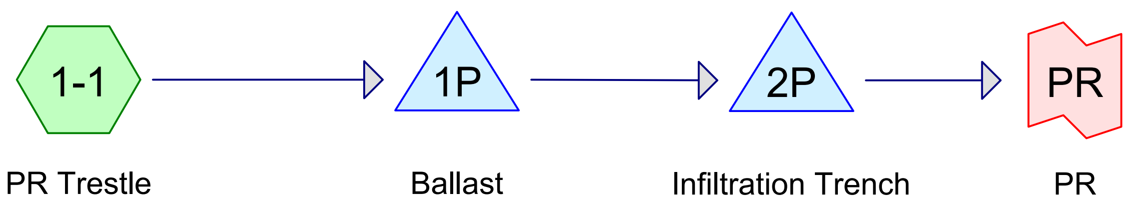
Inflow Area =	0.138 ac,	0.00% Impervious,	Inflow Depth = 3.45"	for 100-year event
Inflow =	0.56 cfs @	12.09 hrs,	Volume=	0.040 af
Primary =	0.56 cfs @	12.09 hrs,	Volume=	0.040 af, Atten= 0%, Lag= 0.0 min

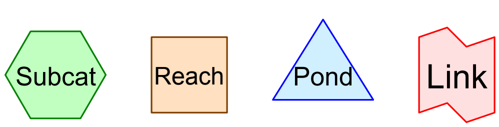
Primary outflow = Inflow, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs

Link EX: EX



HydroCAD Analysis: Proposed Conditions





Routing Diagram for TrestleDrainage - 50 ft spans
Prepared by Vanasse Hangen Brustlin, Inc., Printed 6/15/2012

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.138	98	Unconnected pavement, HSG C (1-1)
0.138	**98**	**TOTAL AREA**

Time span=0.00-90.00 hrs, dt=0.01 hrs, 9001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1-1: PR Trestle Runoff Area=6,000 sf 100.00% Impervious Runoff Depth=3.02"
Tc=6.0 min CN=98 Runoff=0.43 cfs 0.035 af

Pond 1P: Ballast Peak Elev=100.28' Storage=892 cf Inflow=0.43 cfs 0.035 af
6.0" Round Culvert n=0.010 L=10.0' S=0.3100 '/' Outflow=0.08 cfs 0.027 af

Pond 2P: Infiltration Trench Peak Elev=92.78' Storage=198 cf Inflow=0.08 cfs 0.027 af
Discarded=0.00 cfs 0.010 af Primary=0.07 cfs 0.018 af Outflow=0.07 cfs 0.027 af

Link PR: PR Inflow=0.07 cfs 0.018 af
Primary=0.07 cfs 0.018 af

Total Runoff Area = 0.138 ac Runoff Volume = 0.035 af Average Runoff Depth = 3.02"
0.00% Pervious = 0.000 ac 100.00% Impervious = 0.138 ac

Summary for Subcatchment 1-1: PR Trestle

Assumes that six spans (50 ft long x 20 ft wide) drain to a single discharge point.

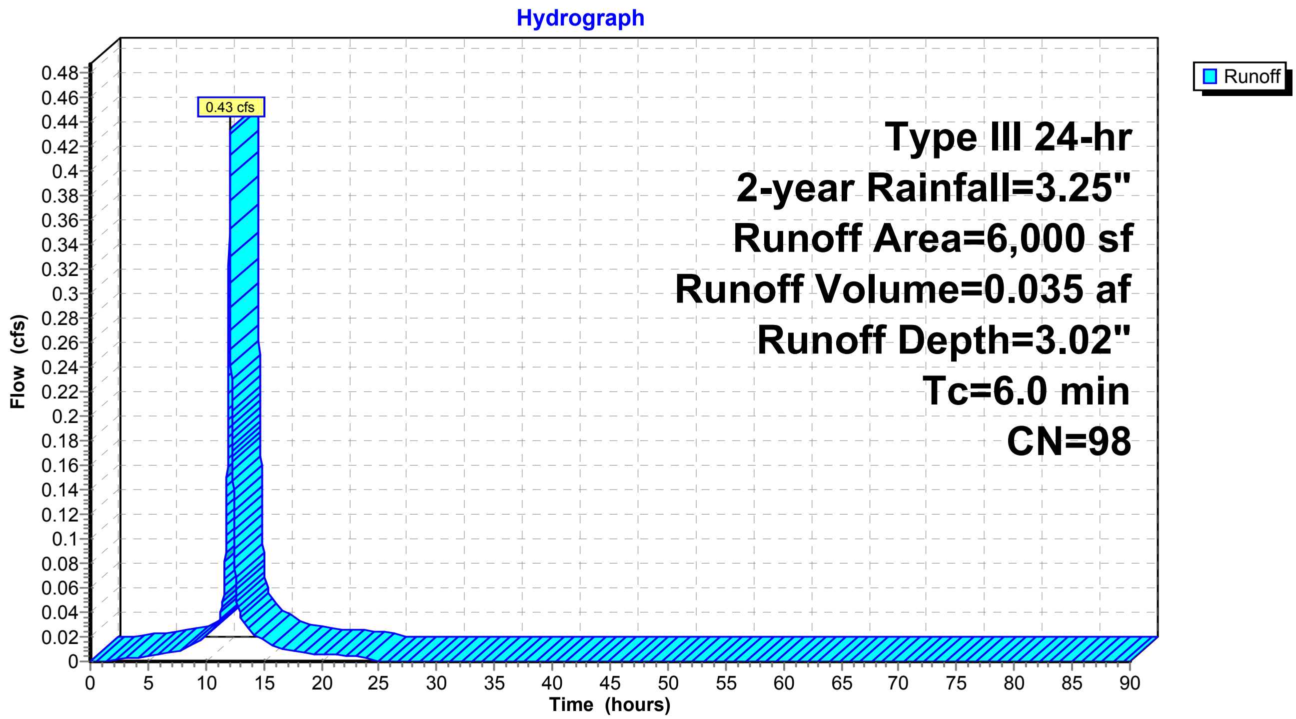
Runoff = 0.43 cfs @ 12.08 hrs, Volume= 0.035 af, Depth= 3.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.25"

Area (sf)	CN	Description
6,000	98	Unconnected pavement, HSG C
6,000		100.00% Impervious Area
6,000		100.00% Unconnected

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

Subcatchment 1-1: PR Trestle



Summary for Pond 1P: Ballast

Storage within the ballast on top of the trestle. Assumes that perforated pipe accepts all flow and that orifice to 6-inch downspout is only restriction.

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth = 3.02" for 2-year event
Inflow = 0.43 cfs @ 12.08 hrs, Volume= 0.035 af
Outflow = 0.08 cfs @ 12.54 hrs, Volume= 0.027 af, Atten= 83%, Lag= 27.1 min
Primary = 0.08 cfs @ 12.54 hrs, Volume= 0.027 af

Routing by Stor-Ind method, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Peak Elev= 100.28' @ 12.54 hrs Surf.Area= 3,320 sf Storage= 892 cf

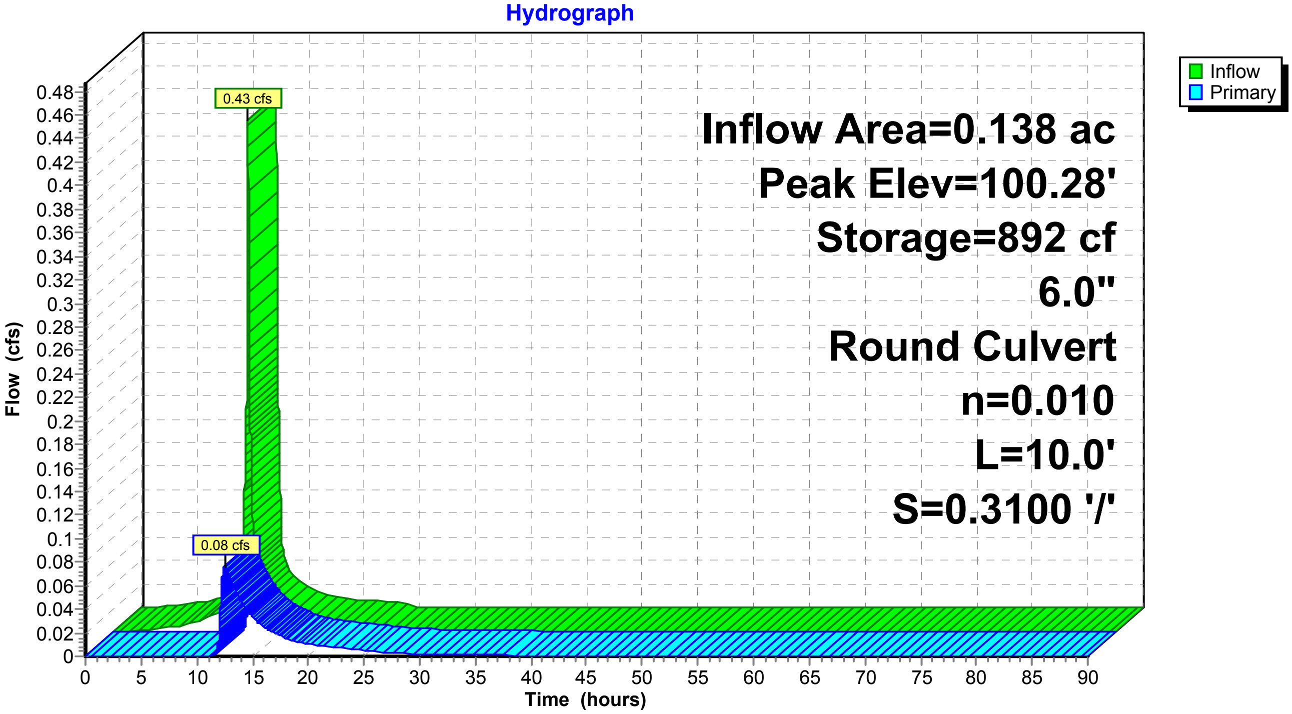
Plug-Flow detention time= 404.4 min calculated for 0.027 af (79% of inflow)
Center-of-Mass det. time= 326.6 min (1,082.7 - 756.1)

Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	3,391 cf	**10.30'W x 300.00'L x 1.00'H Prismatoid Z=1.3** 3,496 cf Overall - 105 cf Embedded = 3,391 cf
#2	100.10'	59 cf	**6.0" D x 300.0'L Pipe Storage** Inside #1 105 cf Overall - 1.0" Wall Thickness = 59 cf
		3,450 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	100.10'	**6.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 100.10' / 97.00' S= 0.3100 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.08 cfs @ 12.54 hrs HW=100.28' (Free Discharge)
└**1=Culvert** (Inlet Controls 0.08 cfs @ 1.15 fps)

Pond 1P: Ballast



Summary for Pond 2P: Infiltration Trench

Infiltration trench receives flow from six segments of trestle. Exfiltration assumed from floor of trench, overflows via level spreader from mid-size storms and from both sides of trench for flood events.

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth > 2.39" for 2-year event
Inflow = 0.08 cfs @ 12.54 hrs, Volume= 0.027 af
Outflow = 0.07 cfs @ 12.97 hrs, Volume= 0.027 af, Atten= 11%, Lag= 26.1 min
Discarded = 0.00 cfs @ 12.97 hrs, Volume= 0.010 af
Primary = 0.07 cfs @ 12.97 hrs, Volume= 0.018 af

Routing by Stor-Ind method, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 92.78' @ 12.97 hrs Surf.Area= 401 sf Storage= 198 cf

Plug-Flow detention time= 326.7 min calculated for 0.027 af (100% of inflow)
Center-of-Mass det. time= 326.4 min (1,409.1 - 1,082.7)

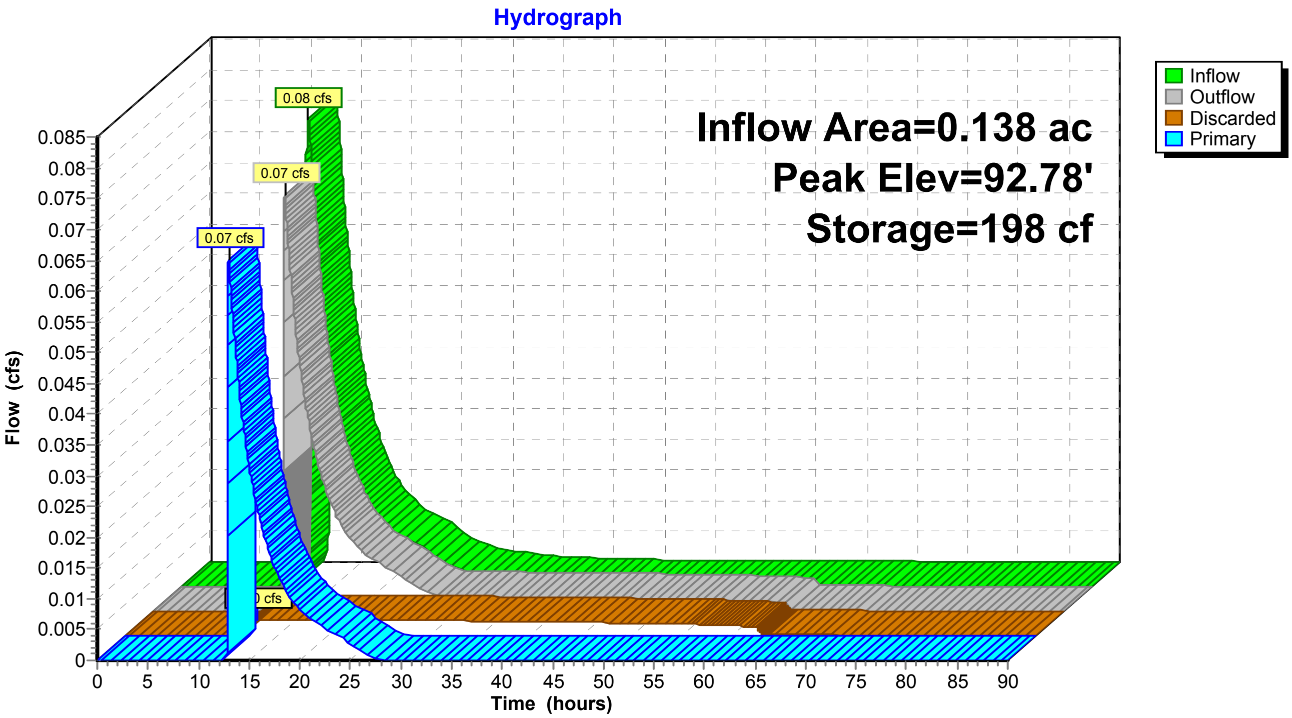
Volume	Invert	Avail.Storage	Storage Description
#1	91.75'	81 cf	**8.00'W x 29.00'L x 2.00'H Prismatoid Z=2.0**
			803 cf Overall - 533 cf Embedded = 270 cf x 30.0% Voids
#2	92.25'	533 cf	**8.00'W x 29.00'L x 1.50'H Prismatoid Z=2.0** Inside #1
		614 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	91.75'	**0.270 in/hr Exfiltration over Horizontal area**
#2	Primary	92.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	93.00'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir X 2.00**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
			2.50 3.00 3.50 4.00 4.50 5.00 5.50
			Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66
			2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.00 cfs @ 12.97 hrs HW=92.78' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.06 cfs @ 12.97 hrs HW=92.78' (Free Discharge)
├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.06 cfs @ 0.55 fps)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Infiltration Trench

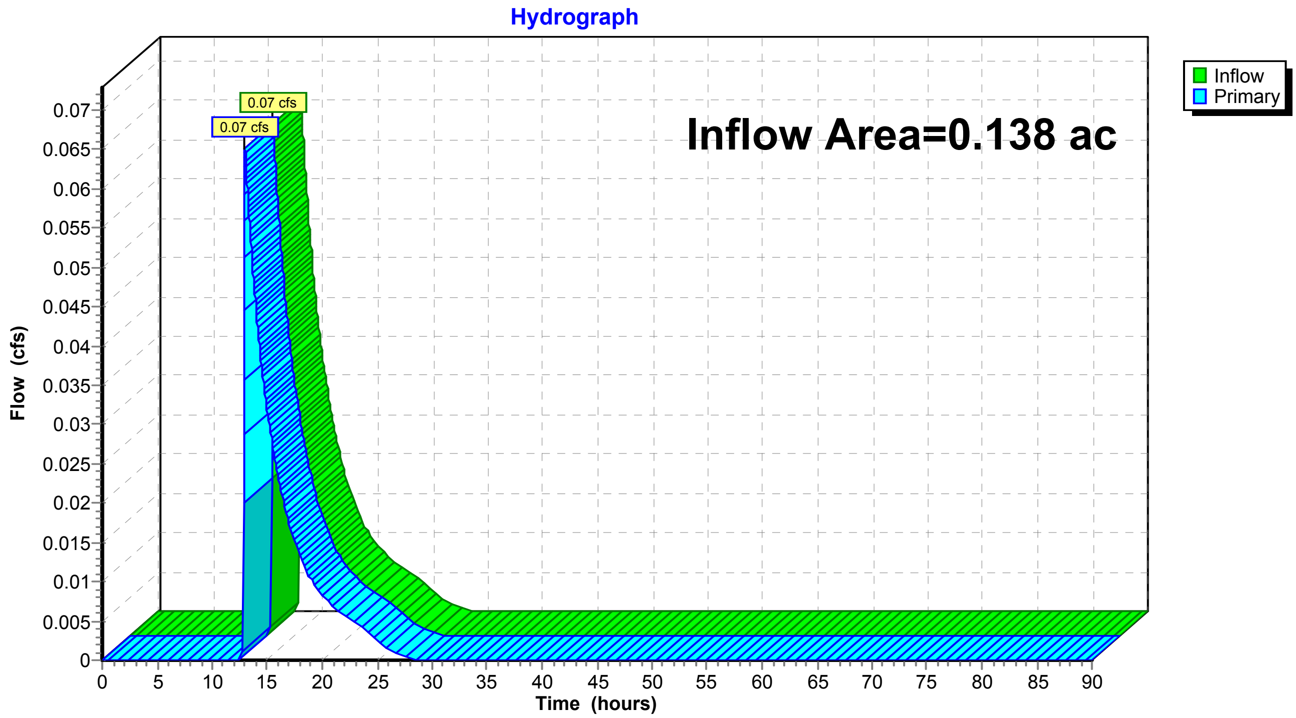


Summary for Link PR: PR

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth = 1.54" for 2-year event
Inflow = 0.07 cfs @ 12.97 hrs, Volume= 0.018 af
Primary = 0.07 cfs @ 12.97 hrs, Volume= 0.018 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs

Link PR: PR



Time span=0.00-90.00 hrs, dt=0.01 hrs, 9001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1-1: PR Trestle Runoff Area=6,000 sf 100.00% Impervious Runoff Depth=4.41"
Tc=6.0 min CN=98 Runoff=0.63 cfs 0.051 af

Pond 1P: Ballast Peak Elev=100.37' Storage=1,183 cf Inflow=0.63 cfs 0.051 af
6.0" Round Culvert n=0.010 L=10.0' S=0.3100 '/' Outflow=0.15 cfs 0.043 af

Pond 2P: Infiltration Trench Peak Elev=92.80' Storage=205 cf Inflow=0.15 cfs 0.043 af
Discarded=0.00 cfs 0.010 af Primary=0.15 cfs 0.033 af Outflow=0.15 cfs 0.043 af

Link PR: PR Inflow=0.15 cfs 0.033 af
Primary=0.15 cfs 0.033 af

Total Runoff Area = 0.138 ac Runoff Volume = 0.051 af Average Runoff Depth = 4.41"
0.00% Pervious = 0.000 ac 100.00% Impervious = 0.138 ac

Summary for Subcatchment 1-1: PR Trestle

Assumes that six spans (50 ft long x 20 ft wide) drain to a single discharge point.

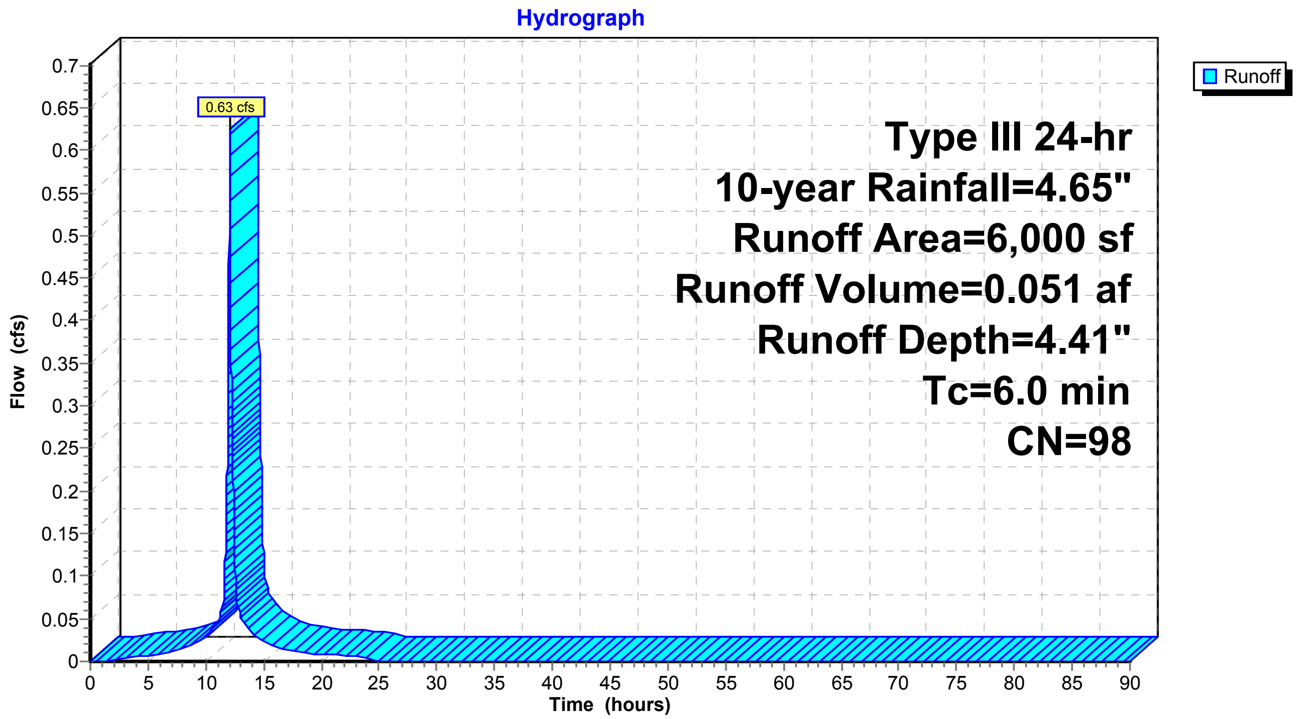
Runoff = 0.63 cfs @ 12.08 hrs, Volume= 0.051 af, Depth= 4.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.65"

Area (sf)	CN	Description
6,000	98	Unconnected pavement, HSG C
6,000		100.00% Impervious Area
6,000		100.00% Unconnected

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

Subcatchment 1-1: PR Trestle



Summary for Pond 1P: Ballast

Storage within the ballast on top of the trestle. Assumes that perforated pipe accepts all flow and that orifice to 6-inch downspout is only restriction.

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth = 4.41" for 10-year event
Inflow = 0.63 cfs @ 12.08 hrs, Volume= 0.051 af
Outflow = 0.15 cfs @ 12.46 hrs, Volume= 0.043 af, Atten= 75%, Lag= 22.4 min
Primary = 0.15 cfs @ 12.46 hrs, Volume= 0.043 af

Routing by Stor-Ind method, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Peak Elev= 100.37' @ 12.46 hrs Surf.Area= 3,391 sf Storage= 1,183 cf

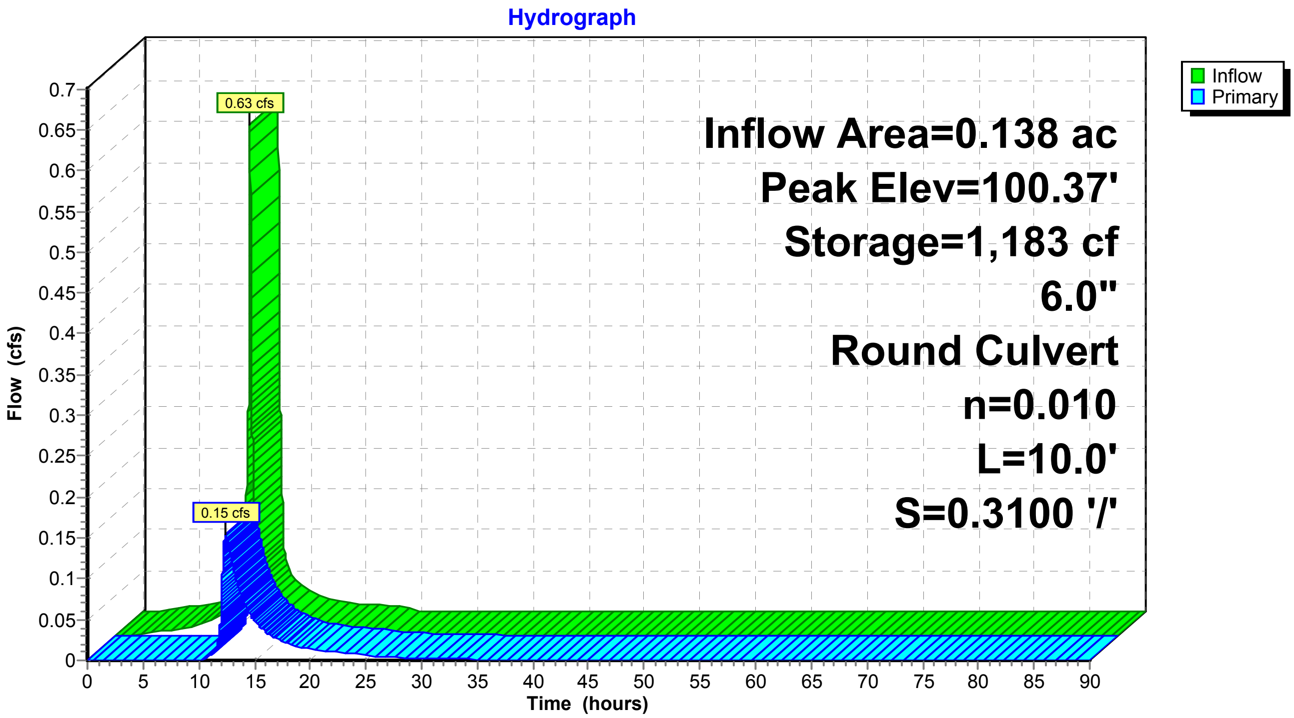
Plug-Flow detention time= 321.6 min calculated for 0.043 af (86% of inflow)
Center-of-Mass det. time= 258.9 min (1,008.2 - 749.2)

Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	3,391 cf	**10.30'W x 300.00'L x 1.00'H Prismatoid Z=1.3**
			3,496 cf Overall - 105 cf Embedded = 3,391 cf
#2	100.10'	59 cf	**6.0" D x 300.0'L Pipe Storage** Inside #1
			105 cf Overall - 1.0" Wall Thickness = 59 cf
		3,450 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	100.10'	**6.0" Round Culvert**
			L= 10.0' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 100.10' / 97.00' S= 0.3100 '/' Cc= 0.900
			n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.15 cfs @ 12.46 hrs HW=100.37' (Free Discharge)
└─**1=Culvert** (Inlet Controls 0.15 cfs @ 1.40 fps)

Pond 1P: Ballast



Summary for Pond 2P: Infiltration Trench

Infiltration trench receives flow from six segments of trestle. Exfiltration assumed from floor of trench, overflows via level spreader from mid-size storms and from both sides of trench for flood events.

Inflow Area =	0.138 ac,100.00% Impervious,	Inflow Depth > 3.78"	for 10-year event	
Inflow =	0.15 cfs @	12.46 hrs, Volume=	0.043 af	
Outflow =	0.15 cfs @	12.49 hrs, Volume=	0.043 af,	Atten= 0%, Lag= 1.9 min
Discarded =	0.00 cfs @	12.49 hrs, Volume=	0.010 af	
Primary =	0.15 cfs @	12.49 hrs, Volume=	0.033 af	

Routing by Stor-Ind method, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 92.80' @ 12.49 hrs Surf.Area= 405 sf Storage= 205 cf

Plug-Flow detention time= 215.2 min calculated for 0.043 af (100% of inflow)
Center-of-Mass det. time= 214.9 min (1,223.1 - 1,008.2)

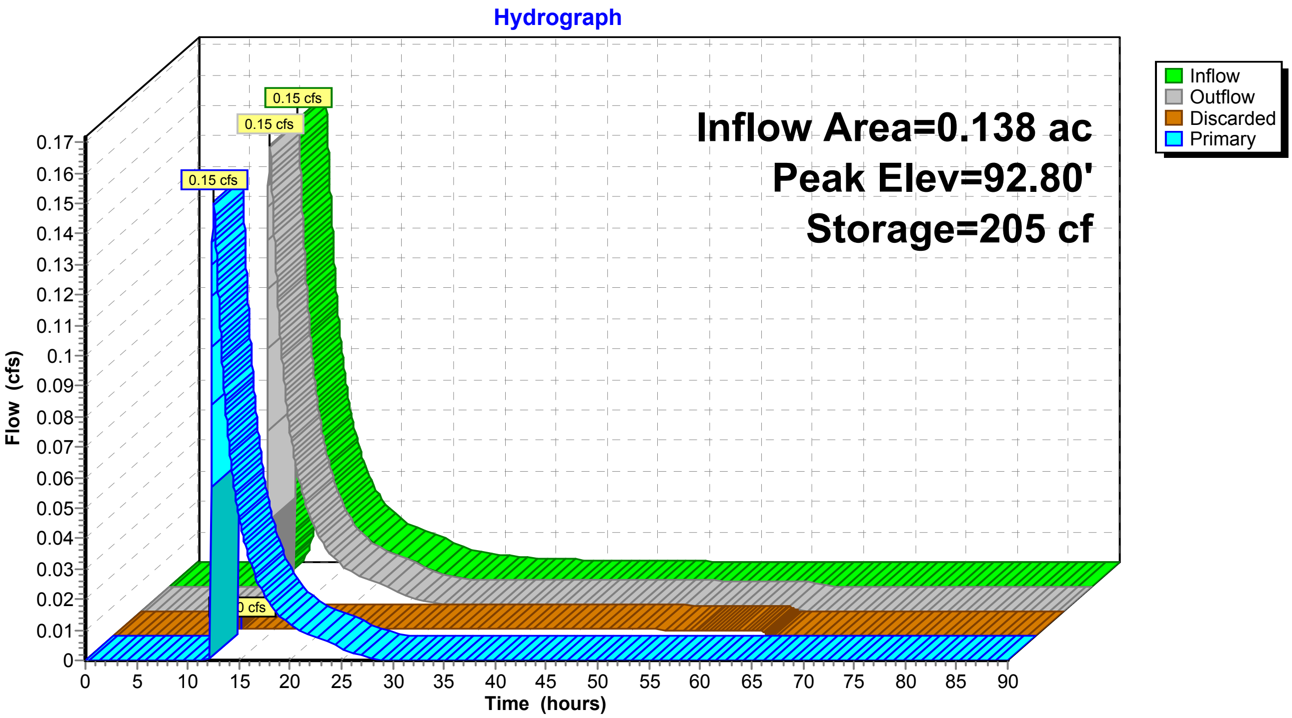
Volume	Invert	Avail.Storage	Storage Description
#1	91.75'	81 cf	**8.00'W x 29.00'L x 2.00'H Prismatoid Z=2.0** 803 cf Overall - 533 cf Embedded = 270 cf x 30.0% Voids
#2	92.25'	533 cf	**8.00'W x 29.00'L x 1.50'H Prismatoid Z=2.0** Inside #1
		614 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	91.75'	**0.270 in/hr Exfiltration over Horizontal area**
#2	Primary	92.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	93.00'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir X 2.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.00 cfs @ 12.49 hrs HW=92.80' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.15 cfs @ 12.49 hrs HW=92.80' (Free Discharge)
├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.15 cfs @ 0.74 fps)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Infiltration Trench

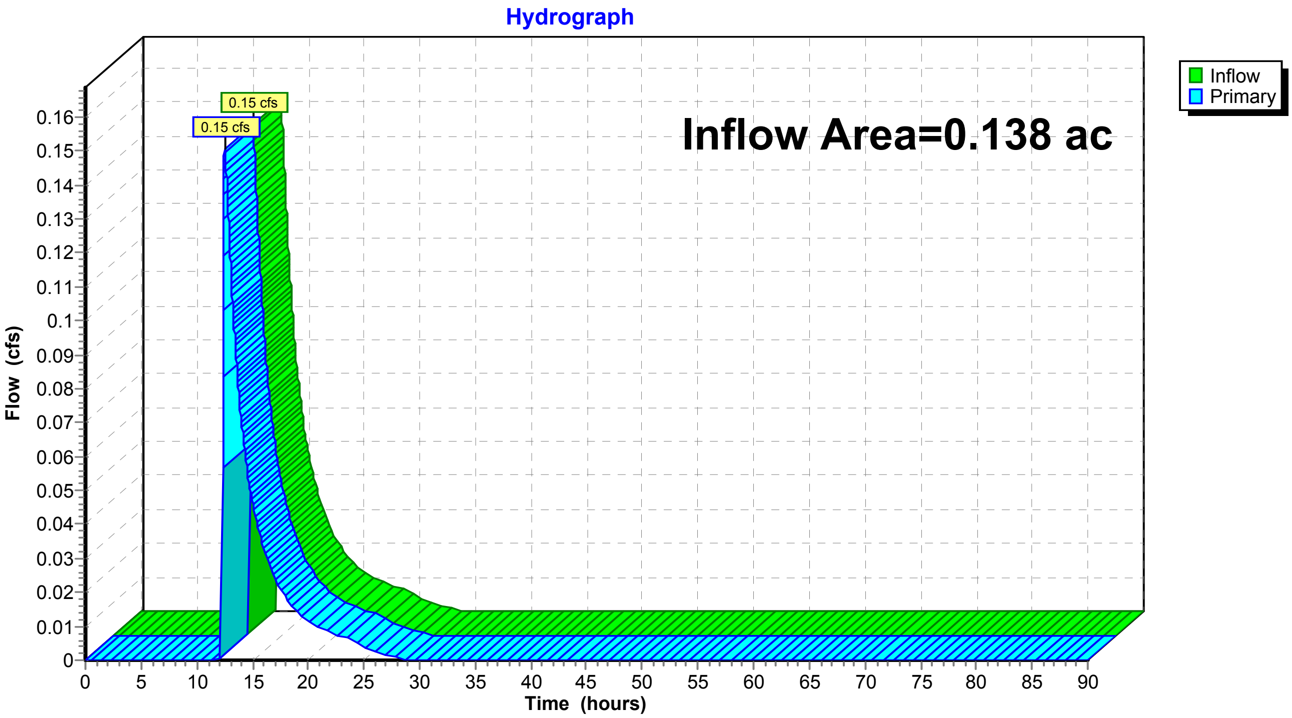


Summary for Link PR: PR

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth = 2.91" for 10-year event
Inflow = 0.15 cfs @ 12.49 hrs, Volume= 0.033 af
Primary = 0.15 cfs @ 12.49 hrs, Volume= 0.033 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs

Link PR: PR



Time span=0.00-90.00 hrs, dt=0.01 hrs, 9001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1-1: PR Trestle Runoff Area=6,000 sf 100.00% Impervious Runoff Depth=6.56"
Tc=6.0 min CN=98 Runoff=0.92 cfs 0.075 af

Pond 1P: Ballast Peak Elev=100.48' Storage=1,553 cf Inflow=0.92 cfs 0.075 af
6.0" Round Culvert n=0.010 L=10.0' S=0.3100 '/' Outflow=0.27 cfs 0.068 af

Pond 2P: Infiltration Trench Peak Elev=92.82' Storage=213 cf Inflow=0.27 cfs 0.068 af
Discarded=0.00 cfs 0.011 af Primary=0.26 cfs 0.058 af Outflow=0.27 cfs 0.068 af

Link PR: PR Inflow=0.26 cfs 0.058 af
Primary=0.26 cfs 0.058 af

Total Runoff Area = 0.138 ac Runoff Volume = 0.075 af Average Runoff Depth = 6.56"
0.00% Pervious = 0.000 ac 100.00% Impervious = 0.138 ac

Summary for Subcatchment 1-1: PR Trestle

Assumes that six spans (50 ft long x 20 ft wide) drain to a single discharge point.

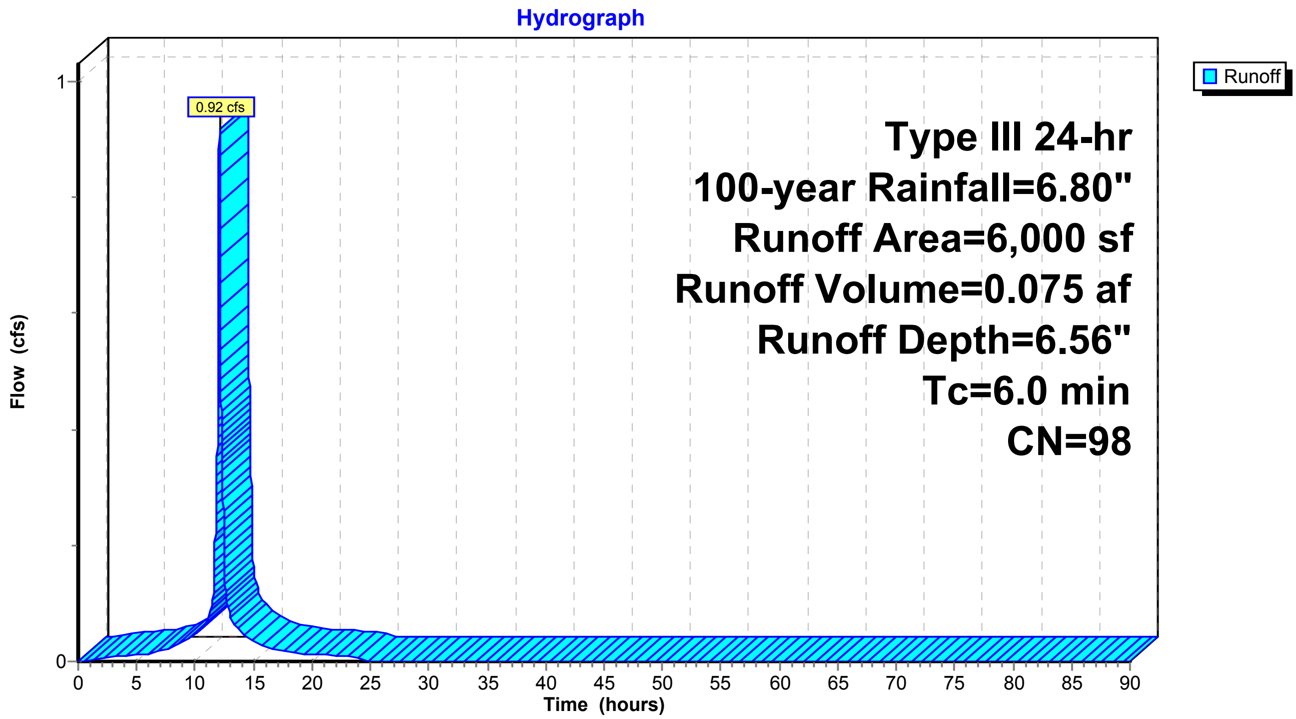
Runoff = 0.92 cfs @ 12.08 hrs, Volume= 0.075 af, Depth= 6.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.80"

Area (sf)	CN	Description
6,000	98	Unconnected pavement, HSG C
6,000		100.00% Impervious Area
6,000		100.00% Unconnected

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

Subcatchment 1-1: PR Trestle



Summary for Pond 1P: Ballast

Storage within the ballast on top of the trestle. Assumes that perforated pipe accepts all flow and that orifice to 6-inch downspout is only restriction.

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth = 6.56" for 100-year event
Inflow = 0.92 cfs @ 12.08 hrs, Volume= 0.075 af
Outflow = 0.27 cfs @ 12.41 hrs, Volume= 0.068 af, Atten= 71%, Lag= 19.4 min
Primary = 0.27 cfs @ 12.41 hrs, Volume= 0.068 af

Routing by Stor-Ind method, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs
Peak Elev= 100.48' @ 12.41 hrs Surf.Area= 3,480 sf Storage= 1,553 cf

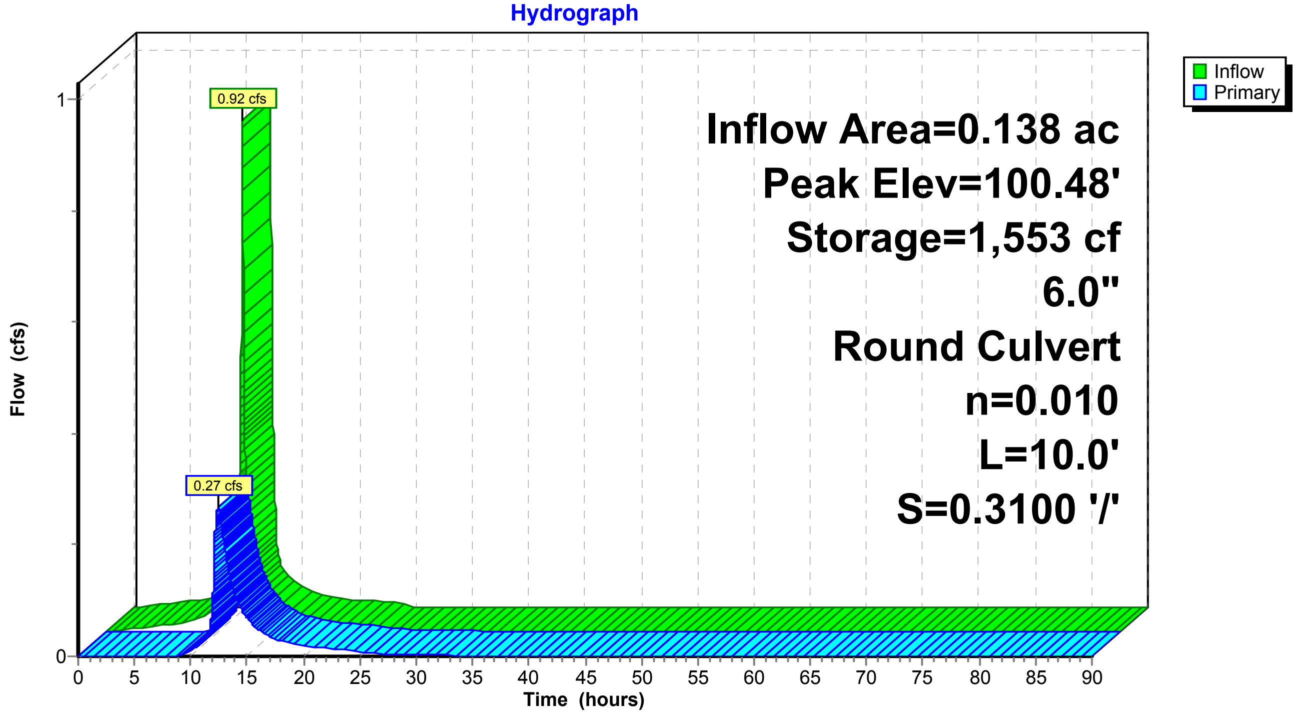
Plug-Flow detention time= 257.3 min calculated for 0.068 af (90% of inflow)
Center-of-Mass det. time= 208.9 min (952.2 - 743.3)

Volume	Invert	Avail.Storage	Storage Description
#1	100.00'	3,391 cf	**10.30'W x 300.00'L x 1.00'H Prismatoid Z=1.3**
			3,496 cf Overall - 105 cf Embedded = 3,391 cf
#2	100.10'	59 cf	**6.0" D x 300.0'L Pipe Storage** Inside #1
			105 cf Overall - 1.0" Wall Thickness = 59 cf
		3,450 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	100.10'	**6.0" Round Culvert**
			L= 10.0' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 100.10' / 97.00' S= 0.3100 '/' Cc= 0.900
			n= 0.010 PVC, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.27 cfs @ 12.41 hrs HW=100.48' (Free Discharge)
└─**1=Culvert** (Inlet Controls 0.27 cfs @ 1.66 fps)

Pond 1P: Ballast



Summary for Pond 2P: Infiltration Trench

Infiltration trench receives flow from six segments of trestle. Exfiltration assumed from floor of trench, overflows via level spreader from mid-size storms and from both sides of trench for flood events.

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth > 5.93" for 100-year event
Inflow = 0.27 cfs @ 12.41 hrs, Volume= 0.068 af
Outflow = 0.27 cfs @ 12.43 hrs, Volume= 0.068 af, Atten= 0%, Lag= 1.1 min
Discarded = 0.00 cfs @ 12.43 hrs, Volume= 0.011 af
Primary = 0.26 cfs @ 12.43 hrs, Volume= 0.058 af

Routing by Stor-Ind method, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 92.82' @ 12.43 hrs Surf.Area= 409 sf Storage= 213 cf

Plug-Flow detention time= 144.7 min calculated for 0.068 af (100% of inflow)
Center-of-Mass det. time= 144.6 min (1,096.8 - 952.2)

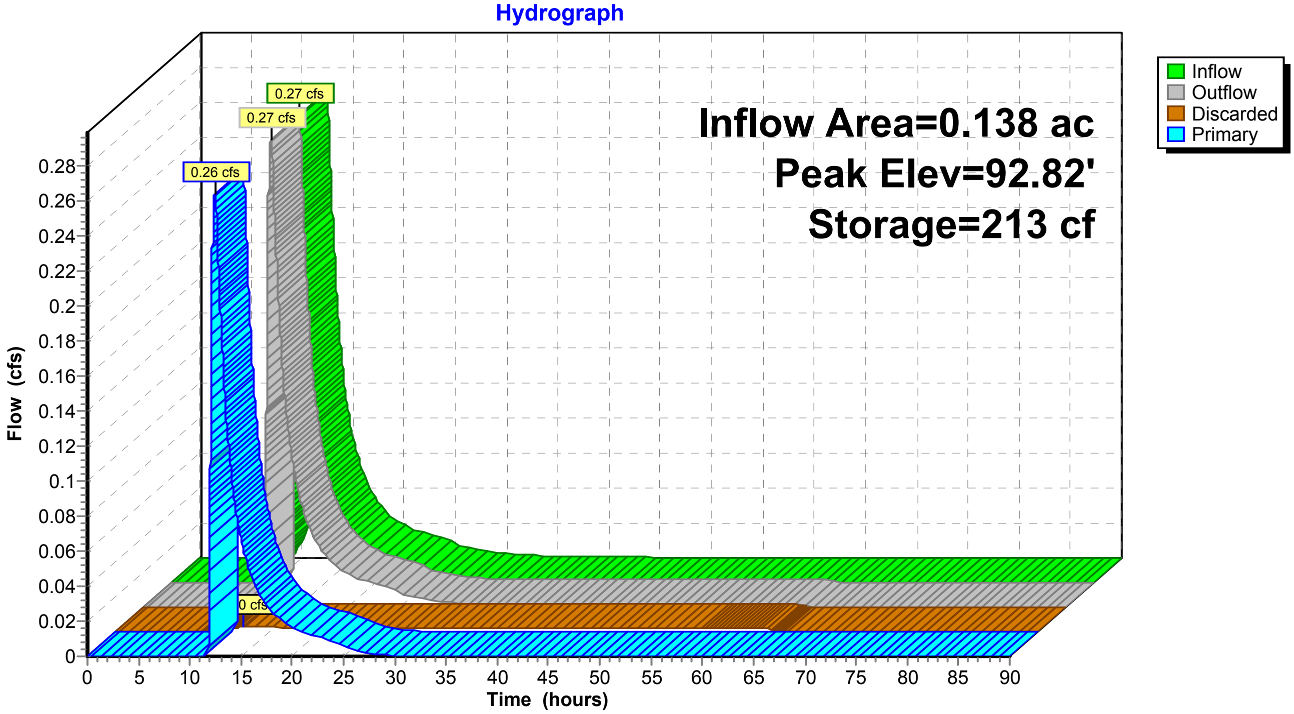
Volume	Invert	Avail.Storage	Storage Description
#1	91.75'	81 cf	**8.00'W x 29.00'L x 2.00'H Prismatoid Z=2.0** 803 cf Overall - 533 cf Embedded = 270 cf x 30.0% Voids
#2	92.25'	533 cf	**8.00'W x 29.00'L x 1.50'H Prismatoid Z=2.0** Inside #1
		614 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	91.75'	**0.270 in/hr Exfiltration over Horizontal area**
#2	Primary	92.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Primary	93.00'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir X 2.00** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.00 cfs @ 12.43 hrs HW=92.82' (Free Discharge)
└—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.26 cfs @ 12.43 hrs HW=92.82' (Free Discharge)
├—**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.26 cfs @ 0.89 fps)
└—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Infiltration Trench

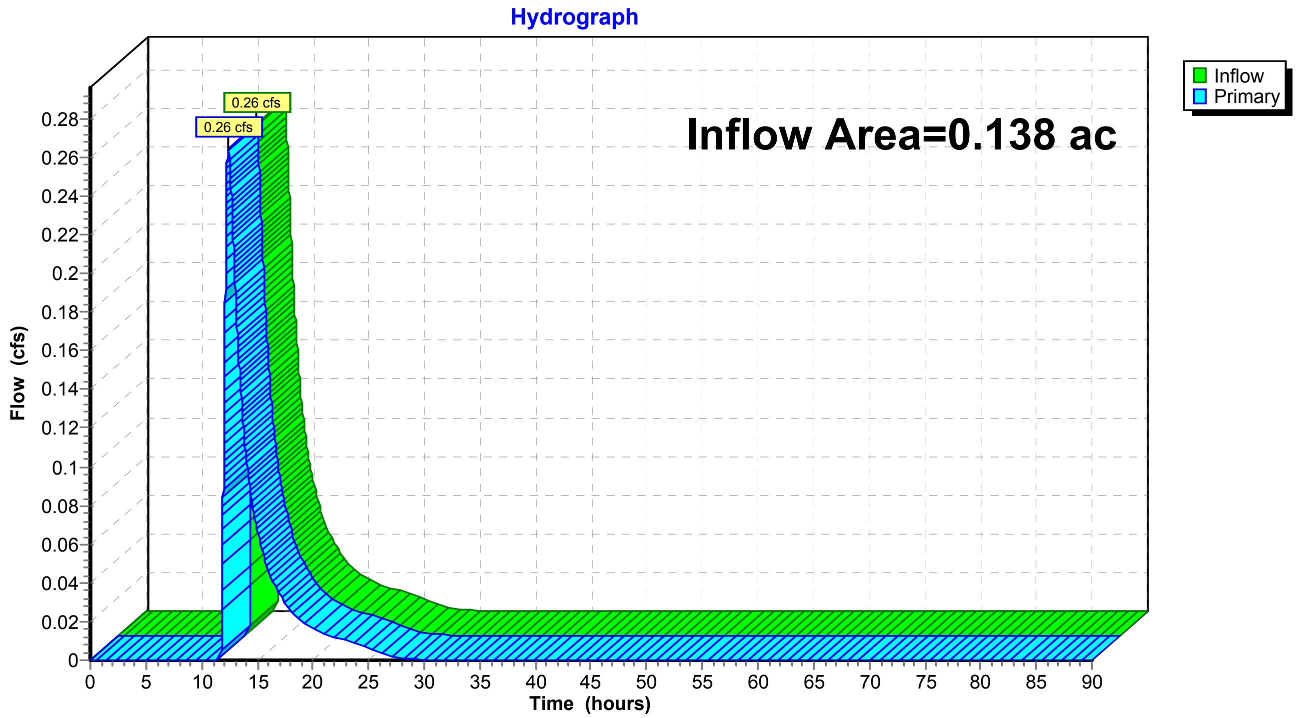


Summary for Link PR: PR

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth = 5.01" for 100-year event
Inflow = 0.26 cfs @ 12.43 hrs, Volume= 0.058 af
Primary = 0.26 cfs @ 12.43 hrs, Volume= 0.058 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-90.00 hrs, dt= 0.01 hrs

Link PR: PR



Appendix C
Standard 3 Computations and Supporting Information

FEIS/FEIR Technical Report
Stormwater
Hockomock Swamp Trestle

Soil Evaluation and Analysis


71° 5' 35"
71° 4' 5"
42° 0' 25"
42° 0' 26"
326700
327000
327300
327600
327900
328200
328500
4652400
4652100
4651800
4651500
4651200
4650900
4650600
4650300
4650000
43A
1
52A
602
Black Brook
Turnpike St
41° 58' 54"
41° 58' 56"
71° 5' 32"
71° 4' 2"
Map Scale: 1:13,300 if printed on A size (8.5" x 11") sheet.
N
Meters
0 100 200 400 600
Feet
0 500 1,000 2,000 3,000

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

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

MAP INFORMATION

Map Scale: 1:13,300 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 19N NAD83

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

Soil Survey Area: Bristol County, Massachusetts, Northern Part
Survey Area Data: Version 5, Jul 27, 2010

Date(s) aerial images were photographed: 7/10/2003; 7/31/2003

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Bristol County, Massachusetts, Northern Part (MA602)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		0.7	0.8%
43A	Scarboro mucky loamy fine sand, 0 to 3 percent slopes	D	1.0	1.1%
52A	Freetown muck, 0 to 1 percent slopes	D	91.3	97.5%
602	Urban land		0.6	0.7%
Totals for Area of Interest			**93.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Required and Provided Recharge Volumes

Recharge Calculations

Project Name: **Hockomock Swamp Trestle** **Proj. No.:** 10111.32
Project Location: **Easton & Raynham, MA** **Date:** 11-Jun-12
Calculated by: RW
Checked by:

Proposed Impervious Surface Summary

Net Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
1	0.0	0.0	0.14	0.0	0.14
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
TOTAL	**0.0**	**0.0**	**0.14**	**0.0**	**0.14**

Required Recharge Volume (Cubic Feet)

HSG	Area (acres)	Recharge Depth * (in.)	Volume (c.f.)
A	0.0	0.60	0
B	0.0	0.35	0
C	0.14	0.25	127
D	0.0	0.10	0
TOTAL			**127**

* Per 2008 Massachusetts DEP Recharge Requirement

Provided Recharge Volume (Cubic Feet)

Infiltration Volumes Provided in Infiltration Basins (below lowest overflow outlet)

Infiltration	254	
Total	**254**	c.f.

72-hour Drawdown Analysis

Drawdown Calculations

Project Name:	Hockomock Swamp Trestle	**Proj. No.:**	10111.00
		Date:	6/12/2012
Project Location:	Easton and Raynham, MA	**Calculated by:**	RW

Stone-Lined Infiltration Trench

Infiltration volumes provided in basin below lowest outlet.
Elevation is based on an arbitrary datum with the top of the trestle being at 100.0.

Basin Volume Below Outlet

Elevation	Incremental Volume (c.f.)*
91.75	59
92.25	195
TOTAL	**254**

* volumes assume 30% void space in 0.5-foot thick stone layer

Assumptions:

Exfiltration Area 348 sq ft

Recharge Rate: 0.17 in/hr**

** 1982 Rawls Rate for sandy clay loam

Drawdown Time: 51.5 hours

Appendix D
Standard 4 Computations and Supporting Information

FEIS/FEIR Technical Report
Stormwater
Hockomock Swamp Trestle

Water Quality Volume Calculations

VHB

Water Quality Volume Calculations

Project Name: **Hockomock Trestle** **Proj. No.:** 10111.00

Project Location: **Easton & Raynham, MA** **Date:** 6/11/2012

Calculated by: RW

Infiltration Trench
(Runoff from Trestle Unit Drainage Area)

Total Impervious Area = 0.14 Acres

Required:

	Runoff Depth to be Treated (in.)	Required Volume (c.f.)
Forebay Volume	0.1	51
0.5" Water Quality Volume	0.5	254
1.0" Water Quality Volume	1	508

Provided:

Infiltration Trench	Elevation	Depth	Cumulative Volume (c.f.)
Storage within stone bedding	91.75	0.50	59
Storage above stone bedding	92.25	0.50	195
Weir elevation	92.75	-	254

NOTE: Infiltration trench does not have sufficient volume to fully treat the 1" WQV. The trestle ballast is drained completely by the underdrain, so no credit is taken for it to provide WQV.

TSS Removal Worksheets

TSS Removal Calculation Worksheet

VHB
Vanasse Hangen Brustlin, Inc.
Consulting Engineers and Planners
101 Walnut Street
Watertown, MA 02471
(617) 924-1770

Project Name:	**Hockomock Swamp Trestle**
Project Number:	**10111.00**
Location:	**Easton & Raynham, MA**
Discharge Point:	**DP-1**
Drainage Area(s):	**DA-1**
Sheet:	**1 of 1**
Date:	**25-May-2012**
Computed by:	**RW**
Checked by:	

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (B*C)	Remaining Load (D-E)
Infiltration Trench	**80%**	**1.00**	**0.80**	**0.20**
	0%	**0.20**	**0.00**	**0.20**
	0%	**0.20**	**0.00**	**0.20**
	0%	**0.20**	**0.00**	**0.20**
	0%	**0.20**	**0.00**	**0.20**

Treatment Train TSS Removal = **80%**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).
** Equals remaining load from previous BMP (E)
*** Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 75% removal is used for this calculation based upon the NJCAT study provided on the MA STEP website. (Change name of device and the claimed removal rate shown on the calc. sheet. ALSO provide backup documentation to support TSS removal rate from the MA STEP website. Remove this sentence if not applicable.)

Appendix E
Geotechnical Report

JACOBS
343 Congress Street
Boston, MA 02210

Design Memorandum

Date	March 28, 2012
To	Rick Carey, Natasha Velickovic - VHB
From	Paul Murphy, Peter Chou, Ahmad Hasan - Jacobs
Subject	MBTA South Coast Rail (New Bedford/Fall River Commuter Rail Extension) Hockomock Swamp Preliminary Geotechnical Recommendations Easton and Raynham, MA
Project No.	E2347101

INTRODUCTION

The South Coast Rail project will restore passenger rail transportation from South Station in Boston to the cities of Fall River and New Bedford. The project limits are between South Station in Boston and the termini in Falls River and New Bedford, Massachusetts. The MBTA's selected route, the Stoughton Alternative will traverse through the towns of Stoughton, Easton, Raynham, and Taunton, and will continue along an existing rail freight corridor running south from Taunton to Fall River and New Bedford. The project will include the reconstruction of several existing stations and construction of new passenger stations and two terminal layover facilities. This memorandum presents the preliminary geotechnical assessment report of the Hockomock Swamp Area located in the towns of Easton and Raynham, Massachusetts. The preliminary design recommendations presented in this report are based on the results of subsurface exploration performed by Jacobs in 2012.

Existing Conditions

The proposed railway alignment at the Hockomock Swamp area is shown in Figure 1. The site has several wetland areas, and vegetated open fields. The site extends from the south of Purchase Street at Station 1325+50 and continues south to Station 1531+00 at Raynham Park Crossing. Compared to existing grades adjacent to the existing embankment, it appears that 3 to 5 feet of fill may have been placed to create the embankment for the former railroad in this area through the Hockomock Swamp. Existing grades along the proposed tracks range from approximately elevation 69.5 to 123.5 feet (NGVD29 Datum).

Proposed Construction

Current plans are to install a single track on the alignment. An 8,500-foot long trestle will be constructed within the swamp between Stations 1425+00 and 1510+00. A maintenance turnout will be provided from Station 1462+00 to approximately 1468+00. The details of new track layout (including grading) and the trestle span arrangements are still under development at the time of this preliminary report preparation. Span lengths of 30, 40, and 50 feet are being considered for the trestle. The trestle will be 20 feet wide. A 4 feet wide catenary overhang on either side will be installed at every 200 feet on an extended pier cap. This report focuses on the Preliminary Geotechnical Study at the Hockomock Swamp area, and includes design and recommendation for at-grade railroad tracks and the trestle.

SCOPE OF WORK

This memorandum is prepared by Jacobs in accordance with the scope of work under the contract between Jacobs and VHB for work on the New Bedford/Fall River Commuter Rail Line Extension Project for Massachusetts Bay Transportation Authority (MBTA). The geotechnical work included the following tasks:

- Perform geotechnical explorations with twenty widely spaced borings and conduct a laboratory testing program;
- Report and interpret the results of the explorations and laboratory testing program; and
- Provide preliminary geotechnical recommendations for design and construction of the trestle foundations and at-grade tracks.

The Jacobs scope of work did not include environmental assessment of the potential presence of any hazardous materials at the project site or potential impacts to adjacent structures during construction.

LOCAL GEOLOGY

The geologic map of Massachusetts shows the Hockomock Swamp to be located in the Narragansett Basin, underlain and surrounded to the north and south by the Milford-Dedham zone. The bedrock in the Narragansett Basin is lightly metamorphosed siltstone, shale, greywacke, argillite, and coarse-grained conglomerate of Pennsylvanian and Permian age. The bedrock in the Milford-Dedham zone is mostly granite of Proterozoic age.

Hockomock Swamp is a vast wetland, encompassing as much as 6,000 acres of southeastern Massachusetts in Bristol and Plymouth Counties. It is the largest peatland in Massachusetts. Approximately 12,000 years ago, the area was part of the Glacial Lake Taunton, occupying a location between the glacial ice to the north and higher land to the south. Fine textured sediments consisting of varved silts and clays as much as 100 feet thick were deposited within this lake. As the ice retreated, the land rebounded or uplifted, and the lake began to fill in with alluvial deposits washed into low spots by streams cutting through glacial deposits of gravel, clay and sand. Loose, non-compacted peat deposits formed at the bottom of the lake and may extend to depths of 20 to 60 feet below ground surface at certain locations within the swamp. The area generally is characterized by shallow and deep organic soils and alluvial soils underlain by thick deposits of silts and clays. The old glacial lake bed gradually became the soggy swampy woodland of the Hockomock Swamp.

Soils associated with the Glacial Lake Taunton and Hockomock Swamp include the Scio, Raynham, Birdsall, and Enosburg Series. These soils consist of nearly level to gently sloping, moderately well-drained to predominantly poorly-drained soils which were formed on old lake beds.

GEOTECHNICAL EXPLORATIONS

A subsurface exploration program consisting of 20 borings were drilled for this project in February, 2012. Jacobs planned the subsurface exploration program and retained the drilling contractor to perform the explorations. A total of eleven at-grade alignment borings (HS-1 through HS-11) and nine trestle borings (HST-1 through HST-9) were drilled for the proposed crossing through Hockomock Swamp. Boring locations are shown on the Subsurface Exploration Plan (Figures 2A – 2I). The at-grade alignment borings were drilled to depths ranging from 25 to 50 feet below ground surface, while the trestle borings were typically drilled to depths of 55 to 75 feet below grade. One trestle boring (HST-9) was roller-bit drilled through weathered rock to a depth of 120 feet.

The test borings were drilled by New Hampshire Boring under subcontract to Jacobs using several different drill rigs including a remote-controlled ATV mounted drill rig, a D-50 ATV mounted drill rig, and a Mobile drill rig. The borings were advanced through the soil primarily using wash boring with casing drill methods, although some of the borings used augers in the first 5 feet of boring. Three of the at-grade borings and six of the trestle borings were advanced into the underlying bedrock using NX rock coring methods. Standard penetration tests (SPT), consisting of a 140-pound safety hammer dropping 30 inches onto a standard 2-inch-diameter (OD) split-spoon sampler, were performed to establish the consistency of the subsurface soils. The SPT's were typically performed at 5 foot intervals for full length of boring. The obtained samples were sealed in glass jars to retain their natural moisture. In four of the borings (HS-1, HS-6, HST-3, and HST-8), observation wells with 10-foot long screens set at a depth of 5 to 15 feet below ground surface were installed to monitor fluctuations in the groundwater level.

The borings were observed by a representative from Jacobs. The soil samples were classified in the field in accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) by Jacobs' representative, and appropriate stratum breaks were interpolated from drilling and sampling observations. Top of boring elevations were obtained from the project cross section developed by VHB. The boring logs were prepared by Jacobs based on the field classifications and laboratory testing, and are presented in Appendix A.

LABORATORY TESTING

Laboratory tests were performed to determine the physical and engineering characteristics of selected split-spoon and undisturbed soil samples obtained during the subsurface exploration program. The Laboratory testing was conducted by GeoTesting Express under subcontract to Jacobs. The testing program was in general accordance with ASTM standards, and included moisture content determination, grain size analysis, Atterberg Limits, triaxial unconfined undrained test, density determination, consolidation, soil pH, soil organic content, and soil electrical resistivity. Unconfined compression tests were performed on representative samples of the bedrock recovered from the core borings. The results for rock and soils testing are summarized in Tables 1 and 2.

Table 1: Summary of Laboratory Test Results for Bedrock

Boring No.	Sample Depth ft.	Rock Description	Bulk Density lb/ft^3	Uniaxial Compressive Strength, psi
HS-4	32.0 - 32.5	Siltstone	170	6,500
HST-3	72.0 – 72.5	Sandstone	159	7,822
HST-7	47.5 – 48.0	Sandstone	167	4,693
HST-8	66.5 – 67.0	Granite	162	6,689

Table 2: Summary of Laboratory Test Result for Soils

Boring No.	Sample No.	Depth (ft)	Soil Classification		Moist. Content (%)	Su (UU) (psi)	Gravel (%)	Sand (%)	Silt & Clay (%)	LL	PL	PI	Organic Content (%)	pH	Electr. Resist. (ohm-cm)
			USCS	AASHTO											
HST-1	S-6	25-27		A-4(0)	25.2		0.0	3.2	96.8						
HST-2	S-4	14-16	CL		31.6					34	20	14			
HST-2	S-9	39-41	CL-ML		31.4					24	18	6			
HST-3	S-4	15-17		A-3(0)			0.0	93.3	6.7						
HST-3	S-7	30-32	CL		36.6					39	23	16			
HST-4	S-2A	5-7			74.4								11.8		
HST-4	S-4	15-17		A-3(0)			0.0	92.9	7.1						
HST-4	S-9A	40-42	Clay		40.0					40	21	19			
HST-4	S-10	45-47	ML	A-4(0)	28.5		0.0	0.7	99.3	NP	NP	NP			
HST-5	S-1	0-2	SM		16.4								4.0	4.5	
HST-6	S-2	5.5-7.5	SM		95.7								11.6		
HST-6	S-6	25-27	CL	A-6(21)	40.9		0.0	0.9	99.1	40	22	18			
HST-7	S-2B	4-6	OL		59.8								9.6	5.2	
HST-7	S-7	29-31	ML		30.4					NP	NP	NP			
HST-8	S-5	19-21		A-2-4(0)			0.0	84.0	16.0						
HST-8	S-9	39-41	CL		31.3					28	20	8			
HST-9	S-4	15-17	OL		409.3								61.7		
HST-9	S-7	30-32		A-4(0)	66.5		0.0	1.1	98.9						
HS-3	S-2	4-6		A-2-4(0)			21.2	44.8	34.0						
HS-4	S-2	5-7		A-2-4(0)			25.9	40.8	33.3						
HS-7	UD-1	14	CL		26.7	22.3				25	18	7			
HS-8	S-4	15-17	ML		26.6					NP	NP	NP			
HS-9	S-4	14-16		A-4(0)			0.0	38.8	61.2						
HS-10	S-6	21-23	CL		30.9					28	19	9			
HS-11	S-3	9-11	CL		7.8					25	16	9			
HST1,2,3	S1 (Composite)	0-2			9.5								3.1	4.7	31,401

SUBSURFACE CONDITIONS

The subsurface conditions at the site were inferred from the boring data collected for this project, with some interpretations. The subsurface conditions encountered in the borings drilled for this project generally consist of a layer of granular fill with thickness of about 0 to 3 feet, underlain by natural, loose to dense stratified silt and sand deposits, and very dense glacial till. A thin 2- to 7-foot thick layer of organic silt was encountered in the upper 5 to 10 feet of soil in almost all of the trestle borings. Boulders were encountered in several of the borings. The till was often underlain by severely to completely weathered rock (generally appearing as silt with gravel) which could be penetrated by roller-bit drilling but often resulted in SPT N-counts ranging from 100 blows for 1- to 9-inch penetration to 100 blows per 1 inch penetration. Bedrock along the alignment was noted to include weathered shale, siltstone and granite.

Subsurface soil conditions are summarized in Table 3 below.

Table 3: Summary of Subsurface Conditions at Borings

BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. SOIL THICKNESS (FT)	ORGANIC SOIL THICKNESS (FT)	DEPTH TO BOTTOM OF BORING (FT)	APPROX. TOP OF WEATHERED ROCK ELEV (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
Trestle Borings									
HST – 1	78.8	> 60.6	5	60.6	NE	NE	18.2	70.3	
HST – 2	72.8	62	3	72	10.8	NE	0.8	67.8	
HST – 3 OW	71.4	65	1	75	6.4	1.4	-3.6	67.7	Well screened from 5 to 15 ft
HST – 4	70.5	> 65	2.3	65	NE	NE	5.5	66.1	
HST – 5	70.3	52	4	62	NE	18.3	8.3	64.3	
HST – 6	69.5	> 60	2.5	60	NE	NE	9.5	66.0	
HST - 7	69.6	39	3	56	30.6	23.6	13.6	65.6	Possible weathered rock at 39 to 46 ft
HST – 8 OW	70.3	64	NE	74	NE	6.3	-3.7	61.3 / 66.8	Well screened from 5 to 15 ft
HST - 9	71.6	66.4	7.5	120	5.2	NE	-48.4	67.5	Boulders at 61.4 to 66.4 ft; roller bit through weathered rock at 76.4 to 120 ft
NE = Not encountered at the boring during drilling; NM = Not measured.									

Table 3: Summary of Subsurface Conditions at Borings (Continued)

BORING NUMBER	GROUND SURFACE ELEV. (FT)	APPROX. SOIL THICKNESS (FT)	ORGANIC SOIL THICKNESS (FT)	DEPTH TO BOTTOM OF BORING (FT)	APPROX. TOP OF WEATHERED ROCK ELEV (FT)	APPROX. TOP OF ROCK ELEV. (FT)	BOTTOM OF BORING ELEV. (FT)	APPROX. GROUND WATER ELEV. (FT)	REMARKS
At-Grade Alignment Borings									
HS – 1 OW	123.6	9	NE	25	114.6	108.6	98.6	121.6	Well screened from 5 to 15 ft; possible weathered rock at 9 to 15 ft
HS - 2	115.1	19	NE	50.2	96.1	NE	64.9	113.0	Weathered rock at 19 to 50.2 ft
HS - 3	106.9	34	NE	49.5	72.9	NE	57.4	NM	Rollerbit through weathered rock at 34 to 49.5 ft
HS - 4	97.7	10	NE	40	87.7	67.7	57.7	96.2	Rollerbit through weathered rock at 10 to 30 ft
HS - 5	88.7	25	NE	50.2	63.7	NE	50.25	81.5	Rollerbit through weathered rock at 25 to 50 ft
HS – 6 OW	77.7	35	NE	42	42.7	NE	35.7	73.7	Well screened from 5 to 15 ft.
HS - 7	78.1	> 42	NE	42	NE	NE	36.1	75.1	
HS - 8	77.8	> 42	NE	42	NE	NE	35.8	NM	
HS - 9	79.2	> 41	NE	41	NE	NE	38.2	71.2	
HS - 10	78.9	30	NE	32	48.9	NE	46.9	67.9	Possible weathered rock at 30 ft
HS - 11	87.3	19	NE	44	68.3	53.5	43.3	82.5	
NE = Not encountered at the boring during drilling; NM = Not measured.									

Fill: Compared to existing grades adjacent to the existing embankment, it appears that 3 to 5 feet of fill may have been placed to create the embankment for the former railroad in this area through the Hockomock Swamp. The uppermost soils encountered in the borings typically consisted of well-graded sand containing secondary amounts of silt and fine gravel.

Organic Soil: A one to five foot thick layer of organic silt/peat was encountered within the upper 5 to 10 feet of soil in several of the trestle borings (HST-1, -2, -3, -4, -5, -6, and -7). These borings are located adjacent to wetland areas. The elevation of the bottom of the organic layer generally decreased to the south, ranging from ± El. 74 ft at Boring HST-1 to ± El. 61.5 ft in Boring HST-7. Organic soils may also be located near other wetland areas at the site.

Natural Granular Deposits: The natural soil deposits below the fill materials or organic soils is quite variable but generally consist of predominantly poorly (SP) to well graded (SW) sand containing secondary amounts of silt and/or gravel, silty sand (SM), and interlayers of fine-grained silt (ML), low plasticity clay (CL, ML-CL), or occasionally high plasticity clay (CH). The sand and gravel deposits are loose to very dense with Standard Penetration Test (SPT) N-values ranging between 6 and 100 blows per foot (bpf) and averaging about 29 bpf. The fine-grained interlayers ranged from medium stiff to hard, with SPT N-values ranging generally from 8 bpf to 44 bpf.

Glacial Till: Dense to very dense glacial till consisting predominantly of well graded sand (SW) with little to some (15 to 45 percent) gravel and silt and ranging from 2 to 25 feet thick was encountered in several of the at-grade alignment borings. The glacial till encountered in the at-grade alignment borings appeared to dip to the south, being encountered in Boring HS-2 at 9 to 19 feet depth (± El. 106 to El. 96 ft), in Boring HS-6 at 20 to 35 feet depth (± El. 57.7 to El. 42.7 ft), in Boring HS-7 at 35 to 42 ft depth (El. 43.1 to El. 36.1 ft) and in Boring HS-9 at 39 to 41 ft depth (El. 40.2 to El. 38.2 ft).

The glacial till was also encountered in all of the trestle borings, ranging from about 3 to 20 feet thick and generally encountered at depths between 35 and 65 feet below ground surface. SPT N-counts ranged from 27 blows per foot to 100 blows per 1 inch penetration. The glacial till was typically underlain by weathered rock or harder rock which could be cored. In a few cases, the bottom of the till layer was underlain by a layer of boulders.

Bedrock: Bedrock recovered in the test borings was typically severely to completely weathered and difficult to classify. The completely weathered rock was often recovered as silt with gravel (ML). In several areas, roller-bit drilling was able to penetrate as much as nearly 45 feet into weathered rock without having to switch over to rock coring methods. Associated SPT N-values in the completely weathered rock ranged from 100 blows per 1 to 9 inch penetration. Where slightly harder rock was encountered, NX coring was used to penetrate as much as 10 feet into the rock. Core recoveries and Rock Quality Designation (RQD) values of the samples recovered via NX coring ranged from 14 to 60 percent and from 0 to 60 percent, respectively, indicative of primarily very poor to poor quality rock. The top of rock was typically encountered at depths ranging from 9 to 35 feet depth in the at-grade alignment borings and 39 to 66.5 feet depth along the trestle borings as presented in Table 2.

Groundwater: Groundwater levels were measured in the test borings using a weighted tape during and at completion of drilling. The data indicated the groundwater level to be approximately 2 to 11 feet below ground surface, ranging from approximate elevations 68 to 121.5 feet along the at-grade borings and from elevations 64 to 70 feet in the trestle area. Groundwater level readings at termination of drilling were consistently at 3.5 to 6 feet depth along the trestle borings. The use of wash boring techniques for some of the borings may have artificially increased the water level readings due to the addition of water to the borings; however, it is anticipated that the groundwater is very shallow throughout the wetland areas encompassed by this project.

Groundwater levels should be expected to fluctuate with rainfall and other seasonal variations. More long-term observations would be required to evaluate true groundwater levels and their influence on planned construction.

GEOTECHNICAL RECOMMENDATIONS

Based on the contour maps shown on the boring location plan, the immediate alignment appears to be built up about 3 to 5 feet above the surrounding wetland areas. The built up width appears to be the corridor previously used for railroad traffic and is currently abandoned. The railroad tracks at Hockomock Swamp will be installed on at-grade sections, and on an 8,500-foot long trestle through the swamp.

Trestle Loading

For the preliminary design, span lengths of 30, 40, and 50 feet are being considered for the trestle. Trestle pier loading, as determined by VHB is shown in the table below:

Table 4 – Trestle Bent Loads

Pier Span	Dead Load, D*	Live Load, L	Impact Load, I	Longitudinal Braking**			Longitudinal Traction**		
				Force, LF_B	Moment, M_B***	Vertical, V_B	Force, LF_T	Moment, M_T***	Vert., V_T
(ft)	(kips)	(kips)	(kips)	(kips)	(k-ft)	(kips)	(kips)	(k-ft)	(kips)
30	330	346	142	81	1,235	41	137	1,404	47
40	425	432	153	93	1,418	35	158	1,620	40
50	520	546	174	105	1,601	32	177	1,814	36

Notes:
* Dead load includes weight of pier cap (50 kips for a single row of piles and 100 kips for a double row)
** Longitudinal braking and tractive forces are applied as a longitudinal lateral force (LF) at center height of the pier cap.
***The moments are about the center of the pier cap. The moment is applied to the piers as a vertical couple applied downward on the pier at one end of the span and upward on the pier at the other end of the span. The moment is not applied directly to the pier cap, but is only given for information.

Trestle Foundations

Various foundation alternatives were investigated to support the trestle foundations. Preliminary foundation type selection took into account soil conditions and shear strength of near surface soils, and depth to bedrock.

Spread Footings: Spread footings were evaluated for pier support. Given the strength consistency of the upper overburden soils to be mostly loose to medium dense, and the presence of organic soils, the spread footing option was discarded.

Drilled Shafts: Drilled shafts were considered but due to the high ground water level and the variable depth to bedrock within the trestle footprint, it does not appear that drilled shafts are a cost effective alternative compared to driven piles.

Driven Piles: Based on our review of available subsurface conditions, the proposed trestle bents are recommended to be founded on driven steel H-piles bearing on the underlying bedrock.

The pile design and the initial pile layout for each bent should be based upon using an allowable stress of 12.6 ksi on HP pile sections, as required by AREMA Section 4.4.3.6. Piles are recommended to be driven vertically, unless pile batter is determined necessary to resist lateral loads. Based on the design loads shown in the pier loading table above, lateral loads will govern the design of pile supported trestle bent foundations.

LPILE by Ensoft was used to develop charts of applied lateral loads versus pile head deflection on a single pile to assist in the final design of trestle foundations. Sample calculations are included in Appendix C showing the parameters used in our analyses as well as the plots of deflection, moment and shear for various applied lateral loads.

Table 5 – Summary of Lpile Analyses (Fixed Head Condition)

Pier Span	Total Vertical Load	Pile Size	Qall/Pile	No. of Piles/Pier	Vertical Load/Pile	Results: Max. Horizontal Load	Results: Max. Top Deflection
(ft)	(kips)		(kips)		(kips)	(kips)	(inches)
30	865	HP10X42	156	8	108	14	0.64
	865	HP12X53	195	8	108	21	0.73
	865	HP14X73	269	8	108	32	0.86
	865	HP14X89	328	8	108	39	0.97
	865	HP14X89	328	4	215	33	0.80
40	1,050	HP10X42	156	8	131	12	0.53
	1,050	HP12X53	195	8	131	20	0.69
	1,050	HP14X73	269	8	131	31	0.83
	1,050	HP14X89	328	8	131	38	0.94
	1,050	HP14X89	328	4	256	30	0.71
50	1,276	HP10X42	156	8	160	11	0.48
	1,276	HP12X53	195	8	160	18	0.61
	1,276	HP14X73	269	8	160	29	0.77
	1,276	HP14X89	328	8	160	37	0.92
	1,276	HP14X89	328	4	318	28	0.66

The preliminary geotechnical design of the bent foundations was further advanced by applying lateral loads resulting from longitudinal braking and tractive forces using Ensoft's GROUP 7.0 software. Per AREMA, three load combinations were checked, and Group III (a) and Group III (b) were determined for the span lengths of 30, 40, and 50 feet. Preliminary analyses for 40- and 50-foot spans were performed for the pile supported bents for the most critical Group III (b) loading. A single row of 5 HP 14X89 (50 ksi) piles battered in two directions did not work since the resulting loads and stresses on the piles exceeded the capacity. Hence, a double row of 4 piles, HP 12X53, HP 14X73 and HP 14X89 were analyzed. The 12-inch piles failed because it exceeded the allowable axial load limit of 195 kips, and the deflection at the pile top was more than 1-inch. The 14-inch piles provide desired results as shown in the table below:

Table 6 – Summary of GROUP Analyses

Pier Span	Pile Size	Load Condition	Qall	GROUP Analysis Results					
				Axial Pile Force (kips)		Max. Moment	Max. Pile Stress	Max. Top Deflection
			(kips)	Comp.	Tension	(kips-in)	(ksi)	(inches)
50ft	HP14X89	Group III(b)	328	271	NO	1,720	23.7	0.83
	HP14X73	Group III(b)	269	270	NO	1,690	28.9	0.95
	HP12X53	Group III(b)	195	269	NO	1,650	42.6	1.33
40ft	HP14X89	Group III(b)	328	230	NO	1,510	20.5	0.72
	HP14X73	Group III(b)	269	229	NO	1,480	24.9	0.82
	HP12X53	Group III(b)	195	228	NO	1,420	36.4	1.12

Notes:

1. No pile corrosion was considered.
2. Fixed pile head condition was assumed.
3. The maximum moment and maximum axial force occurs at the pile heads (bottom of the pier cap). Structural engineers should check the structure capacities of the piles at the bottom of pier.

We anticipate that pile tip elevations will range between El. 5 ft and El. 20 ft based on the widely spaced borings drilled in this preliminary phase. Additional borings are required to develop more refined estimates of pile lengths and pile tip elevations.

Pile point reinforcement (shoes) should be used to protect the pile tip when driving through cobbles and boulders, and into the weathered rock.

It is recommended that one production pile should be driven as a test pile at each abutment and pier for the trestle bridge structure. Due to the presence of organic soils and relatively high groundwater levels, we recommend the piles be designed for corrosion protection by including an allowance for 1/16-inch corrosion on the piles.

At-Grade Railroad Tracks

Two segments of railroad tracks within the Hockomock Swamp area, on either side of the trestle, will be constructed at-grade. The two segments are between Stations 1325+50 to 1425+00, and Stations 1510+00 to 1531+00. Preliminary plans show the top of rail to be within 0 to 3 feet of the existing grade. It is recommended that the track subgrade be cleared of all unsuitable organic and fill materials and replaced with structural fill. The structural fill material, where needed, should be free from organics and other deleterious substances and should conform to the requirements listed in the MBTA Standard Specification Section 02200 - Earthwork for Type B Gravel Borrow. The structural fill should be compacted to 95% of the maximum dry density as determined by the Modified Proctor compaction test (ASTM D1557).

Retaining Walls

Lateral earth pressure parameters are required for the design of retaining walls at the approaches to the trestle. The maximum wall height is anticipated to be approximately 5 feet.

The following lateral earth pressures are recommended for retaining walls backfilled with properly compacted materials as defined under fill placement and compaction.

Since the retaining walls that can develop "active" pressures, equivalent fluid pressures of 40 pounds per cubic foot (pcf) should be used for backfill consisting of granular backfill. Additional lateral pressures due to railroad traffic surcharge should also be used.

For passive pressures, an equivalent fluid pressure of 360 pcf should be used. The effects of the top two feet of wall embedment should be ignored in utilizing passive pressure.

It is recommended that the foundation soil has a maximum net allowable pressure of 4 kips per square feet (ksf) and a sliding resistance coefficient of 0.45.

Seismic Consideration

The seismic design should comply with the requirements of the most current Massachusetts State Building Code 780 CMR and other relevant project design codes such as AREMA and AASHTO. Modification of the peak acceleration by the soils overlying bedrock depends upon the type of soil at the site. For the subsurface conditions encountered at the Hockomock Swamp, the site is classified as Seismic Site Class D soil profile in accordance with 780 CMR Chapter 1614.0 Section 9.4 Site Ground Motion. The trestle structure should be designed for the total lateral seismic force using the equations specified in the code, or by the response spectrum method using the design spectra presented in the code. The maximum considered earthquake ground motions shall be as represented by the spectral response acceleration at short periods (Ss) and at 1-sec (S_1) obtained from Table 1604.10 of the Massachusetts State Building Code and adjusted for Site Class effects using the site coefficients of Section 9.4.1.2.4.

For Site Class D Soils at the location of this station:

S_{MS} = 0.384 and S_{M1} = 0.149

S_{DS} = 0.256 and S_{D1} = 0.099

where:

- S_{MS} is the maximum consider earthquake spectral response acceleration for short periods adjusted for site class
- S_{M1} is the maximum consider earthquake spectral response acceleration at 1-sec adjusted for site class
- S_{DS} is the design earthquake spectral response acceleration for short periods adjusted for site class
- S_{D1} is the design earthquake spectral response acceleration at 1-sec adjusted for site class

The building code also requires that the soil be evaluated for the following potential hazards: soil liquefaction, or surface rupture due to faulting or lateral spreading. The existing overburden soils do not appear to be subject to surface rupture due to faulting or lateral spreading.

Liquefaction

Jacobs performed an analysis for liquefaction potential of the site. The simplified method described by Youd et al. (2001), and refined by Cetin et al. (2004) was used to assess liquefaction. For the site class D and peak horizontal ground surface acceleration value of 0.110g, and based on the recorded water levels, percentage of fine contents and sample relative densities, obtained from the borings, the existing soils underlying the site are judged to be not susceptible to liquefaction. Further liquefaction analysis is recommended when additional borings are performed for the final design.

CONSTRUCTION CONSIDERATIONS

Foundation Installation – Pile Foundations

Installation of piles should be done per MBTA Standards. Piles should be driven to refusal on the bedrock. No more than one splice should be permitted per pile. Care should be taken in driving piles to hard rock to avoid tip damage. Pile tips should be protected using a cast steel tip. With the hardened tip, we anticipate the piles to penetrate through the boulders without difficulty. Piles should have minimum yield strength of 50 ksi. A relatively small hammer should be used to minimize the risk of pile damage. In our opinion, a hammer with a rated energy of around 15,000 ft-lb per blow would be appropriate for this site.

Subgrade Preparation

Prior to performing any required grading operations and excavations in the proposed at-grade railroad track footprints, the area should be stripped of topsoil, vegetation, and organic silt. Following site clearing, stripping, and required excavations, the exposed subgrade should be proof compacted with 10 passes of a large vibratory drum roller (minimum 10,000 pound static weight). Any pockets of excessively soft, wet or disturbed soil or unsuitable soils should be removed and replaced with properly compacted fill materials.

If additional rolling does not correct the unstable condition as determined by the project geotechnical engineer, the subgrade should be scarified to a depth of at least six inches but not exceeding eighteen inches, aerated, re-compacted, and retested to provide uniform compaction. Following satisfactory compaction of the subgrade, controlled compacted fill material should be placed to bring the site to the required grade.

Fill should not be placed over frozen soil. Soil subgrades should be protected against frost both during and after construction.

Proper drainage of construction areas should be provided to protect the subgrades from the detrimental effects of weather conditions. Excavations should be made with as few passes of the backhoe bucket as possible to reduce disturbance of the subgrade. A backhoe bucket fitted with a smooth blade should be used during the final subgrade preparation, where necessary. The exposed base should be kept free of standing water at all times. The site should be graded to carry any surface runoff away from the work areas.

Fill Placement and Compaction

Fill materials for at-grade construction and for the approach retaining walls most likely will be obtained by importing granular fill materials from off-site borrow sources. However, it may be possible to reuse existing site granular fill material provided that it can be properly placed and compacted. The gradation shall be in accordance with MBTA Standard Specification Section 02200-Earthwork for Type B Gravel Borrow.

All structural fill for the retaining walls and railroad track bed (below the ballast) should be free of organics, demolition debris or other deleterious substances. The fill material should have a plasticity index (PI) less than 4 and a liquid limit (LL) less than 10, and contain fragments less than 4 inches in maximum dimension. Each lift should be compacted to the specified density prior to placing any subsequent lift. All materials to be used as structural fill should be tested in the laboratory to determine their project suitability and compaction characteristics.

The fill should be systematically compacted to 95 percent of the maximum dry density per ASTM D 1557. Soils which exhibit a well-defined moisture content–dry density relationship should be compacted to within plus or minus two percentage points of the optimum moisture content.

Where fill materials are placed against an existing embankment slope, the slope should be benched as the fill is brought up in layers. Benching should be of a sufficient width to permit placing and compaction of fill material upon the existing embankment materials. Typically, benches are between four to eight feet wide. Each bench cut should begin at the intersection of the existing embankment and the vertical side of the previous bench. Trench backfills over pipelines or utility structures should be performed so as not to adversely impact the underlying utilities. In fill areas, the backfill material, compaction method, and degree of compaction requirements should be similar to that for the fill adjacent to the trench.

Construction Dewatering

All excavations should be performed in the dry condition. Discharge of pumped water should be performed in accordance with all federal, state and/or local regulations which may require a discharge permit and possible filtration and chemical testing of the water prior to discharge.

Permanent Slopes

Permanent slopes with loamed and seeded surfaces should not be steeper than 2-1/2 horizontal to 1 vertical (2-1/2H:1V) without slope protection to limit erosion and surficial sloughing of the slope. Additional analyses may be required to assess the stability of slopes steeper than 2-1/2H:1V as the area design is finalized.

Excavation Slopes and Shoring

The slopes of temporary open cuts should be no steeper than 1-1/2H:1V. Open cuts should not be used below the water table because of the likelihood of soil sloughing into the excavation.

The temporary excavation support system, if needed, should be selected by the Contractor and designed by an experienced Professional Engineer registered in the Commonwealth of Massachusetts and retained by the Contractor. Where excavation sides can be sloped back, they should be performed in accordance with the Occupational Safety and Health Administration (OSHA) Construction Industry Standards.

CLOSING

This report and the recommendations contained herein have been prepared for the exclusive use of MBTA and VHB and their representatives for specific application to the design and construction of the proposed trestle and at-grade railroad tracks at the Hockomock Swamp in Raynham, Massachusetts.

This report was prepared in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made. The analysis, design and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations available at the time of this report. Subsurface stratification variations between borings are anticipated. The reported groundwater levels only represent the water levels at the time noted on the logs. The nature and extent of variations between these explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

ATTACHMENTS

FIGURE 1 – PROJECT LOCATION PLAN
FIGURE 2A – 2I – SUBSURFACE EXPLORATION PLAN
FIGURE 3A – 3C – SUBSURFACE PROFILE
APPENDIX A – EXPLORATION LOGS
APPENDIX B – LABORATORY DATA
APPENDIX C – GEOTECHNICAL CALCULATIONS

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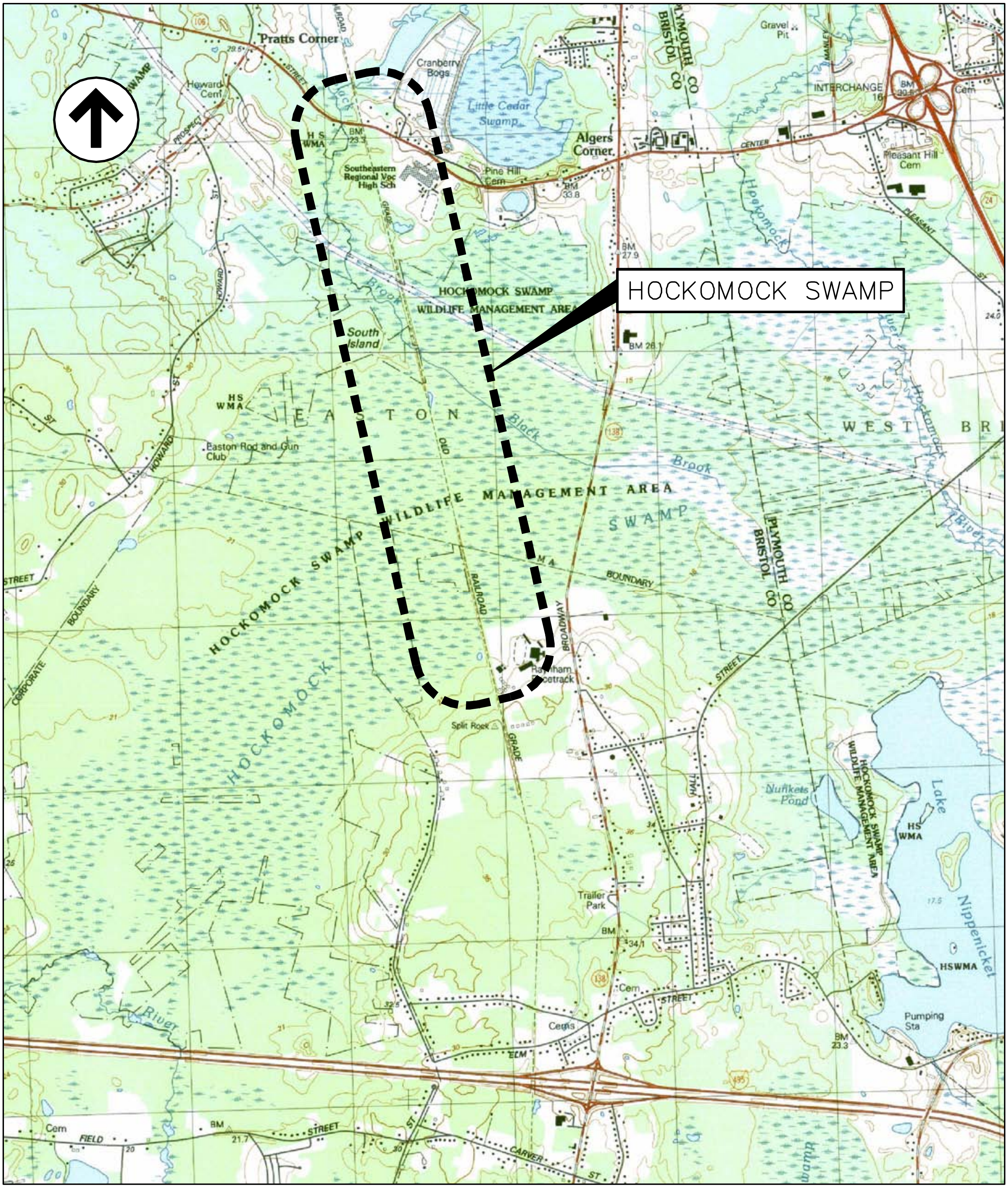
FIGURES

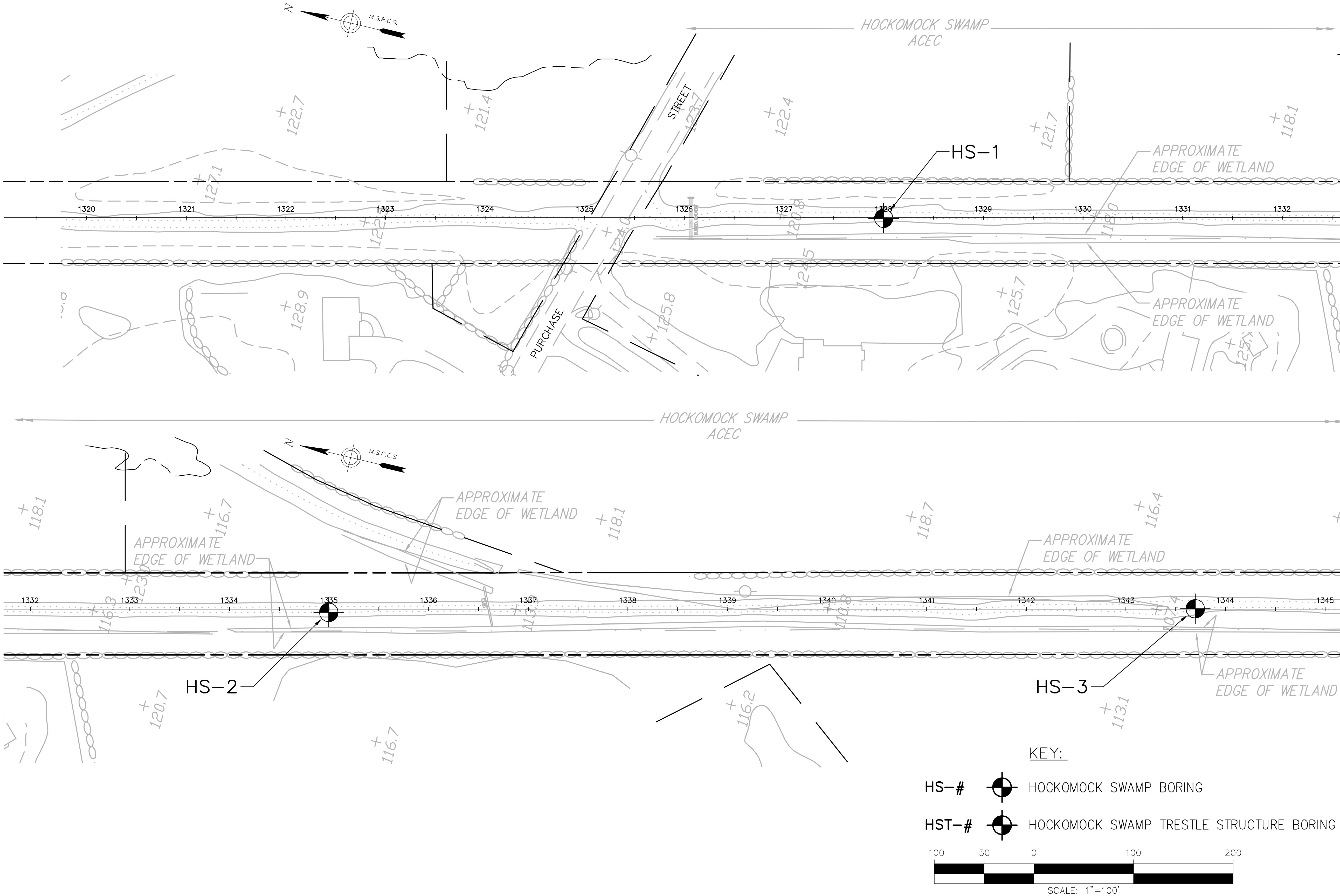


<u>HOCKOMOCK SWAMP</u>

<u>PROJECT LOCUS PLAN</u>

NOT TO SCALE

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY	HOCKOMOCK SWAMP
SOUTH COAST RAIL COMMUTER RAIL EXTENSION PROJECT MBTA CONTRACT NO. X2PS68	EASTON, MASSACHUSETTS FIGURE 1



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MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

SOUTH COAST RAIL
COMMUTER RAIL EXTENSION PROJECT
MBTA CONTRACT NO. X2PS68

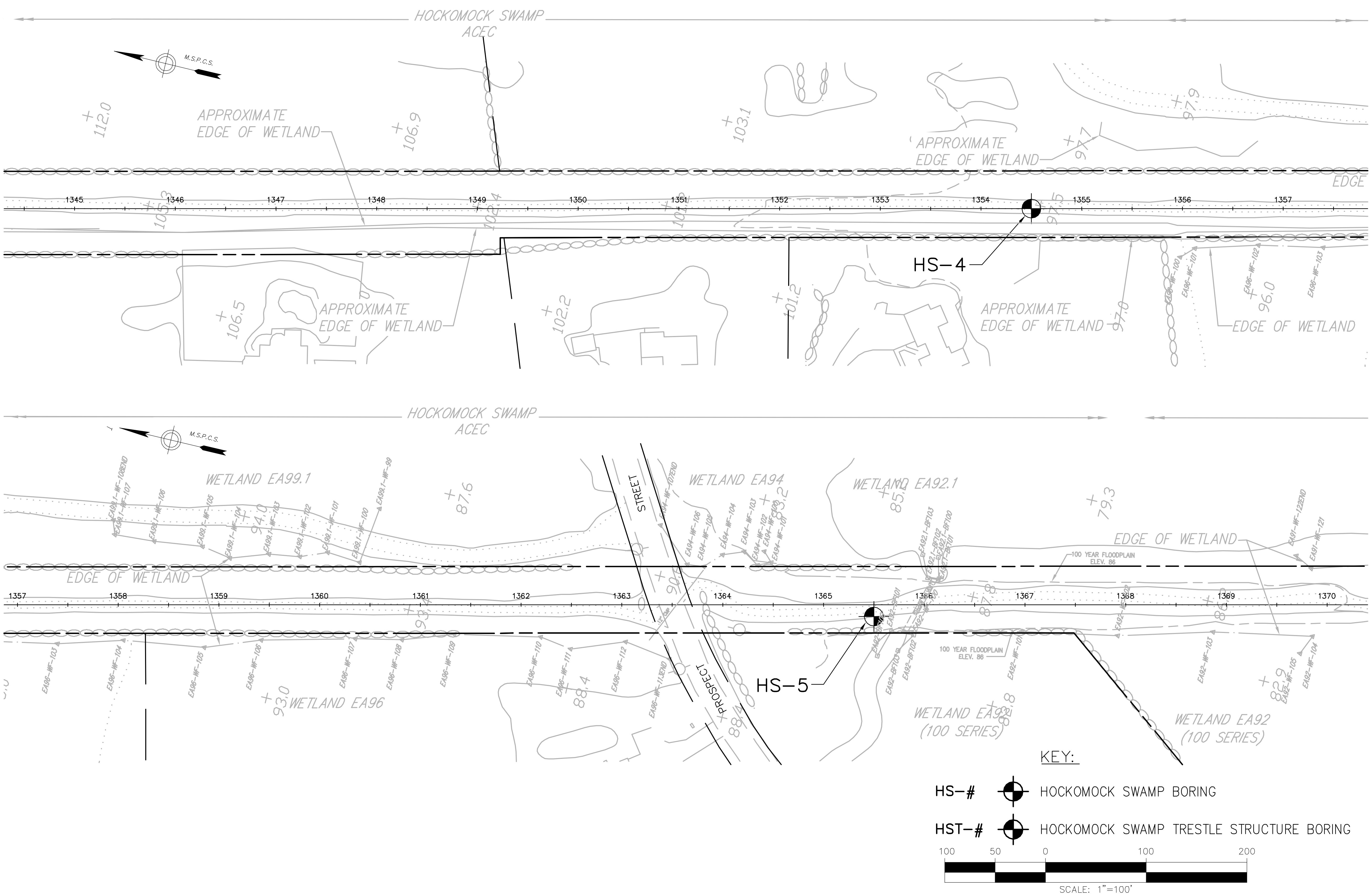
JACOBS

343 CONGRESS STREET
BOSTON, MA 02110
(617) 242-9222

STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2A



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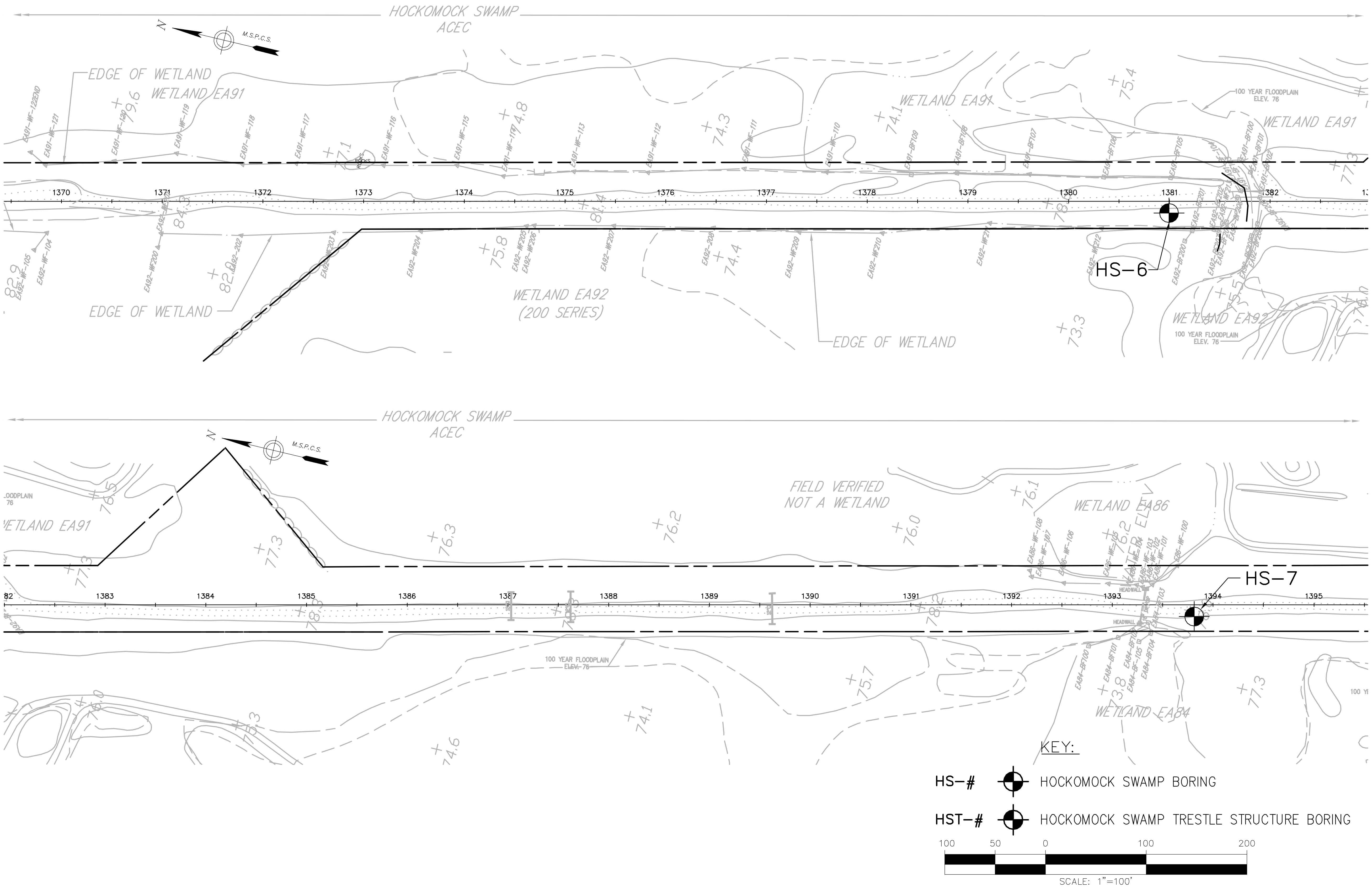
STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2B



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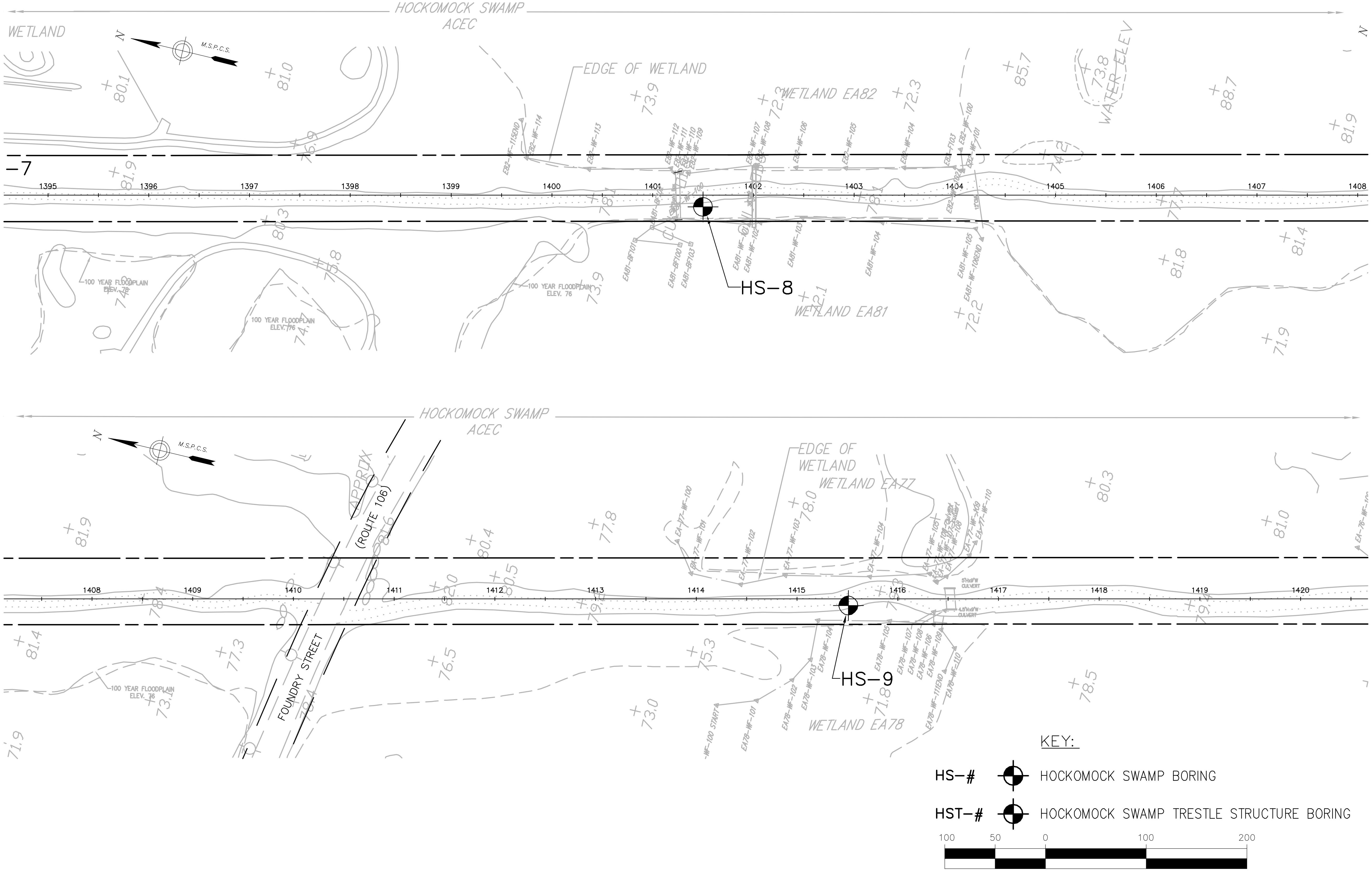
STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2C



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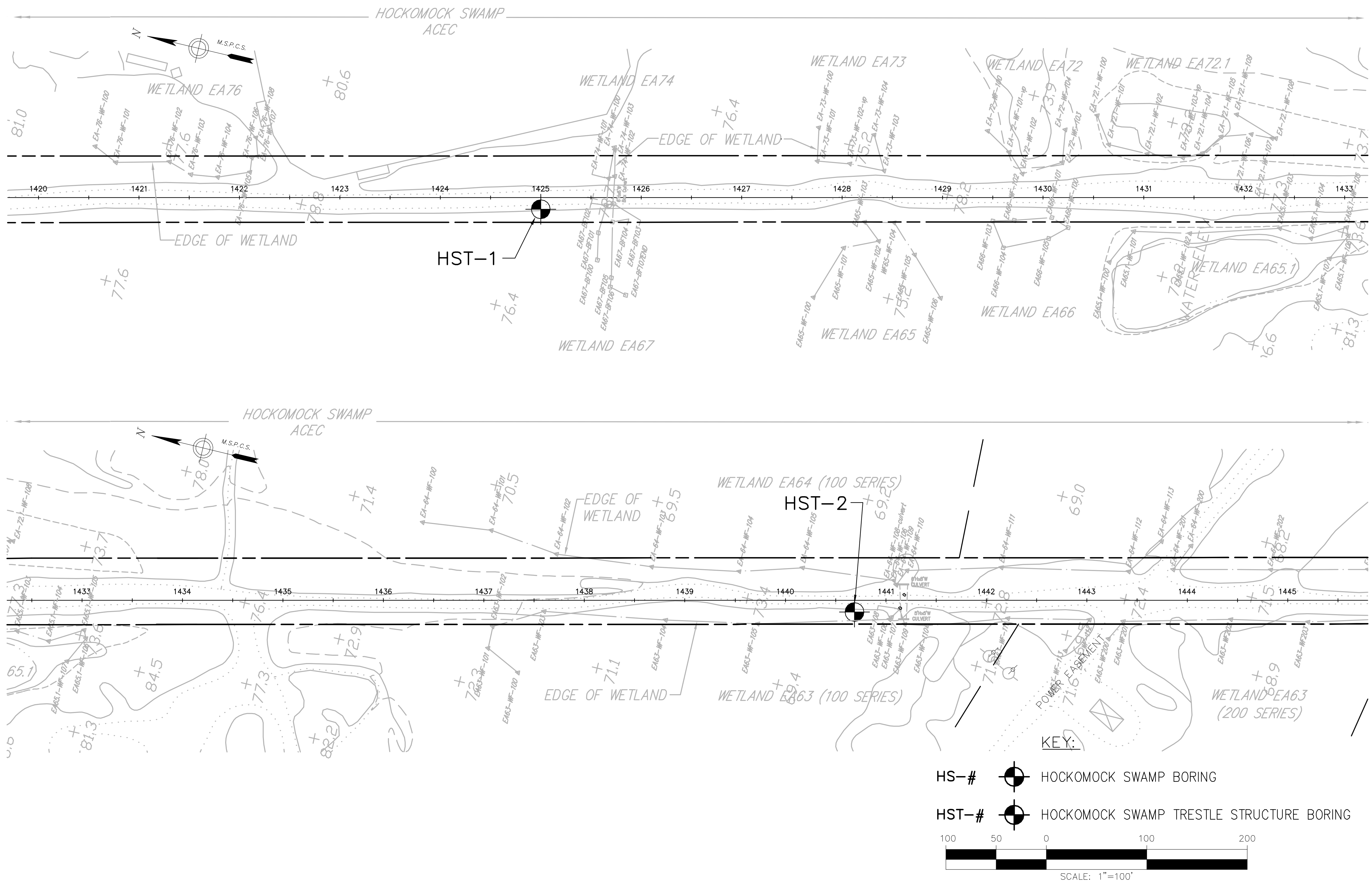
STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2D



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STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2E

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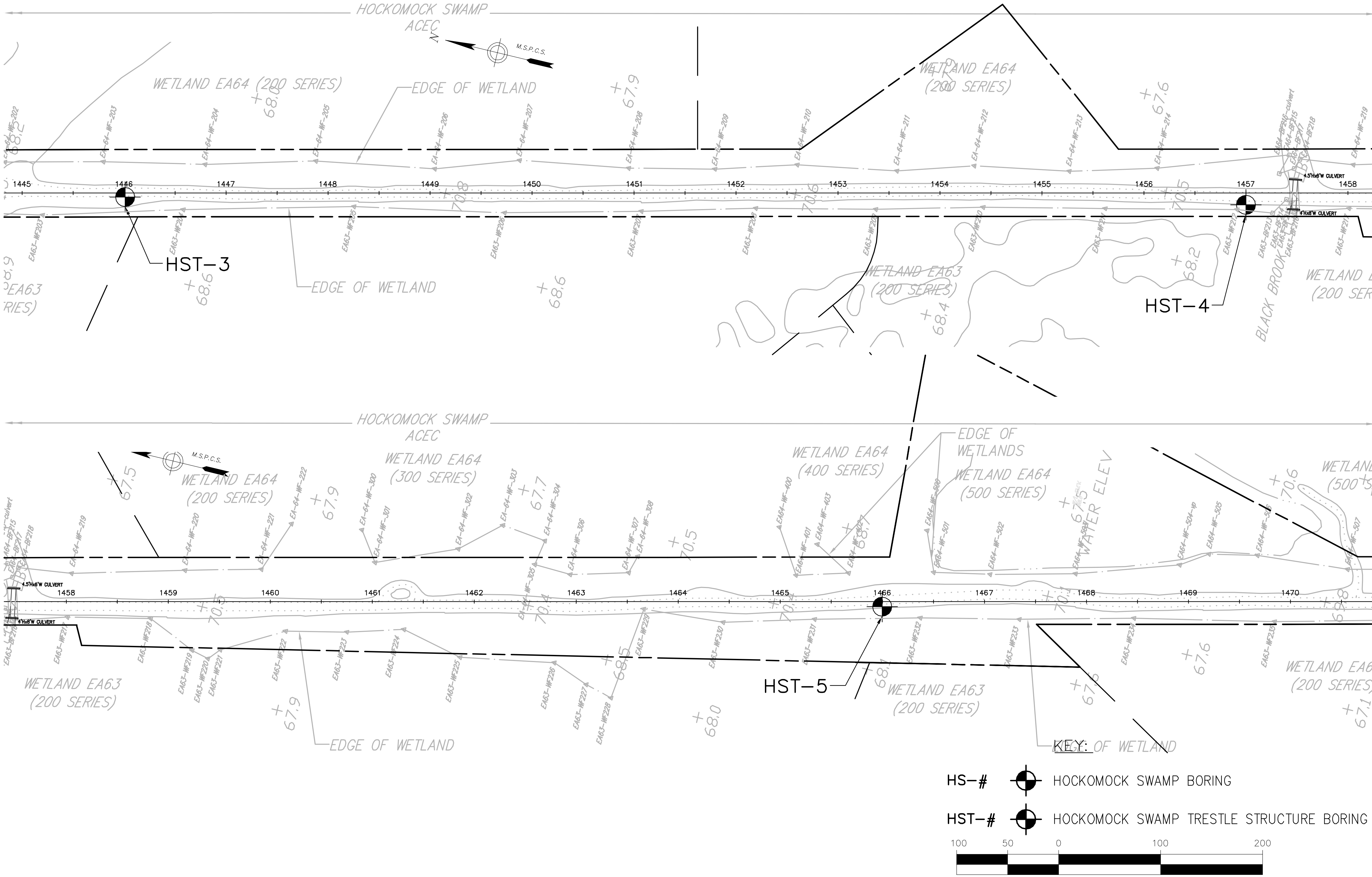

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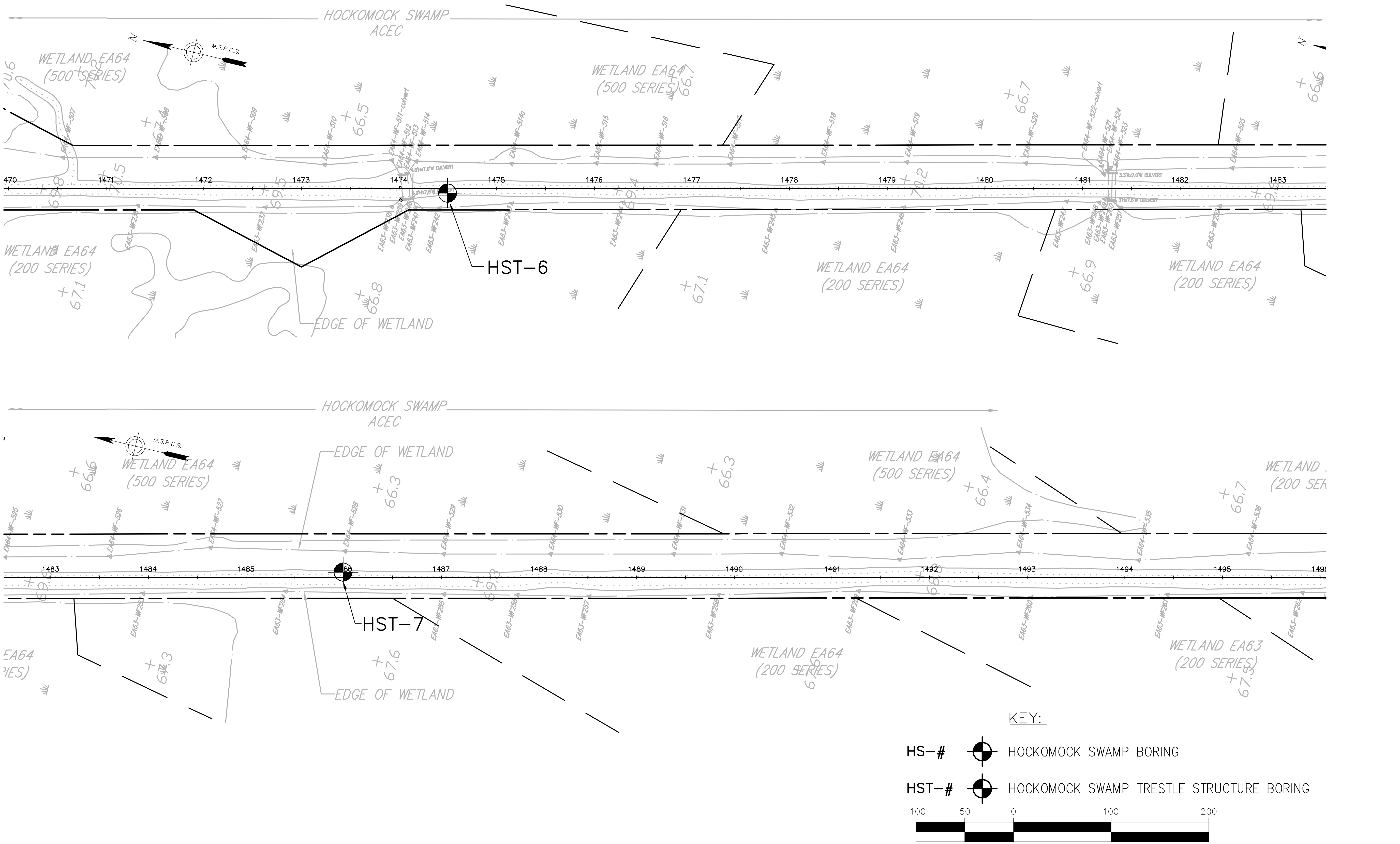
STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2F



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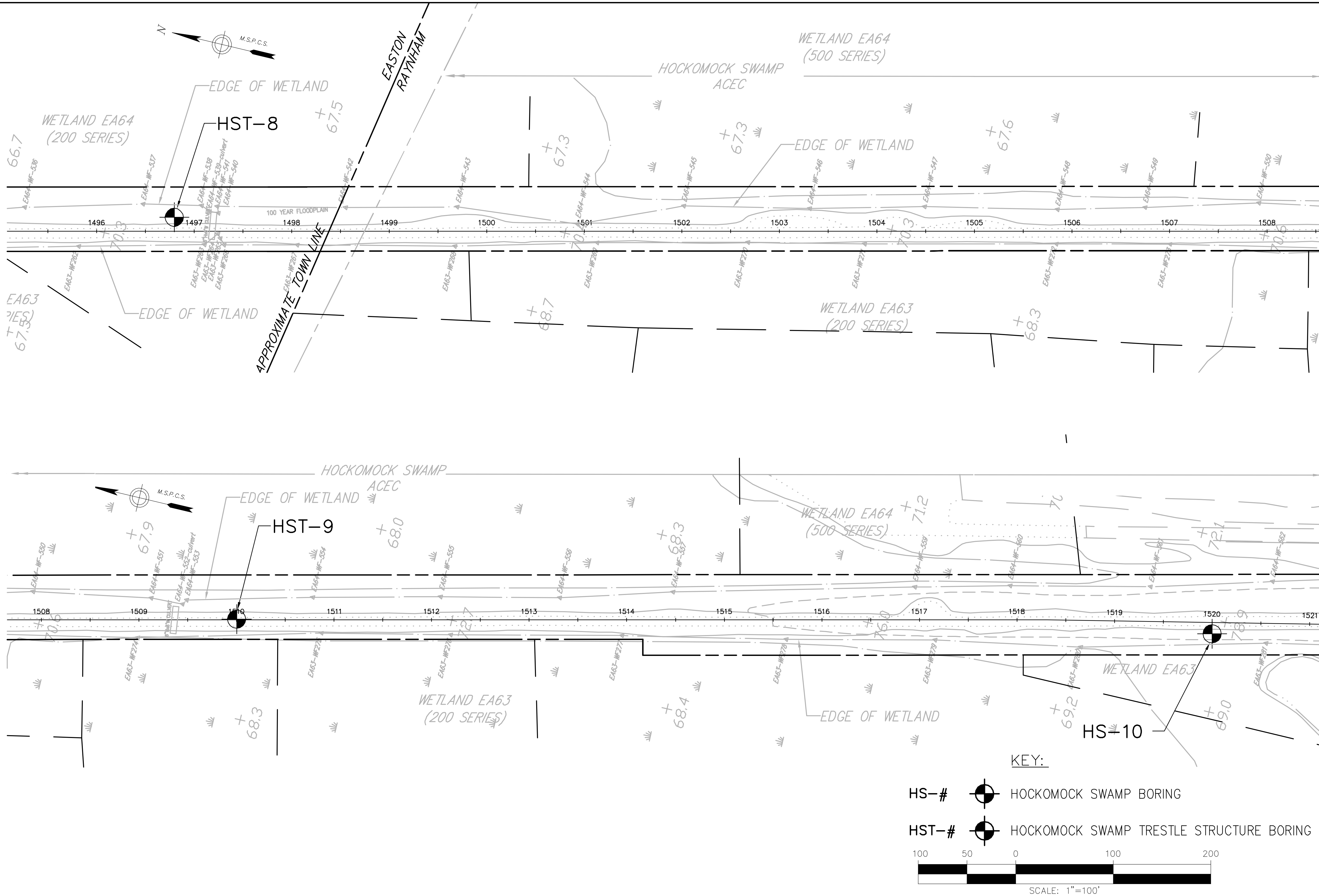
(617) 242-9222

STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012
FIGURE NO: 2G



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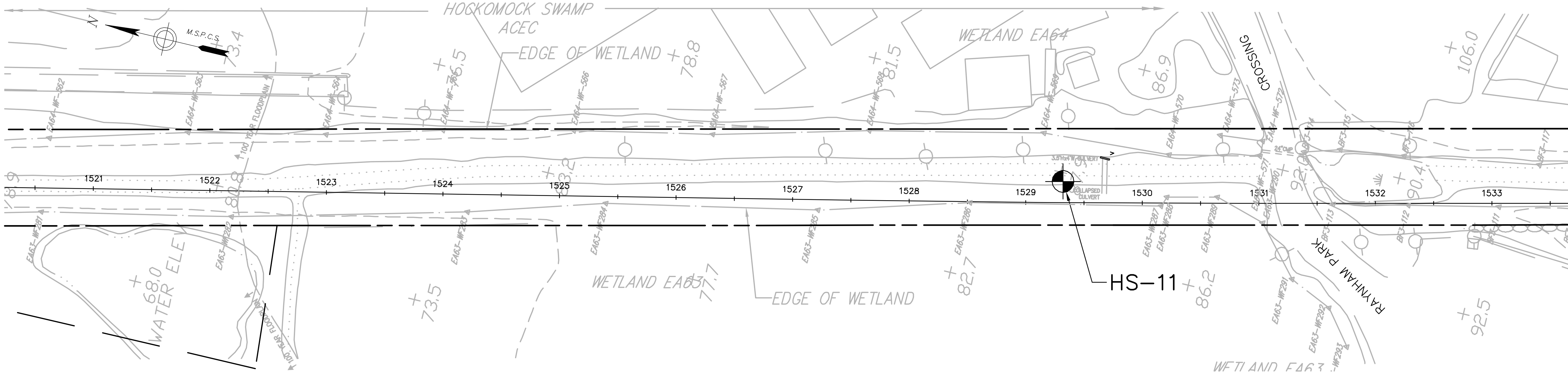
STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2H



KEY:

HS-# HOCKOMOCK SWAMP BORING

HST-# HOCKOMOCK SWAMP TRESTLE STRUCTURE BORING

100 50 0 100 200

SCALE: 1"=100'

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HOCKOMOCK SWAMP
SUBSURFACE EXPLORATION PLAN

DATE: MARCH 2012

FIGURE NO: 2I

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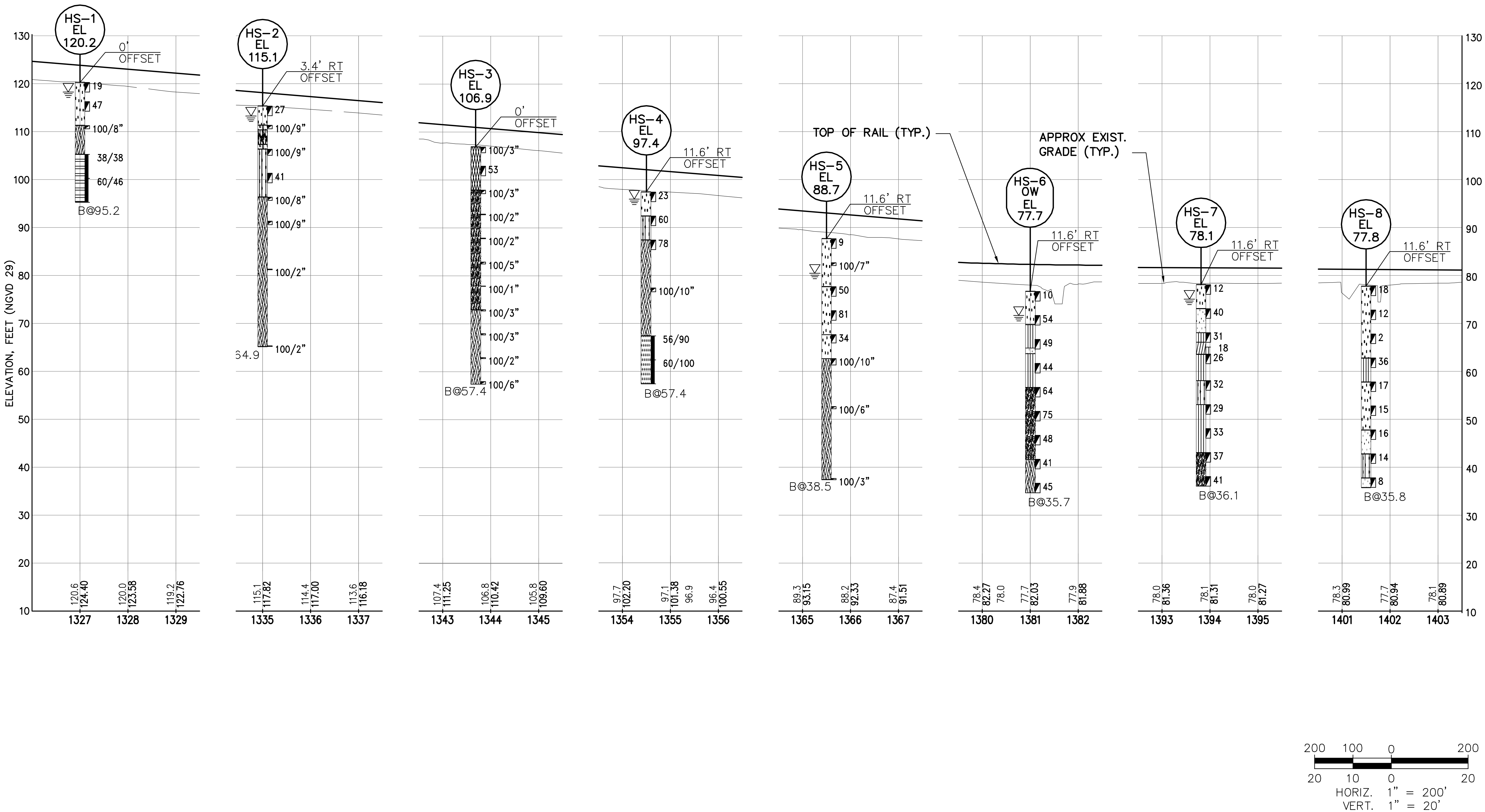

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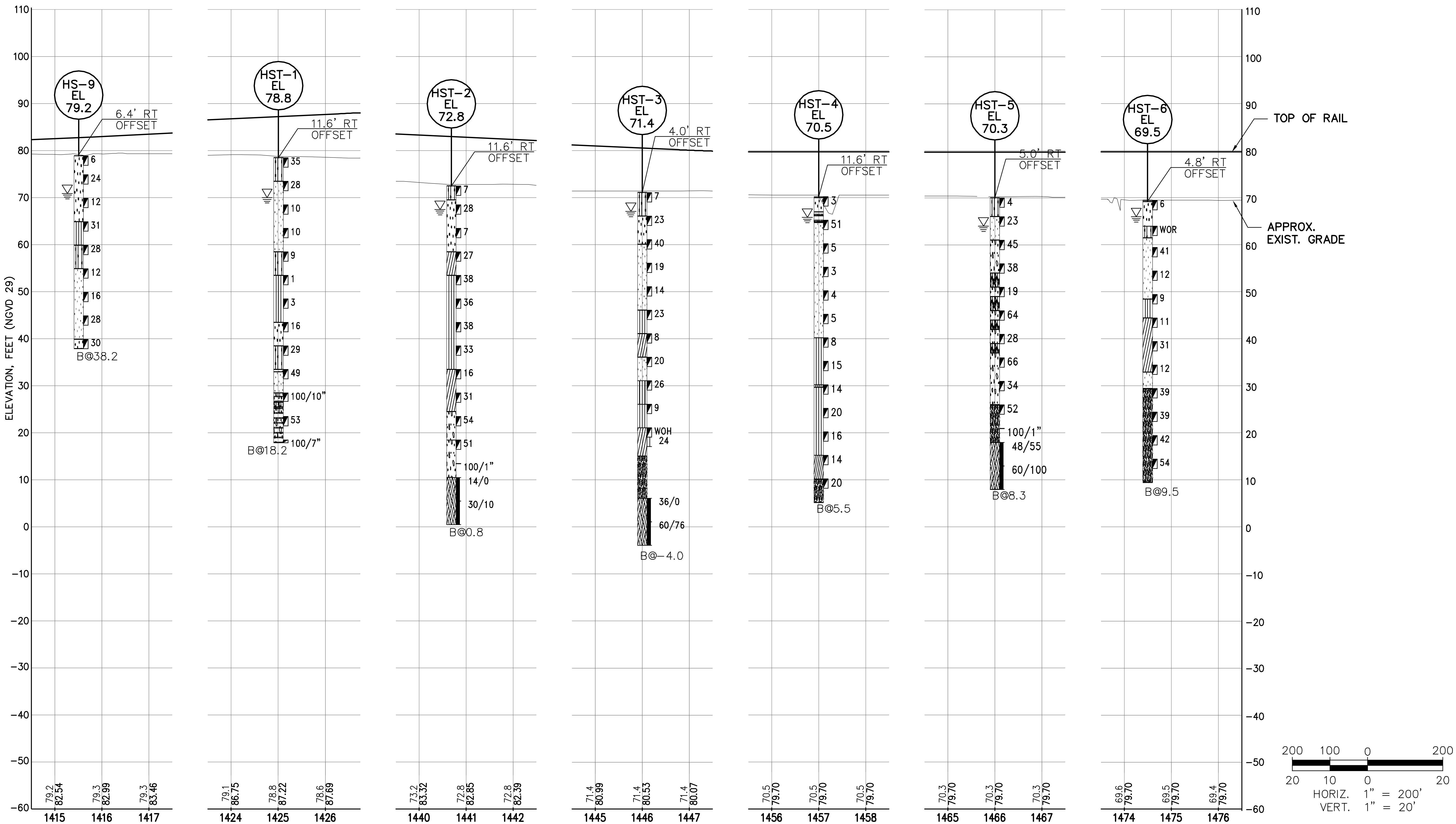
STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE PROFILE

DATE: MARCH 2012

FIGURE NO: 3A



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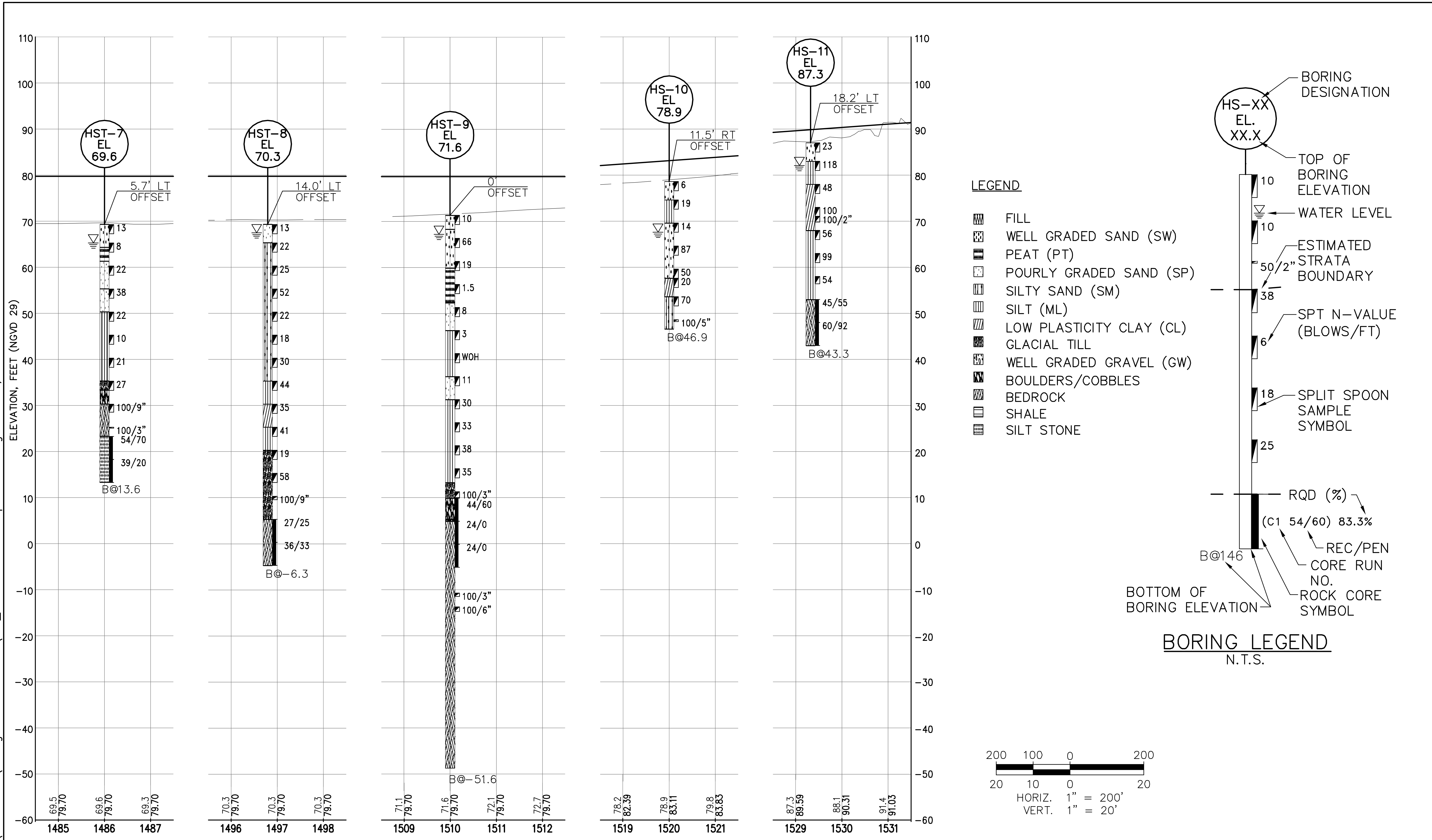
STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE PROFILE

DATE: MARCH 2012

FIGURE NO: 3B



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STOUGHTON LINE
HOCKOMOCK SWAMP
SUBSURFACE PROFILE

DATE: MARCH 2012

FIGURE NO: 3C

APPENDIX A: EXPLORATION LOGS

HST-1 to HST-9
HS-1 to HS-11

LOG OF TEST BORING

JACOBS			BORING NO.	HST-1
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	Mike (ME)	ELEVATION	78.8
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	Mobile Drill	DATUM	NGVD 29

METHOD OF DRILLING		DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID COORD	N	2828542.27
0.0	Auger							E	769018.31
5.0	Wash Boring w/Casing						DATE START		1/27/12
60.6	Terminated						DATE END		1/30/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0		2 19 16 10	1	0 - 2	8		Silty SAND with Gravel (SM) - mostly fine sand, some silt, little fine to coarse gravel, dark brown, moist.
5		12 14 14 15	2	5 - 7	24	73.8	Poorly graded SAND (SP) - Mostly fine SAND, wet, tan
10		2 5 5 7	3	10 - 12	18		Poorly graded SAND (SP) - Mostly fine SAND, trace silt, wet, tan
15		4 5 5 5	4	15 - 17	15		Similar to S3
20		6 4 5 5	5	20 - 22	15	58.8	Silty SAND (SM) - Mostly fine SAND, little(-) silt, tan, wet, no plasticity
25		2 .5 .5 3	6	25 - 27	24	53.8	SILT (ML) - non-plastis silt, olive brown, moist.
30		3 2 1 2	7	30 - 32	19		Similar to S6
							Change in drilling at 34' - Possible gravel
35							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-1

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO. HST-1
	LOCATION	Hockomock Swamp	
	OWNER	Mass.Bay Transportation Authority	
	JOB NUMBER	E2347101	SHEET 2 OF 2

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
35	5 7 9 7	8	35 - 37	6	43.8	Well graded SAND (SW) - Mostly f/c SAND, little(+) silt, little(-) fine gravel, tan, wet
40	16 14 15 18	9	40 - 42	15	38.8	Silty SAND (SM) - Mostly fine SAND, some(+) silt, tan, wet
45	13 16 33 25	10	45 - 47	11	33.8 33.3	(Top 8" of sample): Well graded SAND (SW) - Mostly f/c SAND, trace fine gravel, grey & reddish brown, wet (Bottom 3" of sample): Poorly graded SAND (SP) - Mostly fine SAND, some(-) fine gravel, little silt, grey, wet -TILL-
50	51 35 100/10"	11	50 - 51.83	11	28.8	Well graded SAND with gravel (SW) - Mostly f/c SAND, some(-) f/c gravel, brown, wet -TILL-
					26.8	Boulder from 52'-53' (roller bit)
55	16 22 31 41	12	55 - 57	12	25.8	Well graded SAND with gravel (SW) - Mostly f/c SAND, some f/c gravel, trace silt, brown, wet -TILL-
60	100/7"	13	60 - 60.58	13	18.2	Similar to S12
						Bottom of Hole at 60.6'.
65						
70						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-1

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-2
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	P. Rushina	ELEVATION		72.8
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	D50 ATV	DATUM		NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2827016.56
62.0	NX Rock Core						COORD	E	769383.02
72.0	Terminated						DATE START		1/25/12
							DATE END		1/26/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0		2 2 5 8	S1	0 - 2	12		Silty SAND with Gravel (SM) - mostly fine sand, some silt, little fine to coarse gravel, dark brown, moist.
3						69.8	
5		12 12 16 17	S2	4 - 6	16	▼	Well graded SAND (SW) - Mostly f/c SAND, trace fine gravel, light brown, wet
10		3 3 4 23	S3	9 - 11	0		No recovery
15		10 13 14 17	S4	14 - 16	10	58.8	Lean CLAY (CL) - grey, wet, medium plasticity, moist.
20		16 20 18 19	S5	19 - 21	9	53.8	SILT (ML) - grey, wet, no plasticity
25		12 18 18 18	S6	24 - 26	20		Similar to S5
30		15 18 20 21	S7	29 - 31	12		SILT (ML) - grey, wet, very low plasticity
35		8	S8	34 - 36	11		Similar to S7

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-2

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-2
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 2 OF 2
	JOB NUMBER	E2347101		

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
	14 19 23					
40	12 7 9 11	S9	39 - 41	15	33.8	Lean CLAY (CL) - grey, wet, medium plasticity
45	4 11 20 11	S10	44 - 46	10		Similar to S9 Change in drilling at 48' - Possible till
50	24 36 18 23	S11	49 - 51	3	24.8	Well graded GRAVEL with sand (GW) - Mostly f/c GRAVEL, some(-) f/c sand, brown, wet -TILL- Boulder at 53', driller losing water (rolller bit)
55	24 34 17 25	S12	54 - 56	5	18.8	Well graded GRAVEL with silt and sand (GW) - Mostly f/c GRAVEL, some f/c sand, little (-) silt, black (possible rock or weathered rock fragments)
60	100/1"	S13	59 - 59.08	0		No recovery, spoon bouncing Roller bit to 62', possible top of rock
	RQD=0	C-1	62 - 67	14	10.8	Minutes/ft = 1 - 1 - 1 - 1 - 2 Completely weathered rock, possible shale, black
65						
	RQD=10	C-2	67 - 72	30		Minutes/ft = 3 - 4 - 4 - 3 - 4 Severely weathered rock with completely weathered seams, possible shale, black
70					0.8	
						Bottom of Hole at 72'.

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-2

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-3
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 3

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	Mike (ME)	ELEVATION		71.4
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM		NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2826500.48
5.0	Wash Boring w/Casing						COORD	E	769514.16
65.0	NX Rock Core						DATE START		1/25/12
75.0	Terminated						DATE END		1/26/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0		2, 2, 5, 10	S1	0 - 2	10		Silty SAND with Gravel (SM) - mostly fine sand, some silt, little fine to coarse gravel, dark brown, moist.
5		16, 18, 5, 3	S2	5 - 7	0	66.4	No recovery
10		6, 17, 23, 24	S3	10 - 12	12		(Top 6" of sample): Similar to S1
						60.4	(Bottom 6" of sample): Poorly graded SAND (SP) - Mostly fine SAND, trace fine gravel, trace silt, light brown, wet
15		5, 6, 13, 16	S4	15 - 17	10		Same as S3B
20		3, 6, 8, 10	S5	20 - 22	3		Same as S3B
25		6, 7, 16, 13	S6	25 - 27	13	46.4	SILT (ML) - Mostly SILT, little(-) fine sand, grey, wet
30		3, 4, 4, 3	S7	30 - 32	24	41.4	Lean CLAY (CL) - grey, wet, medium plasticity. Attempt to push Shelby Tube at 32', unable to advance sample - too stiff
35							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-3

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-3
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 2 OF 3

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		12 11 9 8	S8	35 - 37	14	36.4	Poorly graded SAND (SP) - Mostly fine SAND, trace silt, light brown, wet
40		6 13 13 18	S9	40 - 42	13	31.4	Elastic SILT (MH) - Mostly silt, some(-) clay, grey, wet, medium plasticity, slow dilatancy, approx. 1/8" diameter thread rolled
45		3 5 4 4	S10	45 - 47	7	26.4	SILT (ML) - grey, wet, no plasticity
50		WOH WOH 3 4	S11	50 - 52	22	21.4	Lean CLAY (CL) - Mostly clay, little(-) silt, grey, wet, medium plasticity
			UD1	52 - 54	24		.90 tsf penetrometer
55						15.4	Change in drilling at 56'-3" Possible till
60							
							Top of rock at 65'
65		RQD=0	C1	65 - 70	36	6.4	Severely to completely weathered rock
70		RQD=76	C2	70 - 75	60		Blue-grey rock, sandstone

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

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COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-3

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-3
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 3 OF 3
	JOB NUMBER	E2347101		

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
75						-3.6	Bottom of Hole at 75'. Observation well set at 15' (10' screen, 5' riser)
80							
85							
90							
95							
100							
105							
110							

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SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-3

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-4
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 1 OF 2
	JOB NUMBER	E2347101		

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	Mike (ME)	ELEVATION		70.5
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM		NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2825429.93
5.0	Wash Boring w/Casing						COORD	E	769762.28
65.0	Terminated						DATE START		1/24/12
							DATE END		1/25/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	2 1 2 5	S1	0 - 2	8	70.3	(Top 3" of sample) - Well graded SAND (SW) - Mostly f/c SAND, trace fine gravel, possible slag, black, dry (Bottom 5" of sample) - Well graded SAND (SW) - Mostly f/c SAND, little silt, trace fine gravel, moist, light brown
					67.3	Change in wash color at 3'-4"
5	4 10 41 16	S2	5 - 7	20	65.0	(Top 2" of sample) - PEAT (PT) - brown, wet (Bottom 18" of sample) - Poorly graded SAND (SP) - Mostly fine SAND, tract silt, wet brown
10	1 2 3 5	S3	10 - 12	12		Poorly graded SAND (SP) - Mostly fine SAND, little(-) silt, tan, wet
15	1 2 1 2	S4	15 - 17	10		Similar to S3
20	2 2 2 3	S5	20 - 22	12		Similar to S3
25	WOH 2 3 4	S6	25 - 27	12		Similar to S3, very loose
30	WOH 3 5 3	S7	30 - 32		40.5	Sandy SILT (ML) - little(+) fine sand, wet, non-cohesive
35						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-4

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-4
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		7 9 6 4	S8	35 - 37	10		SILT (ML) - Mostly SILT, little(-) clay, grey, wet, low plasticity, 1.5 tsf penetrometer
40		WOH 6 8 8	S9	40 - 42	21	30.5 30.0	(Top 6" of sample) - Lean CLAY (CL) - wet, grey, stiff, 1.5 tsf (penetrometer) (Bottom 15" of sample) - SILT (ML) - wet, grey, stiff
45		8 10 10 10	S10	45 - 47	14		SILT (ML) - non-plastic clay, wet, grey.
50		7 8 8 10	S11	50 - 52	20		Similar to S10
55		3 7 7 10	S12	55 - 57	24	15.5	Lean CLAY (CL) - wet, grey, medium plasticity, approx. 1/8" thread rolled, stiff
60		10 11 9 19	S13	60 - 62	5	10.5	Well graded SAND with gravel (SW) - Mostly f/c SAND, some f/c gravel, little(-) silt Roller bit to 65' No change in color or density
65						5.5	Bottom of Hole at 65'.
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-4

LOG OF TEST BORING

JACOBS

PROJECT	New Bedford/Fall River Commuter Rail			BORING NO.	HST-5
LOCATION	Hockomock Swamp				
OWNER	Mass.Bay Transportation Authority				
JOB NUMBER	E2347101				SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	P. Rushina	ELEVATION		70.3
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	D50 ATV	DATUM		NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2824556.4
52.0	NX Rock Core						COORD	E	769977.94
62.0	Terminated						DATE START		1/24/12
							DATE END		1/25/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
	1 1 3 6	S1	0 - 2	5		Silty SAND (SM) - mostly fine sand, some silt, dark brown, moist.
5	8 9 14 20	S2	4 - 6	12	66.3	Poorly graded SAND (SP) - Mostly fine SAND, little silt, light brown, wet
10	18 25 20 17	S3	9 - 11	7	61.3	Well graded GRAVEL with sand (GW) - Mostly f/c GRAVEL, some(-) f/c sand, trace silt, dark brown, wet
15	16 21 17 46	S4	14 - 16	16		Similar to S3
					54.3	Cobbles from 16'-19', driller losing water (roller bit)
20	12 10 9 10	S5	19 - 21	2	51.3	Poorly graded GRAVEL (GP) - Mostly coarse gravel, varying colors (tan, red, brown), wet
					49.3	Cobbles from 21'-24' (roller bit)
25	22 32 32 37	S6	24 - 26	5	46.3	Well graded GRAVEL with sand (GW) - Mostly f/c GRAVEL, some(-) f/c sand, light brown, wet
					44.3	Cobbles from 26'-28', no water return (roller bit)
30	5 8 20 16	S7	29 - 31	6	42.3	Similar to S6
					39.3	Cobbles from 31'-33' (roller bit)
35	16	S8	34 - 36	7	37.3	Well graded GRAVEL with sand (GW) - Mostly fine to coarse GRAVEL, some(-) f/c

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) · Rock Core (RC) and RQD (%) REC (%) · Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) · Undisturbed (U)-Shelby Tube, (P)-Piston · Jar Sample (JS) · Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-5

LOG OF TEST BORING

JACOBS			
PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-5
LOCATION	Hockomock Swamp		
OWNER	Mass.Bay Transportation Authority		
JOB NUMBER	E2347101		SHEET 2 OF 2

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
	32 34 30					sand, trace silt, grey, wet
40	26 20 14 30	S9	39 - 41	2		Poorly graded GRAVEL (GP) - Two pieces of 3/4" diameter gravel, wet
					26.3	
45	28 22 30 55	S10	44 - 46	11		Well graded SAND with gravel (SW) - Mostly f/c SAND, some(-) f/c gravel
						Cobbles 47'-48' (roller bit)
	100/1"	S11	49 - 49.08	0		No recovery, spoon bouncing
50						Roller bit to 52', possible top of rock
					18.3	
	RQD=55	C1	52 - 57	48		Run #1 - Cored 52'-57' Minutes/ft = 3 - 5 - 6 - 6 - 7 Possible granite with quartz seams
55						
	RQD=100	C2	57 - 62	60		Run #2 - Cored 57'-62' Minutes/ft = 7 - 7 - 6 - 7 - 8 Same as C1, no quartz seams, fresh rock
60						
					8.3	
						Bottom of Hole at 62'.
65						
70						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-5

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-6
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	Mike (ME)	ELEVATION	69.5
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	Mobile Drill	DATUM	NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N	2823729.66
5.0	Wash Boring w/Casing					E	770175.66
60.0	Terminated					DATE START	1/23/12
						DATE END	1/24/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	1 2 4 5	S1	0 - 2	13	69.3	(Top 3" of sample): Well graded SAND (SW) - Mostly f/c SAND, little silt, trace organics, black, moist (Bottom 10" of sample): Well graded SAND (SW) - Mostly f/c SAND, trace fine gravel, light brown, moist
5	WOR WOR 1 1	S2	5.5 - 7.5	1	64.0	Silty SAND (SM) - mostly fine sand, some silt, little organic material.
					61.5	
10	14 20 21 22	S3	10 - 12	12		Poorly graded SAND (SP) - Mostly fine SAND, grey, moist
15	5 7 5 9	S4	15 - 17	14		Poorly graded SAND (SP) - Mostly fine SAND, trace silt, grey, wet
20	1 4 5 5	S5	20 - 22	12	48.5	(Top 6" of sample): Similar to S4 (Bottom 6" of sample): SILT (ML) - grey, wet
25	2 5 6 5	S6	25 - 27	24	44.5	LEAN CLAY (CL) - medium plasticity clay, gray, wet, approx 1/8" thread rolled
30	8 14 17 11	S7	30 - 32	19		Similar to S6
35						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS); Rock Core (RC) and RQD (%) REC (%); Split-Spoon Sample (SS) and Blow Counts per 6" REC (in); Undisturbed (U)-Shelby Tube, (P)-Piston; Jar Sample (JS); Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-6

LOG OF TEST BORING

JACOBS		
PROJECT	New Bedford/Fall River Commuter Rail	BORING NO. HST-6
LOCATION	Hockomock Swamp	
OWNER	Mass.Bay Transportation Authority	
JOB NUMBER	E2347101	SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		2 5 7 12	S8	35 - 37	22		(Top 19" of sample): Similar to S6
						33.0	(Bottom 3" of sample): Poorly graded SAND (SP) - Mostly f/c SAND, trace fine gravel, trace silt, light brown, wet
40		21 24 15 24	S9	40 - 42	6	29.5	Poorly graded SAND (SP) - Mostly fine SAND, some silt, trace fine gravel, grey, moist, dense -TILL-
45		14 19 20 30	S10	45 - 47	10		Similar to S9 -TILL-
50		20 18 24 38	S11	50 - 52	11		Similar to S9 -TILL-
55		20 17 37 31	S12	55 - 57	7		Well graded SAND with gravel (SW) - Mostly f/c SAND, some f/c gravel, little(-) silt, grey, wet -TILL-
							Roller bit to 60' No change in wash color or density
60						9.5	Bottom of Hole at 60'.
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-6

LOG OF TEST BORING

JACOBS			BORING NO.	HST-7
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	P. Rushina	ELEVATION	69.6
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D50 ATV	DATUM	NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N	2822614.04
46.0	NX Rock Core					GRID COORD E	770453.14
56.0	Terminated					DATE START	1/23/12
						DATE END	1/23/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	3 5 8 20	S1	0 - 2	9		Well graded SAND (SW) - Mostly f/c SAND, trace silt, black, moist
5	6 2 6 6	S2	4 - 6	6	64.6	(Top 3" of sample): Well graded SAND (SW): Mostly f/c SAND, trace organics, light brown, wet (Bottom 3" of sample): Silty SAND (SM); fine sand, some silt, little organic material. Change in wash color at 8'
					61.6	
10	10 11 11 12	S3	9 - 11	12		Poorly graded SAND (SP) - Mostly fine SAND, little(-) silt, tan, wet
15	14 17 21 28	S4	14 - 16	14	55.6	Poorly graded SAND (SP) - Mostly fine SAND, little(-) silt, grey, wet
20	12 12 10 10	S5	19 - 21	13	50.6	Elastic SILT (MH): grey, wet, medium plasticity, medium dry strength
25	4 6 4 4	S6	24 - 26	24		Similar to S5
30	8 9 12 12	S7	29 - 31	18		Similar to S5 0.75 tsf (penetrometer) Too stiff to take Shelby Tube sample
35	19	S8	34 - 36	8	35.6	Well graded GRAVEL with sand (SW) - Mostly f/c GRAVEL, some f/c sand, little silt,

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) — Rock Core (RC) and RQD (%) REC (%) — Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) — Undisturbed (U)-Shelby Tube, (P)-Piston — Jar Sample (JS) — Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-7

LOG OF TEST BORING

JACOBS			BORING NO.	HST-7
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 2 OF 2
	JOB NUMBER	E2347101		

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
	17 10 19					grey, wet -TILL-
					33.6	Hard drilling 36'-39', Drilling losing water, probable boulders & cobbles
40	61 29 100/9"	S9	39 - 40.75	7	30.6	Well graded GRAVEL with silt and sand (GM) - Mostly f/c GRAVEL, some silt, grey, moist -Moderately to severly weathered bedrock-
45	100/3"	S10	44 - 44.25	1		Well graded GRAVEL with silt (GW) - Mostly f/c GRAVEL, some silt, grey, moist -Completley weathered rock-
	RQD=70	C1	46 - 51	54	23.6	Roller bit to 46' - top of rock Minutes/ft = 4 - 4 - 5 - 5 - 5 Sandstone
50	RQD=20	C2	51 - 56	39		Minutes/ft = 3 - 4 - 3 - 3 - 4 Sandstone, more fractures than C1
55					13.6	Bottom of Hole at 56'.
60						
65						
70						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-7

LOG OF TEST BORING

JACOBS			BORING NO.	HST-8
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 1 OF 3
	JOB NUMBER	E2347101		

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	P. Rushina	ELEVATION	70.3
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D50 ATV	DATUM	NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N	2821565.43
64.0	NX Rock Core					E	770712.51
						DATE START	1/19/12
						DATE END	1/20/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
	6 5 8 12	S1	0 - 2	6		Well graded SAND (SW) - Mostly f/c SAND, little(-) fine gravel, trace silt, trace organics, black dry
5	11 14 8 5	S2	4 - 6	12	66.3	Silty SAND (SM) - Mostly fine SAND, some(-) silt, light brown, wet
10	6 11 14 22	S3	9 - 11	7		Silty SAND (SM) - Mostly fine SAND, some(-) silt, trace wood fibers, light brown, wet
15	18 24 28 27	S4	14 - 16	12		Silty SAND (SM) - Mostly fine SAND, some(+) silt, grey, wet
20	6 10 12 16	S5	19 - 21	13		Similar to S4
25	7 7 11 12	S6	24 - 26	6		Similar to S4
30	13 16 14 16	S7	29 - 31	20		Similar to S4
35	13	S8	34 - 36	18	36.3	SILT (ML) - Mostly SILT, trace fine sand, grey, wet

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-8

LOG OF TEST BORING

JACOBS			
PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-8
LOCATION	Hockomock Swamp		
OWNER	Mass.Bay Transportation Authority		
JOB NUMBER	E2347101		SHEET 2 OF 3

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		19 25 30					
40		12 17 18 16	S9	39 - 41	15	31.3	CLAY (CL) - clay, little sand, grey, wet, medium plasticity, 0.5 tsfpenetrometer
45		10 19 22 21	S10	44 - 46	19	26.3	SILT (ML) - grey, wet, no plasticity
50		16 9 10 13	S11	49 - 51	3	21.3	Well graded SAND with gravel (SW) - Mostly f/c GRAVEL, some(-) f/c sand, brown, wet -TILL-
55		25 27 31 60	S12	54 - 56	3		Well graded SAND with gravel (SW) - Mostly f/c SAND, some(-) fine gravel, little silt, grey, moist -TILL-
60		100/9"	S13	59 - 59.75	4		Well graded SAND with gravel (SW) - Mostly f/c SAND, some fine gravel, little silt, light brown, wet, possible rock fragments -TILL-
65		RQD=25	C1	64 - 69	27	6.3	Minutes/ft = 5 - 6 - 4 - 5 - 5 Granite
70		RQD=33	C2	69 - 74	36		Minutes/ft = 5 - 5 - 6 - 8 - 7 Granite, vertical fractures
						-3.7	

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-8

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-8
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 3 OF 3
	JOB NUMBER	E2347101		

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
75							Bottom of Hole at 74'. Observation well installed at 15' (10' screen, 5' riser)
80							
85							
90							
95							
100							
105							
110							

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SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-8

LOG OF TEST BORING

JACOBS

PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-9
LOCATION	Hockomock Swamp		
OWNER	Mass.Bay Transportation Authority		
JOB NUMBER	E2347101		SHEET 1 OF 4

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	Mike (ME)	ELEVATION	71.6
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	Mobile Drill	DATUM	NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N 2820278.01
5.0	Wash Boring w/Casing						E 771006.64
61.4	NX Rock Core					DATE START	1/18/12
76.4	Wash Boring w/Casing					DATE END	1/19/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		2 3 7 12	S1	0 - 2	13		Well graded SAND (SW) - Mostly f/c SAND, little fine gravel, trace silt, black dry Change in wash color at 3'
						68.6	
5		17 43 23 17	S2	5 - 7	12		Well graded SAND with gravel (SW) - Mostly f/c SAND, some fine gravel, trace silt, grey, wet
10		10 13 6 4	S3	10 - 12	11		(Top 6" of sample) - Well graded SAND (SW) - Mostly f/c SAND, some silt, trace fine gravel, grey, wet
						60.1	(Bottom 5" of sample) - PEAT (PT) - brown, wet
15		.5 .5 1 1	S4	15 - 17	2		Similar to S3B Change in wash color at 19'
						52.6	
20		4 4 4 2	S5	20 - 22	6		Poorly graded SAND (SP) - Mostly fine SAND, trace organic peat, brown, wet
25		WOH 1 2 2	S6	25 - 27	24	46.6	SILT (ML) - Mostly SILT, trace fine sand, dark brown, wet
30		WOR WOH WOH 2	S7	30 - 32	24		Similar to S5
35							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) · Rock Core (RC) and RQD (%) REC (%) · Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) · Undisturbed (U)-Shelby Tube, (P)-Piston · Jar Sample (JS) · Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-9

LOG OF TEST BORING

JACOBS			BORING NO.	HST-9
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 2 OF 4
	JOB NUMBER	E2347101		

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
	5 6 5 5	S8	35 - 37	6	36.6	Poorly graded SAND (SP) - Mostly fine SAND, little silt, grey, wet
40	4 14 16 18	S9	40 - 42	13	31.6	SILT (ML) - grey, wet
45	22 19 14 15	S10	45 - 47	15		Similar to S9
50	15 19 19 20	S11	50 - 52	11		SILT (ML) - grey, wet, medium plasticity, 3.5 tsf (penetrometer)
55	10 16 19 38	S12	55 - 57	10		SILT (ML) - Mostly silt, little(-) fine sand, trace fine gravel, grey, wet, medium plasticity Change in drilling at 58', possible gravel
					13.6	
60	42 23 100/3"	S13	60 - 61.25	13		Well graded SAND with gravel (SW) - Mostly f/c SAND, some fine gravel, little silt, grey, wet
	RQD=60	C1	61.4 - 66.4	44	10.2	Top of rock at 61.4' Minutes/ft = 3 - 2 - 2 - 2 - 2 0"-26" of recovery - hard granite, light grey 26"-36" of recovery - light blue rock 36"-44" of recovery - dark blue rock Coring through probable boulders
65	RQD=0	C2	66.4 - 71.4	24	5.2	Completely weathered rock
70	RQD=0	C3	71.4 - 76.4	24		Same as C2 - Completely weathered rock Roller bit to 82'

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-9

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-9
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 3 OF 4
	JOB NUMBER	E2347101		

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
75							
80							
		34 100/3"	S14	82 - 82.75			SILT (ML) - very dense completely weathered rock, grey, moist
85		100/6"	S15	85 - 86			Similar to S14
							Continued to roller bit through completely weathered rock to 120' No change in density
90							
95							
100							
105							
110							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-9

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HST-9
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 4 OF 4
	JOB NUMBER	E2347101		

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
115							
120						-48.4	
							Bottom of Hole at 120'.
125							
130							
135							
140							
145							
150							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HST-9

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-1
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 1 OF 1
	JOB NUMBER	E2347101		

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	T. Penticost	ELEVATION		123.6
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	Remote ATV	DATUM		NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS / SPT HAMMER	140 lb Safety	GRID	N	2837979
15.0	NX Rock Core					COORD	E	766773
25.0	Terminated					DATE START		2/13/12
						DATE END		2/13/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	3 9 10 9	S1	0 - 2	14		(Top 11" of Sample) - Well graded SAND (SW) - Mostly f/c SAND, some(-) fine gravel, black, moist (Bottom 3" of Sample): Well graded SAND (SW) - Mostly f/c SAND, trace fine gravel, light brown, moist
4	10 19 28 21	S2	4 - 6	12		Well graded SAND with gravel (SW) - Mostly f/c SAND, little(-) fine gravel, trace silt, light brown, wet
9	100/8"	S3	9 - 9.66	4	114.6	Gravelly SILT(ML) - Mostly SILT, some f/c gravel, tan/black, moist -Weathered Rock- Roller bit to 15', possible top of rock
15	RQD=38	C1	15 - 20	38	108.6	Run #1 - Cored 15'-20' Approx 1' drop in coring at 17' - possible seam Probable shale, grey
20	RQD=46	C2	20 - 25	60		Run #2 - Cored 20'-25' Same as C1, moderately close fractures, slightly weathered, grey, probable shale
25					98.6	Bottom of Hole at 25'. Observation well installed at 15' (10 screen, 5' riser)

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) · Rock Core (RC) and RQD (%) REC (%) · Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) · Undisturbed (U)-Shelby Tube, (P)-Piston · Jar Sample (JS) · Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-1

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO. HS-2
	LOCATION	Hockomock Swamp	SHEET 1 OF 2
	OWNER	Mass.Bay Transportation Authority	
	JOB NUMBER	E2347101	

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	C. Knight	ELEVATION	115.1
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D50 ATV	DATUM	NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N	2837297.94
50.2	Terminated					E	766933.85
						DATE START	2/9/12
						DATE END	2/9/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	7 13 14 17	S1	0 - 2	10		Well graded SAND (SW) - Mostly f/c SAND, trace (+) fine gravel, light brown, moist
4	100/9"	S2	4 - 4.75	3	111.1	Well graded GRAVEL (GW) - Mostly fine GRAVEL, some(-) f/c sand, little(-) silt, light brown, moist
5					110.1	Probable boulder from 5'-8'
8					107.1	
9	24 100/9"	S3	9 - 10.25	12	106.1	Well graded SAND with silt (SM) - Mostly f/c SAND, some(+) silt, trace fine gravel, tan, wet -TILL-
14	26 24 17 15	S4	14 - 16	18		Silty SAND (SM): Mostly fine SAND, some(+) silt, trace fine gravel, dark grey, possible weathered rock
19	100/8"	S5	19 - 19.66	5	96.1	SILT with gravel (ML) - Mostly SILT, some(-) f/c gravel, black, wet -Weathered Rock-
24	100/9"	S6	24 - 24.75	7		Similar to S5
						Roller bit through weathered rock
34	100/2"	S7	34 - 34.16	0		No recovery, spoon bouncing
35						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL BLOWS/FT	CONSISTENCY	NON-COHESIVE SOIL BLOWS/FT	DENSITY	RELATIVE PROPORTIONS OF SOIL COMPONENTS	
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) · Rock Core (RC) and RQD (%) REC (%) · Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) · Undisturbed (U)-Shelby Tube, (P)-Piston · Jar Sample (JS) · Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-2

LOG OF TEST BORING

JACOBS			BORING NO.	HS-2
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
							Continue to roller bit through weathered rock
40							
45							
50		100/2"	S8	50 - 50.16	2	64.9	Similar to S5 -Weathered rock, probable shale-
							Bottom of Hole at 50.2'.
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-2

LOG OF TEST BORING

JACOBS

PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-3	
LOCATION	Hockomock Swamp			
OWNER	Mass.Bay Transportation Authority			
JOB NUMBER	E2347101		SHEET 1 OF 2	

INSPECTOR	T. Telesco	CONTRACTOR	NH Boring		DRILLER	C. Knight	ELEVATION		106.9
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM		NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2836452.83
49.5	Terminated						COORD	E	767139.64
							DATE START		2/8/12
							DATE END		2/8/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0		8 17 100/3"	S1	0 - 1.25	8		Well graded SAND (SW) - f/c SAND, little fine GRAVEL, light brown with grey, moist, probable cobble encountered
5		80 29 24 21	S2	4 - 6	12		Well graded SAND (SW) - f/c SAND, trace silt, trace fine travel, coal, brick -FILL-
10		28 100/3"	S3	9 - 9.75	6	97.9	Silty SAND (SM) - f/c SAND, little silt, trace fine gravel, wet, grey, possible TILL
15		100/2"	S4	14 - 14.16	2		Well graded SAND (SW) - f/c SAND, trace silt, wet, grey -GLACIAL TILL-
20		100/2"	S5	19 - 19.16	0		No recovery
25		100/5"	S6	24 - 24.41	5		Silty SAND (SM) - f/c SAND, little silt, trace fine gravel, wet, grey -GLACIAL TILL-
30		100/1"	S7	29 - 29.08	1		Similar to S6
35		100/3"	S8	34 - 34.25	3	72.9	Well graded SAND with gravel (SW) - f/c SAND, little fine gravel, trace silt,

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-3

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-3
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 2 OF 2
	JOB NUMBER	E2347101		

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
							weathered rock, dark grey, tan
40		100/3"	S9	39 - 39.25	2		Completely weathered SHALE, black
45		100/2"	S10	44 - 44.16	2		Similar to S9
50		100/6"	S11	49 - 49.5	6	57.4	Sandy SILT (ML) - nonplastic silt, some fine sand, grey, dry, completely weathered rock
							Bottom of Hole at 49.5'.
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-3

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-4
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	Mike (ME)	ELEVATION	97.7
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM	NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID N	2825429.94
5.0	Wash Boring w/Casing						COORD E	769762.28
30.0	NX Rock Core						DATE START	2/2/12
40.0	Terminated						DATE END	2/2/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0		2 10 13 23	S1	0 - 2	3		Well graded SAND with silt (SW) - Mostly f/c SAND, little silt, trace(+) fine gravel, black, moist Change in wash color at 3'
5		26 28 32 33	S2	5 - 7	18	92.7	Silty SAND with gravel (SM) - Mostly f/c SAND, some silt. little(-) fine gravel, light brown, moist.
10		41 34 44 56	S3	10 - 12	18	87.7	Well graded GRAVEL with silt (GM) - Mostly f/c GRAVEL, some silt, black, wet - Weathered Rock- Roller bit through weathered rock
15							
20		100/10"	S4	20 - 20.83	7		Well graded GRAVEL with silt (GM) - Mostly f/c GRAVEL, some(+) silt, grey, moist, tan colored seams -Weathered Rock-
25							
30		RQD=90	C1	30 - 35	56	67.7	Run #1 - Cored 30'-35' Minutes/ft = 2 - 3 - 3 - 3 - 3 Probable siltstone, blue/grey
35							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-4

LOG OF TEST BORING

PROJECT	New Bedford/Fall River Commuter Rail	BORING NO. HS-4
LOCATION	Hockomock Swamp	
OWNER	Mass.Bay Transportation Authority	
JOB NUMBER	E2347101	SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		RQD=100	C2	35 - 40	60		Run #2 - Cored 35'-40' Minutes/ft = 3 - 3 - 3 - 2 - 3 Same as C1, fresh rock
40						57.7	
							Bottom of Hole at 40'.
45							
50							
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-4

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-5
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	Mike (ME)	ELEVATION	88.7
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM	NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N	2824556.41
5.0	Wash Boring w/Casing						E	769977.94
50.3	Terminated						DATE START	2/1/12
							DATE END	2/2/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	2 4 5 6	S1	0 - 2	7		Well graded SAND (SW) - Mostly f/c SAND, little fine gravel, trace organics, dark brown, moist
5	100/7"	S2	5 - 5.58	2		Well graded SAND with gravel (SW) - Mostly f/c SAND, some(+) fine gravel, trace silt, brown, moist
						Cobbles from 5.5' to 6.5' (roller bit)
10	17 23 27 39	S3	10 - 12	12	78.7	Well graded SAND with silt and gravel (SW) - Mostly f/c SAND, little(+) fine gravel, little(-) silt, light brown, wet
15	33 39 42 32	S4	15 - 17	18		Well graded SAND with silt and gravel (SW) - Mostly f/c SAND, little(+) silt, little(-) fine gravel, black, wet
20	14 10 24 100/3"	S5	20 - 21.75	7	68.7	Well graded SAND with gravel (SW) - Mostly f/c SAND, some(+) fine gravel, trace silt
25	30 100/10"	S6	25 - 26.33	17	63.7	SILT (ML) - Black, moist, very dense - Weathered rock-
						Roller bit through weathered rock
30						
35						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-5

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-5
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 2 OF 2
	JOB NUMBER	E2347101		

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		100/6"	S7	35 - 35.5	6		Similar to S6
40							
45							
50		100/3"	S8	50 - 50.25	2	38.5	Similar to S6
							Bottom of Hole at 50.3'.
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-5

LOG OF TEST BORING

JACOBS			BORING NO.	HS-6
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	Mike (ME)	ELEVATION		77.7
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM		NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2832821.96
5.0	Wash Boring w/Casing						COORD	E	767995.31
42.0	Terminated						DATE START		1/31/12
							DATE END		2/1/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	2 5 5 12	S1	0 - 2	10		Well graded SAND (SW) - Mostly f/c SAND, some(-) gravel, trace silt, brown,clay
5	9 30 24 6	S2	5 - 7	14	▼ (groundwater)	Well graded SAND with gravel (SW) - Mostly f/c SAND, some(+) f/c gravel, trace silt, brown, wet (more silt in bottom 2" of sample)
					70.8	
10	11 24 25 26	S3	10 - 12	15		(Top 13" of Sample): SILT (ML) - grey, wet, 3.0 tsf penetrometer
					65.9	(Bottom 2" of Sample): Poorly graded SAND - Mostly f/c SAND, little(-) silt, light brown, wet
					64.7	Change in wash color/consistency at 13'
15	12 22 22 13	S4	15 - 17	18		SILT (ML) - light brown, wet, 3.5 tsf, no plasticity
20	38 25 39 28	S5	20 - 22	12	57.7	Well graded SAND (SW) - Mostly f/c SAND, little fine gravel, little (-) silt, grey, wet -TILL-
25	40 38 37 34	S6	25 - 27	0		No recovery - pushing probable cobble
30	20 23 25 28	S7	30 - 32	8		Sandy SILT (ML) - Mostly SILT, some (-) fine sand, trace fine gravel, grey, wet -TILL-
35						

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-6

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-6
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		SHEET 2 OF 2
	JOB NUMBER	E2347101		

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		18 22 19 26	S8	35 - 37	12	42.7	SILT with gravel (ML) - Mostly SILT, some(-) fine gravel, little f/c sand -Weathered Rock-
40		19 25 20 21	S9	40 - 42	14		Similar to S8 -Weathered Rock-
						35.7	
							Bottom of Hole at 42'. Observation well set at 15' (10' screen, 5' riser)
45							
50							
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) — Rock Core (RC) and RQD (%) REC (%) — Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) — Undisturbed (U)-Shelby Tube, (P)-Piston — Jar Sample (JS) — Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-6

LOG OF TEST BORING

JACOBS			BORING NO.	HS-7
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	Mike (ME)	ELEVATION		78.1
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM		NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2831575.54
5.0	Wash Boring w/Casing						COORD	E	768293.25
42.0	Terminated						DATE START		1/31/12
							DATE END		1/31/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0		2 6 6 8	S1	0 - 2	15		(Top 6" of Sample) - Well graded SAND (SW) - Mostly f/c SAND, trace silt and organics, black, dry (Bottom 9" of Sample) - Well graded SAND (SW) - Mostly f/c SAND, trace fine gravel, light brown, dry
5		10 19 21 18	S2	5 - 7	18	73.1	Poorly graded SAND (SP) - Mostly fine SAND, light brown, wet
10		12 17 14 11	S3	10 - 12	17	68.1	SILT (ML) - tan, wet, no plasticity, very stiff, 2.5 tsf penetrometer
						66.1	
			UD-1	13 - 14.5	18		Change in drilling at 12', very soft clay in wash Shelby Tube - 18" recovery, 3.5 tsf penetrometer
15		7 12 14 14	S4	14.5 - 16.5	18	63.6	SILT (ML) - Mostly SILT, little fine sand, grey, wet, low plasticity
20		10 15 17 19	S5	20 - 22	18	58.1	Silty SAND (SM) - Mostly fine SAND, some(-) silt, tan, wet
25		13 14 15 16	S6	25 - 27	18	53.1	SILT (ML) - Mostly silt, trace fine sand, low plasticity, brown, 1.5 tsf penetrometer
30		13 21 12 19	S7	30 - 32	19		Similar to S6
35							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-7

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-7
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		27 23 14 23	S8	35 - 37	12	43.1	Well graded SAND with silt and gravel (SW) - Mostly f/c SAND, some(-) silt, little(+) fine gravel, light brown, wet -TILL-
40		11 19 22 31	S9	40 - 42	12		Well graded GRAVEL with sand (GW) - Mostly f/c GRAVEL, some(+) f/c sand, trace silt, grey, wet
						36.1	
							Bottom of Hole at 42'.
45							
50							
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-7

LOG OF TEST BORING

JACOBS			BORING NO.	HS-8
	PROJECT	New Bedford/Fall River Commuter Rail		
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring		DRILLER	Mike (ME)	ELEVATION		77.8
METHOD OF DRILLING		GROUNDWATER READINGS			DRILL RIG	Mobile Drill	DATUM		NGVD 29
0.0	Auger	DATE/TIME	DEPTH(ft)	REMARKS	SPT HAMMER	140 lb Safety	GRID	N	2830827.86
5.0	Wash Boring w/Casing						COORD	E	768471.97
42.0	Terminated						DATE START		1/30/12
							DATE END		1/31/12

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0		3 7 11 21	S1	0 - 2	17		Top 3" of sample - Poorly graded SAND (SP): Mostly fine SAND, little organics, black, dry Bottom 15" of sample - Well graded SAND (SW): Mostly f/c SAND, trace fine gravel, light brown, moist
5		2 3 9 10	S2	5 - 7	15		Well graded SAND with gravel (SW) - Mostly f/c SAND, little(-) fine gravel, brown, wet
10		2 1 1 4	S3	10 - 12	0		No recovery, pushing probable cobble
15		17 18 18 12	S4	15 - 17	14	62.8	SILT (ML) - grey, wet
20		9 8 9 8	S5	20 - 22	12	57.8	Well graded SAND (SW) - Mostly f/c SAND, trace silt, light brown, wet
25		8 8 7 8	S6	25 - 27	7		Well graded SAND (SW) - Mostly f/c SAND, trace(+) fine gravel, reddish brown, wet
30		8 8 8 12	S7	30 - 32	12	47.8	Poorly graded SAND (SP) - Mostly fine SAND, light brown, wet
35							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-8

LOG OF TEST BORING

JACOBS	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-8
	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		6 7 7 7	S8	35 - 37	8	42.8	Silty SAND (SM) - Mostly fine SAND, some(-) silt, light brown, wet (siltier in bottom 2" of sample)
40		3 4 4 4	S9	40 - 42	4	37.8	Poorly graded SAND (SP) - Mostly fine SAND, light brown, wet
						35.8	Bottom of Hole at 42'.
45							
50							
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) — Rock Core (RC) and RQD (%) REC (%) — Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) — Undisturbed (U)-Shelby Tube, (P)-Piston — Jar Sample (JS) — Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-8

LOG OF TEST BORING

JACOBS

PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-9
LOCATION	Hockomock Swamp		
OWNER	Mass.Bay Transportation Authority		
JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	P. Lanergan	CONTRACTOR	NH Boring	DRILLER	P. Rushina
				DRILL RIG	D50 ATV
				SPT HAMMER	140 lb Safety

ELEVATION	79.2
DATUM	NGVD 29
GRID COORD N	2829466.61
GRID COORD E	768802.66
DATE START	1/27/12
DATE END	1/27/12

METHOD OF DRILLING		GROUNDWATER READINGS		
		DATE/TIME	DEPTH(ft)	REMARKS
0.0	Wash Boring w/Casing			
41.0	Terminated			

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	2 2 4 2	S1	0 - 2	7		Well graded SAND (SW) - Mostly f/c SAND, trace fine gravel, trace silt, black, dry
5	16 12 12 15	S2	4 - 6	7		Well graded SAND with gravel (SW) - Mostly f/c SAND, little fine gravel, light brown, wet
10	2 3 9 24	S3	9 - 11	3		Well graded SAND with gravel (SW) - Mostly f/c SAND some fine gravel, trace (+) silt, grey, wet
15	13 13 18 20	S4	14 - 16	10	65.2	Sandy SILT (ML) - non-plastic silt, some mostly fine sand, light brown, moist.
20	13 13 15 15	S5	19 - 21	12	60.2	Silty SAND (SM) - Mostly fine SAND, little(-) silt, tan, wet
25	7 6 6 6	S6	24 - 26	10	55.2	Poorly graded SAND (SP) - Mostly fine SAND, tan, wet
30	6 7 9 13	S7	29 - 31	17		Similar to S6
35	13	S8	34 - 36	12		Poorly graded SAND (SP) - Mostly fine SAND, trace silt, reddish brown, wet

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) — Rock Core (RC) and RQD (%) REC (%) — Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) — Undisturbed (U)-Shelby Tube, (P)-Piston — Jar Sample (JS) — Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-9

LOG OF TEST BORING

PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-9
LOCATION	Hockomock Swamp		
OWNER	Mass.Bay Transportation Authority		
JOB NUMBER	E2347101		SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
		13 15 15					
40		26 16 14 12	S9	39 - 41	3	40.2	Well graded SAND with gravel (SW) - Mostly f/c SAND, some f/c gravel, light brown, wet -TILL-
						38.2	
							Bottom of Hole at 41'.
45							
50							
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-9

LOG OF TEST BORING

JACOBS

PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-10
LOCATION	Hockomock Swamp		
OWNER	Mass.Bay Transportation Authority		
JOB NUMBER	E2347101		SHEET 1 OF 1

INSPECTOR	D. Melcher/ PJL	CONTRACTOR	NH Boring	DRILLER	P. Rushina	ELEVATION 78.9
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D50 ATV	DATUM NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N 2819302
32.0	Rollerbit Refusal					E 771224.53
						DATE START 1/13/12
						DATE END 1/17/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
0	2 3 3 8	S1	0 - 2	24		SAND - brown, fine grained, trace medium sand, trace silt, dry, medium dense
4	11 9 10 13	S2	4 - 6	14	74.9	SILT - some fine rounded gravel, little fine sand, trace clay, dry, dense
9	7 8 6 6	S3	9 - 11	18	69.9	(9'-9.75'): SAND - reddish brown, fine grained, trace medium sand, trace silt, dry medium dense (9.75'-10.5'): SAND - black, fine grained, trace coarse sand, trace medium sand, some silt, dry, medium dense
14	30 43 44 36	S4	14 - 16	14		SAND - brown, fine grained, little medium sand, trace coarse sand, trace fine rounded gravel, trace silt, wet, very dense
19	17 24 26 18	S5	19 - 21	12		SAND - brown, fine grained, little medium sand, trace coarse sand, trace silt, wet, very dense
21	4 8 12 22	S6	21 - 23	18	57.9	Sandy lean CLAY (CL) - Mostly CLAY, some (-) fine sand, light brown, wet
25	8 44 26 12	S7	25 - 27	8	53.9	Silty SAND with gravel (SM) - Mostly f/c SAND, some (-) silt, little (+) fine gravel, trace clay
30	100/5"	S8	30 - 30.41			Silty SAND with gravel (SM) - Mostly f/c SAND, some (+) silt, little (+) fine gravel - Possible weathered rock- Roller bit to 32'
32					46.9	Bottom of Hole at 32'.

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) · Rock Core (RC) and RQD (%) REC (%) · Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) · Undisturbed (U)-Shelby Tube, (P)-Piston · Jar Sample (JS) · Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-10

LOG OF TEST BORING

	PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-11
JACOBS	LOCATION	Hockomock Swamp		
	OWNER	Mass.Bay Transportation Authority		
	JOB NUMBER	E2347101		SHEET 1 OF 2

INSPECTOR	D. Melcher	CONTRACTOR	NH Boring	DRILLER	P. Rushina	ELEVATION	87.3
METHOD OF DRILLING		GROUNDWATER READINGS		DRILL RIG	D50 ATV	DATUM	NGVD 29
0.0	Wash Boring w/Casing	DATE/TIME	DEPTH(ft) / REMARKS	SPT HAMMER	140 lb Safety	GRID COORD N	2818399.33
34.0	NX Rock Core					E	771457.03
44.0	Terminated					DATE START	1/12/12
						DATE END	1/13/12

DEPTH (ft)	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
	3 9 14 55	S1	0 - 2	20		SAND (SP) - light brown, fine grained, trace silt, dry, very dense
5	20 60 58 55	S2	4 - 6	13	83.3	SILT (ML) - reddish brown, some subangular fine gravel, little fine sand, trace clay, dry, hard
10	21 20 28 41	S3	9 - 11	9	78.3	CLAY (CL) - lean clay, little fine to coarse sand, moist, brown.
15	30 55 45 100/5"	S4	14 - 15.91	0		No Recovery
	26 45 100/2"	S5	16 - 17.16	11		CLAY (CL) - grey, some fine to coarse sand, trace fine subangular gravel, trace silt, weathered rock, dry, hard
20	14 23 33 41	S6	19 - 21	24	68.3	SILT (ML) - dark grey, trace fine sand, dry, trace clay, hard (weathered rock)
25	38 37 62 48	S7	24 - 26	24		SILT (ML) - dark grey, trace clay, dry, hard (weathered rock)
30	16 17 37 100/1"	S8	29 - 30.58	12		SILT (ML) - dark grey, little clay, dry, hard (weathered rock)
35	RQD=55	C1	34 - 39	45	53.3	Granite, light grey, crystalline.

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-11

LOG OF TEST BORING

PROJECT	New Bedford/Fall River Commuter Rail	BORING NO.	HS-11
LOCATION	Hockomock Swamp		
OWNER	Mass.Bay Transportation Authority		
JOB NUMBER	E2347101		SHEET 2 OF 2

DEPTH (ft)	STRATA SYMBOL	SAMPLE DATA	SAMPLE NO.	DEPTH (ft)	REC. (in)/(%)	ELEV.	FIELD CLASSIFICATION AND REMARKS
40		RQD=92	C2	39 - 44	60		Granite, light grey, crystalline.
						43.3	
45							Bottom of Hole at 44'.
50							
55							
60							
65							
70							

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

SAMPLES CLASSIFIED IN ACCORDANCE WITH ASTM D-2488 UNLESS OTHERWISE NOTED.

COHESIVE SOIL		NON-COHESIVE SOIL		RELATIVE PROPORTIONS OF SOIL COMPONENTS	
BLOWS/FT	CONSISTENCY	BLOWS/FT	DENSITY		
0 - 2	VERY SOFT	0 - 4	VERY LOOSE	< 10%	TRACE
3 - 4	SOFT	5 - 10	LOOSE	15 - 25%	LITTLE
5 - 8	MEDIUM STIFF	11 - 30	MEDIUM DENSE	30 - 45%	SOME
9 - 15	STIFF	31 - 50	DENSE	50 - 100%	MOSTLY
16 - 30	VERY STIFF	51 +	VERY DENSE		
30 +	HARD				

LEGEND

Auger Sample (AS) | Rock Core (RC) and RQD (%) REC (%) | Split-Spoon Sample (SS) and Blow Counts per 6" REC (in) | Undisturbed (U)-Shelby Tube, (P)-Piston | Jar Sample (JS) | Bag Sample (B)

REFER TO THE SHEET ENTITLED "KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS" FOR ADDITIONAL SYMBOLOGY.

BORING NO. HS-11

APPENDIX B: LABORATORY DATA

Summary of Laboratory Test Results for Bedrock
Summary of Laboratory Test Results for Soils

Summary of Laboratory Test Results for Bedrock

Client:	Jacobs Civil, Inc.
Project Name:	SCR - Hockomock Swamp
Project Location:	Raynham, MA
GTX #:	11534
Test Date:	02/24/12
Tested By:	daa
Checked By:	mpd

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D 7012 Method C

Boring ID	Sample ID	Depth, ft	Bulk Density, lb/ft^3	Compressive Strength, psi	Failure Type	In conformance with ASTM D 4543
HS-4	C-1	---	170	6,500	1	YES
HST-2	C-2	---	Sample too short to test			
HST-3	C-2	---	159	7,822	1	YES
HST-5	C-1	---	Sample too short to test			
HST-7	C-1	---	167	4,693	1	YES
HST-8	C-1	---	162	6,689	1	NO *,**

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure (See attached photographs)

* The as-received core did not meet the ASTM side straightness tolerance.

** Specimen L/D < 2. Compressive Strength reported is the computed compressive strength of an equivalent L/D = 2 specimen. The value is corrected using the following equation from ASTM D 2938-86:

$$C = C_a/(0.88+(0.24b/h))$$

where:

C = computed compressive Strength for L/D = 2

C_a = measured compressive strength

b = test core diameter

h = test core height

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.	Test Date:	2/22/2012
Project Name:	SCR - Hockomock Swamp	Tested By:	daa
Project Location:	Raynham, MA	Checked By:	mpd
GTX #:	11534		
Boring ID:	HS-4		
Sample ID:	C-1		
Depth:	--- ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.34	4.35	4.35
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	598.13		
Bulk Density, lb/ft^3	170		
Length to Diameter Ratio:	2.2		

Length to Diameter Ratio Tolerance Met? **YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

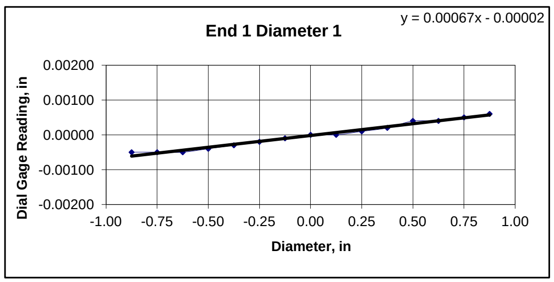
END FLATNESS AND PARALLELISM (Procedure FP1)

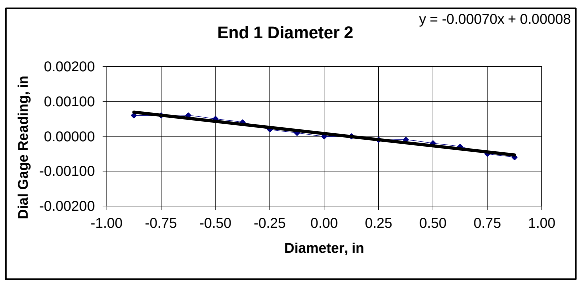
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00050	-0.00050	-0.00050	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00020	0.00040	0.00040	0.00050	0.00060
Diameter 2, in (rotated 90^o)	0.00060	0.00060	0.00060	0.00050	0.00040	0.00020	0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00030	-0.00050	-0.00060

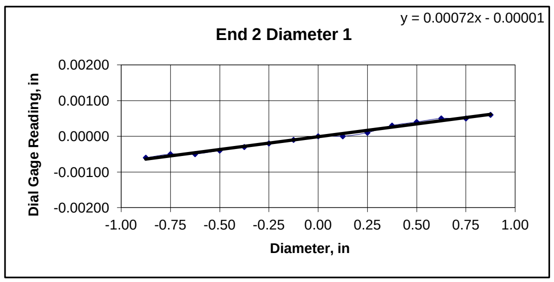
Difference between max and min readings, in:
0° = 0.00110 90° = 0.00120

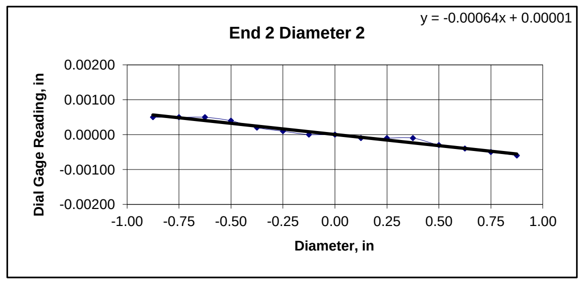
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00060	-0.00050	-0.00050	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00030	0.00040	0.00050	0.00050	0.00060
Diameter 2, in (rotated 90^o)	0.00050	0.00050	0.00050	0.00040	0.00020	0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00030	-0.00040	-0.00050	-0.00060

Difference between max and min readings, in:
0° = 0.0012 90° = 0.0011
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00060
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:	Slope of Best Fit Line	0.00067
	Angle of Best Fit Line:	0.03839
End 2:	Slope of Best Fit Line	0.00072
	Angle of Best Fit Line:	0.04125
Maximum Angular Difference:		0.00286

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	-0.00070
	Angle of Best Fit Line:	-0.04011
End 2:	Slope of Best Fit Line	-0.00064
	Angle of Best Fit Line:	-0.03667
Maximum Angular Difference:		0.00344

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

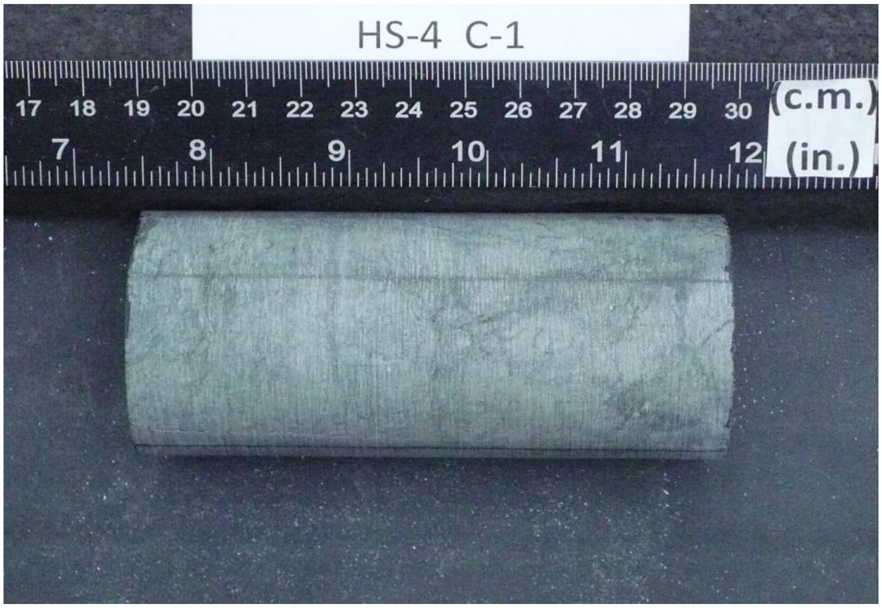
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00110	1.980	0.00056	0.032	YES
Diameter 2, in (rotated 90^o)	0.00120	1.980	0.00061	0.035	YES
END 2					
Diameter 1, in	0.00120	1.980	0.00061	0.035	YES
Diameter 2, in (rotated 90^o)	0.00110	1.980	0.00056	0.032	YES

Maximum angle of departure must be $\leq$ 0.25°

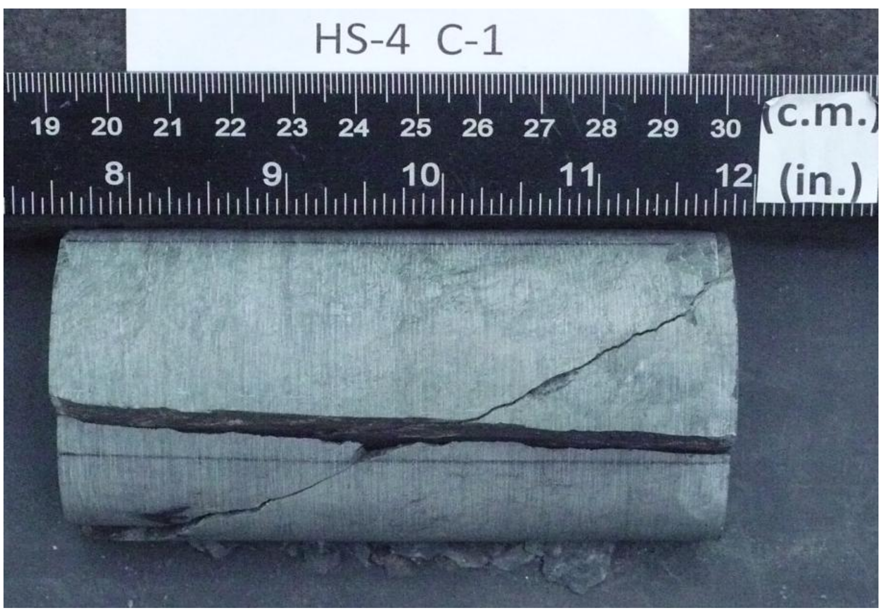
Perpendicularity Tolerance Met? **YES**

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.
Project Name:	SCR - Hockomock Swamp
Project Location:	Raynham, MA
GTX #:	11534
Test Date:	02/24/12
Tested By:	daa
Checked By:	mpd
Boring ID:	HS-4
Sample ID:	C-1
Depth, ft:	---



After cutting and grinding



After break

Client:	Jacobs Civil, Inc.	Test Date:	2/22/2012
Project Name:	SCR - Hockomock Swamp	Tested By:	daa
Project Location:	Raynham, MA	Checked By:	mpd
GTX #:	11534		
Boring ID:	HST-3		
Sample ID:	C-2		
Depth:	--- ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.36	4.36	4.36
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	562.31		
Bulk Density, lb/ft^3	159		
Length to Diameter Ratio:	2.2		

Length to Diameter Ratio Tolerance Met? **YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00000	-0.00010
Diameter 2, in (rotated 90^o)	0.00080	0.00060	0.00060	0.00060	0.00040	0.00020	0.00010	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00050	-0.00070	-0.00090

Difference between max and min readings, in:

0° = 0.00020 90° = 0.00170

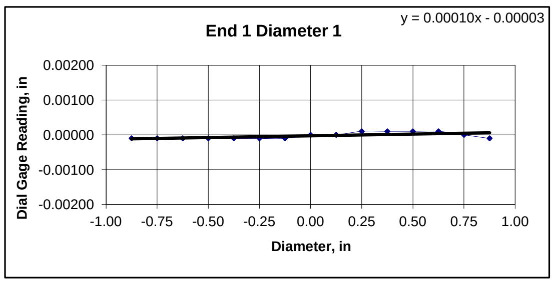
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00020	-0.00040	-0.00020	-0.00010	-0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90^o)	0.00060	0.00050	0.00040	0.00040	0.00040	0.00020	0.00010	0.00000	-0.00010	-0.00020	-0.00030	-0.00050	-0.00070	-0.00090	-0.00100

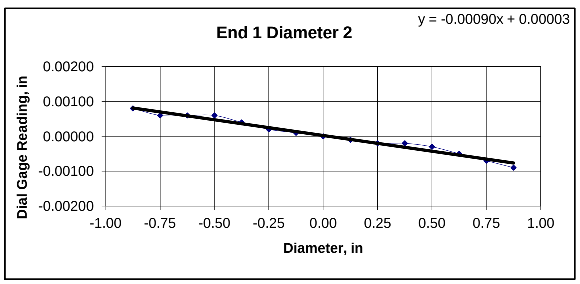
Difference between max and min readings, in:

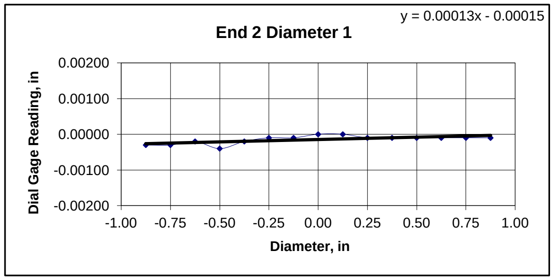
0° = 0.0004 90° = 0.0016

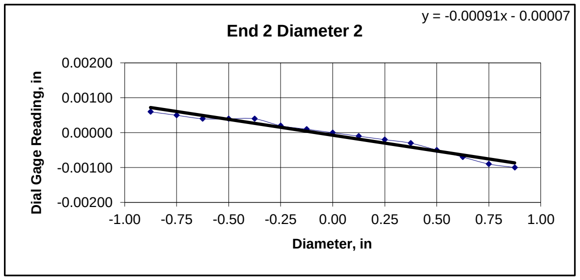
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00085

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00010
Angle of Best Fit Line:	0.00573

End 2:

Slope of Best Fit Line	0.00013
Angle of Best Fit Line:	0.00745

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	-0.00090
Angle of Best Fit Line:	-0.05157

End 2:

Slope of Best Fit Line	-0.00091
Angle of Best Fit Line:	-0.05214

Maximum Angular Difference: 0.00057

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	1.980	0.00010	0.006	YES
Diameter 2, in (rotated 90^o)	0.00170	1.980	0.00086	0.049	YES
END 2					
Diameter 1, in	0.00040	1.980	0.00020	0.012	YES
Diameter 2, in (rotated 90^o)	0.00160	1.980	0.00081	0.046	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	Jacobs Civil, Inc.
Project Name:	SCR - Hockomock Swamp
Project Location:	Raynham, MA
GTX #:	11534
Test Date:	02/24/12
Tested By:	daa
Checked By:	mpd
Boring ID:	HST-3
Sample ID:	C-2
Depth, ft:	---

After cutting and grinding

After break

Client:	Jacobs Civil, Inc.	Test Date:	2/22/2012
Project Name:	SCR - Hockomock Swamp	Tested By:	daa
Project Location:	Raynham, MA	Checked By:	mpd
GTX #:	11534		
Boring ID:	HST-7		
Sample ID:	C-1		
Depth:	--- ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.22	4.22	4.22
Specimen Diameter, in:	1.97	1.98	1.98
Specimen Mass, g:	569.28		
Bulk Density, lb/ft^3	167		
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

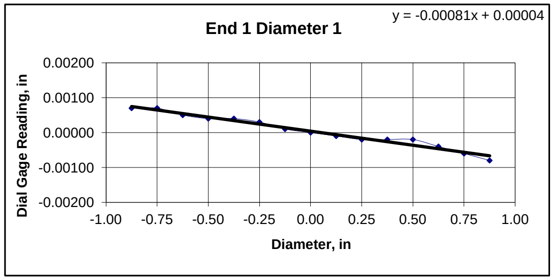
END FLATNESS AND PARALLELISM (Procedure FP1)

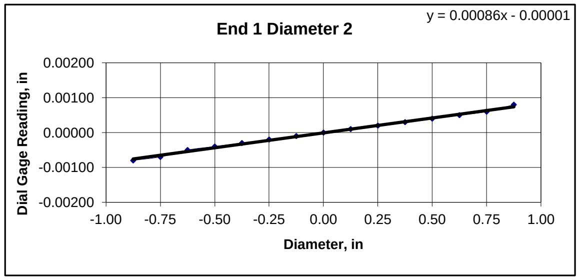
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00070	0.00070	0.00050	0.00040	0.00040	0.00030	0.00010	0.00000	-0.00010	-0.00020	-0.00020	-0.00020	-0.00040	-0.00060	-0.00080
Diameter 2, in (rotated 90^o)	-0.00080	-0.00070	-0.00050	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00010	0.00020	0.00030	0.00040	0.00050	0.00060	0.00080

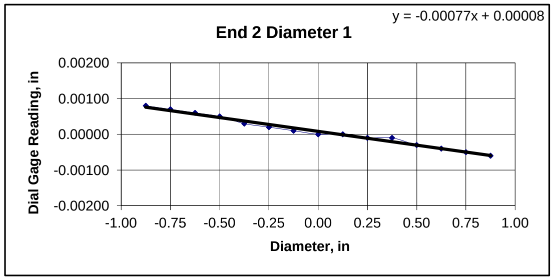
Difference between max and min readings, in:
0° = 0.00150 90° = 0.00160

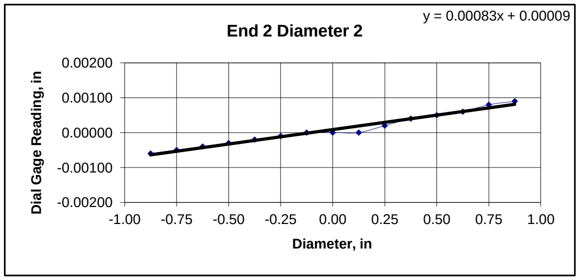
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00080	0.00070	0.00060	0.00050	0.00030	0.00020	0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00030	-0.00040	-0.00050	-0.00060
Diameter 2, in (rotated 90^o)	-0.00060	-0.00050	-0.00040	-0.00030	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00020	0.00040	0.00050	0.00060	0.00080	0.00090

Difference between max and min readings, in:
0° = 0.0014 90° = 0.0015
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00080
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line -0.00081
Angle of Best Fit Line: -0.04641

End 2:
Slope of Best Fit Line -0.00077
Angle of Best Fit Line: -0.04412

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00086
Angle of Best Fit Line: 0.04927

End 2:
Slope of Best Fit Line 0.00083
Angle of Best Fit Line: 0.04756

Maximum Angular Difference: 0.00172

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

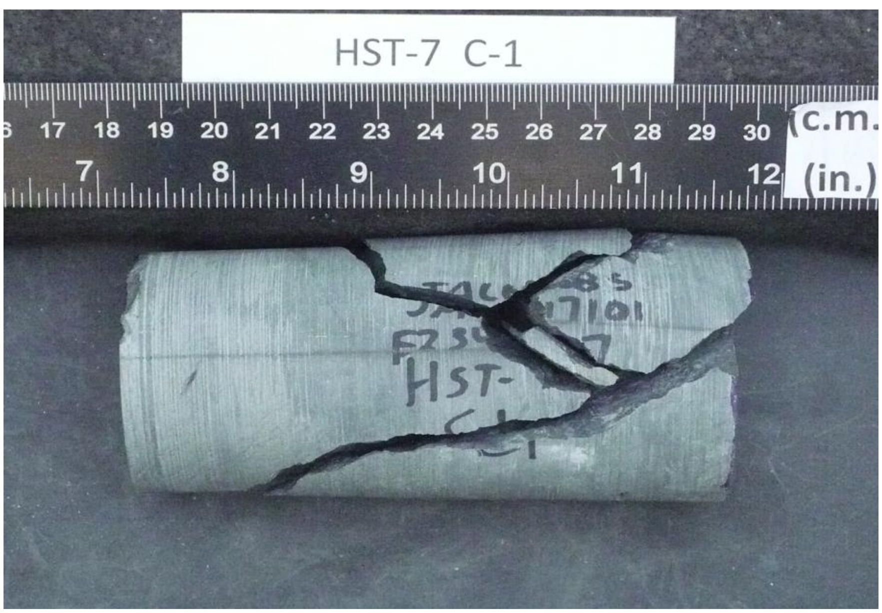
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00150	1.975	0.00076	0.044	YES
Diameter 2, in (rotated 90^o)	0.00160	1.975	0.00081	0.046	YES
END 2					
Diameter 1, in	0.00140	1.975	0.00071	0.041	YES
Diameter 2, in (rotated 90^o)	0.00150	1.975	0.00076	0.044	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Jacobs Civil, Inc.
Project Name:	SCR - Hockomock Swamp
Project Location:	Raynham, MA
GTX #:	11534
Test Date:	02/24/12
Tested By:	daa
Checked By:	mpd
Boring ID:	HST-7
Sample ID:	C-1
Depth, ft:	---

After cutting and grinding



After break

Client:	Jacobs Civil, Inc.	Test Date:	2/22/2012
Project Name:	SCR - Hockomock Swamp	Tested By:	daa
Project Location:	Raynham, MA	Checked By:	mpd
GTX #:	11534		
Boring ID:	HST-8		
Sample ID:	C-1		
Depth:	--- ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D 4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	3.79	3.79	3.79
Specimen Diameter, in:	1.95	1.97	1.96
Specimen Mass, g:	488.41		
Bulk Density, lb/ft^3	162		
Length to Diameter Ratio:	1.9	**Length to Diameter Ratio Tolerance Met?**	**NO**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? NO

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? NO

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00060	0.00060	0.00050	0.00040	0.00030	0.00010	0.00010	0.00000	-0.00020	-0.00030	-0.00040	-0.00040	-0.00060	-0.00070	-0.00080
Diameter 2, in (rotated 90^o)	0.00020	0.00020	0.00020	0.00010	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00030	-0.00040	-0.00040

Difference between max and min readings, in:

0° = 0.00140 90° = 0.00060

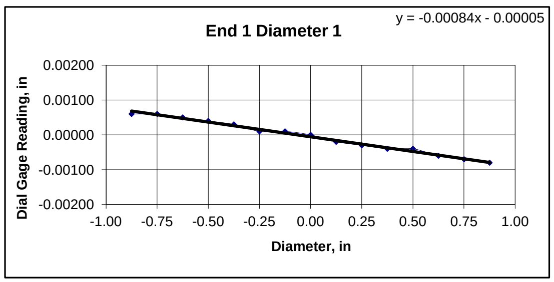
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00080	0.00070	0.00060	0.00040	0.00040	0.00020	0.00010	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00050	-0.00060	-0.00090
Diameter 2, in (rotated 90^o)	0.00020	0.00020	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00030	-0.00030	-0.00040	-0.00050

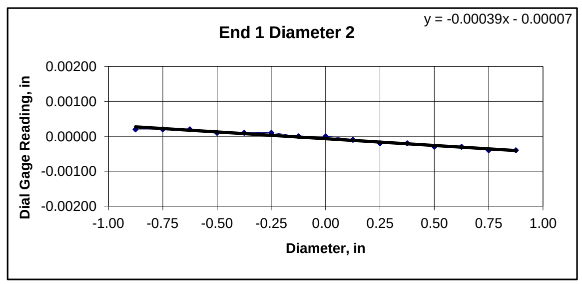
Difference between max and min readings, in:

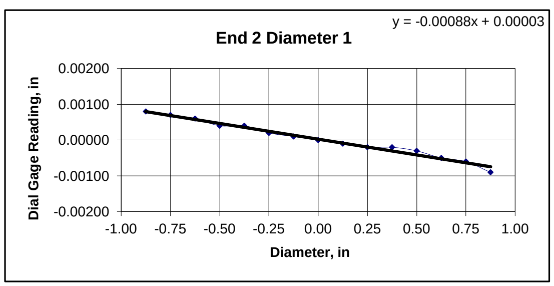
0° = 0.0017 90° = 0.0007

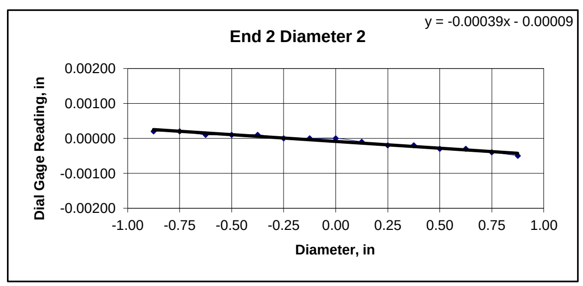
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00085

Flatness Tolerance Met? YES









DIAMETER 1

End 1:	Slope of Best Fit Line	-0.00084
	Angle of Best Fit Line:	-0.04813
End 2:	Slope of Best Fit Line	-0.00088
	Angle of Best Fit Line:	-0.05042
Maximum Angular Difference:		0.00229

Parallelism Tolerance Met? YES

Spherically Seated

DIAMETER 2

End 1:	Slope of Best Fit Line	-0.00039
	Angle of Best Fit Line:	-0.02235
End 2:	Slope of Best Fit Line	-0.00039
	Angle of Best Fit Line:	-0.02235
Maximum Angular Difference:		0.00000

Parallelism Tolerance Met? YES

Spherically Seated

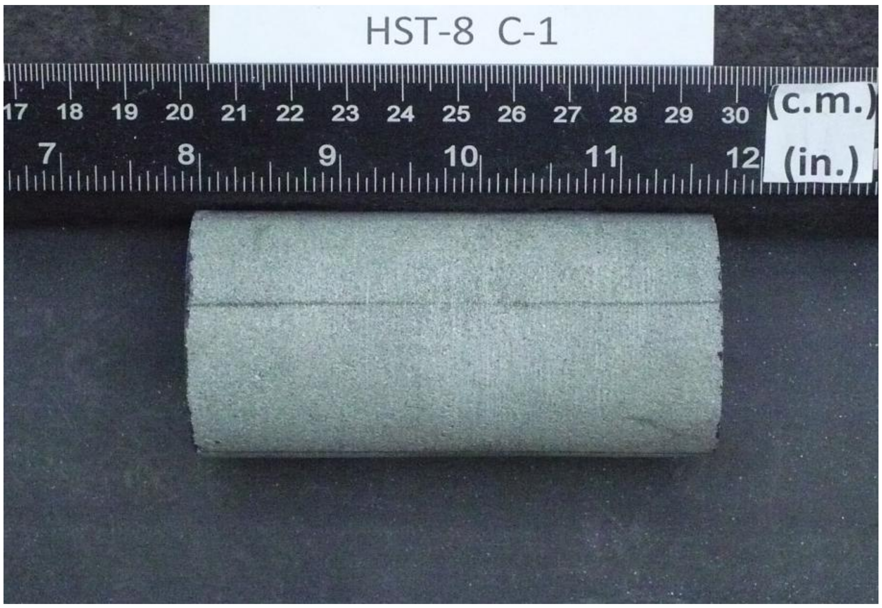
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00140	1.960	0.00071	0.041	YES
Diameter 2, in (rotated 90^o)	0.00060	1.960	0.00031	0.018	YES
END 2					
Diameter 1, in	0.00170	1.960	0.00087	0.050	YES
Diameter 2, in (rotated 90^o)	0.00070	1.960	0.00036	0.020	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? YES

Client:	Jacobs Civil, Inc.
Project Name:	SCR - Hockomock Swamp
Project Location:	Raynham, MA
GTX #:	11534
Test Date:	02/24/12
Tested By:	daa
Checked By:	mpd
Boring ID:	HST-8
Sample ID:	C-1
Depth, ft:	---



After cutting and grinding

After break

Summary of Laboratory Test Results for Soils

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	HST-1, 2, 3	Sample Type:	---	Tested By:	jek
Sample ID:	S-1 (Composite)	Test Date:	02/22/12	Checked By:	jdt
Depth :	0-2 ft	Sample Id:	110172		
Test Comment:	---				
Sample Description:	Moist, very dark brown silty sand with gravel				
Sample Comment:	---				

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
HST-1, 2, 3	S-1 (Composite)	0-2 ft	Moist, very dark brown silty sand with gravel	9.5

Notes: Temperature of Drying : 110° Celsius

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GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-1, 2, 3	Sample Type: ---	Tested By:	jek
Sample ID:S-1 (Composite)	Test Date: 02/16/12	Checked By:	jdt
Depth : 0-2 ft	Test Id: 230270		

Test Comment: ---
Sample Description: Moist, very dark brown silty sand with gravel
Sample Comment: ---

Moisture, Ash, and Organic Matter - ASTM D 2974

Boring ID	Sample ID	Depth	Description	Moisture Content,%	Ash Content,%	Organic Matter,%
HST-1, 2, 3	S-1 (Composite)	0-2 ft	Moist, very dark brown silty sand with gravel	10	96.9	3.1

Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass; dried to a constant mass at temperature of 110º C
Ash content and organic matter determined by Method C; dried to constant mass at temperature 440º C

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GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	HST-1, 2, 3	Sample Type:	---	Tested By:	jek
Sample ID:	S-1 (Composite)	Test Date:	02/20/12	Checked By:	jdt
Depth :	0-2 ft	Test Id:	230271		
Test Comment:	---				
Sample Description:	Moist, very dark brown silty sand with gravel				
Sample Comment:	---				

pH of Soil by ASTM D 4972

Boring ID	Sample ID	Depth	Visual Description	pH
HST-1, 2, 3	S-1 (Composite)	0-2 ft	Moist, very dark brown silty sand with gravel	4.7

Notes: solution water; 10 ml : 10g soil

Sample Preparation: screened through #10 sieve

Method A, pH meter used

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GeoTesting
EXPRESS

Client:	Jacobs Civil, Inc.
Project:	SCR - Hockomock Swamp
Location:	Raynham, MA
GTX#:	11534
Test Date:	02/20/12
Tested By:	jek
Checked By:	jdt

Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G 57

Boring ID	Sample ID	Depth, ft.	Sample Description	Electrical Resistivity, ohm-cm	Electrical Conductivity, $(\text{ohm-cm})^{-1}$
HST-1,2,3	(S-1) Composite	0-2	Moist, very dark brown silty sand with gravel	31,401	3.18E-05

Notes: Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G 57)
Test conducted in standard laboratory atmosphere: 68-73 F

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: ---	Sample Type: ---	Tested By:	jek
Sample ID:---	Test Date: 02/22/12	Checked By:	jdt
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
HST-1	S-6	25-27 ft	Moist, olive brown silt	25.2
HST-2	S-4	14-16 ft	Moist, gray clay with sand	31.6
HST-2	S-9	39-41 ft	Wet, gray silty clay	31.4
HST-3	S-7	30-32 ft	Moist, gray clay	36.6
HST-4	S-2A	5-7 ft	Moist, brown sandy clay with organics	74.4
HST-4	S-9A	40-42 ft	Moist, gray clay	40
HST-4	S-10	45-47 ft	Moist, gray silt	28.5
HST-5	S-1	0-2 ft	Moist, very dark brown silty sand	16.4
HST-6	S-2	5.5-7.5 ft	Moist, dark brown silty sand with organics	95.7
HST-6	S-6	25-27 ft	Moist, gray clay	40.9

Notes: Temperature of Drying : 110° Celsius

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: ---	Sample Type: ---	Tested By:	jek
Sample ID:---	Test Date: 02/22/12	Checked By:	jdt
Depth : ---	Sample Id: ---		

Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
HST-7	S-2B	4-6 ft	Moist, brown silty sand with organics	59.8
HST-7	S-7	29-31 ft	Moist, gray silt	30.4
HST-8	S-9	39-41 ft	Moist, gray clay with sand	31.3
HST-9	S-4	15-17 ft	Moist, brown sand with organics	409.3
HST-9	S-7	30-32 ft	Moist, brown silt	66.5
HS-7	UD-1	14 ft	Moist, olive sandy clay	26.7
HS-8	S-4	15-17 ft	Moist, gray silt	26.6
HS-10	S-6	21-23 ft	Moist, yellowish brown clay with sand	30.9
HS-11	S-3	9-11 ft	Moist, brown clay with sand	7.8

Notes: Temperature of Drying : 110° Celsius

GeoTesting
EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	---	Sample Type:	---	Tested By:	jek
Sample ID:	---	Test Date:	02/16/12	Checked By:	jdt
Depth :	---	Test Id:	230135		

pH of Soil by ASTM D 4972

Boring ID	Sample ID	Depth	Visual Description	pH
HST-5	S-1	0-2 ft	Moist, very dark brown silty sand	4.5
HST-7	S-2B	4-6 ft	Moist, brown silty sand with organics	5.2

Notes: solution water; 10 ml : 10g soil

Sample Preparation: screened through #10 sieve

Method A, pH meter used

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	---	Sample Type:	---	Tested By:	jek
Sample ID:	---	Test Date:	02/14/12	Checked By:	jdt
Depth :	---	Test Id:	230130		

Moisture, Ash, and Organic Matter - ASTM D 2974

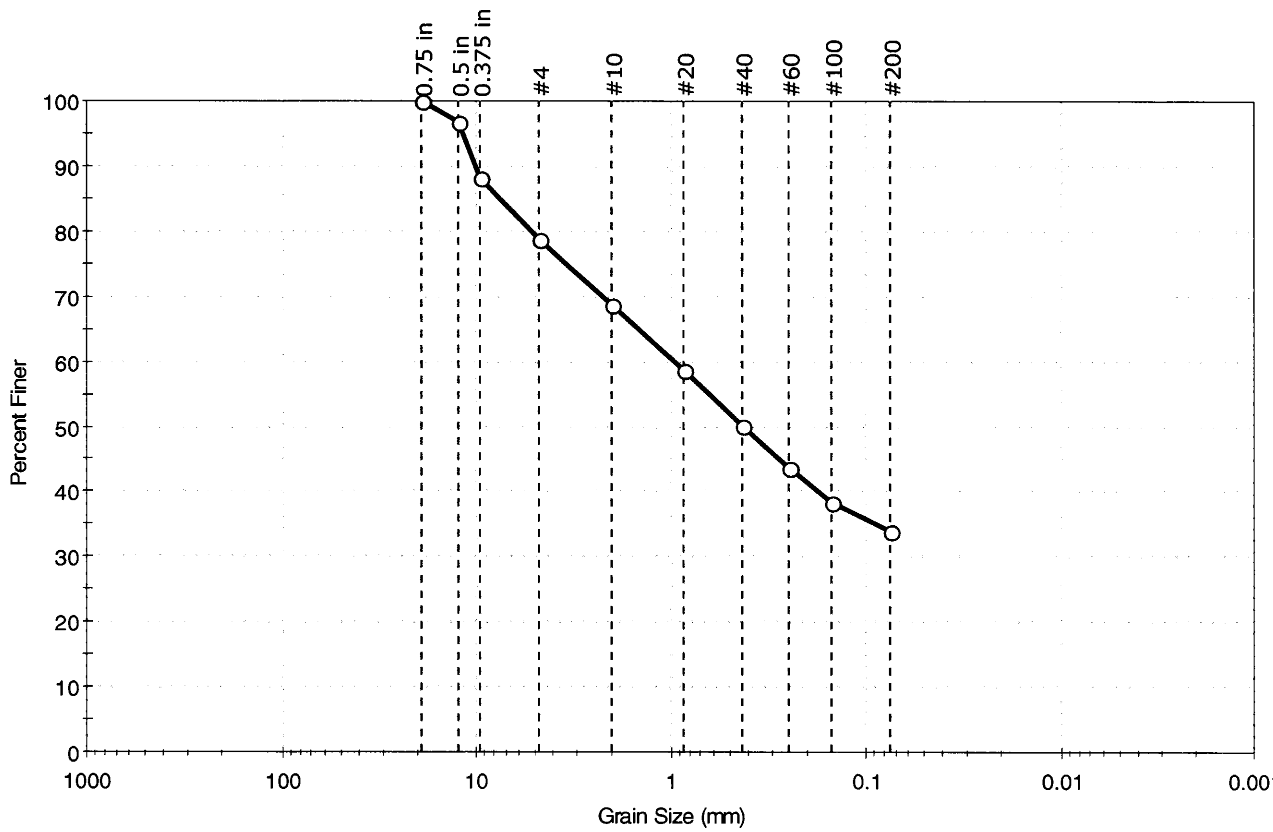
Boring ID	Sample ID	Depth	Description	Moisture Content,%	Ash Content,%	Organic Matter,%
HST-4	S-2A	5-7 ft	Moist, brown sandy clay with organics	74	88.2	11.8
HST-5	S-1	0-2 ft	Moist, very dark brown silty sand	16	96.	4.
HST-6	S-2	5.5-7.5 ft	Moist, dark brown silty sand with organics	96	88.4	11.6
HST-7	S-2B	4-6 ft	Moist, brown silty sand with organics	60	90.4	9.6
HST-9	S-4	15-17 ft	Moist, brown sand with organics	409	38.3	61.7

Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass;
dried to a constant mass at temperature of 110º C
Ash content and organic matter determined by Method C; dried to constant mass at temperature 440º C

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HS-3	Sample Type: jar	Tested By:	jbr
Sample ID:S-2	Test Date: 02/14/12	Checked By:	jdt
Depth : 4-6 ft	Test Id: 230093		
Test Comment: ---			
Sample Description: Moist, brown silty, clayey sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	21.2	44.8	34.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	97		
0.375 in	9.50	88		
#4	4.75	79		
#10	2.00	69		
#20	0.85	59		
#40	0.42	50		
#60	0.25	44		
#100	0.15	38		
#200	0.075	34		

Coefficients

D_{85} =7.5002 mm D_{30} =N/A

D_{60} =0.9537 mm D_{15} =N/A

D_{50} =0.4159 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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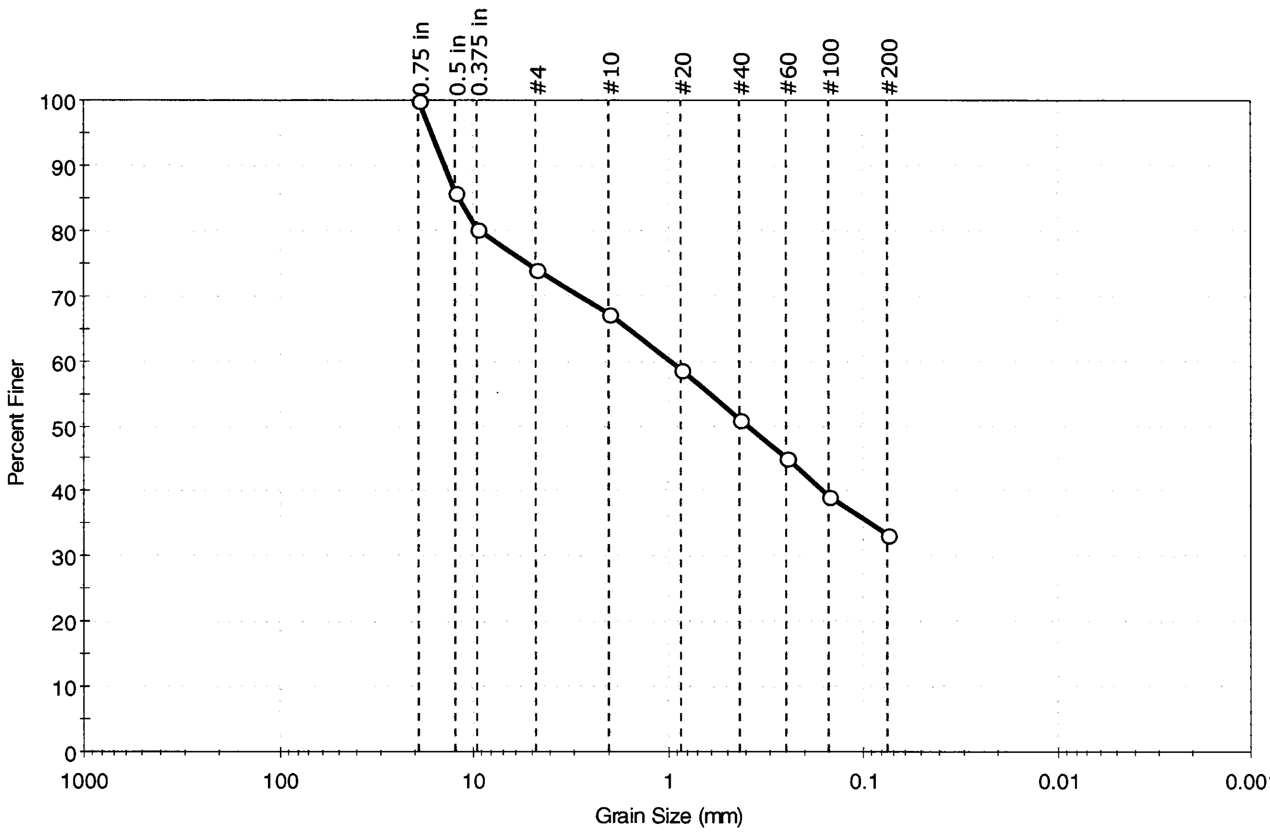
GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HS-4	Sample Type: jar	Tested By:	jbr
Sample ID:S-2	Test Date: 02/16/12	Checked By:	jdt
Depth : 5-7 ft	Test Id: 230094		
Test Comment: ---			
Sample Description: Moist, brown silty, clayey sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	25.9	40.8	33.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	86		
0.375 in	9.50	80		
#4	4.75	74		
#10	2.00	67		
#20	0.85	59		
#40	0.42	51		
#60	0.25	45		
#100	0.15	39		
#200	0.075	33		

Coefficients

D_{85} =11.9648 mm D_{30} =N/A

D_{60} =0.9657 mm D_{15} =N/A

D_{50} =0.3855 mm D_{10} =N/A

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

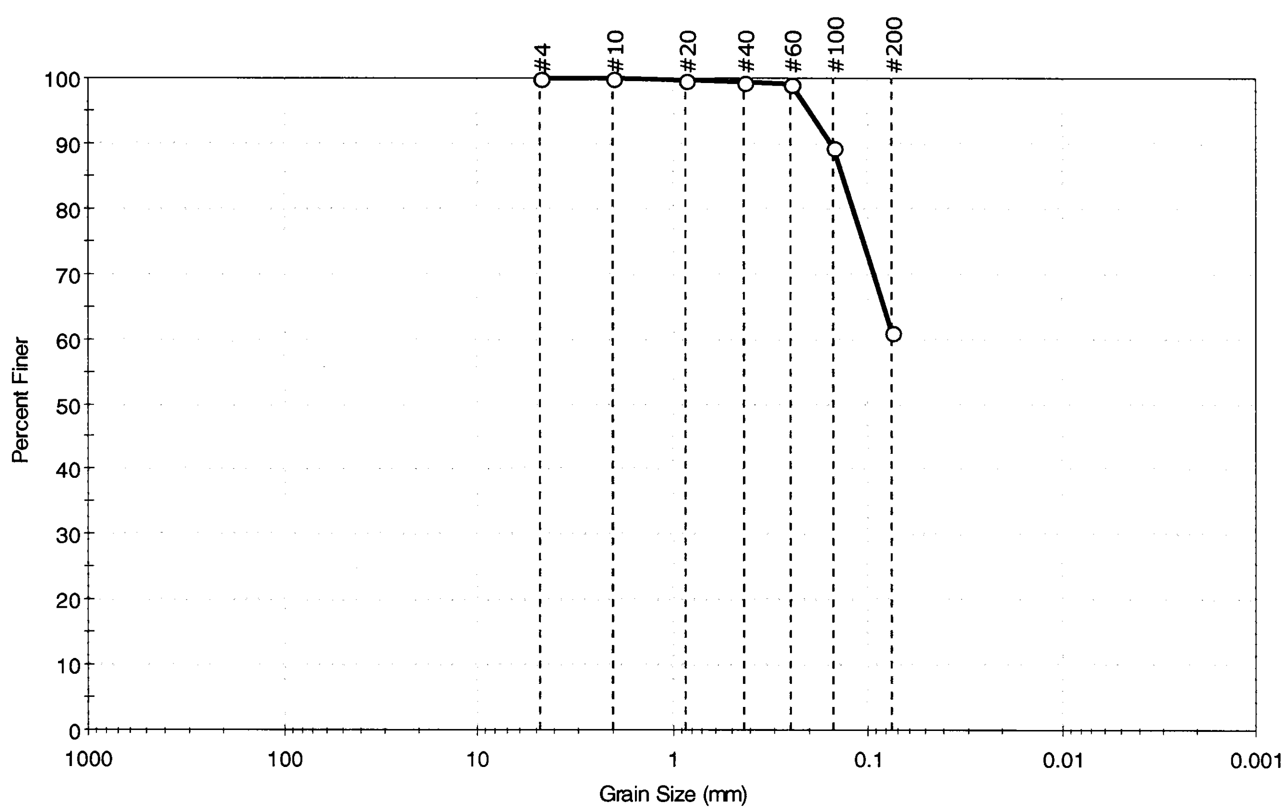
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HS-9	Sample Type: jar	Tested By:	jbr
Sample ID:S-4	Test Date: 02/16/12	Checked By:	jdt
Depth : 14-16 ft	Test Id: 230095		
Test Comment: ---			
Sample Description: Moist, yellowish brown sandy silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	38.8	61.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	89		
#200	0.075	61		

Coefficients

D_{85} =0.1344 mm | D_{30} =N/A
D_{60} =N/A | D_{15} =N/A
D_{50} =N/A | D_{10} =N/A
C_u =N/A | C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

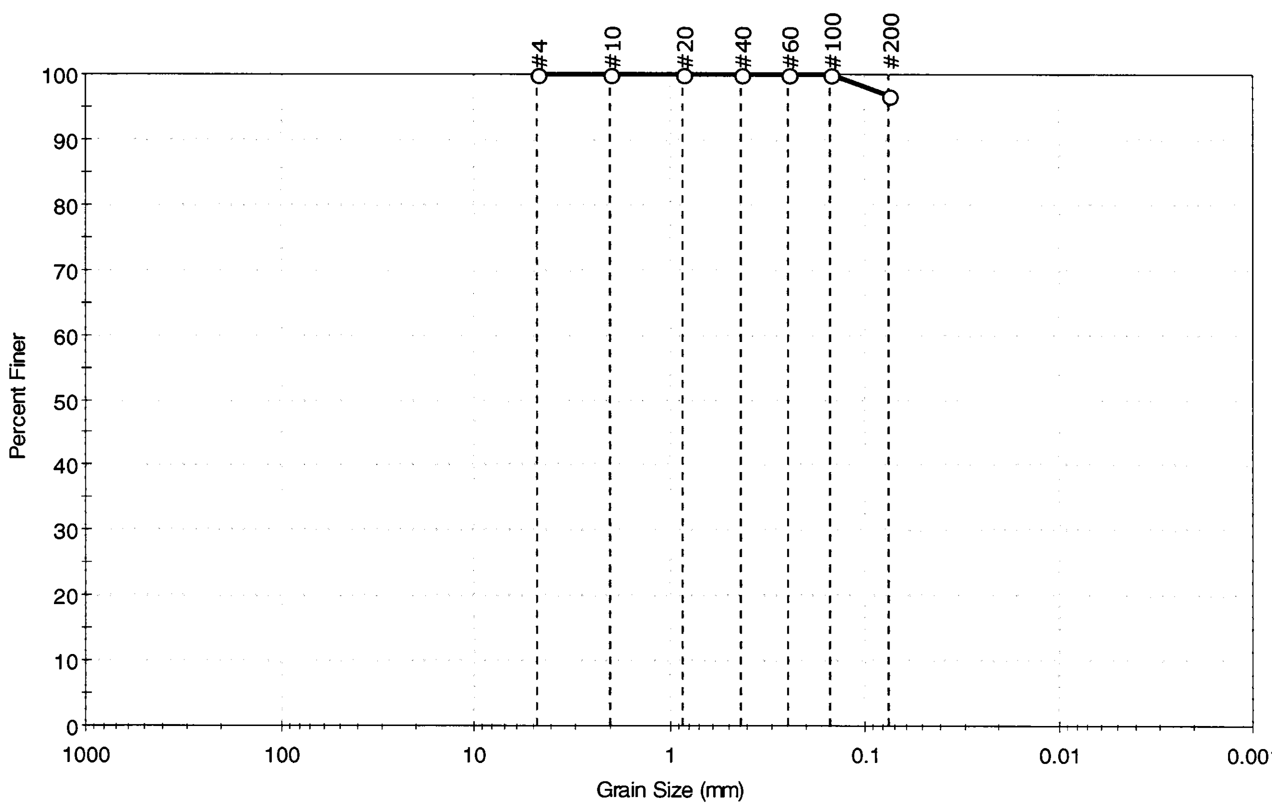
Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-1	Sample Type: jar	Tested By:	jbr
Sample ID:S-6	Test Date: 02/14/12	Checked By:	jdt
Depth : 25-27 ft	Test Id: 230089		
Test Comment: ---			
Sample Description: Moist, olive brown silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	3.2	96.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	97		

Coefficients

D_{85} = N/A D_{30} = N/A
D_{60} = N/A D_{15} = N/A
D_{50} = N/A D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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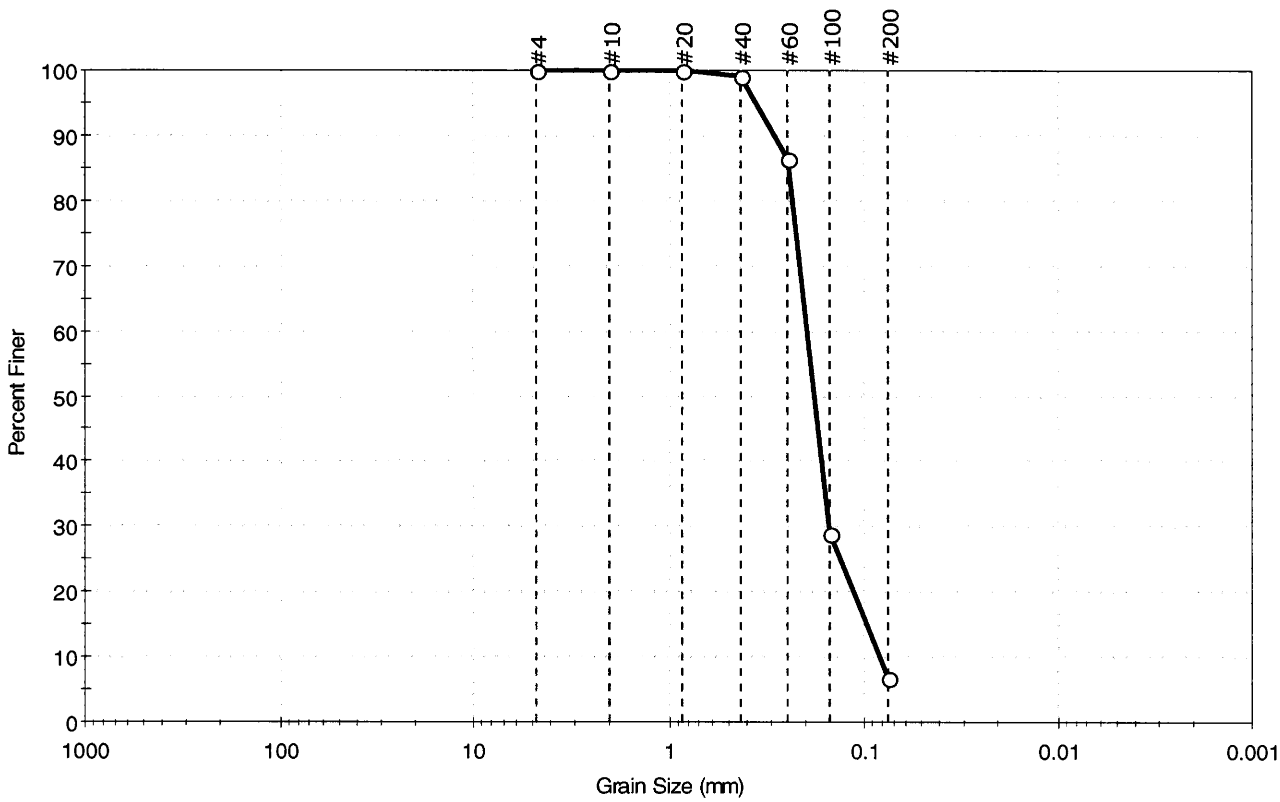
GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-3	Sample Type: jar	Tested By:	jbr
Sample ID:S-4	Test Date: 02/16/12	Checked By:	jdt
Depth : 15-17 ft	Test Id: 230090		
Test Comment: ---			
Sample Description: Moist, gray sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	93.3	6.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	86		
#100	0.15	29		
#200	0.075	7		

Coefficients

D_{85} =0.2467 mm D_{30} =0.1517 mm

D_{60} =0.1978 mm D_{15} =0.0974 mm

D_{50} =0.1810 mm D_{10} =0.0832 mm

C_u =2.377 C_c =1.398

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

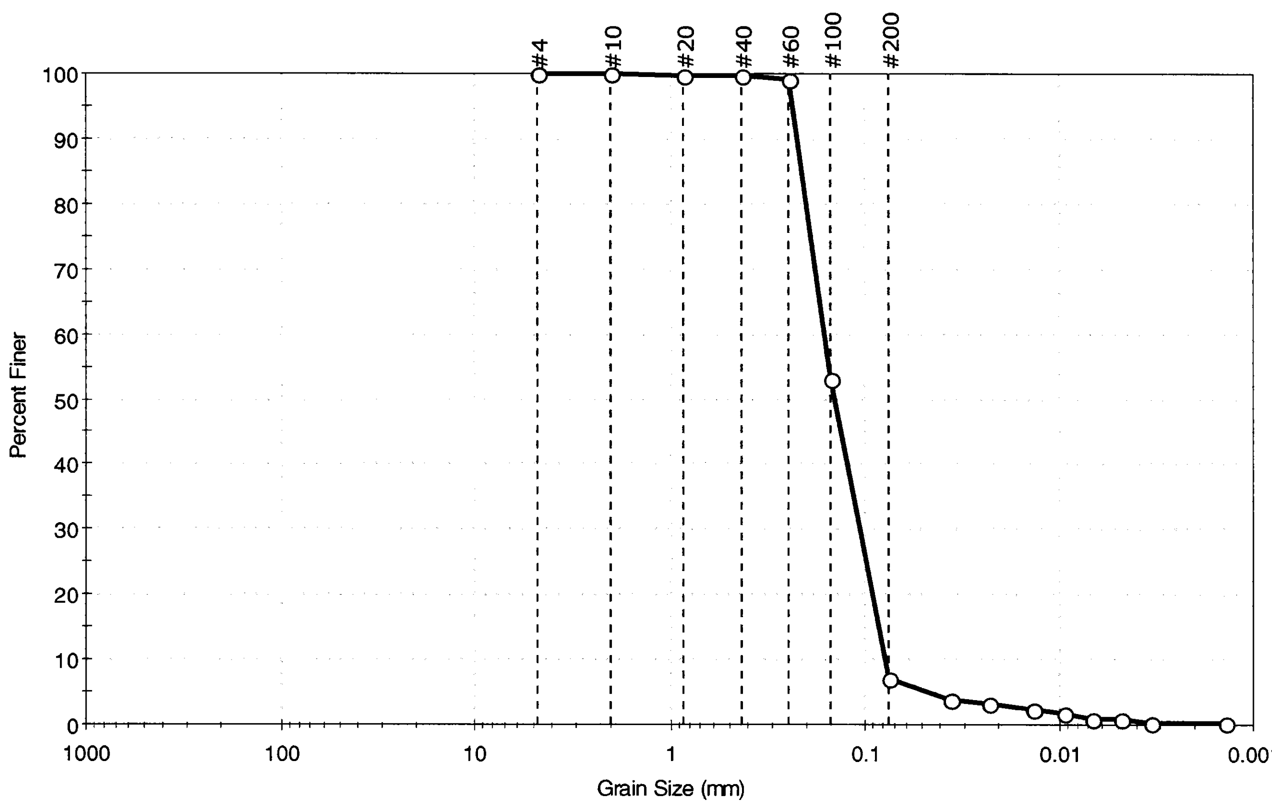
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-4	Sample Type: jar	Tested By:	jbr
Sample ID:S-4	Test Date: 02/16/12	Checked By:	jdt
Depth : 15-17 ft	Test Id: 230098		
Test Comment: ---			
Sample Description: Moist, brownish yellow sand with silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	---	92.9	7.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	53		
#200	0.075	7		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0359	4		
---	0.0226	3		
---	0.0134	2		
---	0.0093	2		
---	0.0068	1		
---	0.0048	1		
---	0.0034	0		
---	0.0014	0		

Coefficients

D_{85} =0.2136 mm	D_{30} =0.1059 mm
D_{60} =0.1620 mm	D_{15} =0.0845 mm
D_{50} =0.1432 mm	D_{10} =0.0783 mm
C_u =2.069	C_c =0.884

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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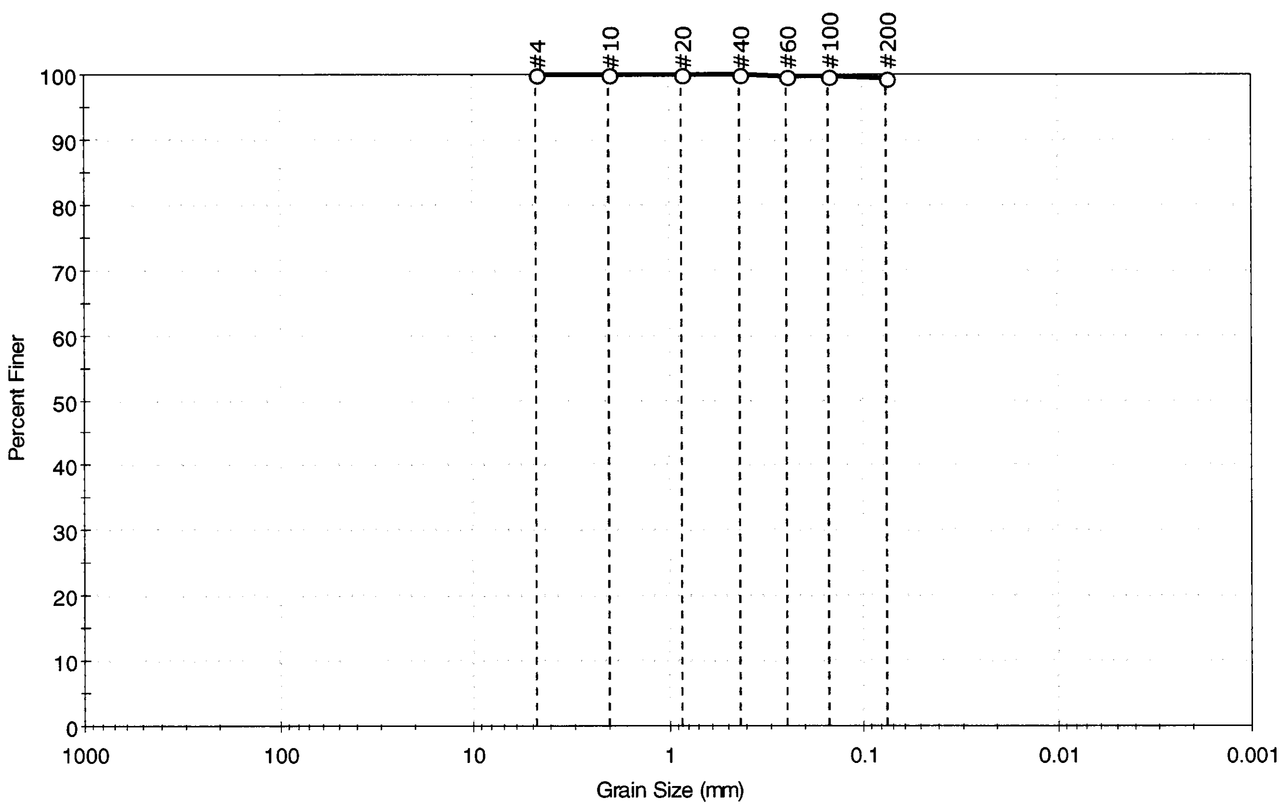
GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-4	Sample Type: jar	Tested By:	jbr
Sample ID: S-10	Test Date: 02/14/12	Checked By:	jdt
Depth : 45-47 ft	Test Id: 230091		
Test Comment: ---			
Sample Description: Moist, gray silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	0.7	99.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	99		

Coefficients

D_{85} = N/A	D_{30} = N/A
D_{60} = N/A	D_{15} = N/A
D_{50} = N/A	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM silt (ML)

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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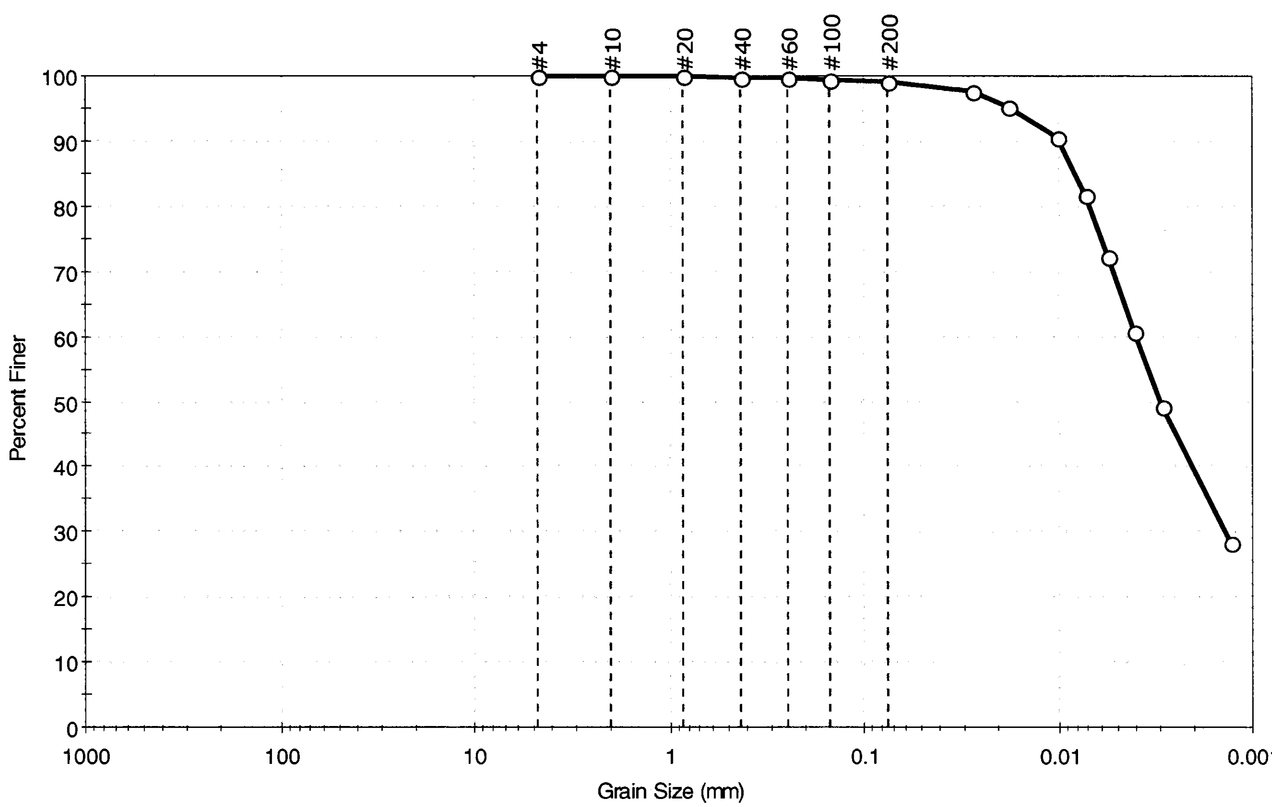
GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-6	Sample Type: jar	Tested By:	jbr
Sample ID:S-6	Test Date: 02/17/12	Checked By:	jdt
Depth : 25-27 ft	Test Id: 230099		
Test Comment: ---			
Sample Description: Moist, gray clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	0.9	99.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	99		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0277	98		
---	0.0178	95		
---	0.0101	91		
---	0.0073	82		
---	0.0055	72		
---	0.0041	61		
---	0.0030	49		
---	0.0013	28		

Coefficients

D_{85} =0.0082 mm
D_{30} =0.0014 mm
D_{60} =0.0040 mm
D_{15} =N/A
D_{50} =0.0030 mm
D_{10} =N/A
C_u =N/A
C_c =N/A

Classification

ASTM lean clay (CL)

AASHTO Clayey Soils (A-6 (21))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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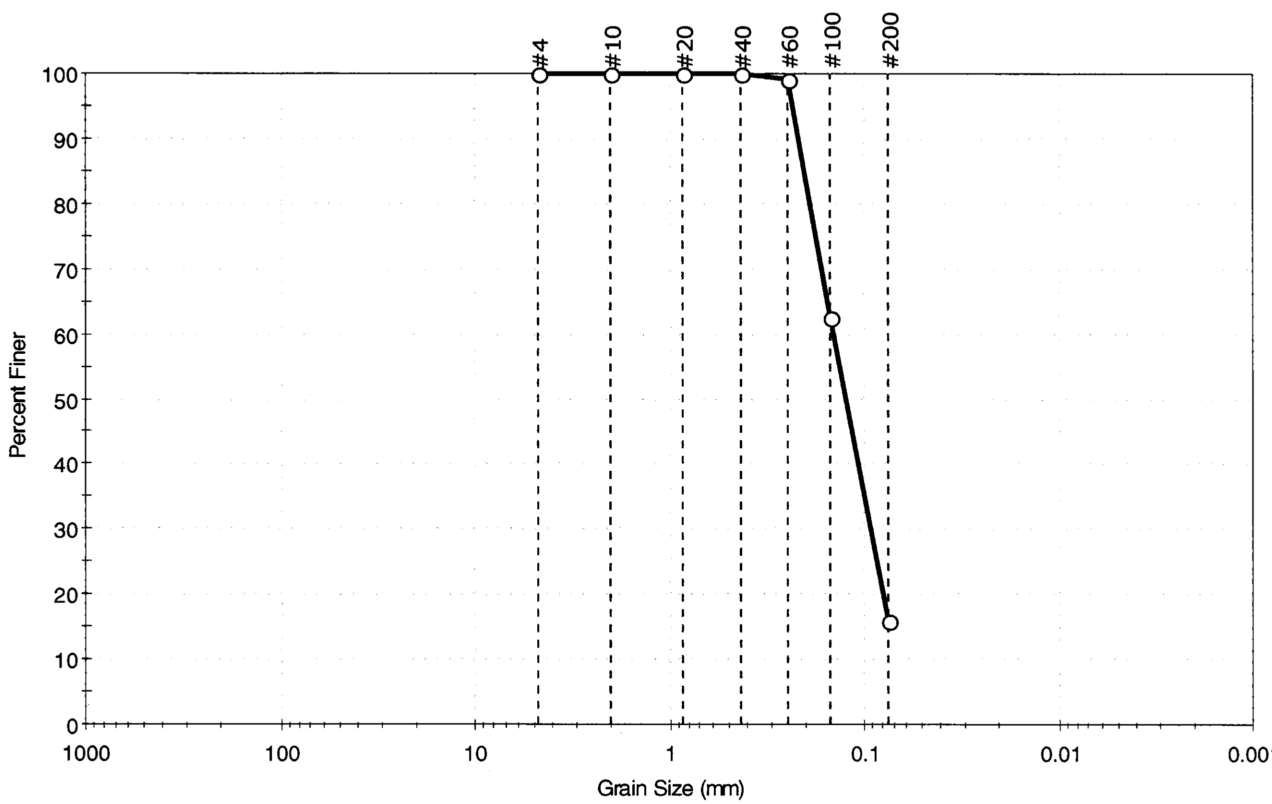
GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-8	Sample Type: jar	Tested By:	jbr
Sample ID: S-5	Test Date: 02/14/12	Checked By:	jdt
Depth : 19-21 ft	Test Id: 230092		
Test Comment: ---			
Sample Description: Moist, light greenish gray silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	84.0	16.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	63		
#200	0.075	16		

Coefficients

D_{85} =0.2055 mm	D_{30} =0.0924 mm
D_{60} =0.1445 mm	D_{15} =N/A
D_{50} =0.1245 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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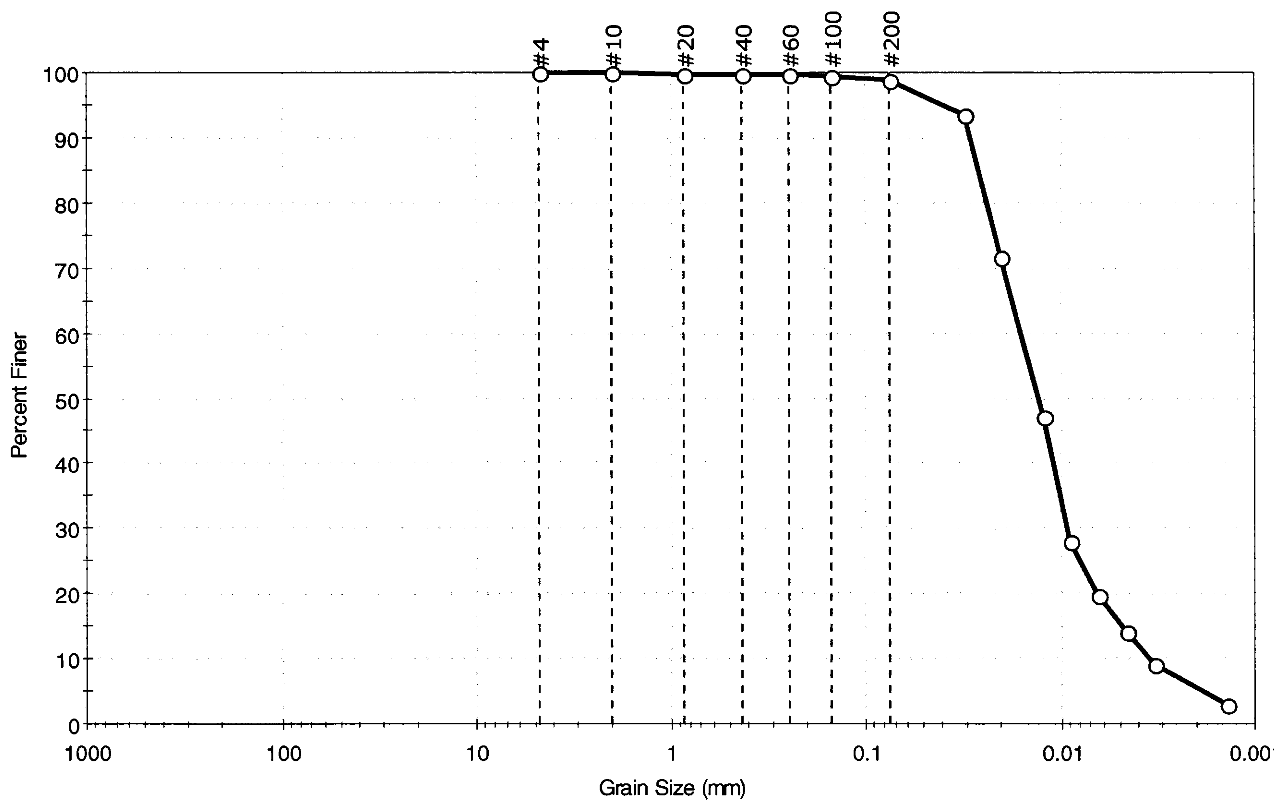
GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-9	Sample Type: jar	Tested By:	jbr
Sample ID:S-7	Test Date: 02/17/12	Checked By:	jdt
Depth : 30-32 ft	Test Id: 230100		
Test Comment: ---			
Sample Description: Moist, brown silt			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	1.1	98.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0308	94		
---	0.0202	72		
---	0.0123	47		
---	0.0091	28		
---	0.0065	20		
---	0.0046	14		
---	0.0033	9		
---	0.0014	3		

Coefficients

D_{85} =0.0261 mm D_{30} =0.0094 mm

D_{60} =0.0160 mm D_{15} =0.0048 mm

D_{50} =0.0131 mm D_{10} =0.0035 mm

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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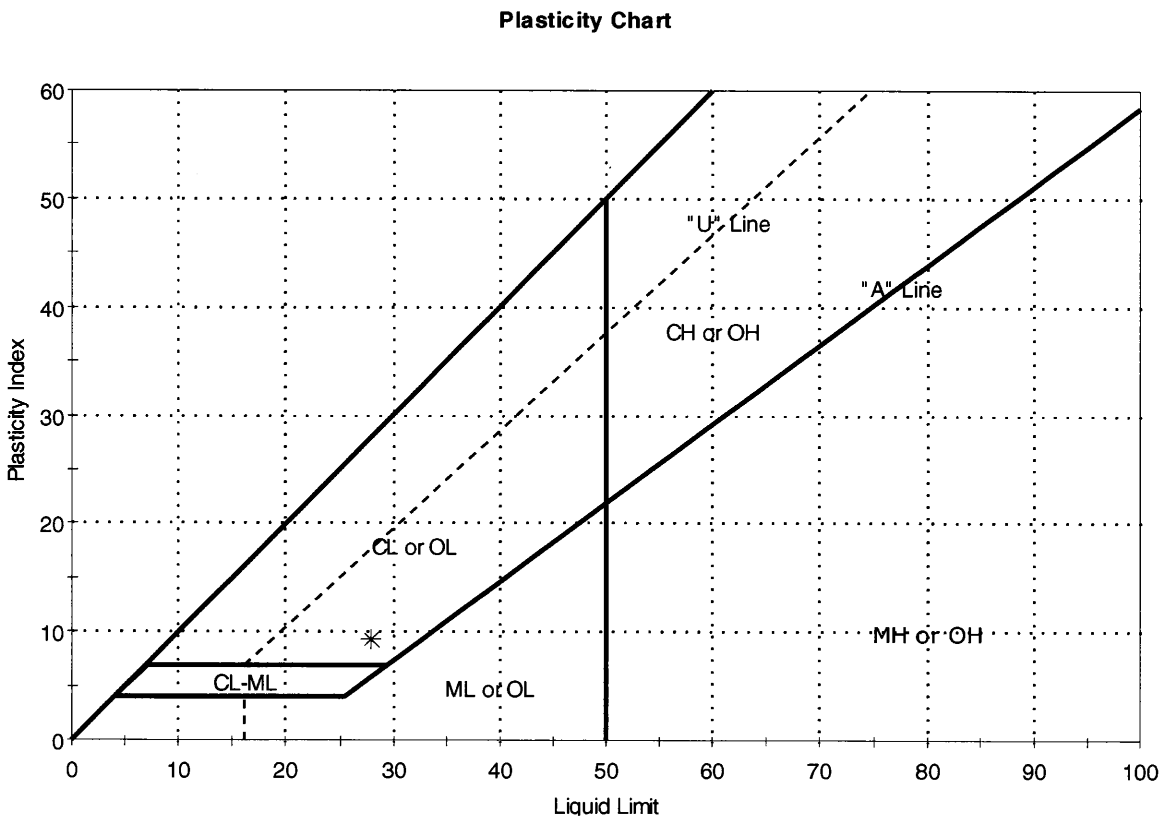
GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HS-10	Sample Type: jar	Tested By:	cam
Sample ID: S-6	Test Date: 02/14/12	Checked By:	jdt
Depth : 21-23 ft	Test Id: 230084		
Test Comment: ---			
Sample Description: Moist, yellowish brown clay with sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-6	HS-10	21-23 ft	31	28	19	9	1	

Sample Prepared using the WET method

Dry Strength: HIGH

Dilentancy: RAPID

Toughness: LOW

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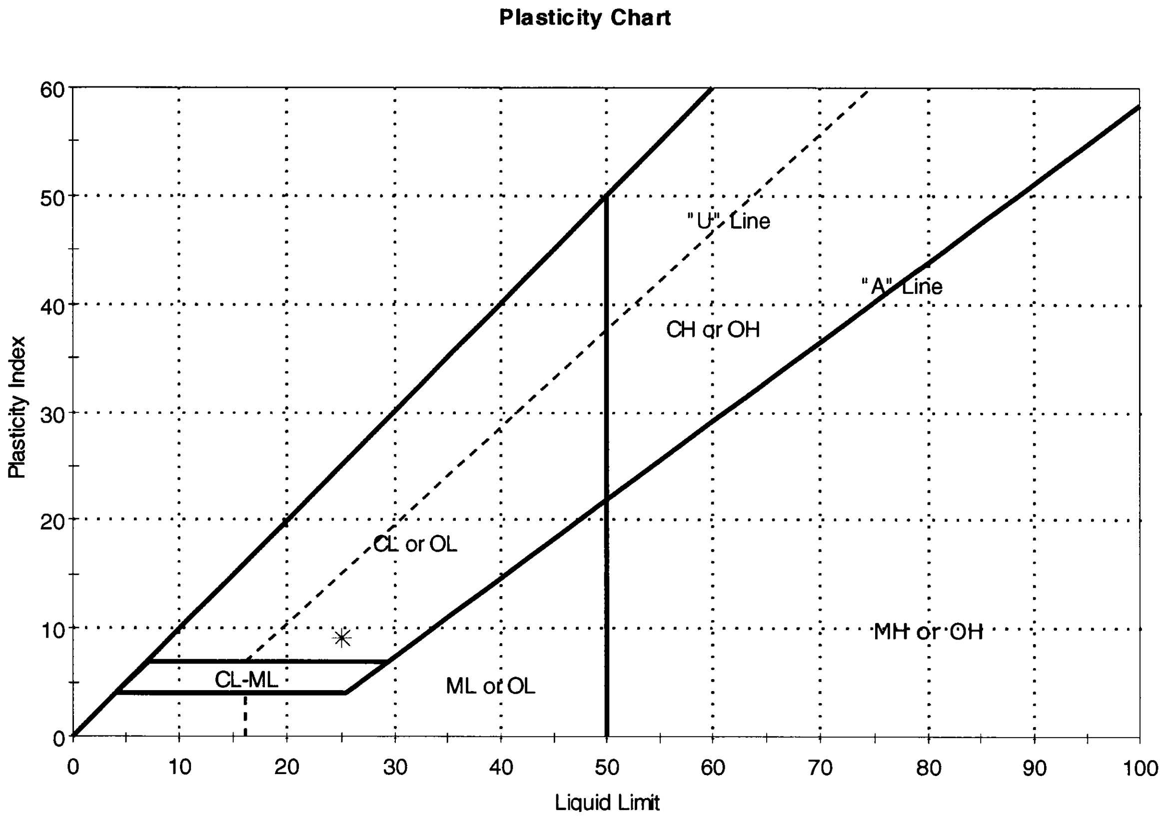
GeoTesting
EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HS-11	Sample Type: jar	Tested By:	cam
Sample ID:S-3	Test Date: 02/14/12	Checked By:	jdt
Depth : 9-11 ft	Test Id: 230085		
Test Comment: ---			
Sample Description: Moist, brown clay with sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-3	HS-11	9-11 ft	8	25	16	9	-1	

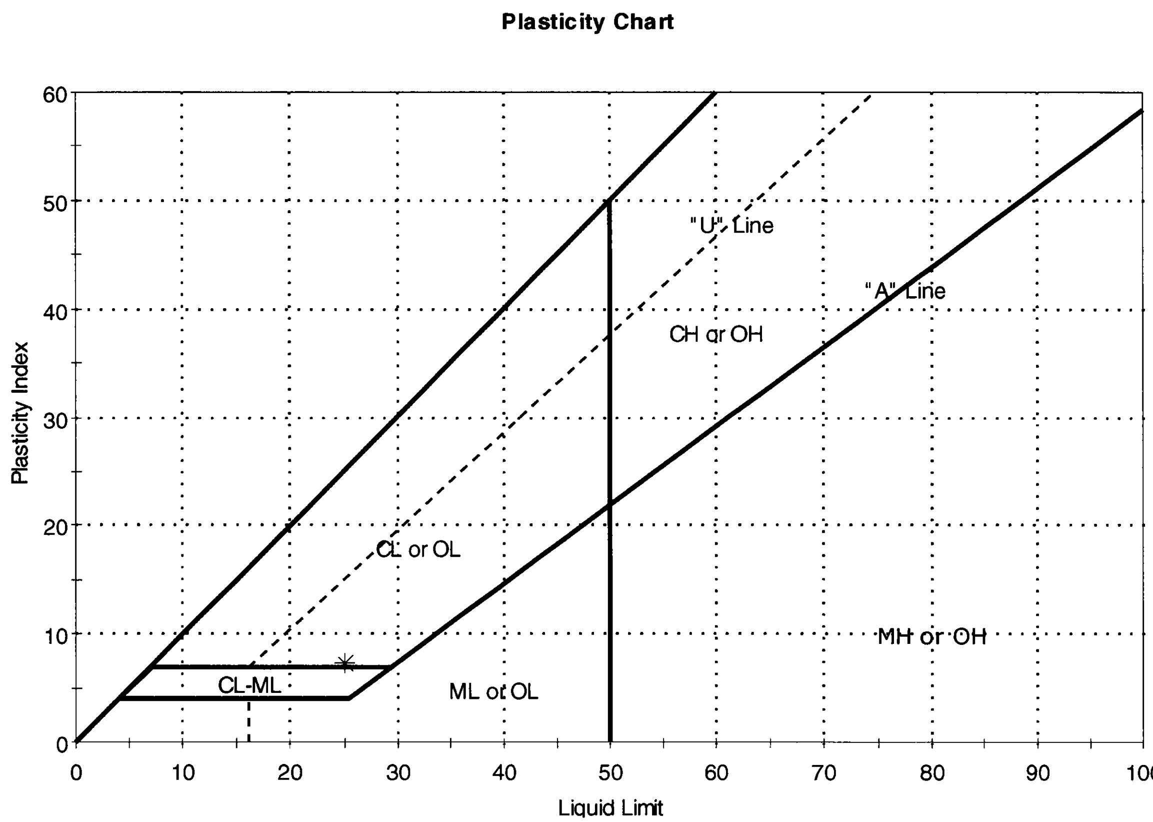
Sample Prepared using the WET method

Dry Strength: HIGH
Dilentancy: SLOW
Toughness: LOW

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	HS-7	Sample Type:	tube	Tested By:	cam
Sample ID:	UD-1	Test Date:	02/14/12	Checked By:	jdt
Depth :	14 ft	Test Id:	230082		
Test Comment:	---				
Sample Description:	Moist, olive sandy clay				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	UD-1	HS-7	14 ft	27	25	18	7	1	

Sample Prepared using the WET method

Dry Strength: MEDIUM

Dilentancy: RAPID

Toughness: LOW

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	HS-8	Sample Type:	jar	Tested By:	cam
Sample ID:	S-4	Test Date:	02/14/12	Checked By:	jdt
Depth :	15-17 ft	Test Id:	230083		
Test Comment:	---				
Sample Description:	Moist, gray silt				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-4	HS-8	15-17 ft	27	n/a	n/a	n/a	n/a	

Dry Strength: MEDIUM

Dilentancy: RAPID

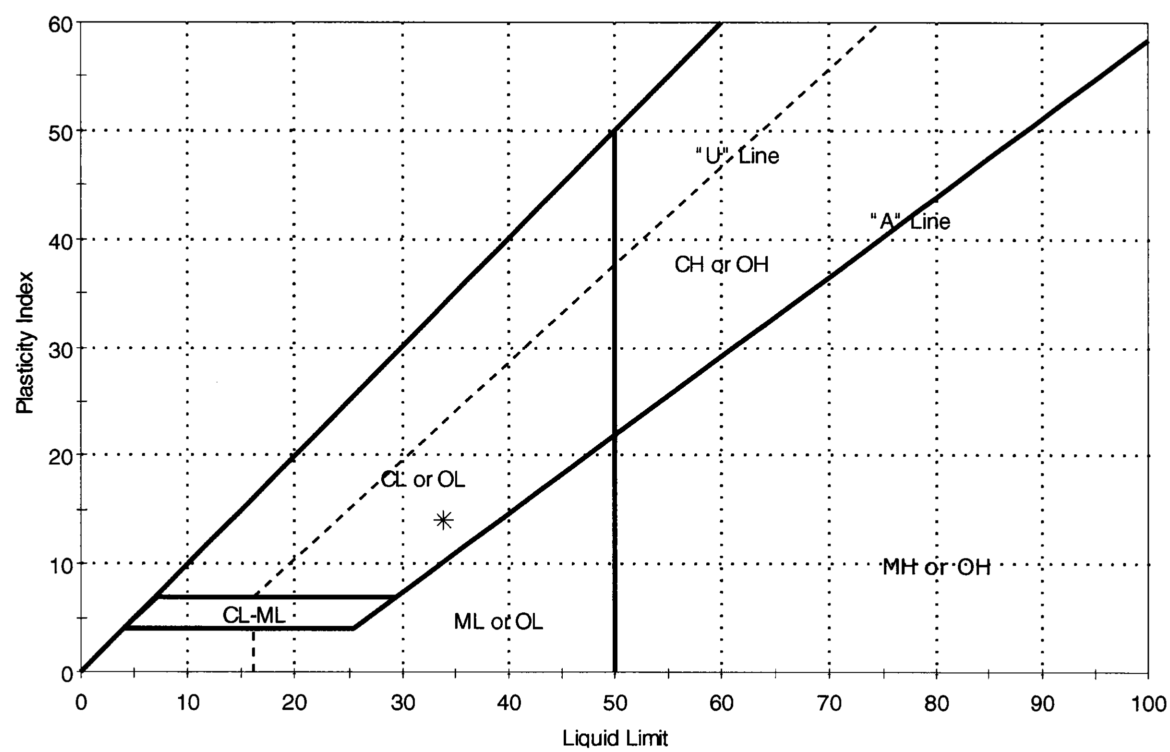
Toughness: n/a

The sample was determined to be Non-Plastic

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-2	Sample Type: jar	Tested By:	cam
Sample ID:S-4	Test Date: 02/14/12	Checked By:	jdt
Depth : 14-16 ft	Test Id: 230073		
Test Comment: ---			
Sample Description: Moist, gray clay with sand			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	S-4	HST-2	14-16 ft	32	34	20	14	1	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

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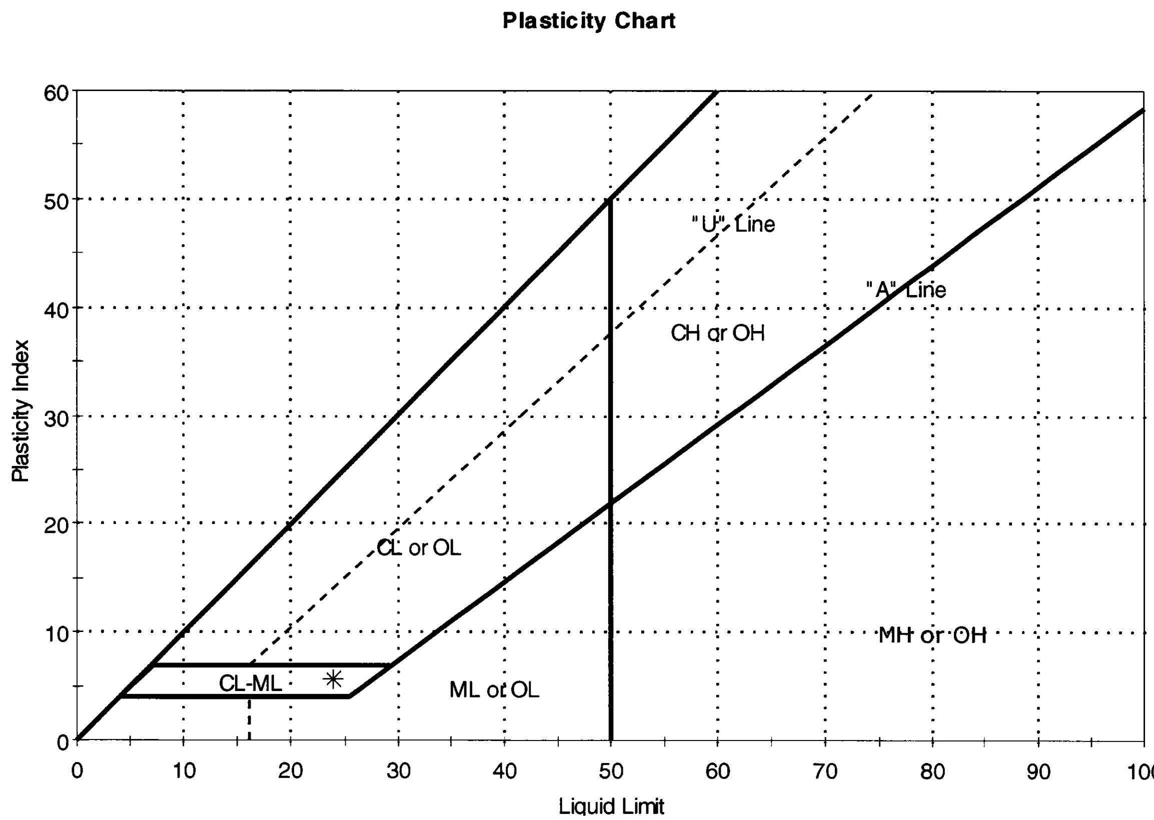
Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	HST-2	Sample Type:	jar	Tested By:	cam
Sample ID:	S-9	Test Date:	02/14/12	Checked By:	jdt
Depth :	39-41 ft	Test Id:	230074		
Test Comment:	---				
Sample Description:	Wet, gray silty clay				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	S-9	HST-2	39-41 ft	31	24	18	6	2	

Sample Prepared using the WET method

Dry Strength: HIGH

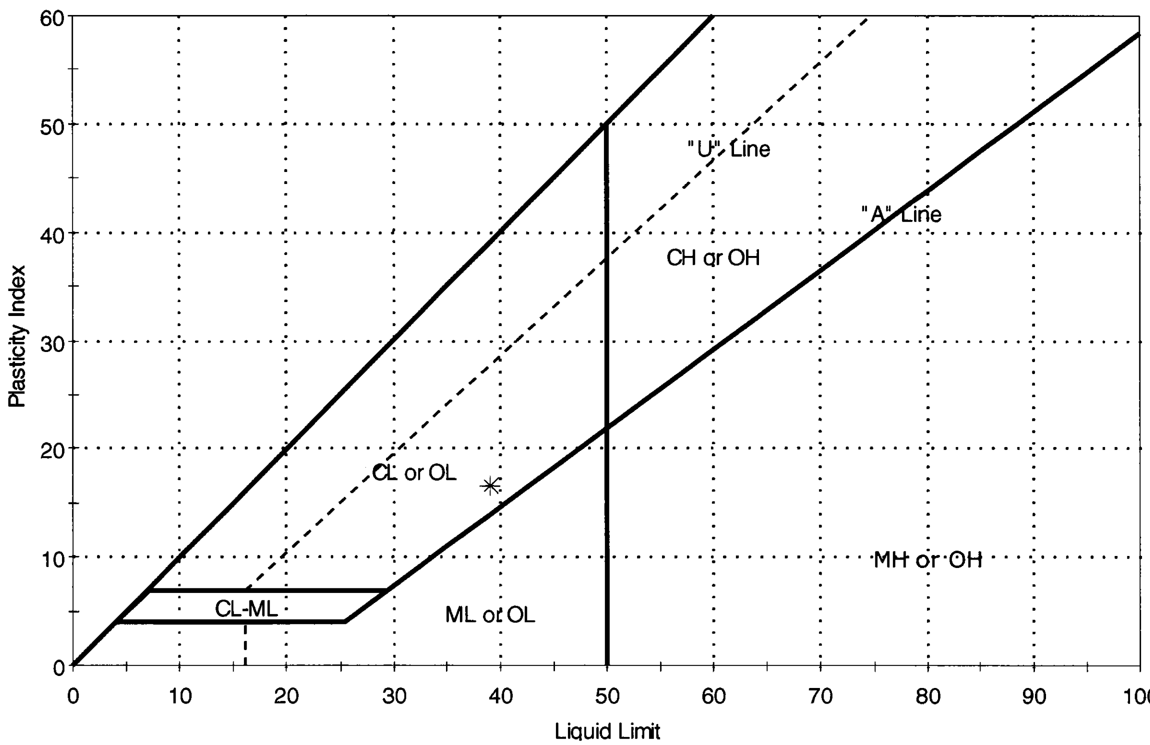
Dilentancy: RAPID

Toughness: LOW

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-3	Sample Type: jar	Tested By:	cam
Sample ID:S-7	Test Date: 02/14/12	Checked By:	jdt
Depth : 30-32 ft	Test Id: 230075		
Test Comment: ---			
Sample Description: Moist, gray clay			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	S-7	HST-3	30-32 ft	37	39	23	16	1	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

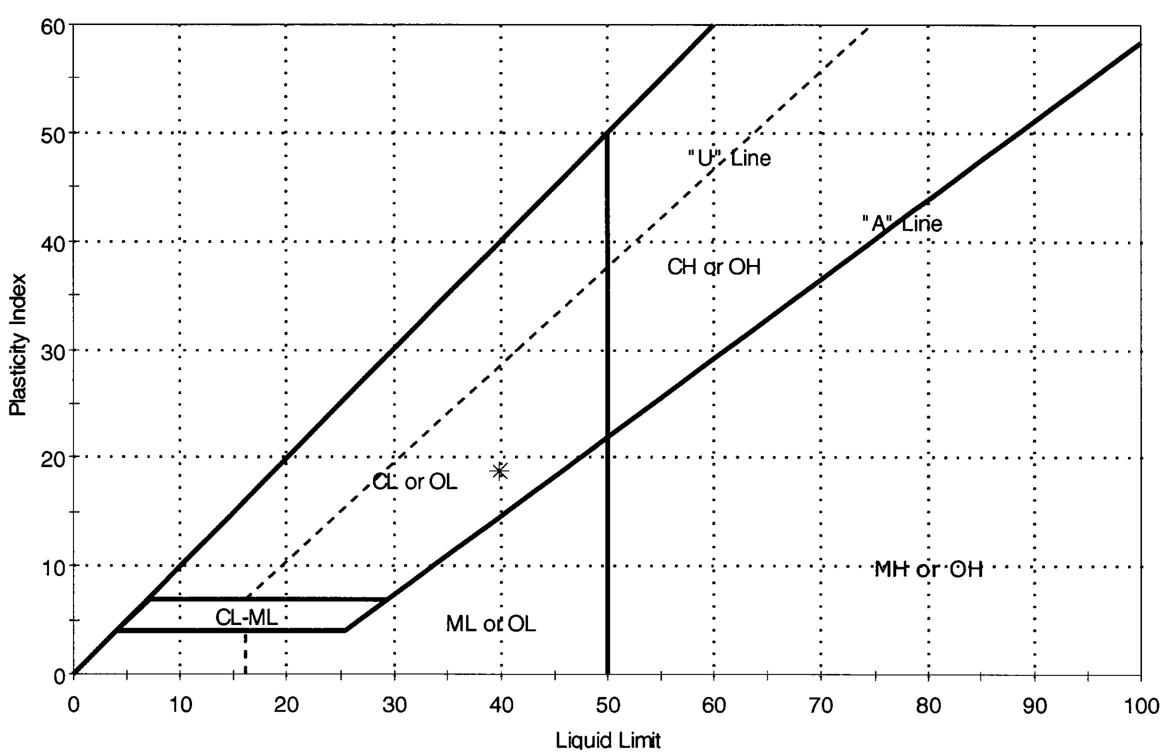
Dilentancy: SLOW

Toughness: LOW

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID: HST-4		Sample Type:	jar	Tested By:	cam
Sample ID:S-9A		Test Date:	02/14/12	Checked By:	jdt
Depth :	40-42 ft	Test Id:	230076		
Test Comment:	---				
Sample Description:	Moist, gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	S-9A	HST-4	40-42 ft	40	40	21	19	1	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilentancy: SLOW

Toughness: LOW

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-4	Sample Type: jar	Tested By:	cam
Sample ID:S-10	Test Date: 02/14/12	Checked By:	jdt
Depth : 45-47 ft	Test Id: 230077		
Test Comment: ---			
Sample Description: Moist, gray silt			
Sample Comment: ---			

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-10	HST-4	45-47 ft	29	n/a	n/a	n/a	n/a	silt (ML)

0% Retained on #40 Sieve

Dry Strength: MEDIUM

Dilentancy: RAPID

Toughness: n/a

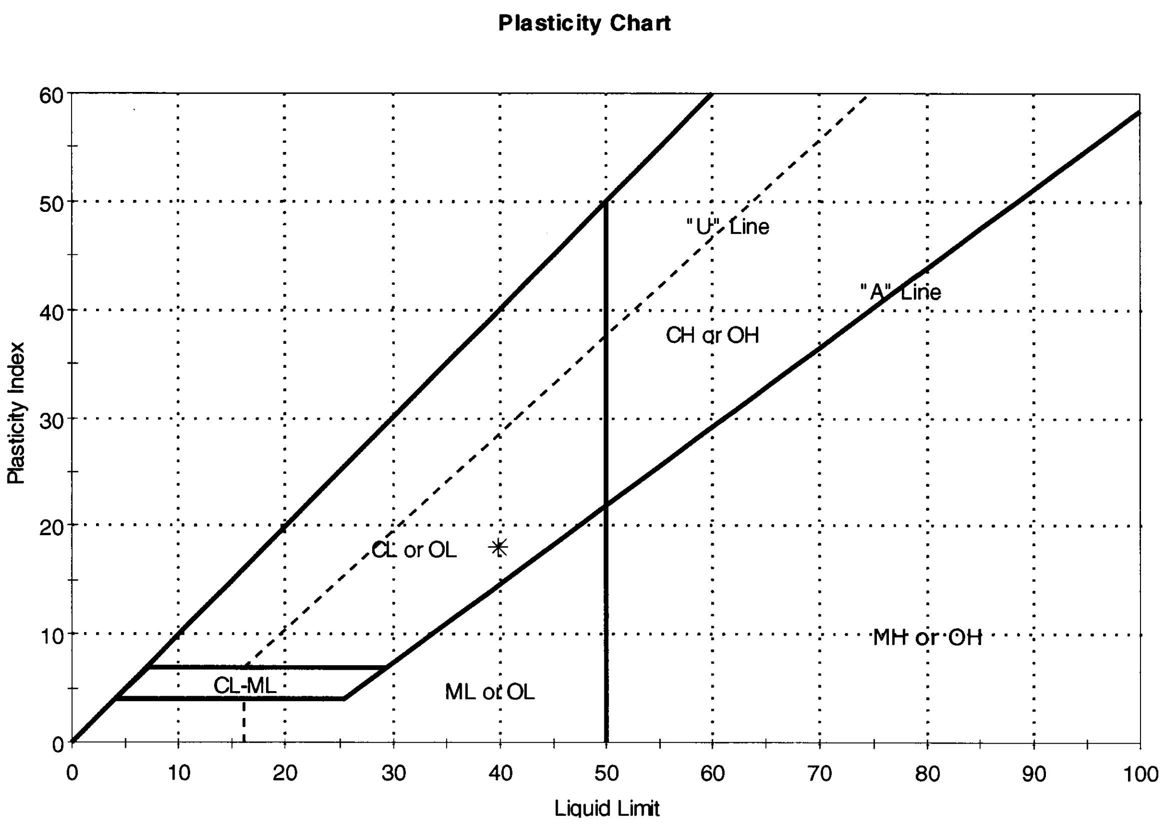
The sample was determined to be Non-Plastic

GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-6	Sample Type: jar	Tested By:	cam
Sample ID: S-6	Test Date: 02/14/12	Checked By:	jdt
Depth : 25-27 ft	Test Id: 230079		

Test Comment: ---
Sample Description: Moist, gray clay
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
✳	S-6	HST-6	25-27 ft	41	40	22	18	1	lean clay (CL)

Sample Prepared using the WET method
0% Retained on #40 Sieve
Dry Strength: VERY HIGH
Dilentancy: SLOW
Toughness: LOW

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GeoTesting EXPRESS

Client: Jacobs Civil, Inc.			
Project: SCR - Hockomock Swamp			
Location: Raynham, MA		Project No:	GTX-11534
Boring ID: HST-7	Sample Type: jar	Tested By:	cam
Sample ID:S-7	Test Date: 02/14/12	Checked By:	jdt
Depth : 29-31 ft	Test Id: 230080		

Test Comment: ---
Sample Description: Moist, gray silt
Sample Comment: ---

Atterberg Limits - ASTM D 4318-05

Sample Determined to be non-plastic

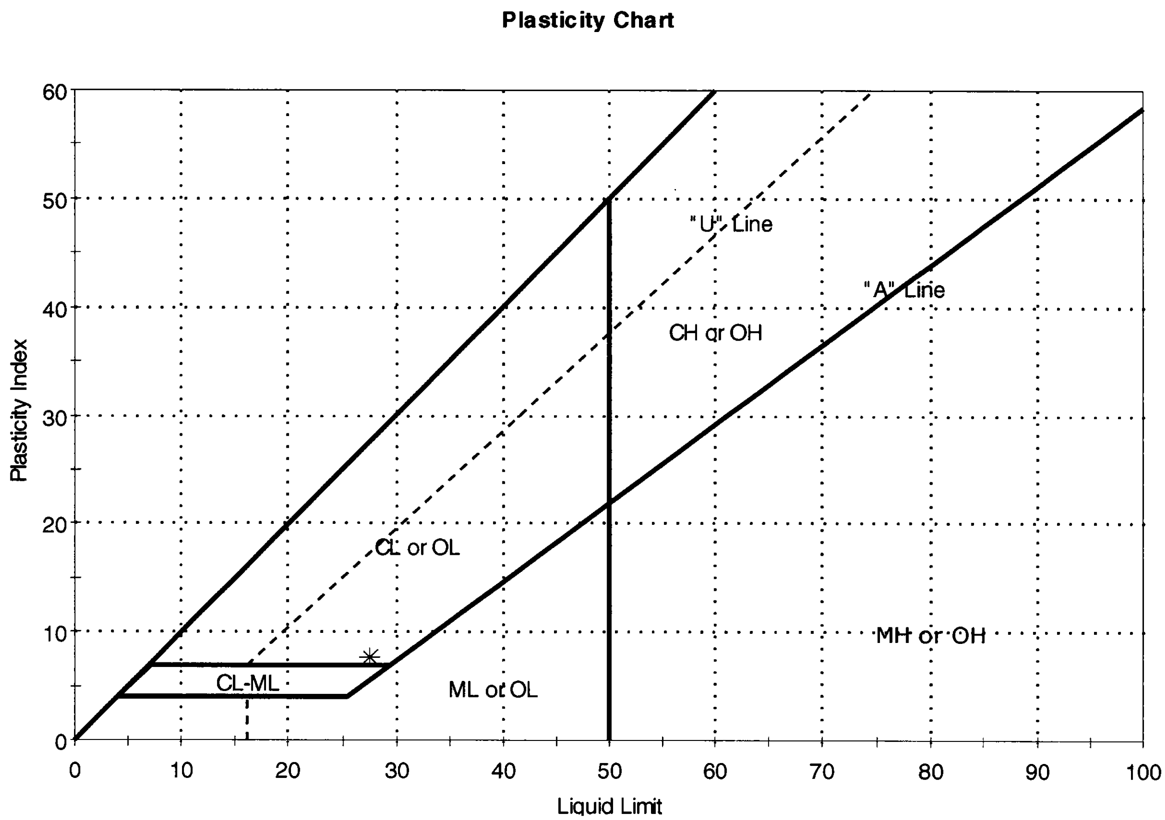
Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-7	HST-7	29-31 ft	30	n/a	n/a	n/a	n/a	

Dry Strength: HIGH
Dilentancy: RAPID
Toughness: n/a
The sample was determined to be Non-Plastic

GeoTesting EXPRESS

Client:	Jacobs Civil, Inc.				
Project:	SCR - Hockomock Swamp				
Location:	Raynham, MA			Project No:	GTX-11534
Boring ID:	HST-8	Sample Type:	jar	Tested By:	cam
Sample ID:	S-9	Test Date:	02/14/12	Checked By:	jdt
Depth :	39-41 ft	Test Id:	230081		
Test Comment:	---				
Sample Description:	Moist, gray clay with sand				
Sample Comment:	---				

Atterberg Limits - ASTM D 4318-05



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	S-9	HST-8	39-41 ft	31	28	20	8	1	

Sample Prepared using the WET method

Dry Strength: HIGH

Dilentancy: RAPID

Toughness: LOW

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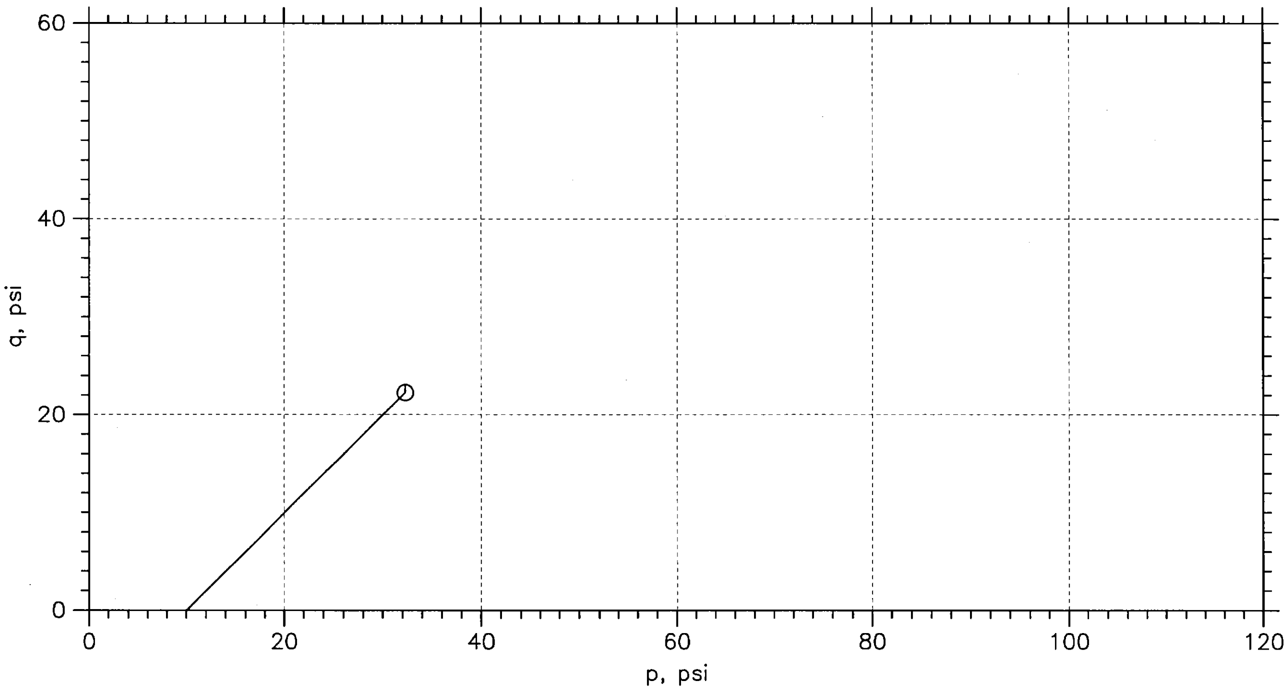
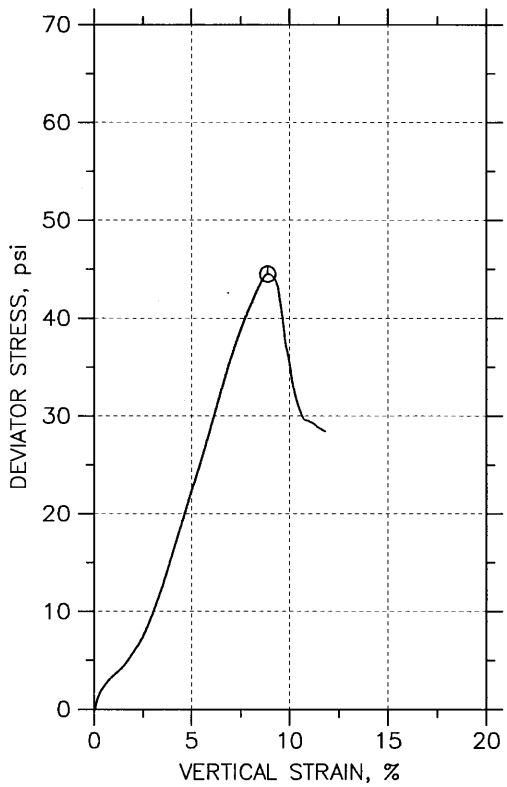
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D2850





Symbol	⊙			
Sample No.	UD-1			
Test No.	UU-1			
Depth	14 ft			
Tested by	md			
Test Date	2/16/12			
Checked by	jdt			
Check Date	02/22/12			
Diameter, in	2.87			
Height, in	6.5			
Water Content, %	25.4			
Dry Density, pcf	98.58			
Saturation, %	92.2			
Void Ratio	0.773			
Confining Stress, psi	10			
Undrained Strength, psi	22.26			
Max. Dev. Stress, psi	44.53			
Strain at Failure, %	8.85			
Strain Rate, %/min	1			
Estimated Specific Gravity	2.8			
Liquid Limit	25			
Plastic Limit	18			
Plasticity Index	7			

GeoTesting EXPRESS

Project: SCR-Hockomock Swamp

Location: Raynham, MA

Project No.: GTX-11534

Boring No.: HS-7

Sample Type: tube

Description: Moist, olive sandy clay

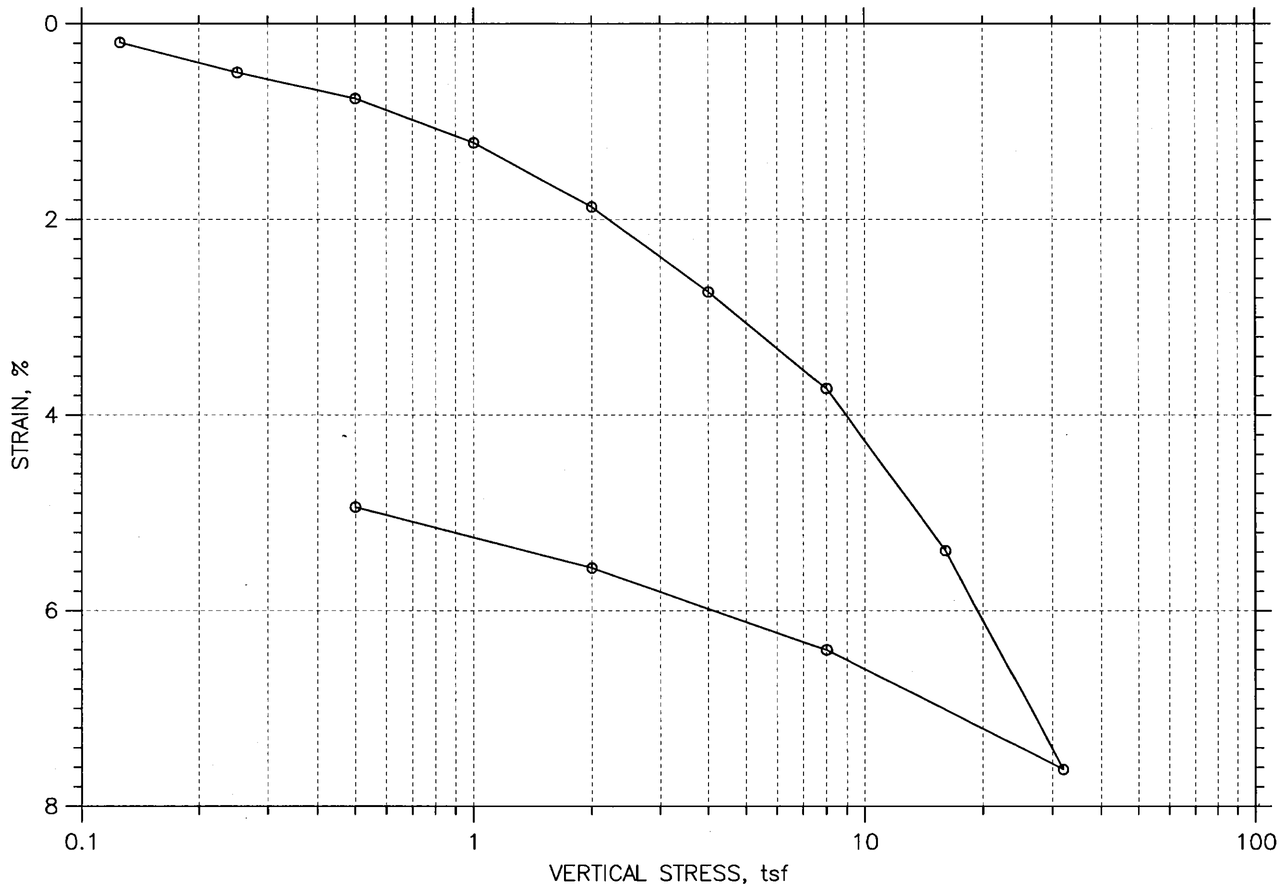
Remarks: System W

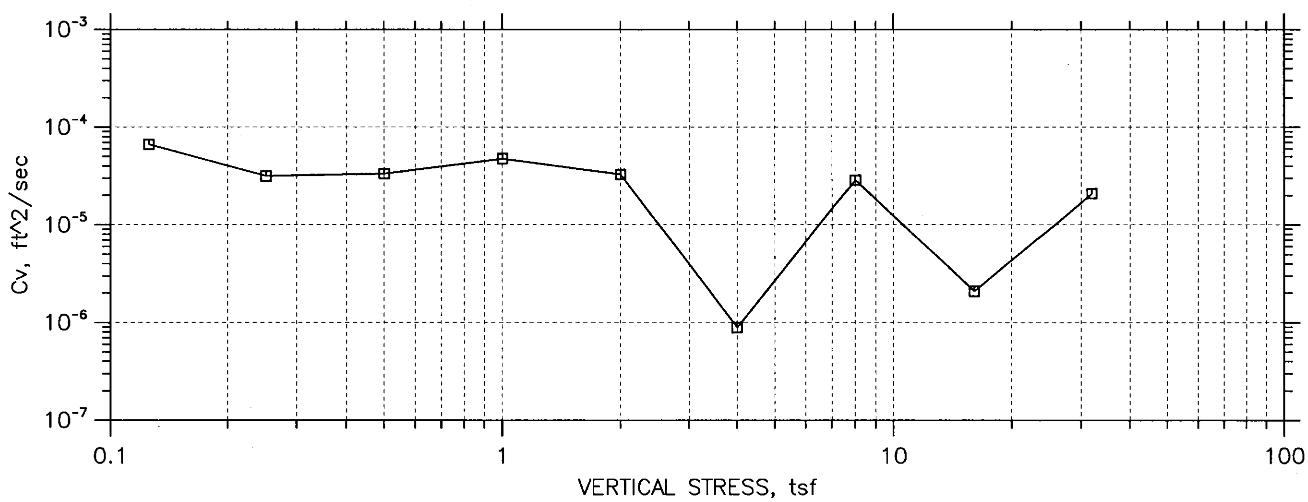
Phase calculations based on start and end of test.

Wed, 22-FEB-2012 10:06:30

One-Dimensional Consolidation by ASTM D 2435 - Method B

SUMMARY REPORT



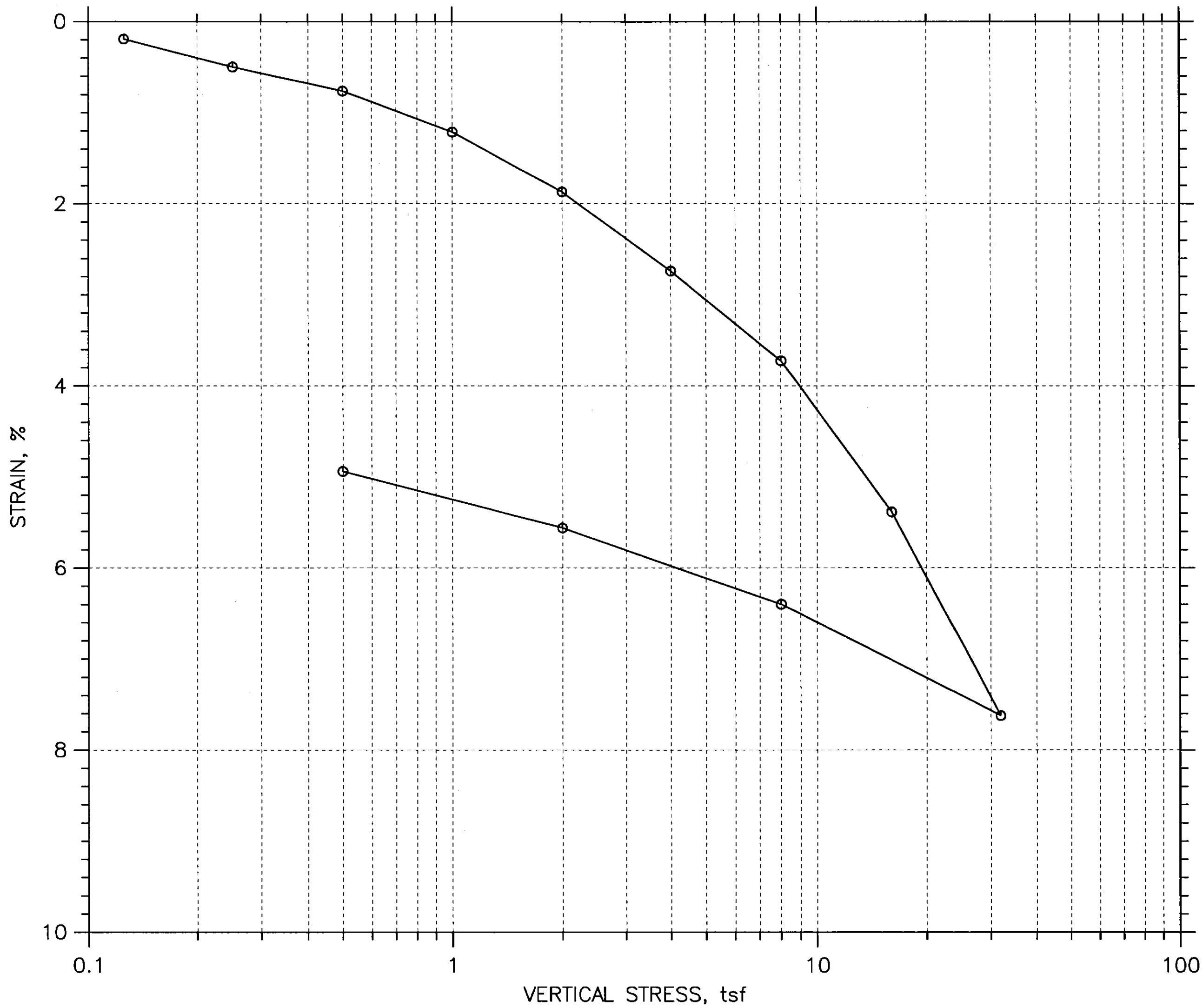


GeoTesting EXPRESS			
	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		
	Displacement at End of Increment		

Wed, 22-FEB-2012 09:54:03

One-Dimensional Consolidation by ASTM D 2435 - Method B

SUMMARY REPORT



					Before Test	After Test
Overburden Pressure: ---				Water Content, %	26.89	23.79
Preconsolidation Pressure: ---				Dry Unit Weight, pcf	100.37	105.65
Compression Index: ---				Saturation, %	99.97	100.00
Diameter: 2.5 in		Height: 1 in		Void Ratio	0.76	0.67
LL: 25	PL: 18	PI: 7	GS: 2.83			

GeoTesting EXPRESS	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		
	Displacement at End of Increment		

Wed, 22-FEB-2012 09:54:04

One-Dimensional Consolidation by ASTM D 2435 - Method B

Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
Boring No.: HS-7	Tested By: md	Checked By: jdt
Sample No.: UD-1	Test Date: 02/16/12	Depth: 14 ft
Test No.: IP-1	Sample Type: tube	Elevation: ---

Soil Description: Moist, olive sandy clay
Remarks: System V

Estimated Specific Gravity: 2.83	Liquid Limit: 25	Specimen Diameter: 2.50 in
Initial Void Ratio: 0.762	Plastic Limit: 18	Initial Height: 1.00 in
Final Void Ratio: 0.674	Plasticity Index: 7	Final Height: 0.95 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	8662	RING		8280
Wt. Container + Wet Soil, gm	201.43	380.46	376.45	169.53
Wt. Container + Dry Soil, gm	161.85	345.68	345.68	138.55
Wt. Container, gm	8.1300	216.35	216.35	8.3400
Wt. Dry Soil, gm	153.72	129.33	129.33	130.21
Water Content, %	25.75	26.89	23.79	23.79
Void Ratio	---	0.762	0.674	---
Degree of Saturation, %	---	99.97	100.00	---
Dry Unit Weight, pcf	---	100.37	105.65	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

One-Dimensional Consolidation by ASTM D 2435 - Method B

Project: SCR-Hockomock Swamp
Boring No.: HS-7
Sample No.: UD-1
Test No.: IP-1

Location: Raynham, MA
Tested By: md
Test Date: 02/16/12
Sample Type: tube

Project No.: GTX-11534
Checked By: jdt
Depth: 14 ft
Elevation: ---

Soil Description: Moist, olive sandy clay
Remarks: System V
Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft^2/sec	Mv 1/tsf	k ft/day
1	0.125	0.001906	0.759	0.191	0.218	1.12e-004	1.53e-002	4.61e-003
2	0.250	0.004971	0.753	0.497	1.306	1.87e-005	2.45e-002	1.23e-003
3	0.500	0.007629	0.749	0.763	0.872	2.78e-005	1.06e-002	7.97e-004
4	1.00	0.01213	0.741	1.21	0.498	4.83e-005	9.01e-003	1.17e-003
5	2.00	0.01869	0.729	1.87	1.259	1.89e-005	6.56e-003	3.34e-004
6	4.00	0.02738	0.714	2.74	23.362	1.00e-006	4.35e-003	1.18e-005
7	8.00	0.03724	0.697	3.72	0.821	2.80e-005	2.46e-003	1.86e-004
8	16.0	0.05384	0.667	5.38	13.532	1.65e-006	2.07e-003	9.24e-006
9	32.0	0.07620	0.628	7.62	1.070	2.00e-005	1.40e-003	7.55e-005
10	8.00	0.06397	0.649	6.40	0.665	3.19e-005	5.09e-004	4.38e-005
11	2.00	0.05561	0.664	5.56	1.773	1.22e-005	1.39e-003	4.60e-005
12	0.500	0.04938	0.675	4.94	3.567	6.18e-006	4.15e-003	6.91e-005

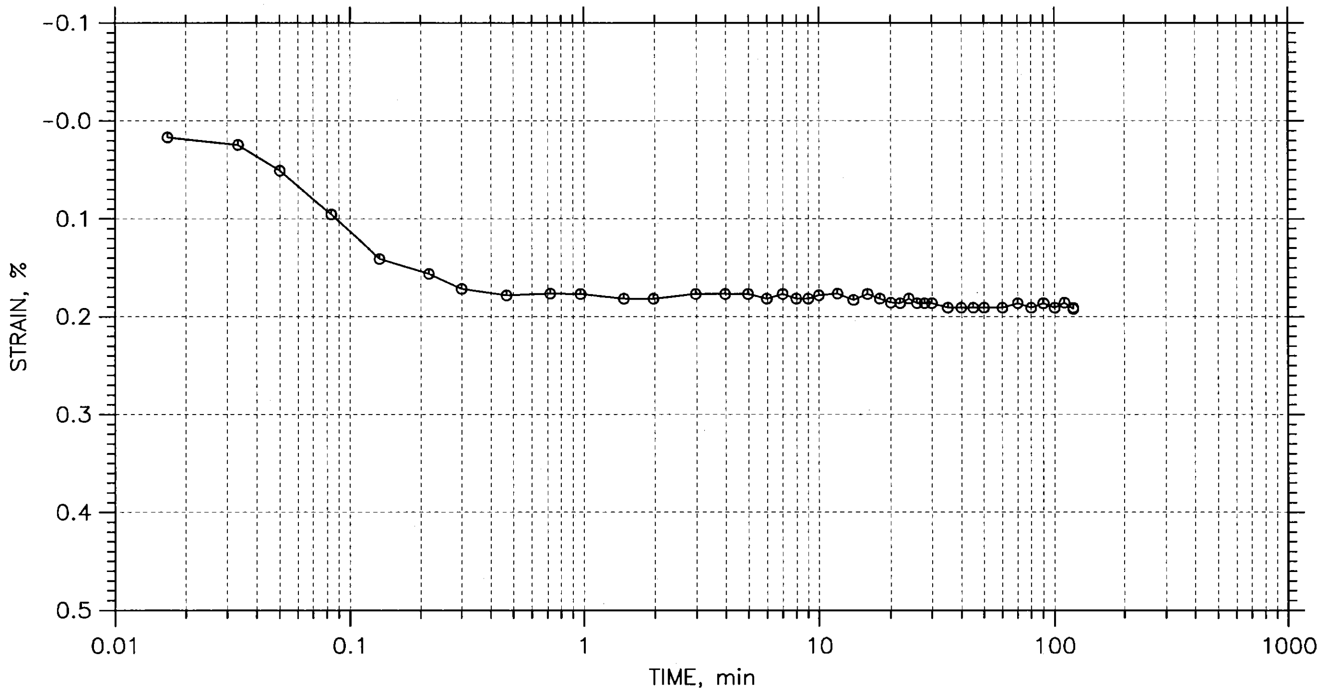
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft^2/sec	Mv 1/tsf	k ft/day	Ca %
1	0.125	0.001906	0.759	0.191	0.000	0.00e+000	1.53e-002	0.00e+000	0.00e+000
2	0.250	0.004971	0.753	0.497	0.102	5.54e-005	2.45e-002	3.66e-003	0.00e+000
3	0.500	0.007629	0.749	0.763	0.000	0.00e+000	1.06e-002	0.00e+000	0.00e+000
4	1.00	0.01213	0.741	1.21	0.054	1.03e-004	9.01e-003	2.50e-003	0.00e+000
5	2.00	0.01869	0.729	1.87	0.069	7.96e-005	6.56e-003	1.41e-003	0.00e+000
6	4.00	0.02738	0.714	2.74	0.000	0.00e+000	4.35e-003	0.00e+000	0.00e+000
7	8.00	0.03724	0.697	3.72	0.000	0.00e+000	2.46e-003	0.00e+000	0.00e+000
8	16.0	0.05384	0.667	5.38	1.543	3.37e-006	2.07e-003	1.88e-005	0.00e+000
9	32.0	0.07620	0.628	7.62	0.108	4.62e-005	1.40e-003	1.74e-004	0.00e+000
10	8.00	0.06397	0.649	6.40	0.128	3.84e-005	5.09e-004	5.28e-005	0.00e+000
11	2.00	0.05561	0.664	5.56	0.150	3.37e-005	1.39e-003	1.27e-004	0.00e+000
12	0.500	0.04938	0.675	4.94	0.213	2.40e-005	4.15e-003	2.69e-004	0.00e+000

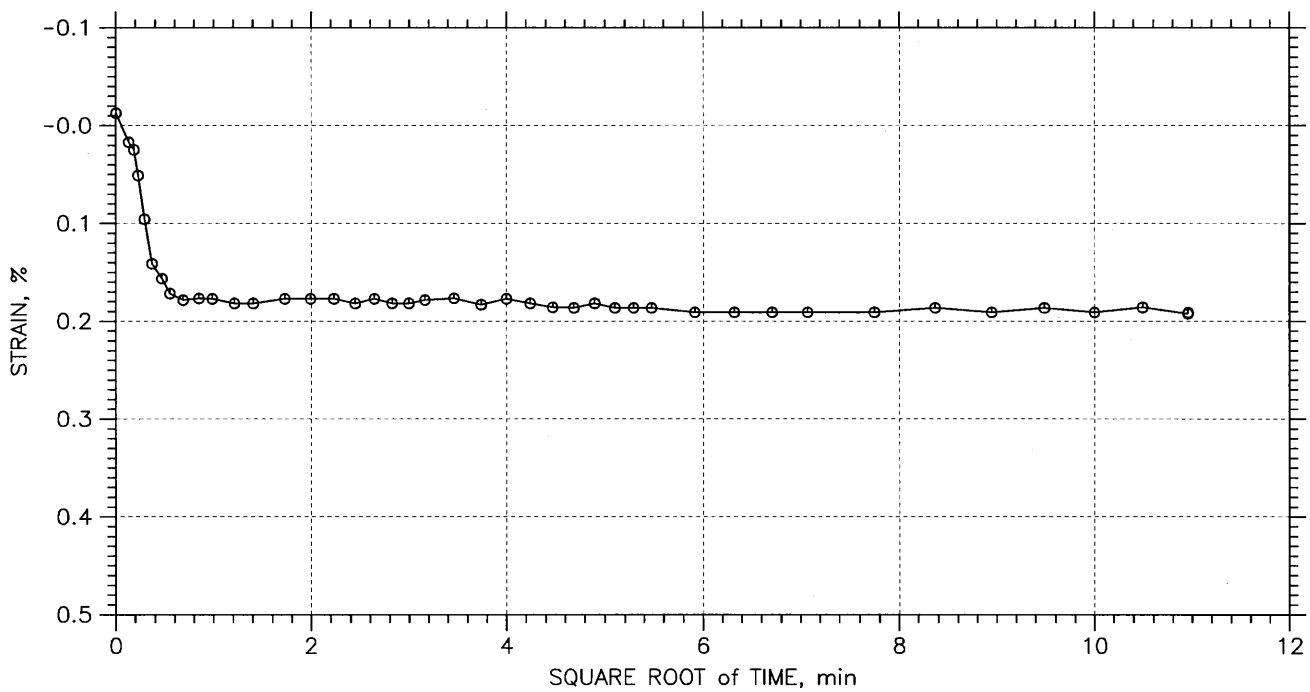
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 1 of 12

Stress: 0.125 tsf





GeoTesting EXPRESS			
	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

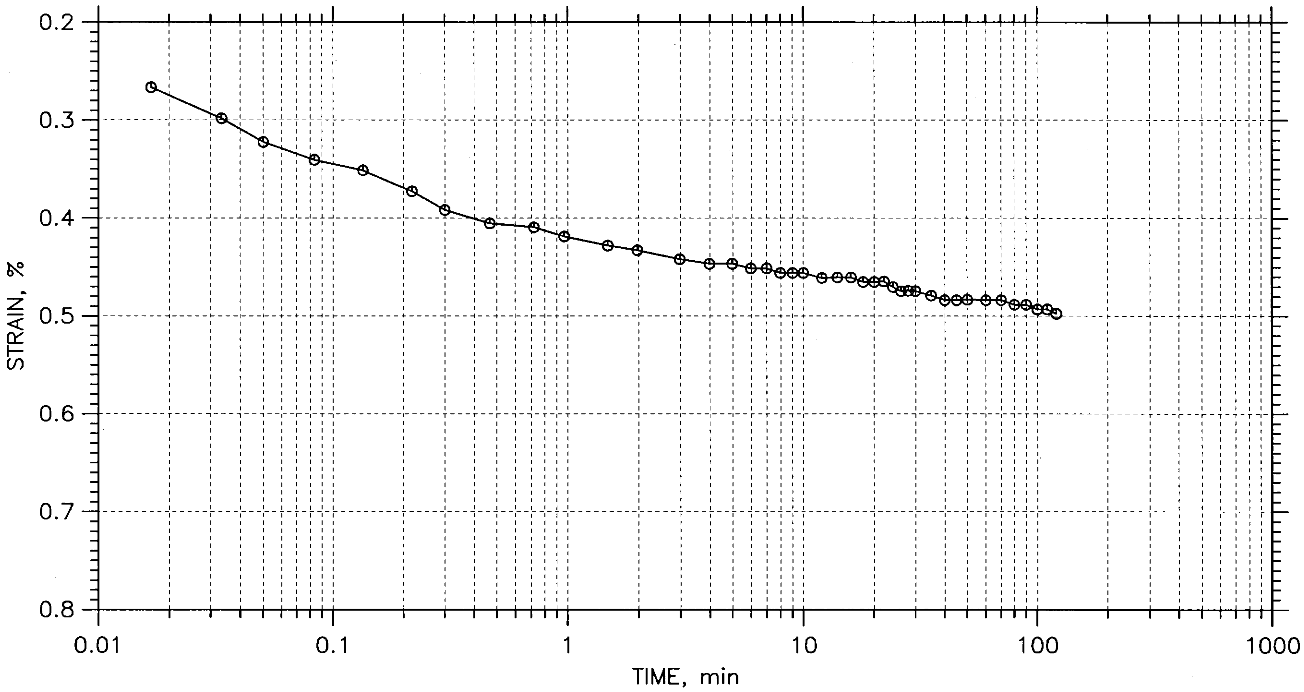
Wed, 22-FEB-2012 09:54:28

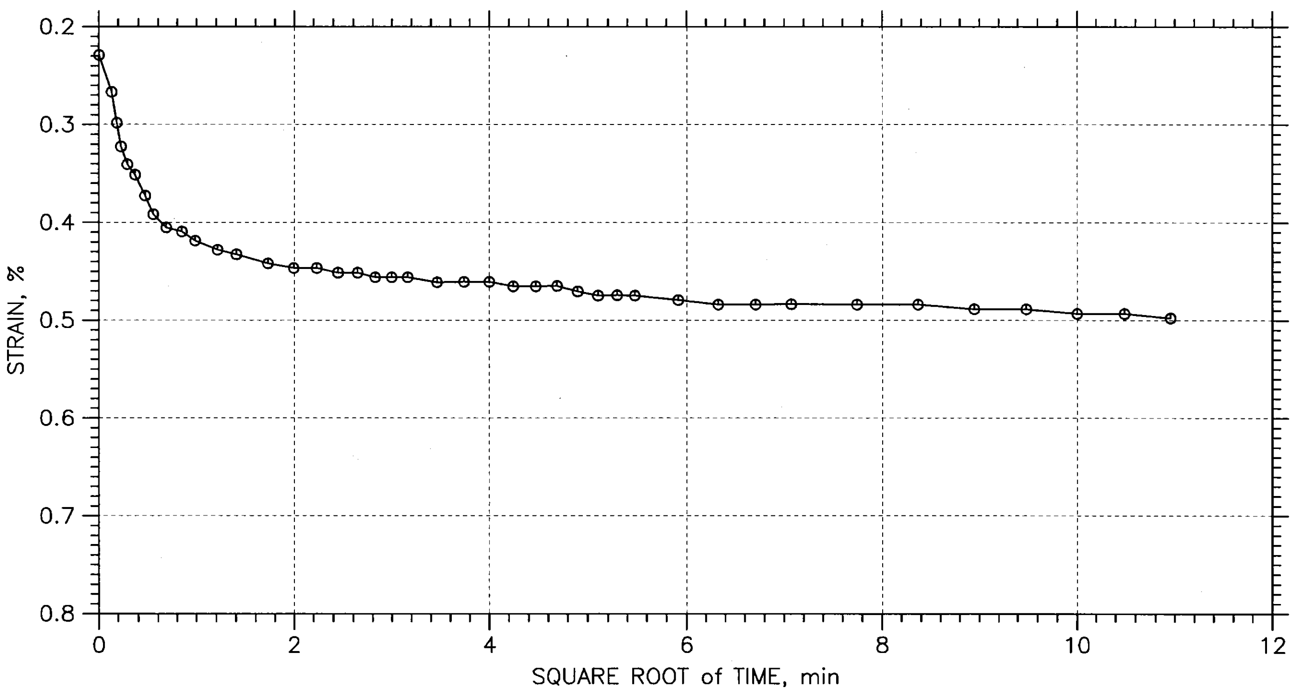
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 2 of 12

Stress: 0.25 tsf





GeoTesting EXPRESS			
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	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

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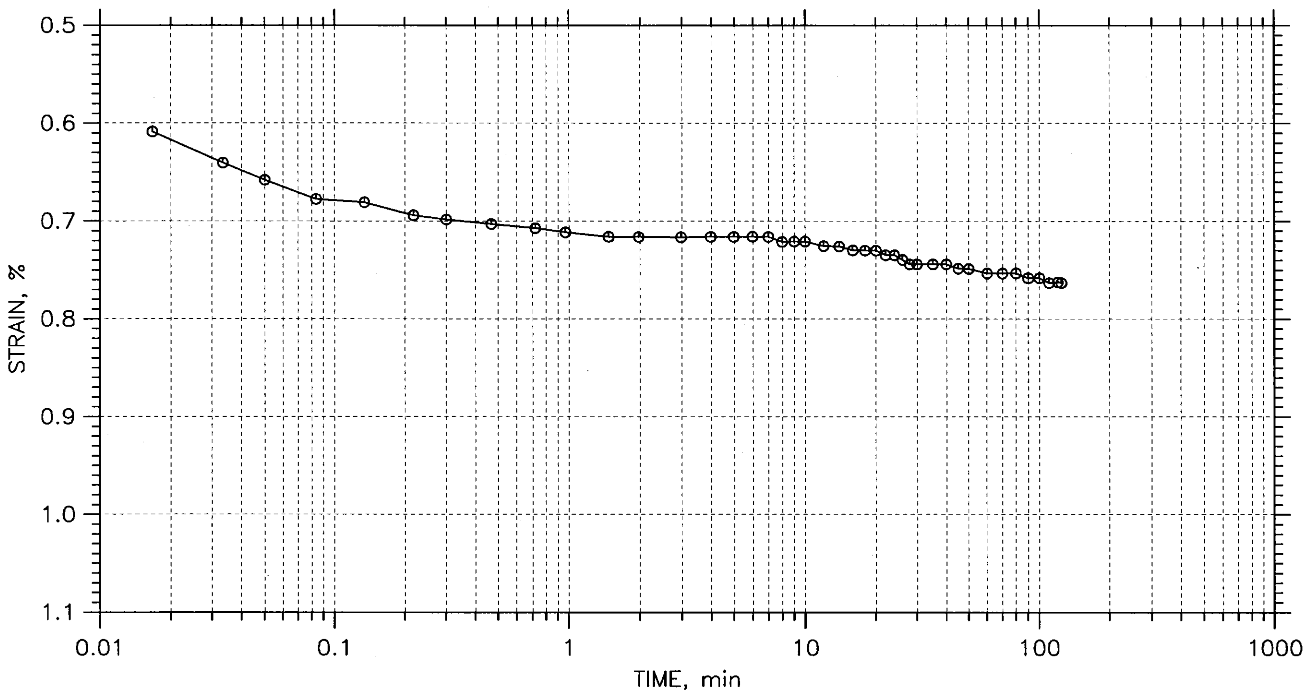
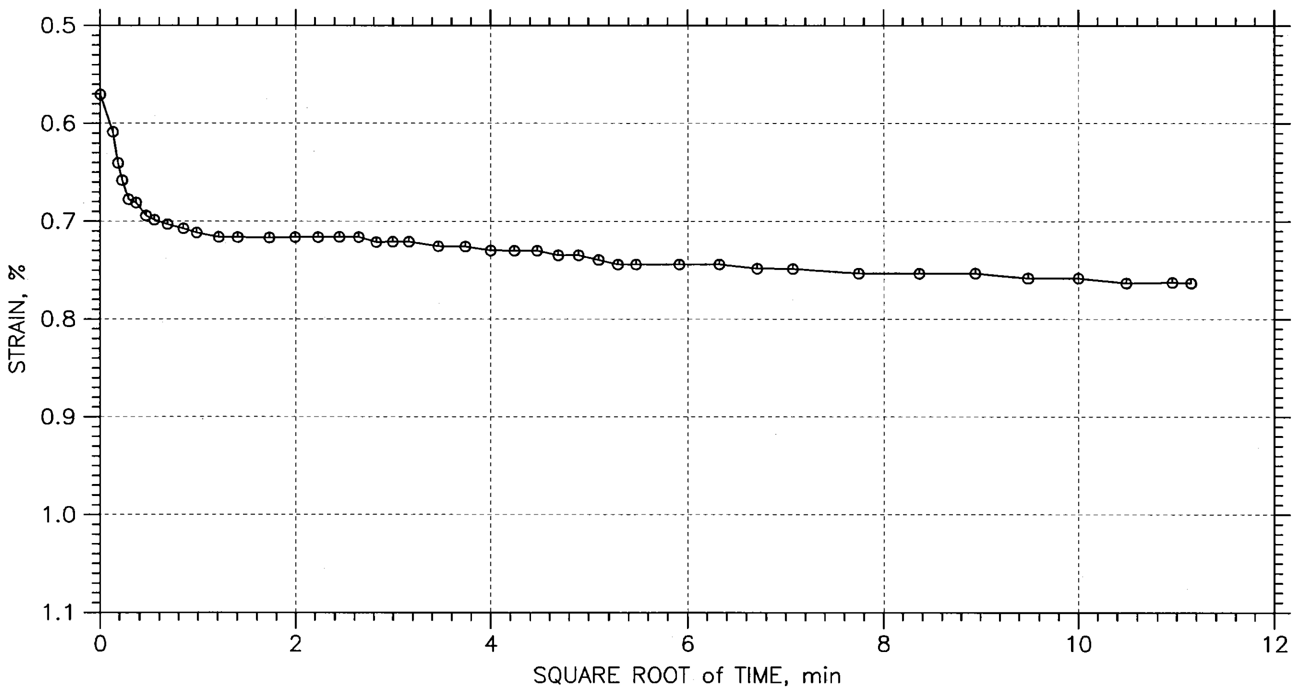
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 3 of 12

Stress: 0.5 tsf





GeoTesting EXPRESS	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

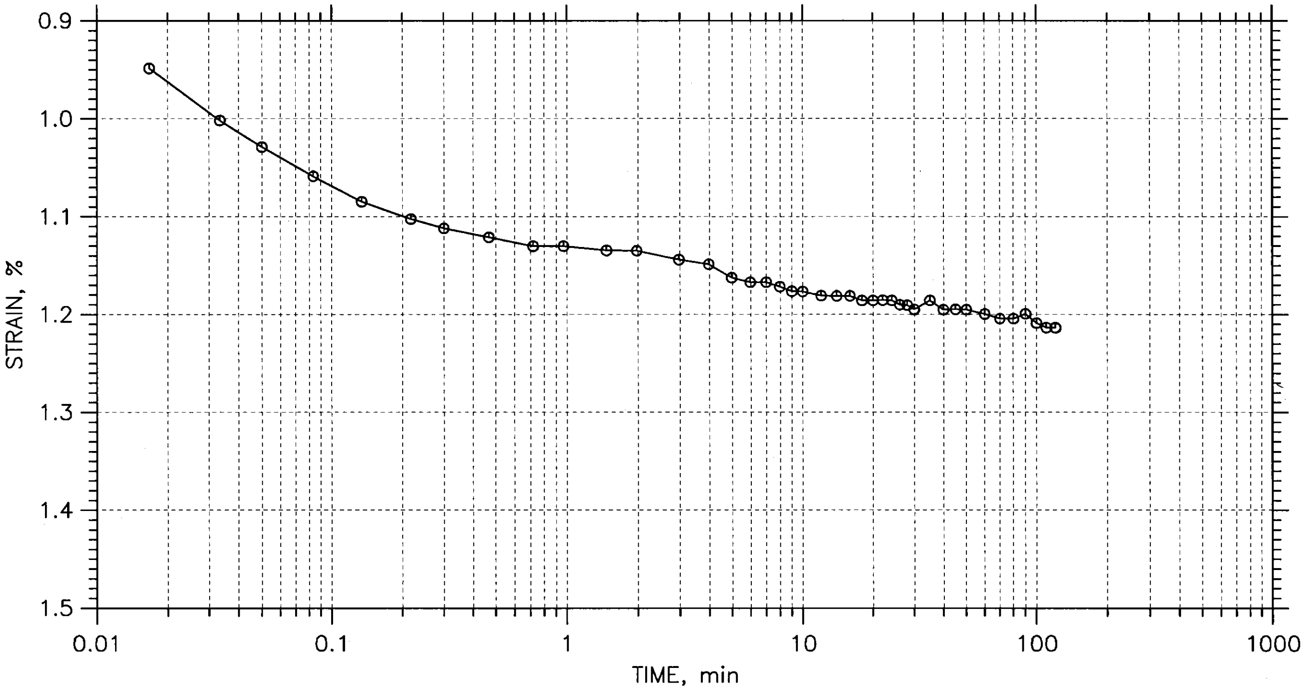
Wed, 22-FEB-2012 09:55:00

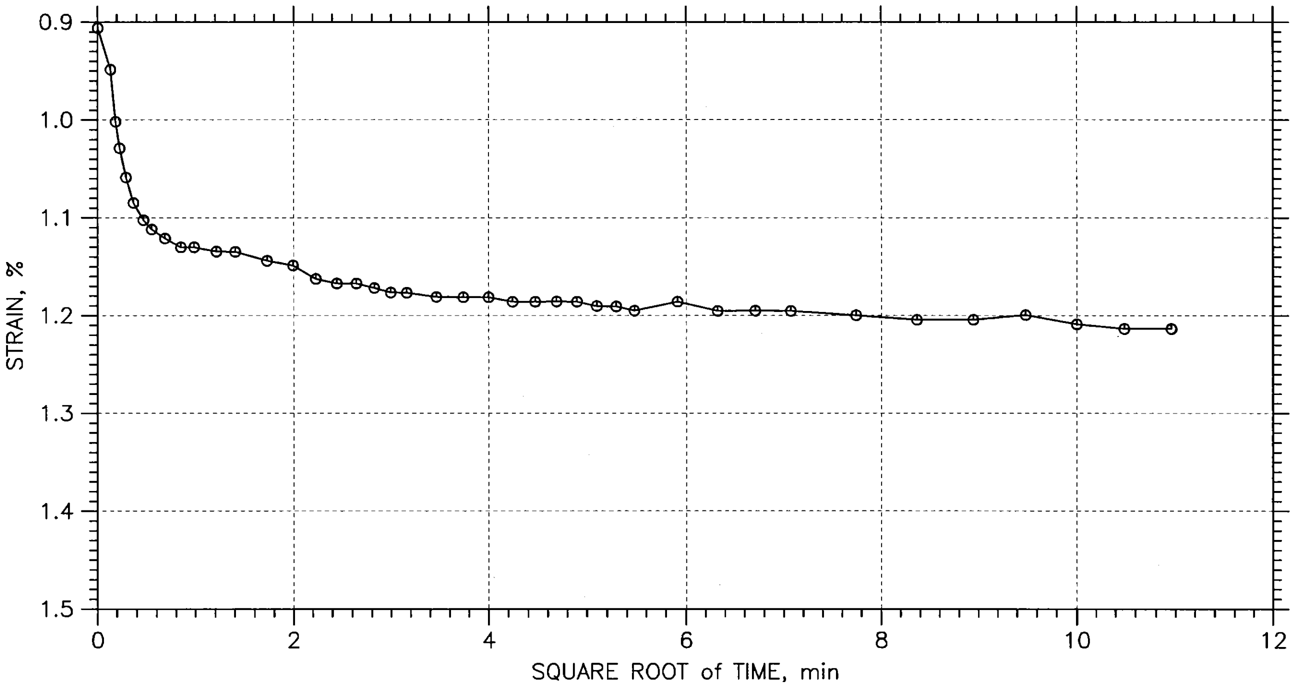
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 4 of 12

Stress: 1 tsf





GeoTesting EXPRESS			
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	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

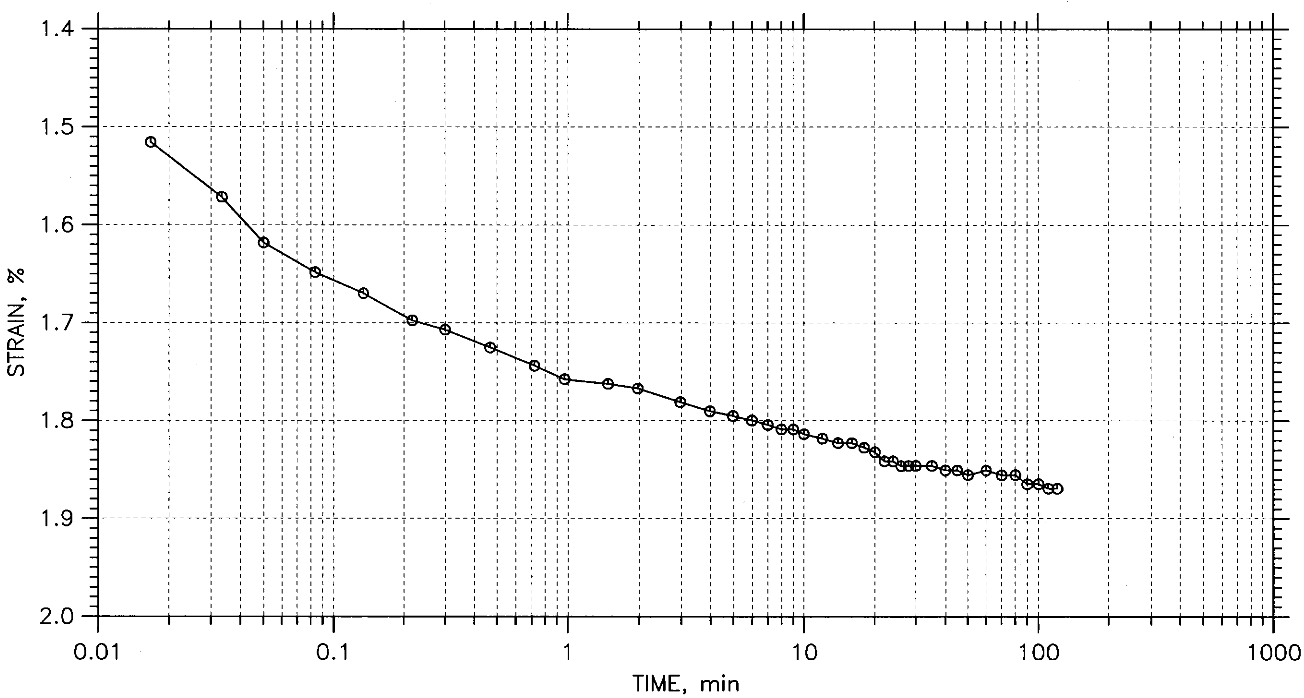
Wed, 22-FEB-2012 09:55:13

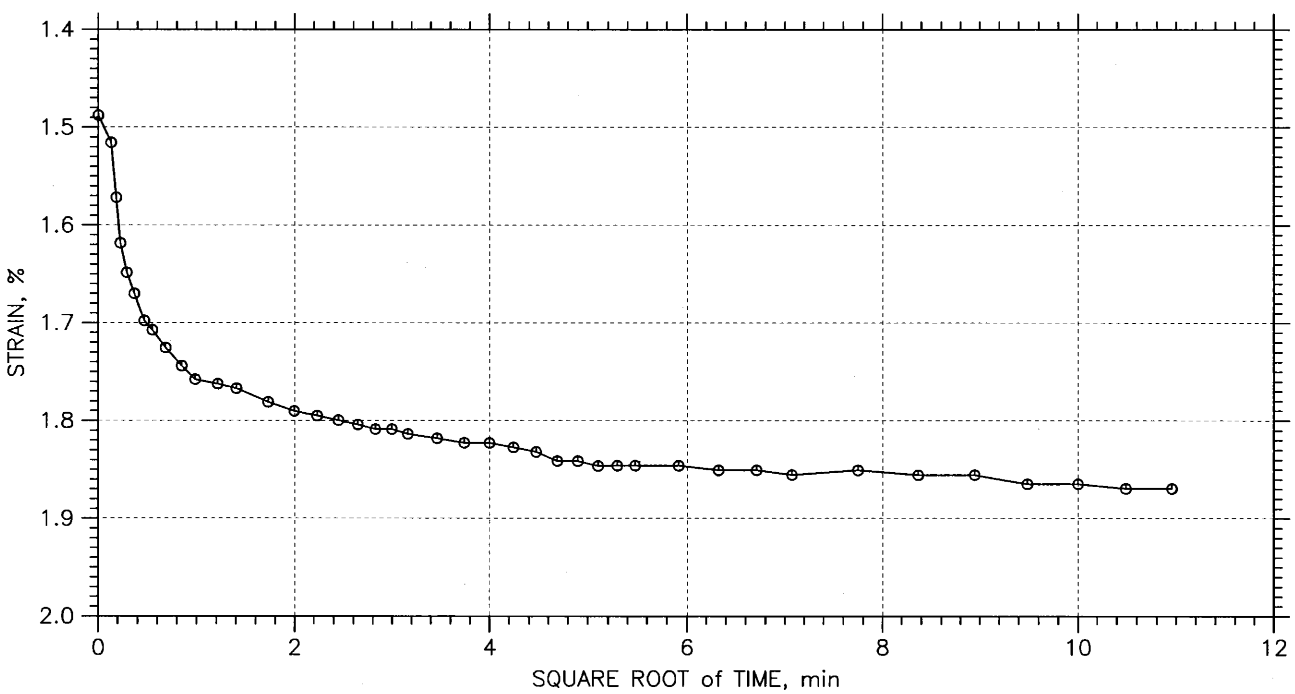
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 5 of 12

Stress: 2 tsf





GeoTesting EXPRESS			
	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

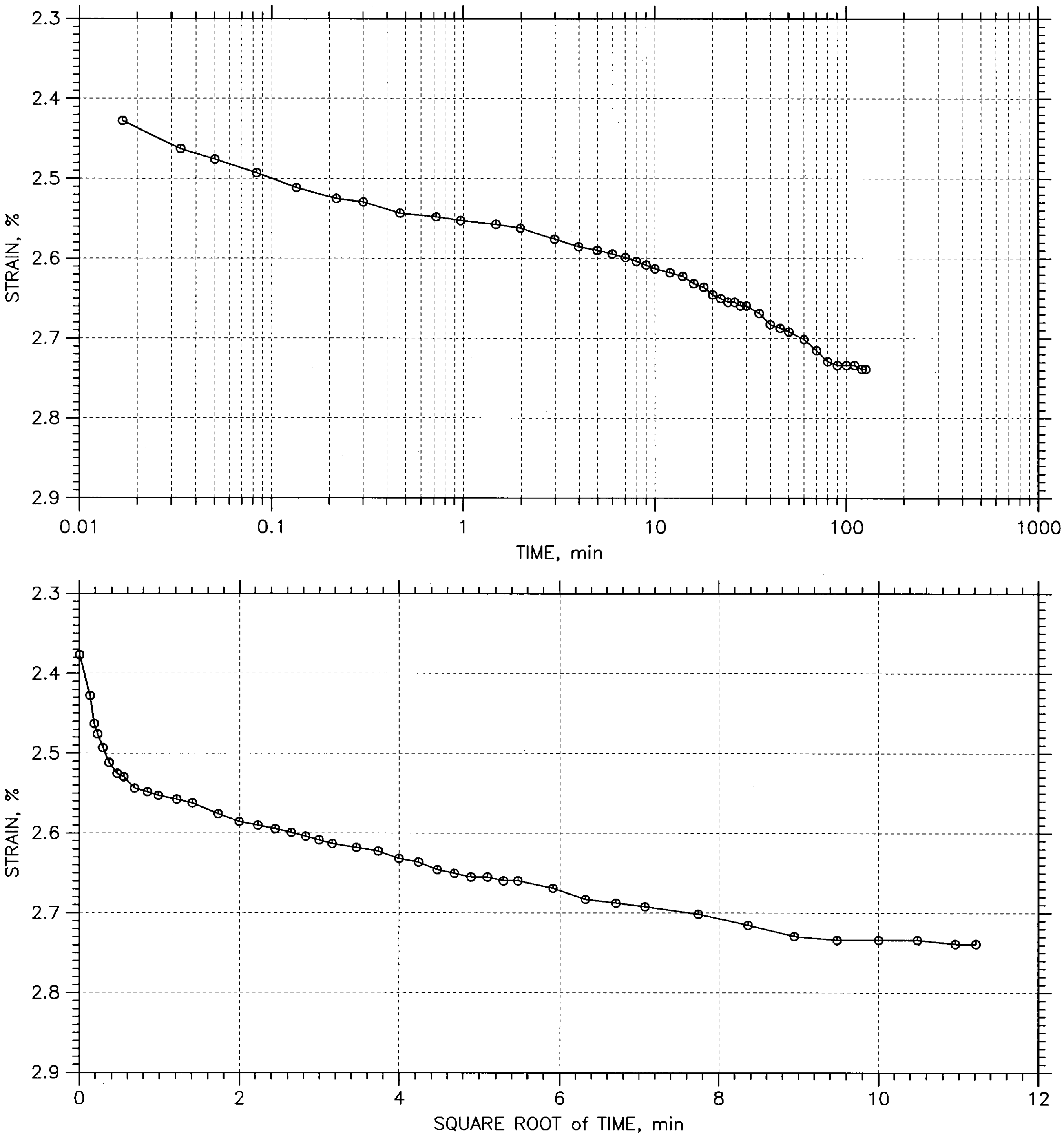
Wed, 22-FEB-2012 09:55:19

One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 6 of 12

Stress: 4 tsf



GeoTesting EXPRESS			
	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

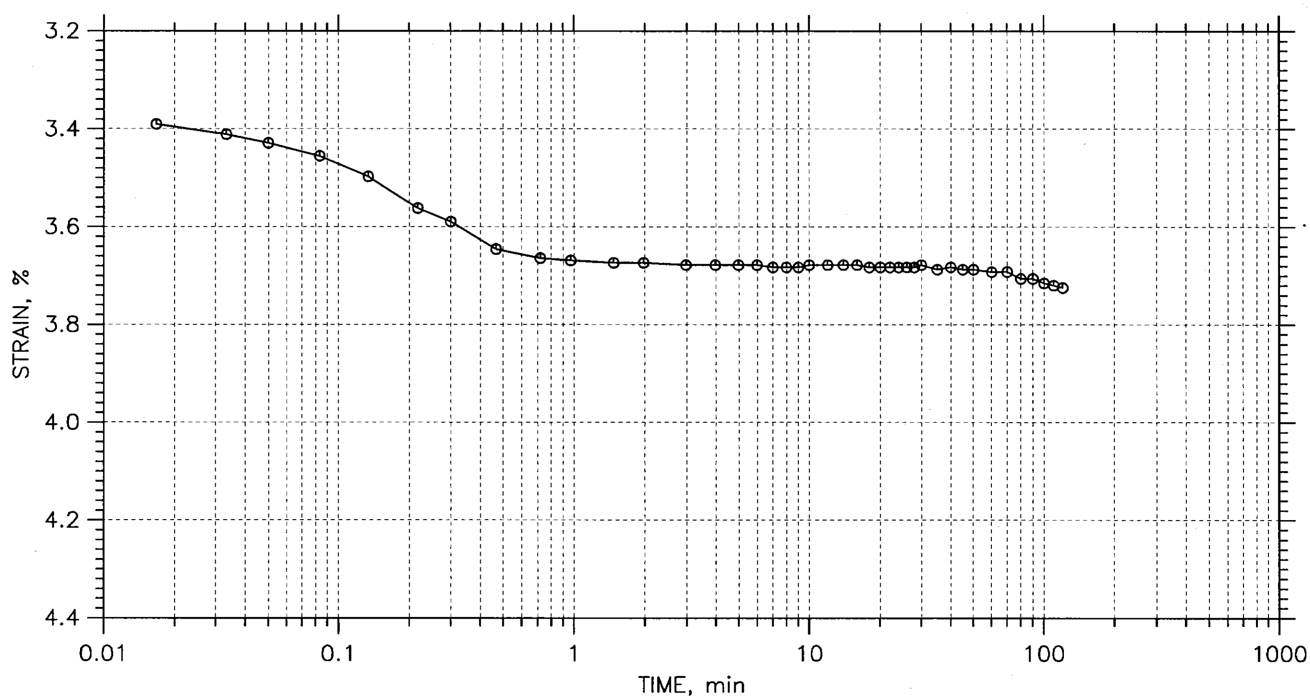
Wed, 22-FEB-2012 09:55:25

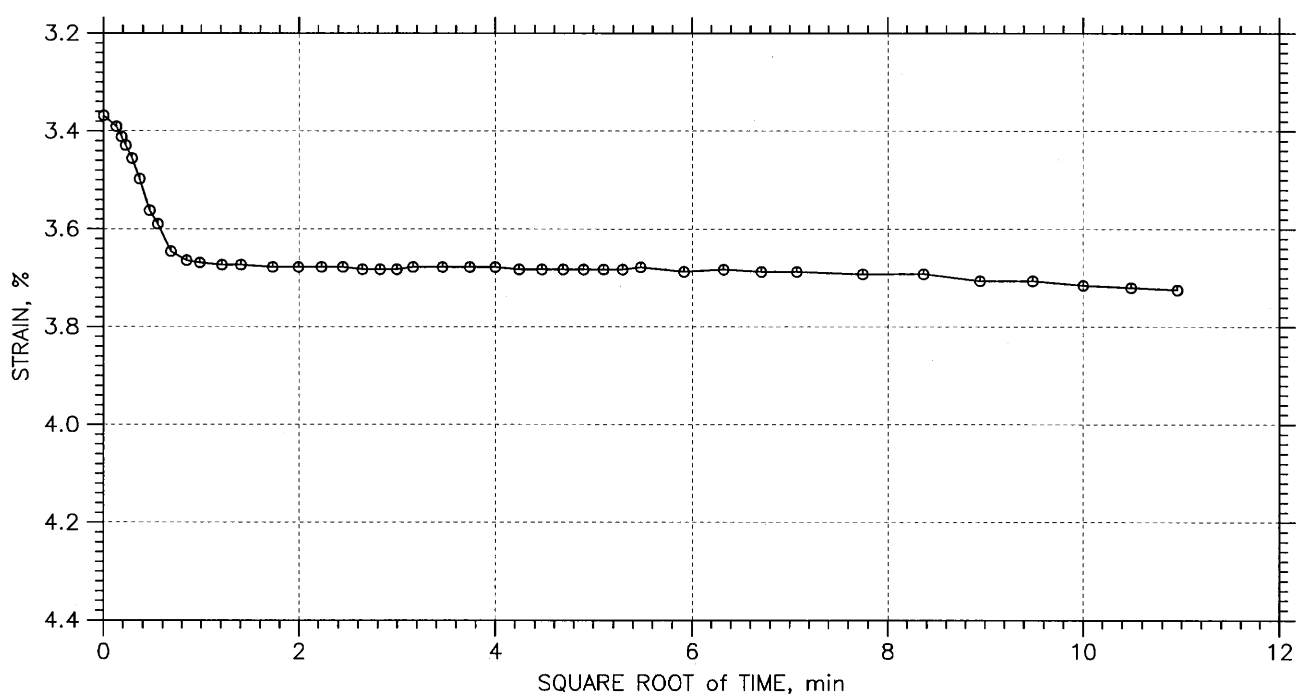
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 7 of 12

Stress: 8 tsf





GeoTesting EXPRESS	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

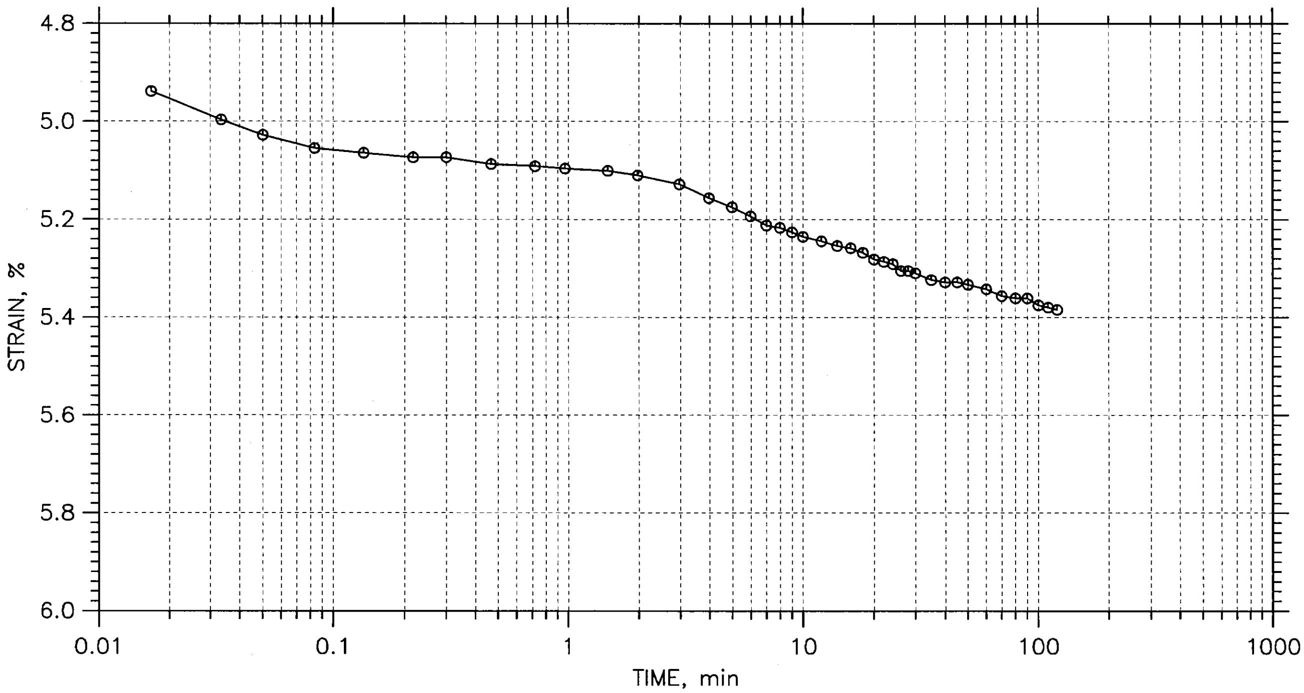
Wed, 22-FEB-2012 09:55:39

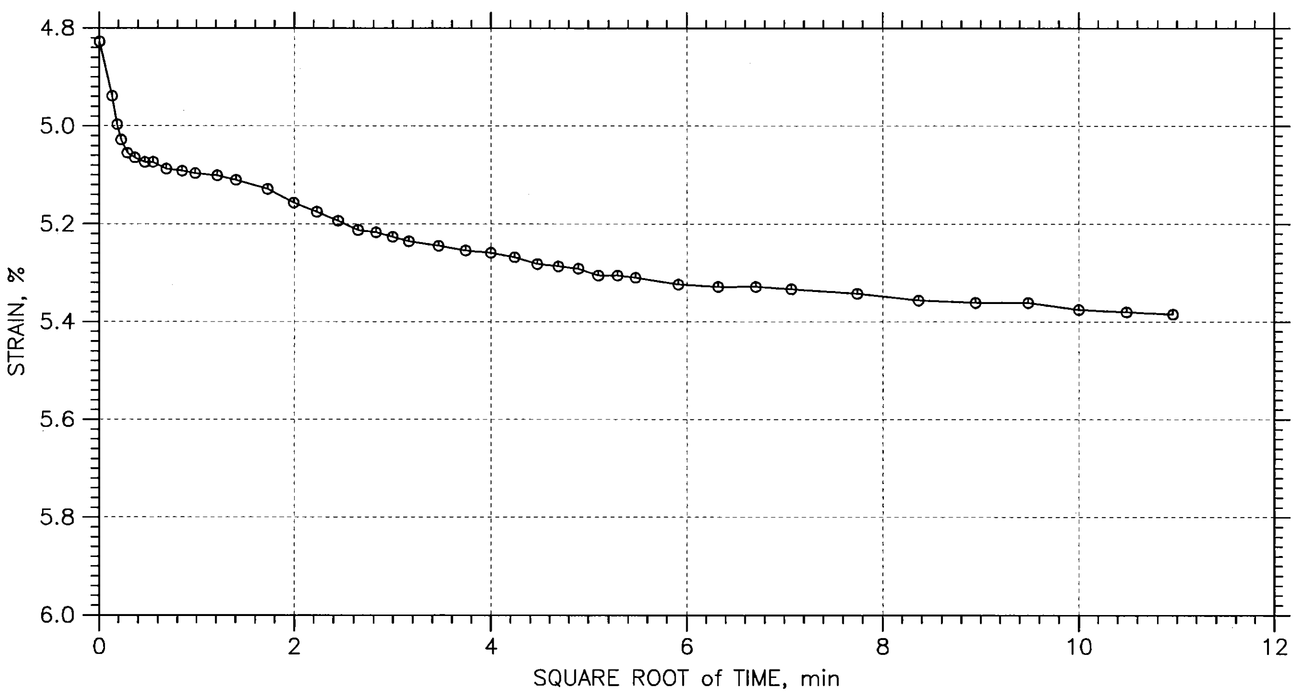
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 8 of 12

Stress: 16 tsf





GeoTesting EXPRESS	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

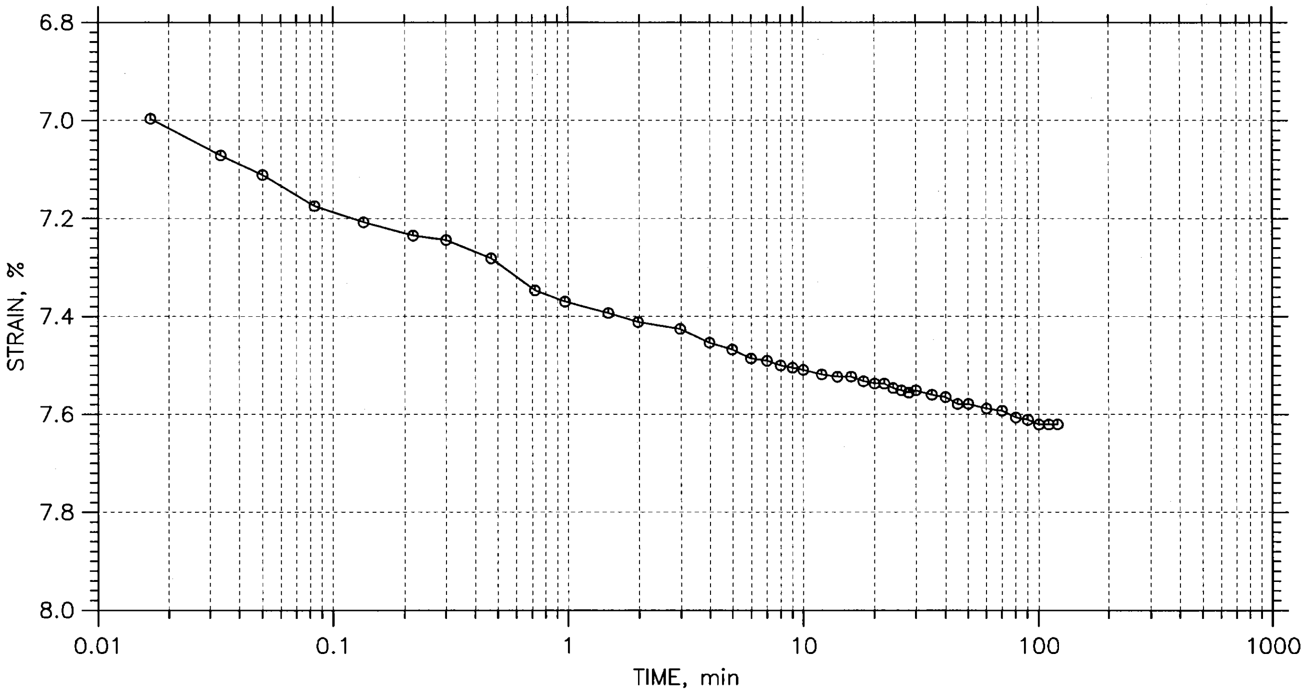
Wed, 22-FEB-2012 09:56:07

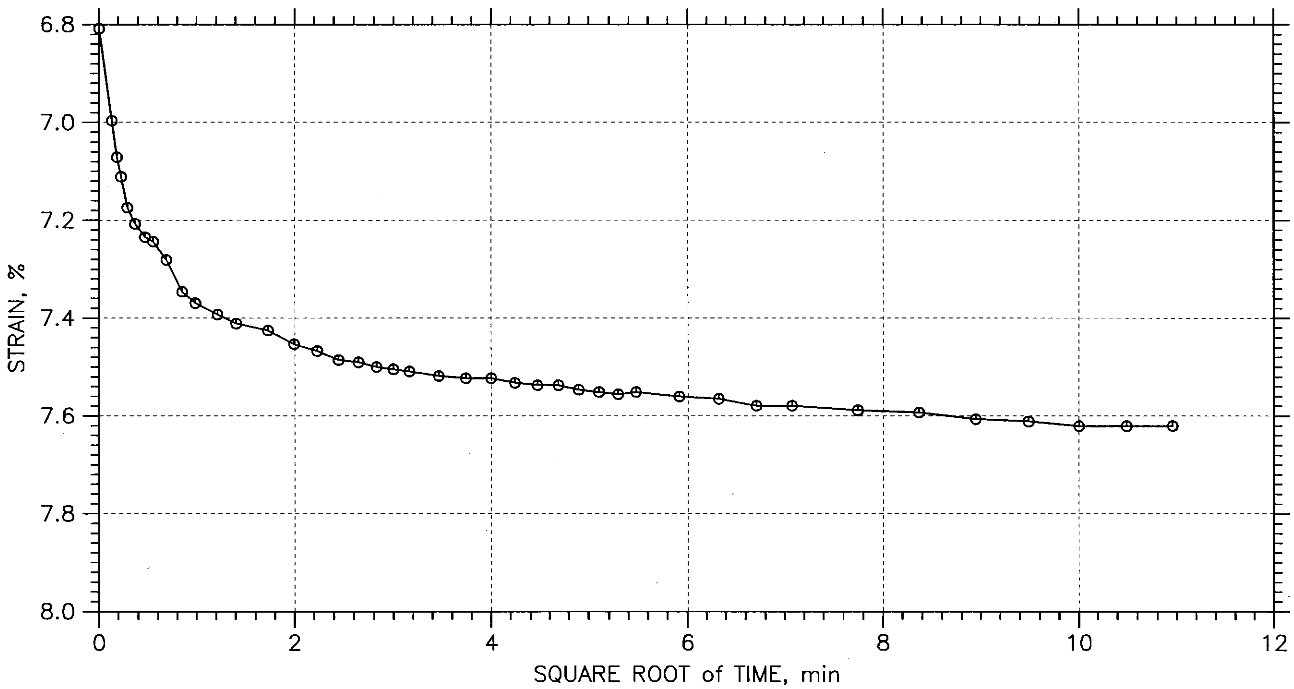
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 9 of 12

Stress: 32 tsf





GeoTesting EXPRESS			
	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

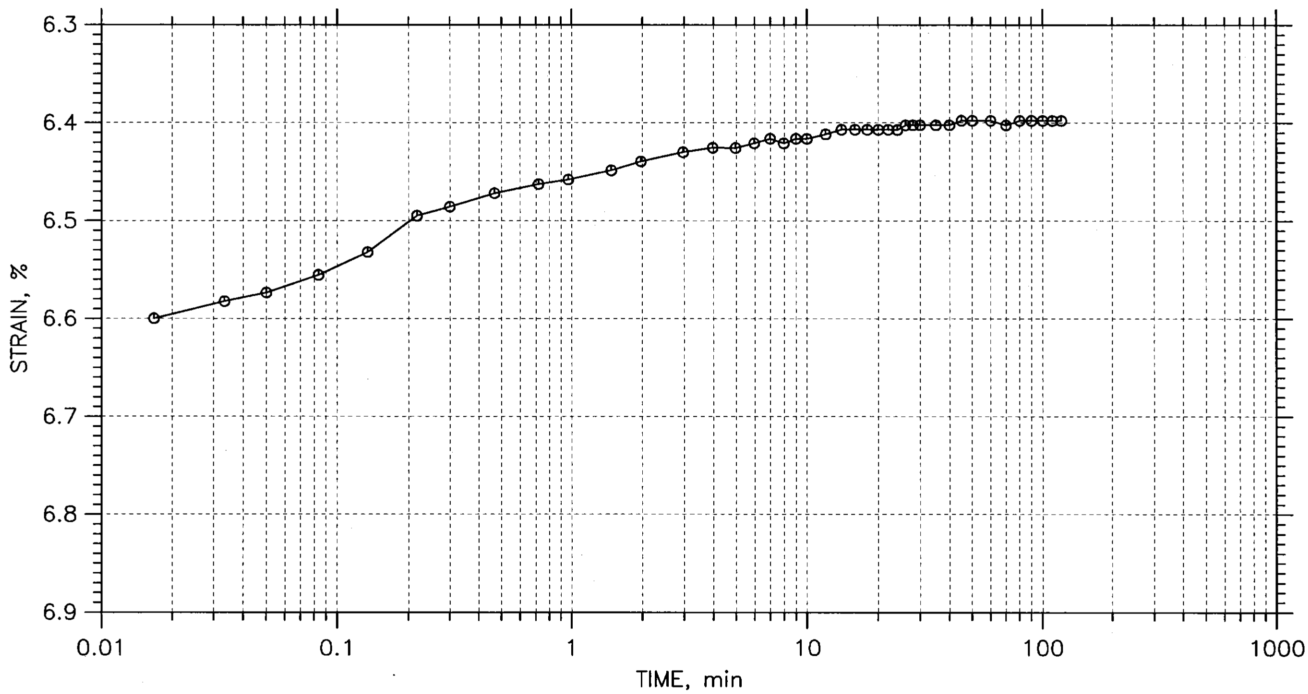
Wed, 22-FEB-2012 09:56:19

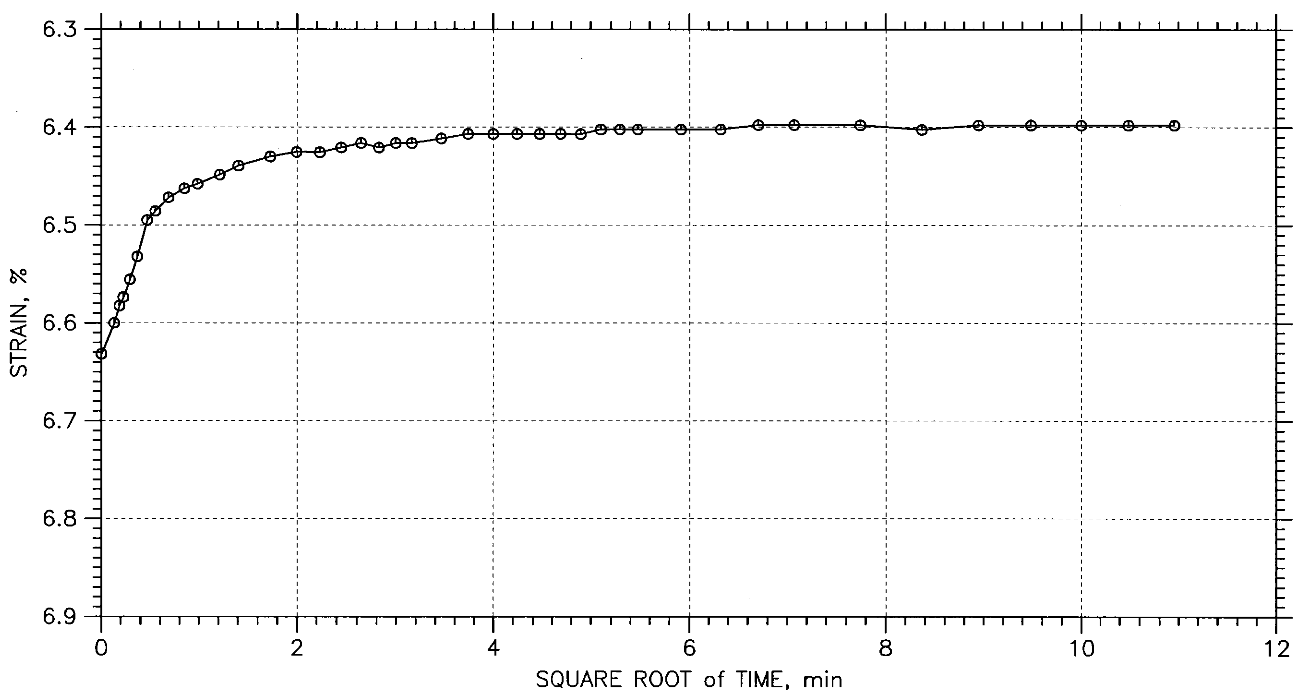
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 10 of 12

Stress: 8 tsf





GeoTesting EXPRESS	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

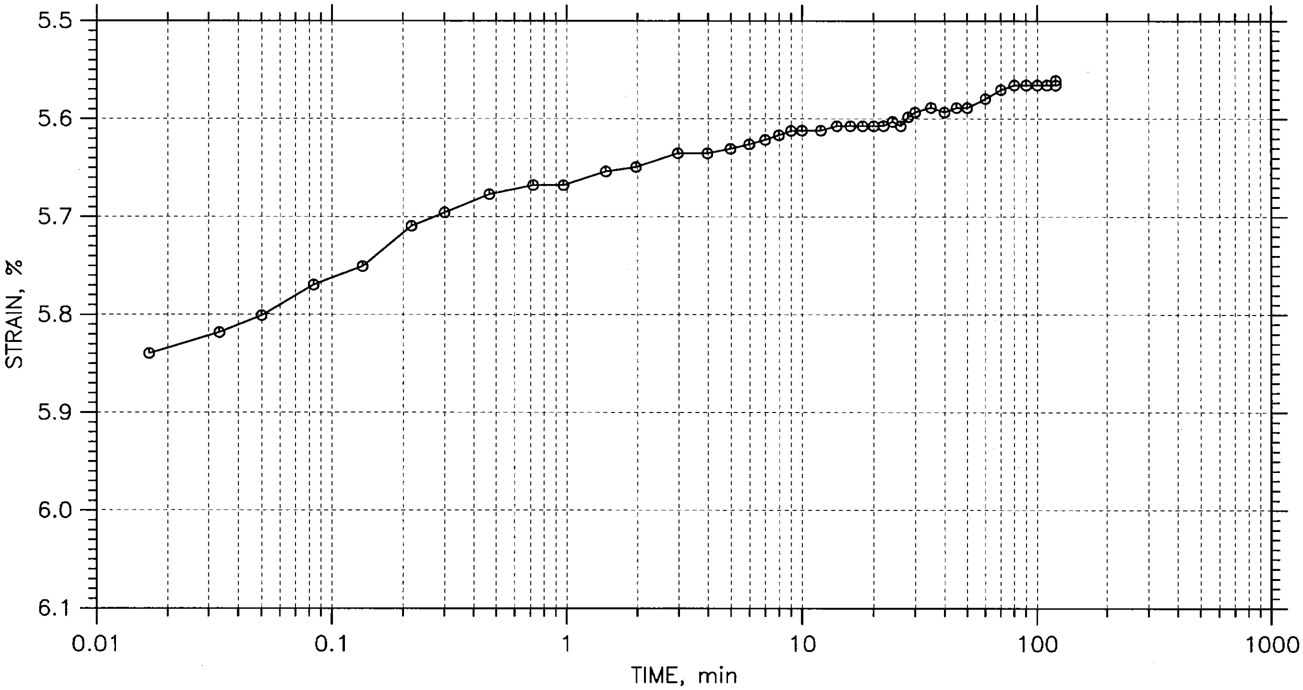
Wed, 22-FEB-2012 09:56:36

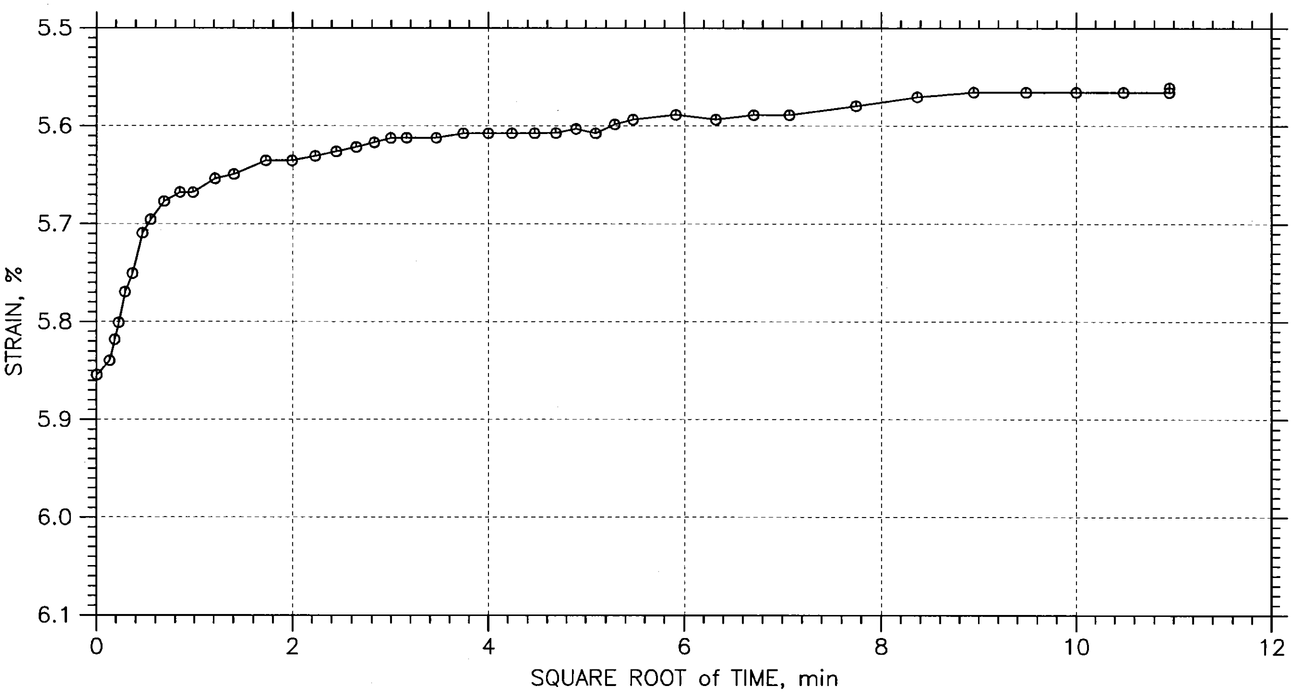
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 11 of 12

Stress: 2 tsf





GeoTesting EXPRESS			
	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

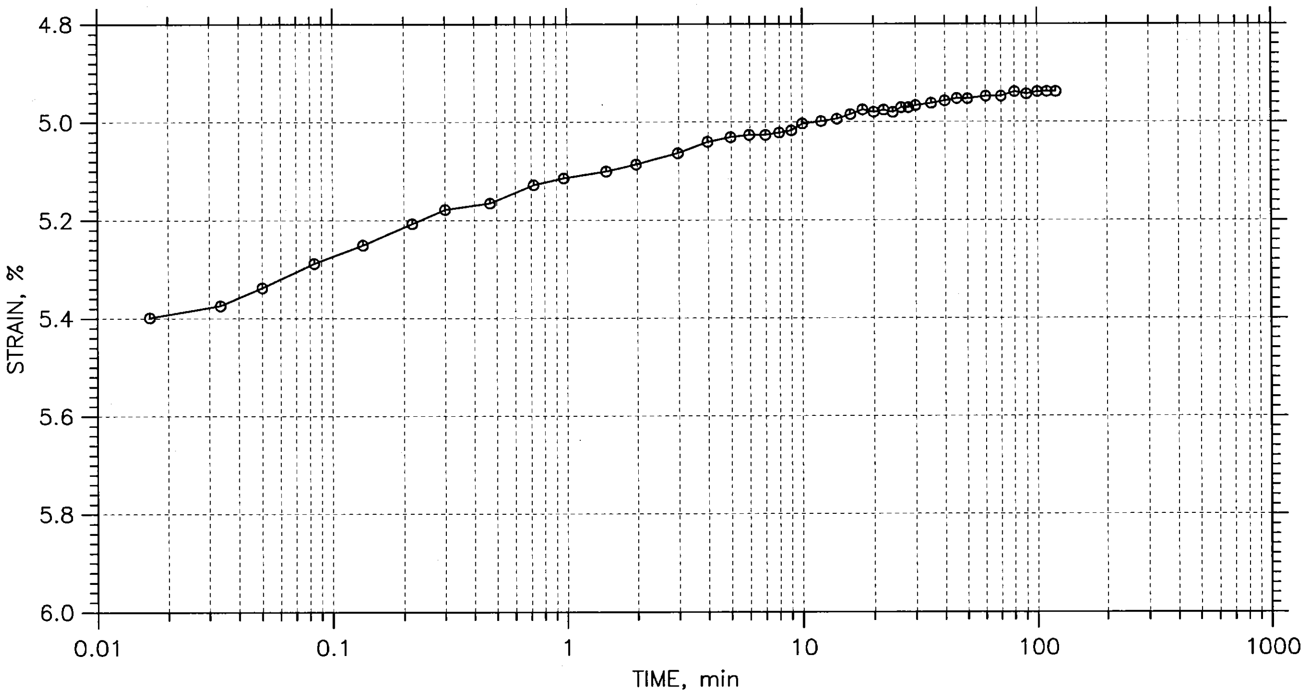
Wed, 22-FEB-2012 09:56:46

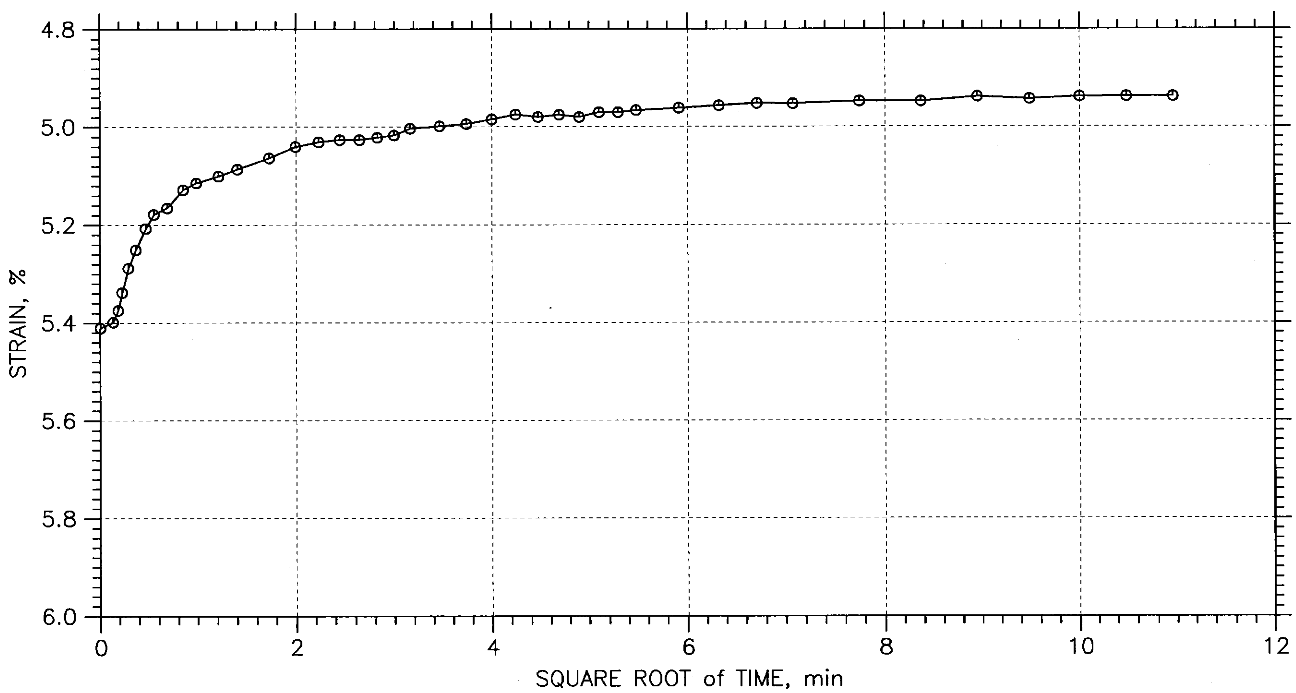
One-Dimensional Consolidation by ASTM D 2435 - Method B

TIME CURVES

Constant Load Step 12 of 12

Stress: 0.5 tsf





GeoTesting EXPRESS	Project: SCR-Hockomock Swamp	Location: Raynham, MA	Project No.: GTX-11534
	Boring No.: HS-7	Tested By: md	Checked By: jdt
	Sample No.: UD-1	Test Date: 02/16/12	Test No.: IP-1
	Depth: 14 ft	Sample Type: tube	Elevation: ---
	Description: Moist, olive sandy clay		
	Remarks: System V		

Wed, 22-FEB-2012 09:56:59

APPENDIX C: GEOTECHNICAL CALCULATIONS

LPile Analyses
Pile GROUP Analyses
Seismic Site Class Evaluation
Liquefaction Analyses

LPile Analyses

Purpose:

The purpose of this calculation is to analyze a single pile response (no group reduction) in the longitudinal direction of the proposed Hockomock Swamp Trestle.

References:

- AREMA Manual.

Assumptions:

- **Boring**

By examining the Borings of HST-1 to HST-9 in areas of the proposed trestle, Boring HST-4 was used for the following analyses.
Boring HST-4 Location: Sta.1457+00
Ground Elevation: EL.70.5

- **Ground water table:**

It is assumed that the ground water at EL 70.5

- **Superstructure**

Top of Track: EL.79.7
Top of Pier Cap: EL.74.2
Bottom of Pier Cap: EL.70.7

- **Pile Size**

Four sizes of HP piles were analyzed. In accordance with AREMA, the maximum allowable pile stresses should be limited to 12.6 ksi for a pile with yield strength of 36 ksi. The maximum allowable single pile capacity was estimated for each size of the HP piles as well as the relevant properties as follows:

Pile Size	As	Ix	Sx	Iy	Sy	Qall
	(in^2)	(in^4)	(in^3)	(in^4)	(in^3)	(kips)
HP10X42	12.4	210	43.4	71.7	14.2	156
HP12X53	15.5	393	66.7	127	21.1	195
HP14X73	21.4	729	107	261	35.8	269
HP14X89	26.1	904	131	326	44.3	328

Elastic Modulus: E = 29,000,000 psi

- **Load From Structure**

The service loads for pier span of 30 ft, 40 ft and 50 ft were obtained from Kristofer Kretsch (email on 2/02/2012).
The longitudinal force due to braking and traction were based on the email from Kristofer Kretsch on 2/24/2012.

All the loads were summarized as follows (Referring to the Computations by KGK dated on 2/23/2012)

Pier Span	Dead Load, D*	Live Load, L	Impact Load, I	Longitudinal Braking			Longitudinal Traction		
				Force, LF_B	Moment,M_B**	Vertical, V_B	Force, LF_T	Moment,M_T**	Vert., V_T
(ft)	(kips)	(kips)	(kips)	(kips)	(k-ft)	(kips)	(kips)	(k-ft)	(kips)
30	330	346	142	81	1,235	41	137	1,404	47
40	425	432	153	93	1,418	35	158	1,620	40
50	520	546	174	105	1,601	32	177	1,814	36

Note: * Dead load includes weight of pier cap (50 kips for single row of piles).
** The moments are about the center of the pier cap. The moment is applied to the piers as a vertical couple applied downward on the pier at one end of the span and upward on the pier at the other end of the span. The moment is not applied directly to the pier cap, but is only given for information.

- **Load Combination**

As per AREMA, three load combinations were checked:

Group I	=	D + L + I	
Group III (a)	=	$D + L + I + LF_B$	Including longitudinal braking load
Group III(b)	=	$D + L + I + LF_T$	Including longitudinal traction load

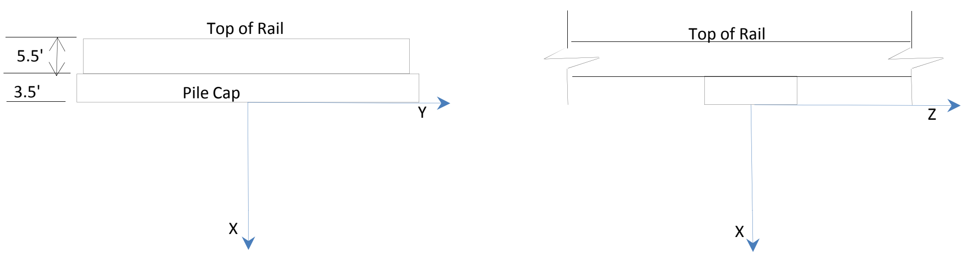
No other loads were considered at present.

The load combinations of Group III(a) and Group III(b) with respect to the following coordinate system are more critical. Therefore, only these two load combinations were summarized as follows:

Pier Span	Load Combination	Fx		Fy	Fz
		Single Row	Double Row*		
(ft)		(kips)	(kips)	(kips)	(kips)
30	Group III(a)	859	909	0	81
	Group III(b)	865	915	0	137
40	Group III(a)	1,045	1,095	0	93
	Group III(b)	1,050	1,100	0	158
50	Group III(a)	1,272	1,322	0	105
	Group III(b)	1,276	1,326	0	177

Note: * For double rows of piles, the pile cap weight is 100k.

Coordinate system:



Analysis:

Software: LPILE Plus 5.0 (Ensoft, Inc.)

Analysis:

By checking the above load combinations, Group III(b) is critical for all three pier spans. The following analyses were based on this load combination only.

Single pile responses under load combination Group III(b) were analyzed assuming that the pile head are fixed in the pile cap which is 3.5 feet deep. The axial load of a single pile was estimated based on 4 piles of a single row and 8 piles of double rows. **No moment was applied at the top of the pile.**

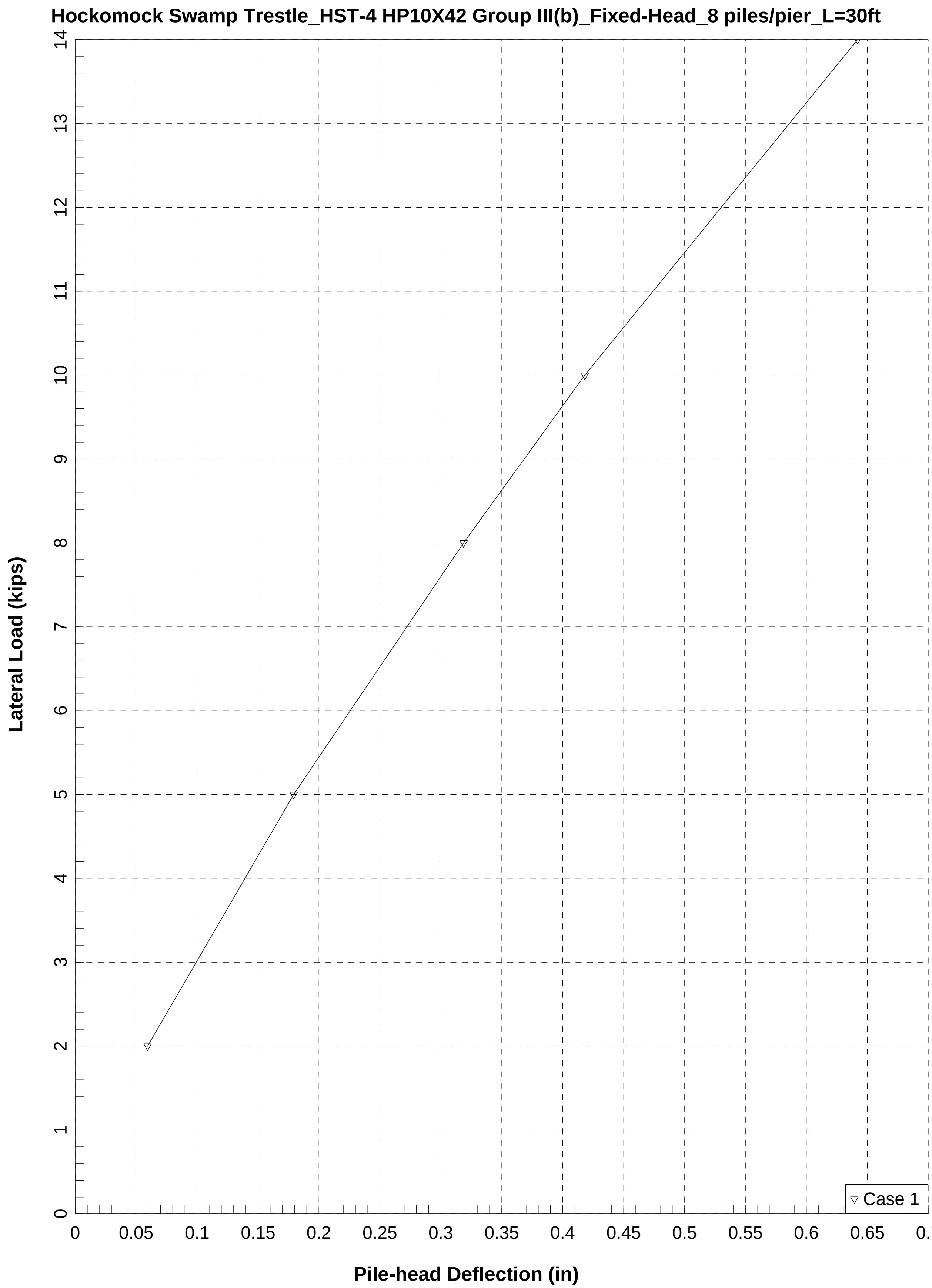
The results were summarized in the next page.

The attachments include Lateral Load vs. Pile-head Deflection, Lateral Deflection vs. Depth, Bending Moment vs. Depth and Shear Force vs. Depth for each loading case.

These results are for preliminary pile layout. Once the preliminary pile layout is available, the pile group analyses should be performed with all the loads applied at the bottom of the pile cap.

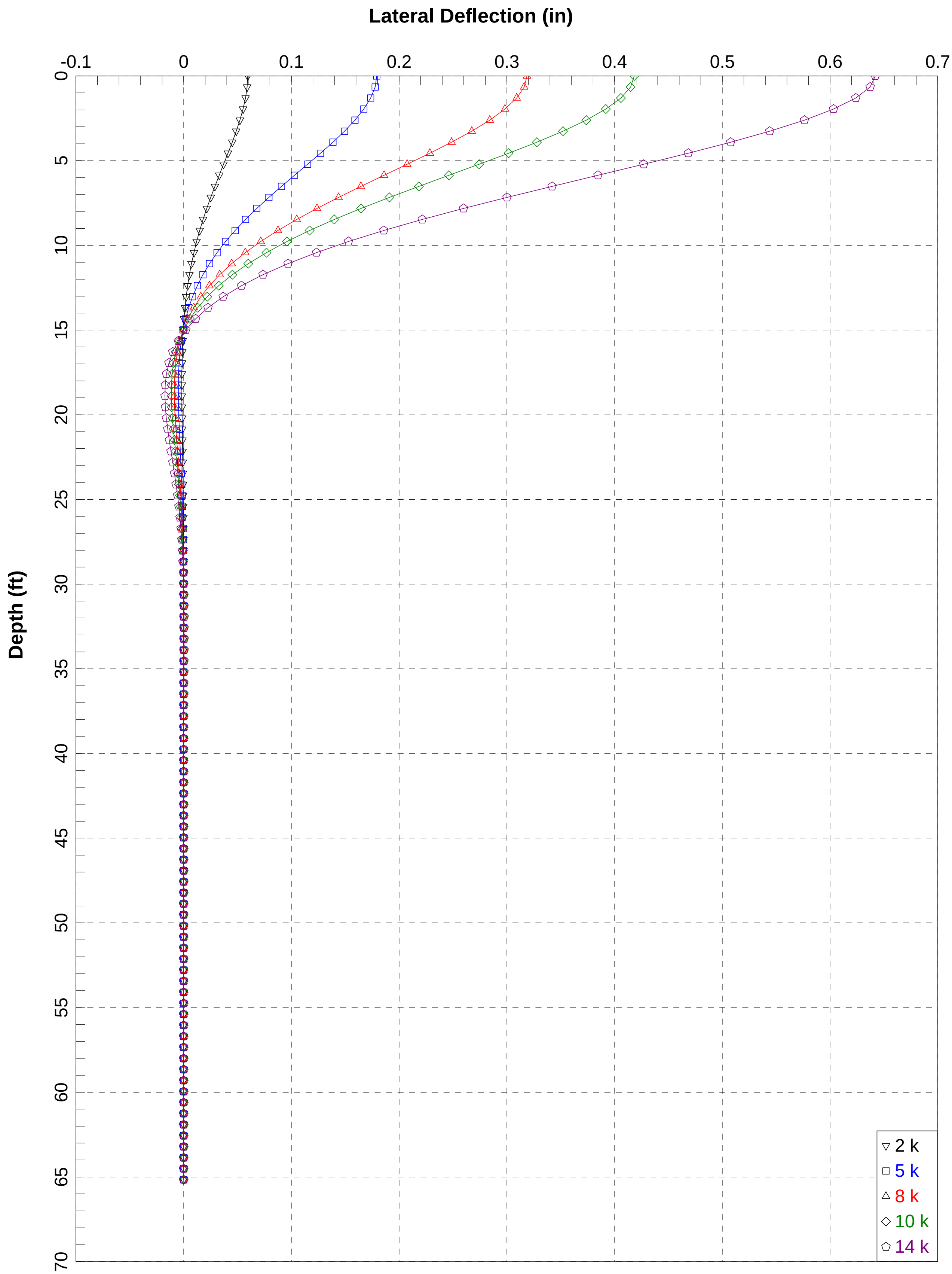
Summary of Lpile Analyses (Fixed Head Condition)

Pier Span	Total Vertical Load	Pile Size	Qall/Pile	No. of Piles/Pier	Vertical Load/Pile	Results: Max. Horizontal Load	Results: Max. Top Deflection
(ft)	(kips)		(kips)		(kips)	(kips)	(inches)
30	865	HP10X42	156	8	108	14	0.64
	865	HP12X53	195	8	108	21	0.73
	865	HP14X73	269	8	108	32	0.86
	865	HP14X89	328	8	108	39	0.97
	859	HP14X89	328	4	215	33	0.8
40	1,050	HP10X42	156	8	131	12	0.53
	1,050	HP12X53	195	8	131	20	0.69
	1,050	HP14X73	269	8	131	31	0.83
	1,050	HP14X89	328	8	131	38	0.94
	1,045	HP14X89	328	4	261	30	0.71
50	1,276	HP10X42	156	8	160	11	0.48
	1,276	HP12X53	195	8	160	18	0.61
	1,276	HP14X73	269	8	160	29	0.77
	1,276	HP14X89	328	8	160	37	0.92
	1,272	HP14X89	328	4	318	28	0.66

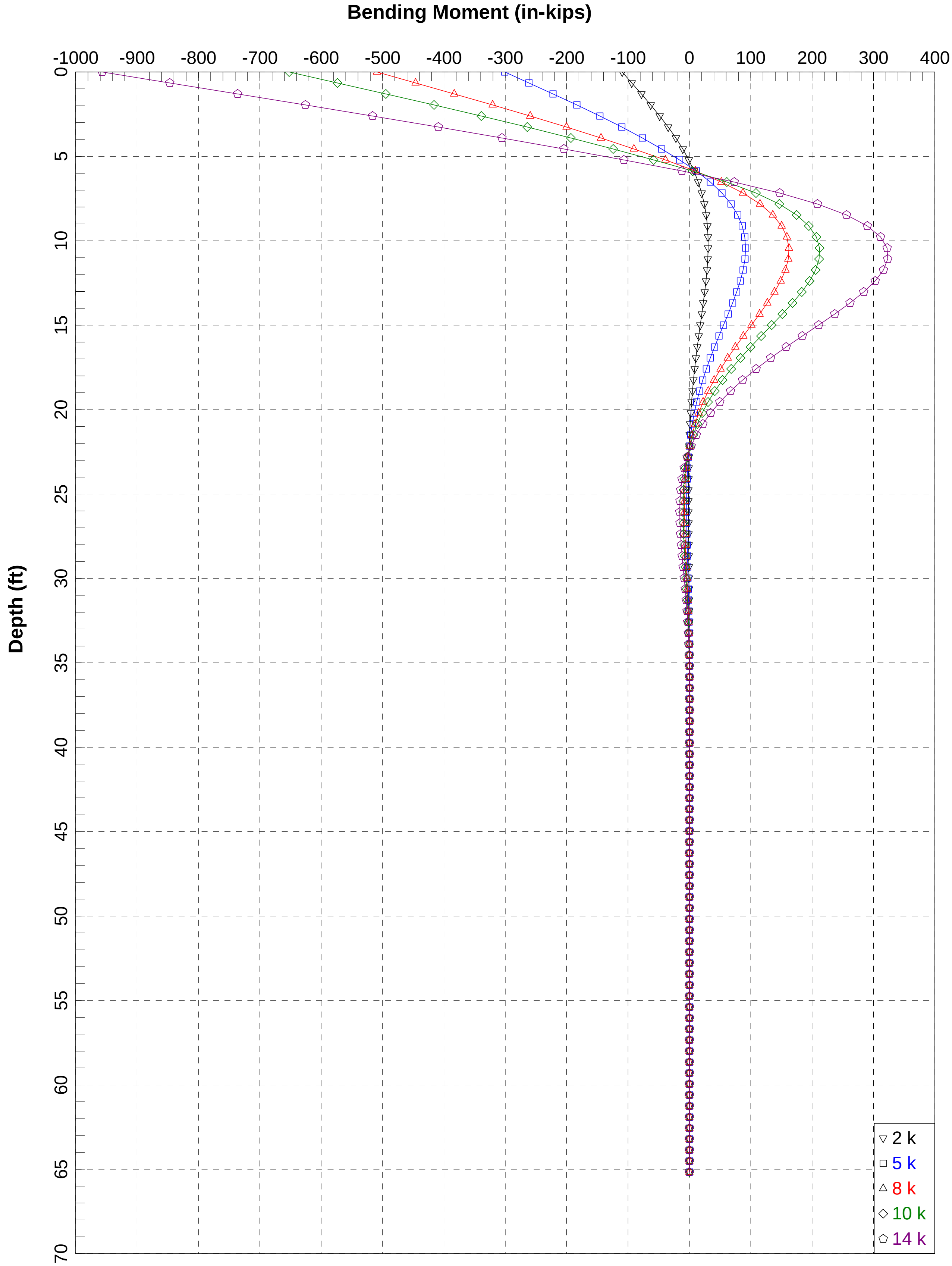


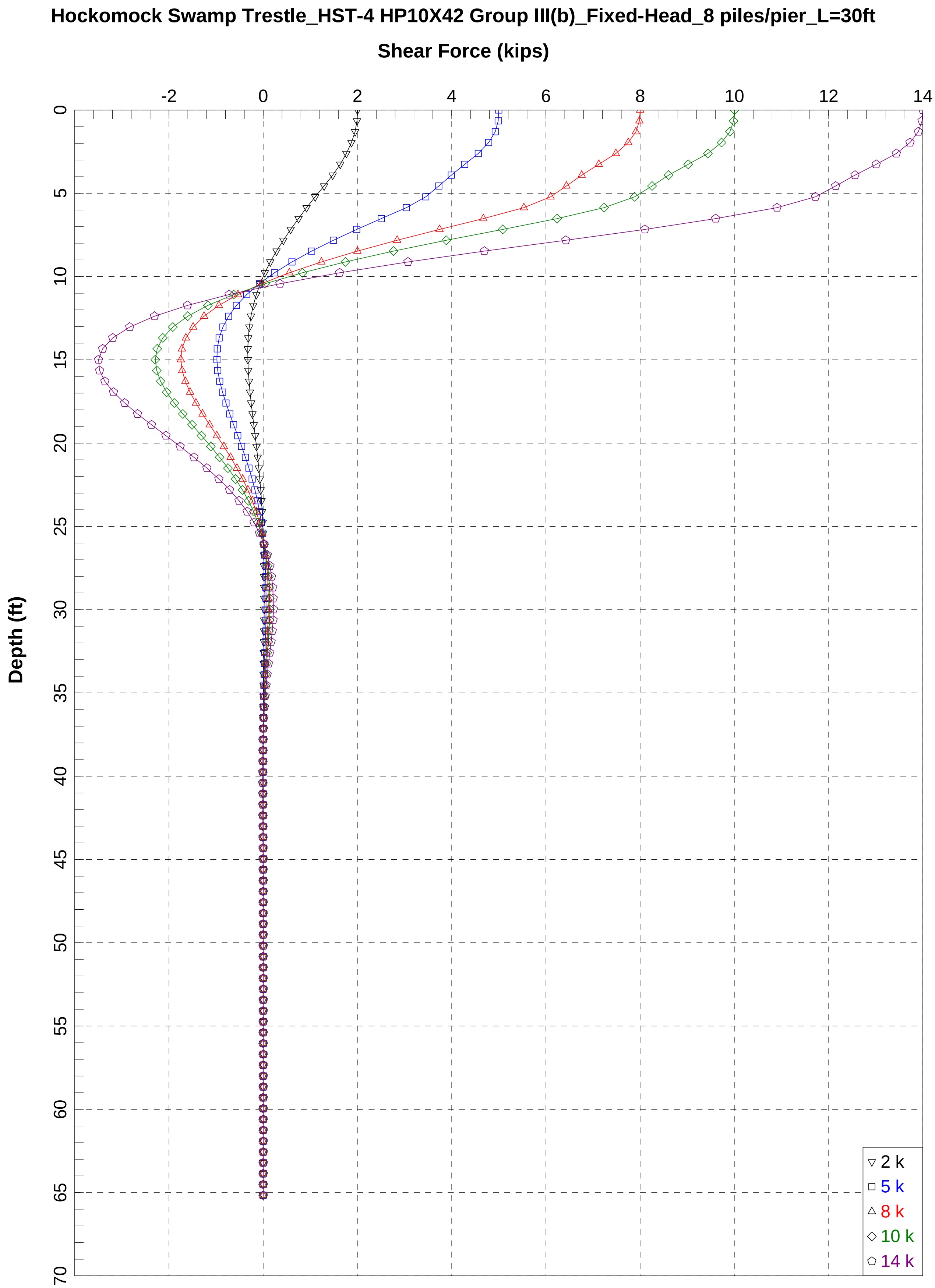
Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=30ft
Lateral Load (kips)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Pile-head Deflection (in)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
Case 1

Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=30ft

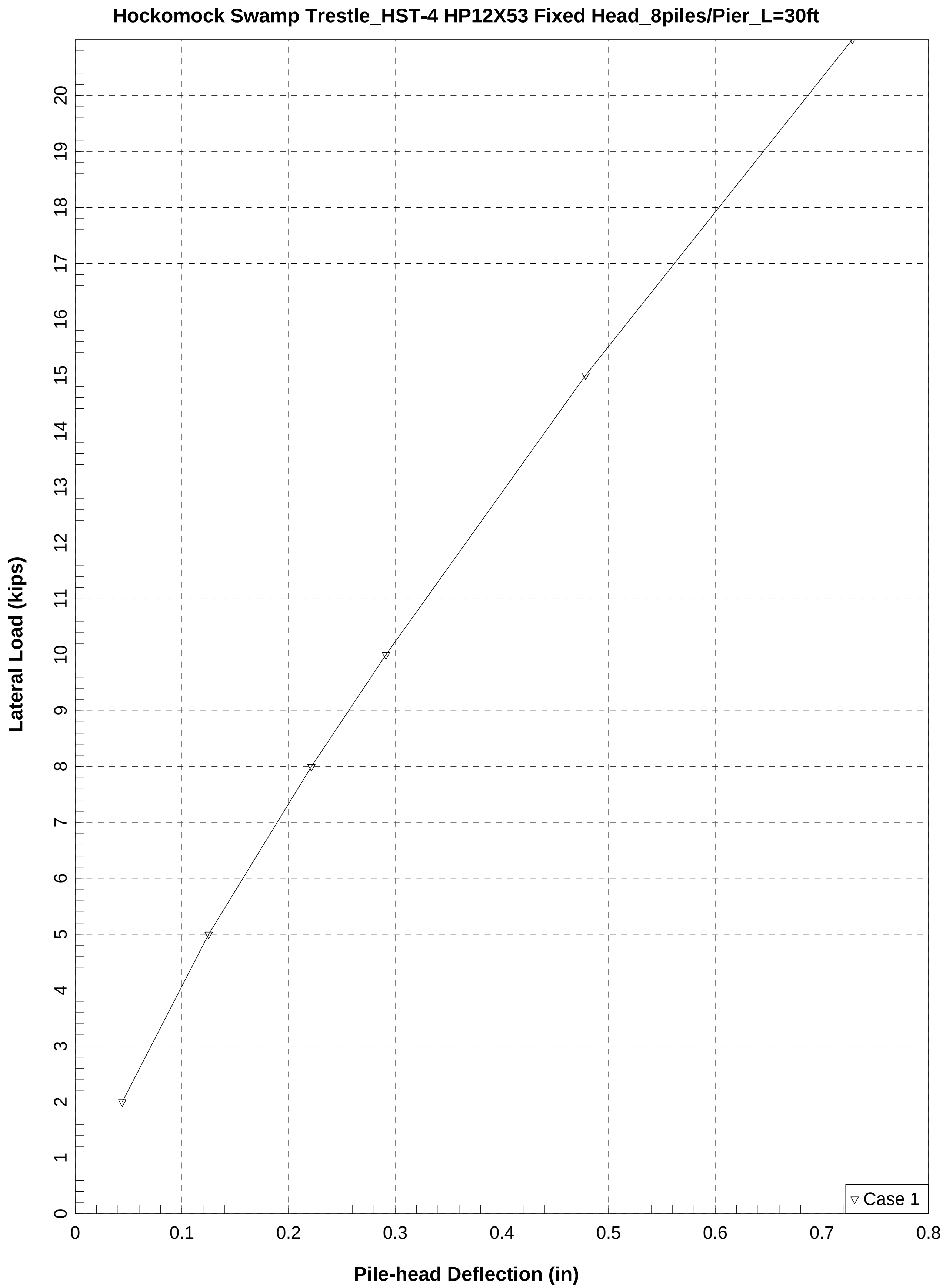


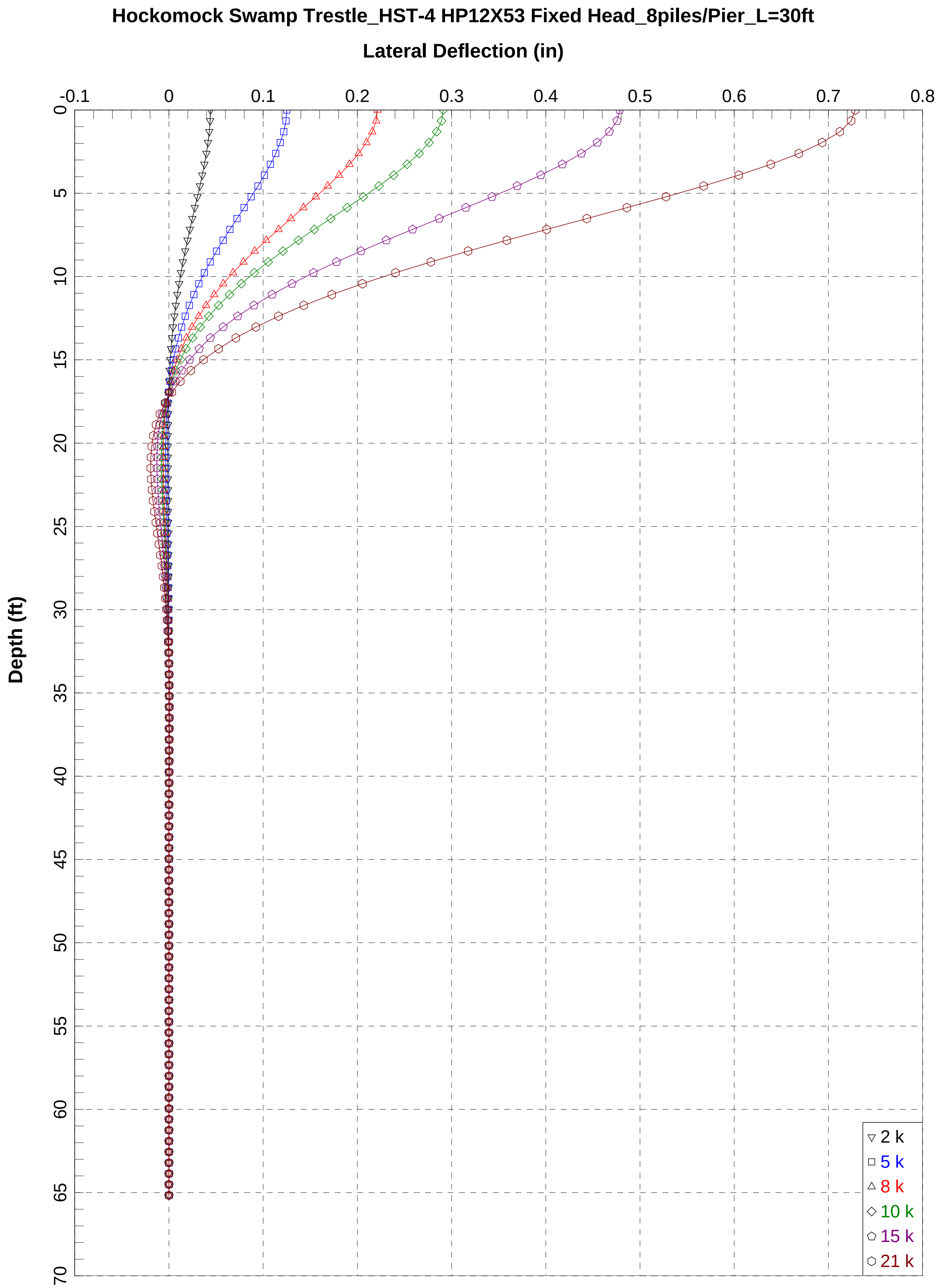
Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=30ft





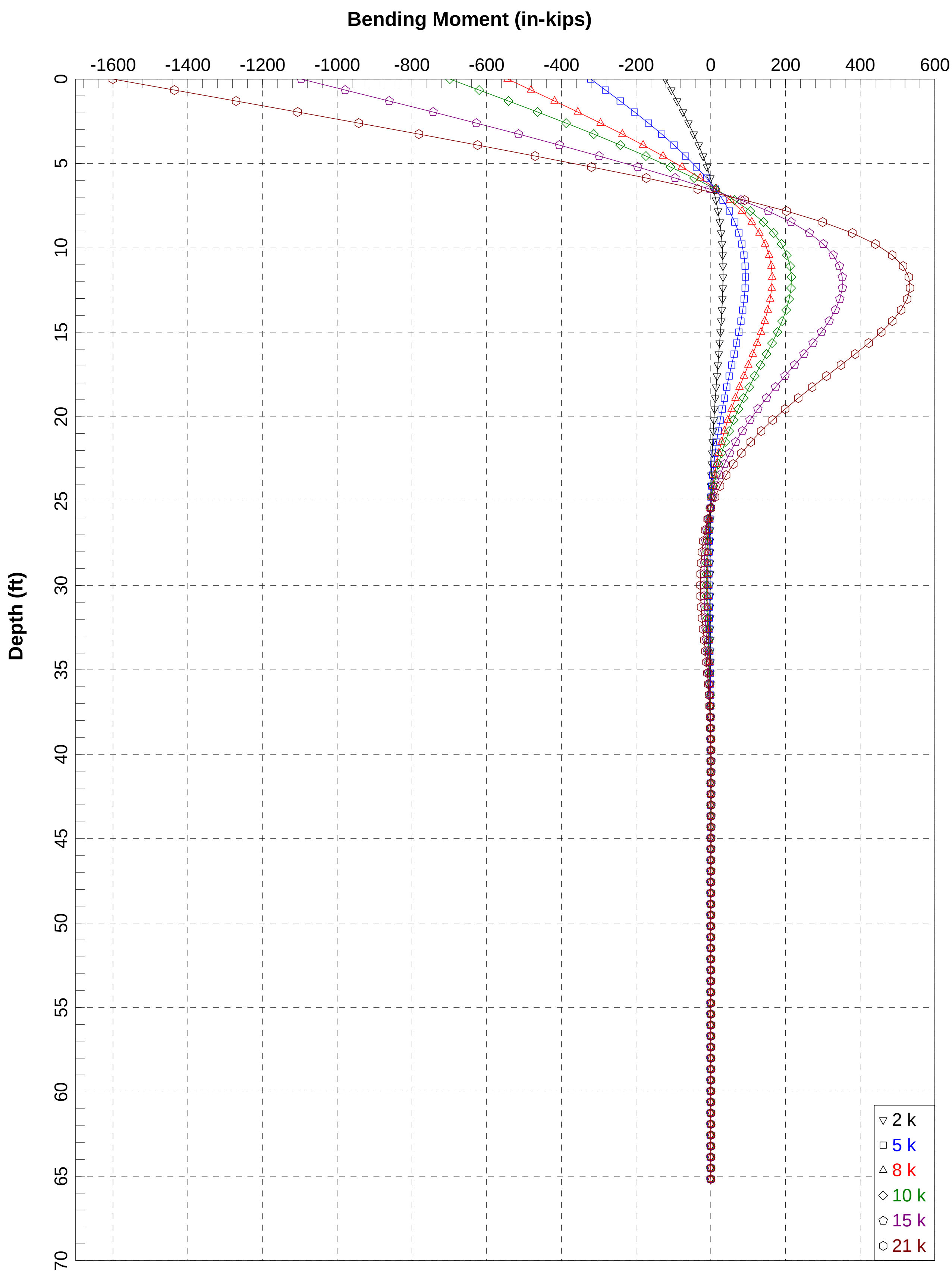
Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=30ft
Shear Force (kips)
-2
0
2
4
6
8
10
12
14
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
14 k

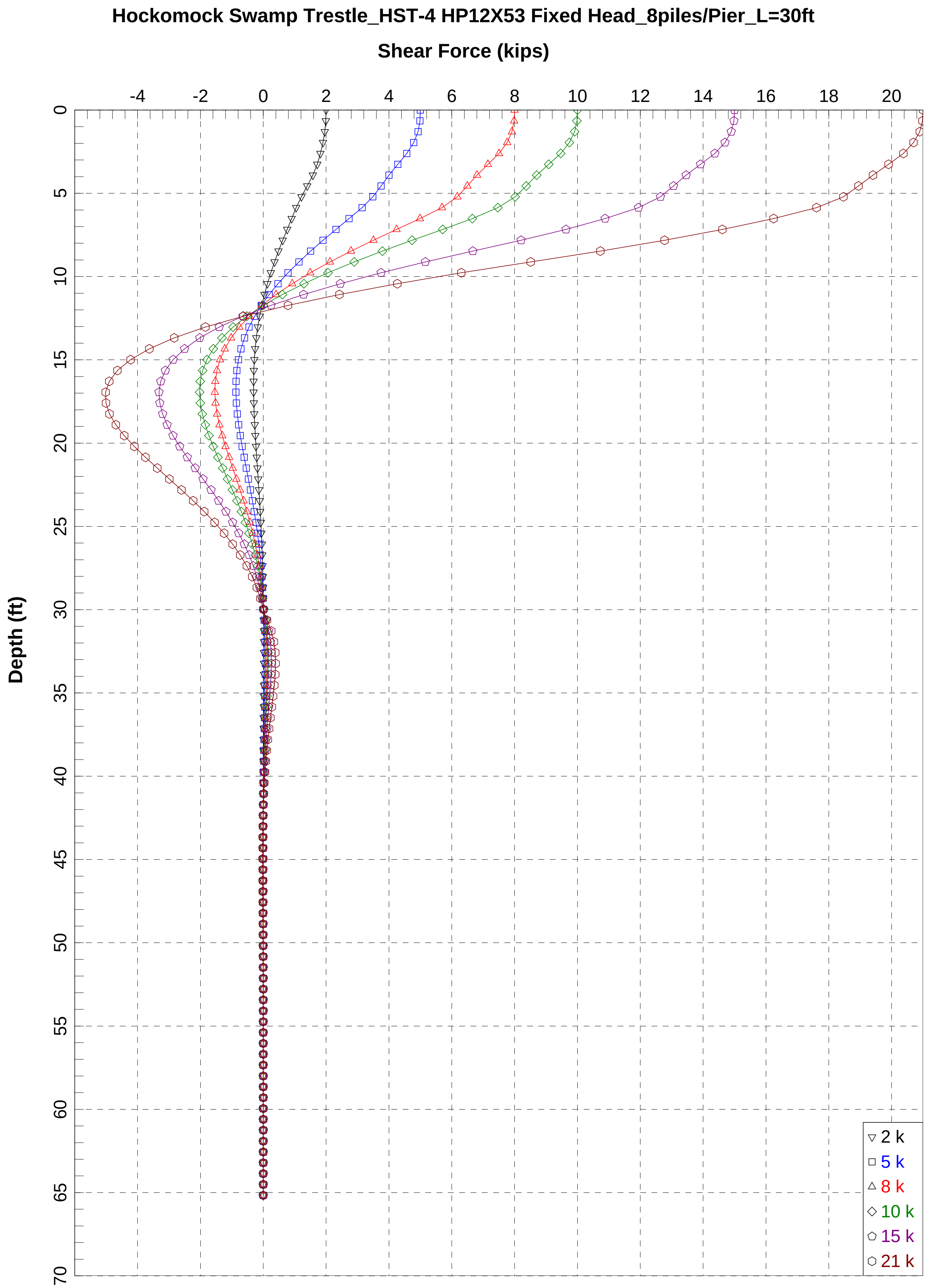

Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=30ft
Lateral Load (kips)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Pile-head Deflection (in)
Case 1



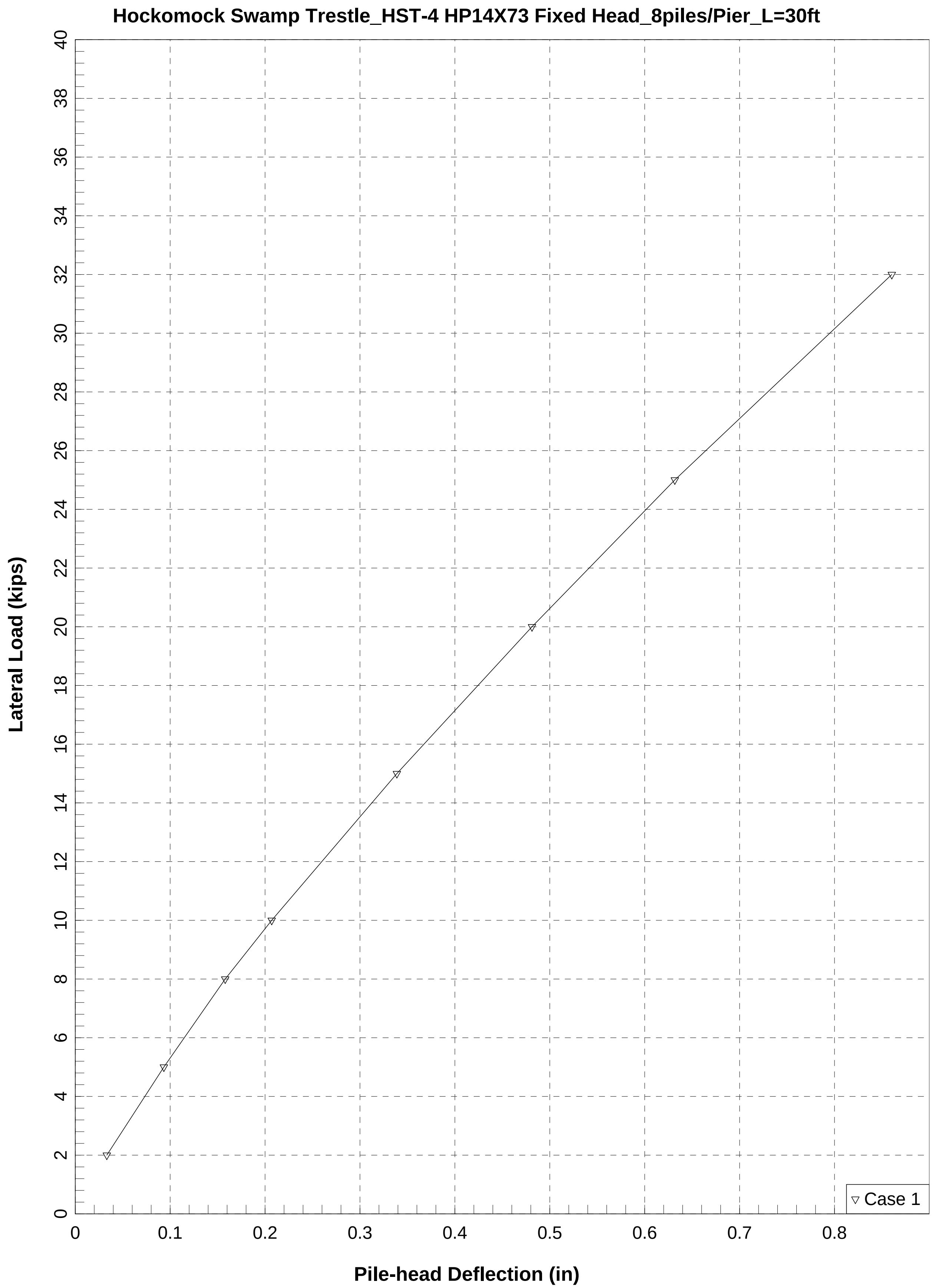
Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=30ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
21 k

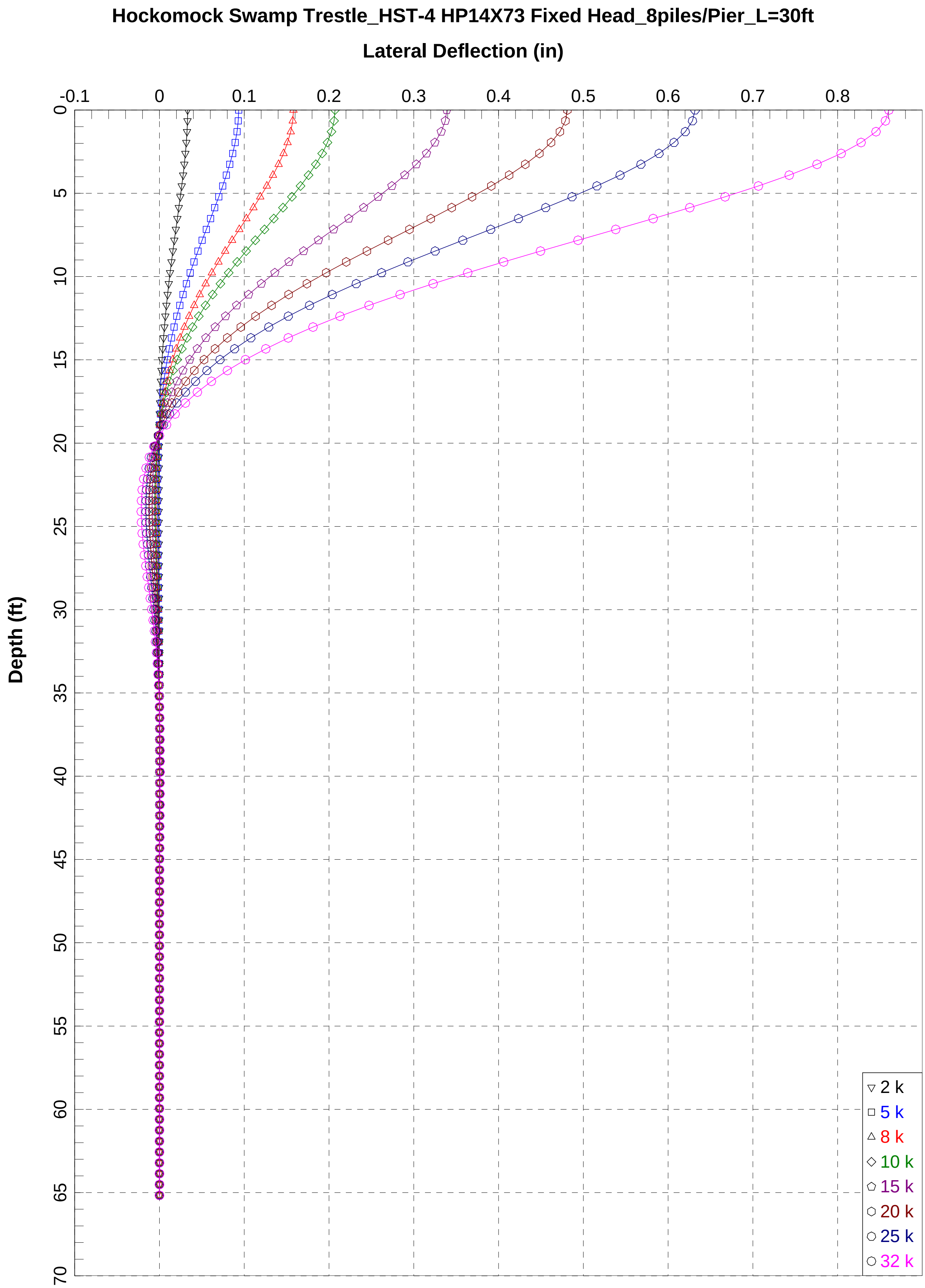
Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=30ft



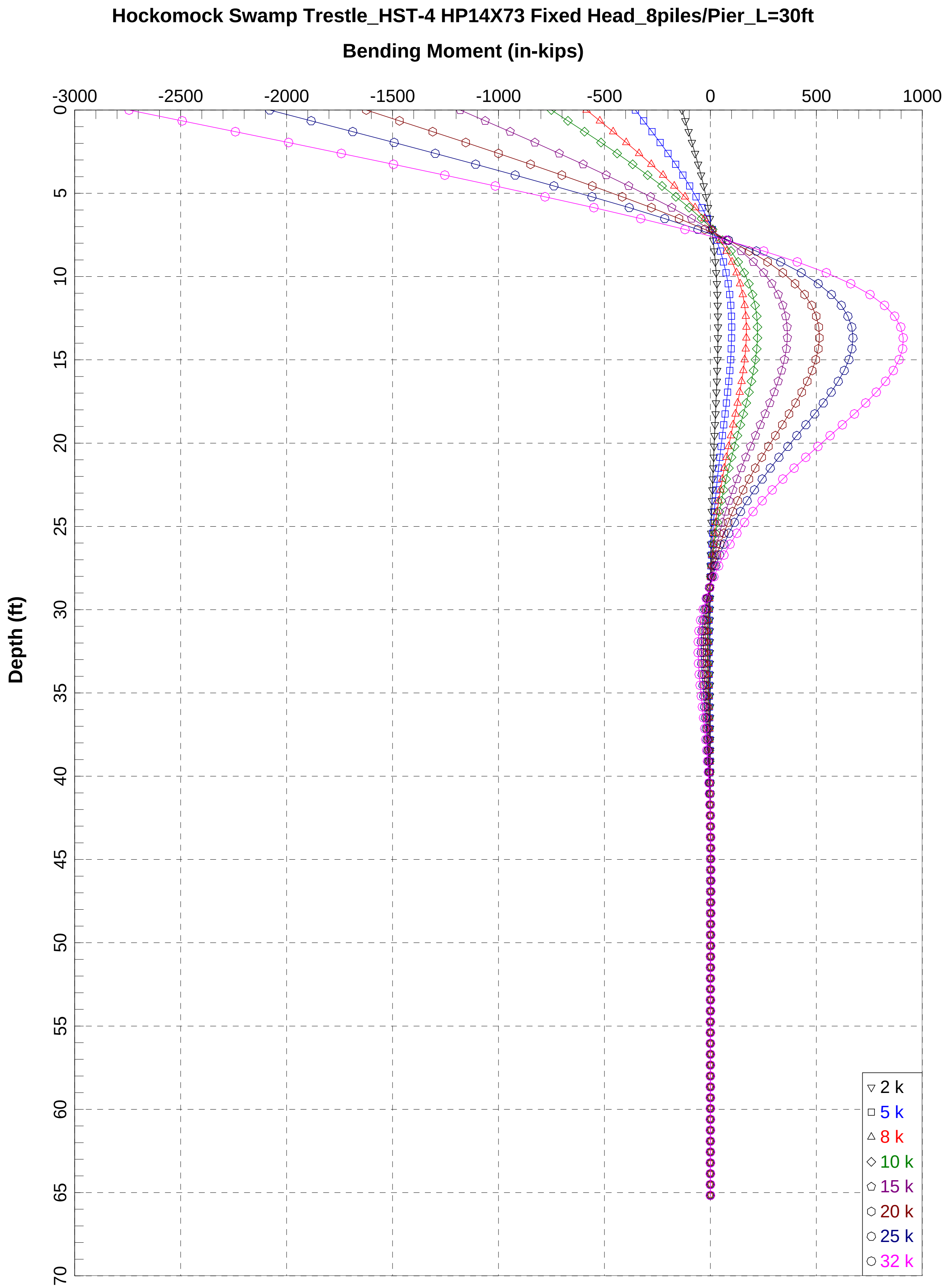


Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=30ft
Shear Force (kips)
-4
-2
0
2
4
6
8
10
12
14
16
18
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
21 k


Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=30ft
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

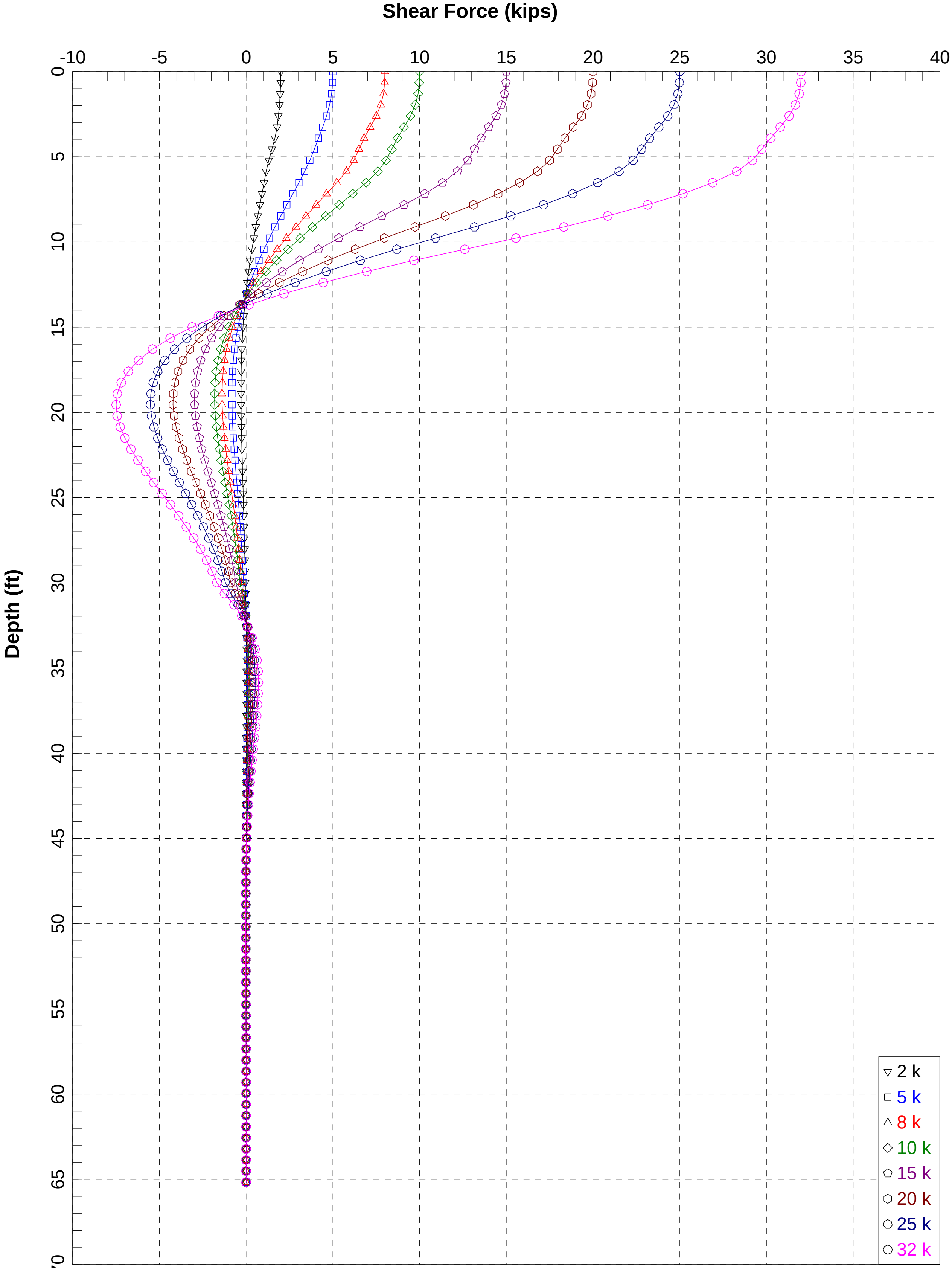


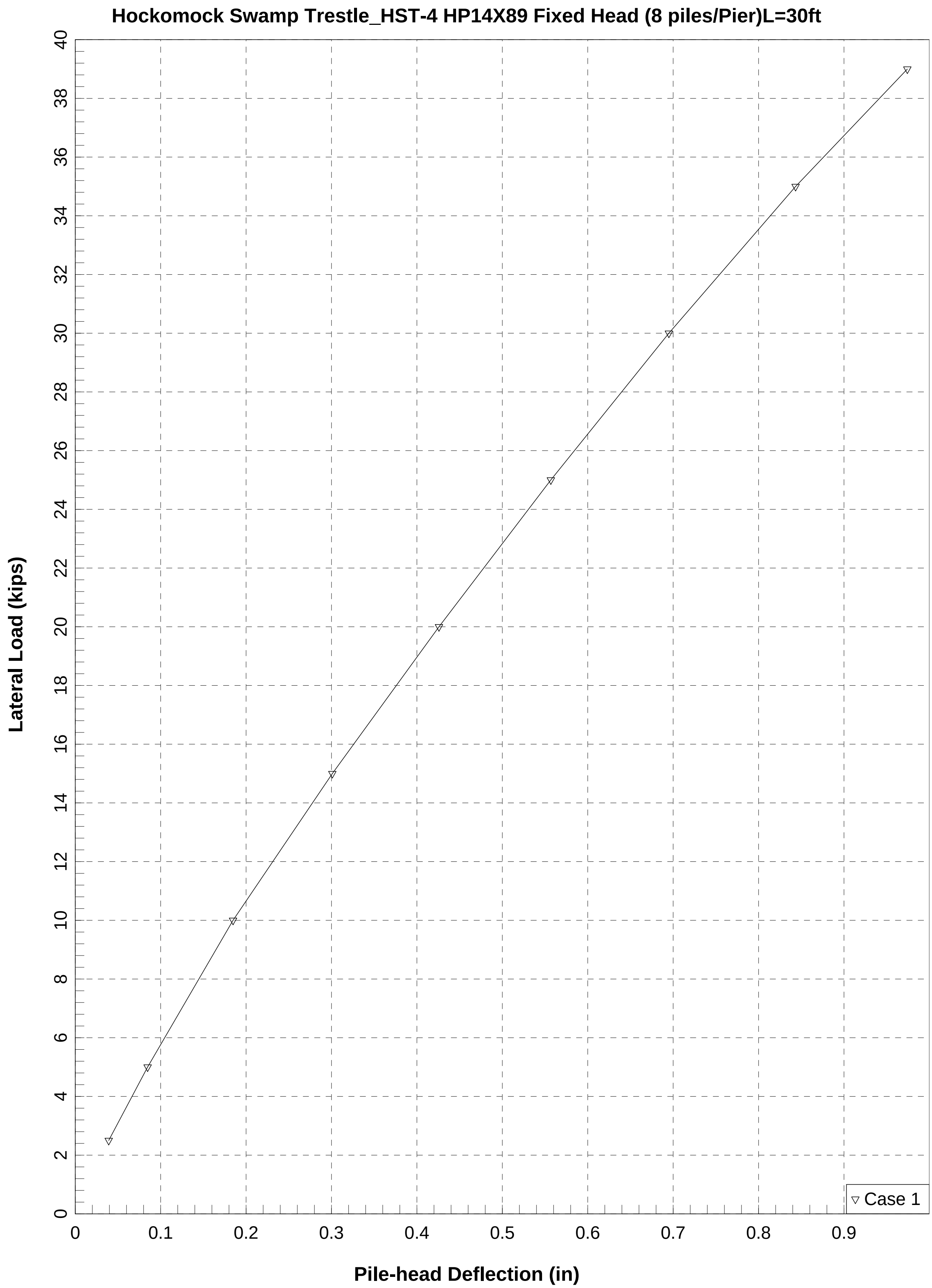
Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=30ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
32 k



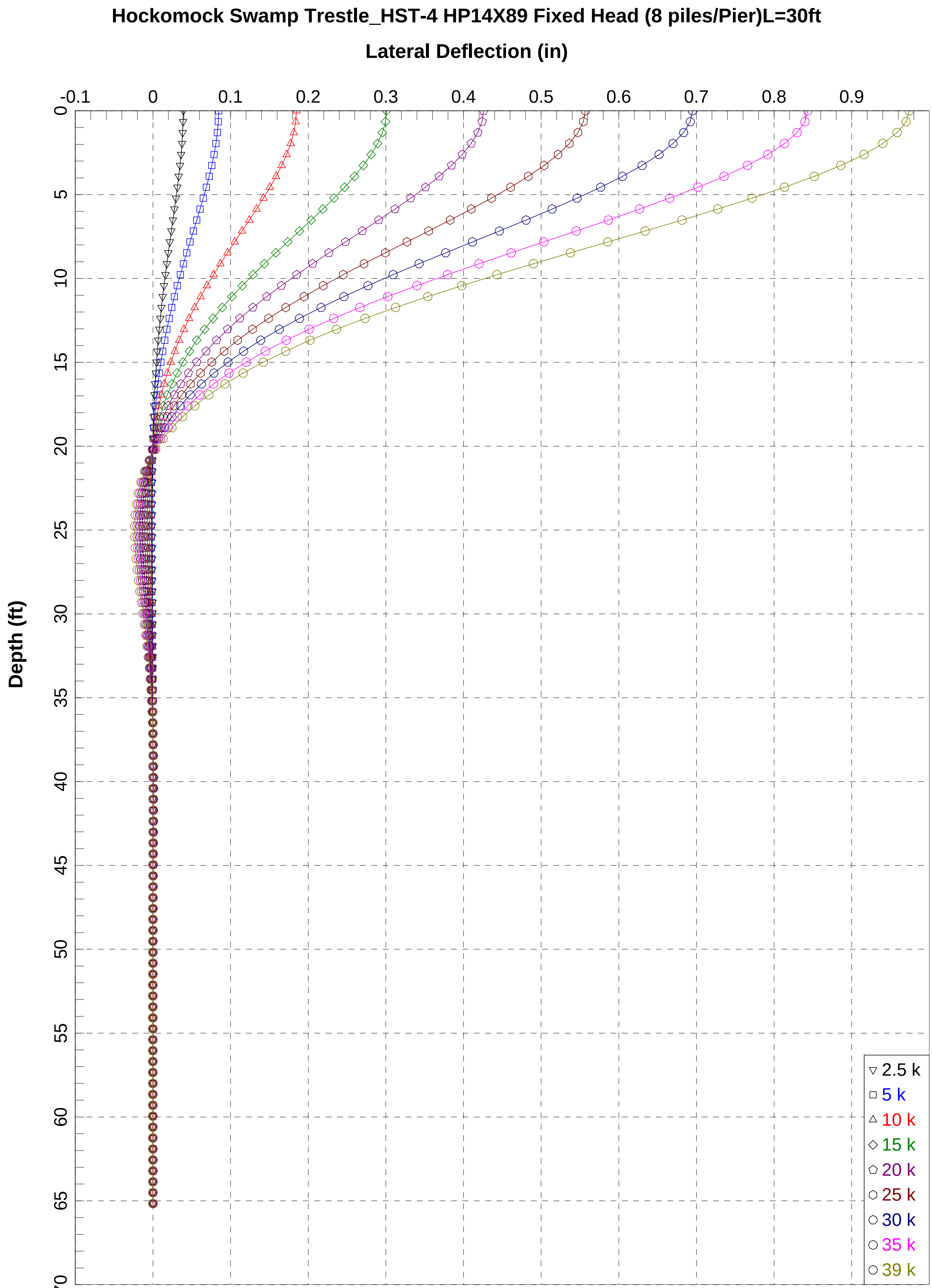
Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=30ft
Bending Moment (in-kips)
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
32 k

Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=30ft



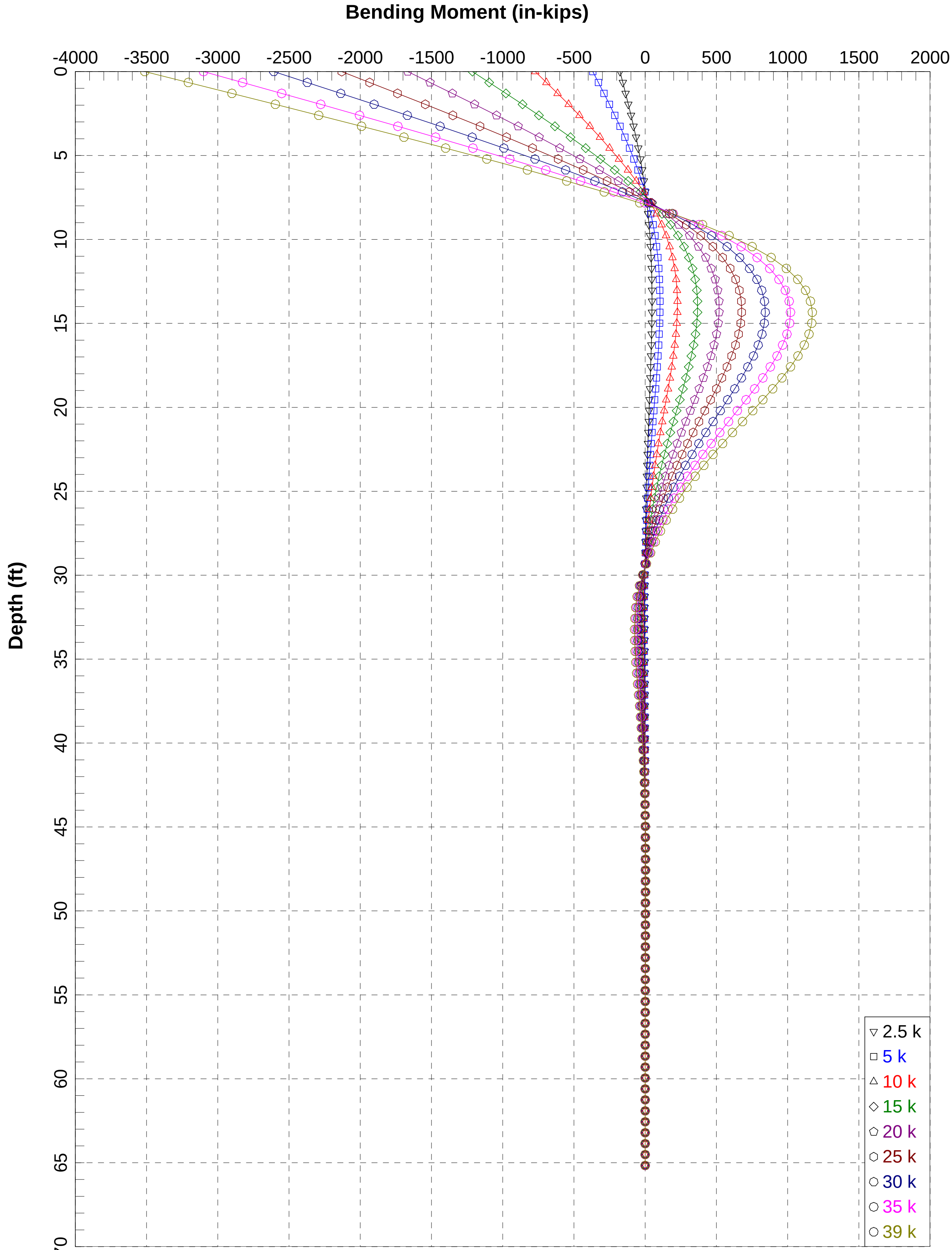


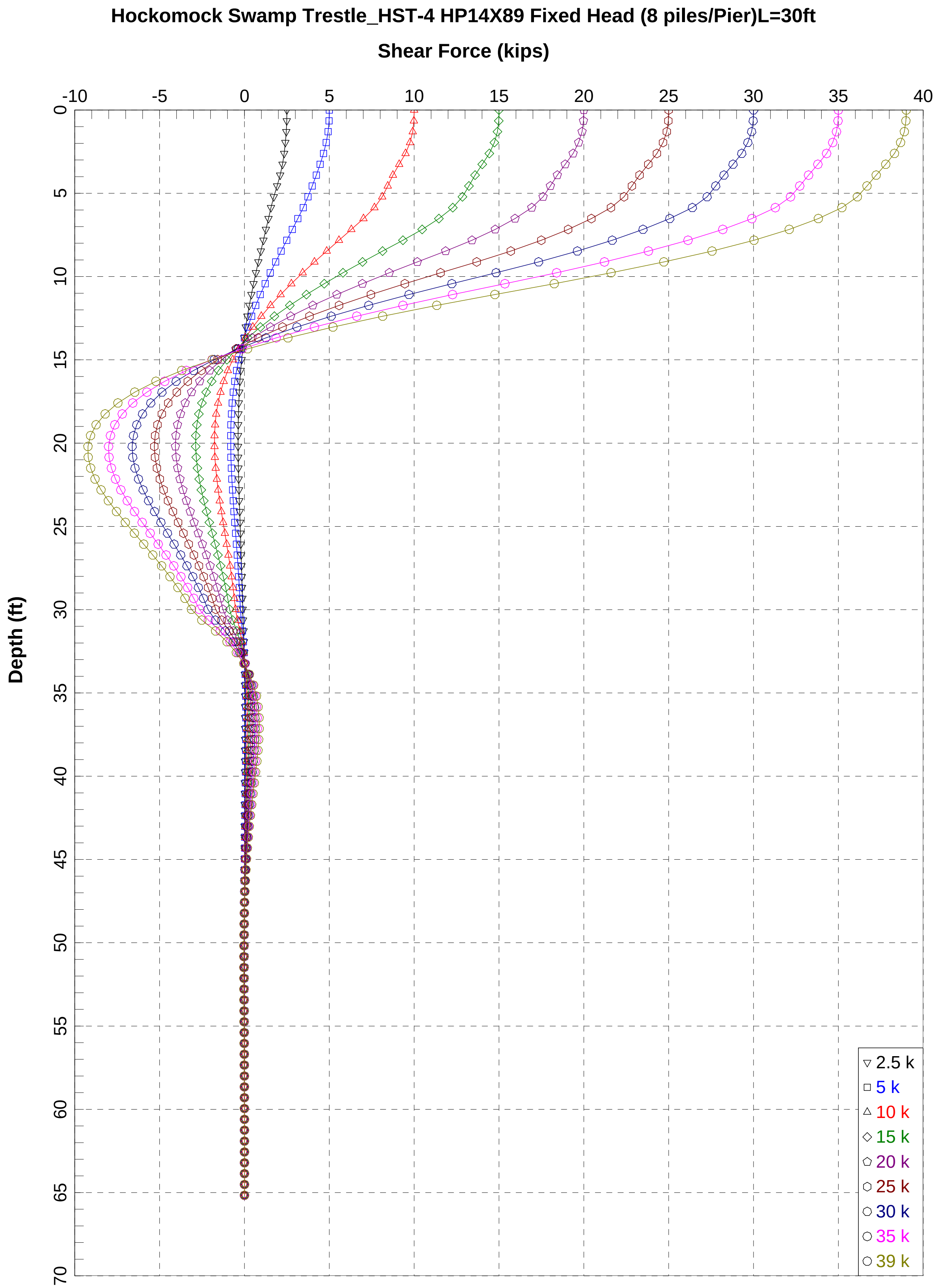
Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=30ft
Lateral Load (kips)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Pile-head Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Case 1

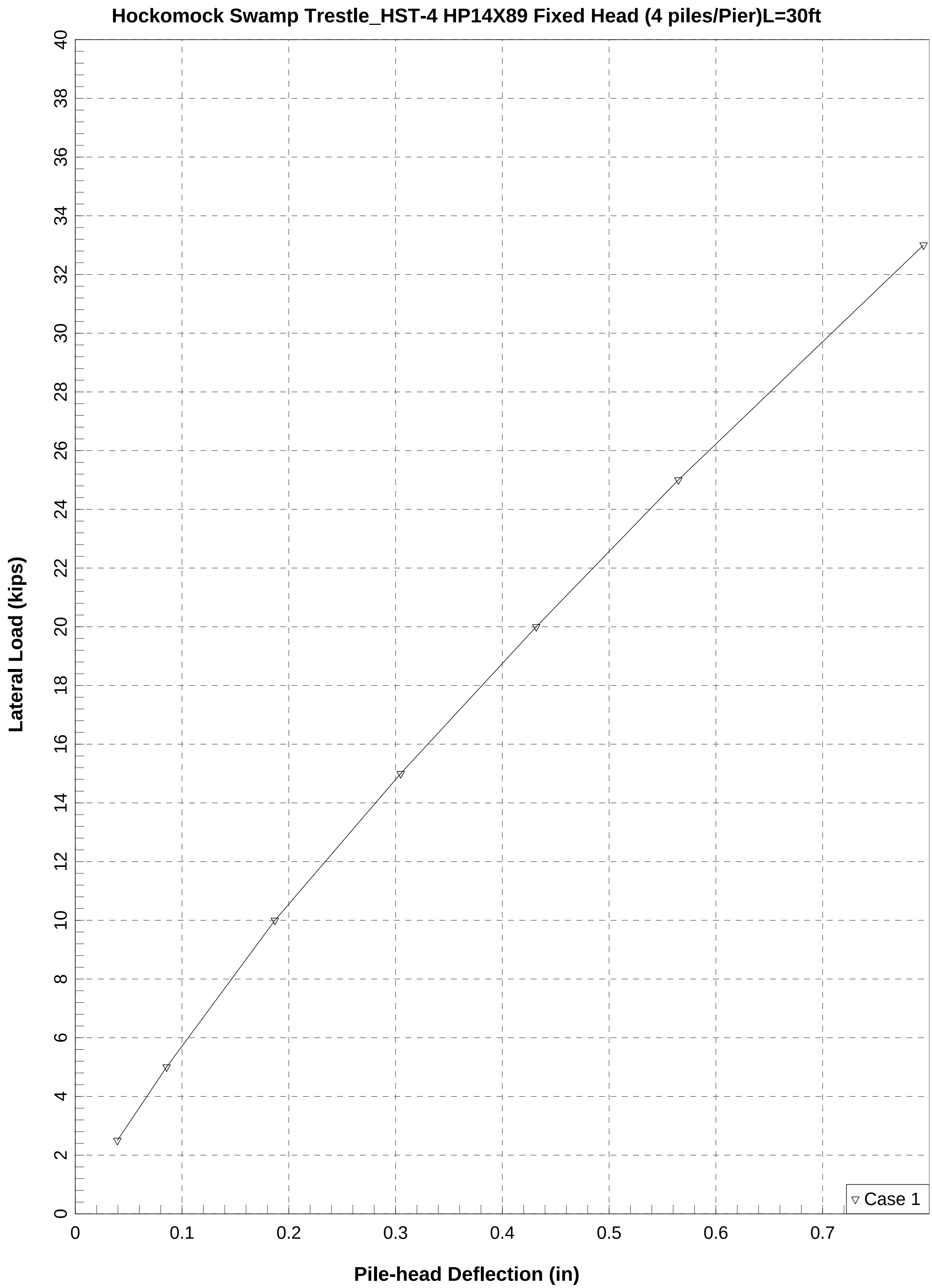


Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=30ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k
35 k
39 k

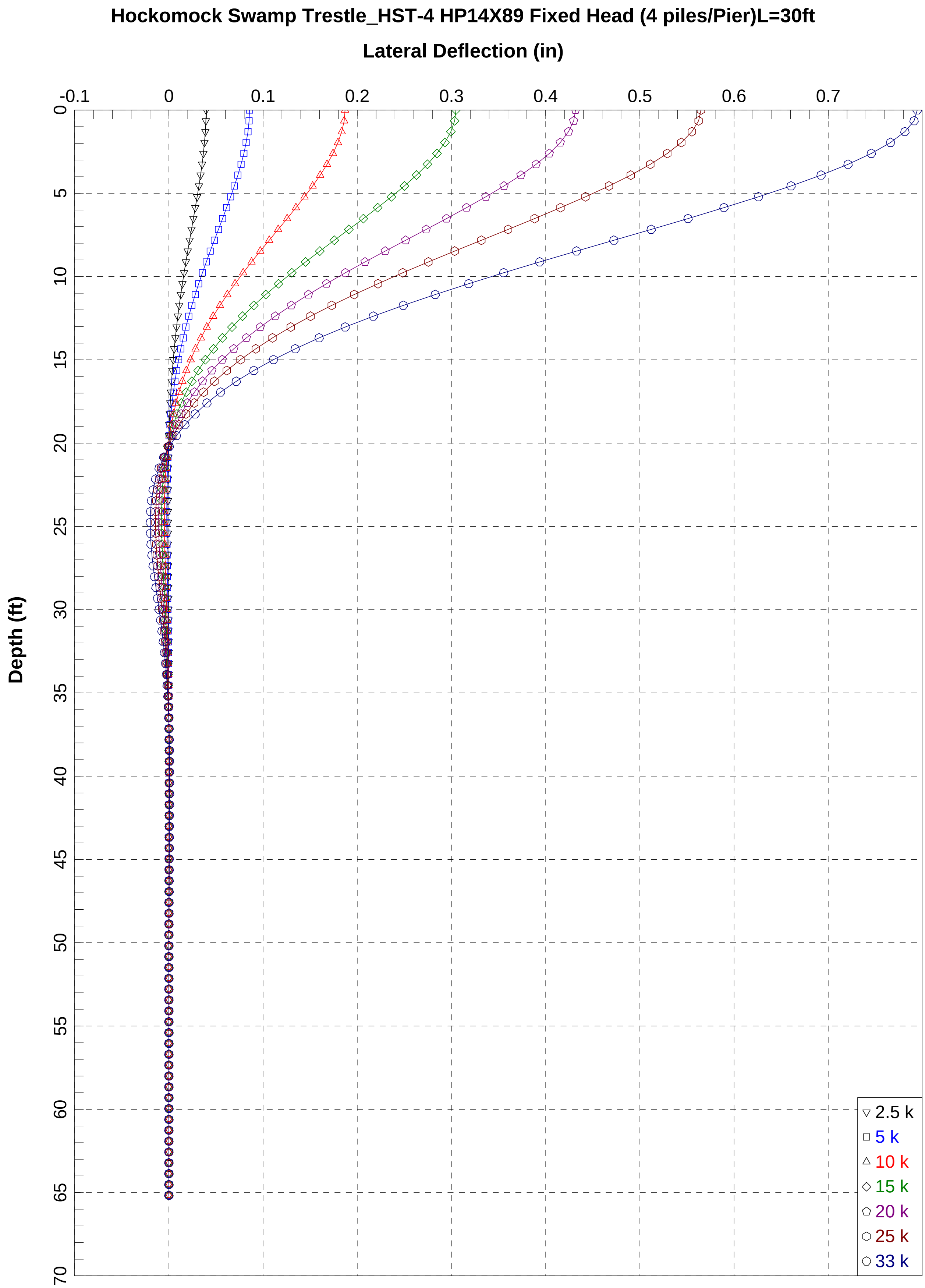
Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=30ft



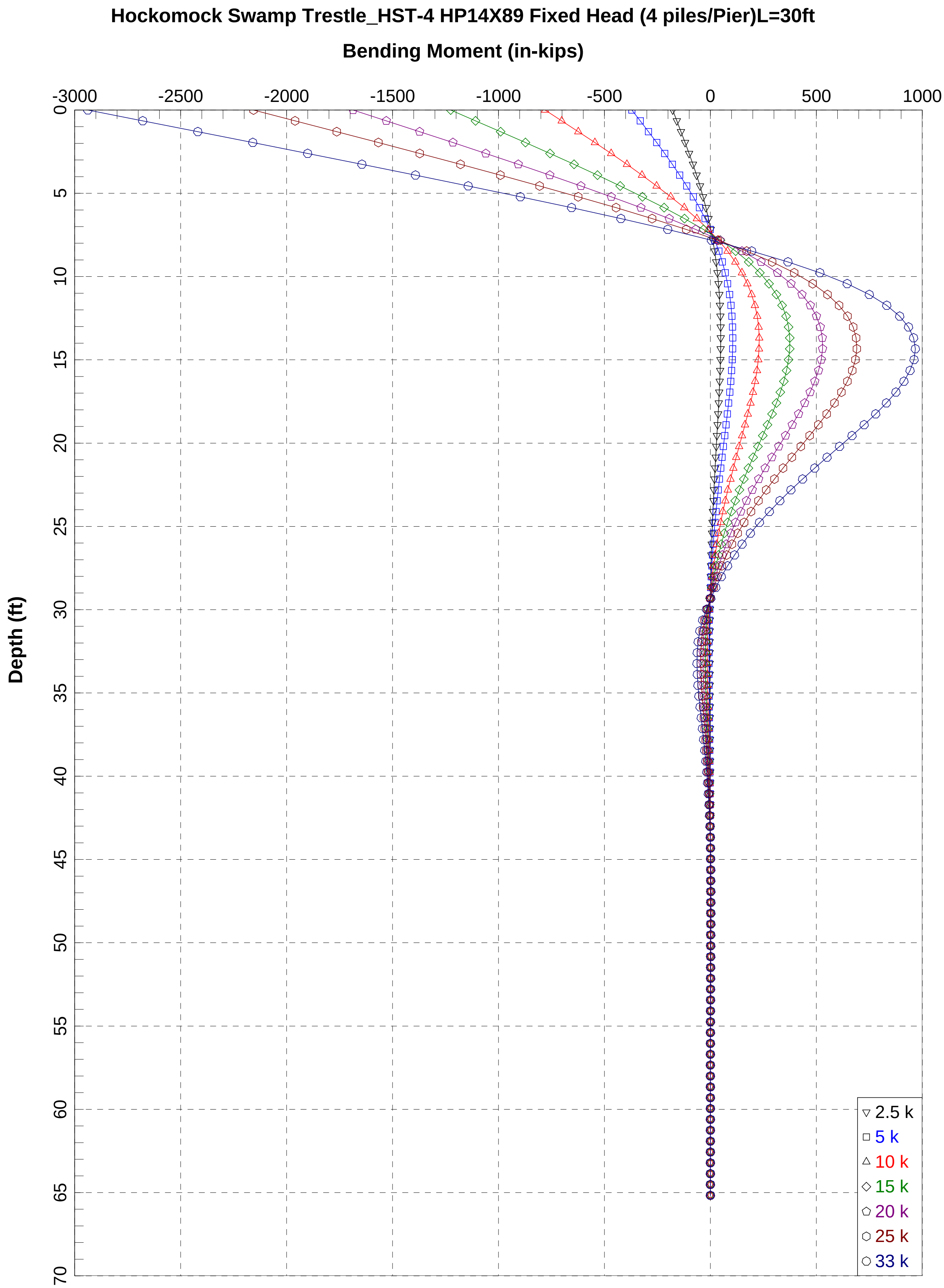

Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=30ft
Shear Force (kips)
-10
-5
0
5
10
15
20
25
30
35
40
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k
35 k
39 k



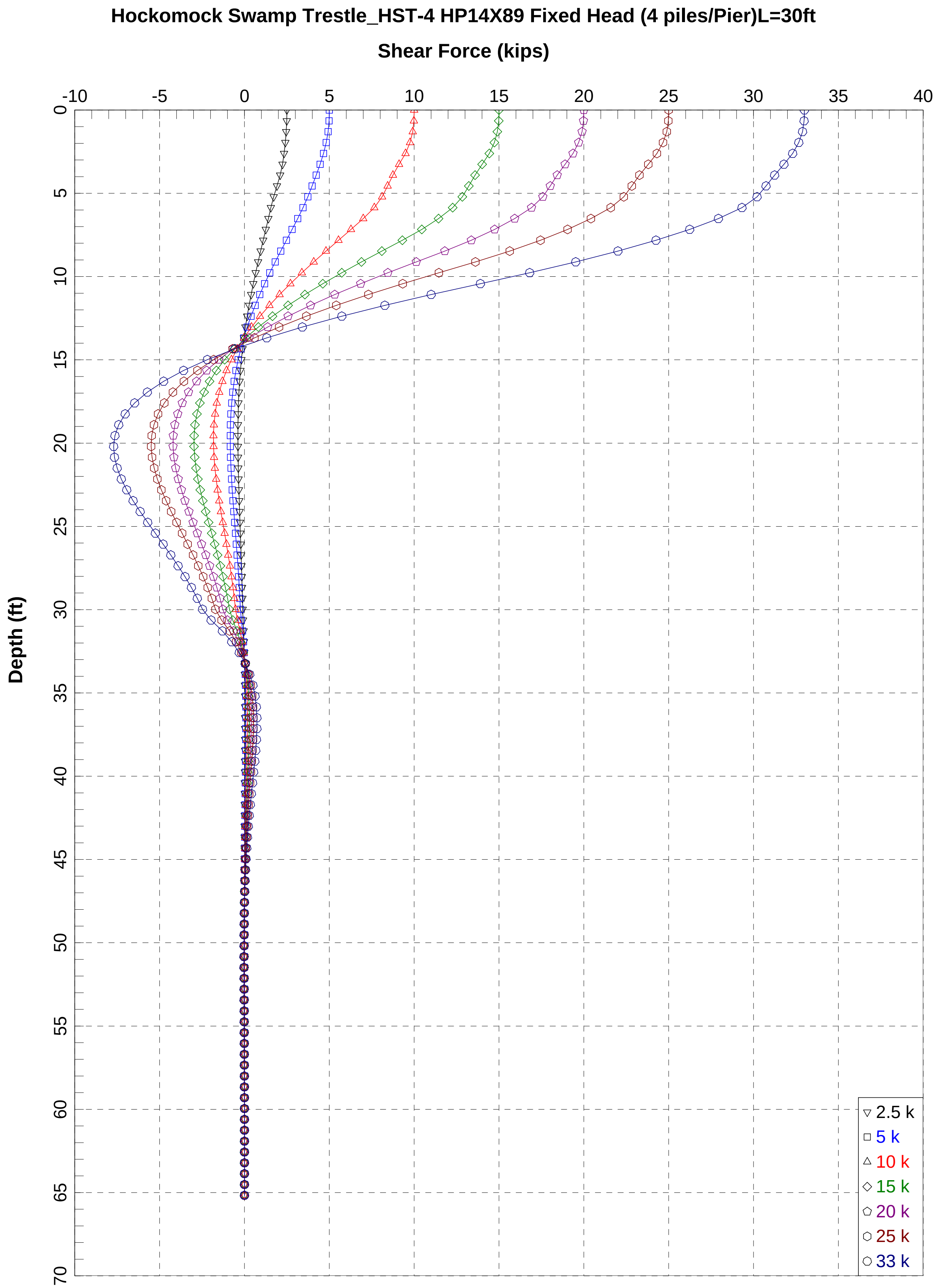
Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=30ft
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7

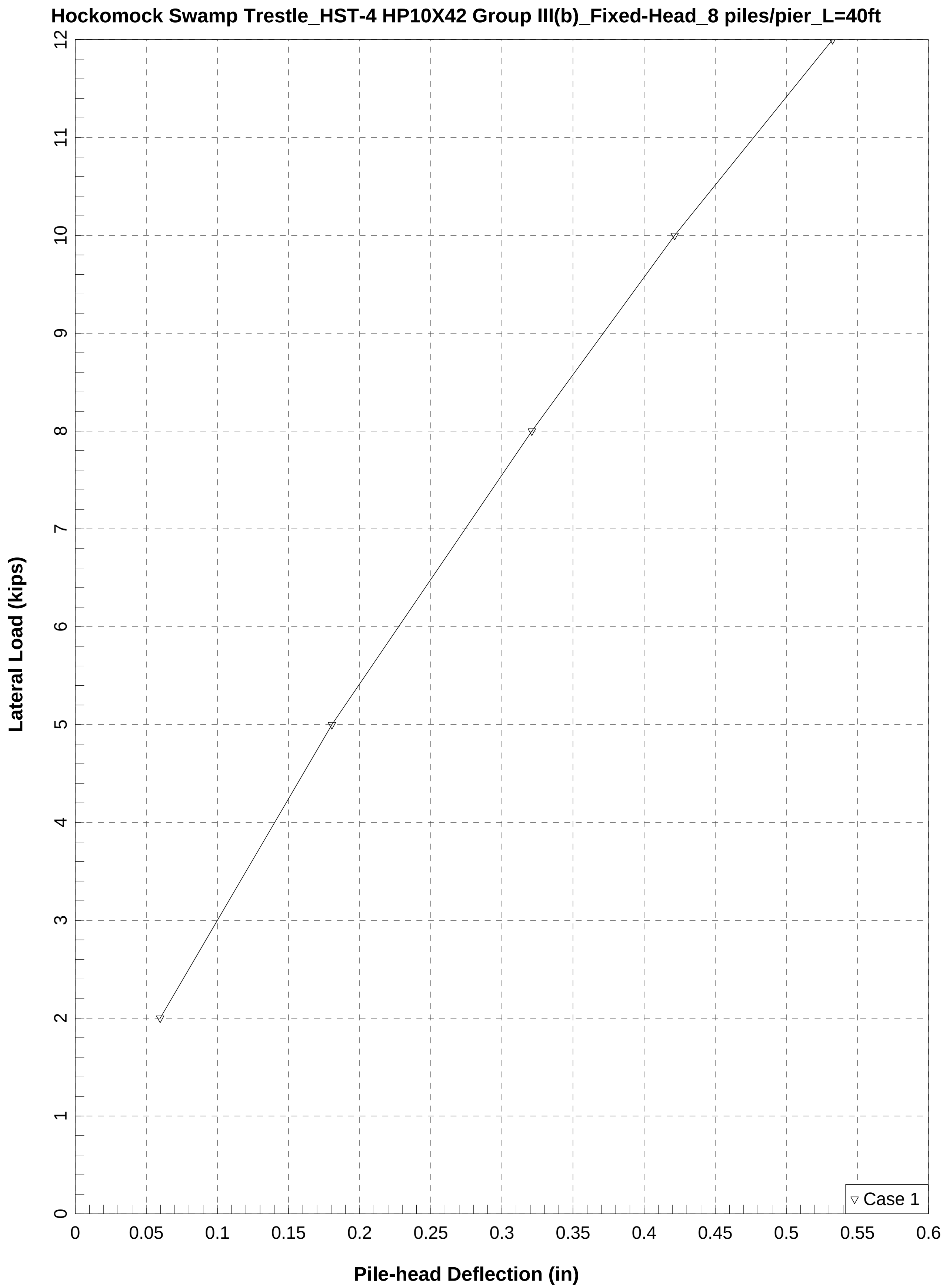


Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=30ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
33 k

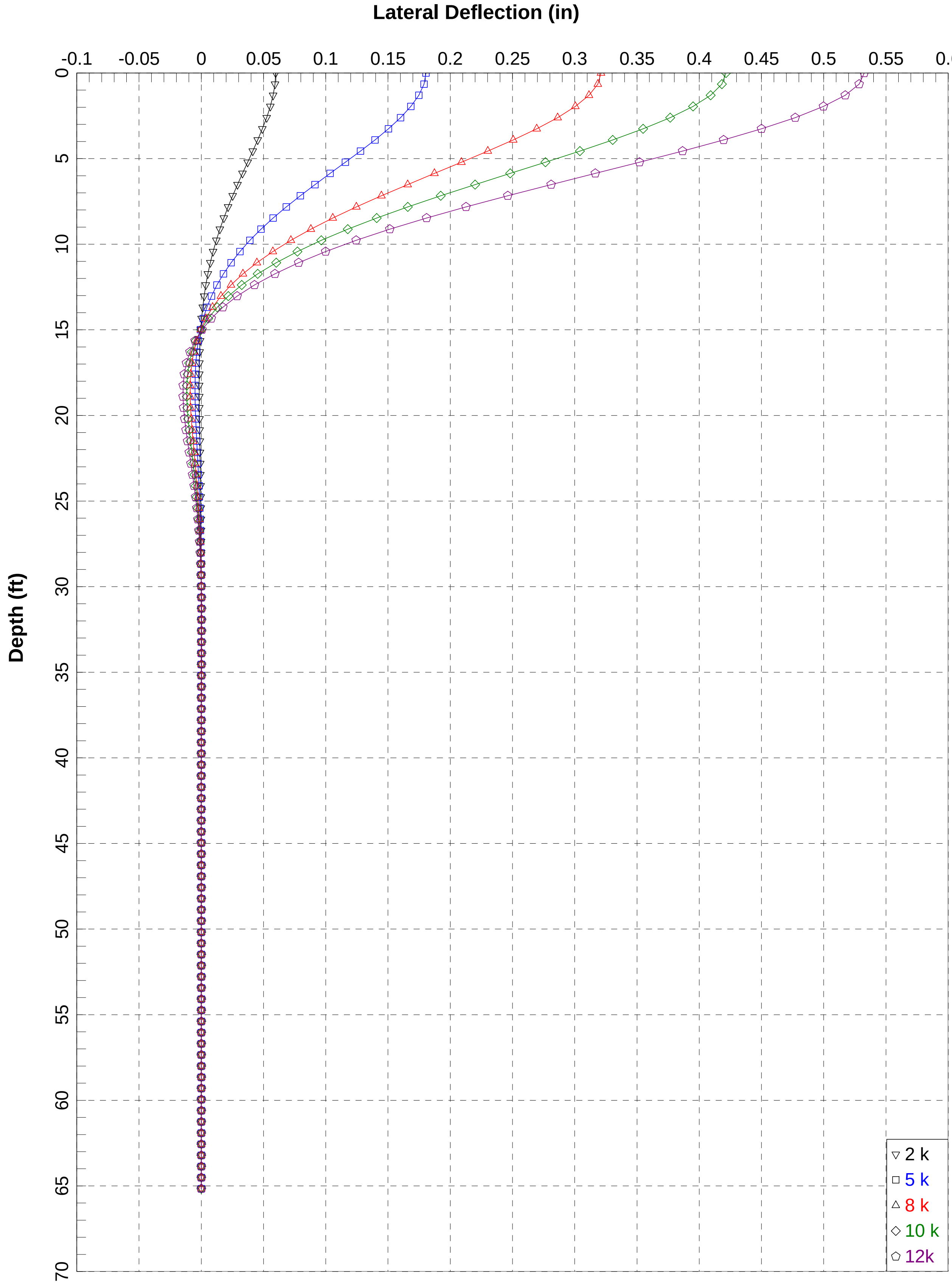


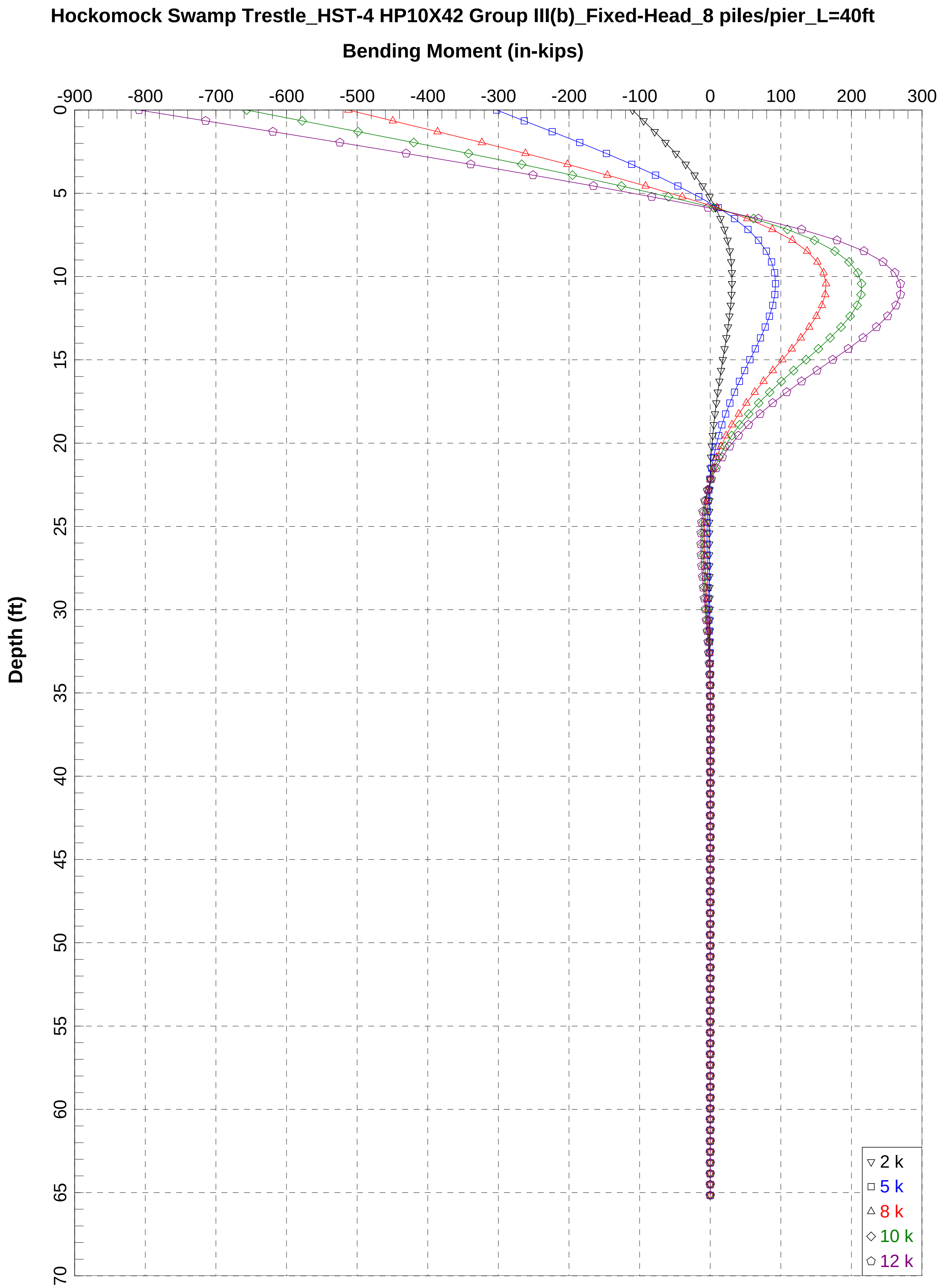
Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=30ft
Bending Moment (in-kips)
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
33 k


Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=30ft
Shear Force (kips)
Depth (ft)
-10
-5
0
5
10
15
20
25
30
35
40
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
33 k

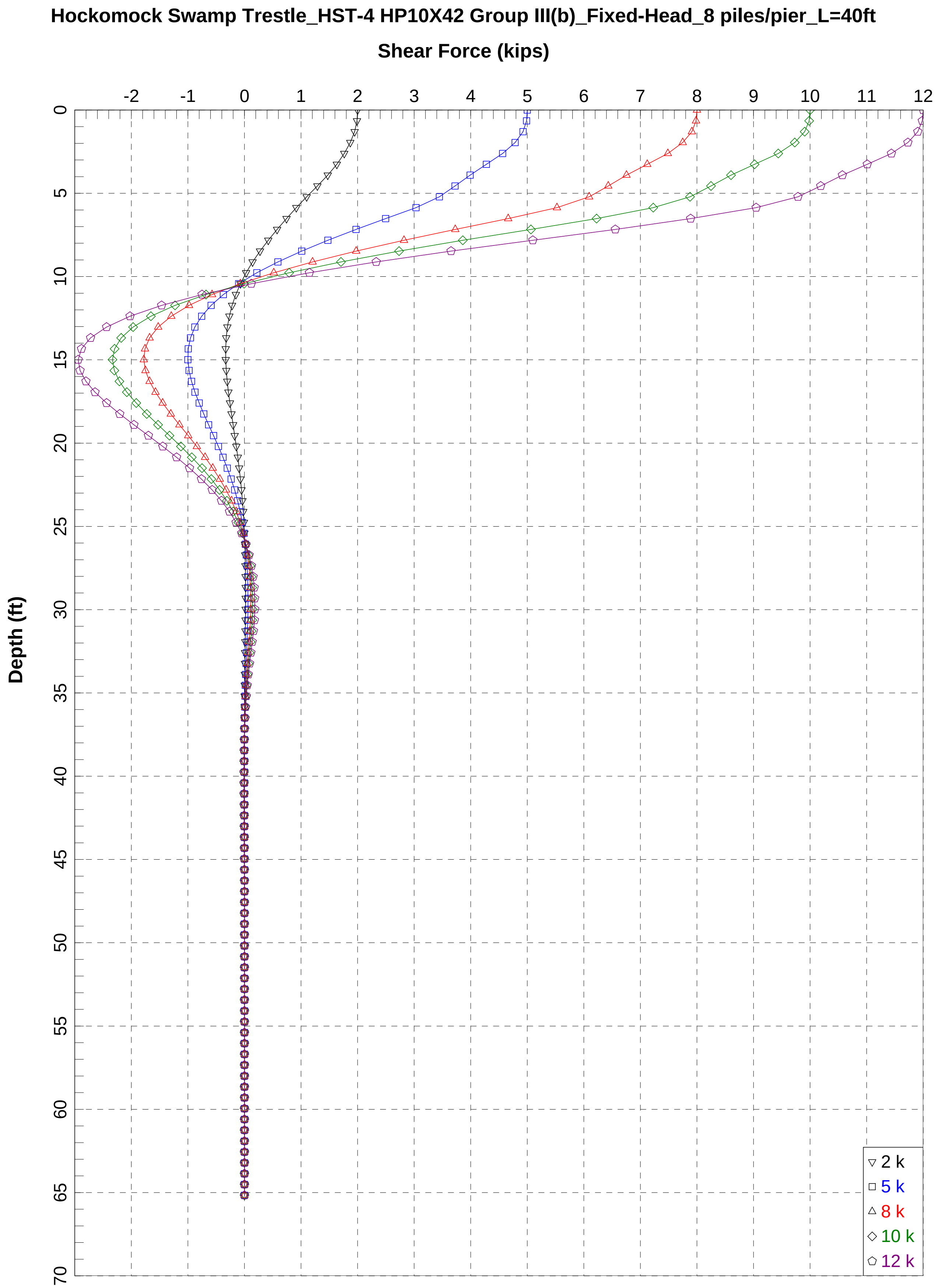

Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=40ft
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
1
2
3
4
5
6
7
8
9
10
11
12
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6

Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=40ft

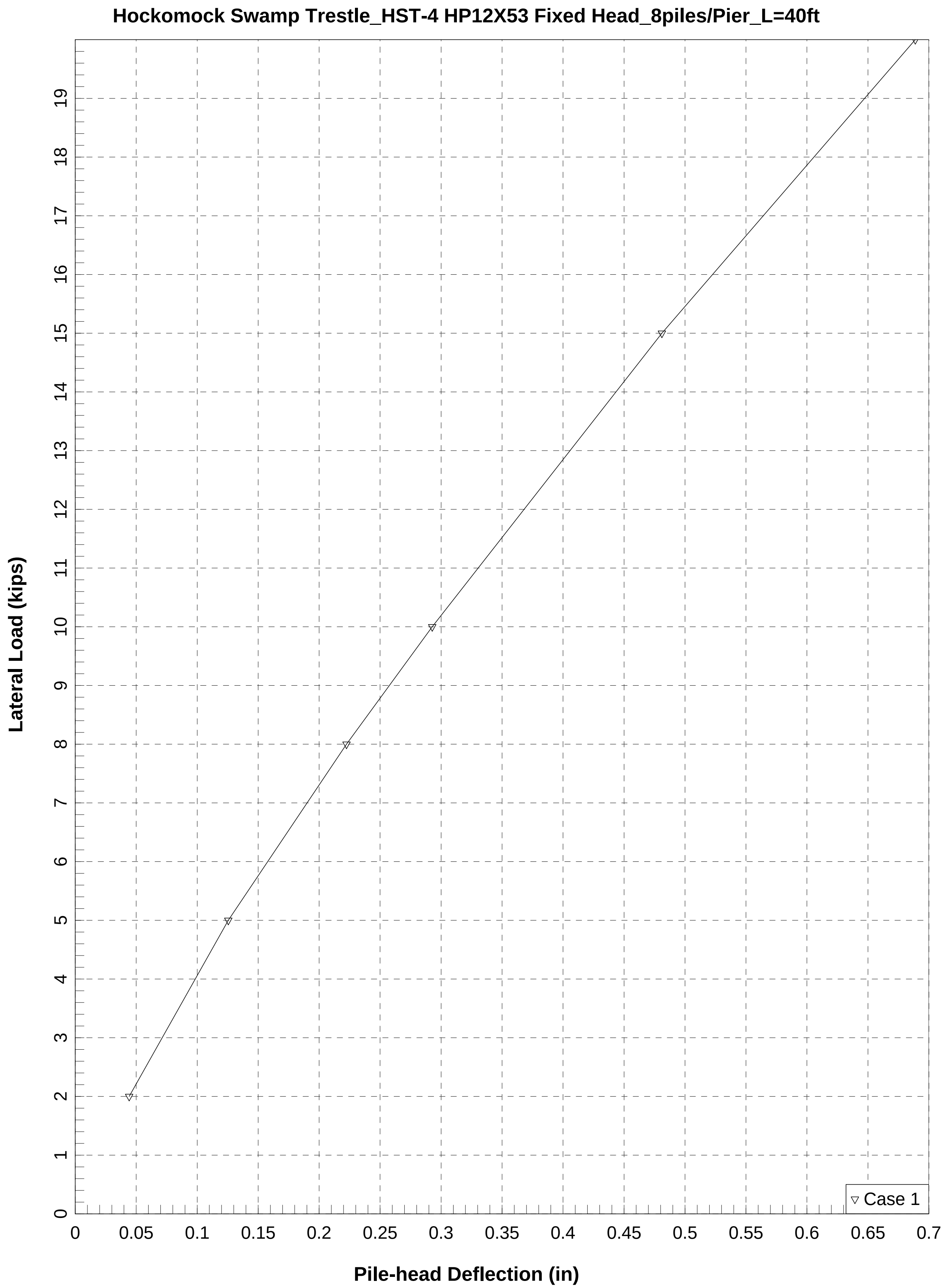




Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=40ft
Bending Moment (in-kips)
-900
-800
-700
-600
-500
-400
-300
-200
-100
0
100
200
300
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
12 k

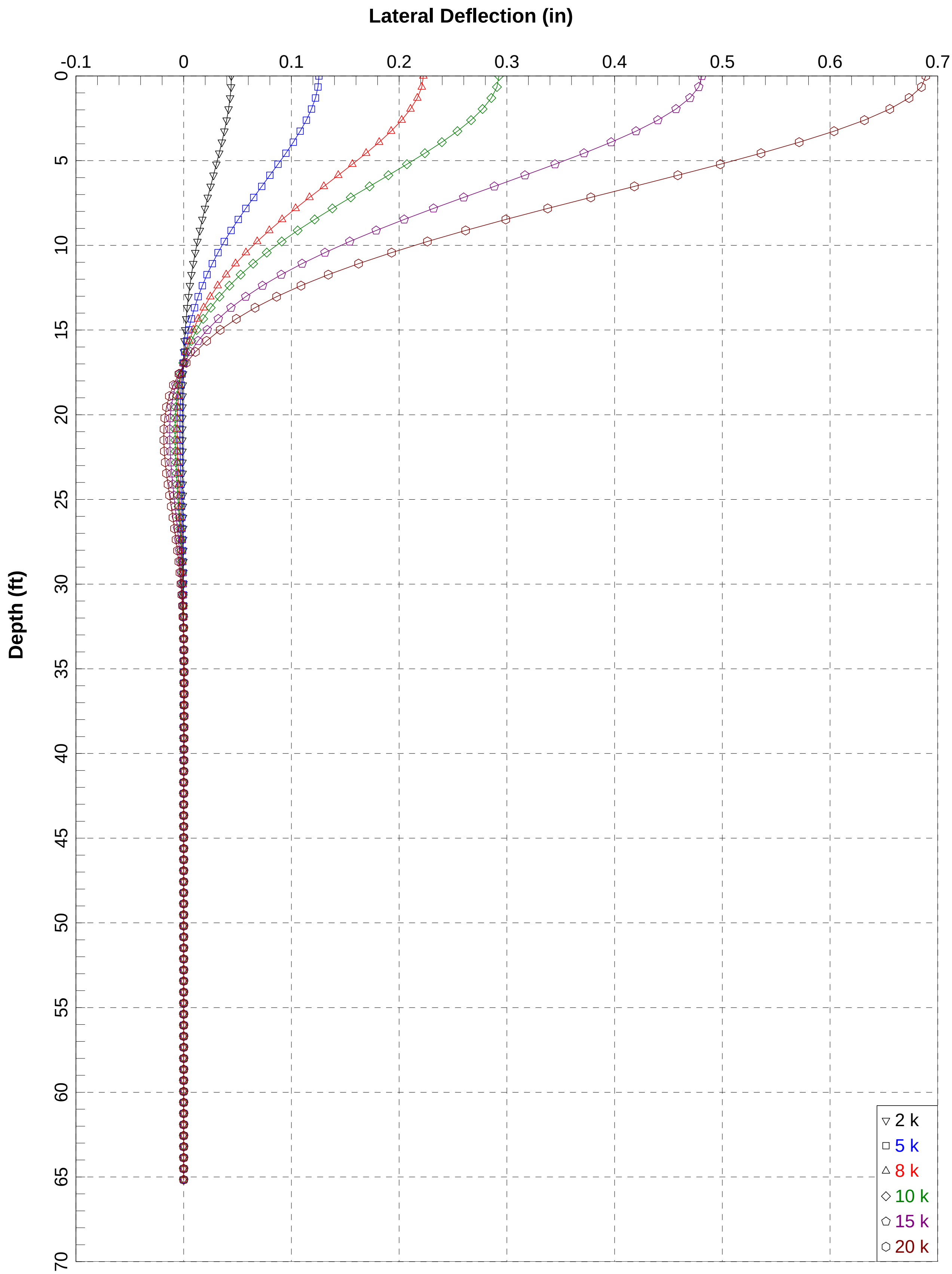


Hockomock Swamp Trestle_HST-4 HP10X42 Group III(b)_Fixed-Head_8 piles/pier_L=40ft
Shear Force (kips)
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
12 k

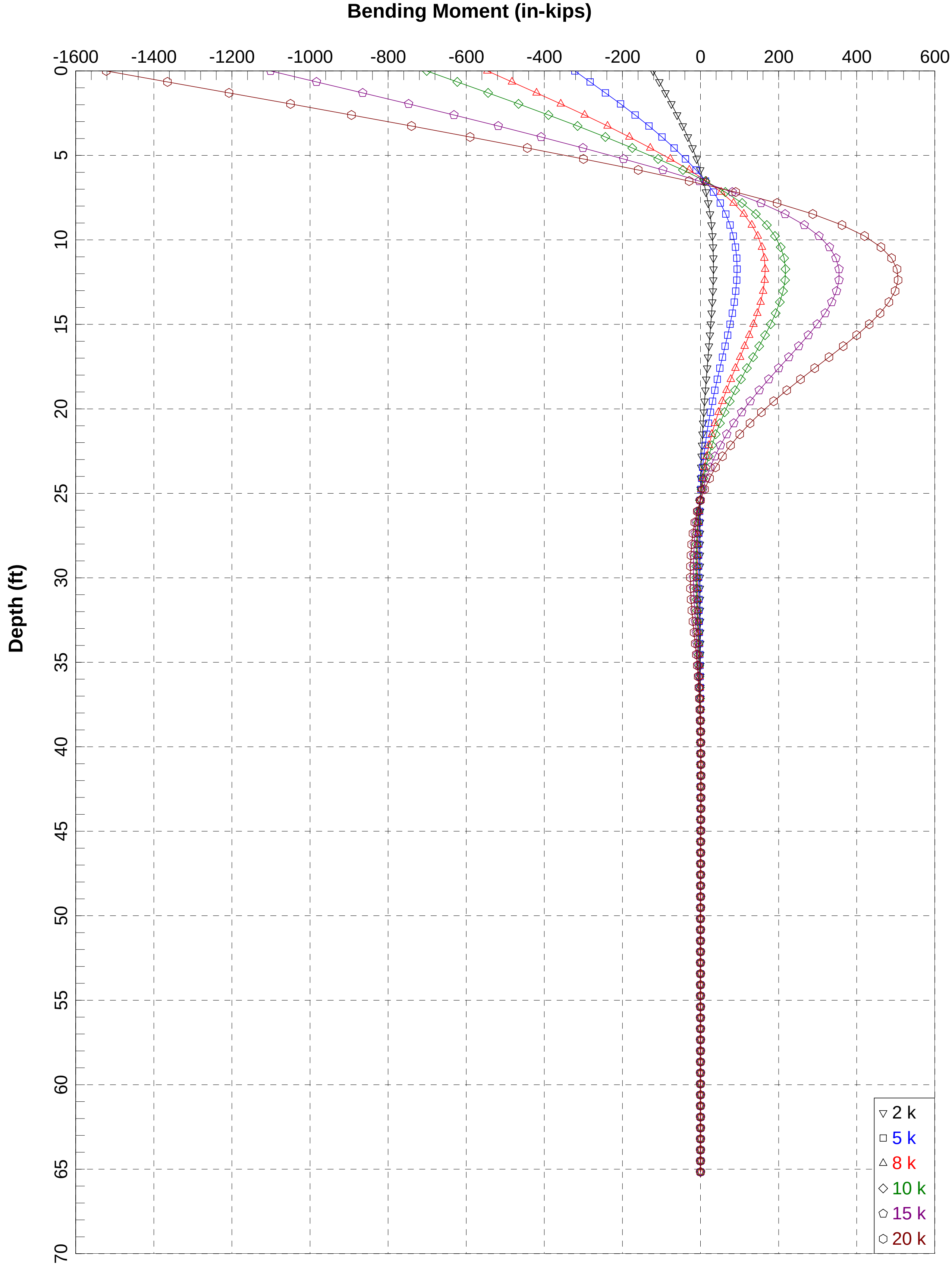


Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=40ft
Lateral Load (kips)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
Pile-head Deflection (in)
Case 1

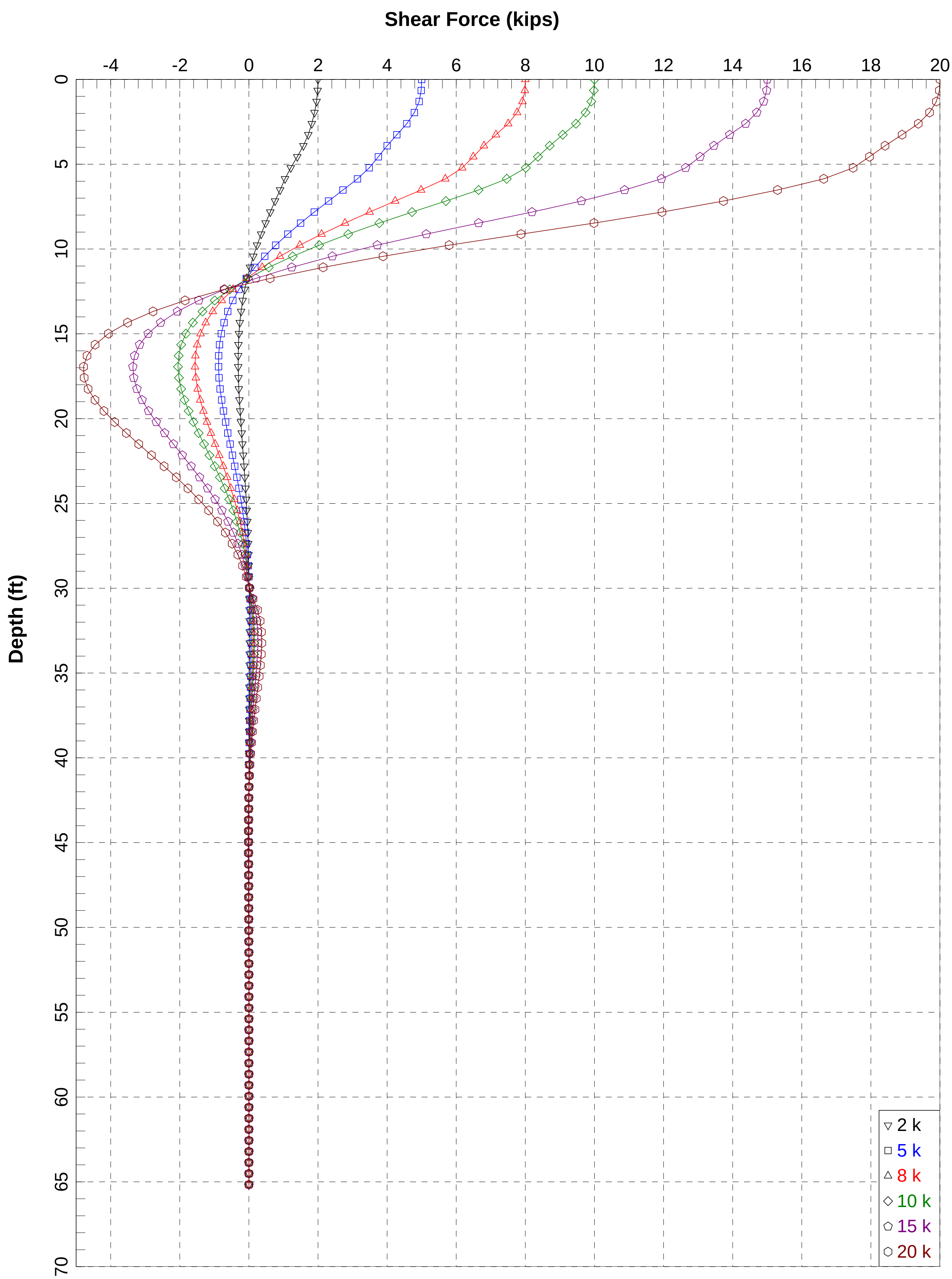
Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=40ft

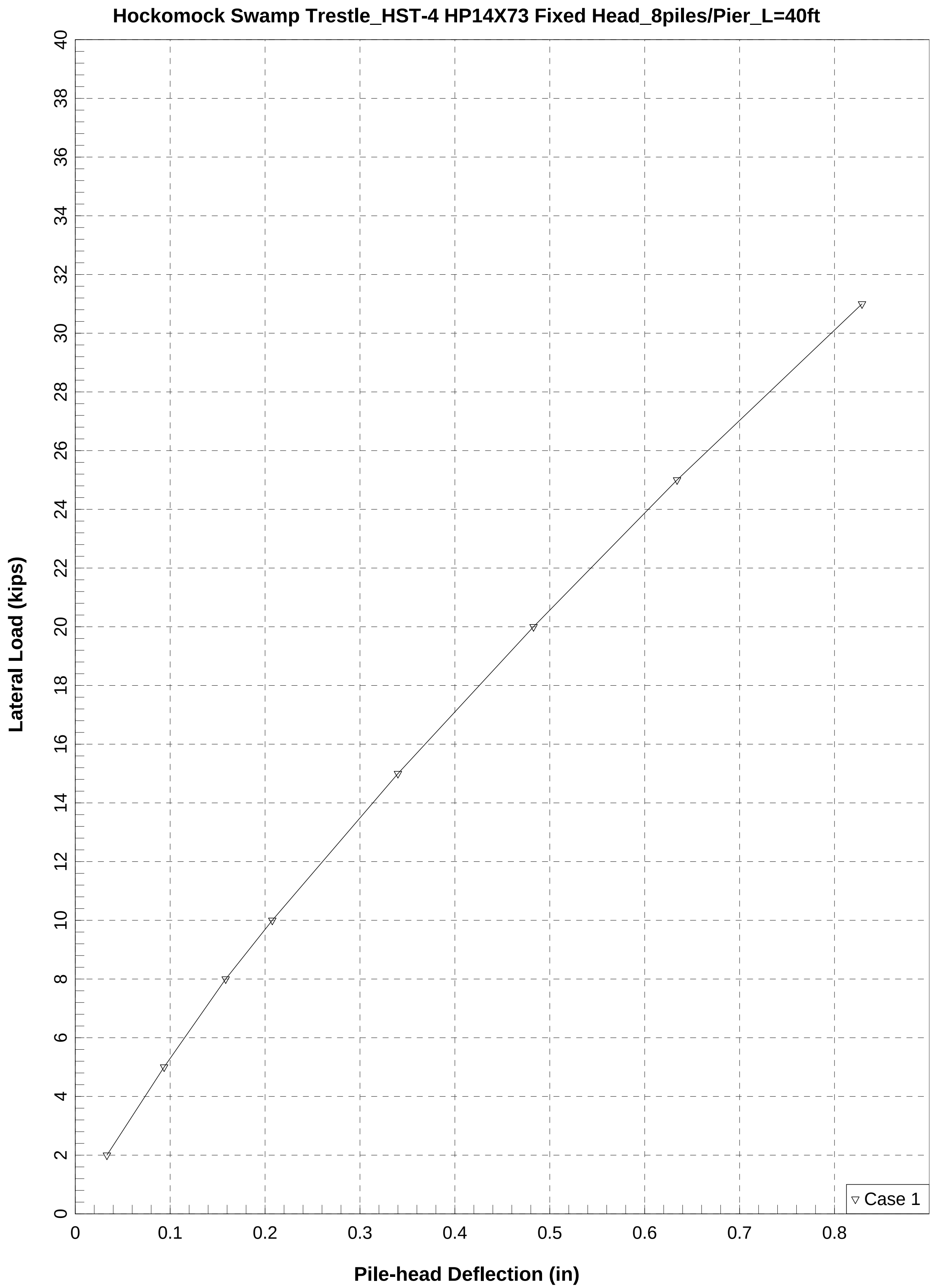


Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=40ft

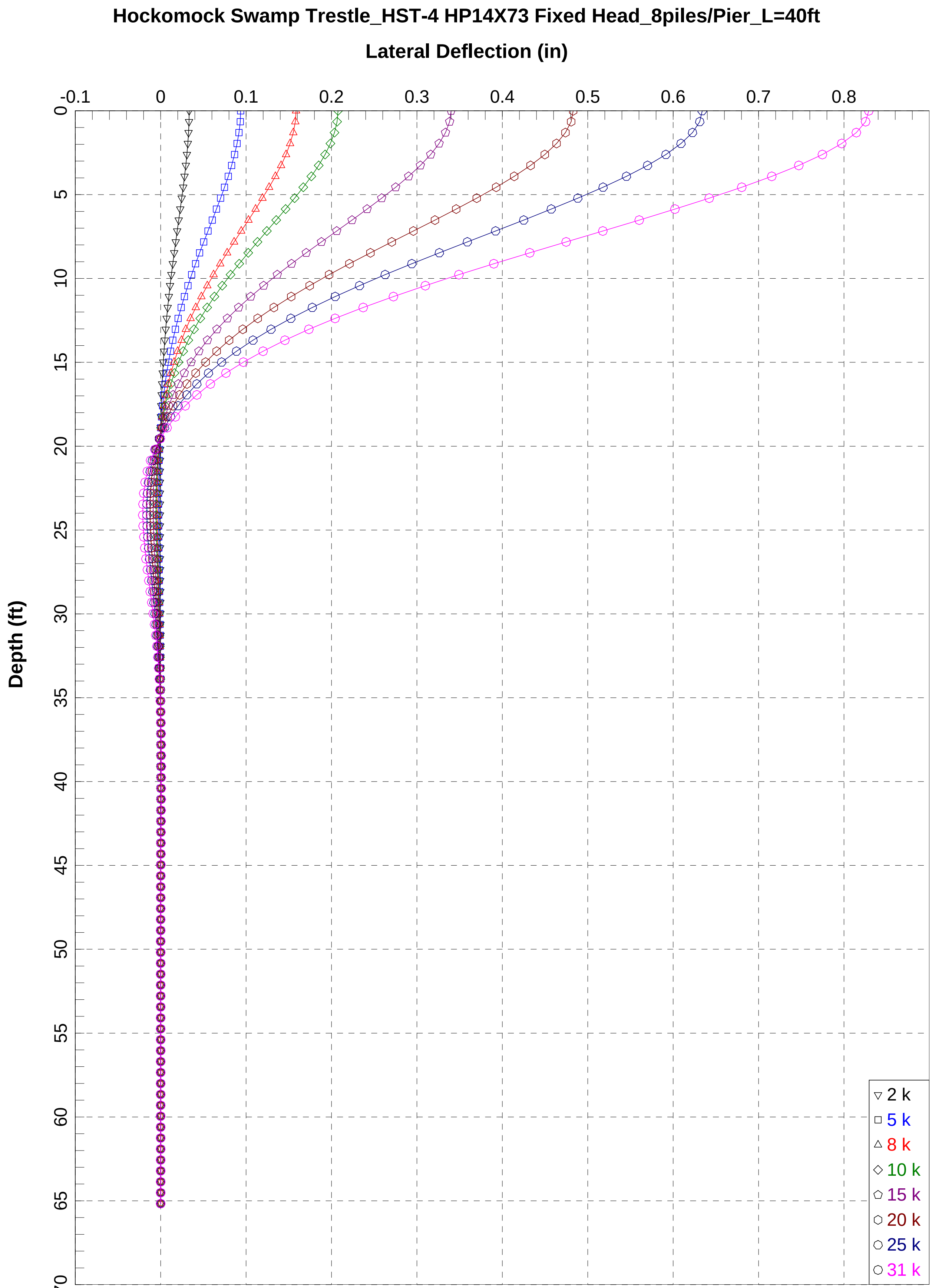


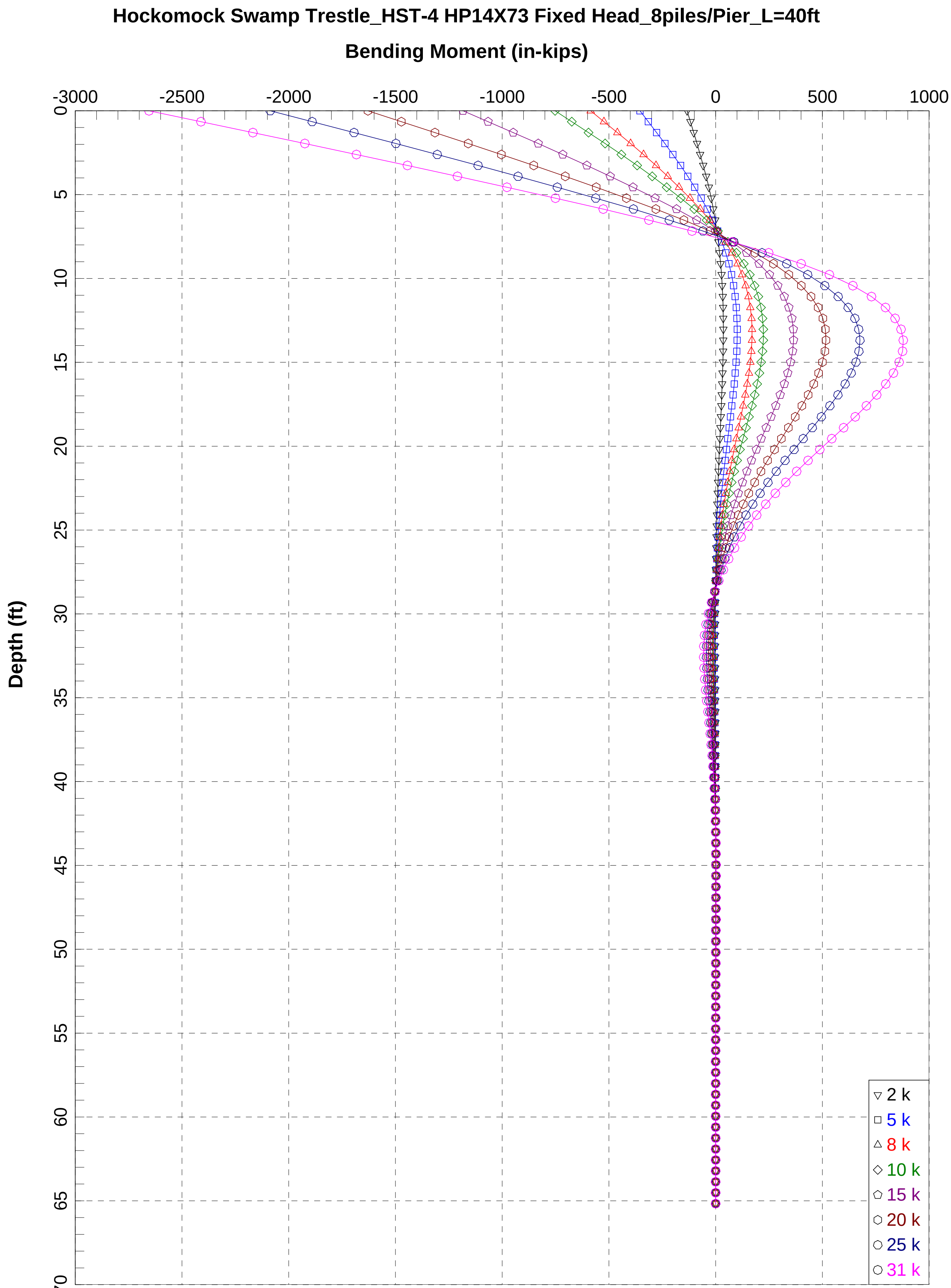
Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=40ft

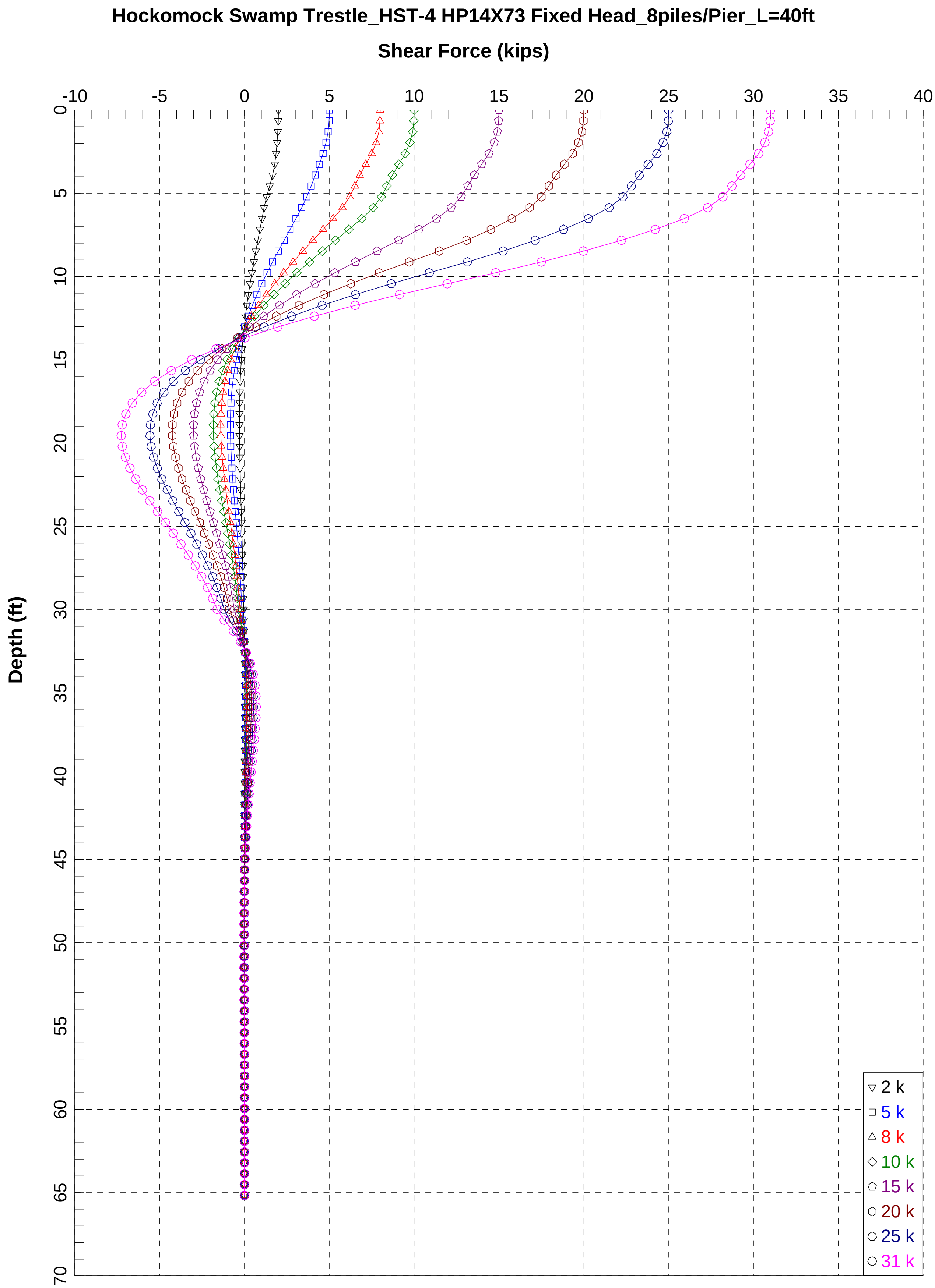


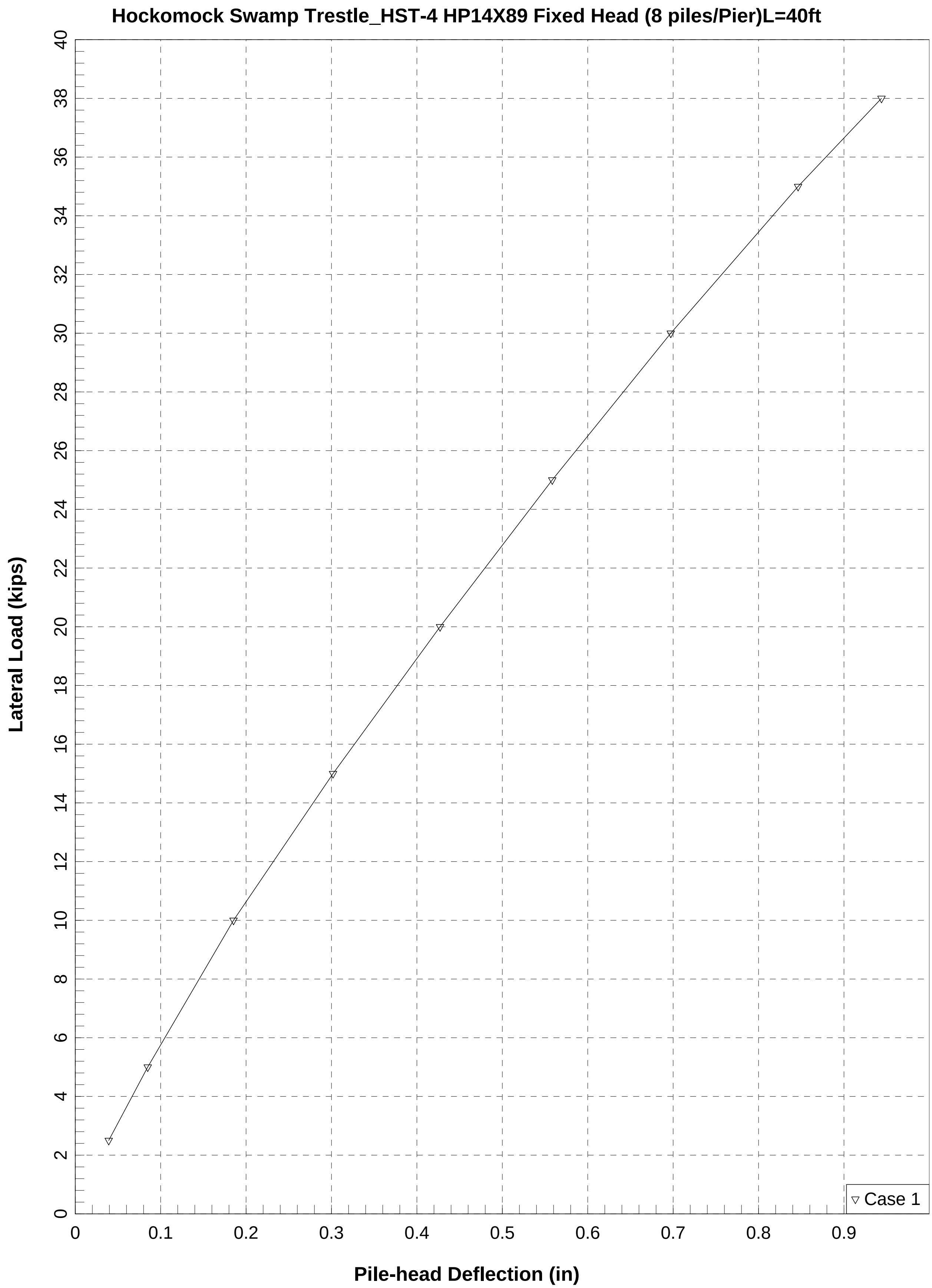


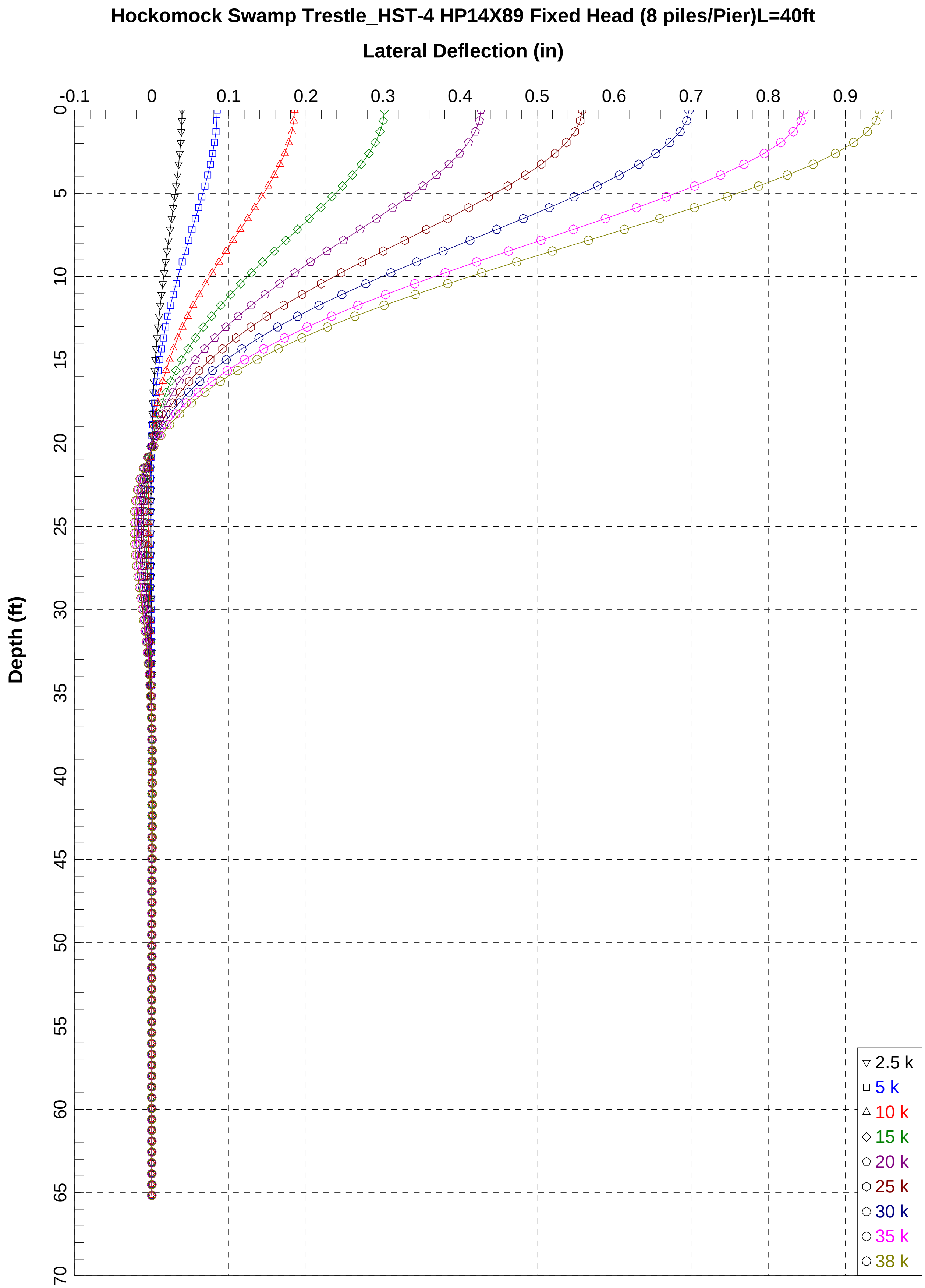
Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=40ft
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8


Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=40ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
31 k


Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=40ft
Bending Moment (in-kips)
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
31 k

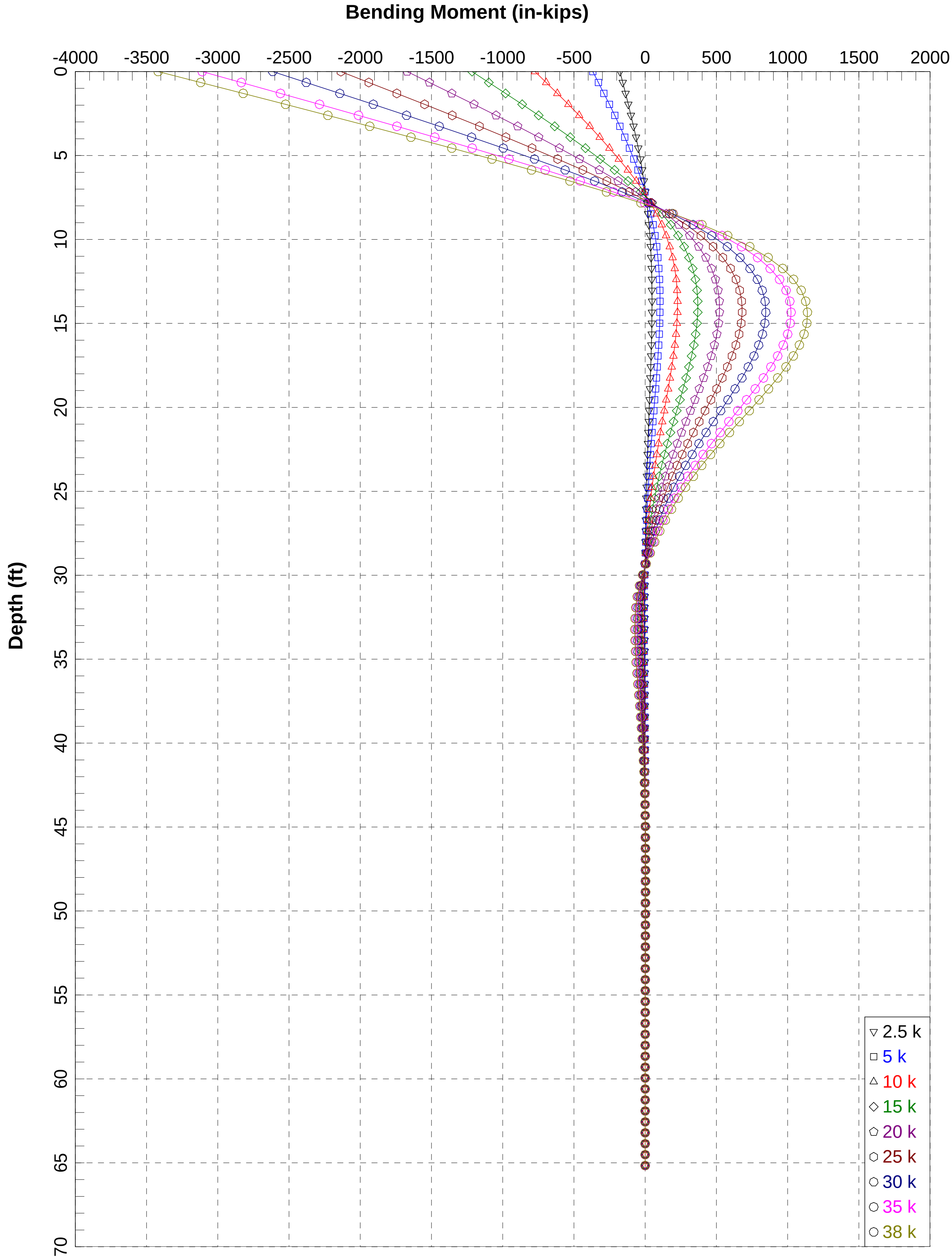

Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=40ft
Shear Force (kips)
-10
-5
0
5
10
15
20
25
30
35
40
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
31 k

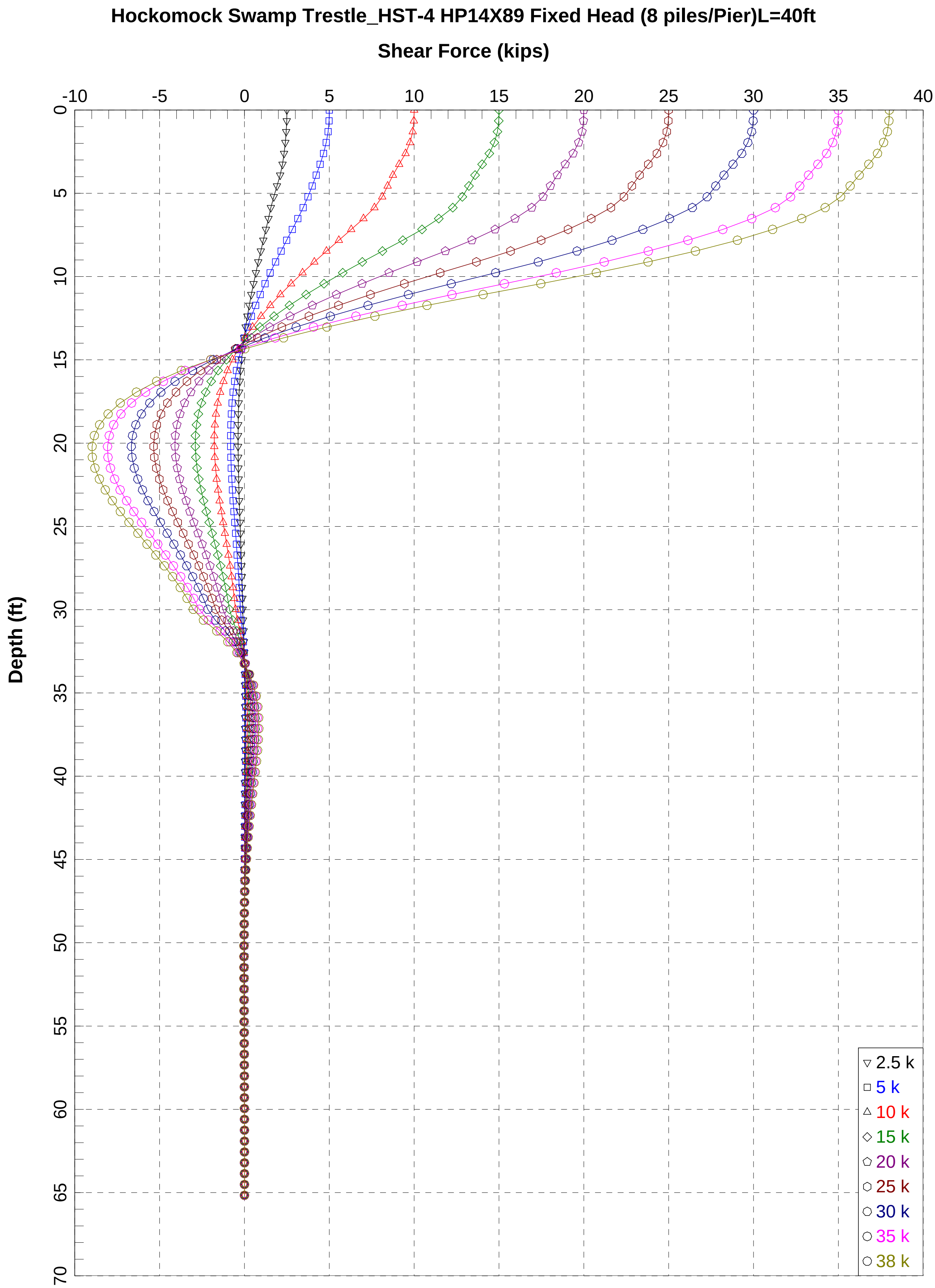

Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=40ft
Lateral Load (kips)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Pile-head Deflection (in)
Case 1



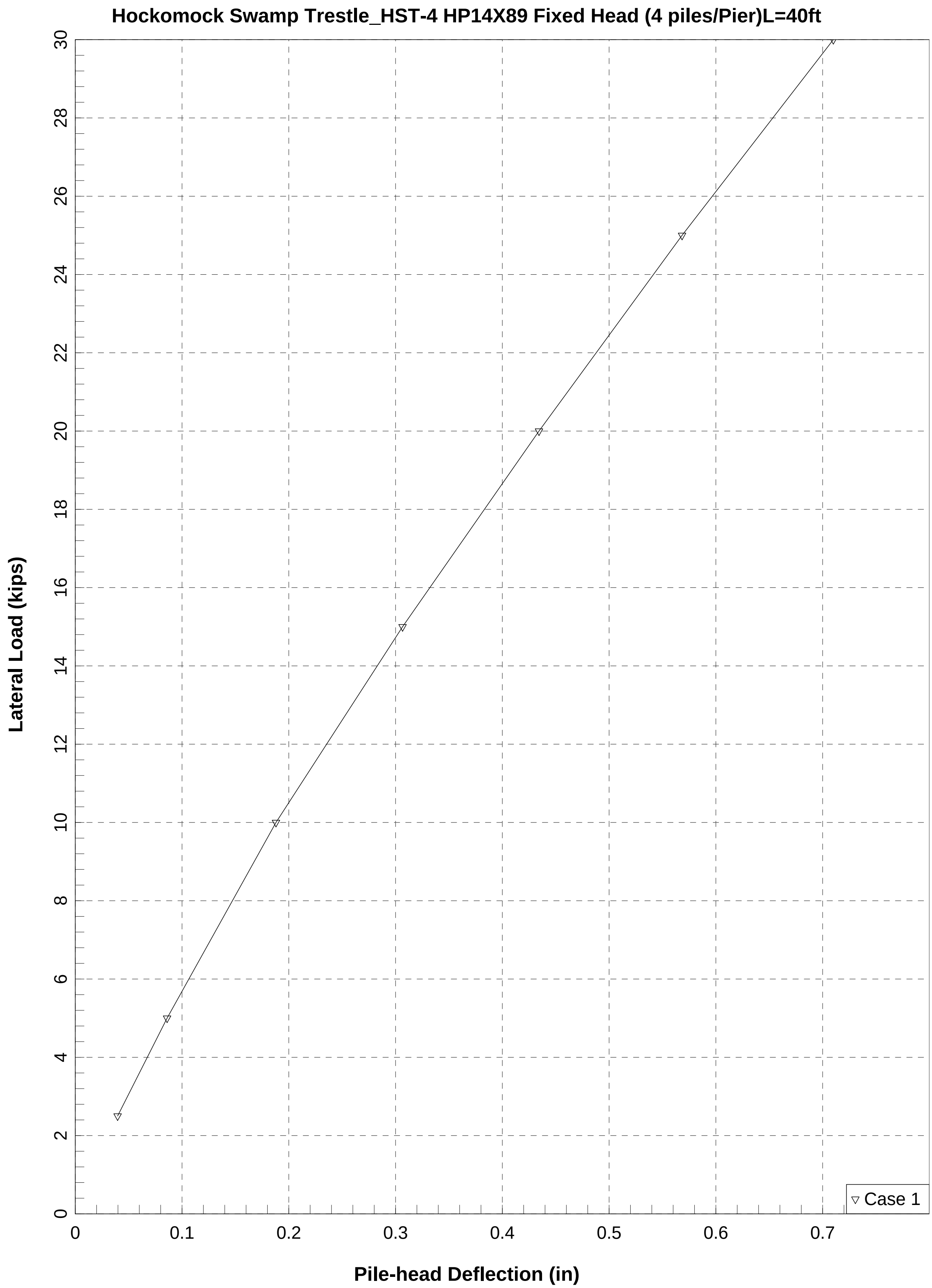
Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=40ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k
35 k
38 k

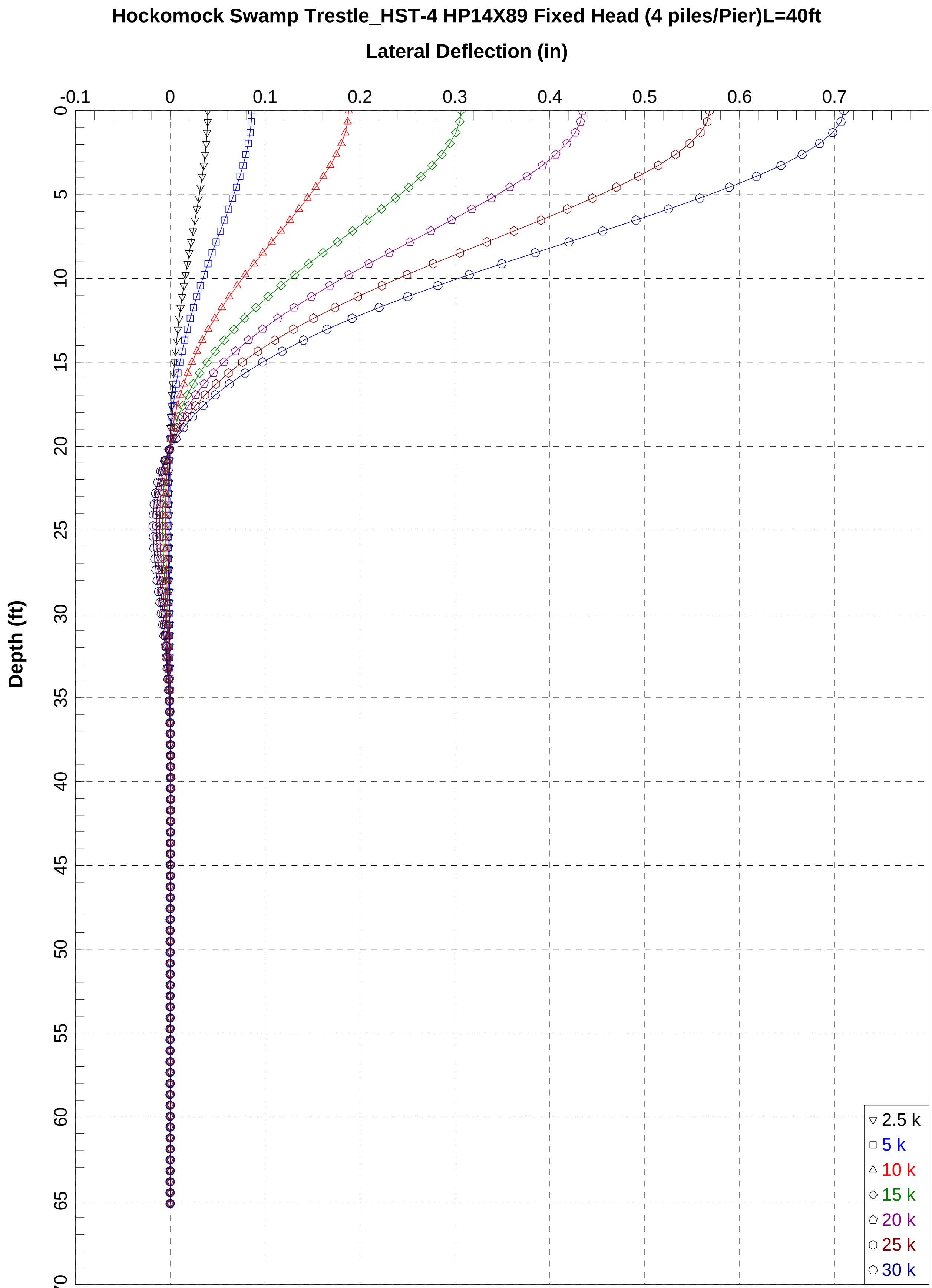
Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=40ft



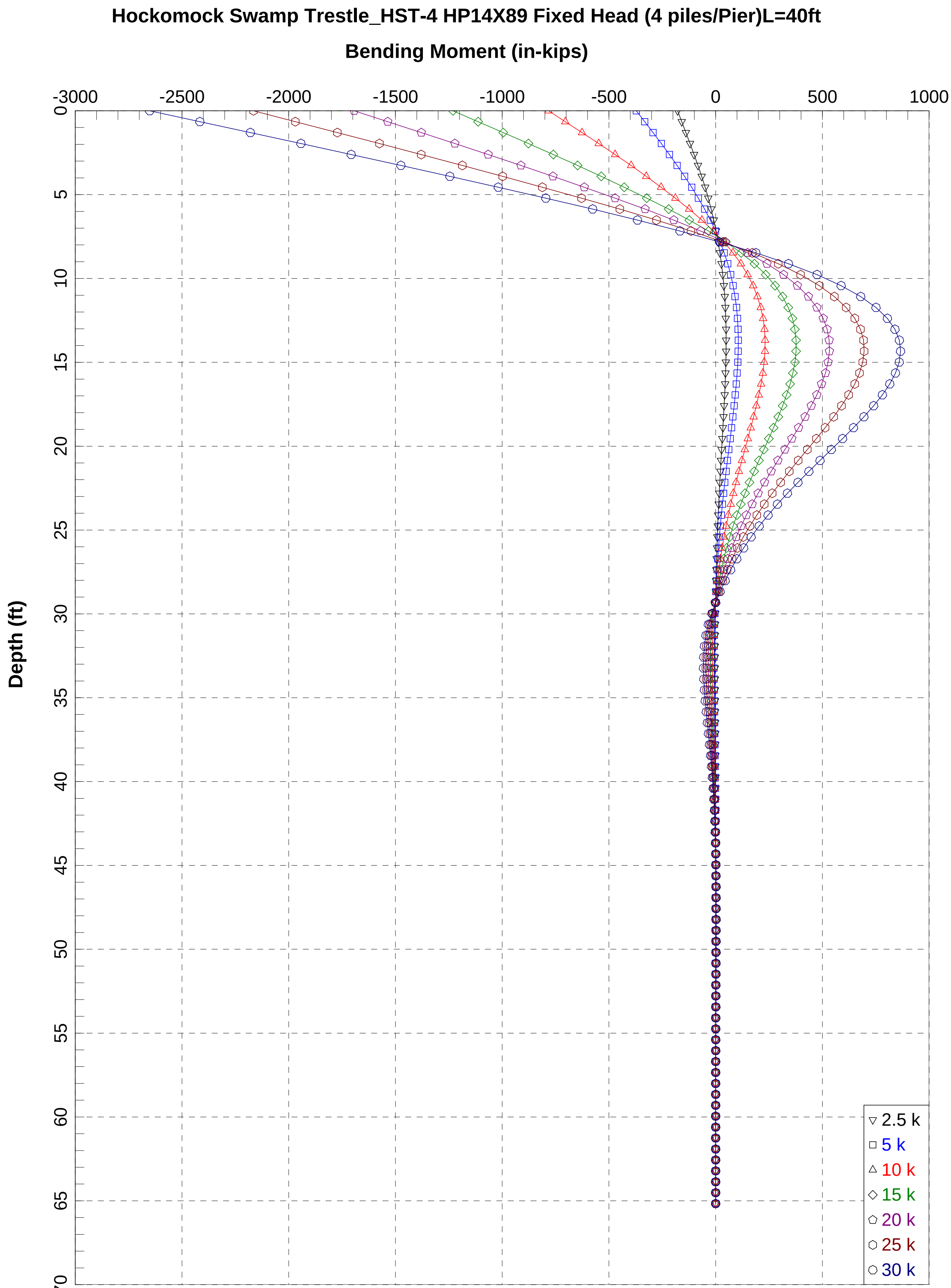


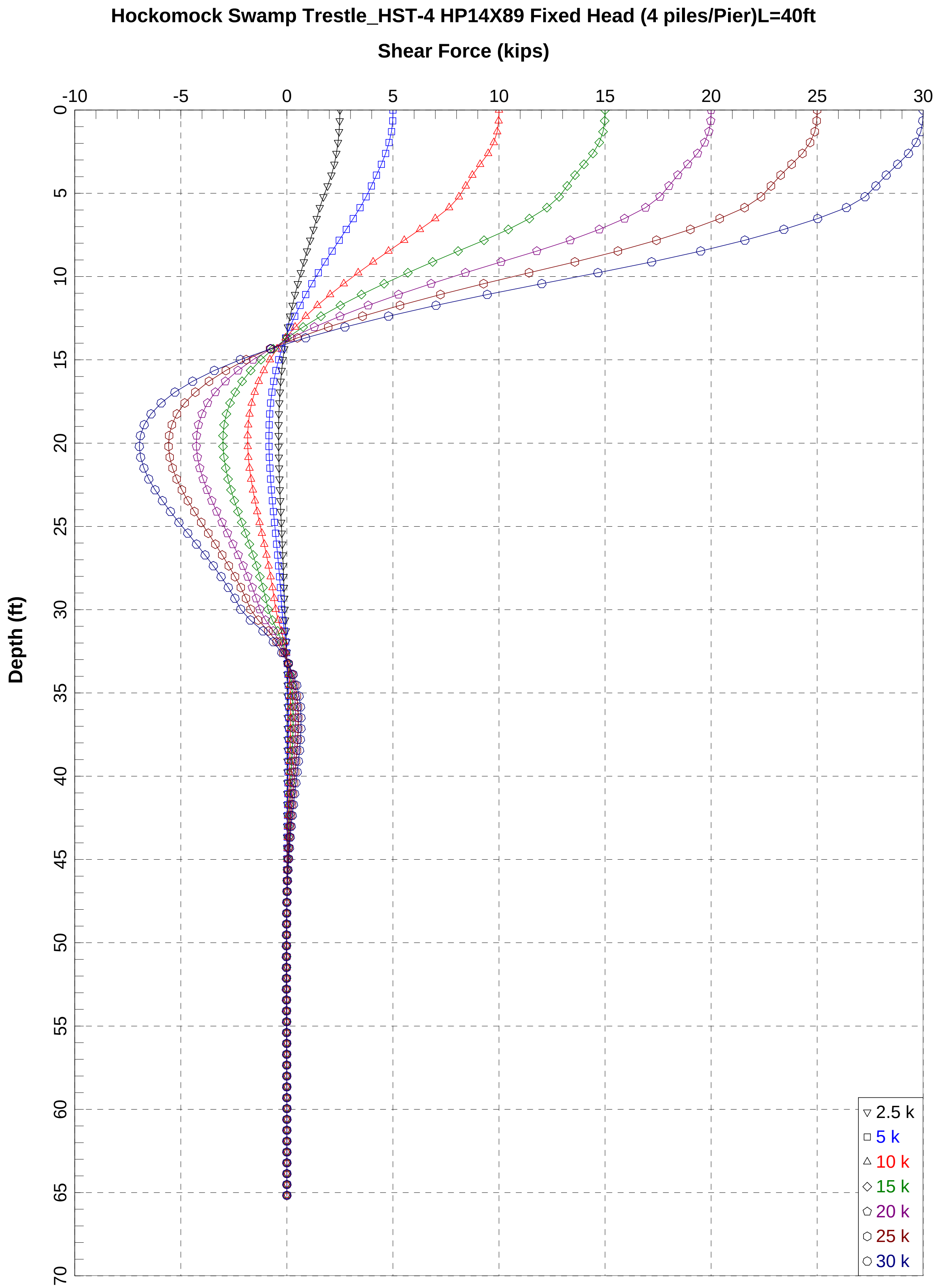
Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (8 piles/Pier)L=40ft
Shear Force (kips)
-10
-5
0
5
10
15
20
25
30
35
40
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k
35 k
38 k

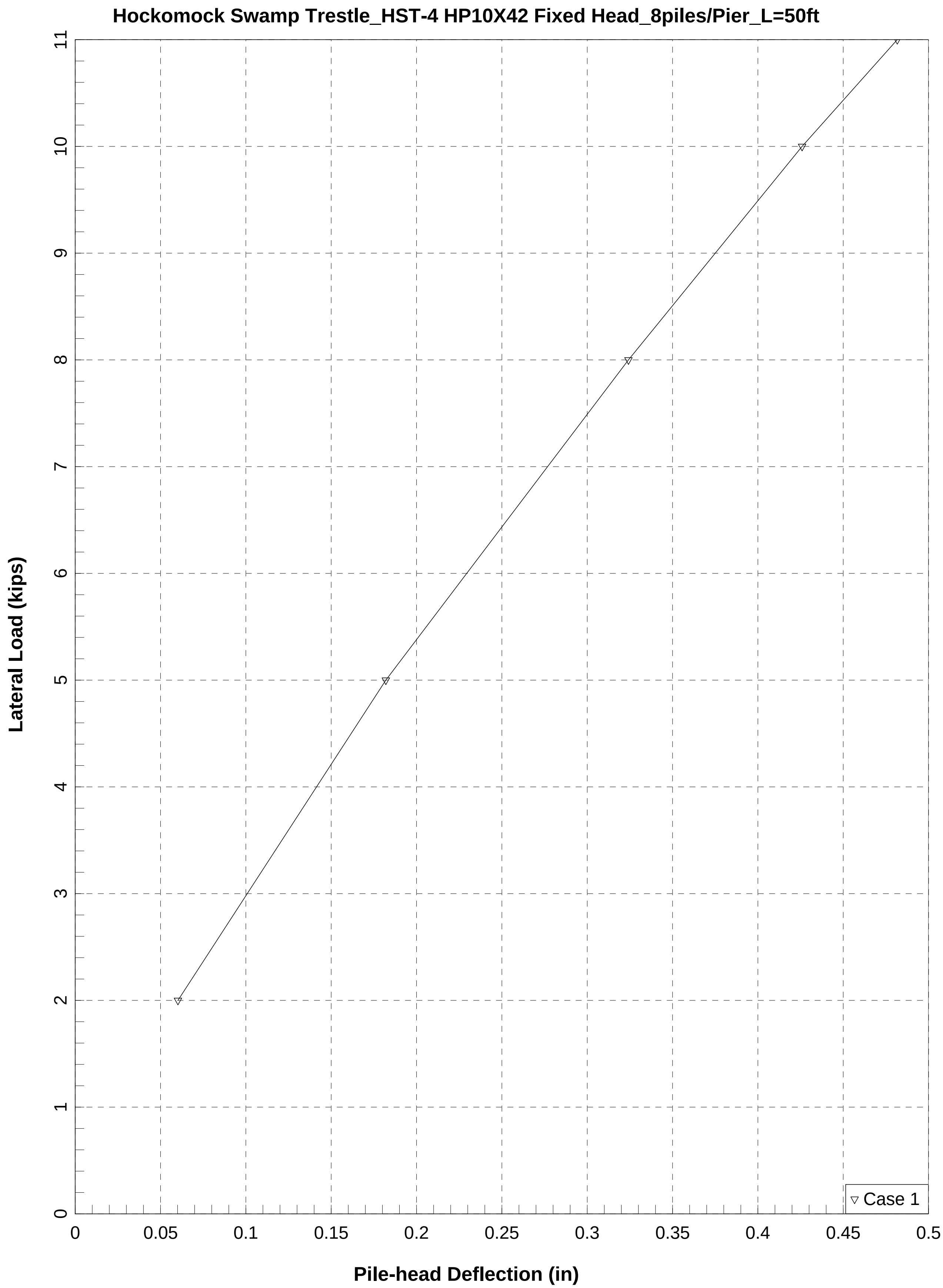

Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=40ft
Lateral Load (kips)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Pile-head Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Case 1

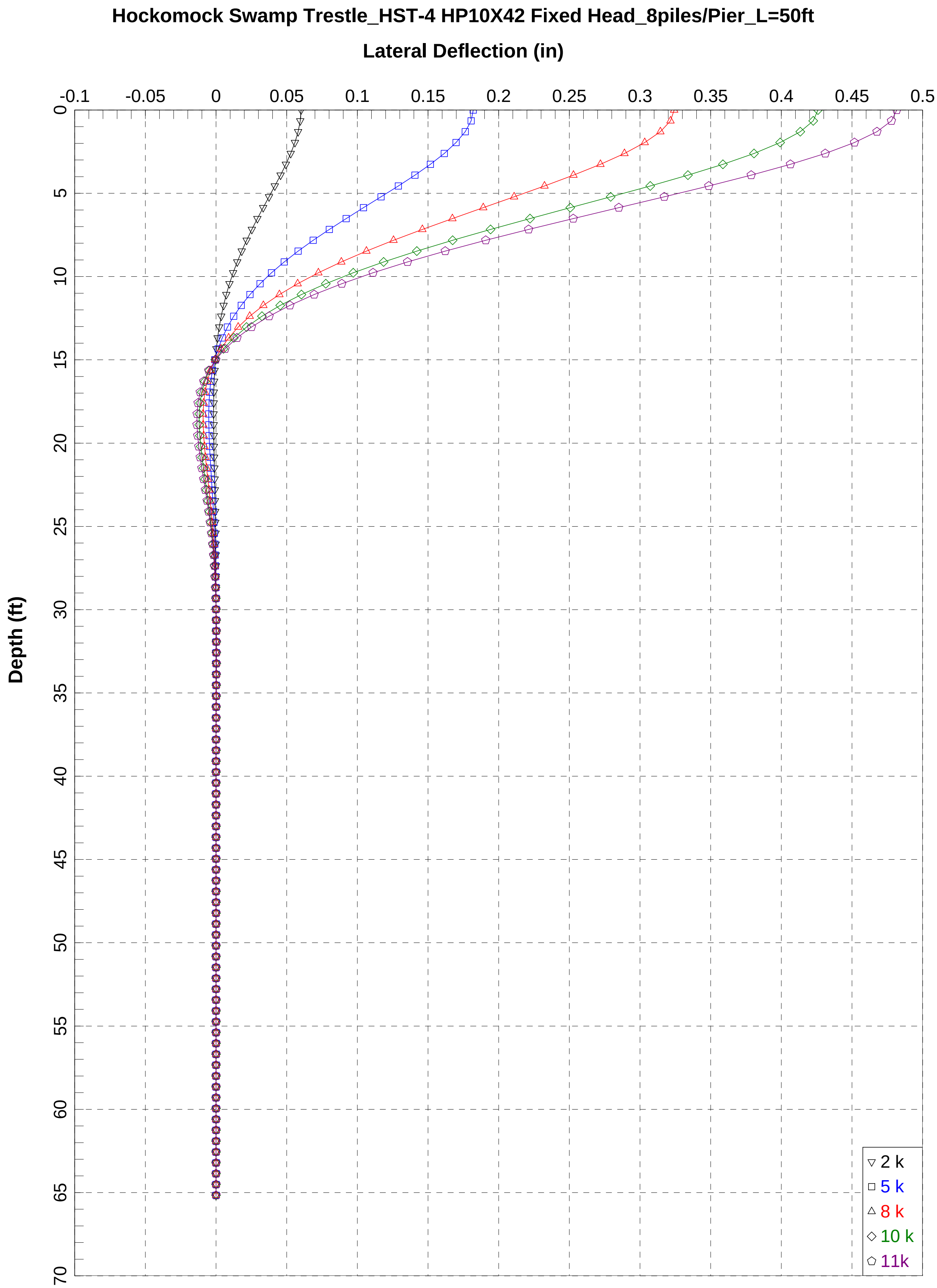


Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=40ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k

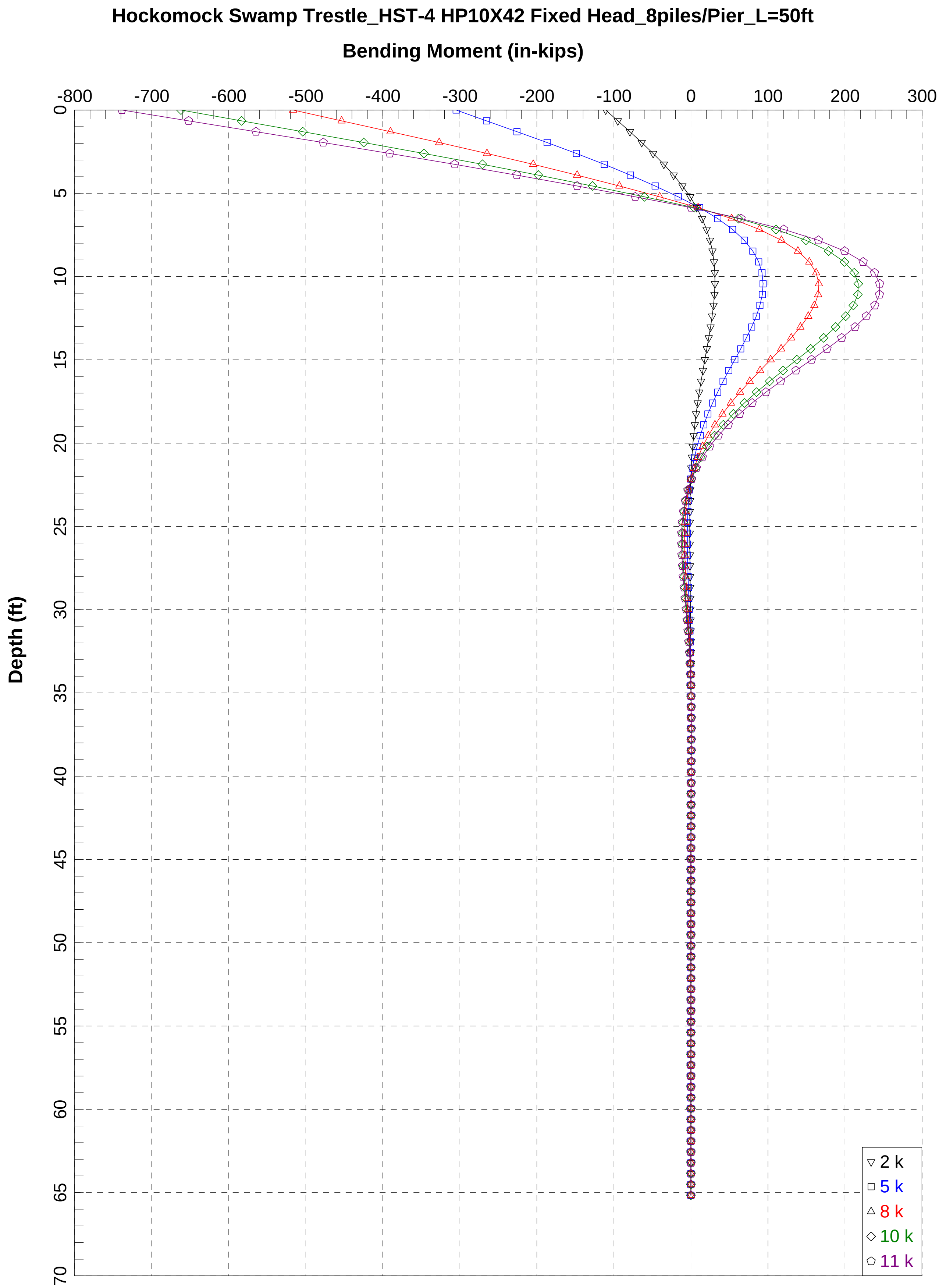

Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=40ft
Bending Moment (in-kips)
Depth (ft)
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k


Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=40ft
Shear Force (kips)
Depth (ft)
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k

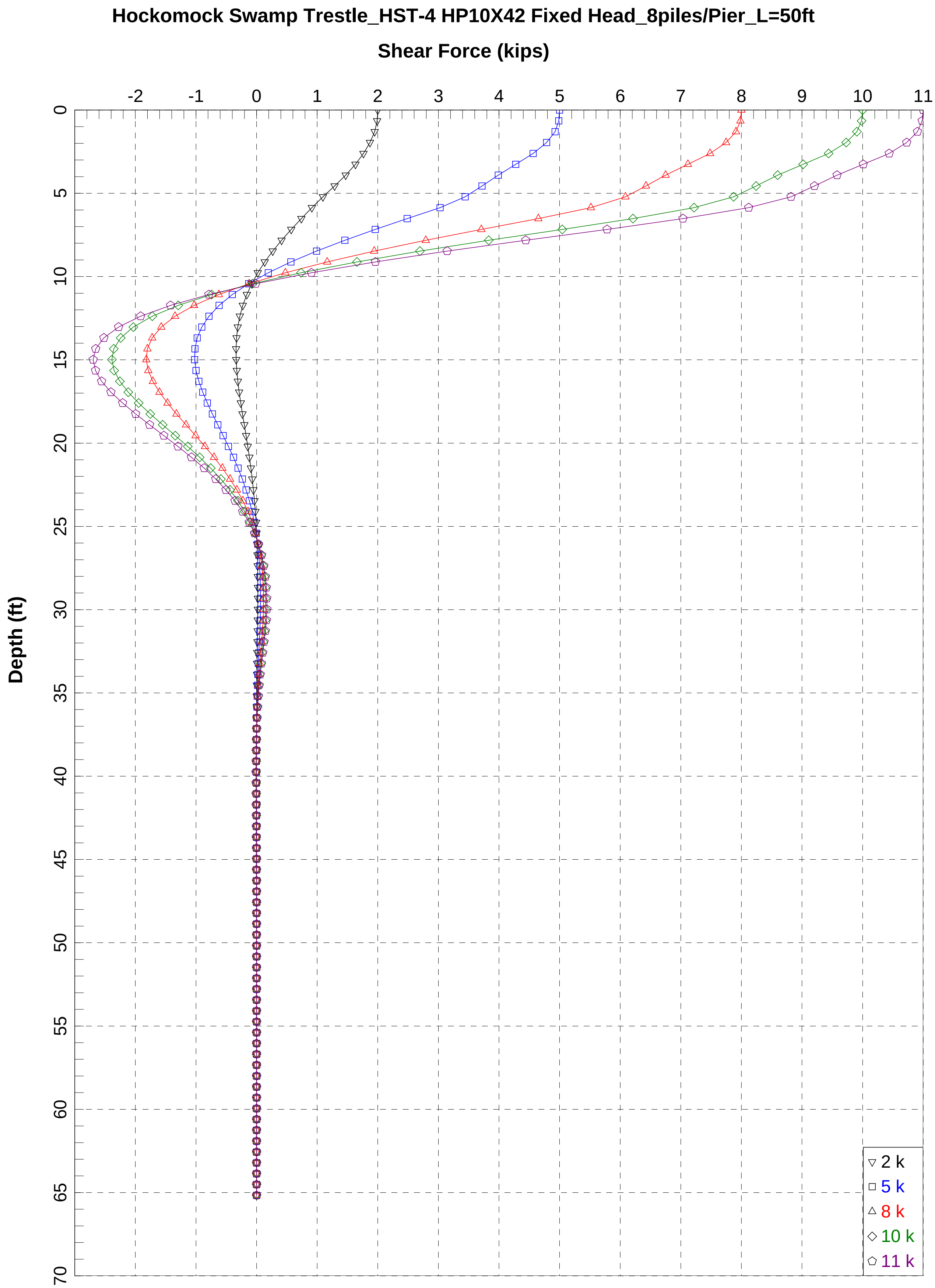

Hockomock Swamp Trestle_HST-4 HP10X42 Fixed Head_8piles/Pier_L=50ft
Lateral Load (kips)
0
1
2
3
4
5
6
7
8
9
10
11
Pile-head Deflection (in)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Case 1



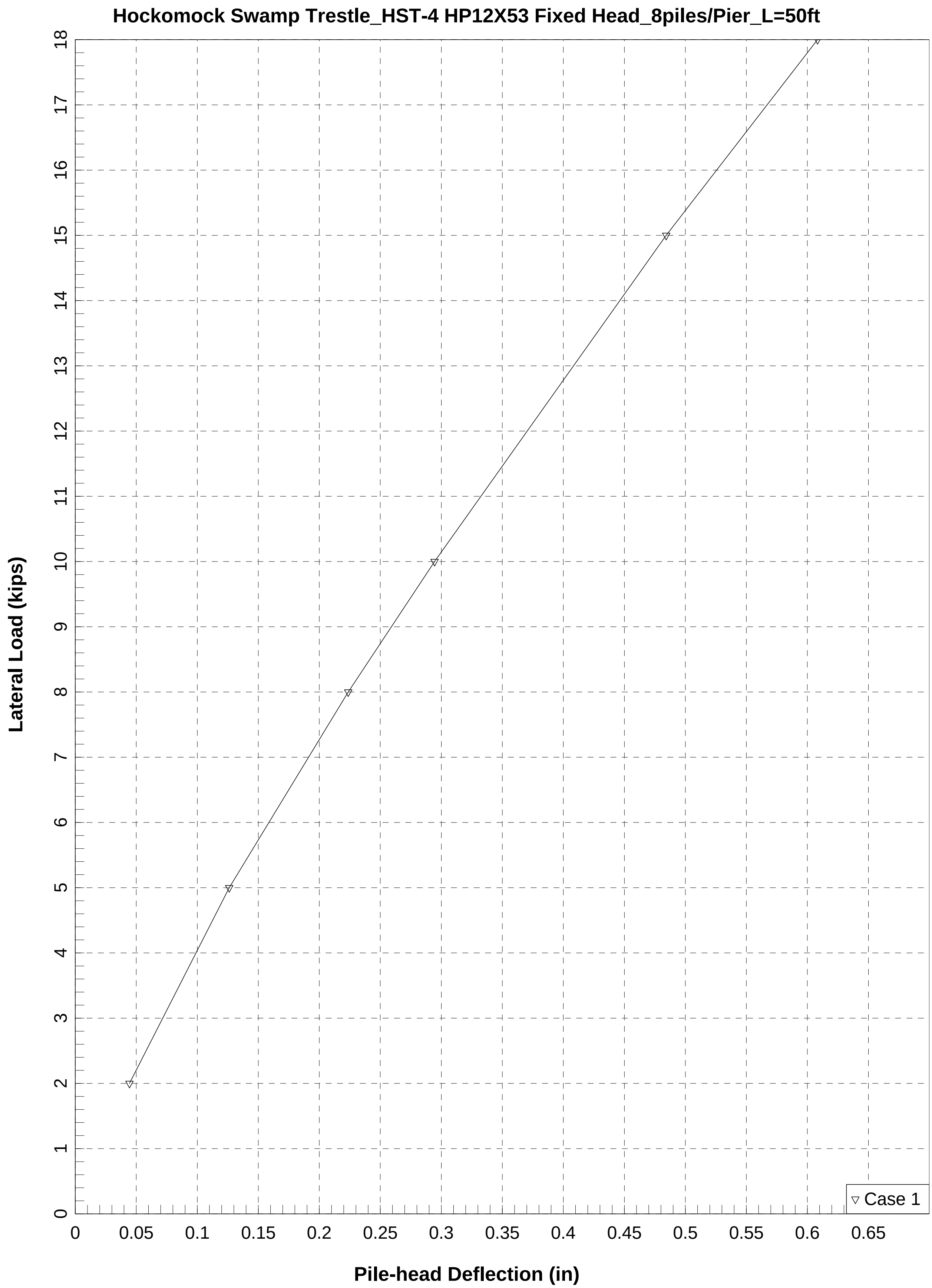
Hockomock Swamp Trestle_HST-4 HP10X42 Fixed Head_8piles/Pier_L=50ft
Lateral Deflection (in)
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
11k



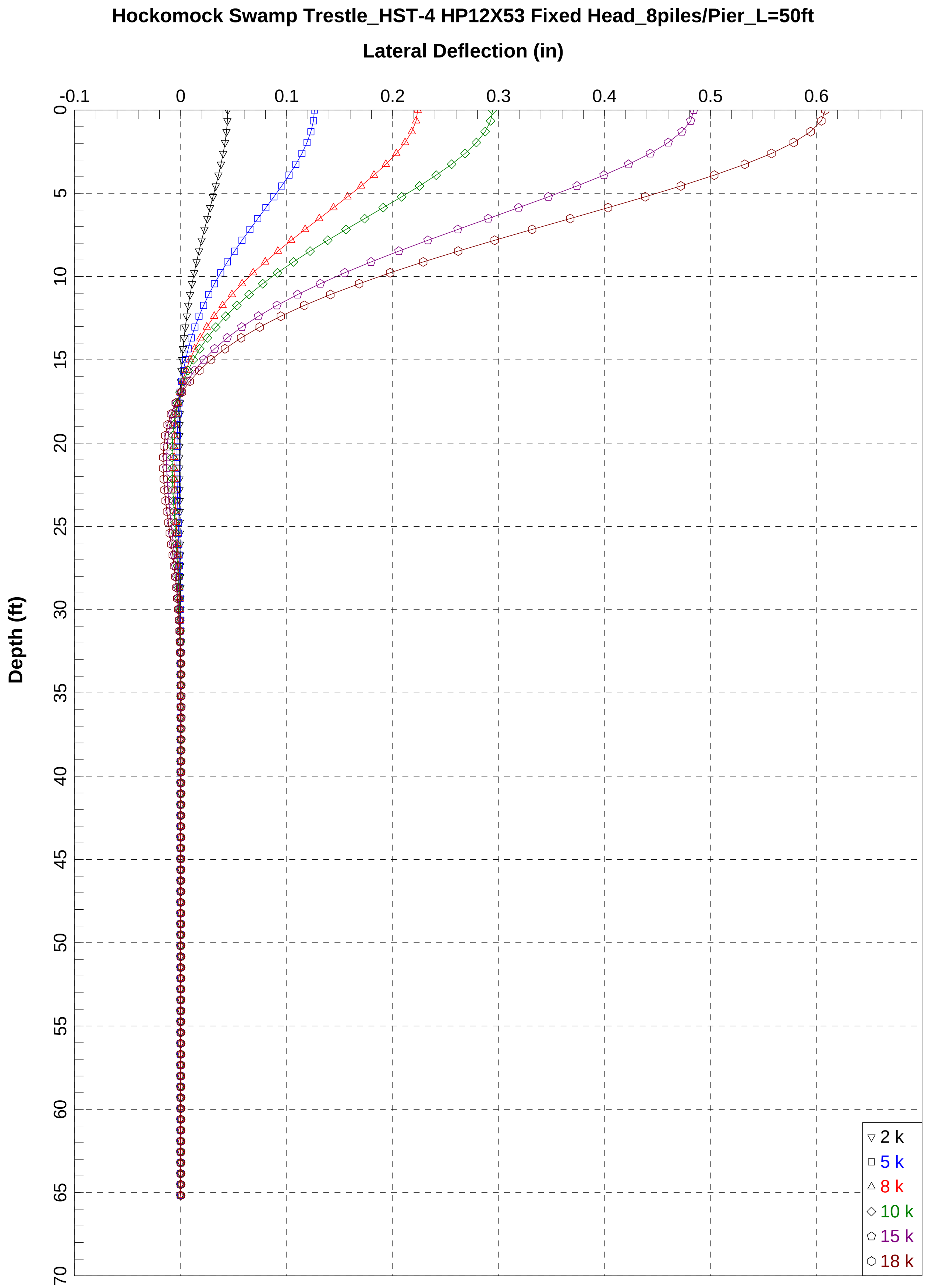
Hockomock Swamp Trestle_HST-4 HP10X42 Fixed Head_8piles/Pier_L=50ft
Bending Moment (in-kips)
-800
-700
-600
-500
-400
-300
-200
-100
0
100
200
300
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
11 k



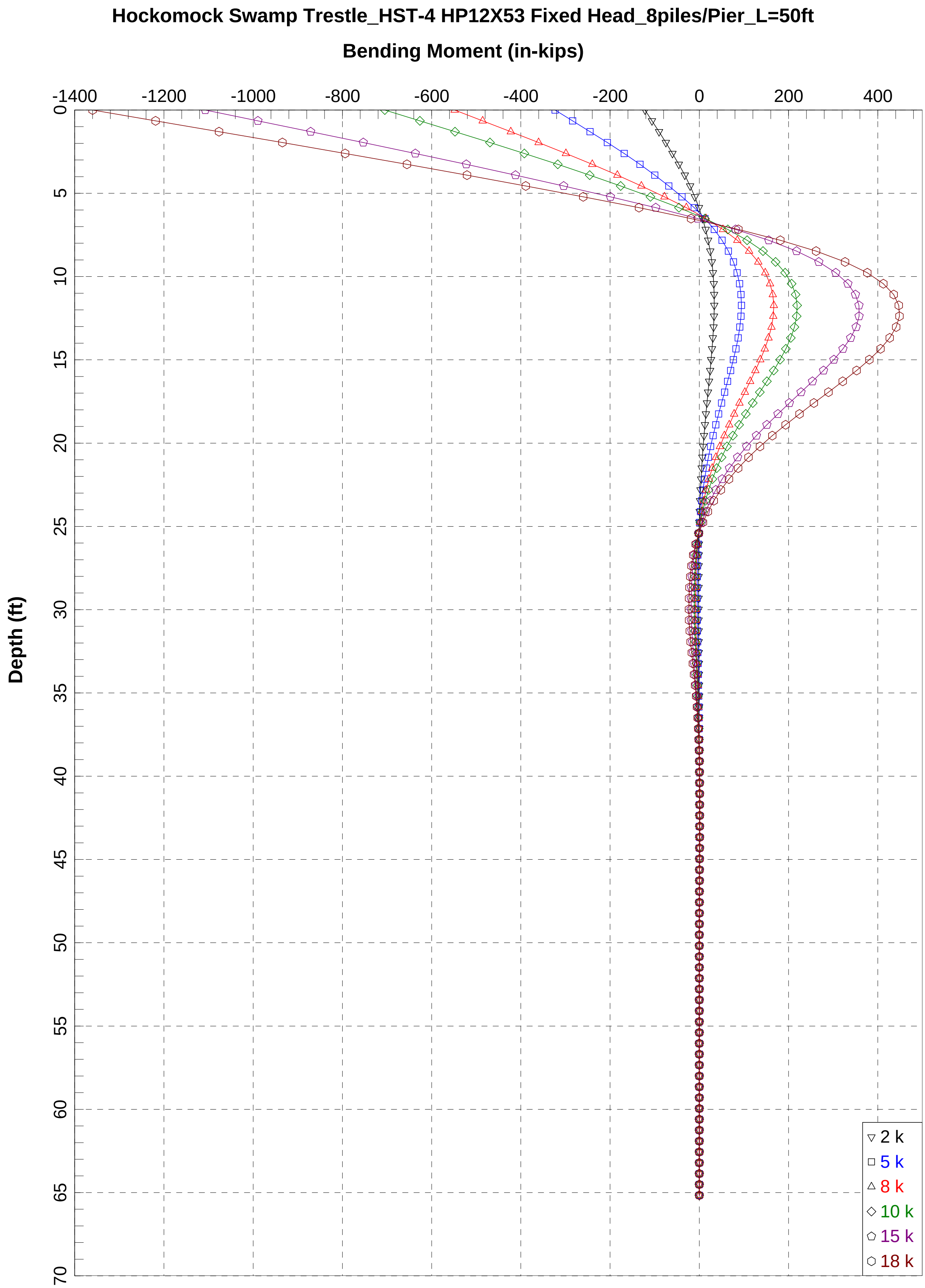
Hockomock Swamp Trestle_HST-4 HP10X42 Fixed Head_8piles/Pier_L=50ft
Shear Force (kips)
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
11 k

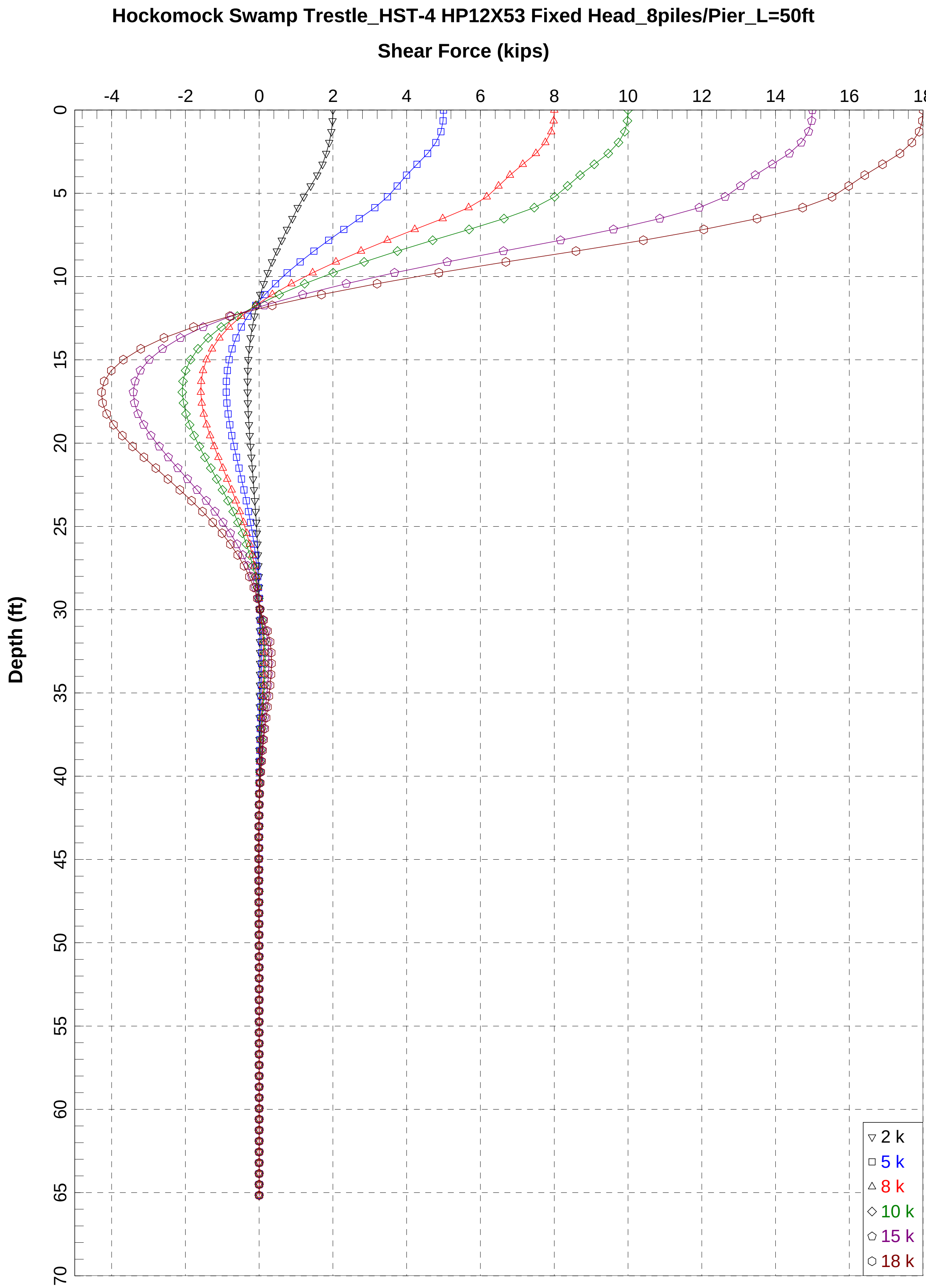


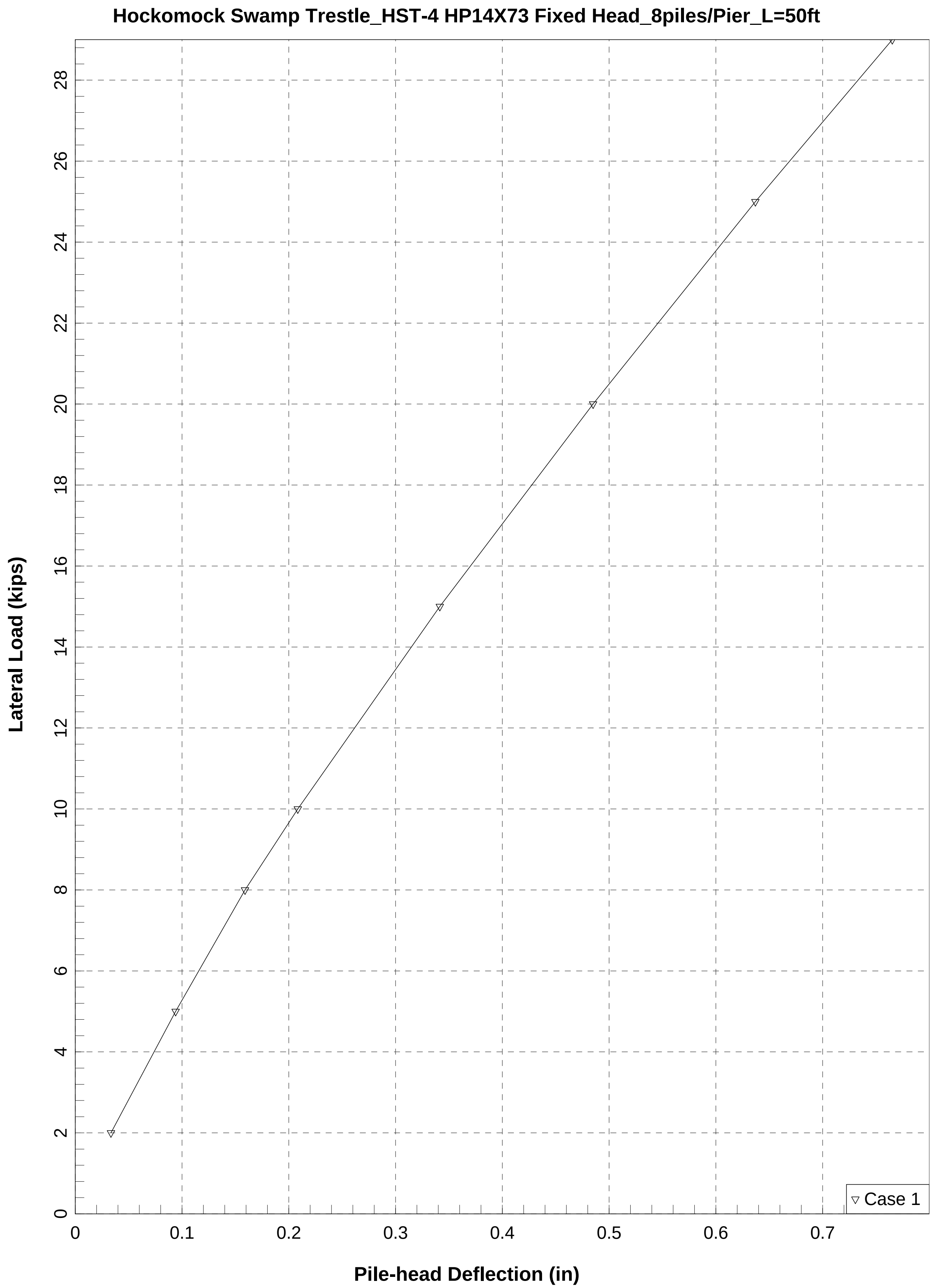
Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=50ft
Lateral Load (kips)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
Pile-head Deflection (in)
Case 1

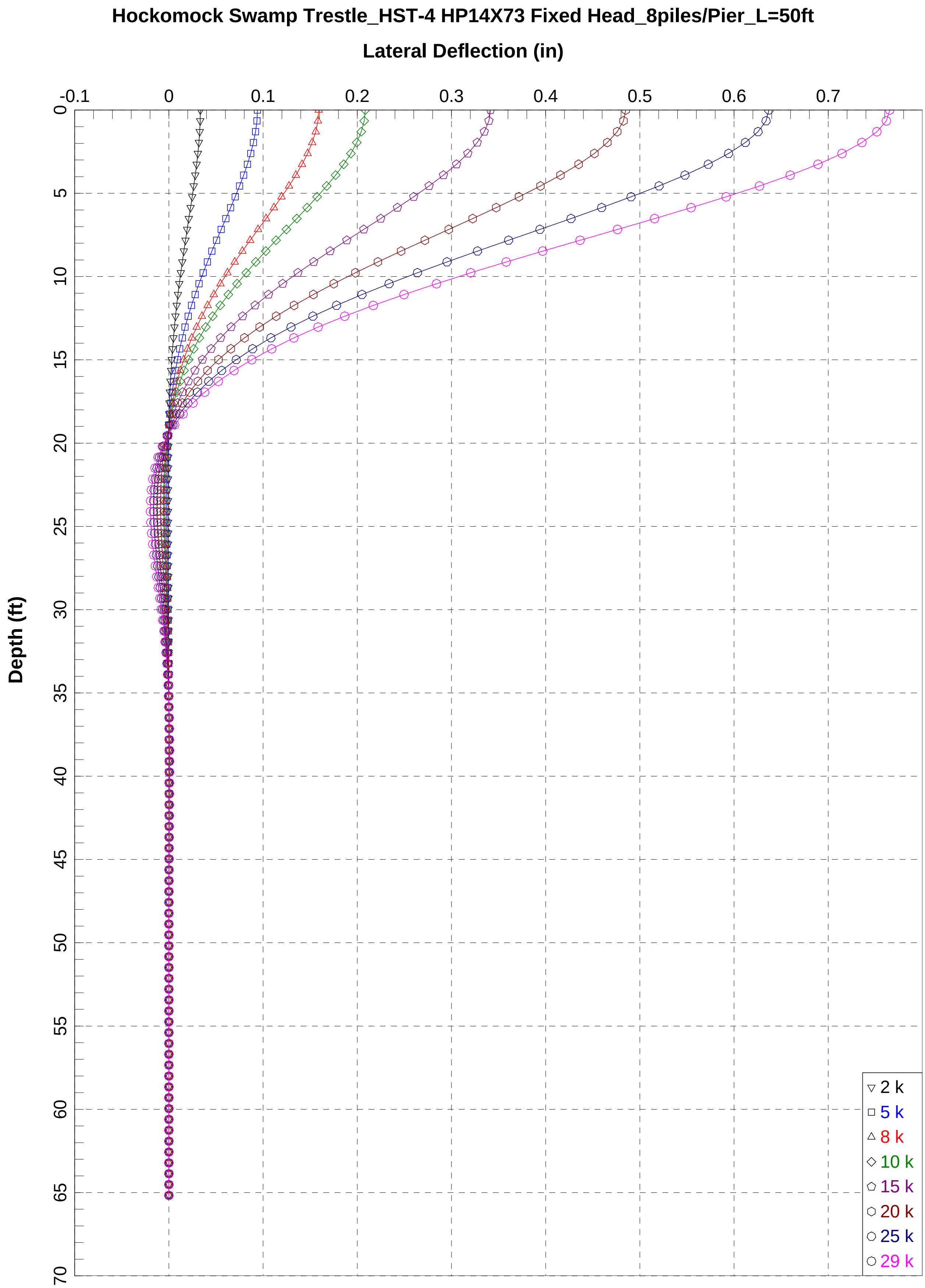


Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=50ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
18 k

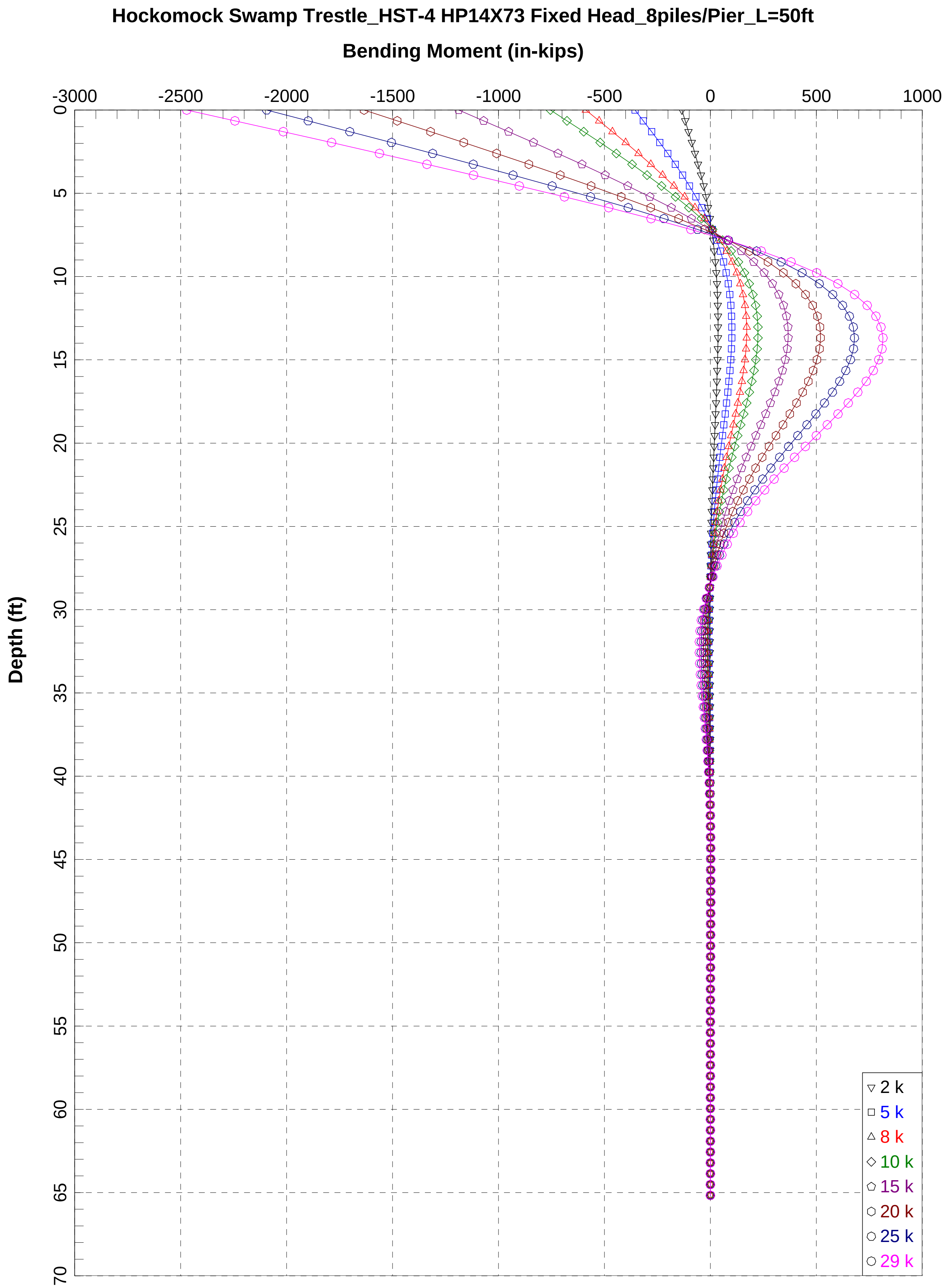

Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=50ft
Bending Moment (in-kips)
-1400
-1200
-1000
-800
-600
-400
-200
0
200
400
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
18 k


Hockomock Swamp Trestle_HST-4 HP12X53 Fixed Head_8piles/Pier_L=50ft
Shear Force (kips)
-4
-2
0
2
4
6
8
10
12
14
16
18
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
18 k

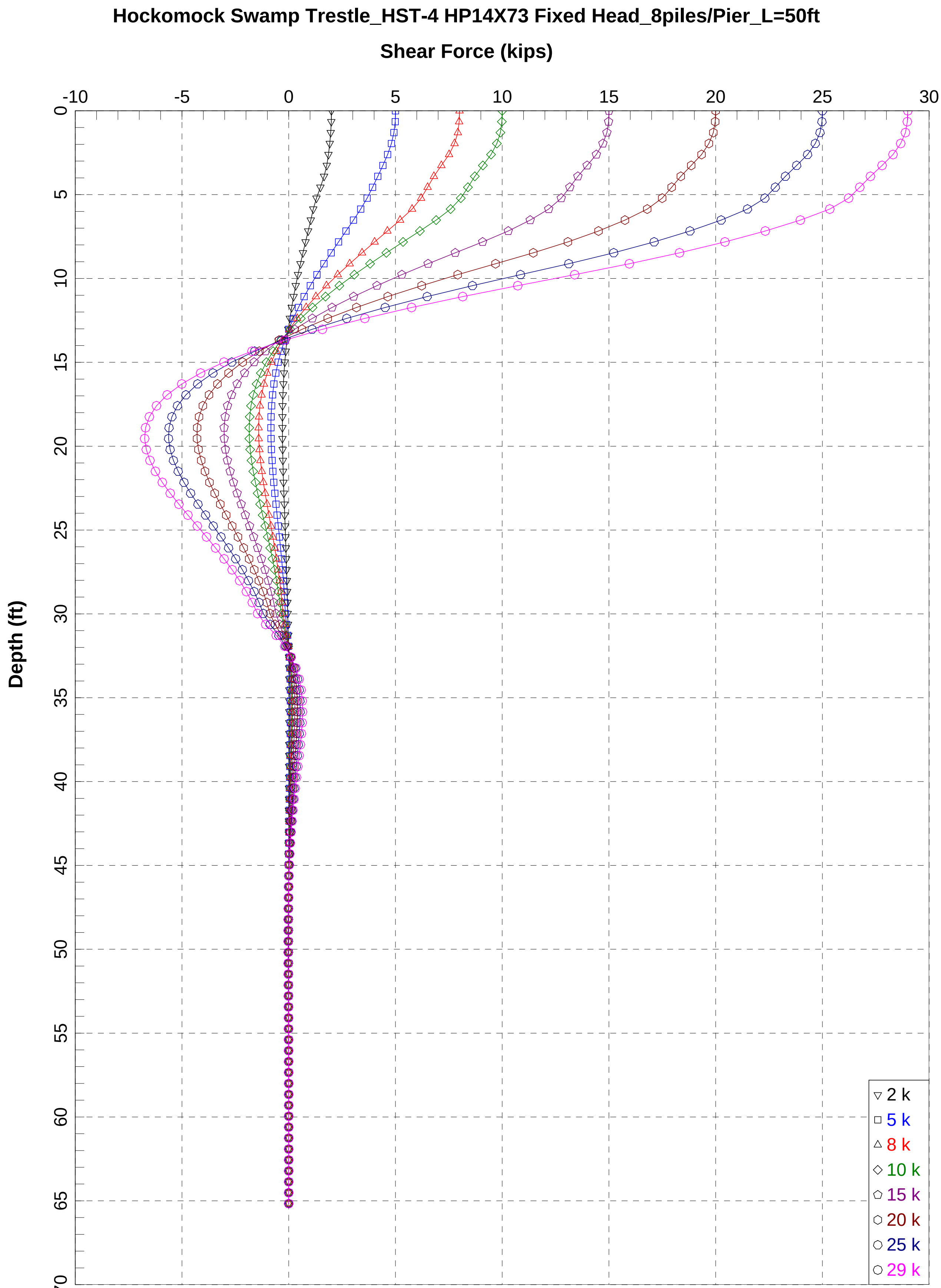

Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=50ft
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
0.1
0.2
0.3
0.4
0.5
0.6
0.7



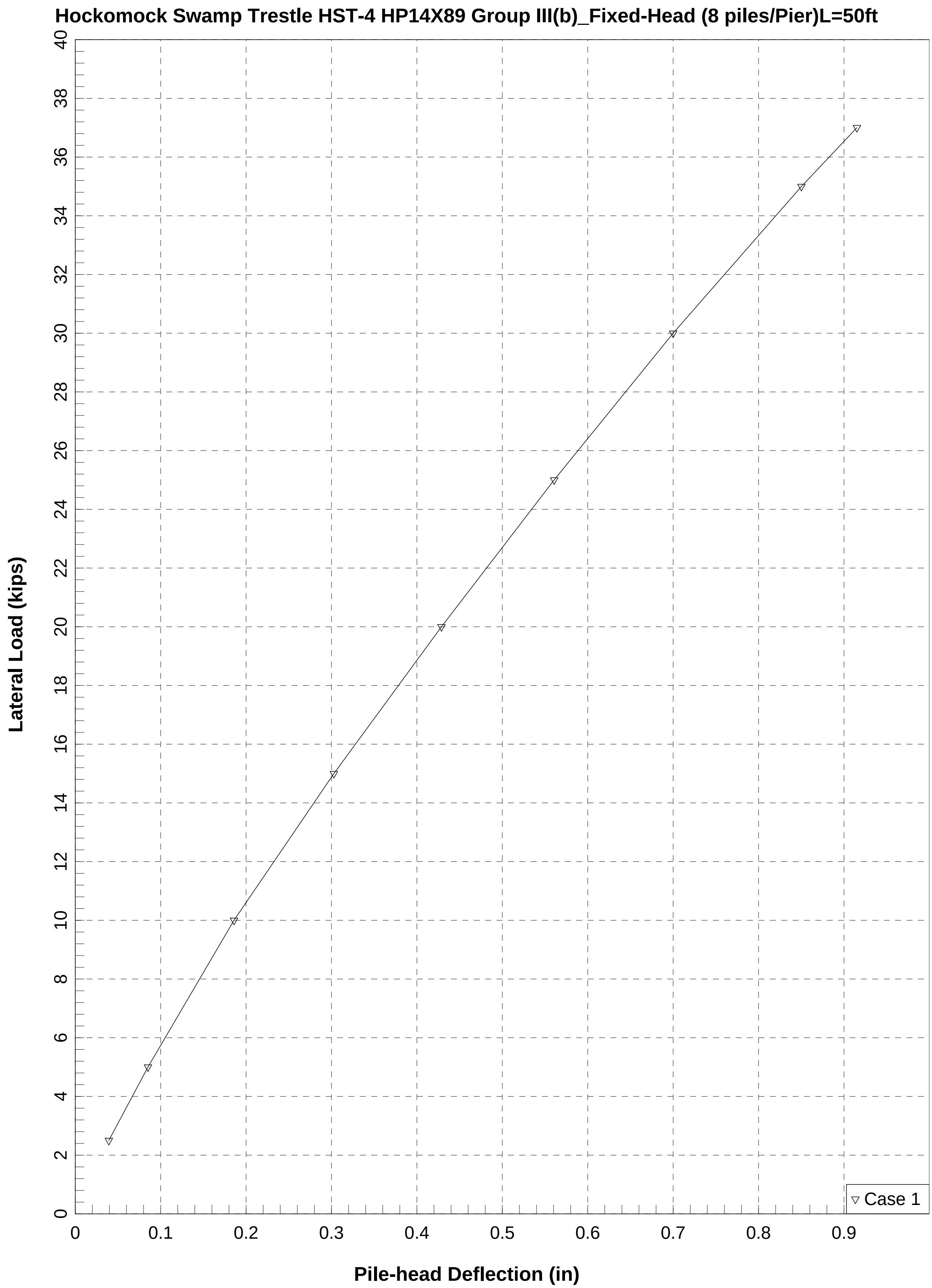
Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=50ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
29 k

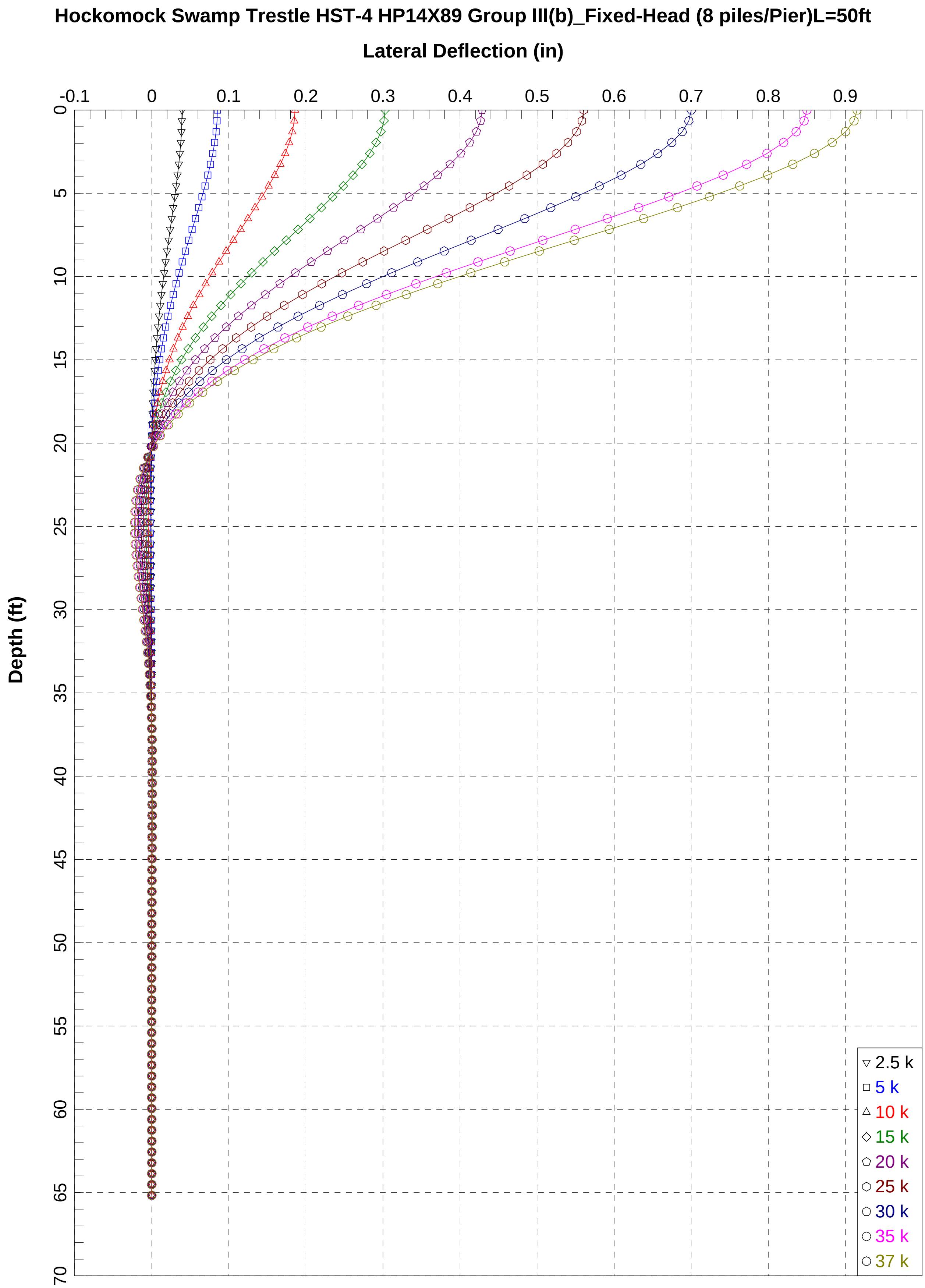


Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=50ft
Bending Moment (in-kips)
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
29 k

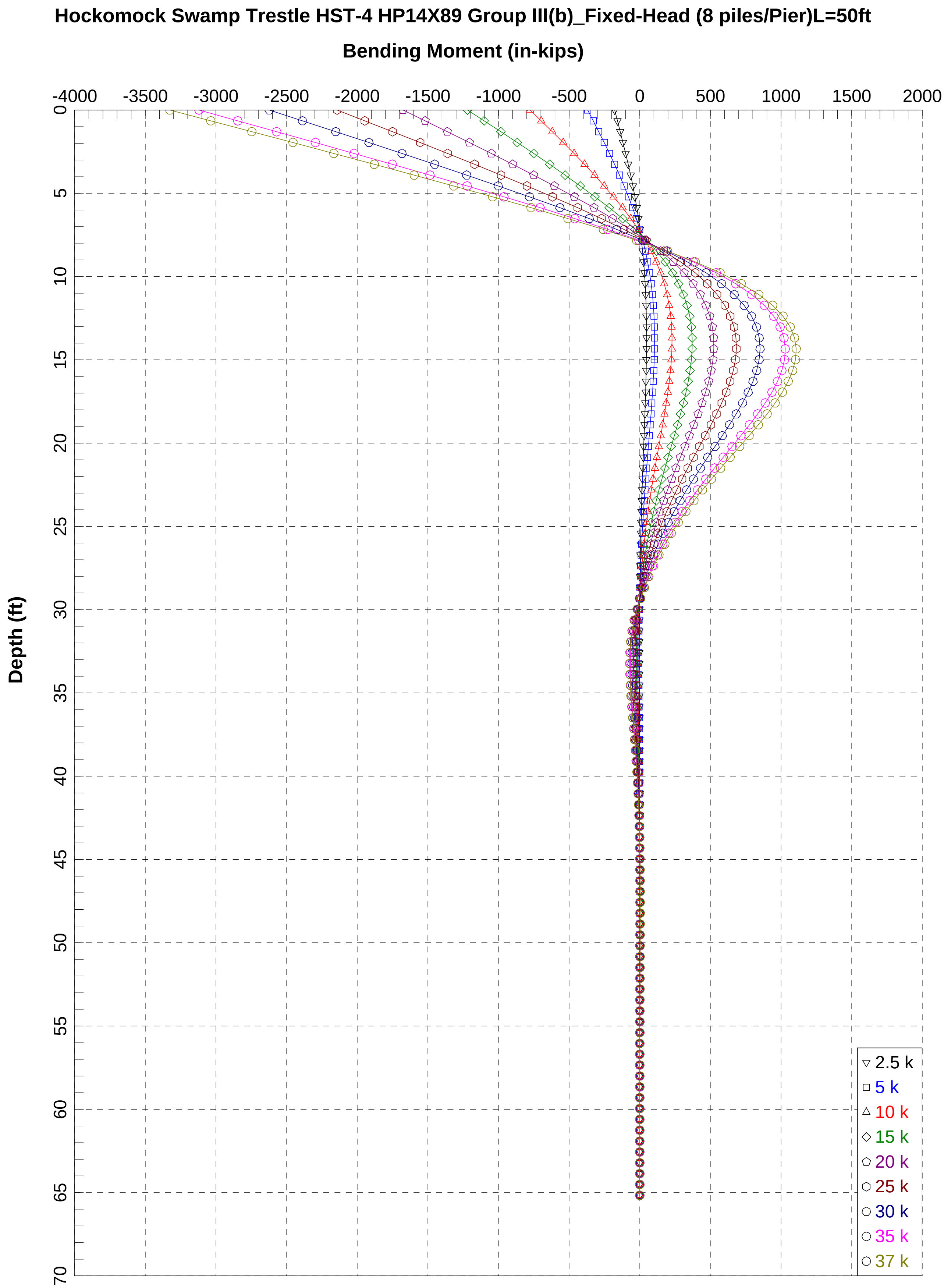


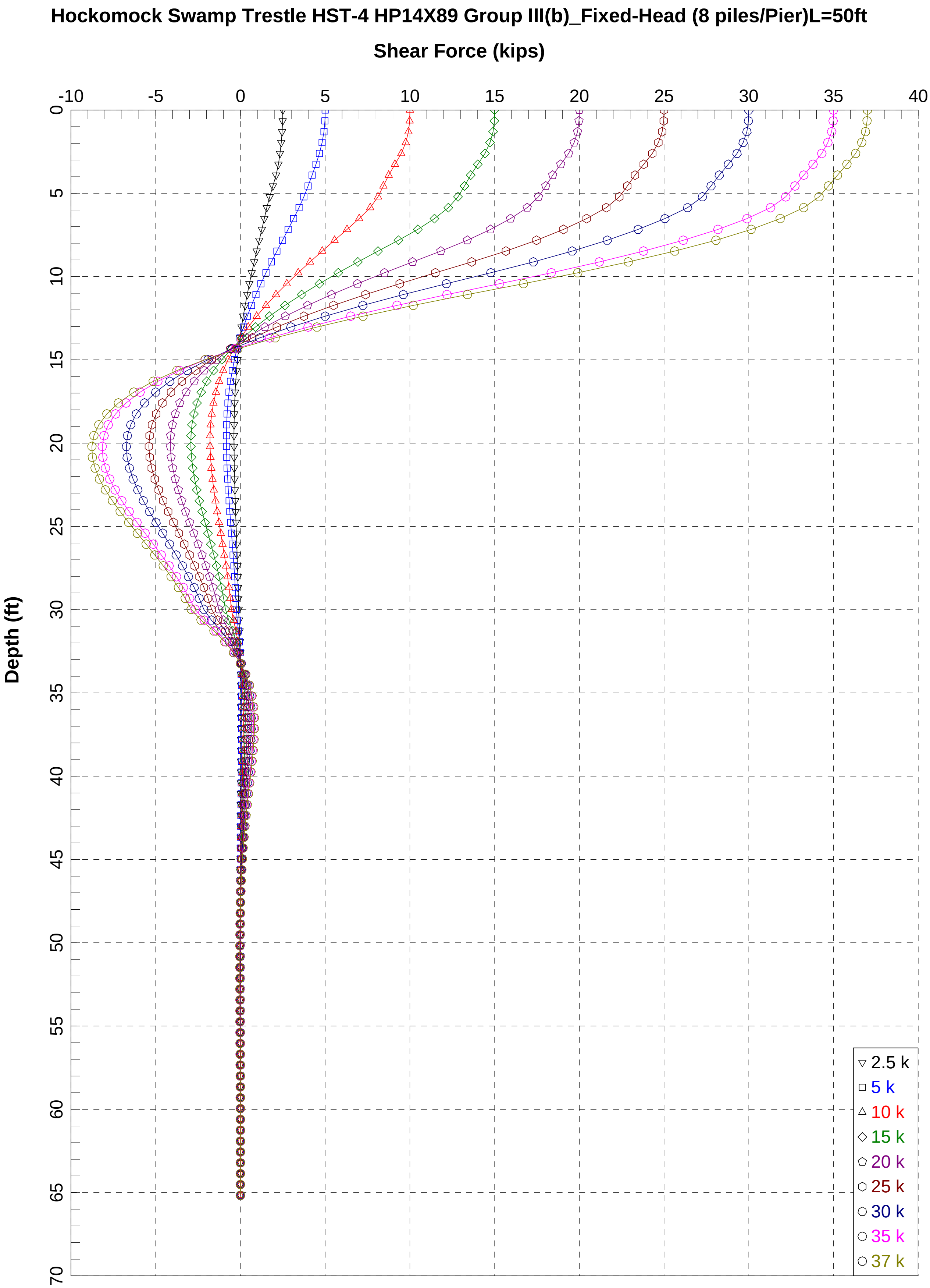
Hockomock Swamp Trestle_HST-4 HP14X73 Fixed Head_8piles/Pier_L=50ft
Shear Force (kips)
-10
-5
0
5
10
15
20
25
30
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2 k
5 k
8 k
10 k
15 k
20 k
25 k
29 k

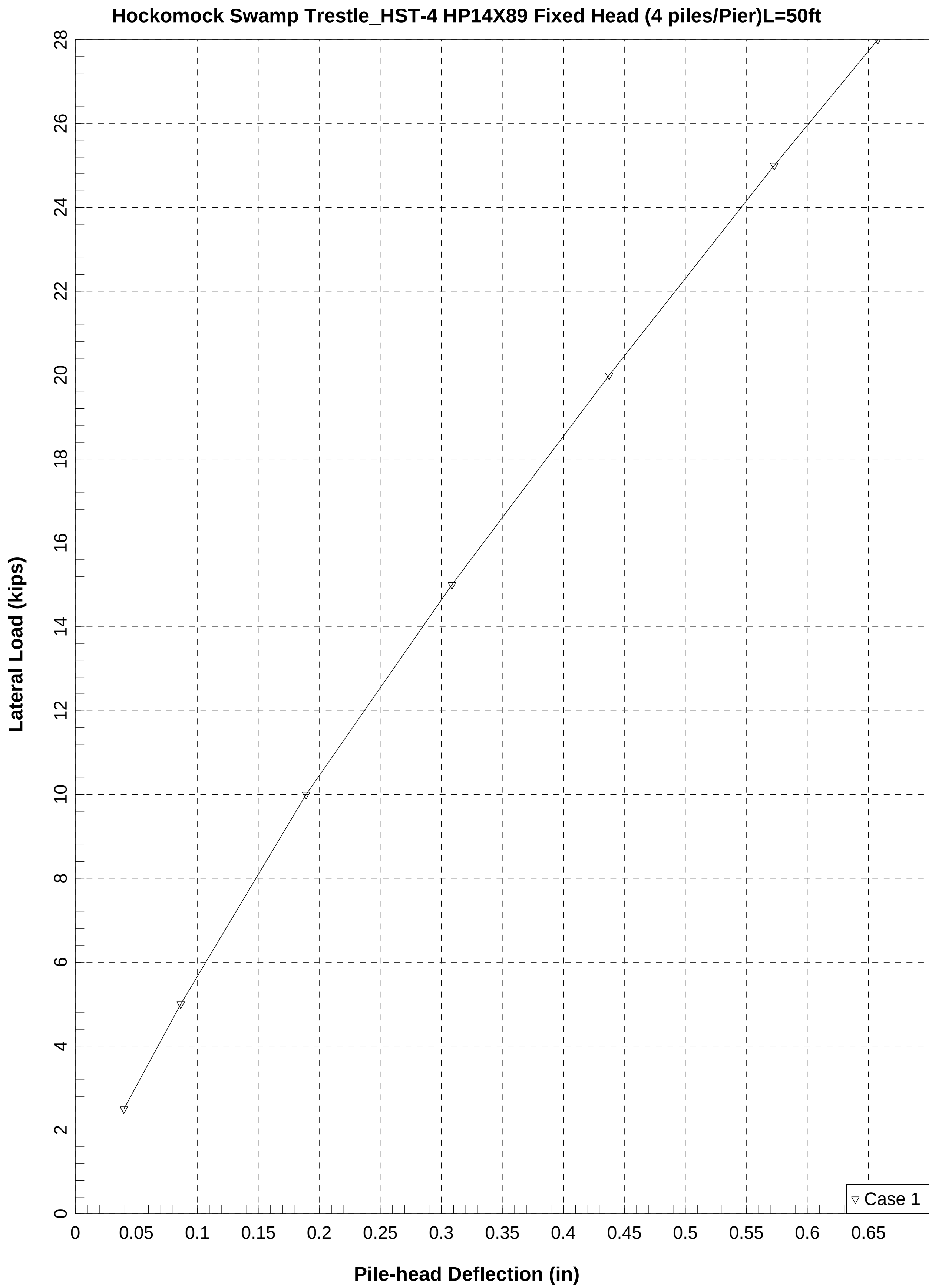

Hockomock Swamp Trestle HST-4 HP14X89 Group III(b)_Fixed-Head (8 piles/Pier)L=50ft
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

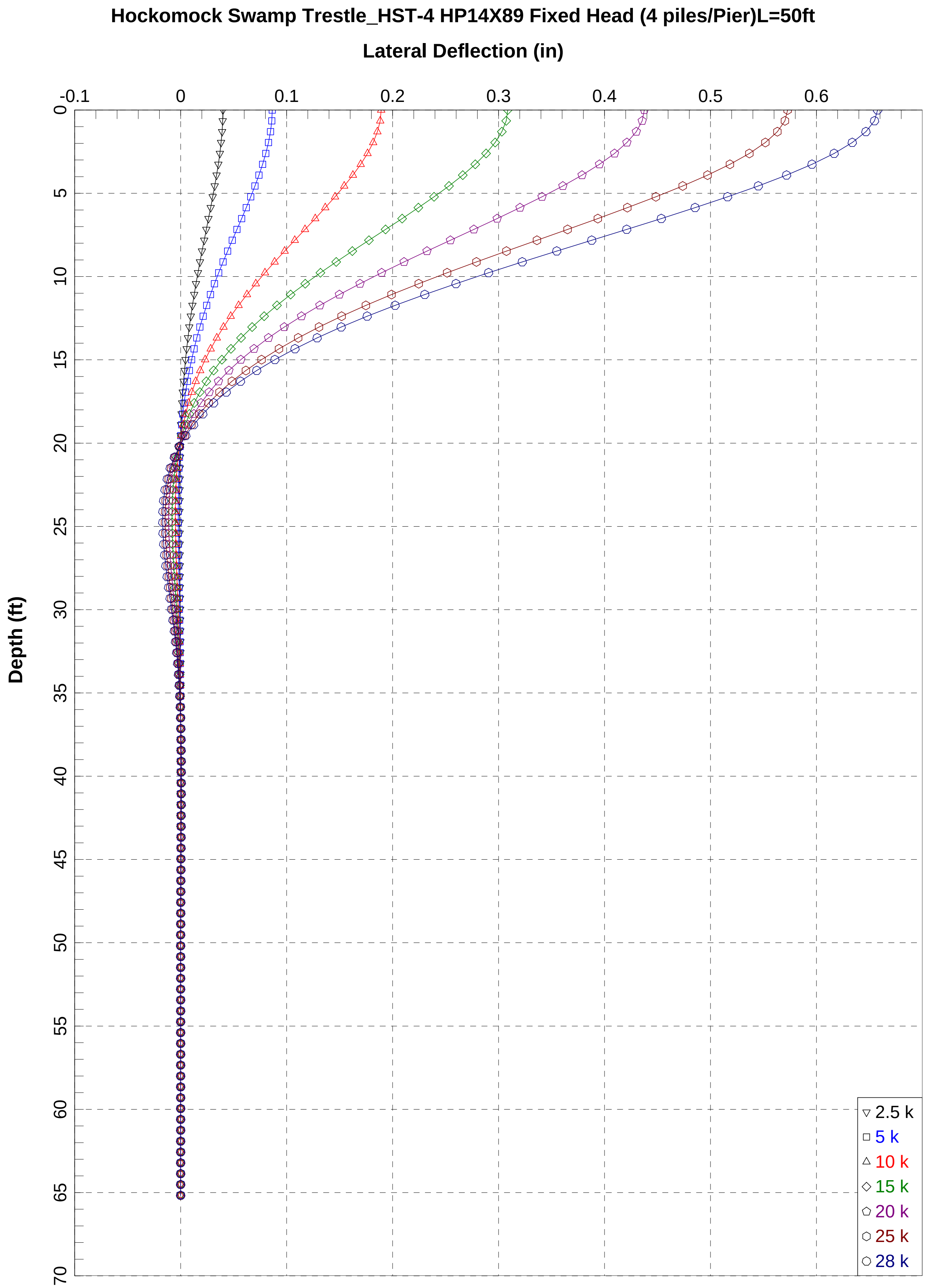


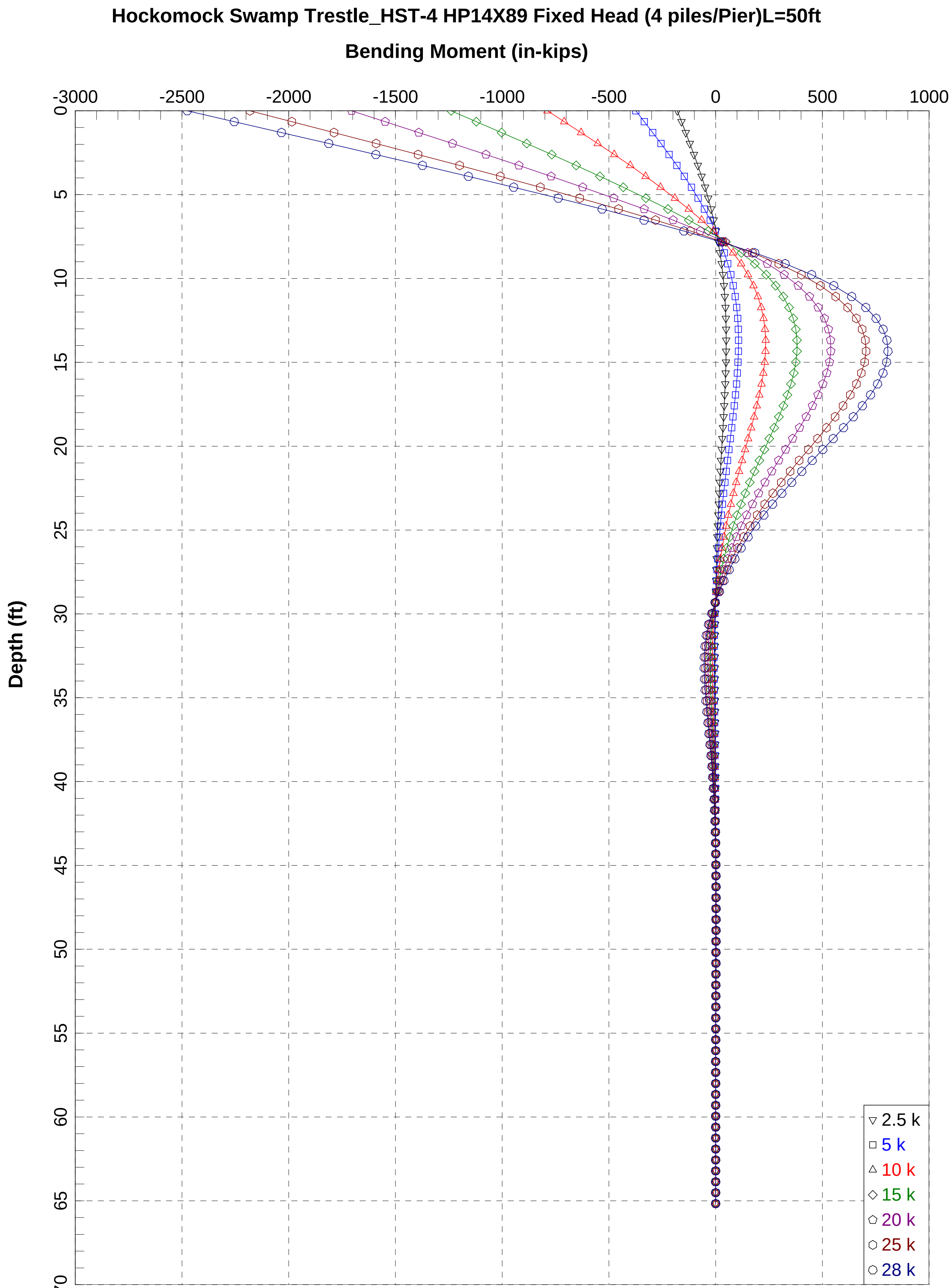
Hockomock Swamp Trestle HST-4 HP14X89 Group III(b)_Fixed-Head (8 piles/Pier)L=50ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k
35 k
37 k


Hockomock Swamp Trestle HST-4 HP14X89 Group III(b)_Fixed-Head (8 piles/Pier)L=50ft
Bending Moment (in-kips)
-4000
-3500
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
1500
2000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k
35 k
37 k


Hockomock Swamp Trestle HST-4 HP14X89 Group III(b)_Fixed-Head (8 piles/Pier)L=50ft
Shear Force (kips)
-10
-5
0
5
10
15
20
25
30
35
40
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
30 k
35 k
37 k

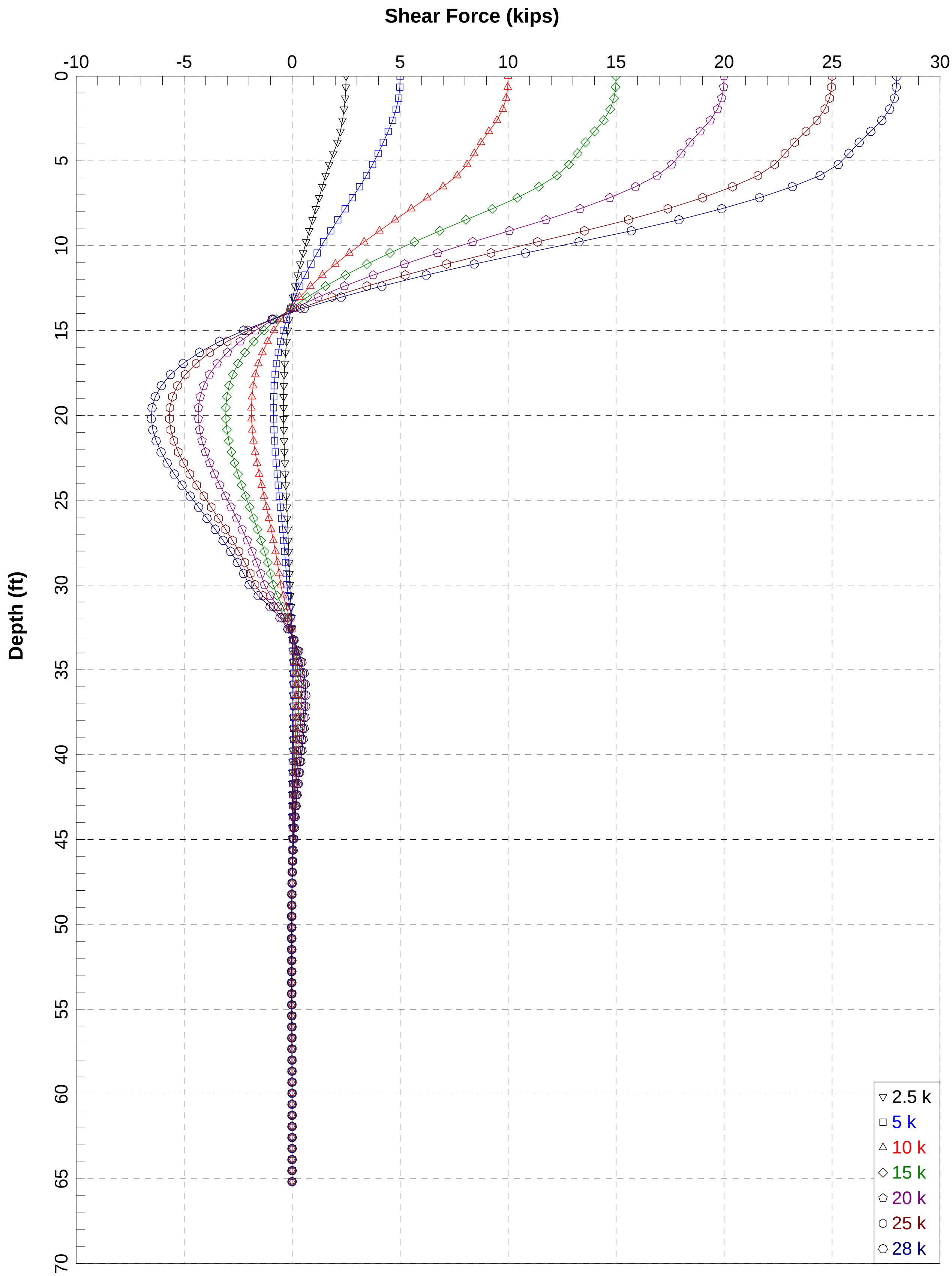

Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=50ft
Lateral Load (kips)
Pile-head Deflection (in)
Case 1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65


Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=50ft
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
28 k



Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=50ft
Bending Moment (in-kips)
-3000
-2500
-2000
-1500
-1000
-500
0
500
1000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
2.5 k
5 k
10 k
15 k
20 k
25 k
28 k

Hockomock Swamp Trestle_HST-4 HP14X89 Fixed Head (4 piles/Pier)L=50ft



Pile GROUP Analyses

Purpose:

The purpose of this calculation is to perform preliminary pile group analysis of a typical deep foundation of the proposed Hockomock Swamp Trestle.

References:

- AREMA Manual.

Assumptions:

- **Boring**

By examining the Borings of HST-1 to HST-9 in areas of the proposed trestle, Boring HST-4 was used for the following analyses.
Boring HST-4 Location: Sta.1457+00
Ground Elevation: EL.70.5

- **Ground water table:**

It is assumed that the ground water at EL 70.5

- **Superstructure**

Top of Track: EL.79.7
Top of Pier Cap: EL.74.2
Bottom of Pier Cap: EL.70.7

- **Pile Size**

Four sizes of HP piles were analyzed. In accordance with AREMA, the maximum allowable pile stresses should be limited to 12.6 ksi for a pile with yield strength of 36 ksi. The maximum allowable single pile capacity was estimated for each size of the HP piles as well as the relevant properties as follows:

Pile Size	As	Ix	Sx	Iy	Sy	Qall	J	GJ
	(in^2)	(in^4)	(in^3)	(in^4)	(in^3)	(kips)	(in^4)	($lbs\text{-}in^2$)
HP10X42	12.4	210	43.4	71.7	14.2	156	0.81	9,034,615
HP12X53	15.5	393	66.7	127	21.1	195	1.12	12,492,308
HP14X73	21.4	729	107	261	35.8	269	2.01	22,419,231
HP14X89	26.1	904	131	326	44.3	328	3.6	40,153,846

Elastic Modulus: E = 29,000,000 psi

Shear Modulus: $G = \frac{E}{2(1+\nu)}$ = 11,153,846 psi

where ν= 0.3

- **Pile Corrosion**

No pile corrosion is considered for preliminary design. However, pile corrosion should be considered for final design.

- **Load From Structure**

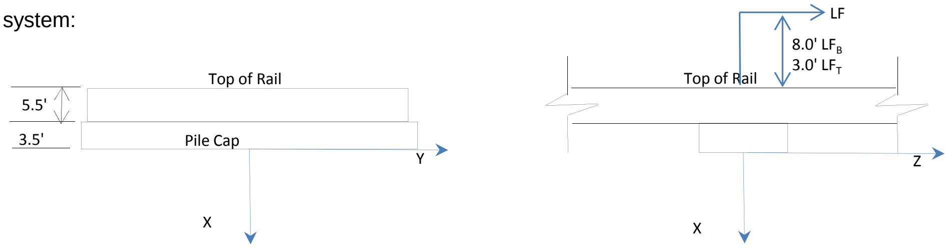
The service loads for pier span of 30 ft, 40 ft and 50 ft were obtained from Kristofer Kretsch (email on 2/02/2012).
The longitudinal forces due to braking and traction were based on the email from Kristofer Kretsch on 2/24/2012.

All the loads were summarized as follows (Referring to the Computations by KGK dated on 2/23/2012)

Pier Span	Dead Load, D*	Live Load, L	Impact Load, I	Longitudinal Braking			Longitudinal Traction		
				Force, LF_B	Moment, M_B**	Vertical, V_B	Force, LF_T	Moment, M_T**	Vert., V_T
(ft)	(kips)	(kips)	(kips)	(kips)	(k-ft)	(kips)	(kips)	(k-ft)	(kips)
30	330	346	142	81	1,235	41	137	1,404	47
40	425	432	153	93	1,418	35	158	1,620	40
50	520	546	174	105	1,601	32	177	1,814	36

Note: * Dead load includes weight of pier cap (50 kips for single row of piles).
** The moments are about the center of the pier cap. The moment is applied to the piers as a vertical couple applied downward on the pier at one end of the span and upward on the pier at the other end of the span. The moment is not applied directly to the pier cap, but is only given for information.

Coordinate system:



To perform GROUP analysis, all the loads should be transferred to the bottom of the pier cap. It was assumed that the longitudinal forces LF_B and LF_T are applied at the top of the pier cap through the bearing pads. When the longitudinal forces are transferred to the bottom of the pier, the above Table should be revised as follows:

Revised loads at the bottom of the pier cap

Pier Span	Dead Load, D	Live Load, L	Impact Load, I	Longitudinal Braking			Longitudinal Traction		
				Force, LF_B	Moment, M_B*	Vertical, V_B	Force, LF_T	Moment, M_T*	Vert., V_T
(ft)	(kips)	(kips)	(kips)	(kips)	(k-ft)	(kips)	(kips)	(k-ft)	(kips)
30	330	346	142	81	1,094	36	137	1,165	39
40	425	432	153	93	1,256	31	158	1,343	34
50	520	546	174	105	1,418	28	177	1,505	30

Note: * The moment is applied to the piers as a vertical couple applied downward on the pier at one end of the span and upward on the pier at the other end of the span. The moment is not applied directly to the pier cap, but is only given for information.

- **Load Combination**

As per AREMA, three load combinations were checked:

Group I	=	D + L + I	
Group III (a)	=	D + L + I + LF_B	with Longitudinal braking load
Group III(b)	=	D + L + I + LF_T	with longitudinal traction load

No other loads were considered at present.

Assuming that the Superstructure and track height is 5.5 ft and pier cap height is 3.5 ft based on the email from Kristofer Kretsch, the load combinations of Group III(a) and Group III(b) with respect to the above coordinate system are more critical. Therefore, only these two load combinations were summarized as follows:

Pier Span	Load Comb.	Force				Moment		
		Fx		Fy	Fz	Mx	My*	Mz
		Single Row	Double Row					
(ft)		(lbs)	(lbs)	(lbs)	(lbs)	(lbs-in)	(lbs-in)	(lbs-in)
30	Group III(a)	854,450	904,450	0	81,000	0	3,402,000	0
	Group III(b)	856,817	906,817	0	137,000	0	5,754,000	0
40	Group III(a)	1,041,388	1,091,388	0	93,000	0	3,906,000	0
	Group III(b)	1,043,575	1,093,575	0	158,000	0	6,636,000	0
50	Group III(a)	1,268,350	1,318,350	0	105,000	0	4,410,000	0
	Group III(b)	1,270,090	1,320,090	0	177,000	0	7,434,000	0

Note: * *My* was calculated with respect to the bottom of the pier cap.

Analysis:

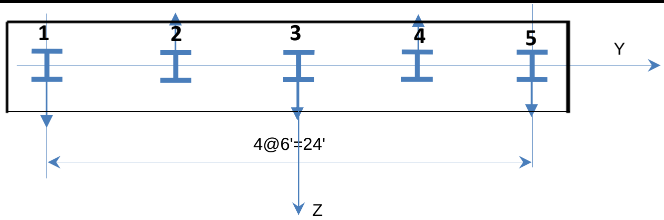
Software: GROUP 7.0 (Ensoft, Inc.)

Analysis:

By checking the above load combinations, Group III(b) is critical for all three pier spans. The following analyses were based on this load combination only.

1. Single Row of Piles Layout

Only pier span equal to 50 ft was analyzed.
Assuming a row of 5 HP14X89 piles is used, and each pile is tilted at 1H:12V as follows:



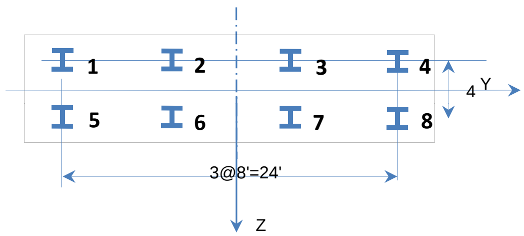
The results with respect to the adjusted moments are as follows:

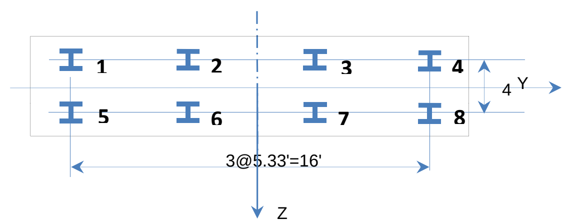
Maximum axial compression force:	547	kips	>328 kips, NG
Maximum axial tension force:	191	kips	>76 kips, NG
Maximum stress in pile:	68	ksi	Overstressed, NG
Maximum pile top deflection	3.1	inches	Too high, NG

Therefore, one row of piles does not work.

2. Double Rows of Piles Layout

Assuming two rows of vertical piles were used. The trestle width of 28 ft and 20 ft were analyzed.





Three sizes of piles were checked. The results were summarized in the following tables:

Summary of GROUP Analyses (Fixed Head Condition) - 28 ft Wide Trestle

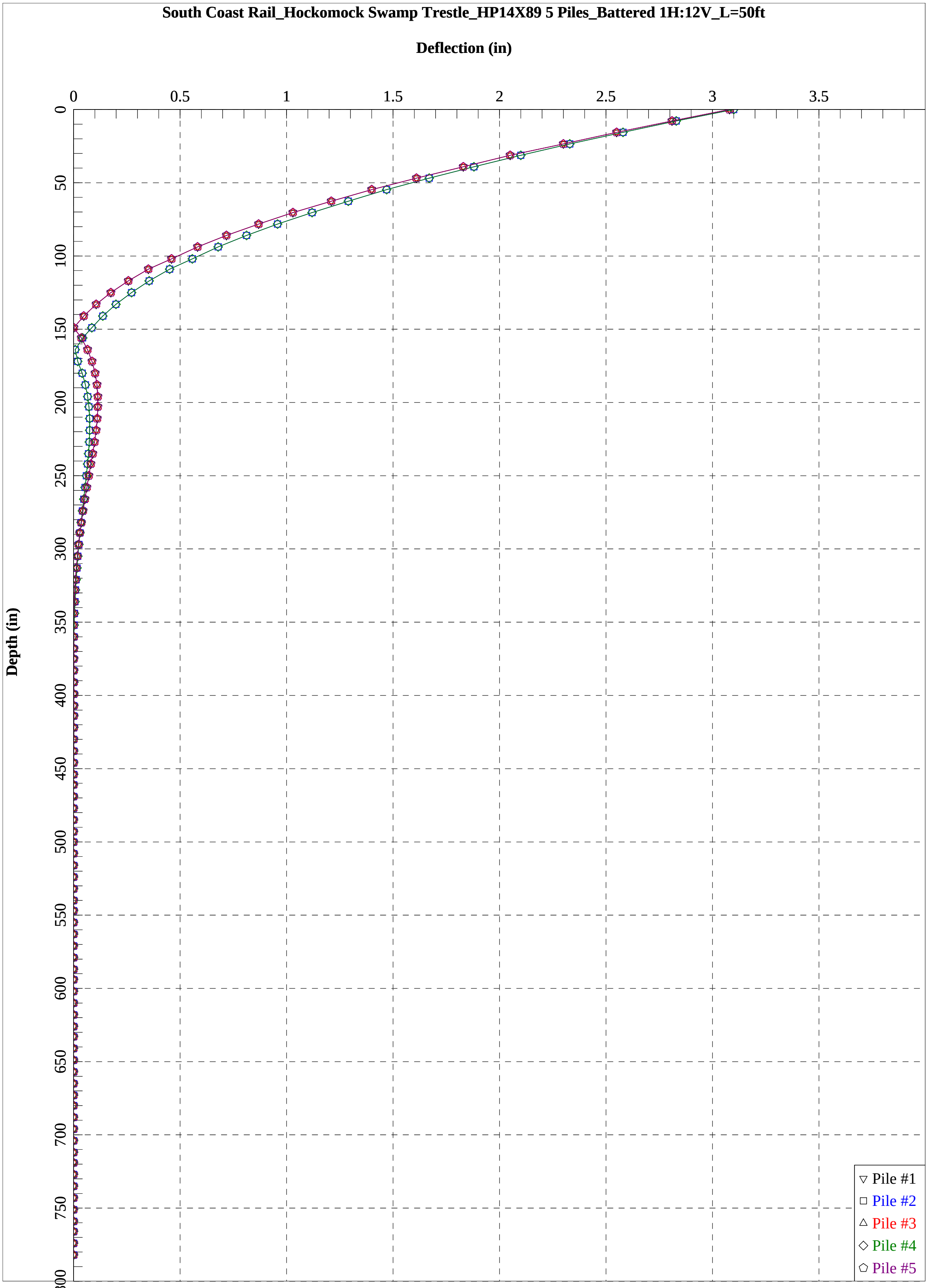
Pier Span	Pile Size	Load Condition	Qall	GROUP Analysis Results				
				Axial Pile Force (kips)		Max. Moment	Max. Pile Stress	Max. Top Deflection
(ft)			(kips)	Comp..	Tension	(kips-in)	(ksi)	(inches)
50ft	HP14X89	Group III(b)	328	271	NO	1,700	23.5	0.82
	HP14X73	Group III(b)	269	270	NO	1,670	28	0.94
	HP12X53	Group III(b)	195	269	NO	1,650	42.5	1.33
40ft	HP14X89	Group III(b)	328	230	NO	1,490	20.3	0.71
	HP14X73	Group III(b)	269	220	NO	1,460	24.7	0.81
	HP12X53	Group III(b)	195	228	NO	1,420	36.4	1.12

Summary of GROUP Analyses (Fixed Head Condition) - 20 ft Wide Trestle

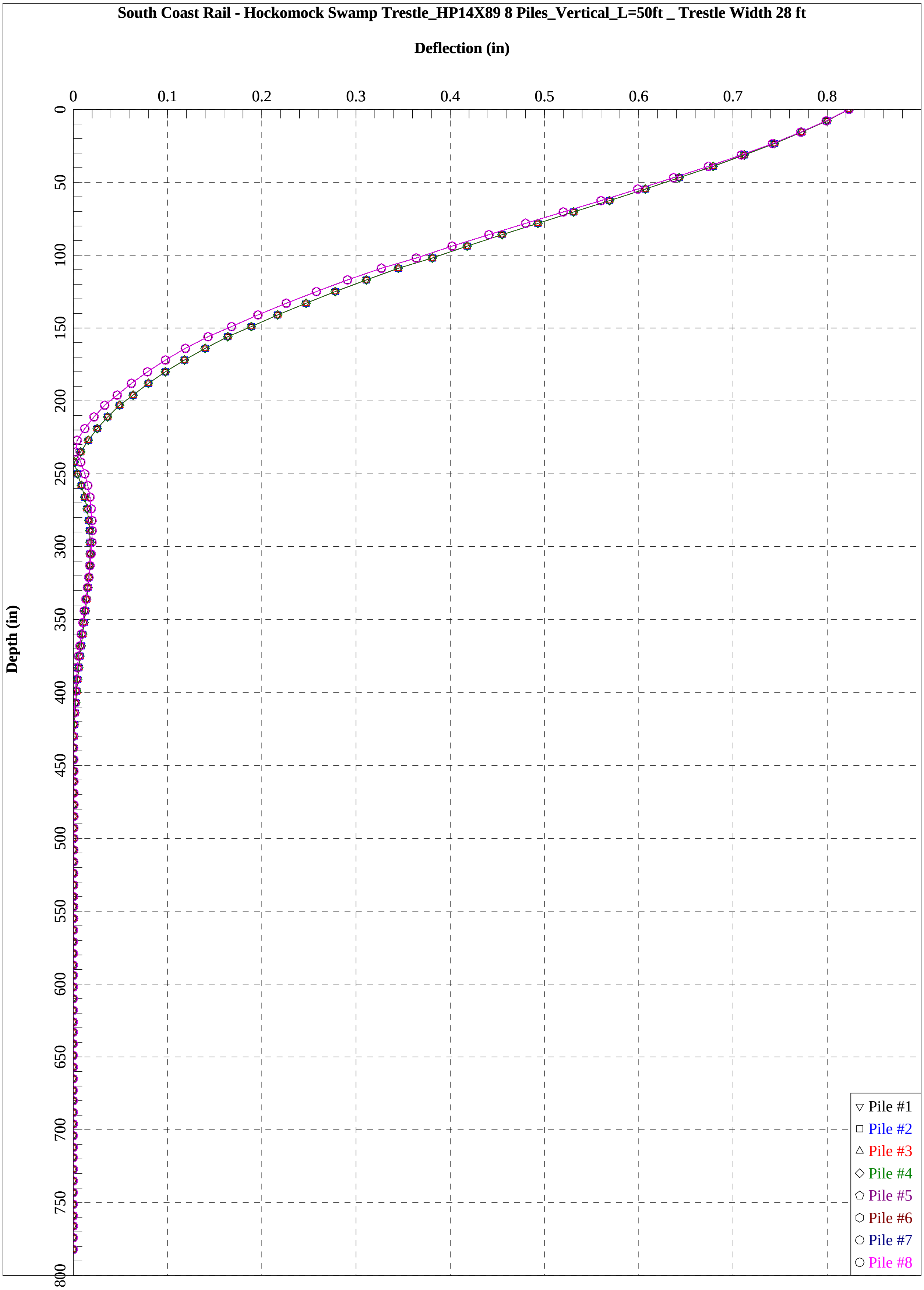
Pier Span	Pile Size	Load Condition	Qall	GROUP Analysis Results				
				Axial Pile Force (kips)		Max. Moment	Max. Pile Stress	Max. Top Deflection
(ft)			(kips)	Comp..	Tension	(kips-in)	(ksi)	(inches)
50ft	HP14X89	Group III(b)	328	271	NO	1,720	23.7	0.83
	HP14X73	Group III(b)	269	270	NO	1,690	28.9	0.95
	HP12X53	Group III(b)	195	269	NO	1,650	42.6	1.33
40ft	HP14X89	Group III(b)	328	230	NO	1,510	20.5	0.72
	HP14X73	Group III(b)	269	229	NO	1,480	24.9	0.82
	HP12X53	Group III(b)	195	228	NO	1,420	36.4	1.12

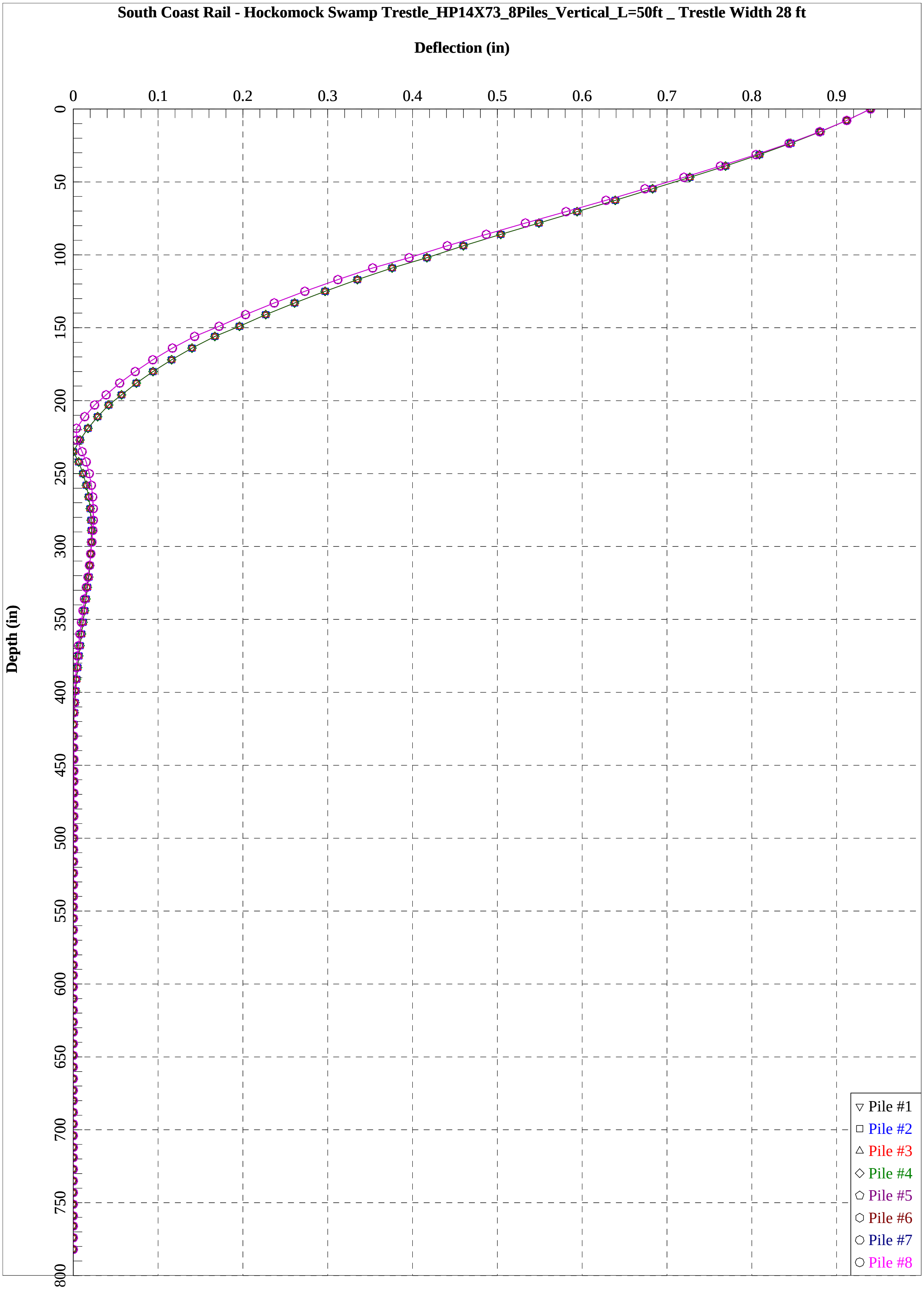
Note:

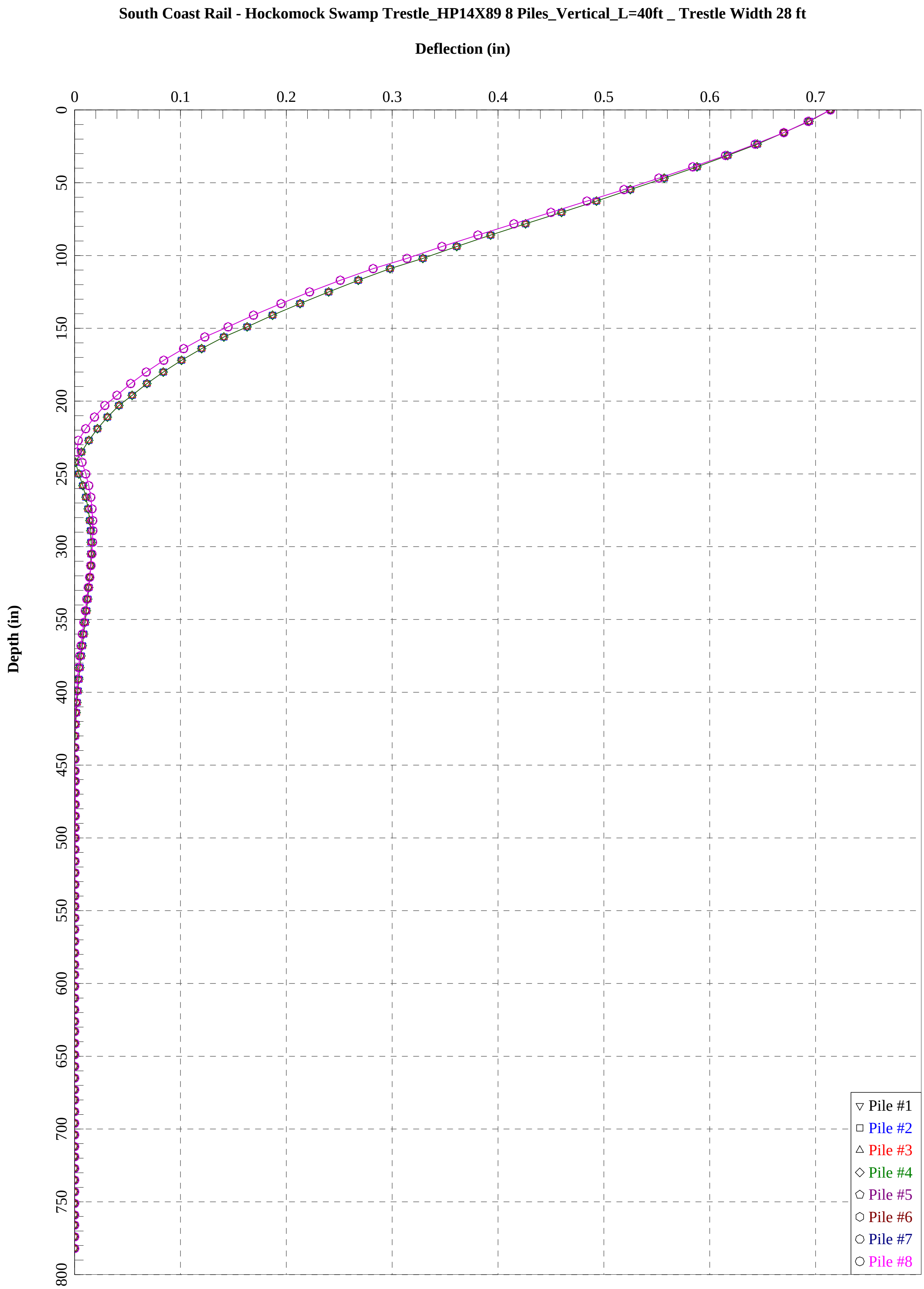
1. No pile corrosion was considered.
2. Fixed pile head condition was assumed.
3. The maximum moment and maximum axial force occur at the pile heads (bottom of the pier cap).
   Structural engineers should check the structural capacities of the piles at the bottom of pier connection.

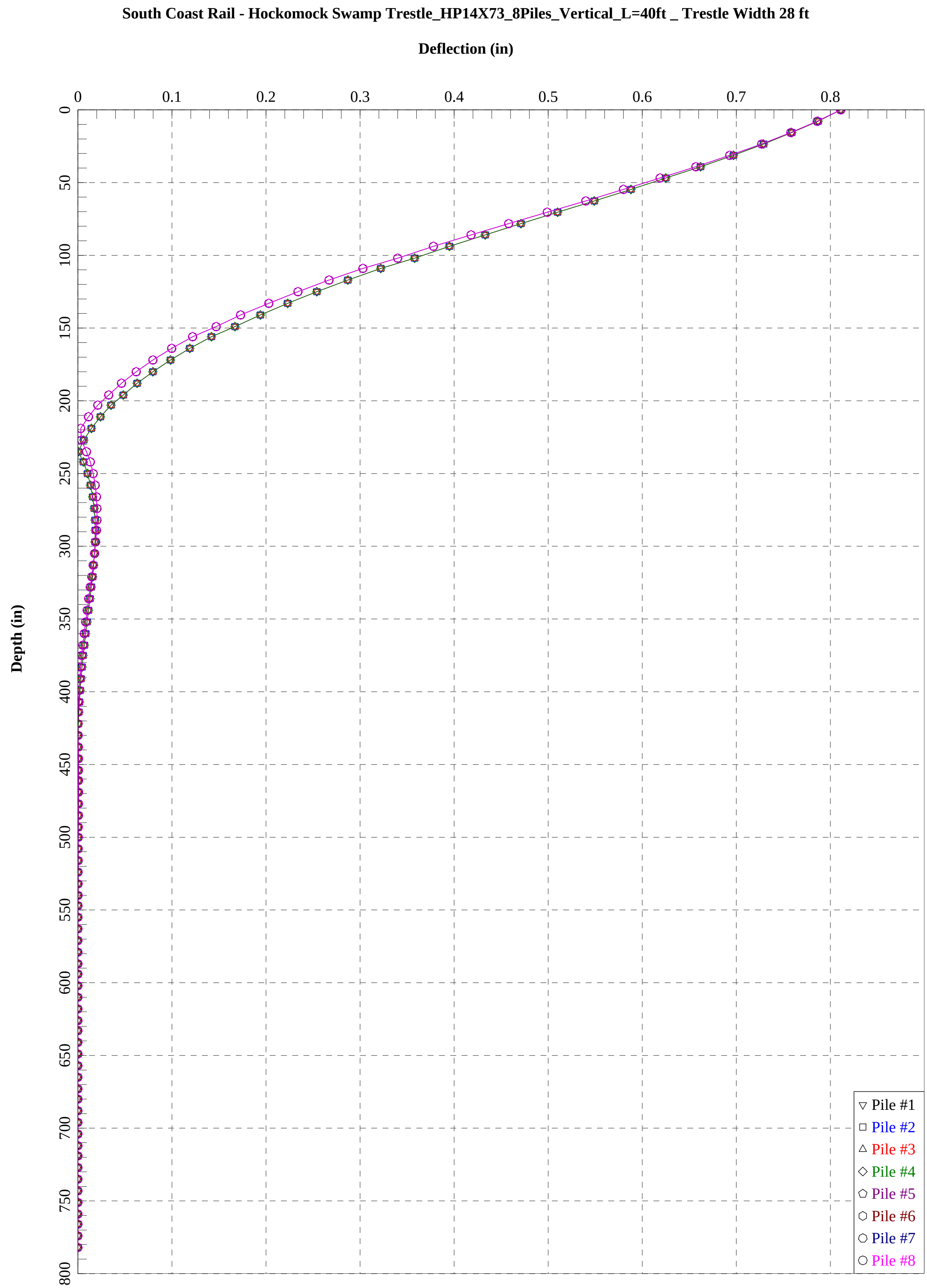


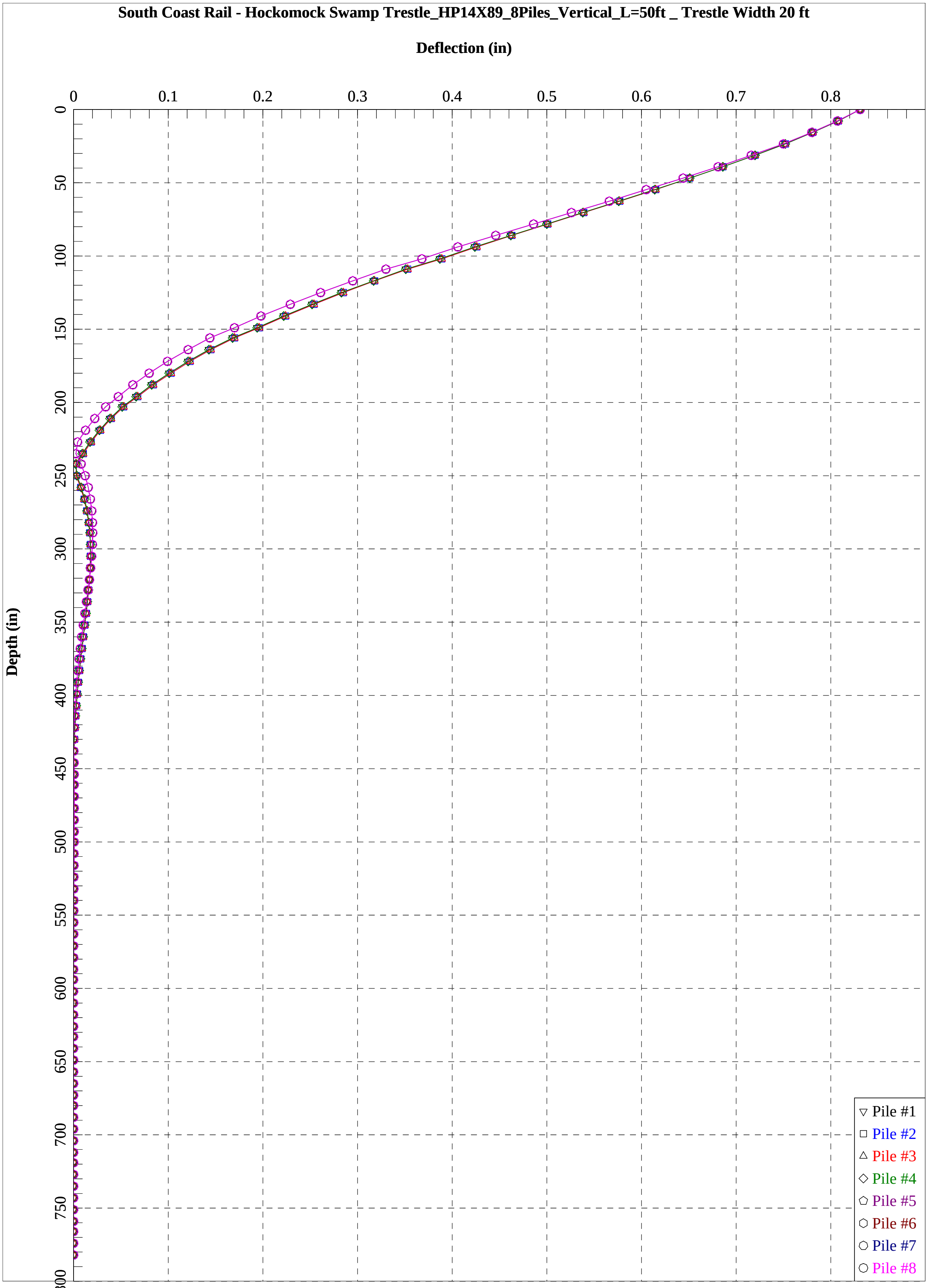
South Coast Rail_Hockomock Swamp Trestle_HP14X89 5 Piles_Battered 1H:12V_L=50ft
Deflection (in)
Depth (in)
0
0.5
1
1.5
2
2.5
3
3.5
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5

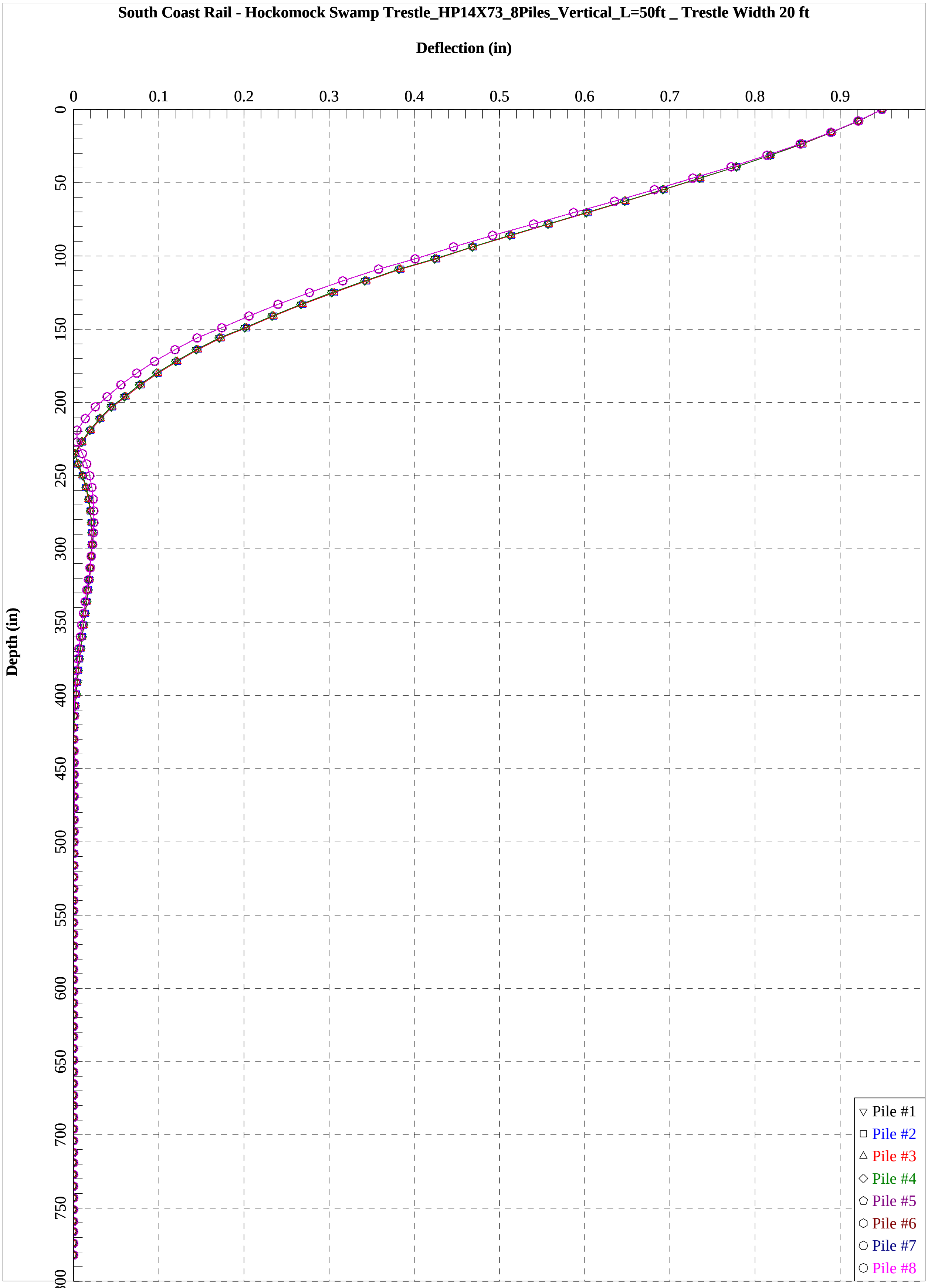

South Coast Rail - Hockomock Swamp Trestle_HP14X89 8 Piles_Vertical_L=50ft _ Trestle Width 28 ft
Deflection (in)
Depth (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8


South Coast Rail - Hockomock Swamp Trestle_HP14X73_8Piles_Vertical_L=50ft _ Trestle Width 28 ft
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8

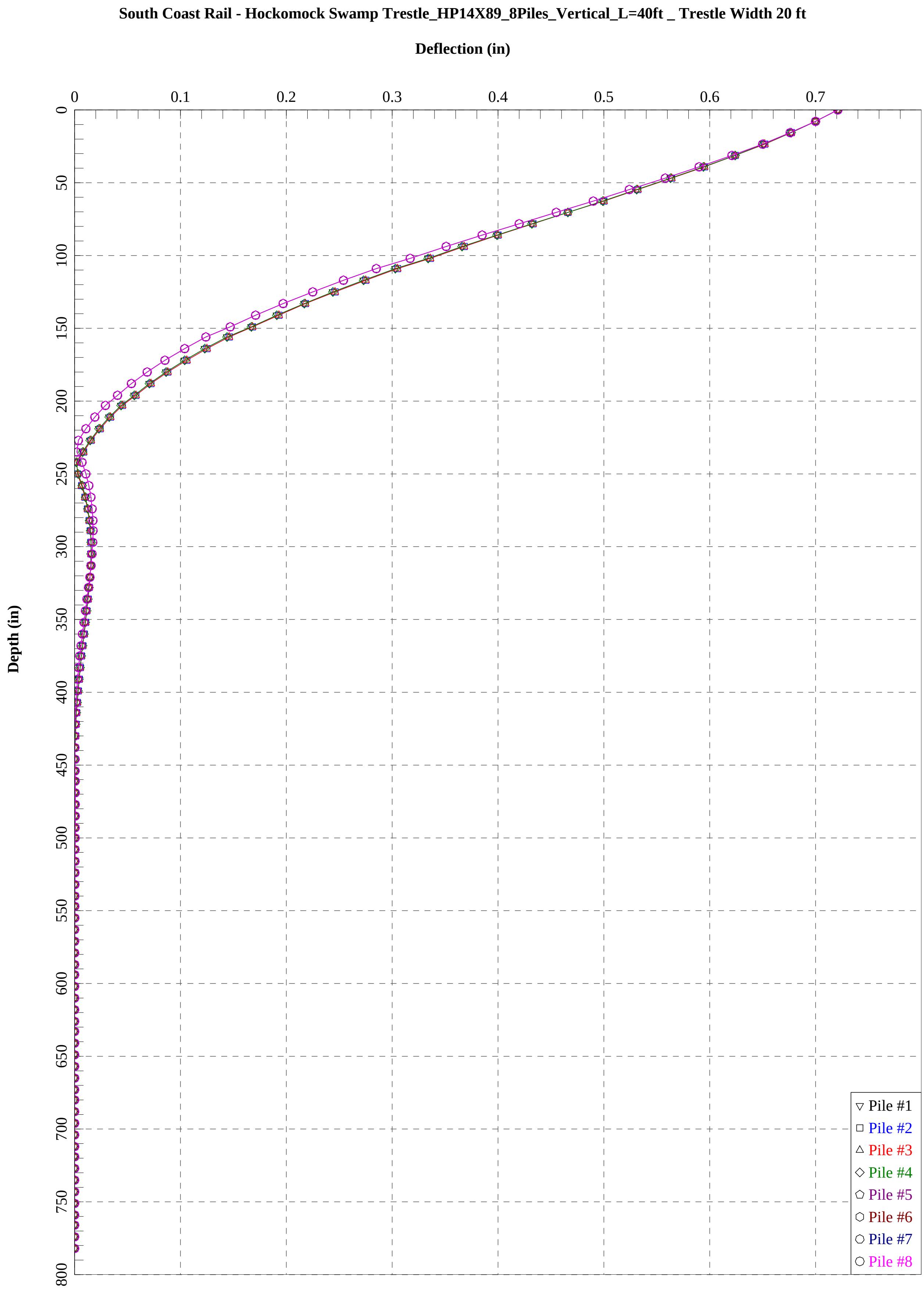

South Coast Rail - Hockomock Swamp Trestle_HP14X89 8 Piles_Vertical_L=40ft _ Trestle Width 28 ft
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8


South Coast Rail - Hockomock Swamp Trestle_HP14X73_8Piles_Vertical_L=40ft _ Trestle Width 28 ft
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8

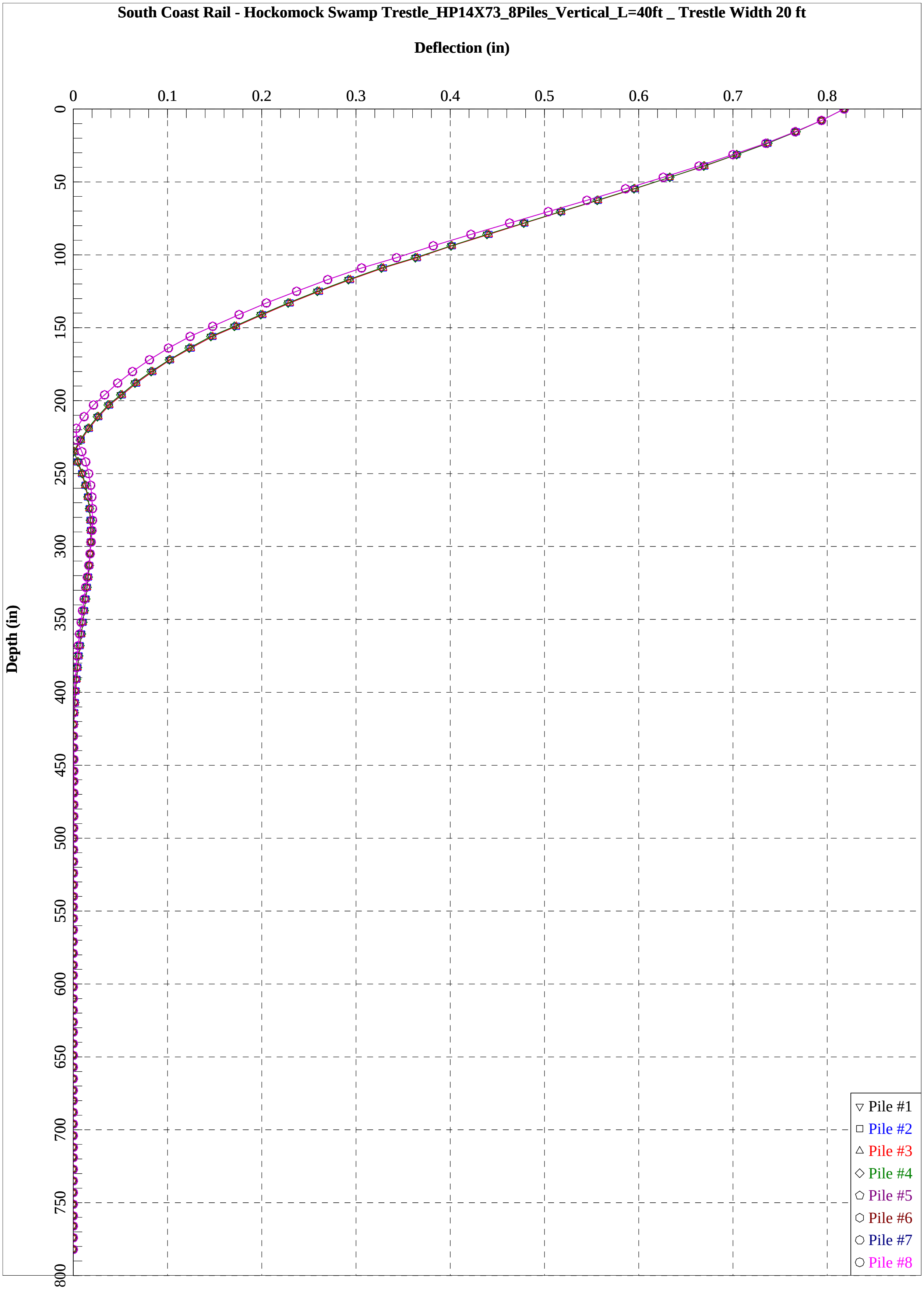

South Coast Rail - Hockomock Swamp Trestle_HP14X89_8Piles_Vertical_L=50ft _ Trestle Width 20 ft
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8



South Coast Rail - Hockomock Swamp Trestle_HP14X73_8Piles_Vertical_L=50ft _ Trestle Width 20 ft
Deflection (in)
Depth (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8



South Coast Rail - Hockomock Swamp Trestle_HP14X89_8Piles_Vertical_L=40ft _ Trestle Width 20 ft
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8


South Coast Rail - Hockomock Swamp Trestle_HP14X73_8Piles_Vertical_L=40ft _ Trestle Width 20 ft
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8

Seismic Site Class Evaluation

Authored by: SR 3/8/2012
Seismic Parameters_HST_6.xlsx

Checked by: AH 3/8/2012

JACOBS

Hockomock Swamp Trestle Seismic Site Class Evaluation

Based on the boring HST-6

Boring No.	Sample No.	N Value	Di	Di/N_i	N_{bar}
HST-6	S-1	6	5.5	0.92	
	S-2	1	2.5	2.50	
	S-3	41	7	0.17	
	S-4	12	5	0.42	
	S-5	9	5	0.56	**15**
	S-6	11	5	0.45	
	S-7	31	5	0.16	
	S-8	12	5	0.42	
	S-9	39	5	0.13	
	S-10	39	5	0.13	
	S-11	42	5	0.12	
	S-12	54	5	0.09	
	Bedrock	100	40	0.40	
	Total Depth =	100			
	Depth to Bedrock =	60	sum	6.46	

Approx. Project Coordinates

Lat	41.999792
Long	-71.080808

Seismic Coefficients

S_S = 0.24 (Table 1604.10*)

S_1 = 0.062 (Table 1604.10*)

For Site Class D

F_A = 1.6 (See Table 9.4.1.2.4a*)

F_V = 2.4 (See Table 9.4.1.2.4b*)

$S_{MS} = Ss \times F_A$ = 0.384

$S_{M1} = S_1 \times F_V$ = 0.149

$S_{DS} = 2/3 \times S_{MS}$ = 0.256

$S_{D1} = 2/3 \times S_{M1}$ = 0.099

Per 9.4.1.2.1, $15 \le N_{bar} \le 50$, Site Class D

9.4.1.2.1 Site Class Definitions. The site shall be classified as one of the following classes:

A = Hard rock with measured shear wave velocity, $\bar{v}_s > 5000$ft/s (1500 m/s)

B = Rock with 2500 ft/s $< \bar{v}_s \le 5000$ ft/s (760 m/s $< \bar{v}_s \le$ 1500 m/s)

C = Very dense soil and soft rock with 1200 ft/s $\le \bar{v}_s \le$ 2500 ft/s (370 m/s $\le \bar{v}_s \le$ 760 m/s) or $\bar{N}$ or $\bar{N}_{ch} > 50$ or $\bar{s}_u \ge$ 2000 psf (100 kPa)

D = Stiff soil with 600 ft/s $\le \bar{v}_s \le$ 1200 ft/s (180 m/s $\le \bar{v}_s \le$ 370 m/s) or with $15 \le \bar{N}$ or $\bar{N}_{ch} \le 50$ or 1000 psf $\le \bar{s}_u \le$ 2000 psf (50 kPa $\le \bar{s}_u \le$ 100 kPa)

E = A soil profile with $\bar{v}_s <$ 600 ft/s (180 m/s) or any profile with more than 10 ft (3 m) of soft clay. Soft clay is defined as soil with *PI* > 20, $w \ge 40\%$, and $s_u <$ 500 psf (25 kPa)

F = Soils requiring site-specific evaluations:

1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. Potential for liquefaction shall be evaluated in accordance with 780 CMR 1804.6: *Liquefaction*.

Exception. None.

2. Peats and/or highly organic clays (*H* > 10 ft [3 m] of peat and/or highly organic clay where *H* = thickness of soil).
3. Very high plasticity clays (H > 25 ft [7.6 m] with *PI* > 75).
4. Very thick soft/medium stiff clays (H>120 ft [37 m].

Exception. None.

Notes: * The Massachusetts State Building Code, 8th Edition (2010)

TABLE 9.4.1.2.4a VALUES OF F_a AS A FUNCTION OF SITE CLASS AND SHORT PERIOD MAXIMUM CONSIDERED EARTHQUAKE SPECTRAL ACCELERATION

Site Class	*Tabulated Maximum Considered Earthquake Spectral Response Acceleration at Short Periods*					
	$S_S \le 0.26$	$0.27 \le S_S \le 0.29$	$0.30 \le S_S \le 0.32$	$0.33 \le S_S \le 0.35$	$0.36 \le S_S \le 0.38$	$S_S \ge 0.39$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.2	1.2	1.2	1.2
D	1.6	1.6	1.55	1.5	1.5	1.5
E	2.5	2.4	2.3	2.2	2.1	2.0
F	Note a	Note a	Note a	Note a	Note a	Note a

Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F_a for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

TABLE 9.4.1.2.4b VALUES OF F_v AS A FUNCTION OF SITE CLASS

Site Class	*Tabulated Maximum Considered Earthquake Spectral Response Acceleration at 1-Second Periods*
	$S_1 \le 0.1$
A	0.8
B	1.0
C	1.7
D	2.4
E	3.5
F	Note a

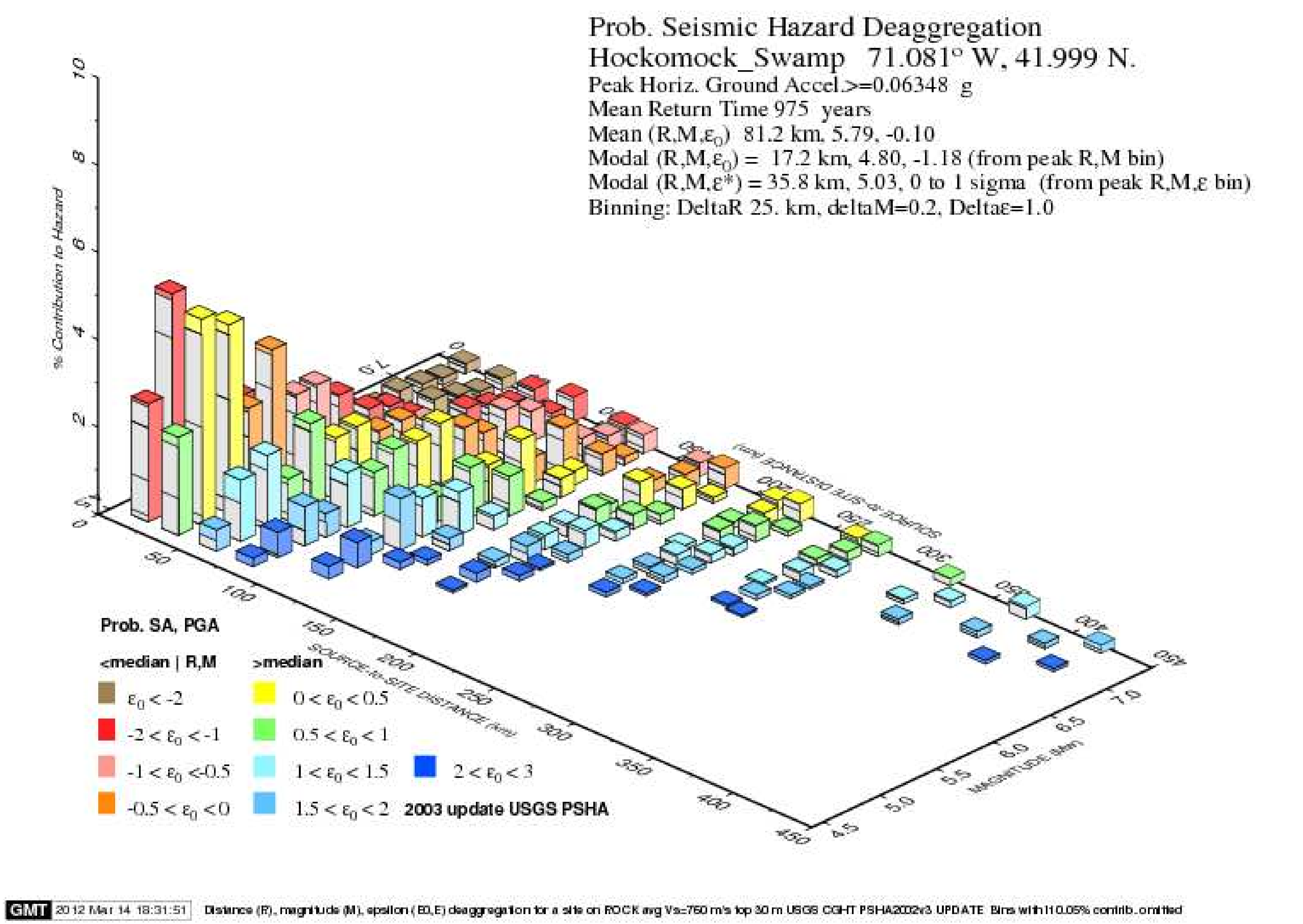
Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed except that for structures with periods of vibration equal to or less than 0.5-seconds, values of F_v for liquefiable soils may be assumed equal to the values for the site class determined without regard to liquefaction in Step 3 of 9.4.1.2.2.

TABLE 1604.10 GROUND SNOW LOADS; BASIC WIND SPEEDS; EARTHQUAKE DESIGN FACTORS

(For R-3 of three stories or less one- and two-family stand alone buildings, see 780 CMR 53.00 for snow and wind loads)

City/Town	Ground Snow Load p_g, psf	Basic Wind Speed V, MPH	Earthquake Design Factors	
			Ss	S_1
Needham	55	100	0.27	0.067
New Ashford	65	90	0.22	0.068
New Bedford	45	110	0.23	0.058
New Braintree	55	100	0.23	0.067
New Marlborough	65	90	0.23	0.066
New Salem	65	100	0.24	0.068
Newbury	55	110	0.35	0.076
Newburyport	55	110	0.35	0.077
Newton	55	105	0.27	0.068
Norfolk	55	100	0.25	0.065
North Adams	65	90	0.22	0.069
North Andover	55	110	0.33	0.075
North Attleborough	55	110	0.24	0.063
North Brookfield	55	100	0.23	0.066
North Reading	55	105	0.32	0.073
Northampton	55	100	0.22	0.066
Northborough	55	100	0.25	0.067
Northbridge	55	100	0.24	0.065
Northfield	65	100	0.24	0.070
Norton	55	110	0.24	0.063
Norwell	45	110	0.26	0.064
Norwood	55	100	0.26	0.065
Oak Bluffs	35	120	0.18	0.051
Oakham	55	100	0.24	0.067
Orange	65	100	0.24	0.070
Orleans	35	120	0.18	0.051
Otis	65	90	0.23	0.066
Oxford	55	100	0.23	0.065
Palmer	55	100	0.23	0.066
Paxton	55	100	0.24	0.067
Peabody	45	110	0.31	0.072
Pelham	55	100	0.23	0.067
Pembroke	45	110	0.25	0.063
Pepperell	65	100	0.30	0.073
Peru	65	90	0.22	0.067
Petersham	65	100	0.24	0.068
Phillipston	65	100	0.24	0.069
Pittsfield	65	90	0.22	0.067
Plainfield	65	100	0.22	0.068
Plainville	55	100	0.24	0.063
Plymouth	45	110	0.24	0.060
Pympton	45	110	0.24	0.061
Princeton	65	100	0.25	0.069
Provincetown	35	120	0.22	0.058
Quincy	45	105	0.27	0.067
Randolph	45	105	0.26	0.065
Raynham	55	110	0.24	0.062
Reading	55	105	0.31	0.072
Rehoboth	55	110	0.24	0.062
Revere	45	105	0.30	0.070
Richmond	65	90	0.22	0.067

Liquefaction Analyses



Prob. Seismic Hazard Deaggregation
Hockomock_Swamp 71.081° W, 41.999 N.
Peak Horiz. Ground Accel.>=0.06348 g
Mean Return Time 975 years
Mean (R,M,ε_0) 81.2 km, 5.79, -0.10
Modal (R,M,ε_0) = 17.2 km, 4.80, -1.18 (from peak R,M bin)
Modal (R,M,ε*) = 35.8 km, 5.03, 0 to 1 sigma (from peak R,M,ε bin)
Binning: DeltaR 25. km, deltaM=0.2, Deltaε=1.0
% Contribution to Hazard
SOURCE-to-SITE DISTANCE (km)
MAGNITUDE (Mw)
Prob. SA, PGA
<median | R,M
>median
$\varepsilon_0 < -2$
$-2 < \varepsilon_0 < -1$
$-1 < \varepsilon_0 < -0.5$
$-0.5 < \varepsilon_0 < 0$
$0 < \varepsilon_0 < 0.5$
$0.5 < \varepsilon_0 < 1$
$1 < \varepsilon_0 < 1.5$
$1.5 < \varepsilon_0 < 2$
$2 < \varepsilon_0 < 3$
2003 update USGS PSHA
GMT 2012 Mar 14 18:31:51 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on ROCK avg Vs=760 m/s top 30 m USGS CGHT PSHA2002v3 UPDATE Bins with lt 0.05% contrib. omitted

*** Deaggregation of Seismic Hazard for PGA & 2 Periods of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 2002 version ***
PSHA Deaggregation. %contributions. site: Hockomock_Swamp long: 71.081 W., lat: 41.999 N.
USGS 2002-03 update files and programs. dM=0.2. Site descr:ROCK
Return period: 975 yrs. Exceedance PGA =0.06348 g.
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.02502

DIST(KM)	MAG(MW)	ALL_EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
16.3	4.60	2.704	0.075	0.481	1.208	0.811	0.124	0.005
35.2	4.60	2.239	0.225	1.177	0.837	0.001	0.000	0.000
58.8	4.61	0.483	0.252	0.231	0.000	0.000	0.000	0.000
81.6	4.61	0.198	0.194	0.004	0.000	0.000	0.000	0.000
17.2	4.80	4.996	0.136	0.871	2.187	1.512	0.279	0.011
36.0	4.80	4.715	0.357	2.115	2.037	0.206	0.000	0.000
60.0	4.81	1.404	0.536	0.865	0.002	0.000	0.000	0.000
83.5	4.81	0.580	0.519	0.062	0.000	0.000	0.000	0.000
114.9	4.82	0.289	0.289	0.000	0.000	0.000	0.000	0.000
17.3	5.03	3.462	0.082	0.534	1.341	1.243	0.251	0.011
36.7	5.03	4.318	0.235	1.489	2.282	0.311	0.000	0.000
60.3	5.04	1.693	0.339	1.244	0.110	0.000	0.000	0.000
83.9	5.03	0.899	0.555	0.344	0.000	0.000	0.000	0.000
116.2	5.05	0.582	0.562	0.020	0.000	0.000	0.000	0.000
16.0	5.21	1.055	0.023	0.151	0.381	0.380	0.113	0.006
35.7	5.21	2.166	0.090	0.574	1.152	0.349	0.000	0.000
61.0	5.21	0.955	0.133	0.662	0.161	0.000	0.000	0.000
84.7	5.21	0.535	0.201	0.335	0.000	0.000	0.000	0.000
111.6	5.21	0.297	0.203	0.093	0.000	0.000	0.000	0.000
131.4	5.21	0.167	0.167	0.000	0.000	0.000	0.000	0.000
164.7	5.21	0.058	0.058	0.000	0.000	0.000	0.000	0.000
17.6	5.39	1.930	0.041	0.277	0.696	0.696	0.206	0.013
37.5	5.39	3.314	0.122	0.775	1.768	0.641	0.008	0.000
61.5	5.40	1.997	0.188	1.148	0.661	0.000	0.000	0.000
85.1	5.40	1.257	0.295	0.961	0.001	0.000	0.000	0.000
118.0	5.41	1.171	0.542	0.629	0.000	0.000	0.000	0.000
137.1	5.37	0.108	0.108	0.000	0.000	0.000	0.000	0.000
165.1	5.42	0.200	0.196	0.004	0.000	0.000	0.000	0.000
16.9	5.61	0.826	0.016	0.117	0.294	0.294	0.097	0.008
37.0	5.62	2.004	0.061	0.386	0.955	0.558	0.044	0.001
62.0	5.62	1.413	0.095	0.603	0.706	0.010	0.000	0.000
85.8	5.62	1.005	0.134	0.737	0.133	0.000	0.000	0.000
116.1	5.62	0.888	0.194	0.691	0.003	0.000	0.000	0.000
134.4	5.60	0.277	0.135	0.142	0.000	0.000	0.000	0.000
161.2	5.63	0.155	0.100	0.055	0.000	0.000	0.000	0.000
178.5	5.61	0.124	0.124	0.000	0.000	0.000	0.000	0.000
15.6	5.80	0.618	0.010	0.085	0.216	0.216	0.082	0.008
36.7	5.80	1.994	0.055	0.350	0.879	0.639	0.070	0.001
61.5	5.81	1.436	0.074	0.469	0.838	0.055	0.000	0.000
85.2	5.80	1.286	0.123	0.763	0.400	0.000	0.000	0.000
110.6	5.83	0.563	0.063	0.403	0.097	0.000	0.000	0.000
126.8	5.79	0.982	0.224	0.758	0.000	0.000	0.000	0.000
168.5	5.81	0.390	0.184	0.206	0.000	0.000	0.000	0.000
177.7	5.80	0.054	0.054	0.000	0.000	0.000	0.000	0.000
217.8	5.82	0.110	0.108	0.002	0.000	0.000	0.000	0.000
13.3	6.01	0.342	0.004	0.046	0.119	0.119	0.047	0.007
36.2	6.01	1.508	0.038	0.240	0.603	0.536	0.089	0.002
61.0	6.01	1.077	0.043	0.271	0.634	0.129	0.000	0.000
85.3	6.01	1.234	0.081	0.512	0.641	0.000	0.000	0.000
118.2	6.01	1.142	0.108	0.683	0.351	0.000	0.000	0.000
134.4	5.99	0.325	0.064	0.261	0.000	0.000	0.000	0.000
164.9	6.02	0.328	0.074	0.254	0.000	0.000	0.000	0.000
181.1	6.00	0.181	0.097	0.085	0.000	0.000	0.000	0.000
213.8	6.02	0.108	0.073	0.035	0.000	0.000	0.000	0.000
230.3	6.00	0.071	0.071	0.000	0.000	0.000	0.000	0.000
19.2	6.21	0.689	0.011	0.092	0.242	0.242	0.093	0.009
40.4	6.21	1.010	0.025	0.158	0.397	0.372	0.057	0.001
60.8	6.21	1.063	0.036	0.231	0.572	0.222	0.002	0.000
84.9	6.21	1.380	0.070	0.447	0.833	0.029	0.000	0.000
114.0	6.23	0.866	0.051	0.326	0.488	0.000	0.000	0.000
130.0	6.20	0.911	0.097	0.544	0.270	0.000	0.000	0.000
163.1	6.24	0.296	0.060	0.197	0.039	0.000	0.000	0.000
177.2	6.20	0.420	0.092	0.328	0.000	0.000	0.000	0.000
215.6	6.24	0.154	0.073	0.081	0.000	0.000	0.000	0.000
226.9	6.20	0.146	0.081	0.065	0.000	0.000	0.000	0.000
264.5	6.24	0.056	0.049	0.007	0.000	0.000	0.000	0.000
276.4	6.20	0.051	0.051	0.000	0.000	0.000	0.000	0.000
17.3	6.42	0.340	0.004	0.042	0.120	0.120	0.048	0.007
38.3	6.42	0.768	0.018	0.113	0.283	0.281	0.071	0.002
61.6	6.42	0.810	0.024	0.151	0.379	0.251	0.006	0.000
85.5	6.42	1.044	0.042	0.265	0.627	0.110	0.000	0.000
121.0	6.43	1.321	0.071	0.451	0.789	0.011	0.000	0.000

136.9	6.39	0.174	0.018	0.105	0.051	0.000	0.000	0.000
167.8	6.43	0.491	0.047	0.300	0.144	0.000	0.000	0.000
182.0	6.41	0.213	0.047	0.167	0.000	0.000	0.000	0.000
218.7	6.43	0.238	0.054	0.184	0.000	0.000	0.000	0.000
229.8	6.41	0.103	0.059	0.044	0.000	0.000	0.000	0.000
268.8	6.43	0.114	0.068	0.046	0.000	0.000	0.000	0.000
18.5	6.59	0.263	0.003	0.032	0.093	0.093	0.037	0.005
40.3	6.59	0.398	0.009	0.058	0.145	0.144	0.041	0.001
60.7	6.59	0.475	0.013	0.082	0.205	0.166	0.009	0.000
85.2	6.59	0.708	0.025	0.156	0.381	0.146	0.000	0.000
114.9	6.59	0.590	0.026	0.165	0.344	0.055	0.000	0.000
133.9	6.59	0.432	0.024	0.151	0.257	0.000	0.000	0.000
160.9	6.59	0.209	0.018	0.094	0.097	0.000	0.000	0.000
179.6	6.60	0.336	0.036	0.198	0.101	0.000	0.000	0.000
210.4	6.59	0.091	0.020	0.064	0.008	0.000	0.000	0.000
228.4	6.59	0.202	0.048	0.154	0.000	0.000	0.000	0.000
260.9	6.60	0.056	0.020	0.036	0.000	0.000	0.000	0.000
279.0	6.59	0.081	0.042	0.039	0.000	0.000	0.000	0.000
18.5	6.78	0.364	0.003	0.041	0.130	0.130	0.052	0.008
40.5	6.78	0.521	0.012	0.074	0.186	0.186	0.061	0.003
61.0	6.78	0.638	0.016	0.103	0.258	0.237	0.024	0.000
85.5	6.78	1.007	0.031	0.197	0.492	0.284	0.003	0.000
121.8	6.79	1.168	0.041	0.259	0.649	0.220	0.000	0.000
129.6	6.77	0.324	0.021	0.131	0.172	0.000	0.000	0.000
169.2	6.80	0.667	0.045	0.258	0.361	0.002	0.000	0.000
185.0	6.76	0.227	0.021	0.127	0.079	0.000	0.000	0.000
219.1	6.80	0.355	0.036	0.229	0.090	0.000	0.000	0.000
230.3	6.76	0.189	0.050	0.139	0.000	0.000	0.000	0.000
269.9	6.80	0.221	0.047	0.174	0.000	0.000	0.000	0.000
278.8	6.76	0.066	0.041	0.025	0.000	0.000	0.000	0.000
332.2	6.80	0.127	0.075	0.052	0.000	0.000	0.000	0.000
387.9	6.79	0.084	0.084	0.000	0.000	0.000	0.000	0.000
17.7	7.00	0.246	0.001	0.024	0.089	0.090	0.036	0.006
40.3	7.00	0.341	0.007	0.047	0.119	0.119	0.045	0.003
60.9	7.00	0.436	0.010	0.066	0.165	0.163	0.031	0.001
85.7	7.00	0.705	0.019	0.121	0.305	0.247	0.013	0.000
117.2	7.01	0.581	0.018	0.112	0.269	0.179	0.003	0.000
131.7	6.99	0.484	0.018	0.116	0.268	0.082	0.000	0.000
160.8	7.02	0.278	0.012	0.078	0.161	0.027	0.000	0.000
181.8	6.99	0.467	0.028	0.175	0.263	0.000	0.000	0.000
211.5	7.03	0.143	0.012	0.063	0.069	0.000	0.000	0.000
228.2	7.00	0.369	0.041	0.220	0.108	0.000	0.000	0.000
263.9	7.03	0.132	0.021	0.092	0.019	0.000	0.000	0.000
279.2	6.99	0.164	0.039	0.125	0.000	0.000	0.000	0.000
319.5	7.02	0.104	0.026	0.079	0.000	0.000	0.000	0.000
367.0	7.01	0.146	0.084	0.062	0.000	0.000	0.000	0.000
415.5	7.00	0.077	0.077	0.000	0.000	0.000	0.000	0.000
17.3	7.18	0.157	0.001	0.014	0.058	0.058	0.023	0.004
40.4	7.18	0.207	0.004	0.029	0.072	0.072	0.028	0.002
60.8	7.19	0.261	0.006	0.038	0.096	0.096	0.024	0.001
85.7	7.18	0.432	0.011	0.070	0.176	0.159	0.016	0.000
121.2	7.19	0.481	0.013	0.082	0.207	0.171	0.008	0.000
131.7	7.18	0.171	0.007	0.045	0.098	0.022	0.000	0.000
170.2	7.18	0.385	0.016	0.102	0.211	0.056	0.000	0.000
187.5	7.19	0.128	0.007	0.044	0.076	0.000	0.000	0.000
219.6	7.19	0.287	0.020	0.112	0.155	0.000	0.000	0.000
234.8	7.19	0.107	0.011	0.061	0.035	0.000	0.000	0.000
271.6	7.19	0.216	0.029	0.135	0.052	0.000	0.000	0.000
337.4	7.19	0.147	0.032	0.115	0.000	0.000	0.000	0.000
396.7	7.19	0.120	0.068	0.052	0.000	0.000	0.000	0.000
17.0	7.39	0.229	0.001	0.018	0.085	0.086	0.034	0.006
40.4	7.38	0.274	0.005	0.038	0.095	0.095	0.038	0.004
60.6	7.39	0.346	0.008	0.050	0.124	0.124	0.039	0.001
85.4	7.38	0.562	0.014	0.087	0.218	0.209	0.034	0.001
117.5	7.40	0.420	0.011	0.070	0.176	0.140	0.023	0.000
130.4	7.37	0.435	0.013	0.083	0.201	0.138	0.000	0.000
164.6	7.41	0.301	0.010	0.062	0.142	0.086	0.001	0.000
181.4	7.37	0.475	0.020	0.127	0.254	0.073	0.000	0.000
213.4	7.42	0.219	0.012	0.075	0.119	0.014	0.000	0.000
229.1	7.37	0.424	0.027	0.155	0.242	0.000	0.000	0.000
264.0	7.42	0.164	0.013	0.071	0.080	0.000	0.000	0.000
278.3	7.37	0.265	0.030	0.150	0.085	0.000	0.000	0.000
322.3	7.41	0.175	0.019	0.122	0.034	0.000	0.000	0.000
370.1	7.39	0.299	0.063	0.236	0.000	0.000	0.000	0.000
418.2	7.38	0.187	0.108	0.079	0.000	0.000	0.000	0.000

Summary statistics for above PSHA PGA deaggregation, R=distance, e=epsilon:
Mean src-site R= 81.2 km; M= 5.79; eps0= -0.10. Mean calculated for all sources.
Modal src-site R= 17.2 km; M= 4.80; eps0= -1.18 from peak (R,M) bin

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Gridded source distance metrics: Rseis Rrup and Rjb
 MODE R*=  35.8km; M*= 5.03; EPS.INTERVAL: 0 to 1 sigma  % CONTRIB.=  2.282

Principal sources (faults, subduction, random seismicity having >10% contribution)
Source Category:                % contr.   R(km)    M   epsilon0 (mean values)
CEUS gridded seism.              100.00    81.2   5.79   -0.10
Individual fault hazard details if contrib.>1%:
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LIQUEFACTION ANALYSIS

Modified 3/14/12

REFERENCE BORING NUMBER	HST-1
ELEVATION OF BORING GROUND SURFACE	78.80 FT.
DEPTH TO GROUNDWATER - DURING DRILLING	8.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE	10.50 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As)	0.110
EARTHQUAKE MOMENT MAGNITUDE	4.8
FINISHED GRADE FILL OR CUT FROM BORING SURFACE	2.00 FT. (Fill Height)
HAMMER EFFICIENCY	70 %
BOREHOLE DIAMETER	8 IN.
SAMPLING METHOD	Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **2.701**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **429** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 4.8
Source-To-Site Distance, R (km) = 17.2
Ground Motion Prediction Equations = CEUS
PGA = **0.110**

IF(P22="","",IF(B22>=(K$7+K$12-K$9),"N.L. (1)",IF(OR(G22>=12,AND(H22>0,I22>

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
77.8	1	35		75				0.133	0.133	77.833	98.400	0.708	0.133	0.373	0.373	1.500	**2.870**	0.963	**0.069**	**N.L. (1)**
72.8	6	28		0				0.130	0.783	51.347	51.347	0.318	0.130	1.023	1.023	1.338	**1.149**	0.886	**0.063**	**N.L. (1)**
67.8	11	10		0				0.061	1.088	16.225	16.225	0.173	0.061	1.328	1.484	1.135	**0.529**	0.791	**0.063**	**8.397 (D)**
62.8	16	10		0				0.061	1.393	16.065	16.065	0.171	0.061	1.633	2.101	1.073	**0.495**	0.686	**0.063**	**7.857 (D)**
57.8	21	9		10				0.060	1.693	13.745	14.911	0.159	0.060	1.933	2.713	1.025	**0.440**	0.587	**0.059**	**7.458 (D)**
52.8	26	1		10				0.043	1.908	1.482	2.384	0.055	0.043	2.148	3.240	0.997	**0.148**	0.502	**0.054**	**2.741 (C)**
47.8	31	3		10				0.051	2.163	4.252	5.213	0.074	0.051	2.403	3.807	0.975	**0.194**	0.439	**0.050**	**3.880 (C)**
42.8	36	16		0				0.065	2.488	22.306	22.306	0.246	0.065	2.728	4.444	0.925	**0.616**	0.394	**0.046**	**13.391 (D)**
37.8	41	19		0				0.067	2.823	25.354	25.354	0.299	0.067	3.063	5.091	0.886	**0.716**	0.365	**0.043**	**N.L. (3)**
32.8	46	49		0				0.075	3.198	68.566	68.566	0.474	0.075	3.438	5.778	0.824	**1.055**	0.346	**0.042**	**N.L. (3)**
27.8	51	135		0				0.086	3.628	######	176.542	1.296	0.086	3.868	6.520	0.786	**2.752**	0.335	**0.040**	**N.L. (3)**
22.8	56	53		0				0.076	4.008	65.495	65.495	0.448	0.076	4.248	7.212	0.757	**0.917**	0.328	**0.040**	**N.L. (3)**
18.8	60	100		0				0.083	4.340	######	117.782	0.856	0.083	4.580	7.794	0.735	**1.698**	0.324	**0.039**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATIO
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

LIQUEFACTION ANALYSIS

Modified 3/14/12

REFERENCE BORING NUMBER ====================================	HST-4
ELEVATION OF BORING GROUND SURFACE ==========================	70.50 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ======================	4.40 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ==================	6.40 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) =====	0.110
EARTHQUAKE MOMENT MAGNITUDE ================================	4.8
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ===============	2.00 FT. (Fill Height)
HAMMER EFFICIENCY===	70 %
BOREHOLE DIAMETER==	8 IN.
SAMPLING METHOD==	Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **2.701**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^*_{s,40'}$ = **454** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 4.8
Source-To-Site Distance, R (km) = 17.2
Ground Motion Prediction Equations = CEUS
PGA = **0.110**

IF(P22="","",IF(B22>=(K$7+K$12-K$9),"N.L. (1)",IF(OR(G22>=12,AND(H22>0,I22>

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
69.5	1	3		10				0.105	0.105	5.645	6.636	0.085	0.105	0.345	0.345	1.465	**0.335**	0.970	**0.069**	**N.L. (1)**
64.5	6	51		5			74	0.076	0.485	######	102.726	0.741	0.076	0.725	0.825	1.500	**3.004**	0.904	**0.074**	**N.L. (3)**
59.5	11	5		10				0.055	0.760	8.693	9.751	0.111	0.055	1.000	1.412	1.189	**0.356**	0.820	**0.083**	**4.289 (C)**
54.5	16	3		6				0.051	1.015	5.243	5.298	0.074	0.051	1.255	1.979	1.112	**0.223**	0.724	**0.082**	**2.720 (C)**
49.5	21	4		10				0.053	1.280	6.769	7.784	0.094	0.053	1.520	2.556	1.075	**0.273**	0.626	**0.075**	**3.640 (C)**
44.5	26	5		10				0.055	1.555	8.051	9.094	0.105	0.055	1.795	3.143	1.038	**0.295**	0.540	**0.068**	**4.338 (C)**
39.5	31	8		80	0			0.059	1.850	12.146	19.576	0.210	0.059	2.090	3.750	1.004	**0.570**	0.472	**0.061**	**9.344 (D)**
34.5	36	15		90	10			0.065	2.175	22.298	31.758	0.677	0.065	2.415	4.387	0.953	**1.742**	0.424	**0.055**	**31.673 (D)**
29.5	41	14		90	19	40	40	0.064	2.495	19.291	28.149	0.375	0.064	2.735	5.019	0.916	**0.928**	0.391	**0.051**	**N.L. (2)**
24.5	46	20		90	20			0.067	2.830	26.995	37.394	-0.022	0.067	3.070	5.666	0.862	**-0.052**	0.370	**0.049**	**N.L. (2)**
19.5	51	16		90	20			0.065	3.155	19.713	28.656	0.395	0.065	3.395	6.303	0.849	**0.905**	0.357	**0.047**	**N.L. (2)**
14.5	56	14		100	20			0.064	3.475	16.058	24.270	0.278	0.064	3.715	6.935	0.835	**0.628**	0.349	**0.047**	**N.L. (2)**
9.5	61	20		10				0.067	3.810	22.519	23.875	0.271	0.067	4.050	7.582	0.814	**0.596**	0.344	**0.046**	**12.957 (D)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI ≥ 12 OR w_c/LL ≤ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

LIQUEFACTION ANALYSIS

Modified 3/14/12

REFERENCE BORING NUMBER ==================================== HST-9
ELEVATION OF BORING GROUND SURFACE ========================== 71.60 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 4.08 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================= 6.08 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.110
EARTHQUAKE MOMENT MAGNITUDE ================================ 4.8
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== 2.00 FT. (Fill Height)
HAMMER EFFICIENCY=== 70 %
BOREHOLE DIAMETER== 8 IN.
SAMPLING METHOD== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **2.701**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^*_{s,40'}$ = **389** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 4.8
Source-To-Site Distance, R (km) = 17.2
Ground Motion Prediction Equations = CEUS
PGA = **0.110**

IF(P22="","",IF(B22>=(K$7+K$12-K$9),"N.L. (1)",IF(OR(G22>=12,AND(H22>0,I22>

ELEV. OF SAMPLE (FT.)	BORING DATA: BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	CONDITIONS DURING DRILLING: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$
70.6	1	10		5				0.118	0.118	20.014	20.014	0.216
65.6	6	66		5				0.078	0.508	######	131.937	0.962
60.6	11	19		20				0.067	0.843	36.961	43.512	0.212
55.6	16	2		90			409	0.048	1.083	3.430	9.116	0.105
50.6	21	8		10				0.059	1.378	13.199	14.354	0.154
45.6	26	3		90	0			0.051	1.633	4.740	10.688	0.119
40.6	31	1		99	0		66.5	0.043	1.848	1.519	6.823	0.086
35.6	36	11		10				0.062	2.158	15.852	17.064	0.182
30.6	41	30		90	15			0.071	2.513	46.555	60.866	0.409
25.6	46	33		90	15			0.072	2.873	48.350	63.020	0.427
20.6	51	38		90	25			0.073	3.238	53.045	68.654	0.475
15.6	56	35		80	20			0.072	3.598	44.924	58.909	0.391
10.6	61	123		10				0.085	4.023	######	156.052	1.143

ELEV. OF SAMPLE (FT.)	CONDITIONS DURING EARTHQUAKE: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
70.6	0.118	0.358	0.358	1.500	**0.874**	0.951	**0.068**	**N.L. (1)**
65.6	0.078	0.748	0.868	1.500	**3.898**	0.851	**0.071**	**N.L. (3)**
60.6	0.067	1.083	1.515	1.308	**0.751**	0.738	**0.074**	**N.L. (3)**
55.6	0.048	1.323	2.067	1.112	**0.317**	0.624	**0.070**	**4.529 (C)**
50.6	0.059	1.618	2.674	1.072	**0.445**	0.523	**0.062**	**7.177 (D)**
45.6	0.051	1.873	3.241	1.030	**0.332**	0.444	**0.055**	**6.036 (C)**
40.6	0.043	2.088	3.768	1.003	**0.234**	0.387	**0.050**	**4.680 (C)**
35.6	0.062	2.398	4.390	0.967	**0.474**	0.349	**0.046**	**10.304 (D)**
30.6	0.071	2.753	5.057	0.901	**0.995**	0.325	**0.043**	**N.L. (2)**
25.6	0.072	3.113	5.729	0.858	**0.990**	0.310	**0.041**	**N.L. (2)**
20.6	0.073	3.478	6.406	0.820	**1.052**	0.300	**0.040**	**N.L. (2)**
15.6	0.072	3.838	7.078	0.789	**0.834**	0.295	**0.039**	**N.L. (2)**
10.6	0.085	4.263	7.815	0.756	**2.334**	0.291	**0.038**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES