State of California
Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Integrated Regional Water Management

# Site Characterization and Groundwater Monitoring Data Collection Summary Prospect Island Tidal Habitat Restoration Project Solano County, California

North Central Region Office

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Memorandum Report
June 2013

State of California | California Natural Resources Agency

# Memorandum

Date: June 26, 2013

To: Dennis McEwan
Environmental Program Manager I
Division of Environmental Services

From: Christopher L. Bonds, Chief
Geology and Groundwater Investigations Section
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Division of Integrated Regional Water Management
**Department of Water Resources**

Subject: Memorandum Report – Site Characterization and Groundwater Monitoring Data Collection Summary, Prospect Island Tidal Habitat Restoration Project, Solano County, California

I am pleased to present the attached Memorandum Report – Site Characterization and Groundwater Monitoring Data Collection Summary - Prospect Island Tidal Habitat Restoration Project - Solano County, California for your information and use. This memorandum report presents the following: an introduction to the restoration project, the purpose of the site characterization and groundwater monitoring study, a summary of previous work, DWR field activities, and a summary of future DWR work. This study has been ongoing since January 2010 and DWR field activities were performed in cooperation with Reclamation District 501 and Ryer Island landowners.

Our field activities on Prospect and Ryer Islands included groundwater and surface water level monitoring, subsurface exploration, well installations on Prospect Island, topographic surveying, bathymetric surveying, and collection of bed sediment samples.

If you have any questions regarding the project or memorandum report, please contact me at (916) 376-9657.

Attachment

| SURNAME DWR 155 (Rev 7/11) | CLB 6/26/13 | [signature] 6/26/13 | G.L. for EH 6/26/13 | |
|---|---|---|---|---|

**Site Characterization and Groundwater Monitoring**
**Data Collection Summary**
**Prospect Island Tidal Habitat Restoration Project**
**Solano County, California**

Memorandum Report
June 2013

This memorandum report was prepared by the following Professional Geologists who were in responsible charge of the work, in accordance with the provisions of the Geologist and Geophysicist Act of the State of California.


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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| bgs | below ground surface |
| CDFW | California Department of Fish & Wildlife |
| CEQA | California Environmental Quality Act |
| CPT | Cone Penetration Test |
| CPTu | Piezocone |
| DEM | Digital Elevation Model |
| DWR | California Department of Water Resources |
| DWSC | Sacramento River Deep Water Ship Channel |
| ERP | Ecosystem Restoration Program |
| FRPA | Fish Restoration Program Agreement |
| GIS | Geographic Information System |
| Gregg D&T | Gregg Drilling and Testing, Inc. |
| GSA | US General Services Administration |
| LiDAR | Light Detection and Ranging |
| MSL | Mean Sea Level |
| NEPA | National Environmental Policy Act |
| NCRO | North Central Region Office |
| PBC | Federal Public Benefit Conveyance |
| PPDT | Pore Pressure Dissipation Test |
| PVC | Polyvinyl Chloride |
| RD 501 | Reclamation District 501 |
| RTK-GPS | Real-Time Kinematic-Global Positioning System |
| SWP | State Water Project |
| USA | Underground Service Alert |
| USACE | US Army Corps of Engineers |
| USBR | US Bureau of Reclamation |
| USFWS | US Fish and Wildlife Service |
| USGS | US Geological Survey |
| WDL | Water Data Library |

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Top: Cone Penetration Testing on Prospect Island (September 2011)

Bottom: Cone Penetration Testing on Ryer Island (March 2012)

## 1.0 INTRODUCTION

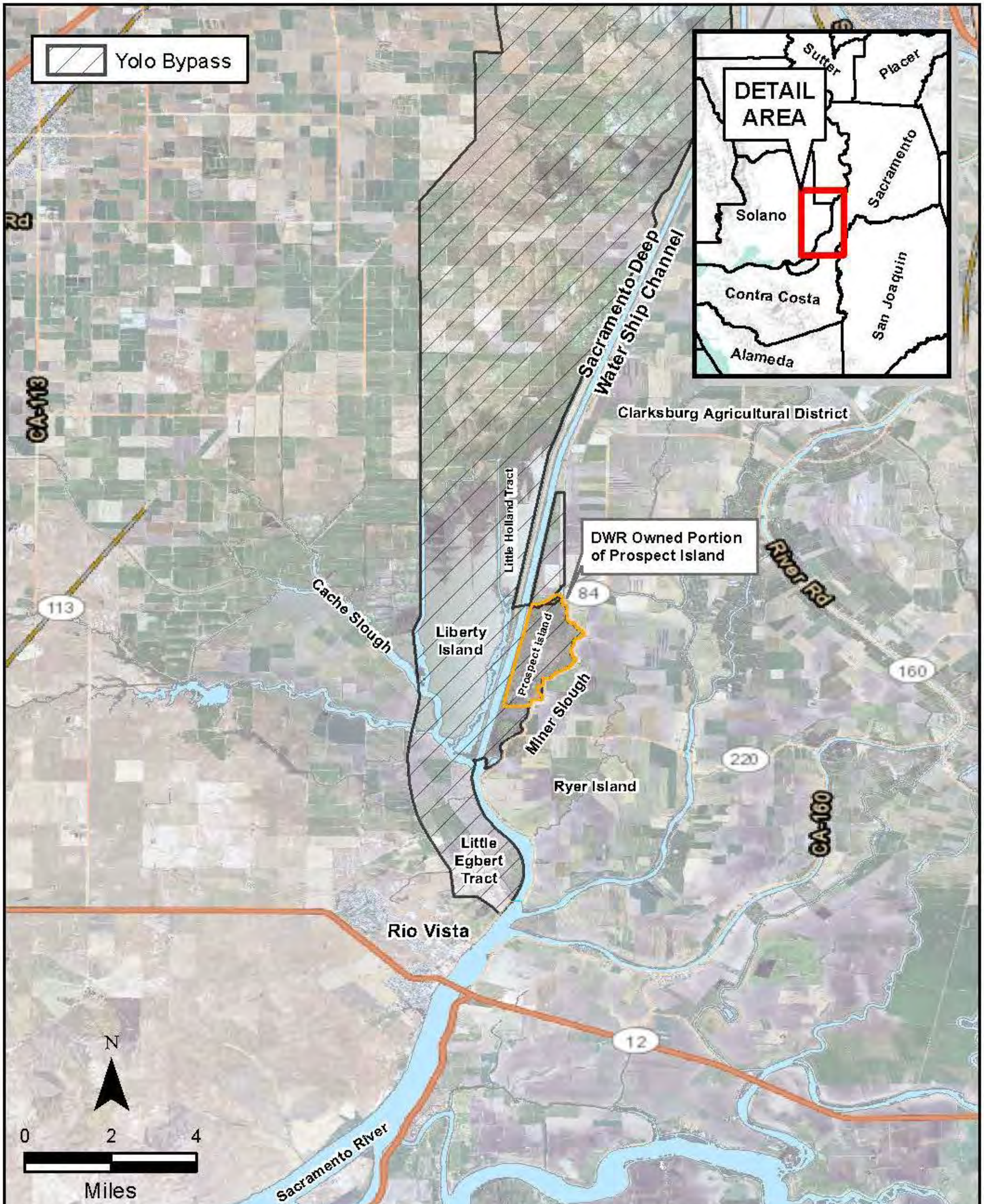
### 1.1 Restoration Project Background

The Prospect Island Tidal Habitat Restoration Project is a joint effort by the California Department of Water Resources (DWR) and the California Department of Fish & Wildlife (CDFW). Together the agencies are developing the plan to restore the property to freshwater tidal wetland and open water (subtidal) habitats to benefit native fish and improve aquatic ecosystem functions. Planned restoration efforts will entail interior grading, vegetation management, possible importation of clean fill for subsidence reversal, possible weir installation, breaching of exterior levees, and addressing various property considerations. Monitoring will take place as part of a science-based adaptive management plan. The design of future restoration projects will incorporate knowledge gained through the implementation and monitoring of this project.

The restoration project is a component of DWR's and CDFW's Fish Restoration Program Agreement (FRPA). FRPA implements the fish habitat restoration actions for the following requirements: US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service biological opinions on the State Water Project (SWP) and Central Valley Project coordinated long-term operations and CDFW Incidental Take Permit for SWP Delta operations. The restoration project is in accordance with DWR's Environmental Stewardship Policy, which states that DWR has a responsibility to protect and restore the environment and should implement projects that contribute to the recovery of listed species.

### 1.2 Location

Prospect Island is a 1,600-acre property located in Solano County, in the Cache Slough Complex of the northwestern Sacramento-San Joaquin Delta (**Figure 1**). The island is comprised of two parcels: the northern 1,300-acre portion is owned by DWR and the southern 300-acre portion is owned by the Port of West Sacramento. Prospect Island is situated between the Sacramento River Deep Water Ship Channel (DWSC) to the west and Miner Slough on the east. Liberty Island, a 4,500-acre naturally-breached island that is restoring to tidal marsh and open water, sits just west across the DWSC.
Ryer Island, a large agricultural tract, lies to the east across Miner Slough. To the north is the Clarksburg Agricultural District and to the south is Cache Slough. Prospect Island is still designated as part of the Yolo Bypass, although it was cut off from the main Yolo Bypass with construction of the DWSC in 1963. Prospect Island functions today as a high stage overflow basin, as does Little Egbert Tract to the southwest.

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Prospect Island
Tidal Habitat Restoration Project
Location Map

**Figure 1**

## 1.3 Benefits

The goal of Prospect Island restoration is to support recovery of delta smelt, Chinook salmon, and many other Delta-dependent fish and wildlife species. Restoration objectives are to enhance aquatic food web productivity within and around Prospect Island while enhancing and creating juvenile salmonid rearing habitat and enhancing habitat for many other species, provide long-term resiliency to climate change, improve water quality, and avoid conditions that detract from meeting the project goal.

## 1.4 Ownership and Restoration Planning History

US Bureau of Reclamation (USBR) purchased Prospect Island from Sakata Brothers, Inc. with the assistance of the Trust for Public Land in 1994. The purchase was part of a multi-agency effort to restore wetland and riparian habitat. Prospect Island, along with Liberty Island and Little Holland Tract, were purchased to be part of a proposed North Delta National Wildlife Refuge to be managed by the USFWS. The refuge has not been established.

Prospect Island and the adjacent Liberty Island and Little Holland Tract are considered a priority area for meeting the objectives of the CALFED Ecosystem Restoration Program (ERP). The ERP Plan's vision for the North Delta included restoration of marsh, slough and shallow water habitat complexes on these three specific parcels. In this vision, these complexes would provide rearing and migrating habitat for juvenile and adult salmon, and rearing and spawning habitat for other native fishes, including delta smelt and splittail.

DWR and the US Army Corps of Engineers (USACE) examined restoration options in the Prospect Island Ecosystem Restoration Project Environmental Assessment/Initial Study, June 2001. This Plan identified restoration alternatives to construct shallow water habitat on Prospect Island. DWR had secured a commitment for the non-Federal cost-share in the form of ERP-related California Urban Water Agency funds and Delta Levee Program AB 360 funds based on the original cost estimates in 1996. By 2002, the original construction costs had increased. DWR was unable to secure the additional funds through the ERP, primarily due to concerns about the lack of a long-term property owner and manager. Without financial assurance of the additional non-Federal cost-share from DWR, USACE could not award a contract to construct the project.

In addition to local opposition to the establishment of a North Delta National Wildlife Refuge, there has been significant local landowner opposition to restoration activities on Prospect Island. Reclamation District 501 (RD 501) and Ryer Island landowners filed a lawsuit against the adequacy of the environmental documentation for the establishment of the Refuge in 2000 under the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). Other legal complaints by a Prospect Island lessee and Ryer Island landowners have alleged significant economic effects due to flooding on Prospect Island.

In 2008, USBR requested that US General Services Administration (GSA) dispose of the property as surplus. In March 2009, the GSA made the property available to qualified agencies through the Federal Public Benefit Conveyance (PBC) process. Subsequently, DWR submitted a Letter of Intent to the GSA to acquire the property through the PBC and in January 2010, DWR acquired the northern portion of Prospect Island from the GSA.

## 2.0 PURPOSE OF SITE CHARACTERIZATION AND GROUNDWATER MONITORING STUDY

The purpose of this study is to better characterize the subsurface hydrogeologic conditions in the Prospect and Ryer Island study area and further evaluate the potential for seepage to occur on Ryer Island as a result of the Prospect Island Restoration Project. This study was designed to collect a more comprehensive data set than has been collected during previous restoration efforts. Furthermore, the additional data collection, monitoring, and analysis efforts proposed for this study are intended to address the previous concerns and data deficiencies raised by RD 501 and Ryer Island landowners.

The term seepage is frequently used in more than one sense. In its broadest meaning, and as most commonly applied, seepage is used to describe a high groundwater table and any surface water which result in part from percolation from river channels and in part from local rainfall and runoff. Seepage has also been used in a more restricted sense to describe the water which results from percolation through or under levees, appearing as surface water or groundwater within the root zone on lands adjacent to the levees. For this study, “seepage” is defined in the more restrictive sense.

The study will be accomplished in two phases over the course of several years including:

> Phase 1 - conducting a review of previous studies, subsurface exploration, well installation, groundwater and surface water level monitoring, land and bathymetry surveying, bed sediment sampling, and data reporting.
>
> Phase 2 – additional data collection, creation of a project-specific 3-D geographic information system (GIS), geologic and hydrologic data analysis, seepage modeling, and final reporting.

## 3.0 PREVIOUS WORK

### 3.1 Introduction

Numerous federal, state, and local agency studies have been performed to evaluate geotechnical and groundwater conditions and/or the nature and extent of seepage in the vicinity of Prospect and Ryer Islands. It is important to note that most of these previous studies have relied upon existing data from surrounding areas to characterize the subsurface geologic and hydrogeologic conditions of Prospect and Ryer Islands and that limited new subsurface exploration was conducted to support these studies.

The following is a chronological listing of pertinent studies and related work performed in the vicinity of Prospect and Ryer Islands to evaluate geotechnical/groundwater conditions and/or seepage followed by a summary of relevant findings/conclusions.

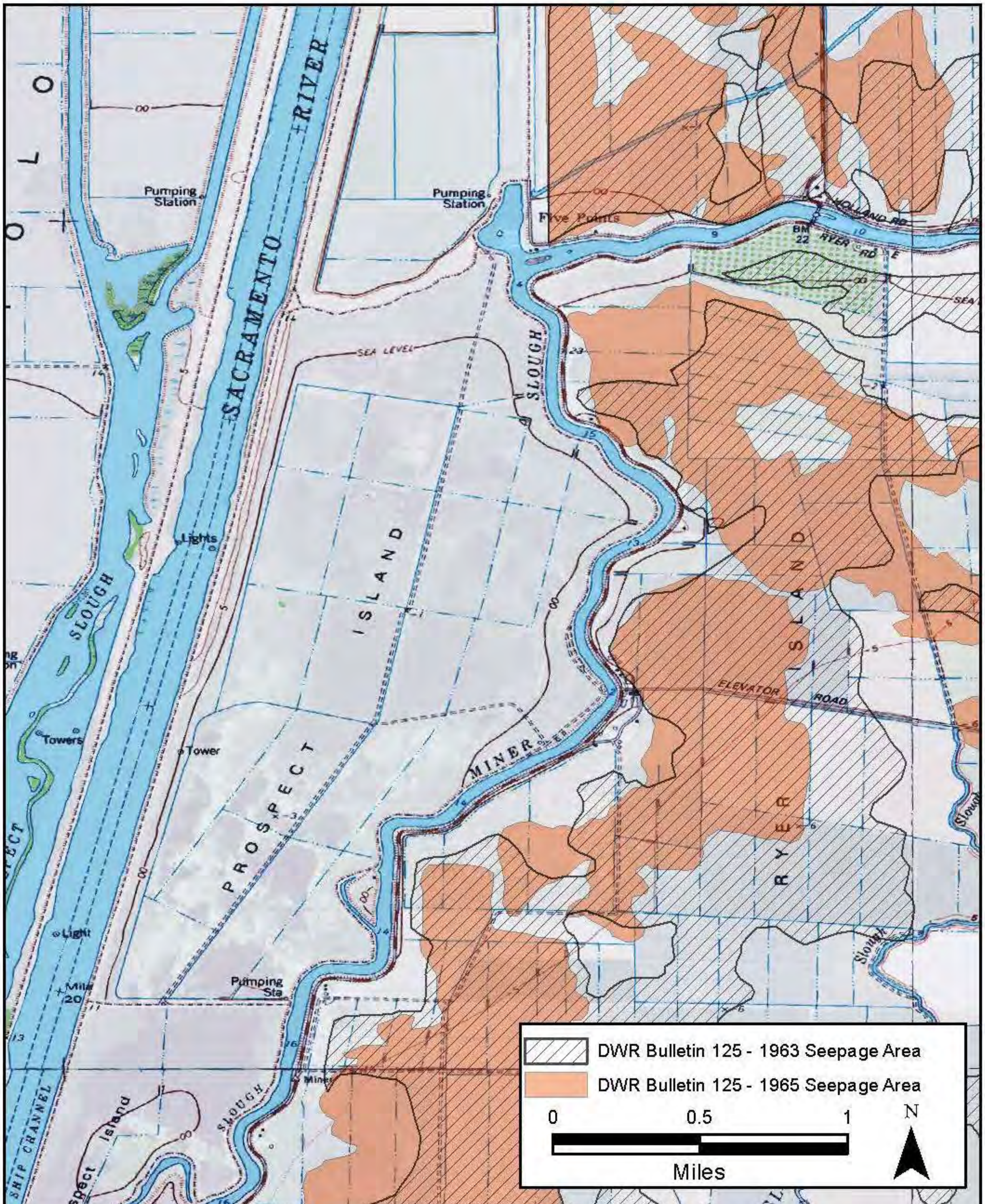
#### 3.1.1 DWR Bulletin 125 – Sacramento Valley Seepage Investigation, August 1967

This bulletin presents the results of an investigation of seepage conditions along the Sacramento and Feather Rivers in the Sacramento Valley between 1959 and 1965. The investigation included review of aerial photographs of areas along both rivers and field visits to areas of observed seepage, which included all of Ryer Island. A map showing observed seepage areas on Ryer Island following two high flow events in 1963 and 1964-65 is shown on **Figure 2**. This map shows that seepage following these events was significant and extended across large portions of Ryer Island from the perimeter sloughs to the island's interior. Mapped seepage on Ryer Island adjacent to Miner Slough extended at least 1,000 feet or more into the islands' interior.

#### 3.1.2 Reconnaissance Report, Proposed Wetlands, Prospect Island prepared by USACE, Sacramento District, Soil Design Section, May 31, 1994

This reconnaissance report summarizes existing geotechnical information along the western side of Prospect Island during planning and design of the DWSC.
The alignment of the ship channel through Prospect Island was explored in three separate programs from 1950 to 1958 as the channel design developed. Eleven (11) combination hand auger and push tube holes were drilled along the channel alignment in 1950 to a maximum depth of 45 feet (**Figure 3**). Four (4) rotary core holes were drilled along the channel alignment in Prospect Island during 1956 to a maximum depth of 30 feet. In 1958, an exploration program was conducted along three transects located on Prospect Island. This involved drilling 30 auger holes along with 19 companion Swedish foil sampler holes. A total of 45 locations were drilled to depths of 30 to 45 feet.

Surficial organic soils (OH, OL, and PT) vary in thickness from 2 feet at the north end of the island to 21 feet at the south end. These soft and compressible soils average

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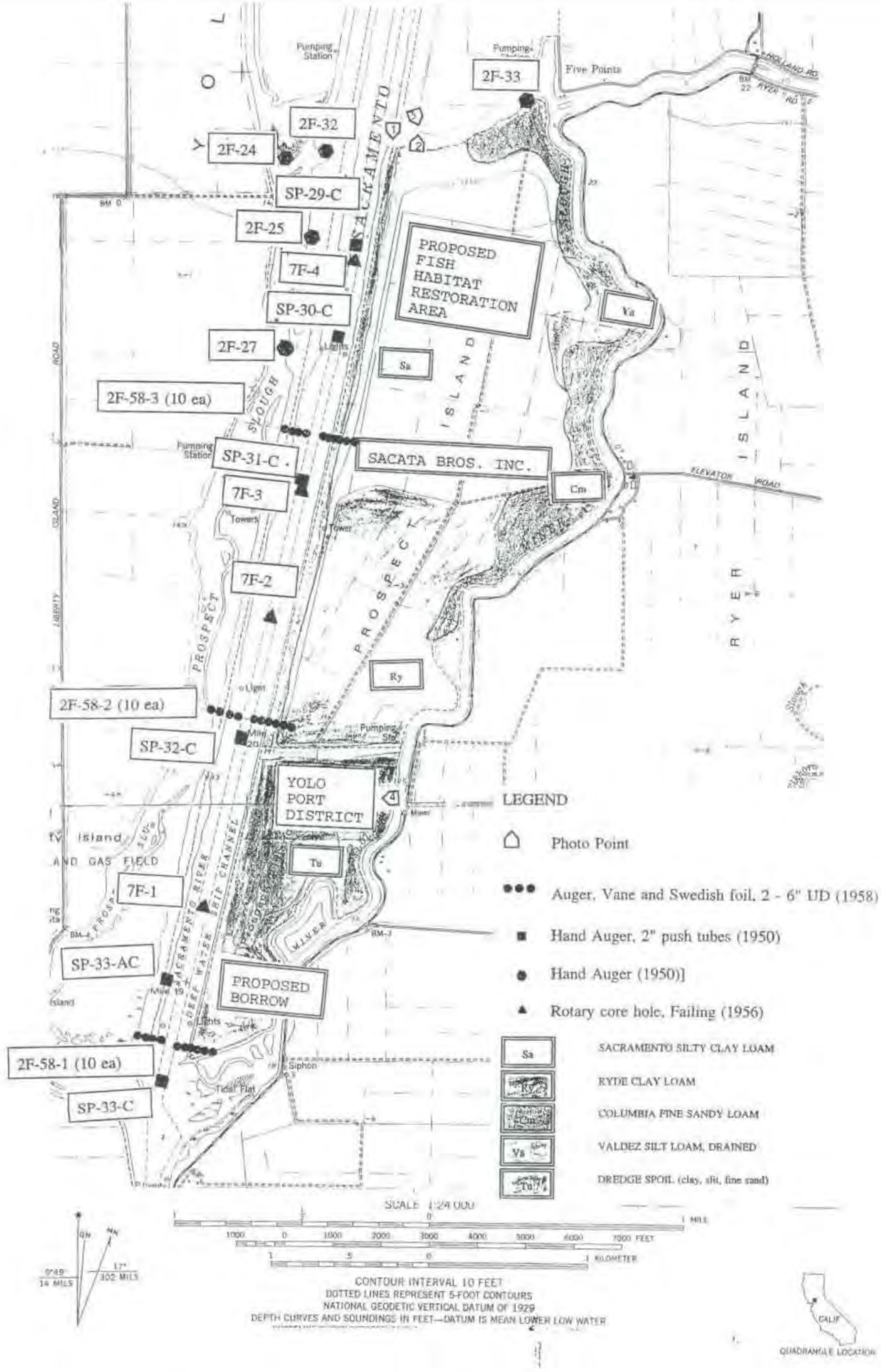
Sacramento Valley
Seepage Investigation
DWR Bulletin No. 125

**Figure 2**




PROPOSED WETLANDS PROJECT AT PROSPECT ISLAND

| | | |
|---|---|---|
| **DEPARTMENT OF WATER RESOURCES**<br>Division of Integrated Regional Water Management<br>**NORTH CENTRAL REGION OFFICE**<br>*Geology and Groundwater Investigations Section* | **USACE Reconnaissance Report, Proposed Wetlands, Prospect Island Map, 1994** | **Figure 3** |

10 feet thick. This surface layer is typically underlain by a firm clay (CL-CH) layer which varies from 4 to 29 feet thick and averages 12 feet. Below this, sand (SP-SW) is encountered which varies from 5 to 10 feet thick and averages 8 feet to the exploration depth of 30 feet.

### 3.1.3 RD 501 Shallow Well Installations on Ryer Island, Spring 1996

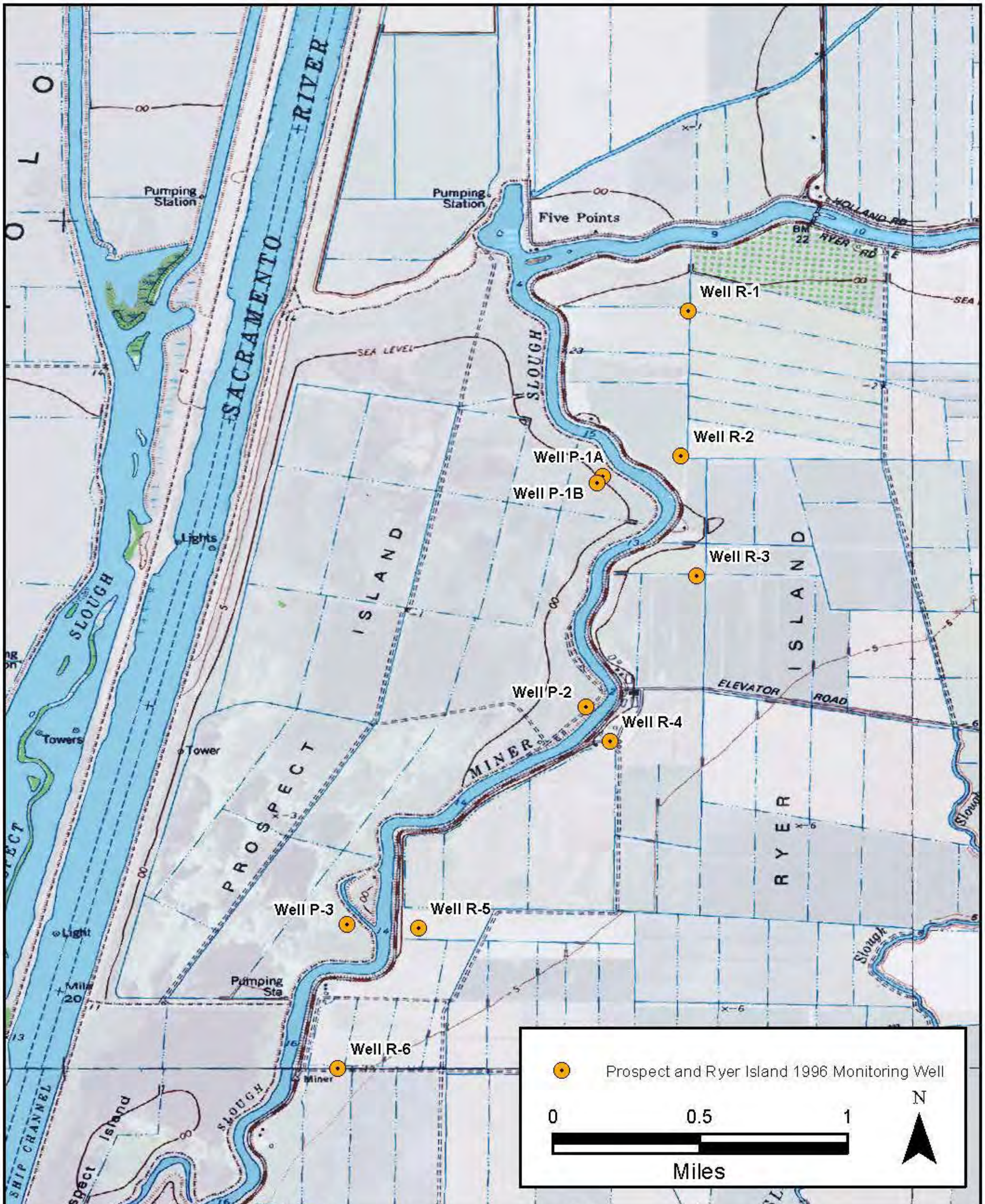
The initial Ryer Island groundwater monitoring network consisted of five wells built in the spring of 1996 by a geophysical surveying company at the request of Tom Hester, a Ryer Island landowner and RD 501 Board member. The network originally consisted of six wells, R-1 through R-6, but well R-2 was reportedly destroyed before monitoring began (**Figure 4**). It is reported that these wells were constructed using 2-inch polyvinyl chloride (PVC) casing to a depth of about 10 feet. Wells R-1 through R-4 were constructed with 1/4-inch diameter holes (perforations) throughout the length of the casings. The perforation type and interval of wells R-5 and R-6 are unknown. The subsurface portions of all wells were wrapped with geotextile filter fabric. Important details such as soil types encountered during drilling and use of filter pack and sealing materials are unknown.

### 3.1.4 Installation of Groundwater Level Monitoring Wells on Prospect Island, Memo, USBR, May 5, 1996

On April 30, 1996, USBR geology staff drilled four 3-inch diameter hand-auger holes along the eastern side of Prospect Island and installed four wells (P-series) ranging in depth from 6 to 9 feet below ground surface (bgs) (**Figure 4**). The wells were constructed of 2-inch diameter PVC casing with hacksaw cut slots (perforations). The annular spaces were backfilled with clean sand to 1 foot bgs followed by a layer of bentonite pellets to the ground surface. Soils observed during the hand auger drilling consisted of mostly lean and fat clay, some organic soil and peat, and minor amounts of clayey and silty sand.

### 3.1.5 Seepage Study, Prospect Island - Miner Slough - Ryer Island, Soil Design Section, Geotechnical Branch, USACE, April 1997

The primary purpose of this study was to develop a "worse case" preliminary answer to the question, "Will the grading and flooding of Prospect Island aggravate the existing seepage conditions on Ryer Island?" The study report notes that it is based on very limited subsurface information from several nearby construction projects and groundwater investigations. Seepage modeling was performed along two transects of Miner Slough between Prospect and Ryer Islands. Approximate hydraulic conductivities were based on water level recovery data from several piezometers on Ryer Island and book values. Under normal conditions with the clay cap on Prospect Island and sedimentation layer in Miner Slough, they estimated that there are no differences in the

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**Prospect and Ryer Island Shallow Monitoring Wells, 1996**

**Figure 4**

quantity of flows along the two transects when only Miner Slough is flooded and when both Prospect Island and Miner Slough are flooded to the same elevations.

A worst case scenario was also simulated with an exposed sand deposit on Prospect Island passing under Miner Slough and surfacing at Ryer Island with a water elevation at 7 feet MSL in both Miner Slough and Prospect Island. The estimated seepage flows into Ryer Island are increased by a factor of eight if scraping-grading operations expose shallow sand layer(s) on Prospect Island that pass under Miner Slough.

The study concluded that in its 1997 flooded condition, Prospect Island has no gross effect on Ryer Island seepage. Ryer Island seepage is primarily correlated with the water surface elevation changes of Miner Slough. In the worst case scenario, exposing a sand layer on Prospect Island may cause localized seepage effects on Ryer Island if that sand layer passes under Miner Slough. However, an exposed sand layer would likely be sealed naturally after several years or could be mechanically sealed using a non-permeable membrane, clay liner, or other material.

### 3.1.6 Prospect Island Seepage Analysis, USACE Hydraulic Design Section, Memo, April 22, 1997

USACE staff evaluated groundwater level data from the wells installed on Prospect and Ryer Island in comparison to stage data from Miner Slough over a period from April through June 1996. They concluded that the groundwater elevations in the Ryer Island wells followed the general trend of Miner Slough stage and that the groundwater levels may be governed by stage in Miner Slough. They also acknowledged that this data represents only a small snapshot in time and that no definite conclusions can be made regarding the relationship between flooding of Prospect Island, stage in Miner Slough, and groundwater elevations on Ryer Island.

### 3.1.7 Update of the 4/22/97 Prospect Island Seepage Analysis, Memo, USACE, March 30, 1998

USACE staff evaluated additional groundwater level data from wells on Prospect and Ryer Islands and stage data from Miner Slough from July 1996 through December 1997. Based on this additional data they concluded that there is no evidence that there is a link between Prospect Island flooding and Ryer Island seepage. They again acknowledged that the available data represents a very small snapshot in time.

### 3.1.8 Preliminary Seepage Analysis, Prospect Island, CA, Todd Engineers, May 26, 1998

Todd Engineers was requested by the U.S. Department of Justice to evaluate potential hydrologic impacts of flooding on Prospect Island. This request was in response to a complaint filed by a landowner on adjacent Ryer Island asserting that flooded conditions on Prospect Island beginning in March 1995 had resulted in the flooding of Ryer Island, preventing farming activities (Sam Sakata Farms v. United States of America, 1996). A portion of Prospect Island was owned by the USBR. This memorandum described the evaluation conducted by Todd Engineers and their preliminary findings are presented below:

- The elevation of the water table beneath Prospect Island and Ryer Island in the vicinity of Miner Slough is controlled predominantly by the stage in Miner Slough.

- Seepage through the Miner Slough/Ryer Island levee is also controlled by the stage in Miner Slough and is not related to the flooding of Prospect Island.

- The suggestion in the complaint (Sam Sakata Farms v. United States of America, 1996) that the flood waters caused "hydrologic pressure" on this levee does not appear to be valid.

- Permanent flooded conditions on Prospect Island as proposed by the Corps are not expected to increase the stage in Miner Slough, and therefore, are not expected to impact water levels beneath Ryer Island.

- Additional borings and groundwater wells will be helpful in developing a more detailed understanding of seepage and groundwater conditions beneath the site.

#### 3.1.9 Shallow Groundwater Level Trends in the Northwest Portion of Ryer Island, Sacramento-San Joaquin Delta, DWR Central District, Office Report, January 20, 1999

This report presented the results of hydrologic monitoring and analysis on and near Prospect and Ryer Islands in order to determine the cause of high groundwater levels occurring on the northwest side of Ryer Island. Key conclusions are as follows:

- The water level in Ryer Island drainage ditches appears to be the primary control on the shallow groundwater level in the northwest corner of Ryer Island. The water level in Miner Slough and rainfall also affect the water level in shallow groundwater, but to a lesser degree. The level of water impounded on Prospect Island does not appear to affect the shallow groundwater levels in the northwest part of Ryer Island.

#### 3.1.10 Evaluation of Potential Impacts on Ryer Island Associated with Flooding Prospect Island, Solano County, CA, GEI Consultants, July 21, 1999

This geotechnical report, prepared on behalf of RD 501 by GEI Consultants, presented the results of drilling, well installation, groundwater level monitoring, levee stability analysis, and preliminary seepage modeling, and also a review of the Todd Engineers

Report. It was noted that measurements in some of the previously installed Ryer Island piezometers (spring 1996) indicated that they may not have effective seals and could be potentially influenced by changes in surrounding surface water conditions. A footnote in this report states that these observation wells were partly backfilled by placing the augered soil cuttings around the plastic pipe at the ground surface. Therefore, RD 501 decided to install new engineered wells to further evaluate the local groundwater conditions because the original wells may have compromised annular seals. In this study, 11 borings were drilled and 11 single and cluster wells were installed to depths between 14 and 58 feet bgs on Ryer Island (**Figure 5**). Groundwater level data from the new monitoring wells for the time period April 23 and June 21, 1999 was analyzed. Significant findings/conclusions are summarized below:

- The groundwater elevations measured in the piezometers are consistent with conditions that would be expected if Prospect Island was a groundwater recharge source that is a generally easterly groundwater gradient from Prospect Island and Miner Slough. These conditions are also consistent with Miner Slough being a groundwater recharge or seepage source.

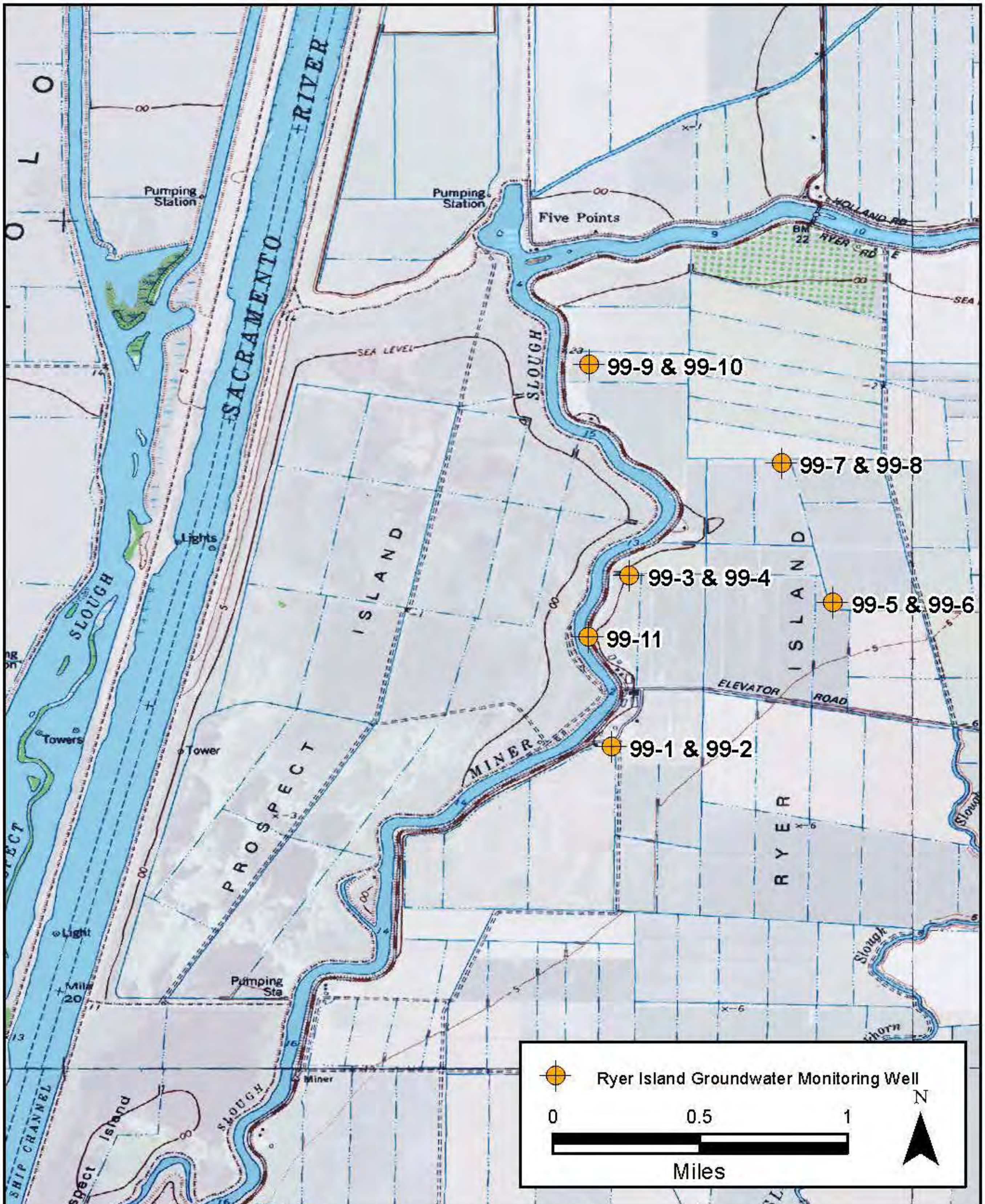
- Preliminary seepage modeling indicated that small amounts of increased seepage flow, an increase of 5 to 6%, could occur due to flooding Prospect Island to about elevation 0 feet.

- They stated that an inadequate level of engineering work was done by the Prospect Island Project to reach a conclusion that flooding Prospect Island will have no impact on Ryer Island. They also stated that the Prospect Island Project should have conducted much more extensive and thorough geologic and geotechnical investigation to evaluate the potential for increased seepage into Ryer Island, especially considering the increased seepage reported by the Ryer Island landowners during periods when Prospect Island was partly flooded.

#### 3.1.11 Prospect Island Seepage Issues, Memo, USACE, July 12, 2000

USACE's most recent explorations in 1999 consisted of relatively shallow trenches on Prospect Island to support the design of the proposed project. The explorations revealed that the near surface soils are predominantly fine grained and that a high plastic clay layer underlies much of the island. This high plastic clay appears to have a very low permeability and separates a shallow perched groundwater condition from deeper water bearing layers. This high-plastic clay aquaclude inhibits or reduces the effects of island flooding on deeper pervious layers that were modeled as the hydraulic connection to the adjacent island.

The available information leads to the conclusion that seepage into Ryer Island is primarily from the adjacent slough and that flooding Prospect Island will have little or no effect on the quantity of seepage entering Ryer Island. Thus with respect to the volume of seepage, the initial finding of no significant impact is still valid.

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Ryer Island Groundwater Monitoring Network Installed by GEI Consultants, 1999

**Figure 5**

### 3.1.12 Prospect Island Restoration Project PH 1 and PH 2 Construction and Revegetation, Exploration Sheets 52-62/Drawings B1.0-B1.10, USACE, July 2001

These exploration sheets document the soil trenching conducted by USACE on September 20-22, 1999 to support the design of the Prospect Island Restoration Project. Twenty five (25) trenches were excavated across Prospect Island to depths ranging from 5 to 10 feet bgs (**Figure 6**). The trenches were excavated using a John Deere 6900-LC backhoe and the excavated soils were logged according to ASTM D 2488 (Description and Identification of Soils, Visual-Manual Procedure). Soil types encountered were mostly clay with only minor amounts of silt and sand observed. Groundwater was encountered in nearly all of the trenches at depths ranging from 2.5 to 8 feet bgs during excavation. Following excavation, groundwater levels rose to the ground surface in all 25 trenches.

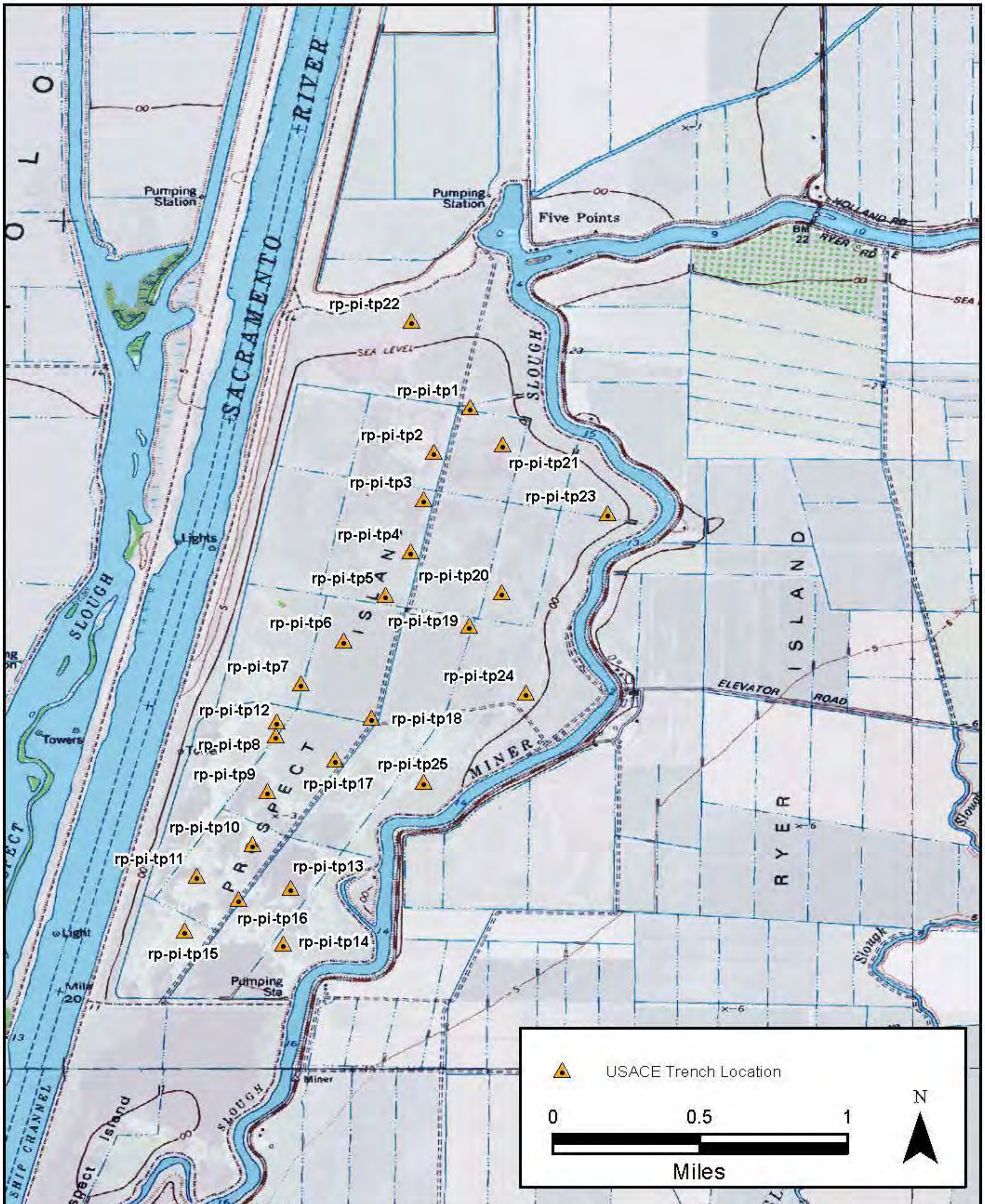
### 3.1.13 West Sacramento Levee System Problem Identification and Alternatives Analysis Reached 1, 3, 4, and 9. Volume 1 – Geotechnical Problem Identification – Solano and Yolo Counties, California, Kleinfelder, June 12, 2007

The purpose of this investigation was to explore subsurface conditions and perform a feasibility evaluation of site levees and subsurface geotechnical conditions in accordance with FEMA requirements for seepage and stability. Exploration, testing, and data analysis were performed along the western levee (right bank) of the DWSC from West Sacramento to just past the Prospect Island southern cross levee (**Figure 7**).

Pertinent findings are as follows: Soils observed below the west levee across from Prospect Island (Borings WSAC-KA-06-164 to WSAC-KA-06-181) consist of variable thicknesses of inorganic clay, silt, and sand to the total exploration depths between 51.5 and 96.5 feet bgs. No organic soils or peat were observed. Significant geologic soil units interpreted to be present in this area include Quaternary basin deposits (Qb), Quaternary Modesto Formation (Qm), and Quaternary Riverbank Formation (Qr), with only a minor presence of Quaternary stream channel deposits (Qsc) (Helley and Harwood, 1985).

### 3.1.14 Ground and Surface Water Monitoring Summary, Ryer Island, CA, ENGEO Inc., July 20, 2012

The purpose of this investigation was to monitor groundwater levels in conjunction with fluctuations in the water levels within the Lasher Duck Ponds (**Figure 8**). Piezometer installation, groundwater and surface water level monitoring, and data analysis were performed from August 2011 to June 2012. Six (6) piezometers were installed with hollow-stem augers to depths of 25 feet bgs and three surface water monitoring stations (stilling wells) were installed in each of the three ponds.

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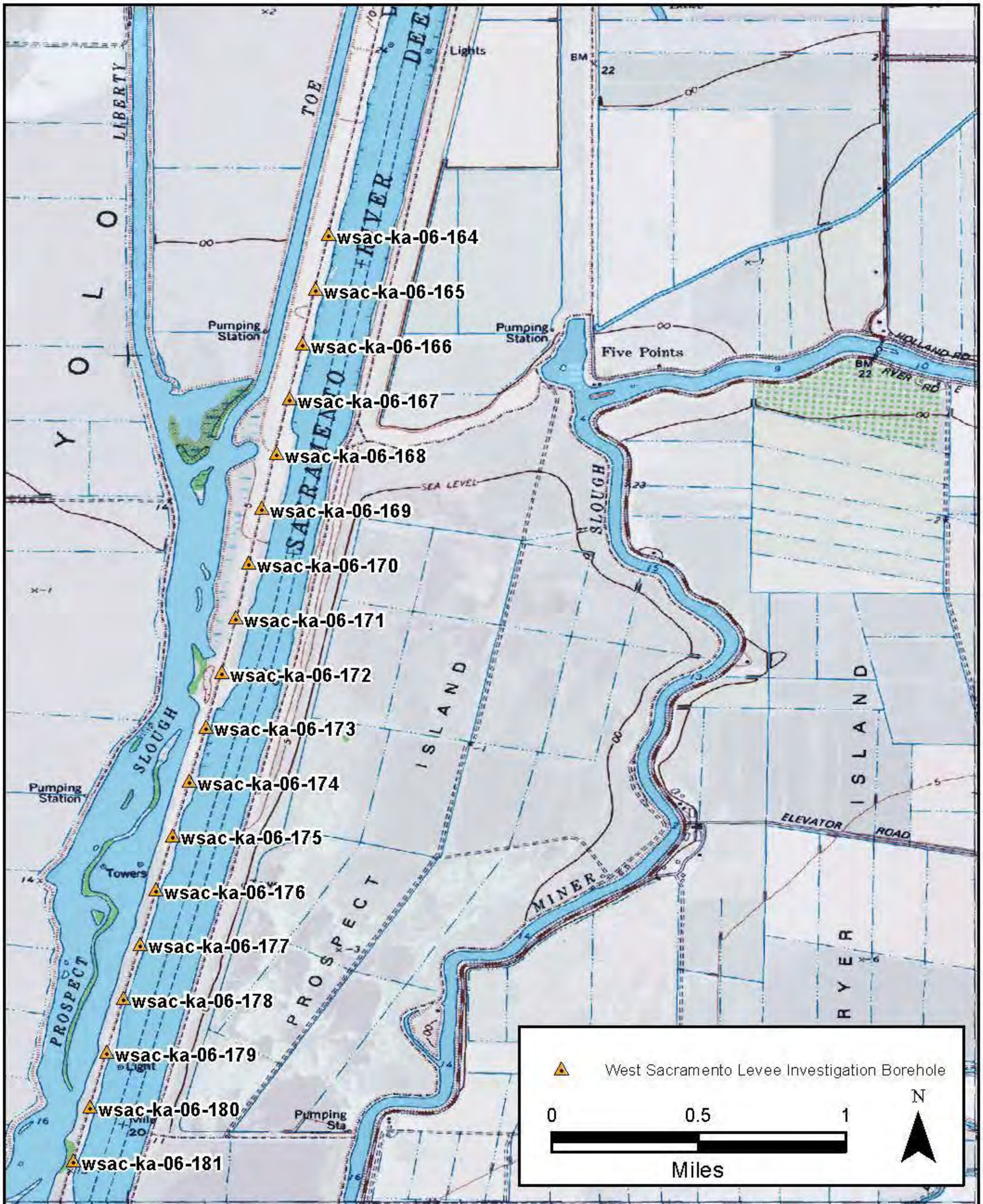
**USACE Prospect Island Trench Locations, 1999**

**Figure 6**

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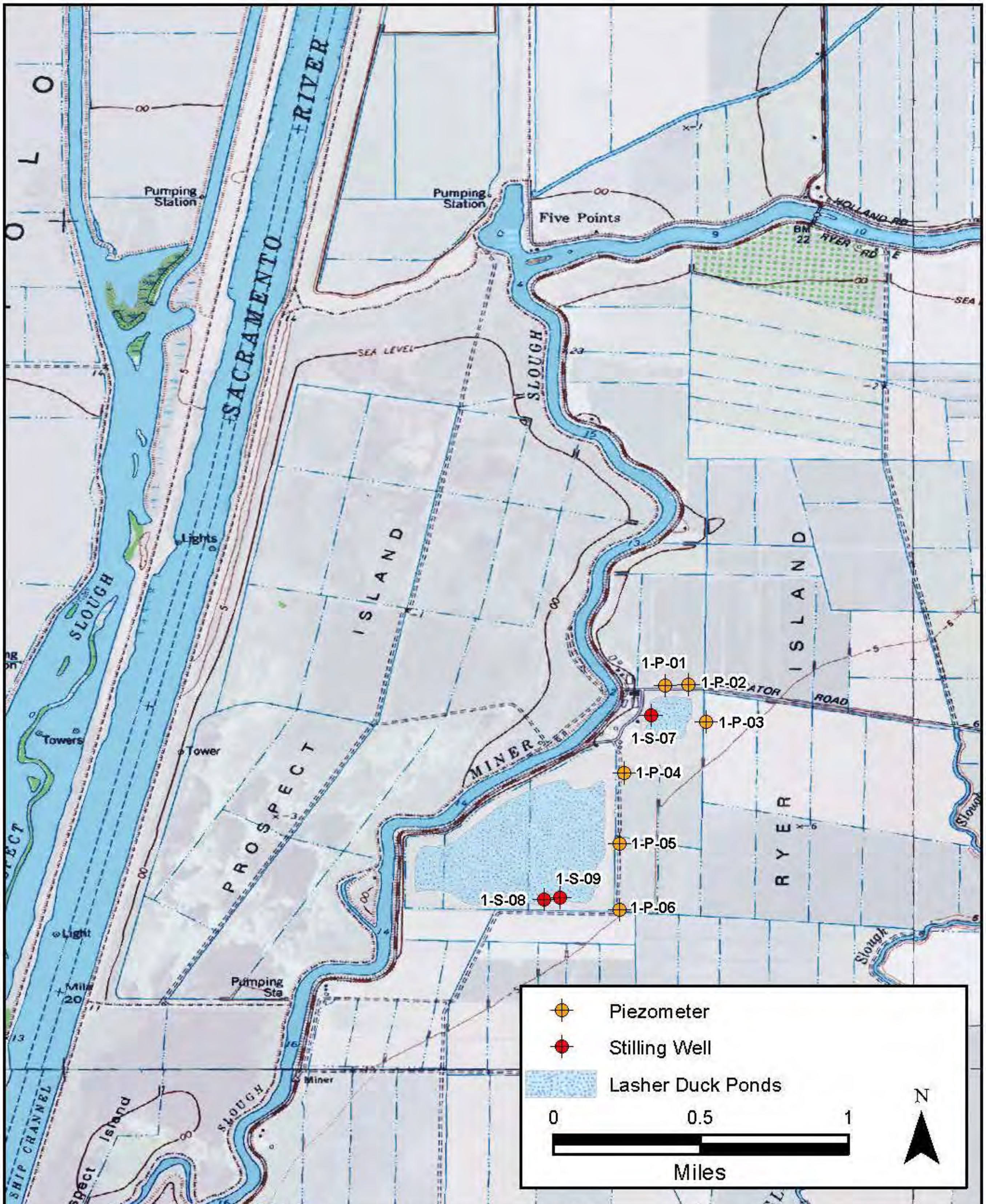
West Sacramento Levee Investigation, Kleinfelder, 2007

Figure 7

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Ryer Island Ground and Surface Water Monitoring Summary, ENGEO, 2012

**Figure 8**

Pertinent findings and conclusions are as follows: Observed soils consist of variable thicknesses of inorganic clay, silt, and sand to the total exploration depth of 28 feet bgs. No organic soils or peat were observed. The general trends in groundwater levels tend to be based primarily on seasonal rainfall influences, agricultural irrigation, and the volume of flow in Miner Slough. Based on the data collected, there appears to be a direct correlation between the duck ponds being filled with water and an increase in groundwater elevation beneath the adjacent fields.

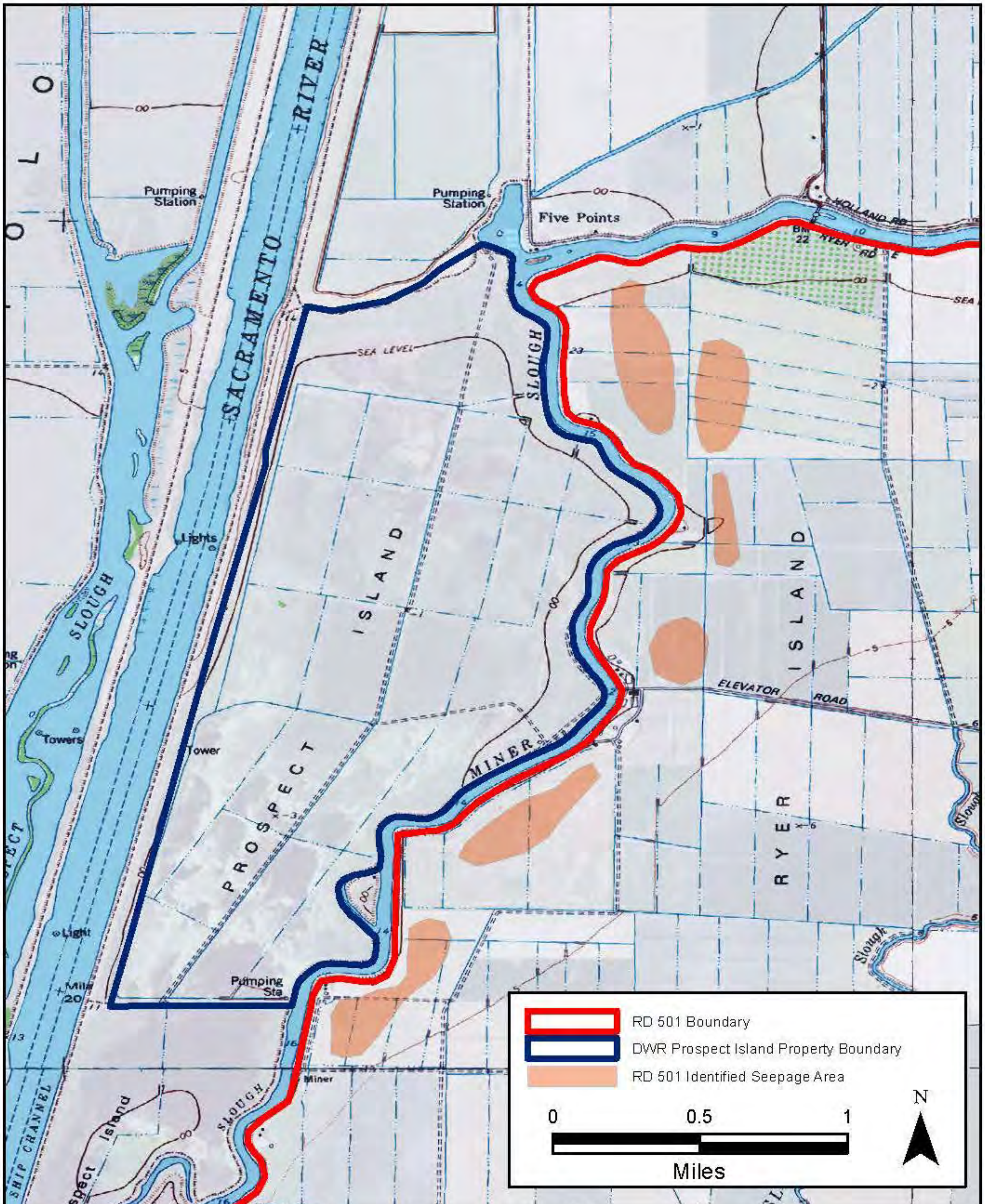
## 4.0 FIELD ACTIVITIES

### 4.1 Initial Ryer Island and Miner Slough Activities, 2010-2011

On January 5, 2010, North Central Region Office (NCRO) staff made their first visit to Ryer Island with DWR-Division of Environmental Services staff and Ryer Island stakeholders. During this visit, DWR obtained valuable information from the stakeholders about past and present Ryer Island conditions. The most significant information reported was that seepage conditions in some areas of Ryer Island adjacent to Miner Slough and Prospect Island have significantly impacted agricultural operations. The stakeholders are concerned that DWR's plan to restore Prospect Island to a tidal habitat will exacerbate the seepage problem. NCRO staff obtained a map from Mr. Tom Hester (RD 501) that identified areas where the seepage problems occur (**Figure 9**) and received verbal permission to begin monitoring groundwater levels in existing monitoring wells on Ryer Island.

Understanding the problem and DWR's responsibility as the lead agency, it was determined that a thorough understanding of the local hydrologic environment was needed to address the problem. NCRO staff began reviewing previous reports and current information in order to develop a comprehensive data collection plan. The plan called for the following field activities:

- Reestablish groundwater level monitoring stations on Ryer Island
- Reestablish surface water monitoring stations on Prospect Island and Miner Slough
- Characterize the subsurface hydrogeology of Prospect and Ryer Islands
- Establish groundwater level monitoring stations on Prospect Island
- Perform groundwater and surface water level data collection
- Determine accurate topography of Prospect and Ryer Islands
- Determine accurate bathymetry of Miner Slough and the Deep Water Ship Channel
- Collect bed sediment samples from Miner Slough and the Deep Water Ship Channel

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**DWR Prospect Island Property Boundary and RD 501 Identified Seepage Areas**

**Figure 9**

Field activities were conducted in general accordance with the proposed scope of work document in **Appendix A**.

Over the next several months, NCRO staff began to reestablish a monitoring network using the existing wells on Ryer Island and a deactivated surface water station on Miner Slough. Existing monitoring well construction was verified with available records, wells were redeveloped using airlifting methods to remove accumulated sediment and improve groundwater flow through the well screens, and the wells were equipped with data loggers for measuring groundwater levels.

In June 2010, monitoring was initiated at wells MW 99-5, -6, -7, and -8. In July 2010, wells MW 99-1, -3, -4, and -11 were added to the network. In February 2011, well MW 99-2 was added to the network. In May 2011, wells MW 99-9 and -10 were added to the network. In July 2010, NCRO Surface Water Data Section staff reestablished a surface water station on Miner Slough at Arrowhead Marina. By May 2011, a monitoring network of 11 groundwater monitoring wells (**Figure 5** and **Table 1**) and one surface water station had been reestablished (**Figure 10**). In February 2012, groundwater monitoring of wells MW 99-9 and -10 was discontinued at the request of the land owner.

## 4.2 Prospect Island

### 4.2.1 Reestablishment of Surface Water Station

In January 2011, a surface water monitoring station was reestablished on Prospect Island (**Figure 10**). During previous studies, a 2” diameter schedule 40 PVC pipe was installed on a pumping platform at the southeast corner of the island to measure surface water levels. NCRO staff removed, cleaned, and remounted this pipe in preparation for its use as a surface water monitoring station. A data logger was then installed at this location to measure surface water levels.

### 4.2.2 Subsurface Exploration and Well Installations

In June 2011, proposed exploration sites were selected on Prospect Island based on the following criteria:

- Proximity to Ryer Island groundwater monitoring well locations
- Location of RD 501 identified seepage areas on Ryer Island
- Site access

NCRO staff marked the proposed exploration locations with wooden stakes and flagging in preparation for Underground Service Alert (USA) site visits. USA was notified prior to the start of field activities in order to allow sufficient time for operators of public and private utilities to mark their underground services in the vicinity of the proposed

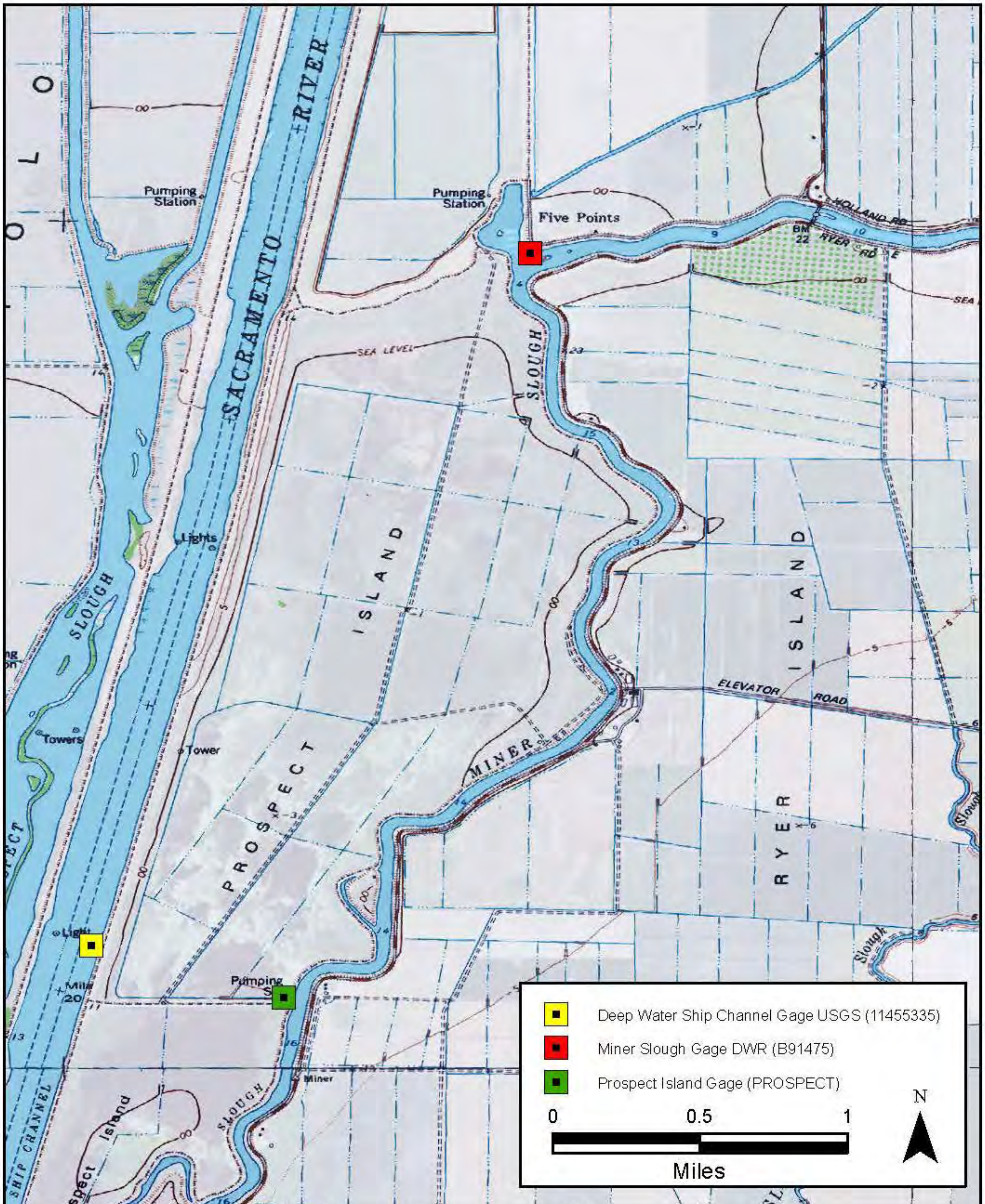
## Table 1. Ryer Island Well Details

| Monitoring Wells | | Location (NAD 83) | | Elevation (NAVD 88 Ft) | | | | | Depth Below Ground Surface | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| State Well Number | Station Name | Latitude | Longitude | Reference Point | Ground Surface | Top of Screen | Bottom of Screen | Bottom of Well | Top of Screen | Bottom of Screen | Bottom of Well |
| 05N03E21H001M * | MW 99-1 | 38.2657434 | -121.6408096 | 6.08* | 2.78* | -30.22* | -35.22* | -37.22* | 33.00 | 38.00 | 40.00 |
| 05N03E21H002M * | MW 99-2 | 38.2657434 | -121.6408096 | 5.76* | 2.93* | -2.07* | -7.07* | -11.07* | 5.00 | 10.00 | 14.00 |
| 05N03E16J001M | MW 99-3 | 38.2741718 | -121.6398880 | 4.26 | 0.93 | -33.07 | -38.07 | -39.07 | 34.00 | 39.00 | 40.00 |
| 05N03E16J002M | MW 99-4 | 38.2741707 | -121.6399062 | 4.16 | 0.82 | -7.18 | -12.18 | -14.18 | 8.00 | 13.00 | 15.00 |
| 05N03E15P001M | MW 99-5 | 38.2728006 | -121.6298577 | 1.06 | -2.91 | -35.91 | -40.91 | -42.91 | 33.00 | 38.00 | 40.00 |
| 05N03E15P002M | MW 99-6 | 38.2728014 | -121.6298837 | 0.81 | -3.17 | -12.17 | -17.17 | -18.17 | 9.00 | 14.00 | 15.00 |
| 05N03E15F001M | MW 99-7 | 38.2796509 | -121.6323683 | 2.18 | -1.76 | -34.76 | -39.76 | -41.76 | 33.00 | 38.00 | 40.00 |
| 05N03E15F002M | MW 99-8 | 38.2796482 | -121.6323878 | 2.12 | -1.62 | -10.62 | -15.62 | -16.62 | 9.00 | 14.00 | 15.00 |
| 05N03E16A001M * | MW 99-9 | 38.2845365 | -121.6418769 | 4.14* | 0.84* | -32.16* | -37.16* | -39.16* | 33.00 | 38.00 | 40.00 |
| 05N03E16A002M * | MW 99-10 | 38.2845365 | -121.6418769 | 5.21* | 1.31* | -6.69* | -11.69* | -12.69* | 8.00 | 13.00 | 14.00 |
| 05N03E16R001M | MW 99-11 | 38.2711299 | -121.6419145 | 27.00 | 27.11 | -25.89 | -30.89 | -32.89 | 53.00 | 58.00 | 60.00 |

Shallow monitoring interval (green)

Intermediate monitoring interval (red)

* These wells were not re-surveyed for this project. Location and elevation from a 1999 survey was used. Elevation values were converted from NGVD 29 to NAVD 88 by adding 2.57 ft.

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Surface Water Monitoring Stations, 2011

**Figure 10**

exploration locations. Lastly, DWR environmental clearance permits for the proposed exploration sites were obtained prior to the start of field activities.

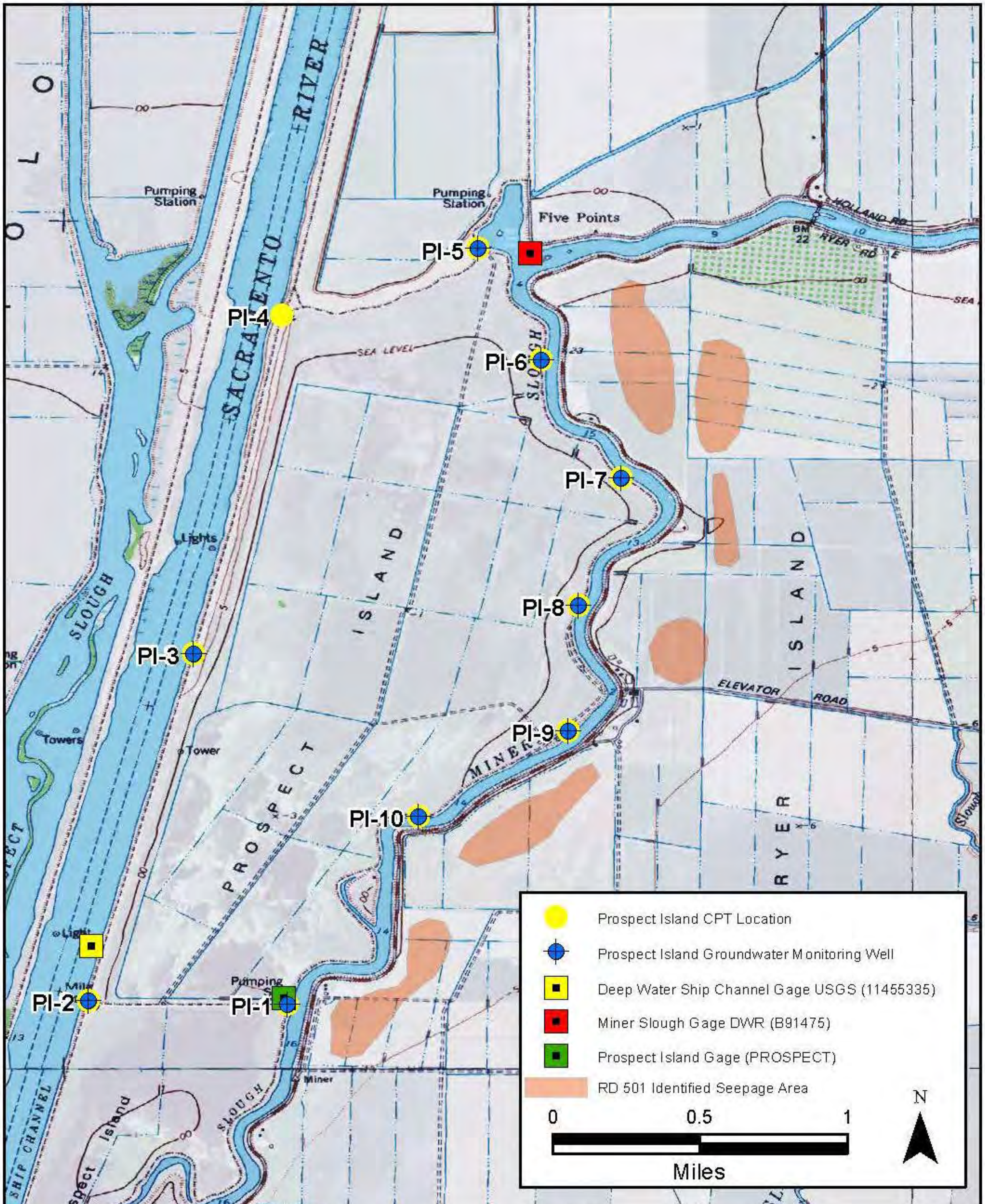
The subsurface exploration and well installations on Prospect Island were performed by Gregg Drilling and Testing, Inc. (Gregg D&T) from September 15-29, 2011 using cone penetration test (CPT) equipment and methods in accordance with ASTM standard D 5778-07.

Prior to the start of each CPT sounding, the location was hand augered using a 3-inch auger to a depth of 5 feet bgs to double check for underground obstructions, such as utilities. Ten (10) CPT soundings approximately 100 foot in depth were completed along the perimeter levees of Prospect Island using a 25-ton rubber tire CPT rig (**Figure 11**). The soundings were conducted with a 20-ton capacity piezocone (CPTu) with a tip area of 15 $cm^2$, a sleeve area of 225 $cm^2$, and a diameter of 43.7 mm. The CPTu collected measurements of the following field parameters: cone resistance ($q_c$), sleeve friction ($f_s$), and pore pressure (u) at 5-cm intervals during penetration to provide a nearly continuous log.

The CPTu data were analyzed onsite as the exploration progressed and these initial soundings established the hydrogeologic framework of Prospect Island. At selected locations and depths, advancement of the CPTu was stopped and a pore pressure dissipation test (PPDT) was performed. A PPDT measures the variation of penetration pore pressure (u) with time measured behind the tip of the cone while the cone is stopped. The test data is recorded by a computer system onboard the CPT rig. PPDT data is useful as it can be interpreted to provide estimates of equilibrium piezometric pressure, phreatic surface, in situ horizontal coefficient of consolidation ($C_h$), and in situ horizontal coefficient of permeability ($K_h$) also known as hydraulic conductivity.

The initial soundings guided subsequent soil sampling, PPDTs, and well installations. Upon completion of each sounding, the test holes were destroyed by advancing a hollow push rod with a sacrificial tip to the termination depth of each CPT hole. Neat cement grout was prepared onsite and then poured through a funnel into the hollow push rod as it was sequentially removed from the hole thereby creating a seal from the total depth to the ground surface. Additional grout was added to each hole if grout settlement occurred following the initial sealing effort.

Twenty (20) supplemental soundings were performed adjacent to the initial 10 soundings to allow for follow up testing and sampling. Supplemental soundings were used to perform additional PPDTs and collect soil samples from subsurface zones of interest. During soil sampling, a CPT-compatible sampler lined with two 6-inch long, 1-inch diameter stainless steel tubes was advanced with push rod to collect the sample. After soil samples were retrieved, they were visually inspected and logged by NCRO staff. Soil sample descriptions are included in **Appendix B** and soil sample and PPDT depths are listed on **Table 2**.

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**Prospect Island CPT and Well Locations and RD 501 Identified Seepage Areas**

**Figure 11**

## Table 2. Prospect Island CPT Summary

| CPT Sounding ID | Date | Latitude (NAD83) | Longitude (NAD83) | Ground Surface Elevation (Ft) | Total Depth (Ft bgs) | Depth of Soil Samples (Ft bgs) | Depth of Pore Pressure Dissipation Tests (Ft bgs) |
|---|---|---|---|---|---|---|---|
| PI-1 | 09/20/2011 | 38.2530612 | -121.6567239 | 14.97 | 100 | 15.5, 60, 68 | 40.0, 55.1, 65.1 |
| PI-1 | 09/28/2011 | 38.2530612 | -121.6567239 | 14.97 | 15 | - | 15.1 |
| PI-2 | 09/15/2011 | 38.2532428 | -121.6665146 | 12.98 | 100 | 8, 12, 51, 58 | 10.0, 40.0, 47.2, 58.1, 83.2, 100.2 |
| PI-3 | 09/15/2011 | 38.2703001 | -121.6613516 | 13.93 | 100 | 12, 40, 80 | 36.9, 51.2, 70.1, 88.9 |
| PI-4 | 09/16/2011 | 38.2869233 | -121.6569905 | 13.83 | 100 | - | 61.8, 66.3, 85.5 |
| PI-5 | 09/16/2011 | 38.2902019 | -121.6473477 | 17.89 | 100 | 29, 30, 75 | 64.5, 81.4, 90.7 |
| PI-6 | 09/16/2011 | 38.2847234 | -121.6442552 | 16.55 | 100 | 15, 24, 46, 54 | 36.7, 44.5, 60.0 |
| PI-6 | 09/23/2011 | 38.2847234 | -121.6442552 | 16.55 | 16 | - | 16.1 |
| PI-7 | 09/20/2011 | 38.2789300 | -121.6403141 | 15.95 | 100 | 14, 23, 45, 53 | 13.3, 13.5, 44.1 |
| PI-8 | 09/19/2011 | 38.2726867 | -121.6424154 | 15.80 | 100 | 14, 22, 46, 54 | 37.4, 50.0, 70.1 |
| PI-8 | 09/26/2011 | 38.2726867 | -121.6424154 | 15.80 | 16 | - | 16.1 |
| PI-9 | 09/19/2011 | 38.2665277 | -121.6429200 | 15.62 | 100 | 12, 20, 46, 54, 80, 93 | 14.1, 41.0, 50.0, 70.1, 89.2 |
| PI-10 | 09/19/2011 | 38.2623090 | -121.6502872 | 14.83 | 100 | 18, 26, 30, 46, 54 | 8.4, 20.5 |

Following these supplemental CPT soundings, well construction was initiated. Well construction consisted of lowering 1-inch diameter schedule 40 PVC blank and screened well casing through the hollow center of a 2.25-inch outside diameter push rod with a sacrificial tip. Once the well screen was lowered to the proper depth, the sacrificial tip was knocked out and the hollow push rod was pulled out of the hole leaving the well in place. The well screen zones consisted of 10-foot lengths of 65 mesh stainless steel screen, secured with stainless steel clamps, over 0.010" machine slotted 1-inch diameter schedule 40 PVC casing. A 5-foot long section of 1-inch diameter schedule 40 PVC blank well casing with a threaded end cap was installed below each screen zone to act as a sediment sump.

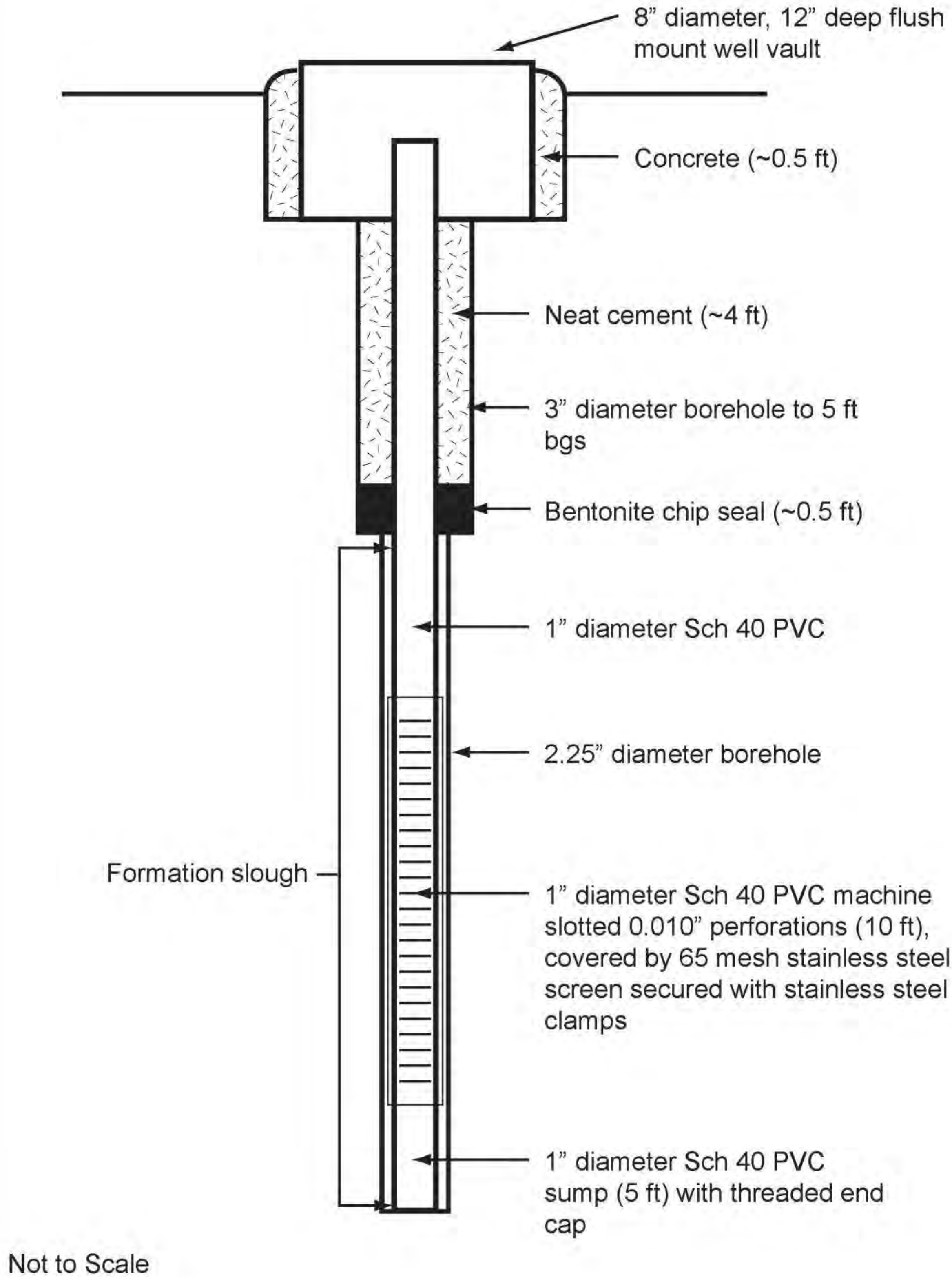
As the hollow push rod was sequentially removed, unconsolidated formation materials collapsed around the well screen and blank casing up to an approximate depth of 5 feet bgs. Immediately following push rod removal, bentonite chips were placed in the remaining annular space followed by neat cement grout up to about 1 foot bgs to create a sanitary seal. Flush-mount Morrison-Dubuque 8-inch vaults (model 8-418XA) were then installed over each well casing slightly above the ground surface and encased in concrete. Lastly, a PVC slip cap was installed on each well casing (**Figure 12**). The Prospect Island groundwater monitoring network consists of the following wells (**Table 3 and Appendix C)** that are monitoring three distinct hydrostratigraphic intervals:

- 9 shallow monitoring wells; PI-1A through PI-10A, except PI-4
- 9 intermediate monitoring wells; PI-1B through PI-10B, except PI-4
- 2 deep monitoring wells; PI-3C and PI-9C

Following well installation, the wells were developed using airlift methods in order to establish optimal groundwater flow through the natural formation filter pack and into the well screens. Shallow wells became dry within 5 minutes of development. They were allowed to recharge and were redeveloped twice. Intermediate and deep wells were purged at about 2 gallons per minute for 10 minutes each. At the end of development, the well purge water was visually low in turbidity.

Following completion of the CPT exploration and well installations, Gregg D&T performed QA/QC of the field measured CPT data and produced a final CPT report (**Appendix D**) that contained the following processed information:

- Corrected cone resistance; $q_t$ (tsf)
- Sleeve friction; $f_s$ (tsf)
- Pore pressure; u (psi)
- Friction ratio; $R_f = (f_s/q_t) \times 100\%$
- SPT N-value corrected for field procedures and apparatus; $N_{60}$ (blows/ft)
- Soil Behavior Type (SBT)
- Normalized cone resistance; $Q_{tl}$
- Normalized friction ratio; $F_r$
- Normalized pore pressure ratio; $B_q$

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**Typical Prospect Island Monitoring Well As-Built**

**Figure 12**

## Table 3. Prospect Island Well Details

| Monitoring Wells | | Location (NAD 83) | | Elevation (NAVD 88 Ft) | | | | | Depth Below Ground Surface | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| State Well Number | Station Name | Latitude | Longitude | Reference Point | Ground Surface | Top of Screen | Bottom of Screen | Bottom of Well | Top of Screen | Bottom of Screen | Bottom of Well |
| 05N03E29A001M | PI-1A | 38.2530582 | -121.6567402 | 14.69 | 14.81 | 1.79 | -8.21 | -13.21 | 13.02 | 23.02 | 28.02 |
| 05N03E29A002M | PI-1B | 38.2530711 | -121.6567103 | 14.68 | 14.79 | -45.82 | -55.82 | -60.82 | 60.61 | 70.61 | 75.61 |
| 05N03E29C001M | PI-2A | 38.2532359 | -121.6664966 | 12.87 | 12.95 | 4.77 | -5.23 | -10.23 | 8.18 | 18.18 | 23.18 |
| 05N03E29C002M | PI-2B | 38.2532589 | -121.6665114 | 12.87 | 12.85 | -36.53 | -46.53 | -51.53 | 49.38 | 59.38 | 64.38 |
| 05N03E20B001M | PI-3A | 38.2702847 | -121.6613492 | 13.96 | 13.85 | 2.02 | -7.98 | -12.98 | 11.83 | 21.83 | 26.83 |
| 05N03E20B002M | PI-3B | 38.2703108 | -121.6613403 | 13.93 | 13.99 | -28.18 | -38.18 | -43.18 | 42.17 | 52.17 | 57.17 |
| 05N03E20B003M | PI-3C | 38.2703247 | -121.6613366 | 13.93 | 13.96 | -70.07 | -80.07 | -85.07 | 84.03 | 94.03 | 99.03 |
| 05N03E09L001M | PI-5A | 38.2902060 | -121.6473309 | 17.48 | 17.61 | -10.22 | -20.22 | -25.22 | 27.83 | 37.83 | 42.83 |
| 05N03E09L002M | PI-5B | 38.2901976 | -121.6473628 | 17.89 | 17.97 | -49.41 | -59.41 | -64.41 | 67.38 | 77.38 | 82.38 |
| 05N03E16B001M | PI-6A | 38.2847104 | -121.6442571 | 16.22 | 16.41 | 0.19 | -9.81 | -14.81 | 16.22 | 26.22 | 31.22 |
| 05N03E16B002M | PI-6B | 38.2847369 | -121.6442530 | 16.42 | 16.45 | -29.13 | -39.13 | -44.13 | 45.58 | 55.58 | 60.58 |
| 05N03E16H001M | PI-7A | 38.2789211 | -121.6403016 | 15.89 | 15.87 | 3.74 | -6.26 | -11.26 | 12.13 | 22.13 | 27.13 |
| 05N03E16H002M | PI-7B | 38.2789382 | -121.6403283 | 15.90 | 15.94 | -30.74 | -40.74 | -45.74 | 46.68 | 56.68 | 61.68 |
| 05N03E16R002M | PI-8A | 38.2726716 | -121.6424158 | 15.60 | 15.70 | 3.85 | -6.15 | -11.15 | 11.85 | 21.85 | 26.85 |
| 05N03E16R003M | PI-8B | 38.2726972 | -121.6423996 | 15.56 | 15.85 | -30.54 | -40.54 | -45.54 | 46.39 | 56.39 | 61.39 |
| 05N03E21G001M | PI-9A | 38.2665200 | -121.6429347 | 15.41 | 15.34 | 4.41 | -5.59 | -10.59 | 10.93 | 20.93 | 25.93 |
| 05N03E21G002M | PI-9B | 38.2665424 | -121.6429141 | 15.32 | 15.33 | -30.18 | -40.18 | -45.18 | 45.51 | 55.51 | 60.51 |
| 05N03E21G003M | PI-9C | 38.2665623 | -121.6428953 | 15.26 | 15.33 | -68.04 | -78.04 | -83.04 | 83.37 | 93.37 | 98.37 |
| 05N03E21L001M | PI-10A | 38.2623045 | -121.6503044 | 14.75 | 14.79 | -3.05 | -13.05 | -18.05 | 17.84 | 27.84 | 32.84 |
| 05N03E21L002M | PI-10B | 38.2623043 | -121.6502694 | 14.76 | 14.85 | -30.54 | -40.54 | -45.54 | 45.39 | 55.39 | 60.39 |

Shallow monitoring interval

Intermediate monitoring interval

Deep monitoring interval

- Corrected SPT resistance; $(N_1)_{60}$ (blows/ft)
- Normalized Soil Behavior Type ($SBT_n$)
- Plots of pore pressure dissipation data versus time (seconds) from PPDTs

Summary plots of CPTu data including soil sample and PPDT depths and well construction information are presented in **Appendix E**.

### 4.3 Ryer Island

#### 4.3.1 Subsurface Exploration

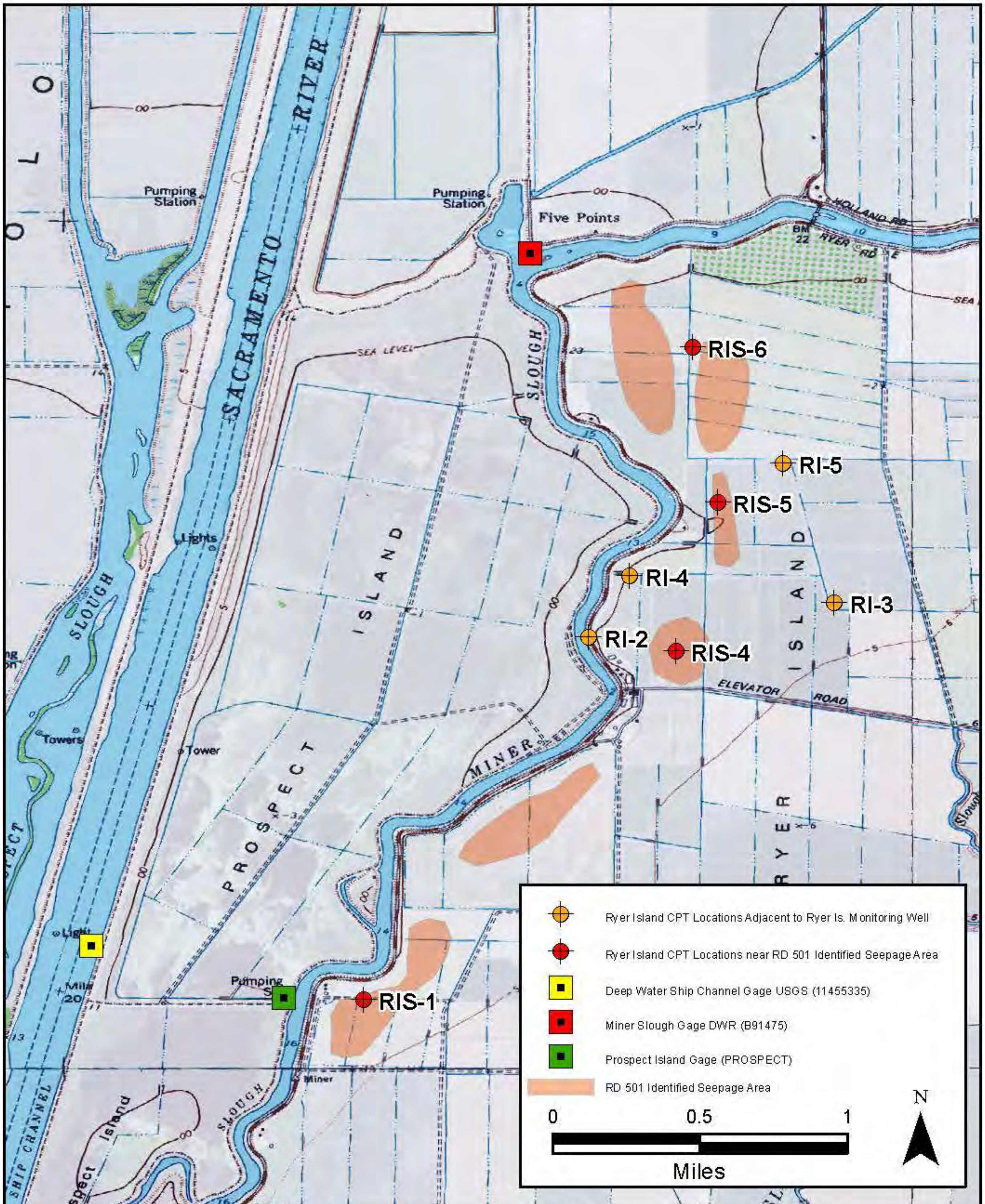
In February 2012, proposed exploration sites were selected on Ryer Island based on the following criteria:

- Ryer Island groundwater monitoring well locations
- Location of RD 501 identified seepage areas on Ryer Island
- Site access

NCRO staff marked the proposed exploration locations with wooden stakes and flagging in preparation for USA site visits. USA was notified prior to the start of field activities in order to allow sufficient time for operators of public and private utilities to mark their underground services in the vicinity of the proposed exploration locations. Additionally, DWR environmental clearance permits for the proposed exploration sites were obtained prior to the start of field activities. Lastly, DWR obtained temporary entry permits from Ryer Island landowners for exploration and continued site visits to the existing Ryer Island groundwater monitoring well sites.

Gregg D&T performed subsurface exploration using CPT on Ryer Island between March 12-29, 2012. Of the 12 originally proposed Ryer Island CPT sites, four (4) were not explored because access was denied by landowners. Of the eight (8) locations explored, four were adjacent to existing Ryer Island monitoring wells, and four were in the vicinity of the RD 501 identified seepage areas on Ryer Island (**Figure 13**). Two (2) of the 8 sites explored were relocated due to field conditions which restricted equipment access (RIS-1 and RIS-6).

Since the exploration sites on Ryer Island were in and around actively farmed fields, a smaller 20-ton, track-mounted, all-terrain CPT rig was used to advance eight (8) CPT soundings to depths ranging from 85 to 110 feet bgs (**Table 4**). The CPTu equipment and PPDT, soil sampling, and sealing methods used on Ryer Island were similar to those used on Prospect Island. The CPTu data were analyzed onsite as the exploration progressed and these soundings established the hydrogeologic framework of the northwestern portion of Ryer Island in relation to the DWR-owned portion of Prospect Island. Following completion of the CPT exploration, Gregg D&T performed QA/QC of the field measured CPT data and produced a final CPT report similar to what was prepared for Prospect Island (**Appendix D**). Summary plots of CPTu data including soil sample and PPDT depths are presented in **Appendix E**.

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Ryer Island CPT Locations and RD 501 Identified Seepage Areas

**Figure 13**

## Table 4. Ryer Island CPT Summary

| CPT Sounding ID | Date | Latitude (NAD83) | Longitude (NAD83) | Ground Surface Elevation (Ft) | Total Depth (Ft bgs) | Depth of Soil Samples (Ft bgs) | Depth of Pore Pressure Dissipation Tests (Ft bgs) |
|---|---|---|---|---|---|---|---|
| RI-2 | 03/15/2012 | 38.2711204 | -121.6567239 | 25.68 | 110 | 37, 58 | 52.0, 76.0 |
| RI-4 | 03/13/2012 | 38.2741467 | -121.6567239 | 0.29 | 85 | 13, 25, 35, 52 | 25.9, 37.9 |
| RIS-4 | 03/13/2012 | 38.2704582 | -121.6665146 | -1.28 | 85 | 10, 20, 35 | 17.1 |
| RI-5 | 03/21/2012 | 38.2796773 | -121.6613516 | -1.68 | 91 | 12, 25, 36, 60, 81 | 11.8, 24.9, 40.4, 79.9, 90.1 |
| RIS-5 | 03/22/2012 | 38.2777516 | -121.6569905 | -0.65 | 85 | 12, 19, 31, 42 | 12.1, 19.0, 35.1, 43.8, 70.2 |
| RI-3 | 03/27/2012 | 38.2728295 | -121.6473477 | -3.15 | 95 | 18, 37, 50, 85, 90 | 13.6, 38.1, 50.0, 87.1 |
| RIS-1 | 03/28/2012 | 38.2533311 | -121.6442552 | -1.69 | 85 | 12, 39 | 10.2, 32.8, 50.0 |
| RIS-6 | 03/26/2012 | 38.2853928 | -121.6442552 | -0.63 | 85 | 10, 26, 35 | 12.8, 25.6, 35.8, 77.4 |

### 4.4 Groundwater Level Monitoring

All groundwater monitoring wells within the active Prospect and Ryer Island network are equipped with In-Situ Level TROLL 500 data loggers set to record water levels at 15-minute intervals. The wells on Ryer Island are equipped with vented data loggers since they are installed within above ground surface completions. The vent is a small tube in the communication cable that runs from the back of the pressure transducer to the top of the well. If the vent is exposed to excessive moisture or submerged in water it can cause failure and damage to the pressure transducer. Because the wells on Prospect Island are below the ground surface in flush mount vaults and are likely to become moist or submerged in water, non-vented data loggers are used.
The groundwater level monitoring network consists of 31 wells (**Tables 1 and 3**).

Groundwater level data are downloaded from the network during regular site visits, typically every 1-2 months. After the site visits, the data are processed and QA/QC checked in the office. Data from an In-Situ BaroTROLL data logger is used to remove the barometric pressure response from the Prospect Island groundwater level data. Once the data are verified, it is uploaded to the Water Data Library (WDL)-Continuous Data Module (http://www.water.ca.gov/waterdatalibrary/docs/Hydstra/index.cfm) and made available to the public. Hydrographs of the groundwater level data (daily mean values) from June 1, 2010 to June 1, 2013 are presented in **Appendix F**.

### 4.5 Surface Water Level Monitoring

DWR operates and maintains surface water monitoring stations on Prospect Island (PROSPECT) and Miner Slough (B91475). The Prospect Island station is equipped with an In-Situ Level TROLL 500 data logger (non-vented model) and the Miner Slough station is equipped with a bubbler-type water level measurement and data logging system.

Both stations measure and record water level data at 15-minute intervals. Additionally, a surface water monitoring station on the DWSC adjacent to Prospect Island is being used for this study. This station, identified as US Geological Survey (USGS) 11455335, is operated and maintained by the USGS and measures and records surface water level data at 15-minute intervals (**Figure 10**).

Hyperlinks to Surface Water Level Monitoring Stations

- Miner Slough
  http://www.water.ca.gov/waterdatalibrary/docs/Hydstra/index.cfm?site=B91475

- Sacramento River Deep Water Ship Channel (DWSC)
  http://waterdata.usgs.gov/usa/nwis/uv?11455335

- Prospect Island
  http://www.water.ca.gov/waterdatalibrary/docs/Hydstra/index.cfm?site=PROSPECT

Surface water level data are downloaded from the DWR stations during regular site visits, typically every 1-2 months. After the site visits, the data is processed and QA/QC checked in the office. After the site visits, the data are processed and QA/QC checked in the office. Data from an In-Situ BaroTROLL data logger is used to remove the barometric pressure response from the Prospect Island surface water level data. Once the data are verified, it is uploaded to the WDL which makes it available to the public. Hydrographs of the surface water level data (daily mean values) from June 1, 2010 to June 1, 2013 are presented in **Appendix F**.

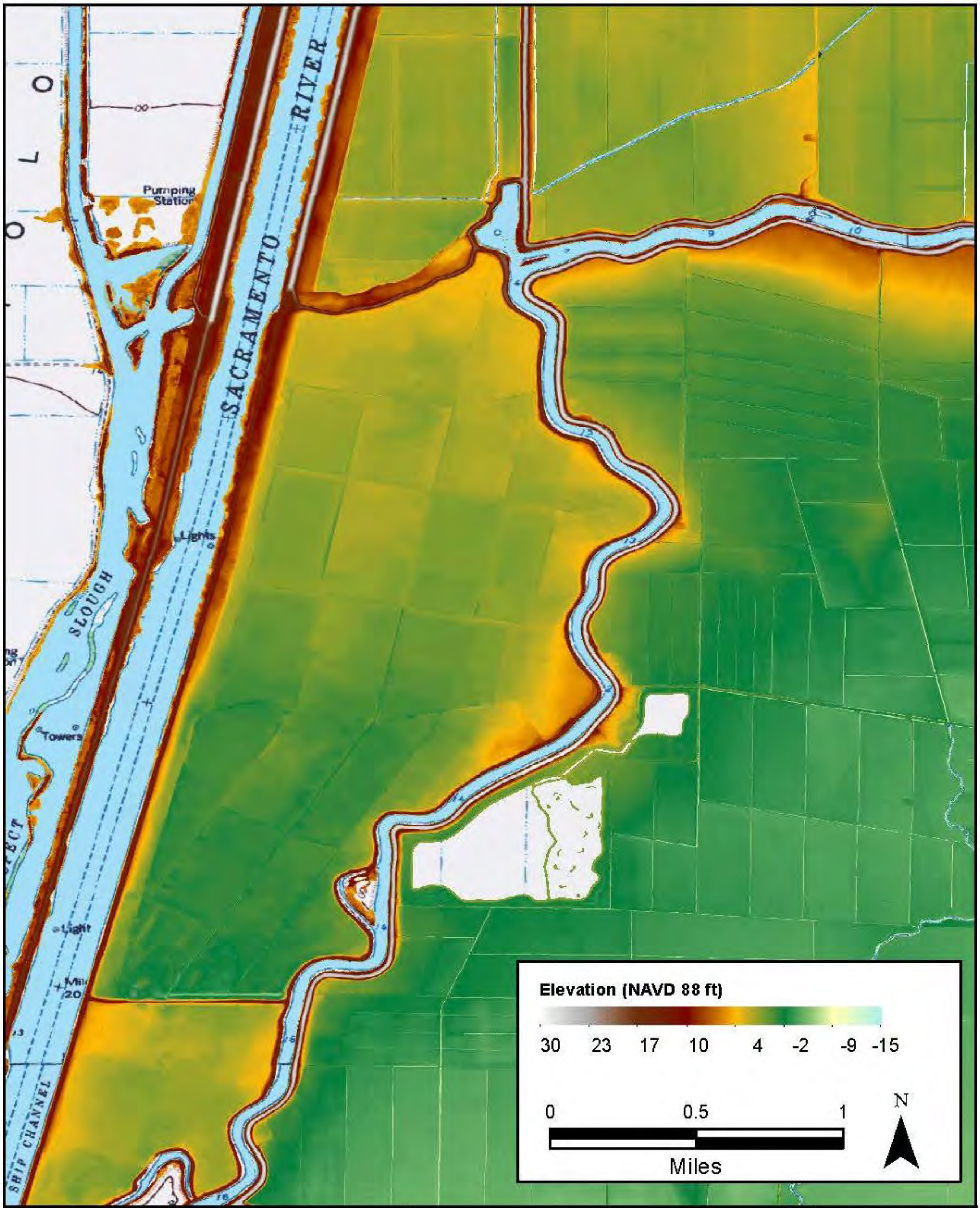
### 4.6 Land Surveying

In 2011, Wetlands and Water Resources, Inc., working for DWR, conducted a comprehensive land survey of Prospect Island using Real-Time Kinematic Global Positioning System (RTK-GPS) equipment and methods (**Appendix G**). This data was used to create a high-resolution topographic map or digital elevation model (DEM) of Prospect Island. The DEM will be used during the data analysis phase of this project.

In 2012 and 2013, DWR-Division of Engineering, Geodetic Branch staff conducted surveys of the surface water monitoring stations on Miner Slough, Prospect Island, and the DWSC and groundwater monitoring stations and CPT locations on Prospect and Ryer Islands using RTK-GPS equipment and methods (**Appendix H**). This data was used to establish accurate ground surface elevations for all CPT soundings and reference point elevations for all monitoring stations.

### 4.7 LiDAR Survey

The DWR FloodSAFE Environmental Stewardship and Statewide Resources Office - Specialized Areas Branch sponsored very high-accuracy Light Detection and Ranging (LiDAR) surveys for the majority of the Delta region. These surveys were conducted using fixed-wing-based LiDAR equipment and methods that provide continuous elevation data at approximately one (1) horizontal meter intervals and to a vertical accuracy specified as being better than one (1) foot. The LiDAR surveys occurred between 2005 and 2008 and the resulting data are available in the public domain. A portion of this LiDAR data set was clipped to the study area boundary and was enhanced by including the new 2011 Prospect Island DEM (**Figure 14**). The study area DEM will be used during the data analysis phase of this project.

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Study Area DEM

**Figure 14**

## 4.8 Bathymetry Surveying

In January and February of 2012, NCRO Bathymetry and Technical Support Section staff collected bathymetry data from Miner Slough and the DWSC in the vicinity of Prospect and Ryer Islands using industry standard equipment and methodology (**Figure 15 and Appendix I**). This data collection effort allowed for the creation of a bathymetric map of the major surface water features within the study area.

The bathymetry data will be added to the land surface DEM to create a seamless elevation dataset of the entire study area which will be used during the data analysis phase of this project.

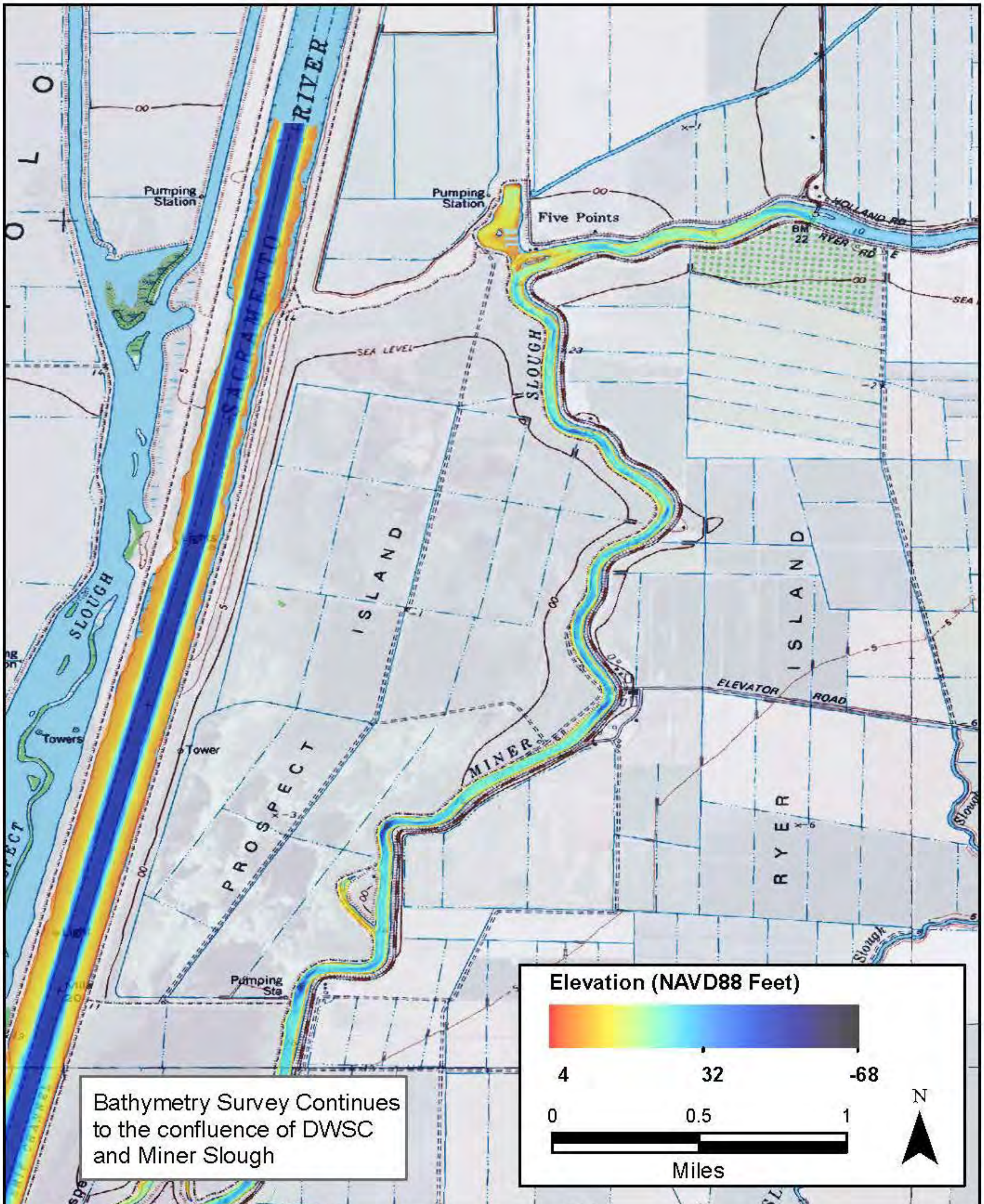
## 4.9 Bed Sediment Sampling

In February 2013, bed sediment samples were collected by NCRO staff using a flat-bottom work boat in an effort to characterize the sediments in Miner Slough and the DWSC (**Figure 16**). The primary sampling locations were selected adjacent to the Prospect Island monitoring wells. Near each well site, a transect of three samples were collected from the left bank, center, and right bank of Miner Slough and the DWSC. Additionally, bed sediment samples were also collected from the deepest portions of Miner Slough based on the results of the bathymetry survey. The samples were collected using a hand-line bed material sampler (US BMH-60). Upon retrieval, the samples were stored in resealable plastic bags with sample identification and date/time information. The samples were submitted to DWR's Bryte Laboratory for grain size and hydrometer analysis following ASTM standards (**Appendix J**).

# 5.0 FUTURE WORK

The second phase of this study will include, at a minimum: additional data collection, creation of a project-specific 3-D GIS, geologic and hydrologic data analysis, seepage modeling, and final reporting. Details are included below:

- Groundwater and surface water monitoring from the existing network will continue
- Several drainage ditch monitoring stations will be established and monitored on Ryer Island (summer 2013)
- Slug testing will be performed on select Prospect and Ryer Island wells (summer 2013)

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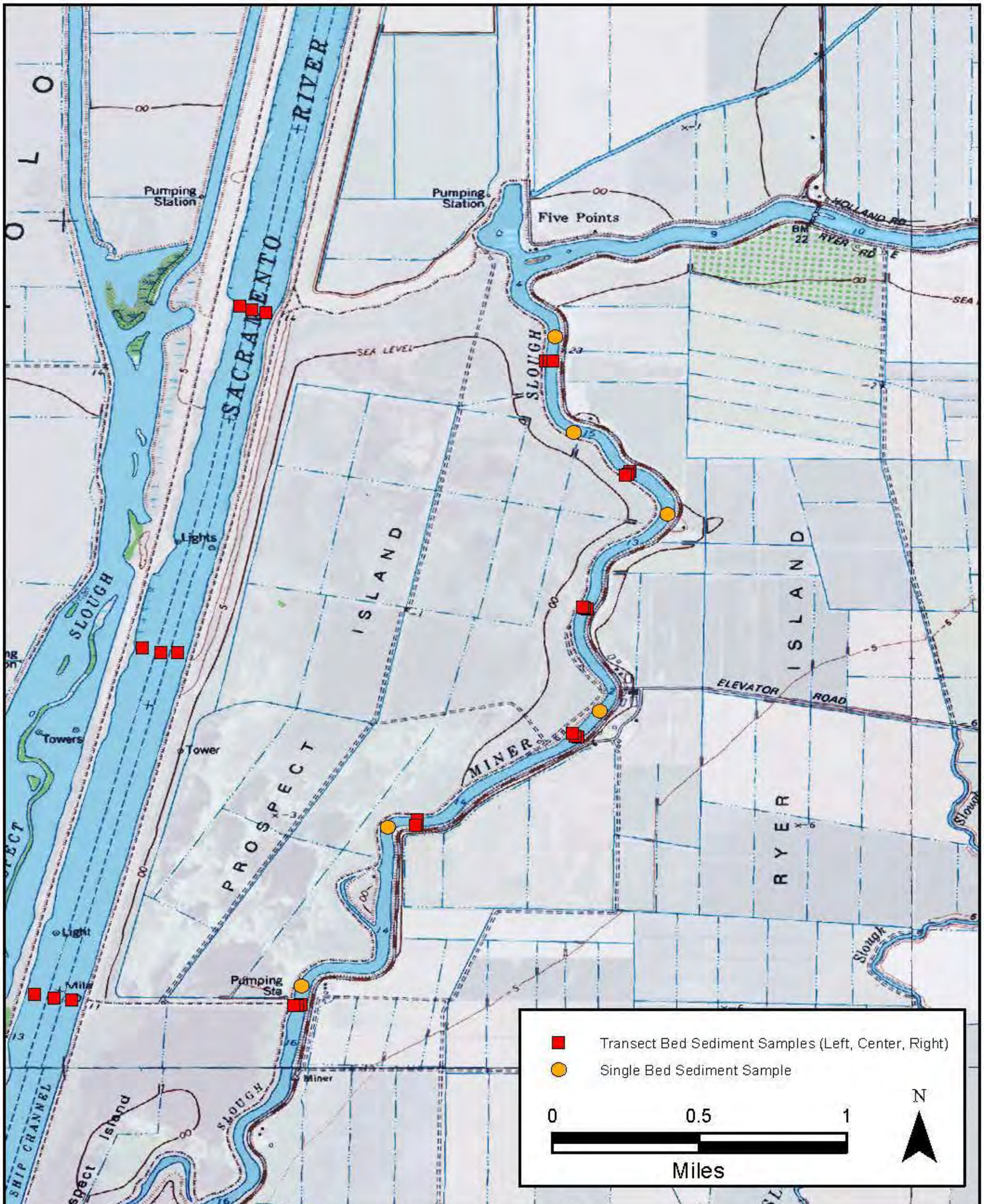
Miner Slough and Sacramento Deep Water Ship Channel Bathymetry

**Figure 15**

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**Miner Slough and Sacramento Deep Water Ship Channel Bed Sediment Sample Locations**

**Figure 16**

- Review historical aerial photographs, maps, and reports in order to characterize the geomorphological changes of the study area through time
- Review historical data and reports and summarize the location of levee breaches and flooding history of Prospect and Ryer Islands
- Develop an integrated 3-D topography, bathymetry, and hydrogeologic conceptual model of the Prospect-Ryer Island study area
- Construct and analyze 2-D geologic cross sections along select island transects
- Map the subsurface distribution of hydrogeologic units within the study area
- Analyze hydrographs of surface water and groundwater level data for the entire study period
- Analyze surface water and groundwater interactions within the study area
- Create and analyze groundwater level contour maps of different hydrogeologic units at select time periods of interest
- Analyze slug testing results and refine estimates of subsurface hydraulic properties of the study area
- Analyze bed sediment samples to refine estimates of streambed hydraulic conductivity of Miner Slough and DWSC
- Create 2-D seepage models along select island transects and evaluate seepage flux to Ryer Island from all potential source areas
- Prepare a comprehensive Data Analysis Report (fall 2013)

## 6.0 REFERENCES


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# Appendix A

# Proposed Scope of Work - Subsurface Exploration, Groundwater and Surface Water Data Collection, and Site Characterization - Prospect Island Tidal Habitat Restoration Project - North Central Region Office

**Proposed Scope of Work -**
**Subsurface Exploration, Groundwater and Surface Water Data Collection, and Site Characterization -**
**Prospect Island Tidal Habitat Restoration Project -**
**North Central Region Office**

## Task 1 - Subsurface Exploration and Hydrogeologic Characterization on Prospect Island

Prior to and during work on Task 1, various pre-field planning, coordination, equipment purchase, and permitting subtasks will need to be accomplished.

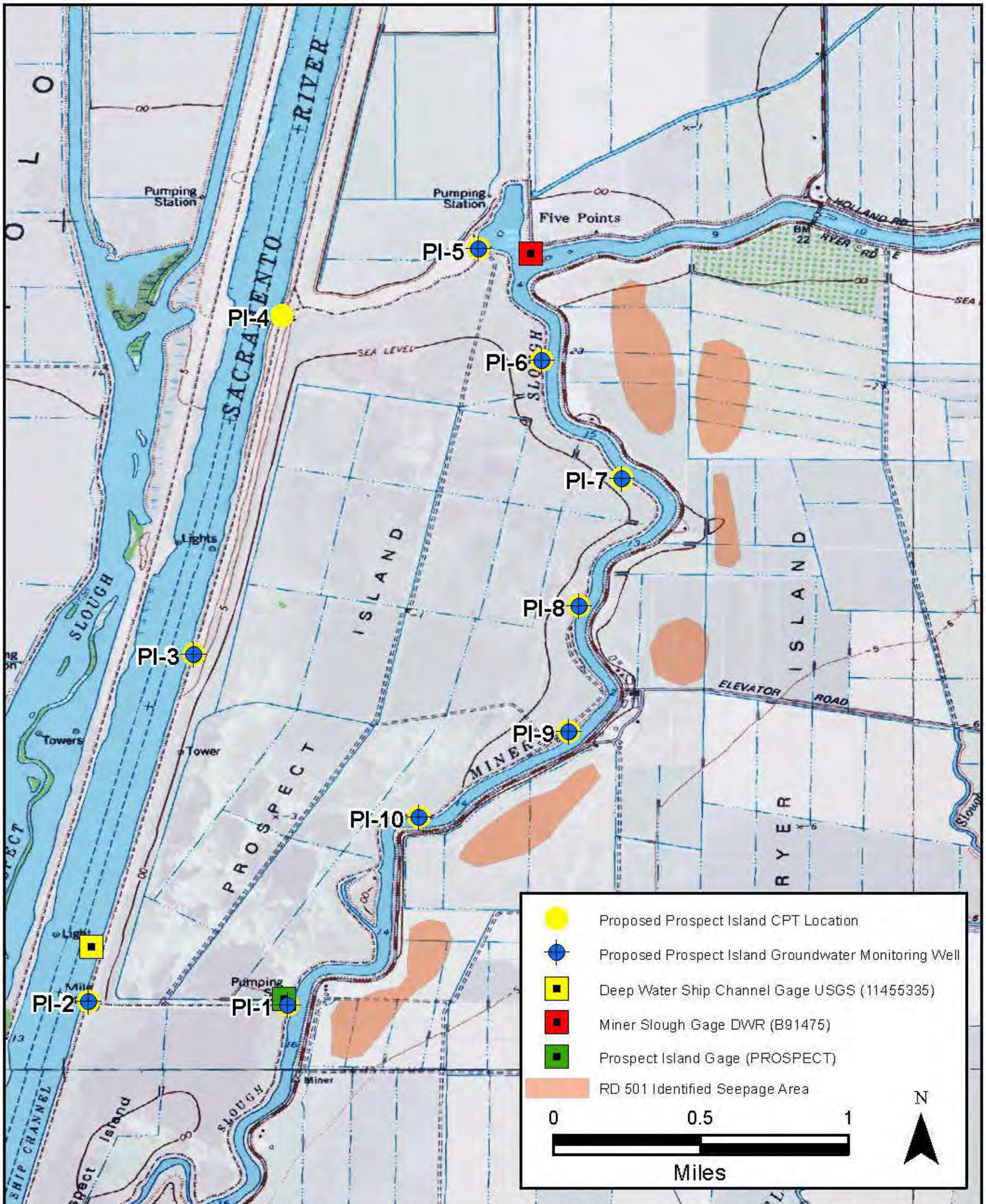
Subsurface exploration for this project will be performed using cone penetration testing (CPT) equipment and methods following ASTM standards. CPT is a rapid and cost effective site assessment tool that can be used to characterize subsurface geologic and hydrogeologic conditions and install small diameter wells. The exploration will occur in several phases until adequate subsurface hydrogeologic data has been collected in the study area. The CPT work will be conducted by the contractor Gregg Drilling & Testing, Inc.

### Task 1A: Prospect Island Exploration (10 sites) [PI-1 to PI-10]

This task will entail approximately ten (10) CPT soundings to depths of about 100 feet spatially distributed along the levees of Prospect Island **(Figure 1).** This data collection will allow for the establishment of a hydrogeologic framework of Prospect Island which will guide further hydrogeologic data collection and subsequent well installations. Subsurface data will be analyzed onsite as the exploration progresses which will streamline the subsequent exploration and well installation process. During this task, hydrogeologic data in the form of continuous pore pressure measurements at each CPT location using a piezocone will be collected. Additionally, at select CPT locations and depths, short-term pore pressure dissipation tests (PPDTs) will be performed using the piezocone to further characterize hydrogeologic conditions in the third dimension.

### Task 1B: Prospect Island Well Installations at all PI sites (except PI-4)

This task will entail additional CPT soundings (2-3 at each site) to a maximum depth of 100 feet to further characterize the hydrogeology and facilitate optimal well installations **(Figure 1).** At some of these locations, select soil core samples will also be collected at subsurface zones of interest. Following these additional CPT soundings, well construction will proceed. Wells will consist of 1-inch diameter polyvinyl chloride (PVC) blank casing with 65 mesh stainless steel screen over 0.010" slotted PVC pipe in 5 to 10 foot lengths. Final well design will be based on the subsurface exploration findings during Task 1A and depth positioning of nearby Ryer Island monitoring wells. Once each well is installed at the proper depth and the outer CPT casing is removed, natural,

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**Proposed Prospect Island CPT and Well Locations and RD 501 Identified Seepage Areas**

**Figure 1**

unconsolidated and saturated formation materials will collapse around the well screen creating the monitoring zones. Above the screen zones, natural, unconsolidated formation materials will collapse around the blank casing to the depth of about 5 feet bgs. Above this, bentonite chips and cement-bentonite grout will be placed to create a sanitary seal to the ground surface. Flush-mount vaults set in concrete will be installed over each well following completion of well installation. Following well installations, the wells will be developed using airlift methods and equipment in order to establish optimal groundwater flow through the natural formation materials and into the well screens. Development water will be discharged to the ground near each well site.

## Task 2: Ryer Island Supplemental Exploration

### Task 2A: New Ryer Island CPT Correlation Soundings adjacent to existing borings (6) [RI-1 to RI-6]

Near each of the six (6) boring locations drilled by GEI in 1999, a correlation CPT sounding is proposed **(Figure 2).** Each sounding will penetrate at least 10 feet deeper than the original 1999 GEI exploration borings of 40 to 60 feet. This will allow for an improved understanding and correlation of subsurface geologic data from the 1999 GEI geotechnical investigation and this new phase of investigation. The piezocone will be used during this task to collect additional hydrogeologic data in the form of PPDT. At select locations, soil core samples will also be collected at subsurface zones of interest.

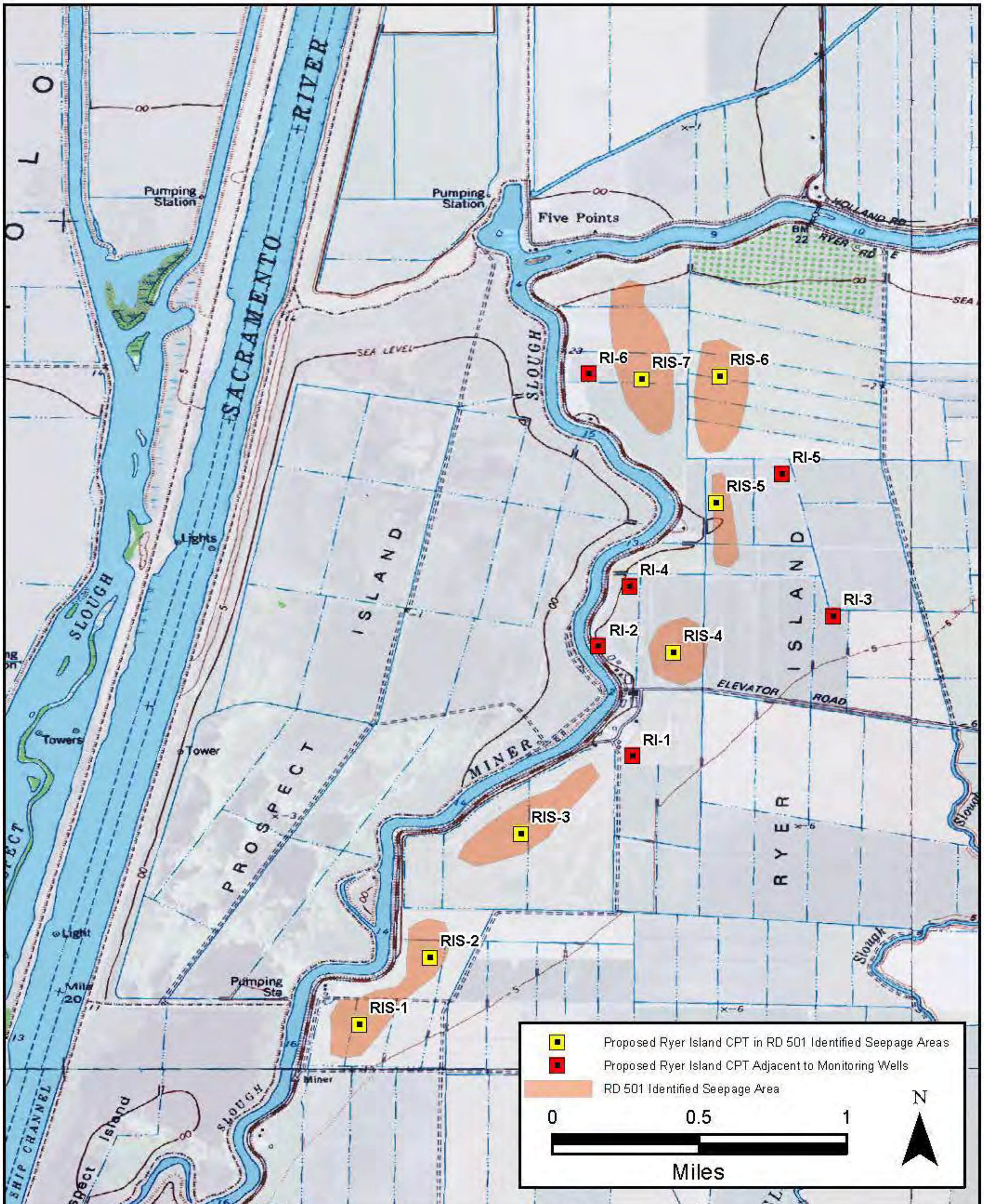
### Task 2B: New Ryer Island Seepage Area CPT Soundings (7) [RIS-1 to RIS-7]

In order to better understand the hydrogeologic characteristics underlying several RD 501 reported seepage areas on Ryer Island, seven (7) new CPT soundings are proposed in these areas to a depth of at least 50 feet which is about 10 feet deeper than was explored in nearby areas of Ryer Island during the 1999 GEI investigation **(Figure 2).** The piezocone will be used during this task to collect additional hydrogeologic data in the form of PPDT. At some of these locations, soil core samples will be collected at subsurface zones of interest.

## Task 3: Groundwater and Surface Water Monitoring on Ryer Island and Prospect Island

Prior to and during work on Task 3, various pre-field planning, coordination, and equipment purchase subtasks will need to be accomplished.

Following well installation, water-level data loggers will be acquired and installed in selected locations in order to establish baseline conditions and facilitate longer-term monitoring. It is anticipated that about 20 water-level data loggers will be needed to monitor the groundwater conditions on Prospect Island. The data loggers proposed for this project are In-Situ Level Trolls (either vented or non-vented models) depending on the final well location and surface completion type. One In-Situ Baro Troll may also be




| DEPARTMENT OF WATER RESOURCES<br>Division of Integrated Regional Water Management<br>NORTH CENTRAL REGION OFFICE<br>*Geology and Groundwater Investigations Section* | **Proposed Ryer Island<br>CPT Locations and<br>RD 501 Identified Seepage Areas** | **Figure<br>2** |
|---|---|---|

required to be installed on Prospect Island to compensate the non-vented data logger measurements for barometric pressure changes over time.

Following data logger installation, the Prospect Island monitoring sites will be visited approximately every 1-2 month to download water level data and to perform operation and maintenance (O&M) on the data loggers. O&M includes checking to make sure all units are functioning properly and to check and replace desiccant and other parts as necessary.
Water level data downloaded from each site will be uploaded and maintained in the Water Data Library (WDL) Continuous Data Module. During the course of the project, all water data will be available to view on the WDL following data processing and QA/QC checks.

Additionally, the 11 existing groundwater monitoring wells on Ryer Island will continue to be measured following the same protocols as defined above for the new Prospect Island groundwater monitoring wells.

In order to obtain accurate stage data from nearby surface water bodies, at least two surface water stations will be installed. It is anticipated that the Miner Slough station will be located at the Five Points Marina where a surface water station was installed in the past (**Figure 3**). In order to obtain accurate stage data on the flooded portion of Prospect Island, a surface water station will be installed on the former pumping platform at the southeast corner of Prospect Island. Additionally, stage data from an existing station located on the DWSC will be obtained and incorporated into the study. Surface water data from Miner Slough and Prospect Island will be available on the WDL following data processing and QA/QC checks. DWSC data can be accessed through the USGS National Water Information System.

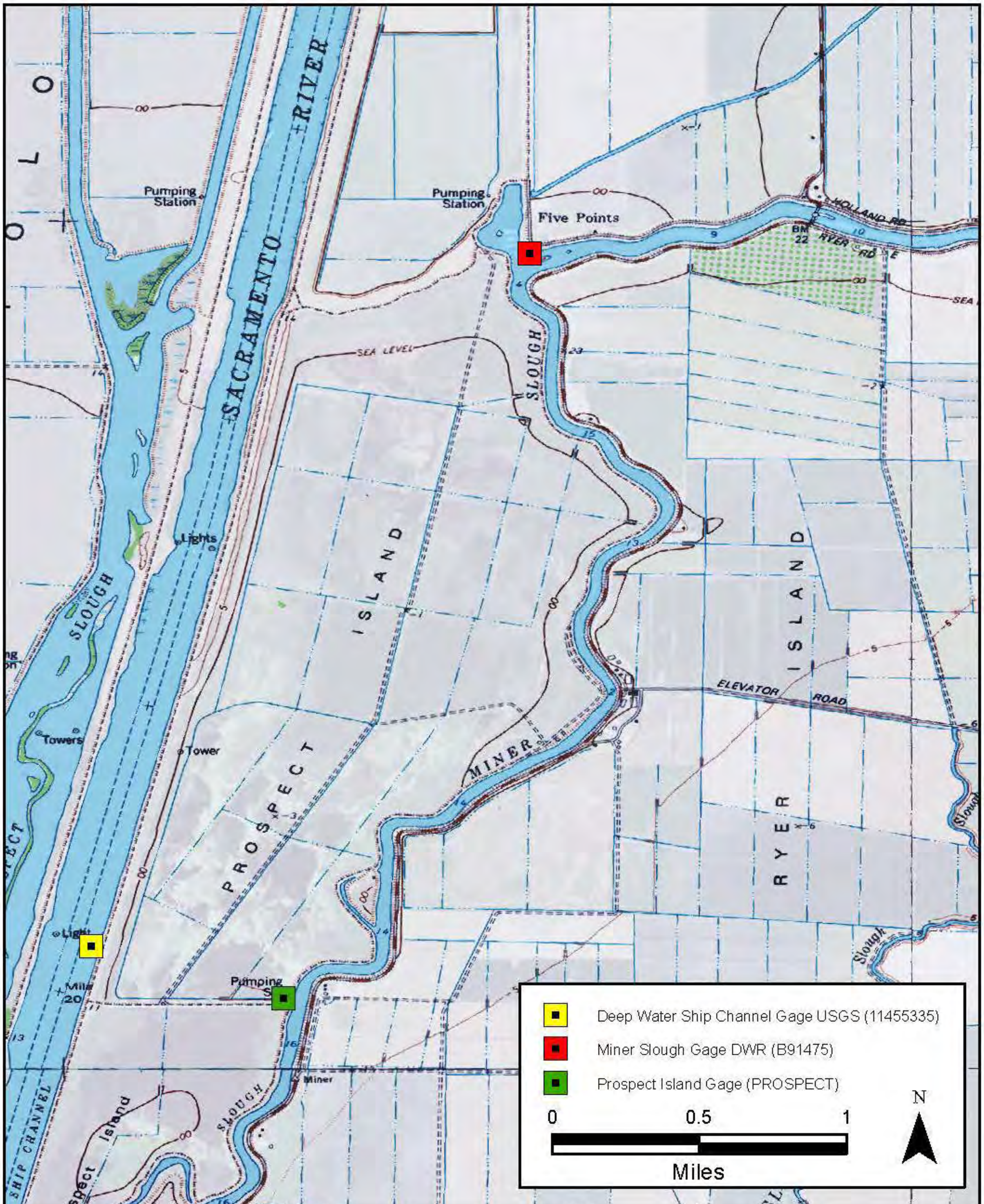
In order to determine accurate groundwater elevations, the new wells on Prospect Island and the existing wells on Ryer Island will be surveyed to establish current land surface and top of casing elevations. Additionally, the CPT sites on both islands and new surface water stations will also be surveyed.

**Task 4: Land Surface Topography Data Research and Compilation**

In order to create a GIS model of the Prospect and Ryer Island study area, all available land surface topography data will be obtained, reviewed, and entered into a GIS. It is anticipated that the best available topography data sets exist in the form of Light Detection and Ranging (LiDAR) and traditional ground-based surveys performed by DWR contractors.

**Task 5: Bathymetry Survey**

In order to create a Geographic Information System (GIS) model of Prospect and Ryer Island study area, a bathymetric survey of Miner Slough and the DWSC surrounding Prospect and Ryer Islands will be performed.

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**Proposed Surface Water Monitoring Stations**

**Figure 3**

This work will be performed by the NCRO Bathymetry and Technical Support Section using industry standard equipment and methodology.

**Task 6: Bed Sediment Sampling**

In order to determine the types of sediments that exist along the bed of Miner Slough and DWSC in the vicinity of Prospect and Ryer Islands, bed sediment sampling will be performed using industry standard equipment and methodology. It is anticipated that samples will be collected along select transects of each channel near groundwater monitoring well locations and in select channel areas that show evidence of scouring based on the bathymetry survey.

# Appendix B

# Prospect Island and Ryer Island Soil Sample Descriptions

| Station ID | Date | Depth of Soil Sample (Feet) | USCS Soil Classification | USCS Soil Description | Comments |
|---|---|---|---|---|---|
| PI-1 | 09/20/2011 | 15.5 | SM | Silty Sand; very dark grayish brown (10YR 3/2); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, quartz, metamorphic and volcanic rock fragments, trace amount of biotite; moderate amount of soft, non-plastic silt. | |
| | | 60 | SW | Sand with Gravel; dark olive brown (2.5Y 3/3); fine to coarse sand with gravel up to 0.25 inch; angular to subrounded; grains consist of feldspar, quartz, metamorphic rock fragments, red and gray volcanic (andesite) rock fragments, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 68 | SW | Sand; olive brown (2.5Y 4/3); fine to coarse sand; angular to subrounded; grains consist of metamorphic rock fragments, quartz, feldspar, red and gray volcanic (andesite) rock fragments, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| PI-2 | 09/15/2011 | 8 | SM | Silty Sand; olive brown (2.5YR 4/4); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, quartz, metamorphic and volcanic rock fragments, trace amount of biotite; moderate amount of stiff, non-plastic silt. | Hand Auger; 0-3 ft. Silty Sand; 3-5 ft. Clay |
| | | 12 | CL | Clay; very dark grayish brown (2.5Y 3/2); medium stiff; medium plasticity. | |
| | | 51 | SM | Silty Sand; very dark grayish brown (2.5YR 3/2); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, quartz, metamorphic and volcanic rock fragments, trace amount of biotite; moderate amount of soft, non-plastic silt. | |
| PI-3 | 09/15/2011 | 12 | SM | Silty Sand; very dark grayish brown (2.5YR 3/2); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, quartz, metamorphic and volcanic rock fragments, trace amount of biotite; moderate amount of soft, non-plastic silt. | Hand Auger; 0-5 ft. Silty Sand |
| | | 40 | SM | Silty Sand; dark olive brown (2.5YR 3/3); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, quartz, metamorphic and volcanic rock fragments, trace amount of biotite; moderate amount of soft, non-plastic silt. | |
| | | 80 | CL | Clay; very dark greenish gray (5GY 3/1); medium stiff; high plasticity. | |
| | | 88 | | Sample not retrieved | Sample @ 88 ft fell out, likely loose coarse sand, keeps falling out of sample tube |
| PI-5 | 09/16/2011 | 29-30 | CL | Clay; dark greenish gray (10Y 4/1) mottled with yellowish red (5YR 4/6); stiff; medium plasticity. | Hand Auger; 0-5 ft. Clay |
| | | 75 | SP | Sand; very dark gray (10YR 3/1); fine to medium sand; well sorted; angular to subrounded; grains consist of, metamorphic and gray and red volcanic rock fragments, feldspar, quartz, biotite, and trace amount of pyroxene. | |

| Station ID | Date | Depth of Soil Sample (Feet) | USCS Soil Classification | USCS Soil Description | Comments |
|---|---|---|---|---|---|
| PI-6 | 09/16/2011 | 15 | CL | Clay; dark brown (7.5YR 3/2); soft; medium plasticity; presence of biotite. | Hand Auger; 0-2 ft. Silty Clay; 2-5 ft. Sand |
| | | 24 | CL | Clay; very dark grayish brown (10YR 3/2) mottled with yellowish red (5YR 4/6); medium stiff; medium plasticity. | |
| | | 46 | SP | Sand; very dark grayish brown (2.5Y 3/2); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, quartz, gray and red volcanic (andesite) rock fragments, orange quartzite, and trace amount of pyroxene and biotite. | |
| | | 54 | SP | Sand; very dark grayish brown (10YR 3/2); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, quartz, gray and red volcanic (andesite) rock fragments, and trace amount of orange quartzite, pyroxene and biotite. | |
| PI-7 | 09/20/2011 | 14 | ML | Clayey Silt; dark yellowish brown (10YR 3/4); soft; low plasticity. | |
| | | 23 | CL | Clay; dark grayish brown (2.5Y 4/2); medium stiff; medium plasticity. | |
| | | 45 | SP | Sand; dark yellowish brown (10YR 3/4); fine to medium sand; well sorted; angular to subrounded; grains consist of quartz, feldspar, red and gray volcanic (andesite) rock fragments, quartzite, and trace amount of biotite, pyroxene, and hornblende. | |
| | | 53 | SP | Sand; dark yellowish brown (10YR 3/4); fine to medium sand; well sorted; angular to subrounded; grains consist of quartz, feldspar, red and gray volcanic (andesite) rock fragments, quartzite, and trace amount of biotite, pyroxene, and hornblende. | |
| PI-8 | 09/19/2011 | 14 | ML | Silt; dark brown (7.5YR 3/2); soft; low plasticity. | Hand Auger; 0-5 ft. Clayey Silt |
| | | 22 | CL | Clay; very dark grayish brown (10YR 3/2); soft; medium plasticity; presence of gray (10YR 6/1) silt, possibly weathered ash | |
| | | 46 | SP | Sand; dark yellowish brown (10YR 3/4); fine to medium sand; well sorted; angular to subrounded; grains consist of quartz, feldspar, red and gray volcanic (andesite) rock fragments, quartzite, and trace amount of biotite, pyroxene, and hornblende. | |
| | | 54 | SP | Sand with Gravel; very dark grayish brown (10YR 3/2); fine to coarse sand with gravel up to 0.25 inch; angular to subrounded; grains consist of feldspar, quartz, metamorphic and gray and red volcanic rock fragments, and trace amount of orange quartzite, pyroxene and biotite. | |

| Station ID | Date | Depth of Soil Sample (Feet) | USCS Soil Classification | USCS Soil Description | Comments |
|---|---|---|---|---|---|
| PI-9 | 09/19/2011 | 12 | ML | Silt; brown (7.5YR 4/4); soft; low plasticity | Hand Auger; 0-5 ft. Sand |
| | | 20 | CH | Clay; black (5Y 2.5/1); stiff; high plasticity when wet; dry | |
| | | 46 | SP | Sand; dark yellowish brown (10YR 3/4); fine sand; well sorted; angular to subrounded; grains consist of quartz, feldspar, red and gray volcanic (andesite) rock fragments, quartzite, and trace amount of biotite, pyroxene, and hornblende. | |
| | | 54 | SP | Sand; dark olive brown (2.5Y 3/3); fine to medium; angular to subrounded; grains consist of feldspar, quartz, metamorphic and gray and red volcanic rock fragments, and trace amount of orange quartzite, pyroxene and biotite. | |
| | | 80 | CL | Clay; dark gray (5Y 4/1); stiff; medium plasticity; presence of gray (10YR 6/1) silt, possibly weathered ash | |
| | | 93 | SP | Sand; dark grayish brown (10YR 4/2); fine to medium sand; angular to subrounded; grains consist of feldspar, metamorphic rock fragments, quartz, and trace amount of red volcanic rock fragments, biotite, and pyroxene. | |
| PI-10 | 09/19/2011 | 18 | ML | Silt; dark grayish brown (10YR 4/2); soft; low plasticity. | |
| | | 26 | SP | Sand; very dark grayish brown (10YR 3/2); fine to medium sand; angular to subrounded; grains consist of quartz, metamorphic rock fragments, feldspar, volcanic rock fragments, and trace amount of biotite, orange quartzite, and pyroxene. | |
| | | 30 | CL | Clay; dark grayish brown (2.5Y 4/2); medium stiff; medium plasticity. | |
| | | 46 | SP | Sand; dark yellowish brown (10YR 3/4); fine to medium sand; well sorted; angular to subrounded; grains consist of quartz, feldspar, red and gray volcanic (andesite) rock fragments, quartzite, and trace amount of biotite, pyroxene, and hornblende. | |
| | | 54 | SP | Sand; dark yellowish brown (10YR 3/4); fine to medium; angular to subrounded; grains consist of feldspar, quartz, metamorphic and gray and red volcanic rock fragments, and trace amount of orange quartzite, pyroxene and biotite. | |

| Station ID | Date | Depth of Soil Sample (Feet) | USCS Soil Classification | USCS Soil Description | Comments |
|---|---|---|---|---|---|
| RI-2 | 03/15/2012 | 37 | CL | Silty Clay; dark greenish gray (10Y 4/1); medium stiff; medium plasticity; dry to moist. | |
| | | 58 | SP | Sand; brown (10YR 4/3); fine to medium sand; well sorted; angular to subrounded; grains consist of quartz, red and gray volcanic (andesite) rock fragments, feldspar, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| RI-3 | 03/27/2012 | 18 | ML | Clayey Silt; light olive brown (2.5Y 5/3); medium stiff; low plasticity; dry. | |
| | | 37 | SM | Silty Sand with Clay; dark yellowish brown (10YR 4/4); fine sand; well sorted; angular to subrounded; grains consist of feldspar, red and light gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 50 | SM | Silty Sand; very dark grayish brown (2.5Y 3/2); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, gray and red volcanic (andesite) rock fragments, metamorphic rock fragments, hornblende, biotite, and pyroxene; moderate amount of soft, low-plasticity silt. | |
| | | 85 | SC | Clayey Sand; light olive brown (2.5Y 5/3); fine sand; well sorted; angular to subrounded; grains consist of feldspar, red and light gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica; moreate amount of soft, medium-plasticity clay | |
| | | 90 | SM | Silty Sand; olive brown (2.5Y 4/4); fine sand; angular to subrounded; grains consist of feldspar, quartz; gray and red volcanic rock fragments; moderate amount of soft, low-plasticity silt. | |
| RI-4 | 03/13/2012 | 13 | CL | Clay; greenish gray (10Y 5/1); medium stiff; high plasticity; dry to slighly moist | |
| | | 25 | SP | Sand; brown (10YR 4/3); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 35 | SP | Sand; brown (10YR 4/3); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 52 | SP | Sand; brown (10YR 4/3); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| RI-5 | 03/21/2012 | 12 | ML | Silt; yellow brown (2.5Y 4/3); soft; medium plasticity. | Hand Auger; 0-3 ft.Grayish black clay, hard, moist to wet; 3-5 ft. Dark gray organic clay, soft, wet |
| | | 25 | SP | Sand; dark yellowish brown (10YR 4/4); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 36 | SW | Sand with Gravel; dark grayish brown (2.5YR 4/2); fine to coarse sand with gravel up to 0.25 inch; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 60 | ML | Silt with Clay; dark olive gray (5Y 3/2); soft; low plasticity; mottled appearance. | |
| | | 81 | SM | Silty Sand; dark gray (10YR 4/1); fine to medium sand; well sorted; angular to subrounded; grains consist of quartz, feldspar, gray and red volcanic (andesite) rock fragments, and trace amount of biotite. | |

| Station ID | Date | Depth of Soil Sample (Feet) | USCS Soil Classification | USCS Soil Description | Comments |
|---|---|---|---|---|---|
| RIS-1 | 03/28/2012 | 23 | SM | Silty Sand; dark olive brown (2.5Y 3/3); fine sand; well sorted; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 39 | SW | Sand with Gravel; very dark grayish brown (2.5Y 3/2); fine to coarse sand with gravel up to 0.5 inch; angular to subrounded; grains consist of grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| RIS-4 | 03/13/2012 | 10 | CL | Clay; greenish gray (10Y 5/1); medium stiff; high plasticity; dry to slighly moist | |
| | | 20 | SW | Sand with Gravel; dark grayish brown (10YR 4/2); fine to coarse sand with gravel up to 0.5 inch; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| | | 35 | SP | Sand; brown (10YR 4/3); fine to medium sand; well sorted; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |
| RIS-5 | 03/22/2012 | 12 | CL | Clay; greenish gray (10Y 5/1); medium stiff; medium plasticity; dry to slighly moist. | |
| | | 19 | SP | Sand; very dark grayish brown (10YR 3/2); fine to medium sand; well sorted; angular to subrounded; grains consist of quartz, gray and red volcanic (andesite) rock fragments, feldspar, and trace amount of pyroxene and biotite. | |
| | | 31 | SW | Gravelly Sand; dark yellowish brown (10YR 3/4); fine to coarse sand and fine gravel up to 0.5 inch; angular to subrounded; grains consist of quartz, gray and red volcanic (andesite) rock fragments, metamorphic rock fragments, feldspar, and trace amount of pyroxene and biotite. | |
| | | 42 | SP | Sand; dark olive brown (2.5Y 3/3); medium to coarse; angulat to subrounded; grains consist of quartz, gray and red volcanic (andesite) rock fragments, metamorphic rock fragments, feldspar, and trace amount of pyroxene and biotite. | |
| RIS-6 | 03/26/2012 | 10 | CL | Clay; greenish gray (10Y 5/1); medium stiff; high plasticity; dry to slighly moist. | Hand Auger; 0-5 ft. Clay; dark gray; soft; moist to wet |
| | | 26 | SM | Silty Sand; very dark grayish brown (2.5Y 3/2); fine to coarse sand; angulat ot subrounded; grains consist of quartz, feldspar, quartzite, red and gray volcanic (andesite) rock fragments. | |
| | | 35 | SP | Sand; olive brown (2.5Y 4/3); medium to coarse sand; angular to subrounded; grains consist of feldspar, red and gray volcanic (andesite) rock fragments, quartz, quartzite, and trace amount of pyroxene, hornblende, and mica. | |

# Appendix C

# Prospect Island Site Photos


**Prospect Island Well Locations**

| Site Number: 1 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
|---|---|---|---|---|---|
| County: Solano | Date: 9/27/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-1A | 13-23 | 38.2530582 | -121.6567402 | 14.69 | 14.81 |
| PI-1B | 61-71 | 38.2530711 | -121.6567103 | 14.68 | 14.79 |


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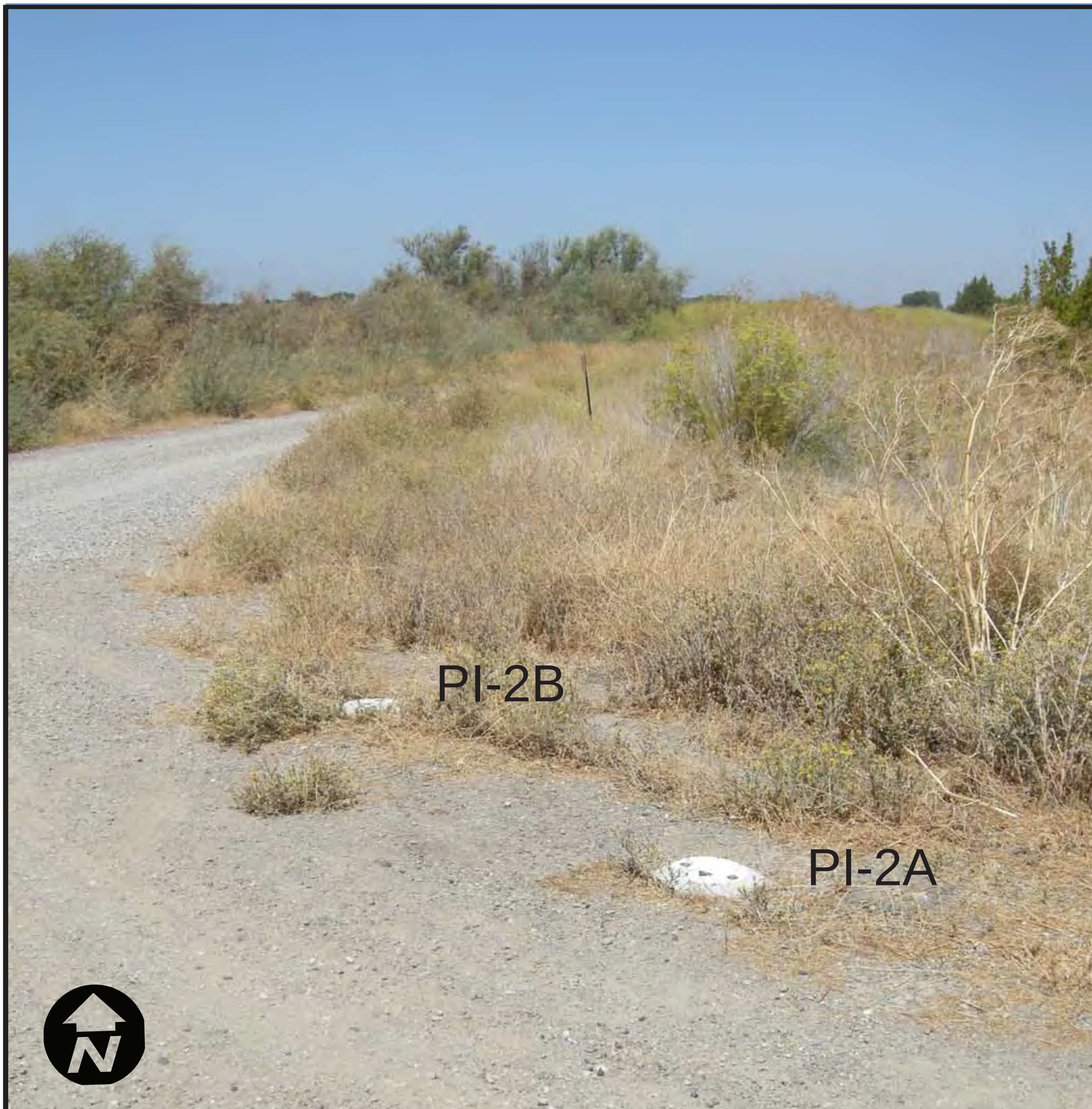
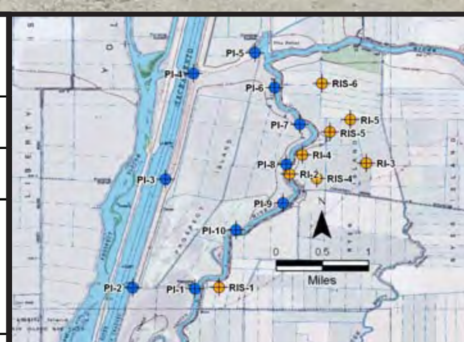



| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 2 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
| County: Solano | Date: 9/29/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-2A | 8-18 | 38.2532359 | -121.6664966 | 12.87 | 12.95 |
| PI-2B | 49-59 | 38.2532589 | -121.6665114 | 12.87 | 12.85 |

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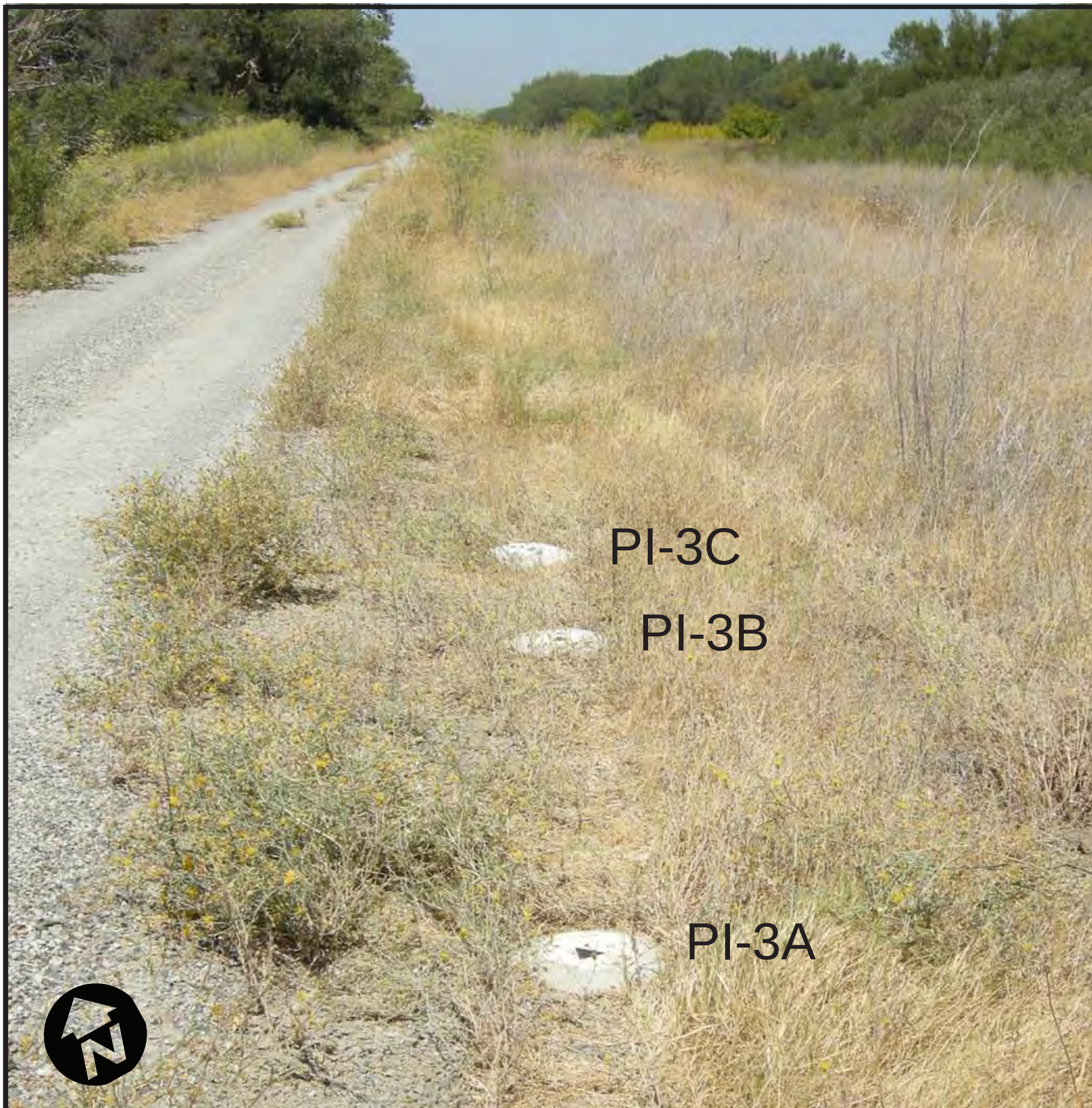


| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 3 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
| County: Solano | Date: 9/16/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-3A | 12-22 | 38.2702847 | -121.6613492 | 13.96 | 13.85 |
| PI-3B | 42-52 | 38.2703108 | -121.6613403 | 13.93 | 13.99 |
| PI-3C | 84-94 | 38.2703247 | -121.6613366 | 13.93 | 13.96 |


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| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 4 | | Installed by: Gregg Drilling and Testing, Inc. | | | |
| County: Solano | | Date: 9/16/2011 | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-4 CPT | -- | 38.2869233 | -121.6569905 | -- | 13.83 |
| Monitoring Wells were not constructed at PI-4 | | | | | |


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| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 5 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
| County: Solano | Date: 9/22/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-5A | 28-38 | 38.2902060 | -121.6473309 | 17.48 | 17.61 |
| PI-5B | 67-77 | 38.2901976 | -121.6473628 | 17.89 | 17.97 |


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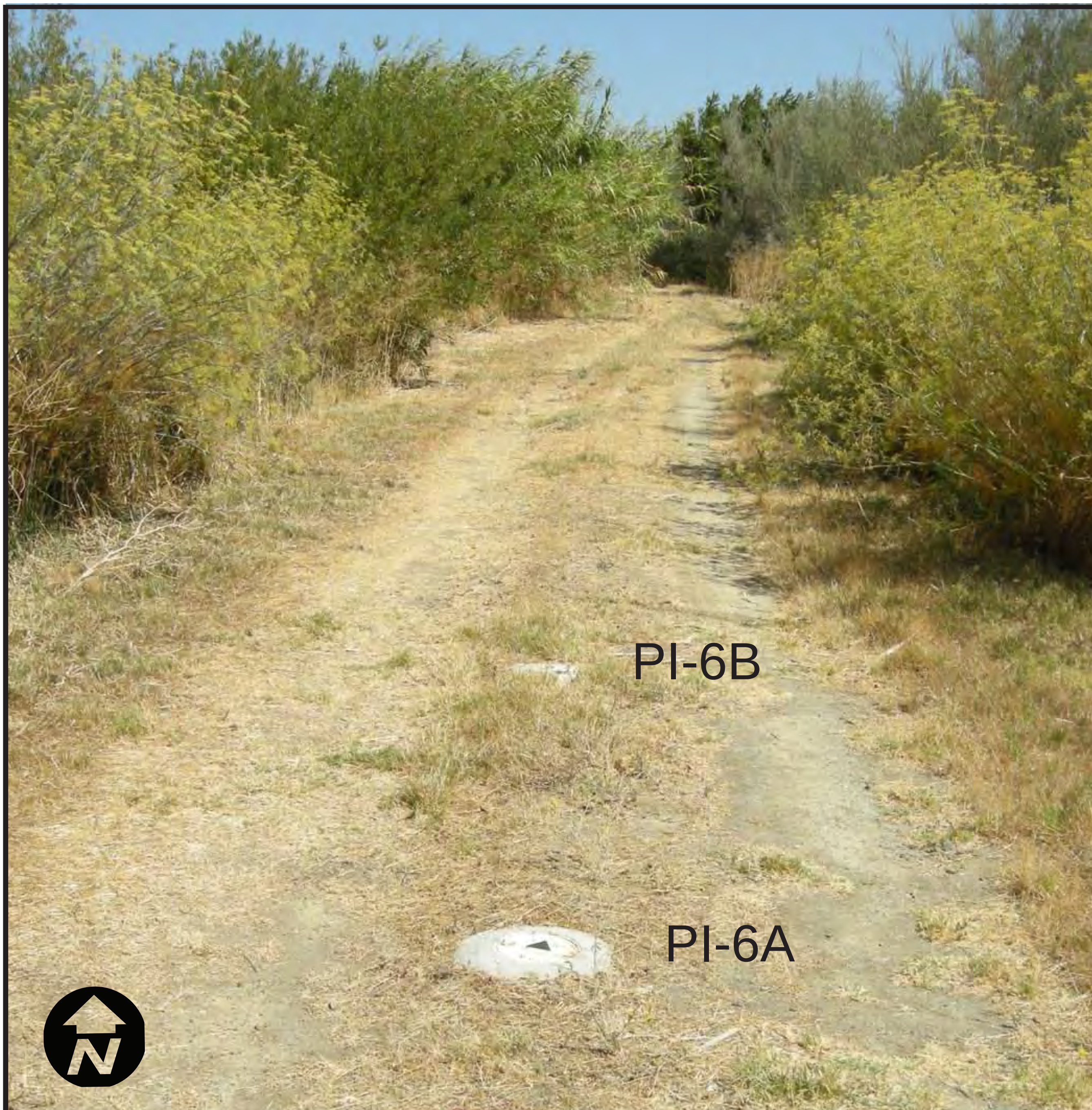


| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 6 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
| County: Solano | Date: 9/23/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-6A | 16-26 | 38.2847104 | -121.6442571 | 16.22 | 16.41 |
| PI-6B | 46-56 | 38.2847369 | -121.6442530 | 16.42 | 16.45 |


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| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 7 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
| County: Solano | Date: 9/23/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-7A | 12-22 | 38.2789211 | -121.6403016 | 15.89 | 15.87 |
| PI-7B | 47-57 | 38.2789382 | -121.6403283 | 15.90 | 15.94 |


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**Prospect Island Well Locations**

Site Number: 8 | Installed by: Gregg Drilling and Testing, Inc.

County: Solano | Date: 9/26/2011

| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
|---|---|---|---|---|---|
| PI-8A | 12-22 | 38.2726716 | -121.6424158 | 15.60 | 15.70 |
| PI-8B | 47-57 | 38.2726972 | -121.6423996 | 15.56 | 15.85 |


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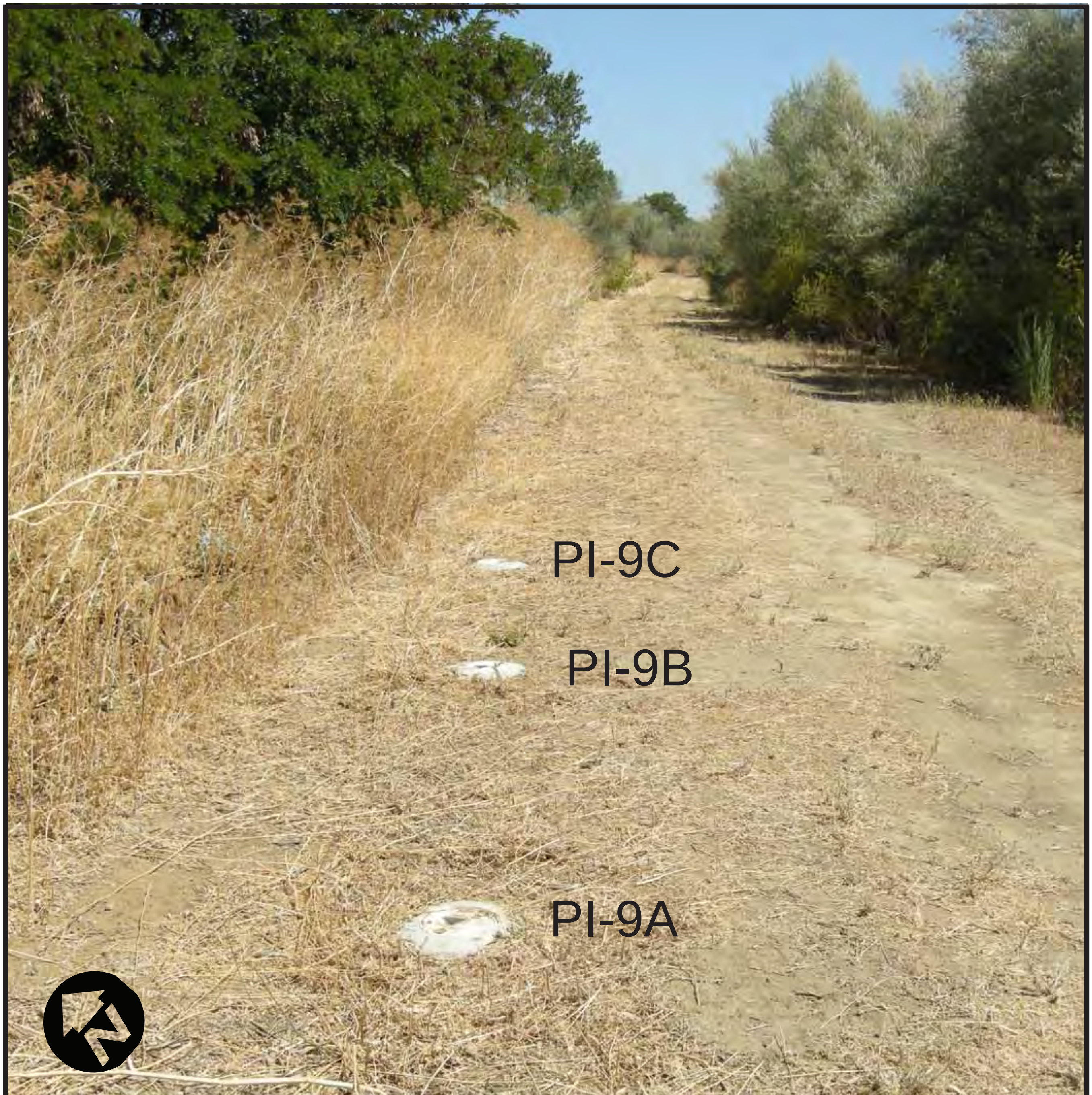


| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 9 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
| County: Solano | Date: 9/27/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-9A | 11-21 | 38.2665200 | -121.6429347 | 15.41 | 15.34 |
| PI-9B | 46-56 | 38.2665424 | -121.6429141 | 15.32 | 15.33 |
| PI-9C | 83-93 | 38.2665623 | -121.6428953 | 15.26 | 15.33 |


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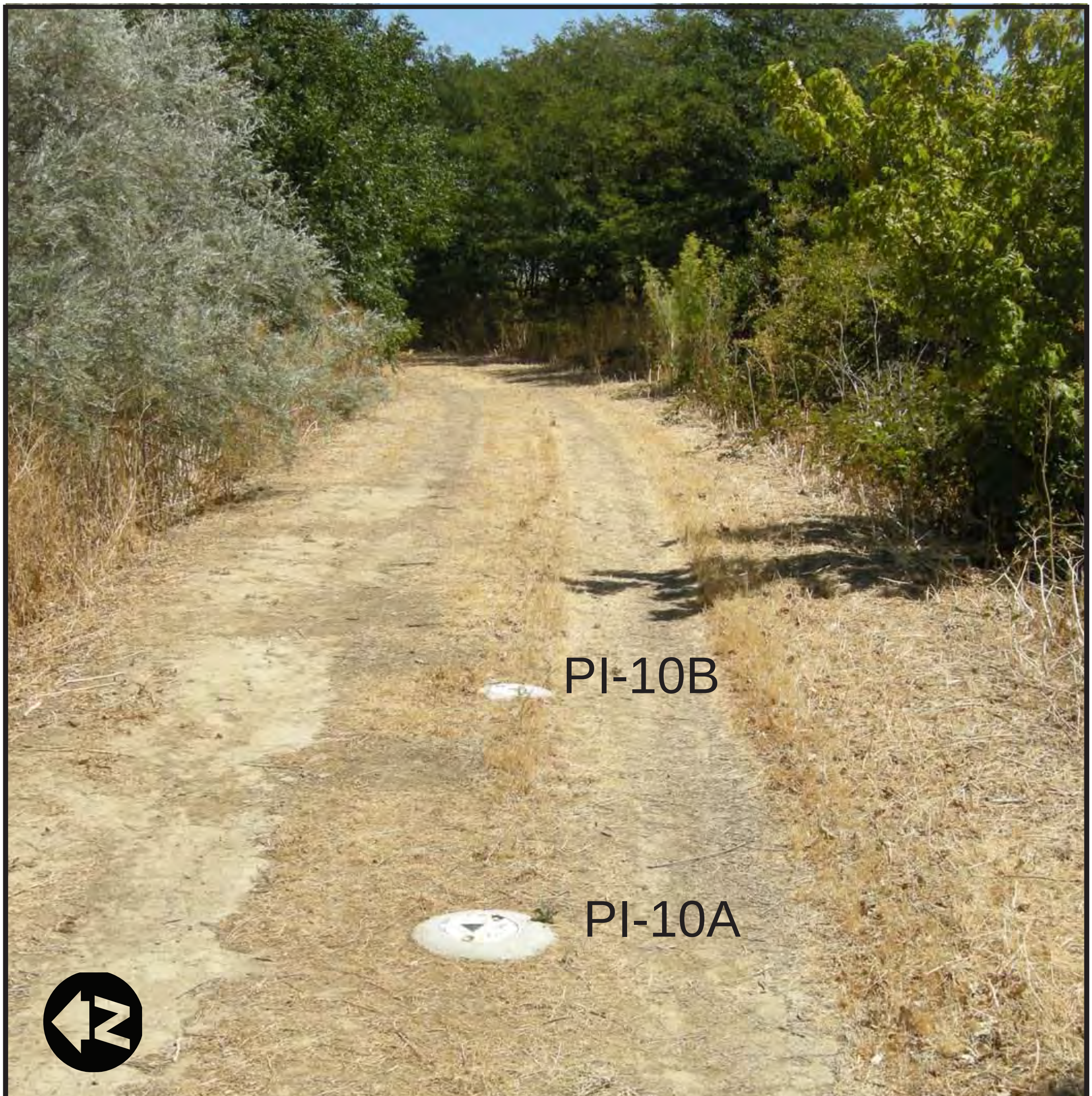
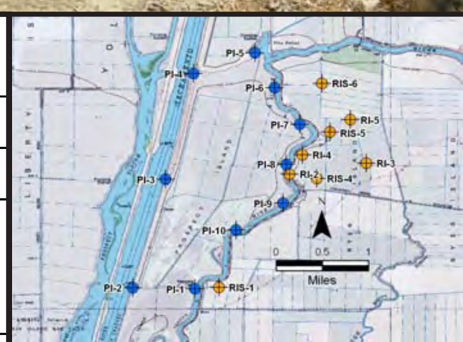



| Prospect Island Well Locations | | | | | |
|---|---|---|---|---|---|
| Site Number: 10 | Installed by: Gregg Drilling and Testing, Inc. | | | | |
| County: Solano | Date: 9/27/2011 | | | | |
| Well ID | Screen Interval (feet) | Latitude (NAD83) | Longitude (NAD83) | Reference Elevation (feet) | Ground Elevation (feet) |
| PI-10A | 18-28 | 38.2623045 | -121.6503044 | 14.75 | 14.79 |
| PI-10B | 45-55 | 38.2623043 | -121.6502694 | 14.76 | 14.85 |

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# Appendix D

# Gregg Drilling & Testing, Inc. Prospect Island and Ryer Island Final Data Reports

GREGG DRILLING & TESTING, INC.
GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

September 30, 2011

DWR
Attn: Mark Souverville

Subject: CPT Site Investigation
Prospect Island
California
GREGG Project Number: 11-141MA

Dear Mr. Souverville:

The following report presents the results of GREGG Drilling & Testing's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

| | | | |
|---|---|---|---|
| 1 | Cone Penetration Tests | (CPTU) | ☒ |
| 2 | Pore Pressure Dissipation Tests | (PPD) | ☒ |
| 3 | Seismic Cone Penetration Tests | (SCPTU) | ☐ |
| 4 | UVOST Laser Induced Fluorescence | (UVOST) | ☐ |
| 5 | Groundwater Sampling | (GWS) | ☒ |
| 6 | Soil Sampling | (SS) | ☒ |
| 7 | Vapor Sampling | (VS) | ☐ |
| 8 | Pressuremeter Testing | (PMT) | ☐ |
| 9 | Vane Shear Testing | (VST) | ☐ |
| 10 | Dilatometer Testing | (DMT) | ☐ |

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (925) 313-5800.

Sincerely,
GREGG Drilling & Testing, Inc.

Mary Walden
Operations Manager

**950 Howe Rd • Martinez, California 94553 • (925) 313-5800 • FAX (925) 313-0302**
**OTHER OFFICES:** LOS ANGELES • HOUSTON
www.greggdrilling.com

## Cone Penetration Test Sounding Summary

### -Table 1-

| CPT Sounding Identification | Date | Termination Depth (Feet) | Depth of Groundwater Samples (Feet) | Depth of Soil Samples (Feet) | Depth of Pore Pressure Dissipation Tests (Feet) |
|---|---|---|---|---|---|
| PI-1 | 9/20/11 | 100 | - | 15.5, 60, 68 | 40.0, 55.1, 65.1 |
| PI-1 PPD | 9/28/11 | 15 | - | - | 15.1 |
| PI-2 | 9/15/11 | 100 | - | 8, 12, 51, 58 | 10.0, 40.0, 47.2, 58.1, 83.2, 100.2 |
| PI-3 | 9/15/11 | 100 | - | 12, 40, 80 | 36.9, 51.2, 70.1, 88.9 |
| PI-4 | 9/16/11 | 100 | - | - | 61.8, 66.3, 85.5 |
| PI-5 | 9/16/11 | 100 | - | 29, 30, 75 | 64.5, 81.4, 90.7 |
| PI-6 | 9/16/11 | 100 | - | 15, 24, 46, 54 | 36.7, 44.5, 60.0 |
| PI-6 PPD | 9/23/11 | 16 | - | - | 16.1 |
| PI-7 | 9/20/11 | 100 | - | 14, 23, 45, 53 | 13.3, 13.5, 44.1 |
| PI-8 | 9/19/11 | 100 | - | 14, 22, 46, 54 | 37.4, 50.0, 70.1 |
| PI-8 PPD | 9/26/11 | 16 | - | - | 16.1 |
| PI-9 | 9/19/11 | 100 | - | 12, 20, 46, 54, 80, 93 | 14.1, 41.0, 50.0, 70.1, 89.2 |
| PI-10 | 9/19/11 | 100 | - | 18, 26, 30, 46, 54 | 8.4, 20.5 |
| | | | | | |
| | | | | | |

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Robertson, P.K., R.G. Campanella, D. Gillespie and A. Rice, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8, 1986 pp. 791-803.

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Campanella, R.G. and I. Weemees, "Development and Use of An Electrical Resistivity Cone for Groundwater Contamination Studies", Canadian Geotechnical Journal, Vol. 27 No. 5, 1990 pp. 557-567.

DeGroot, D.J. and A.J. Lutenegger, "Reliability of Soil Gas Sampling and Characterization Techniques", International Site Characterization Conference - Atlanta, 1998.

Woeller, D.J., P.K. Robertson, T.J. Boyd and Dave Thomas, "Detection of Polyaromatic Hydrocarbon Contaminants Using the UVIF-CPT", 53rd Canadian Geotechnical Conference Montreal, QC October pp. 733-739, 2000.

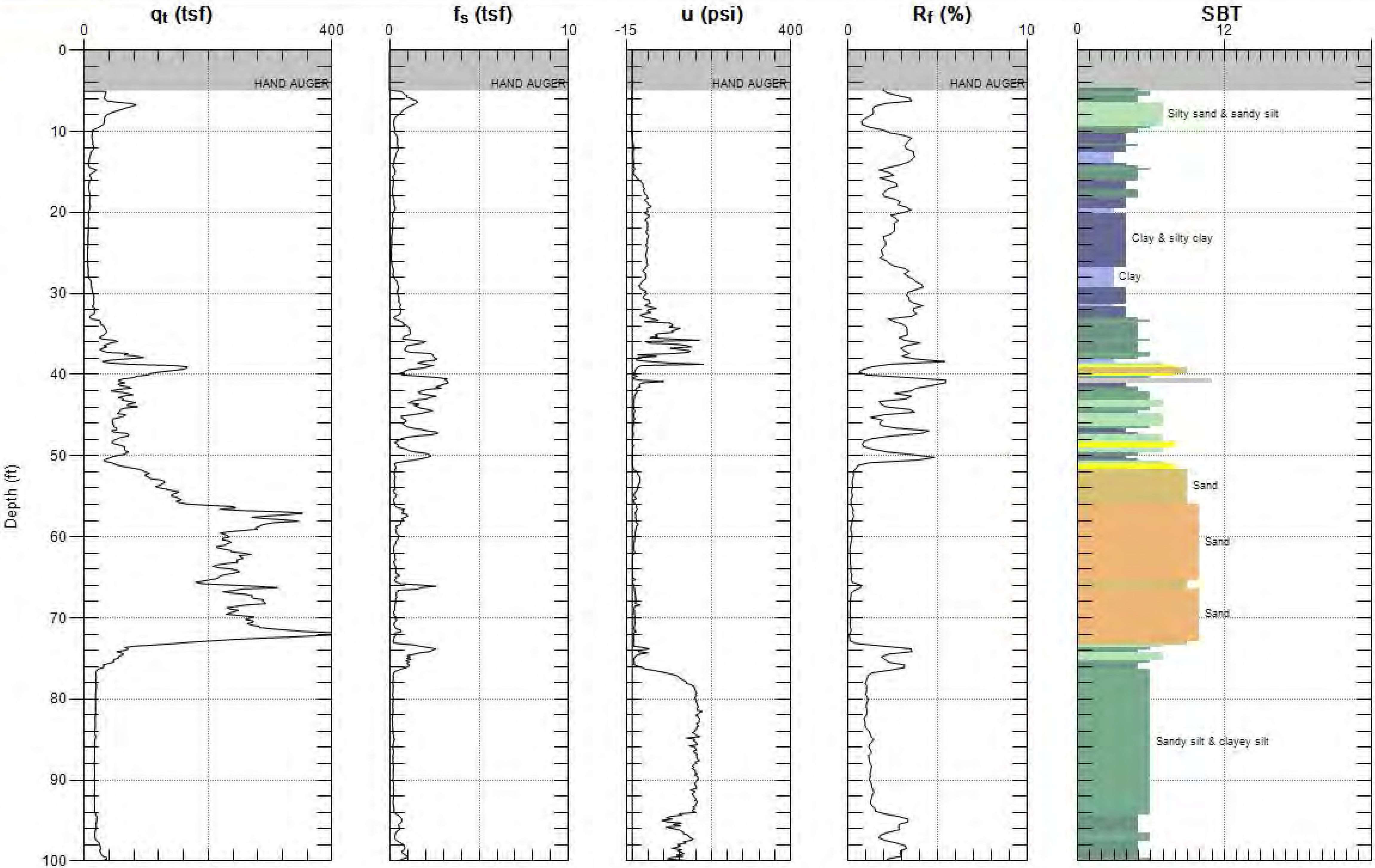
Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, "Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers" BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

**DWR**

**Site: PROSPECT ISLAND** **Engineer: M.SOUVERVILLE**

**Sounding: PI-1** **Date: 9/20/2011 11:37**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

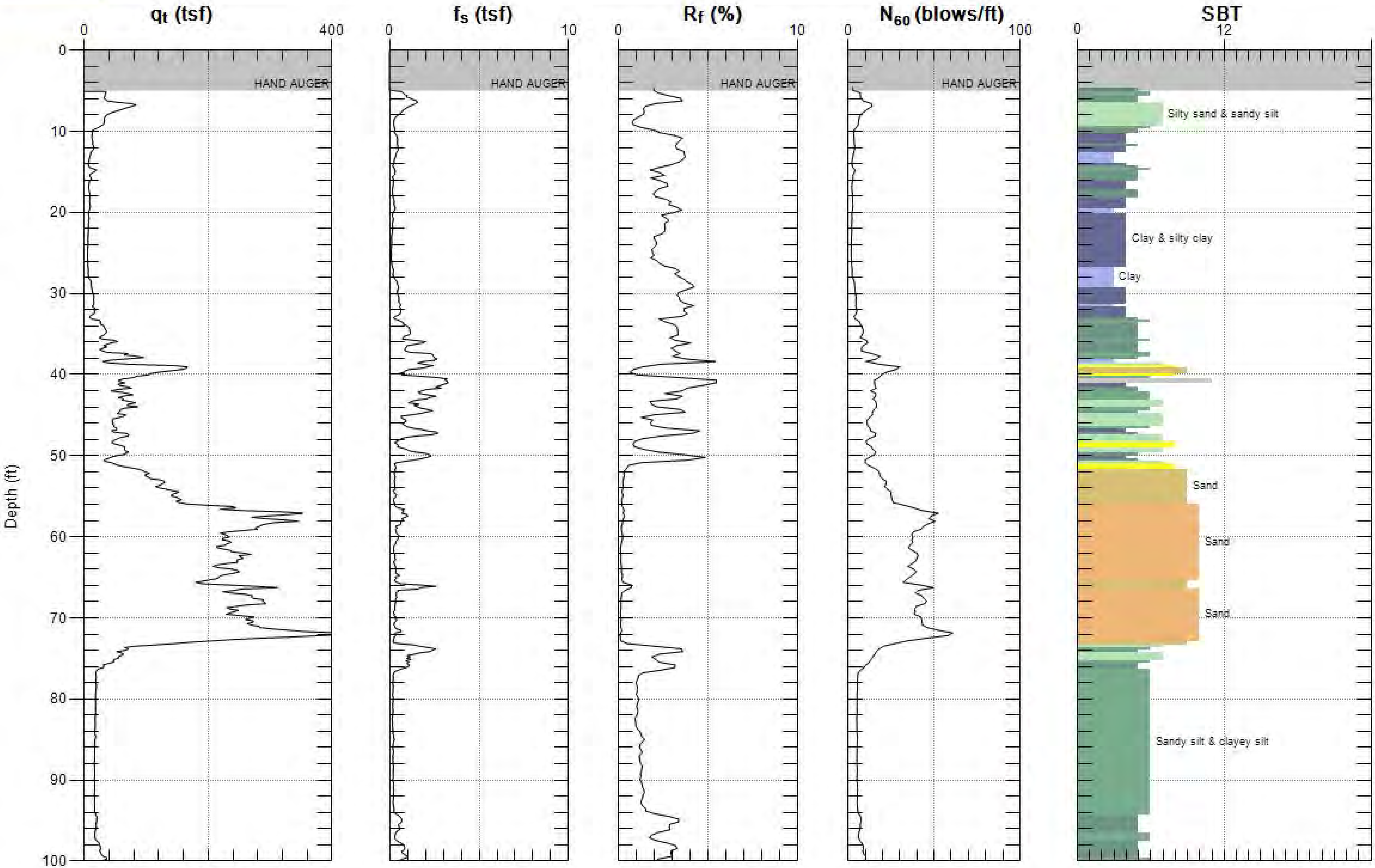
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

**Site: PROSPECT ISLAND** **Engineer: M.SOUVERVILLE**

**Sounding: PI-1** **Date: 9/20/2011 11:37**

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Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

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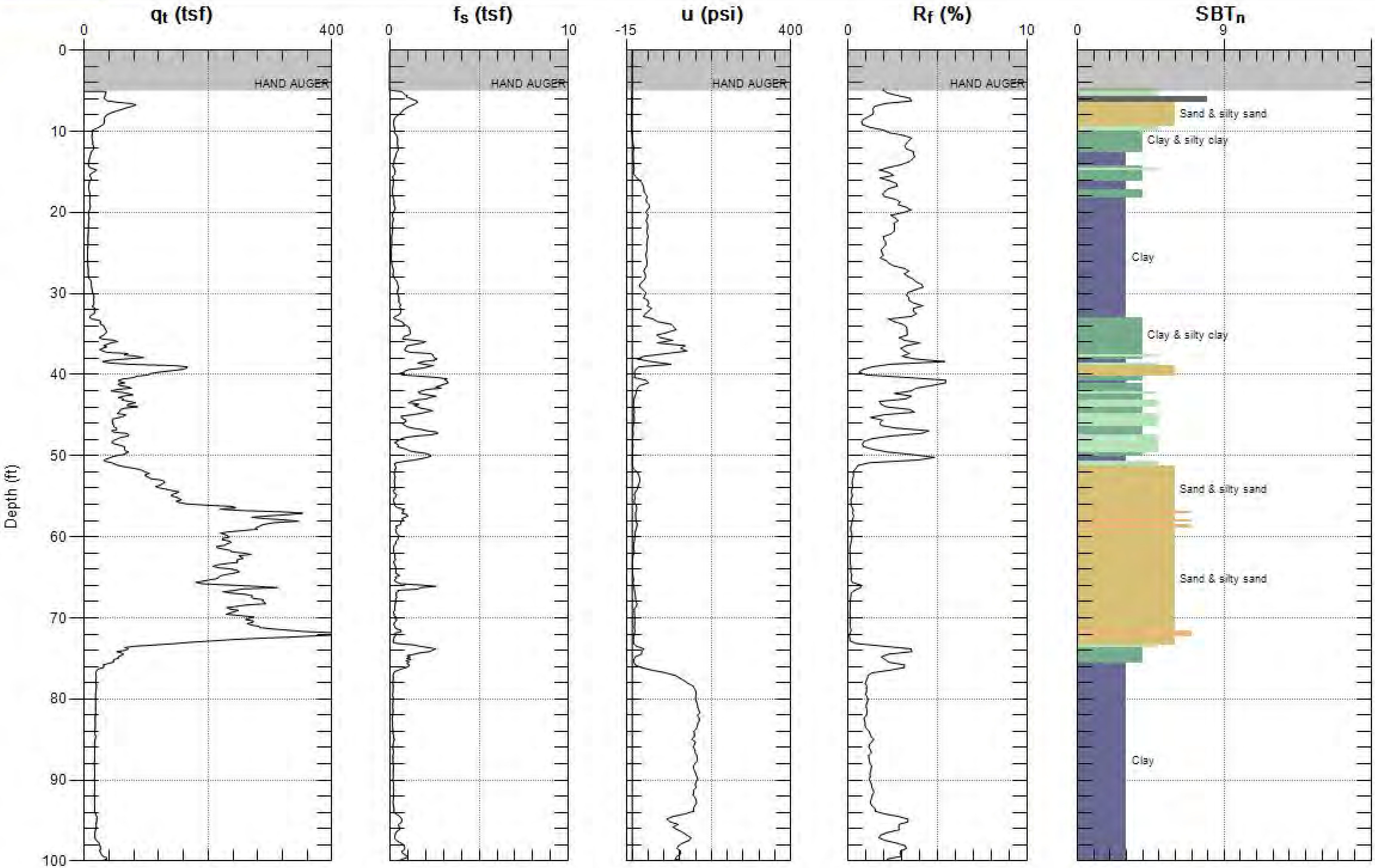
**Sounding: PI-1**

**Engineer: M.SOUVERVILLE**

**Date: 9/20/2011 11:37**

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Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

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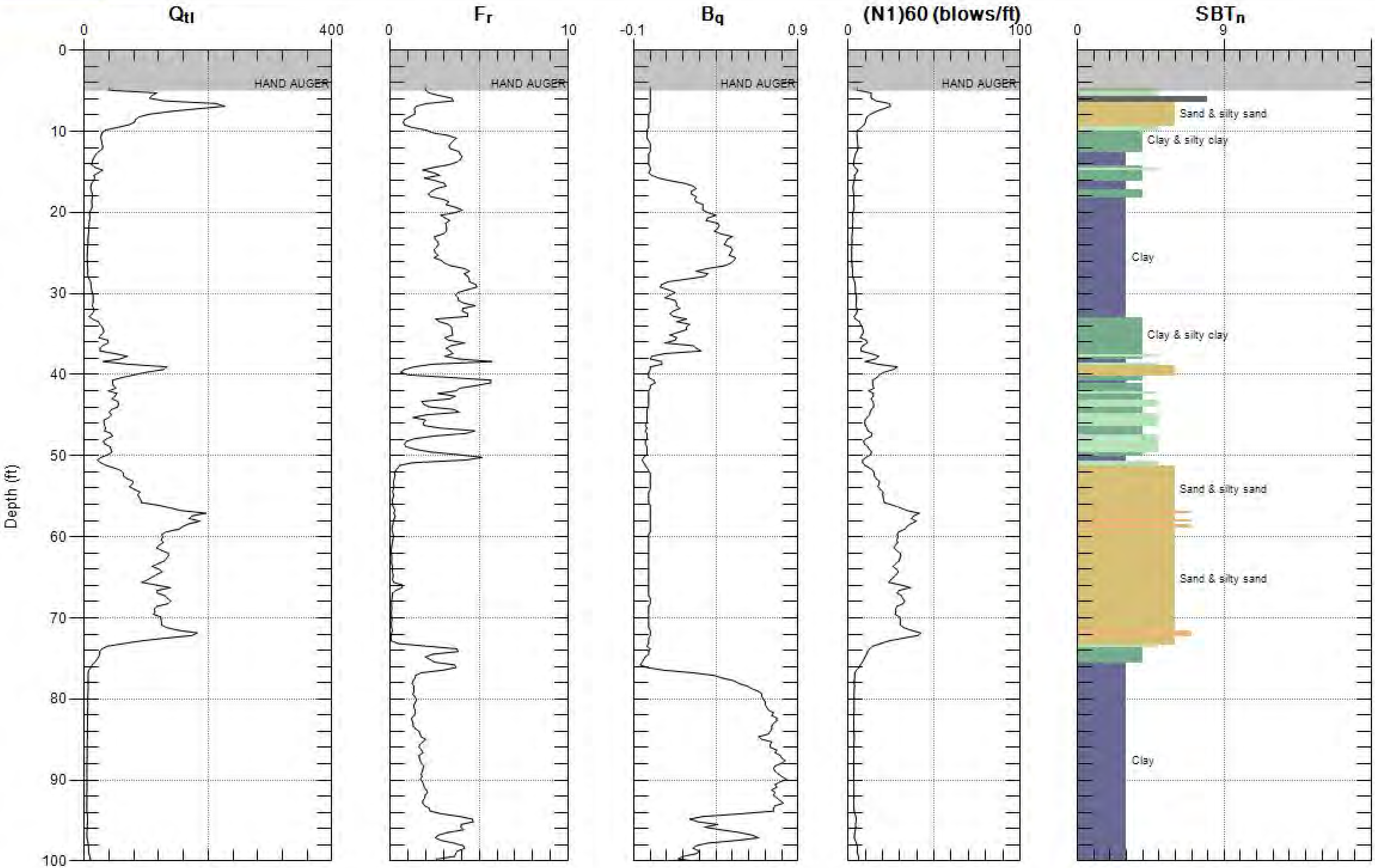
Sounding: PI-1

Engineer: M.SOUVERVILLE

Date: 9/20/2011 11:37

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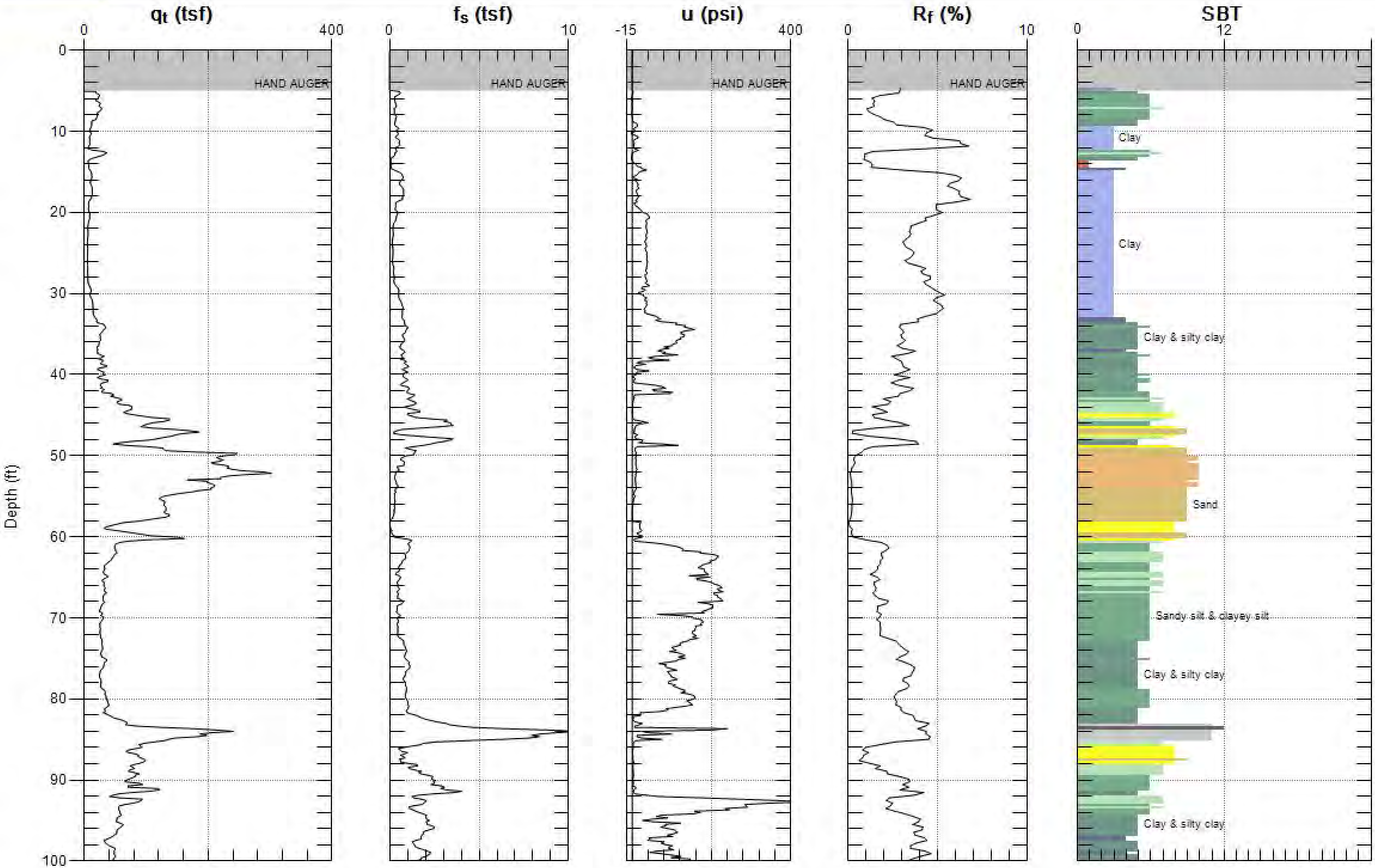
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

**Site: PROSPECT ISLAND** | **Engineer: M.SOUVERVILLE**

**Sounding: PI-2** | **Date: 9/15/2011 12:02**

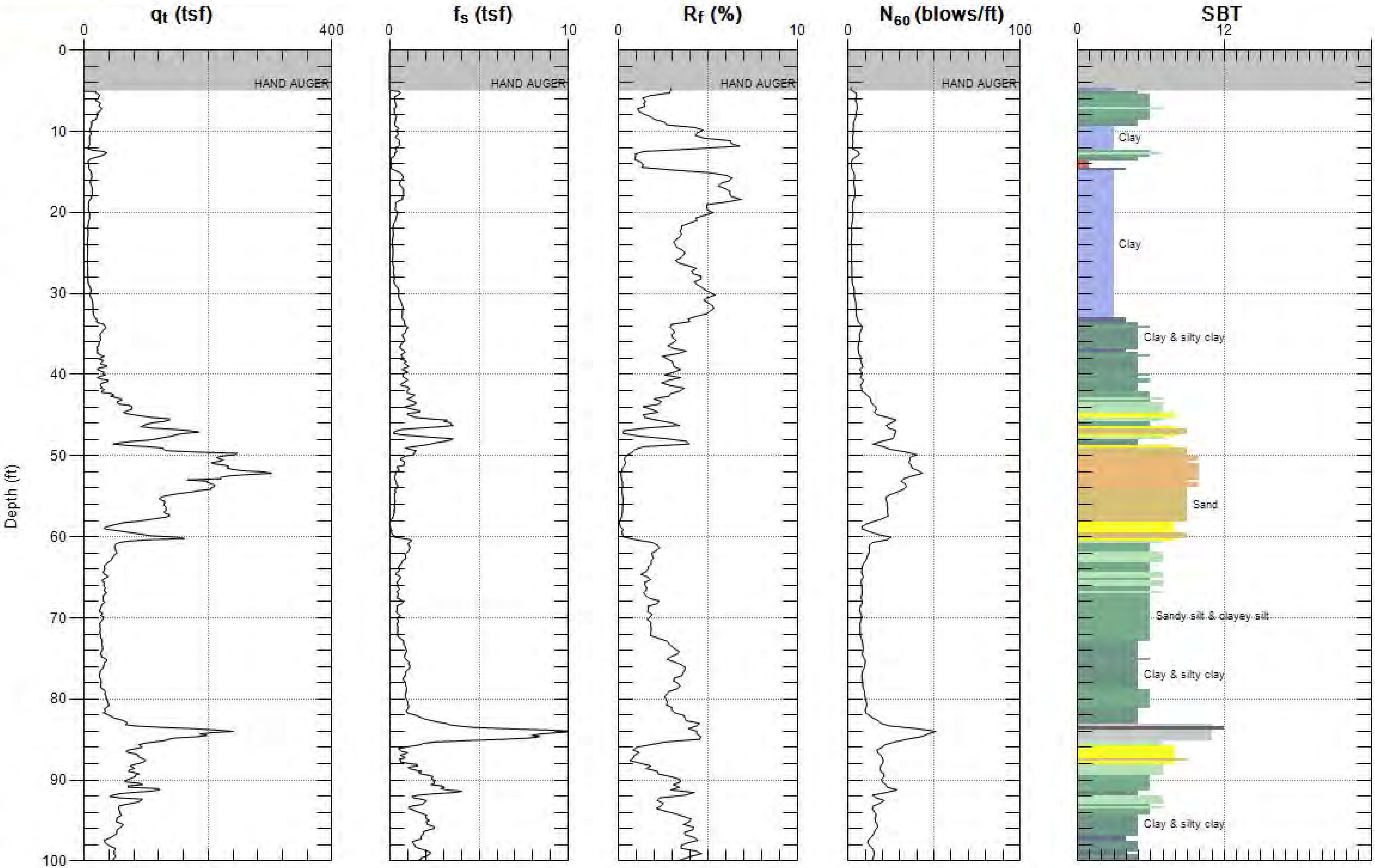



Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

Site: PROSPECT ISLAND | Engineer: M.SOUVERVILLE
Sounding: PI-2 | Date: 9/15/2011 12:02

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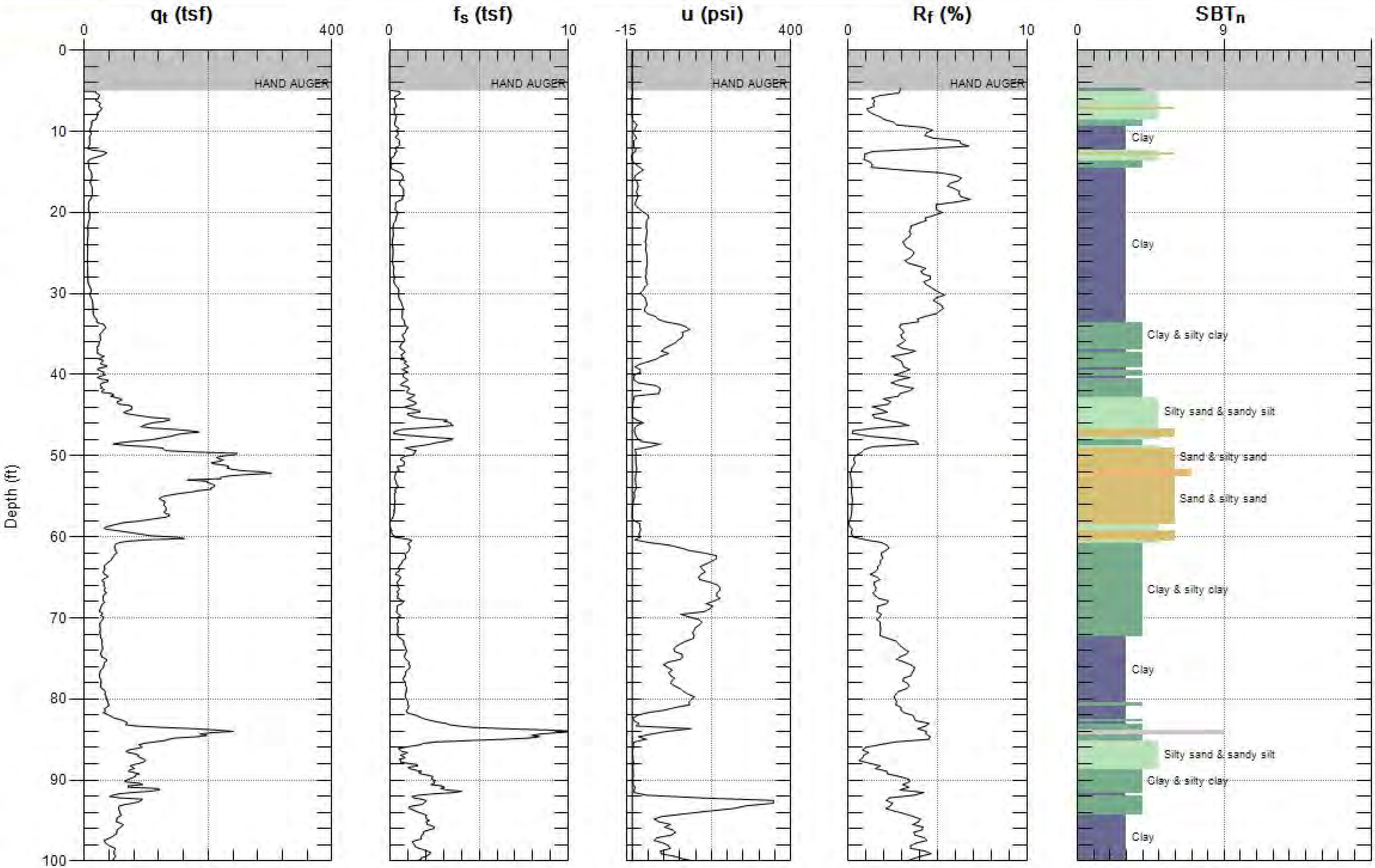
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

DWR

Site: PROSPECT ISLAND
Sounding: PI-2

Engineer: M.SOUVERVILLE
Date: 9/15/2011 12:02

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Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

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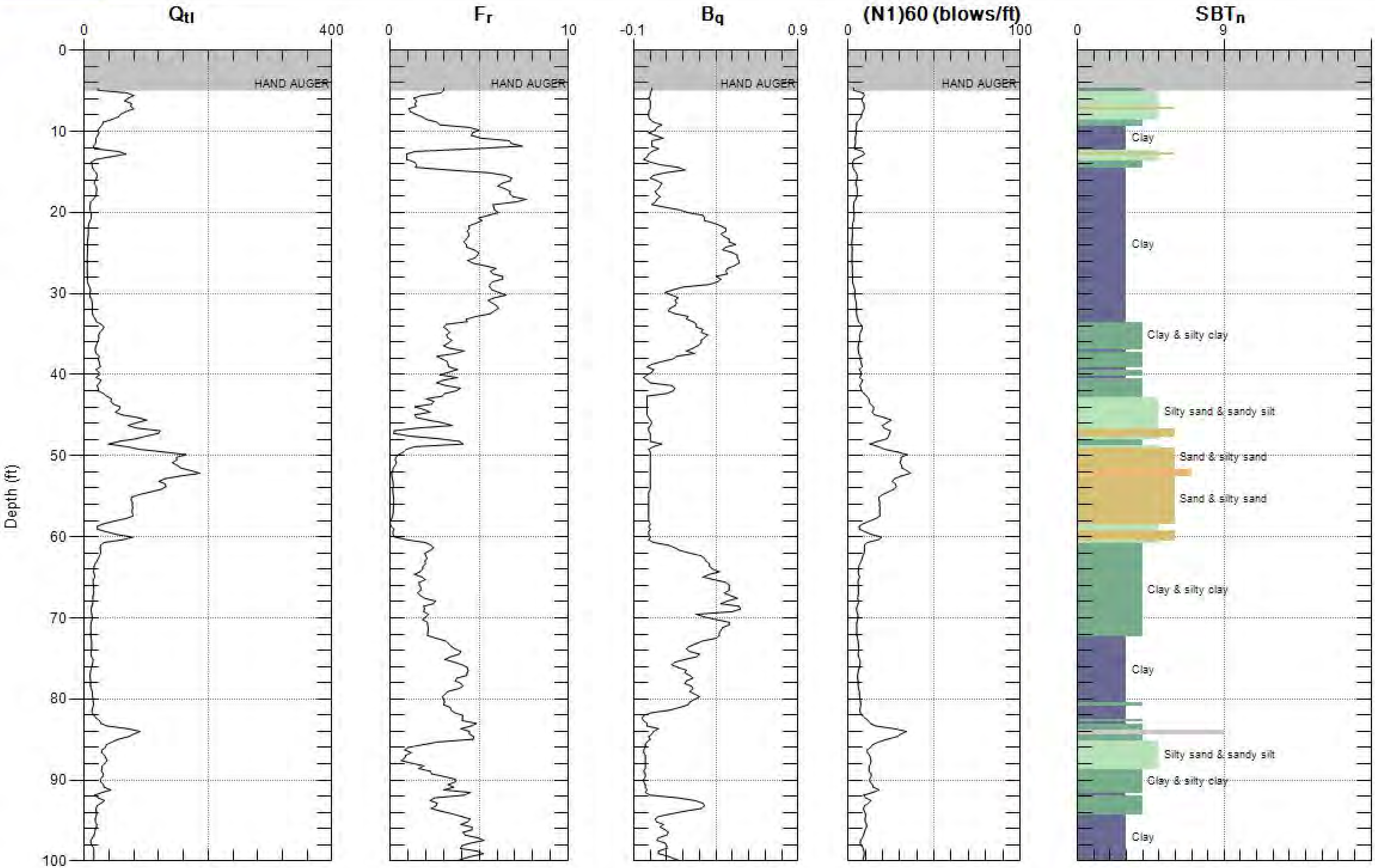
Sounding: PI-2 | Date: 9/15/2011 12:02

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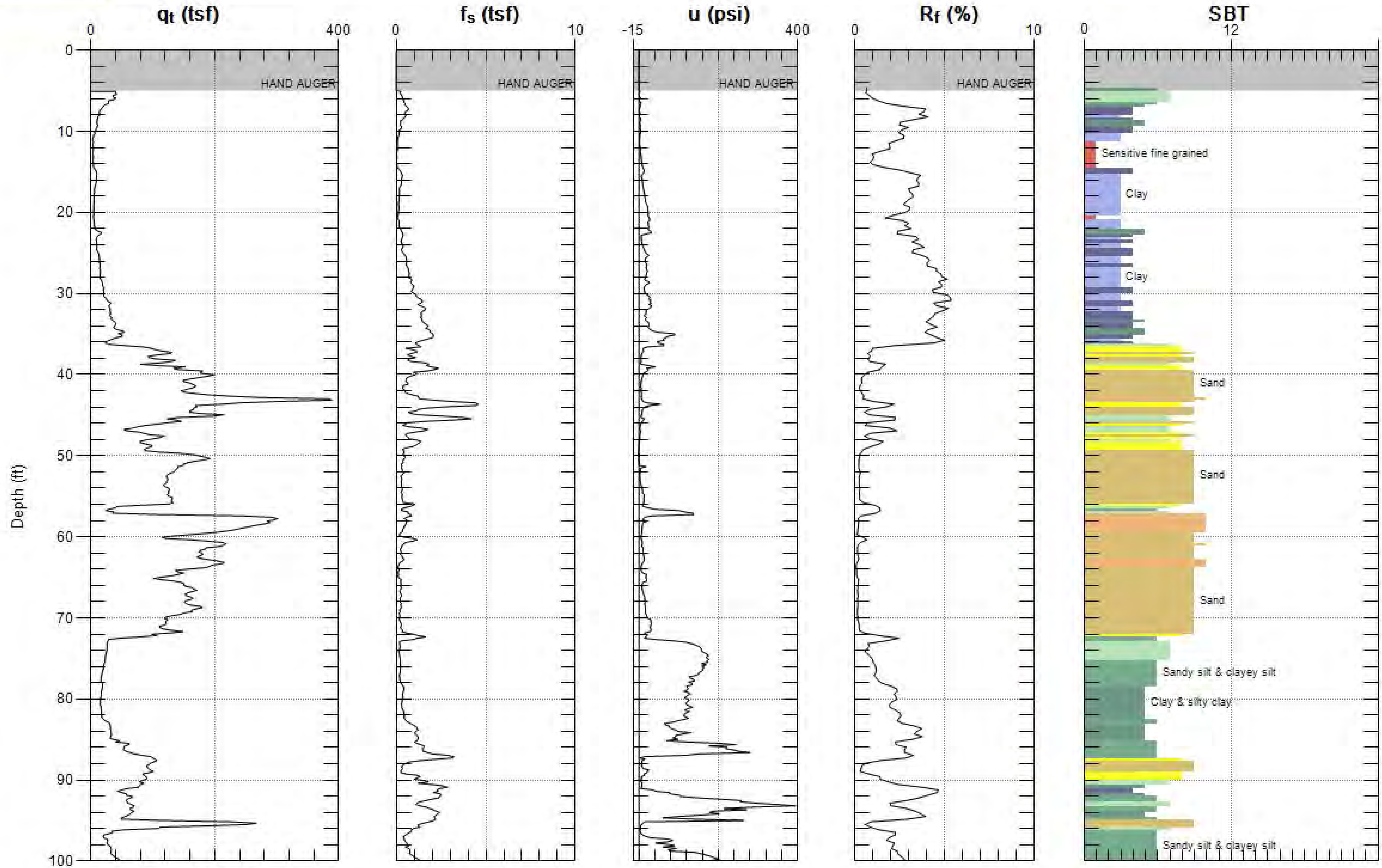
SBT: Soil Behavior Type (Robertson 1990)

DWR

Site: PROSPECT ISLAND
Sounding: PI-3

Engineer: M.SOUVERVILLE
Date: 9/15/2011 03:47




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

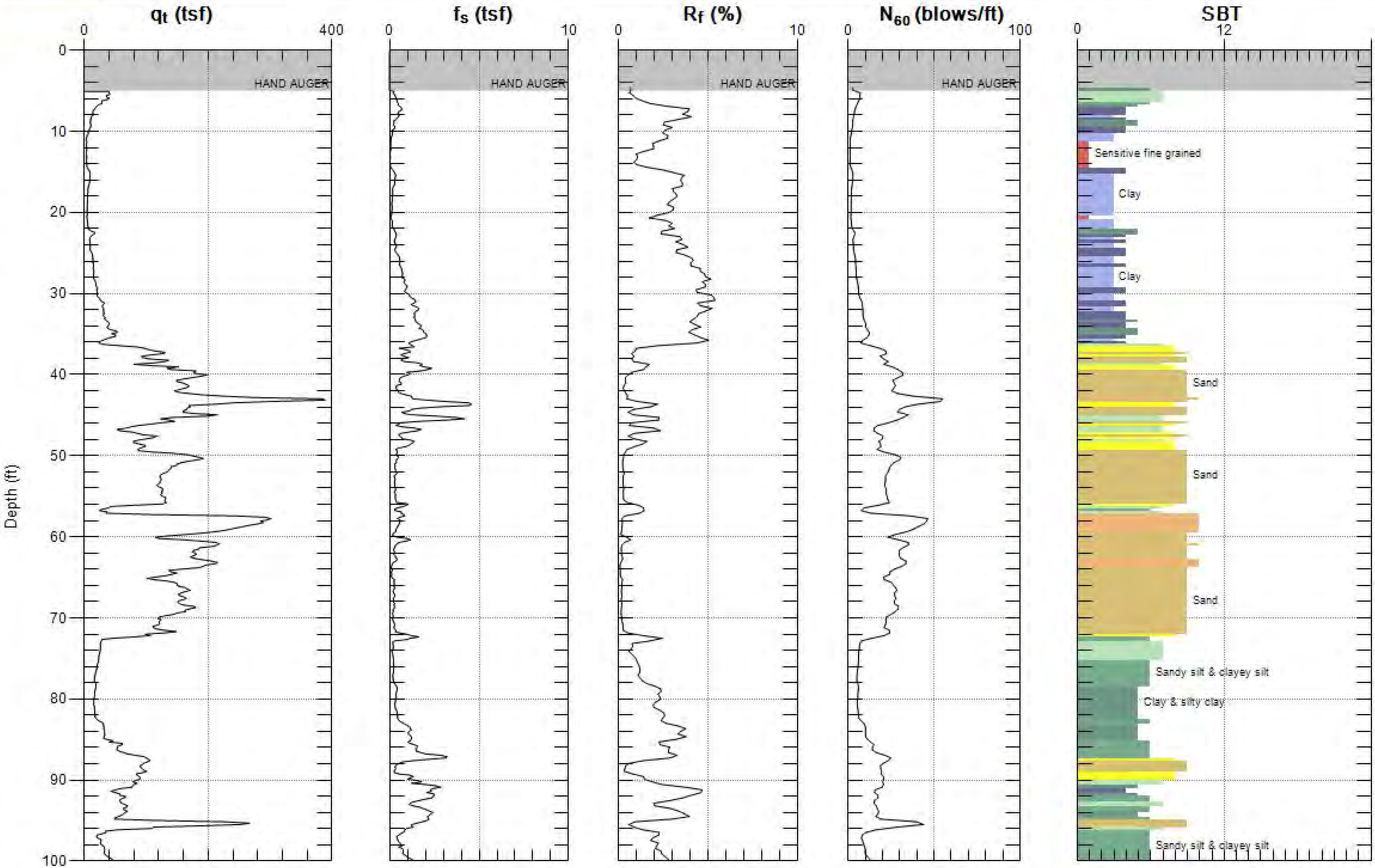
SBT: Soil Behavior Type (Robertson 1990)

GREGG

**DWR**

**Site: PROSPECT ISLAND** **Engineer: M.SOUVERVILLE**

**Sounding: PI-3** **Date: 9/15/2011 03:47**

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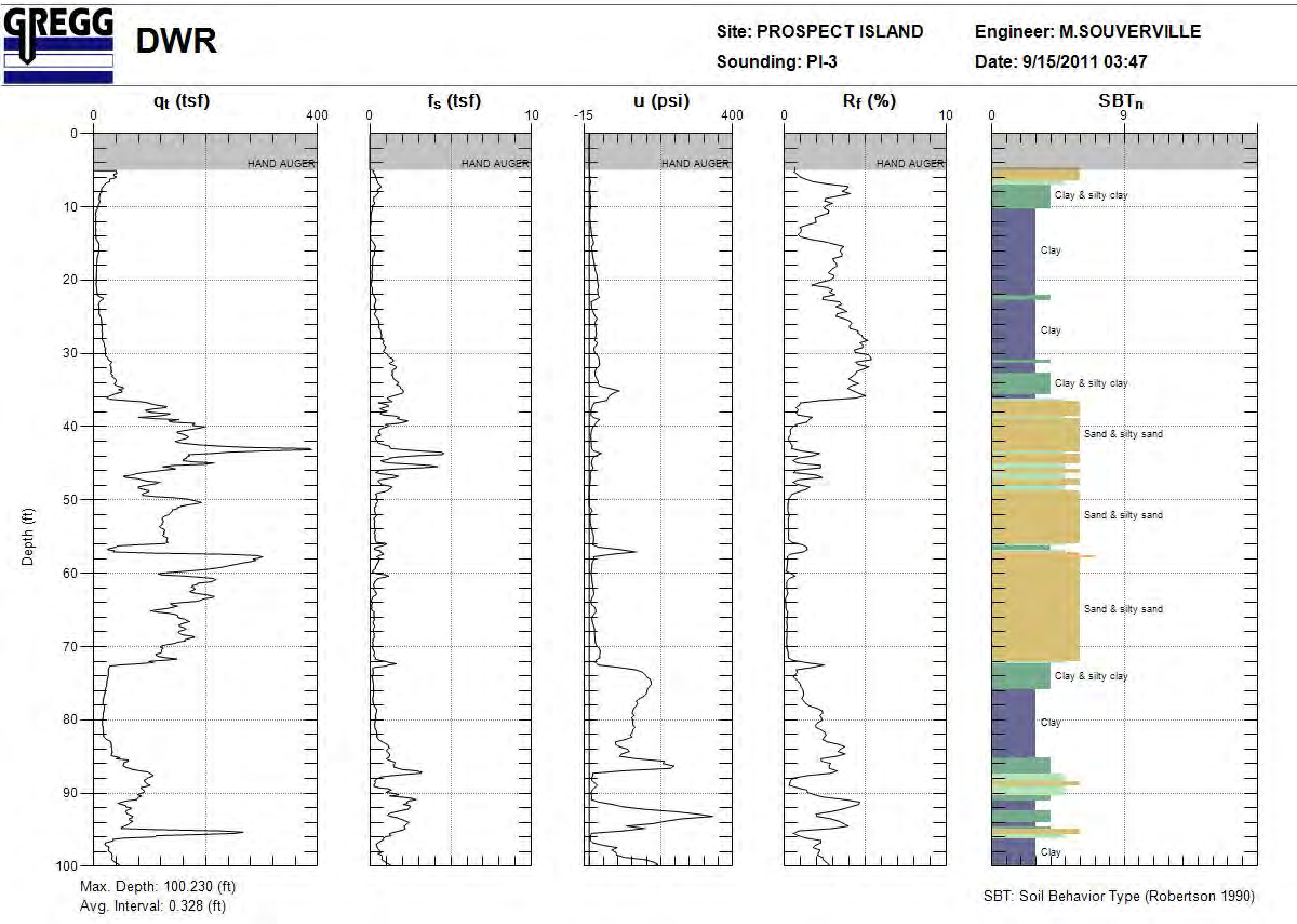
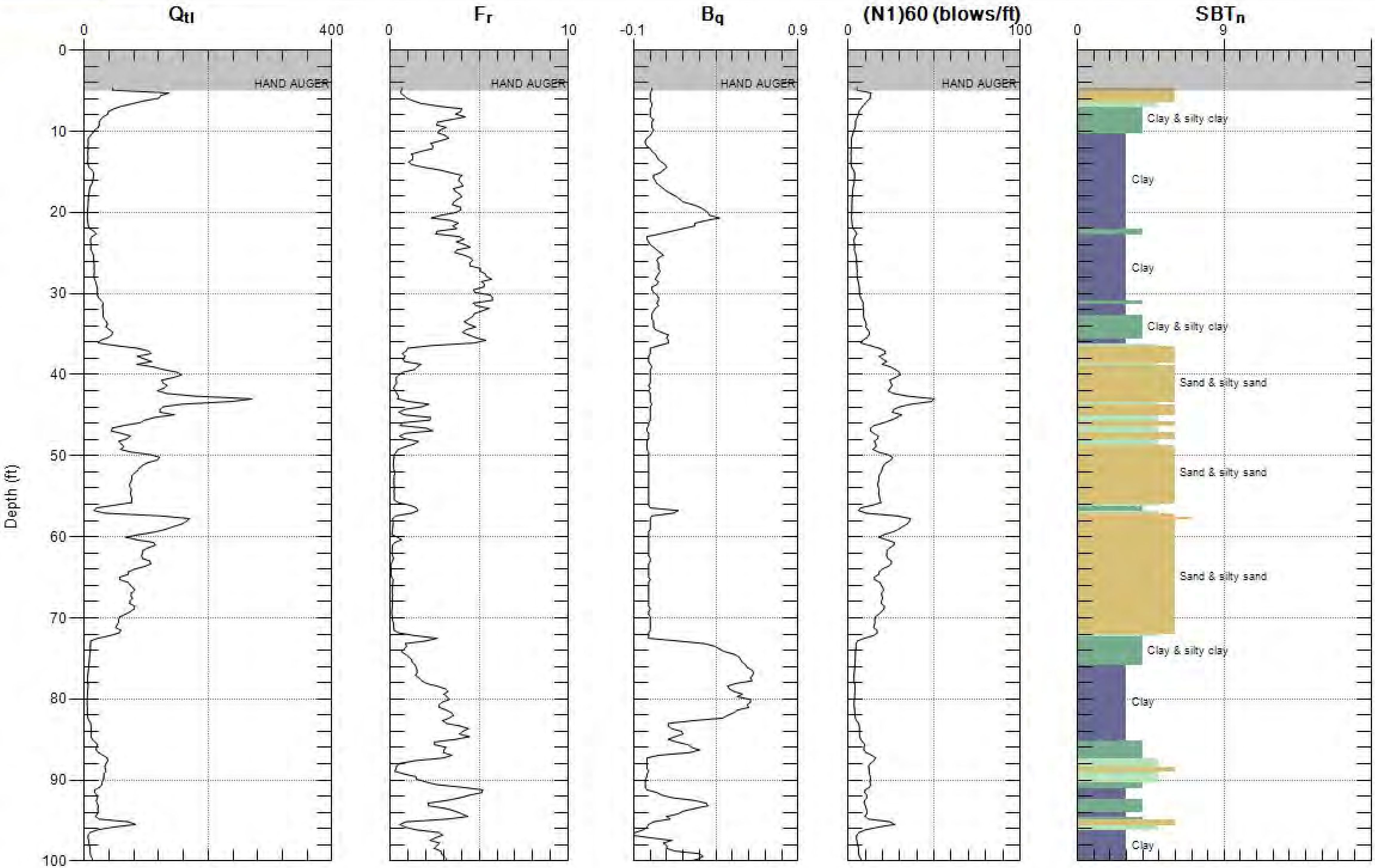
SBT: Soil Behavior Type (Robertson 1990)


GREGG
DWR
Site: PROSPECT ISLAND
Sounding: PI-3
Engineer: M.SOUVERVILLE
Date: 9/15/2011 03:47
qt (tsf)
fs (tsf)
u (psi)
Rf (%)
SBTn
HAND AUGER
Clay & silty clay
Clay
Sand & silty sand
Depth (ft)
Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)
SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

Site: PROSPECT ISLAND
Sounding: PI-3

Engineer: M.SOUVERVILLE
Date: 9/15/2011 03:47

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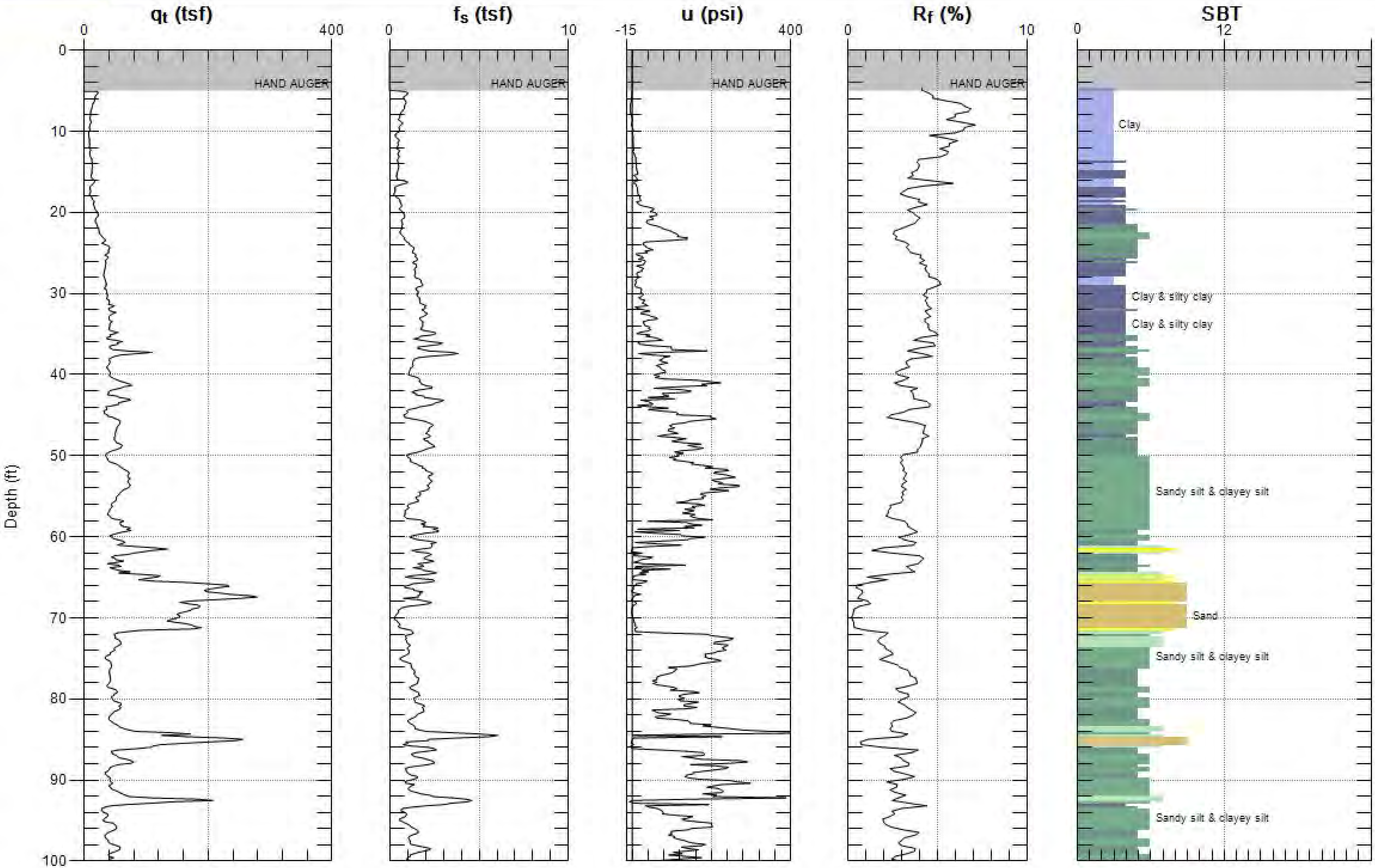
SBT: Soil Behavior Type (Robertson 1990)

GREGG DWR

Site: PROSPECT ISLAND
Sounding: PI-4

Engineer: M.SOUVERVILLE
Date: 9/16/2011 08:47




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

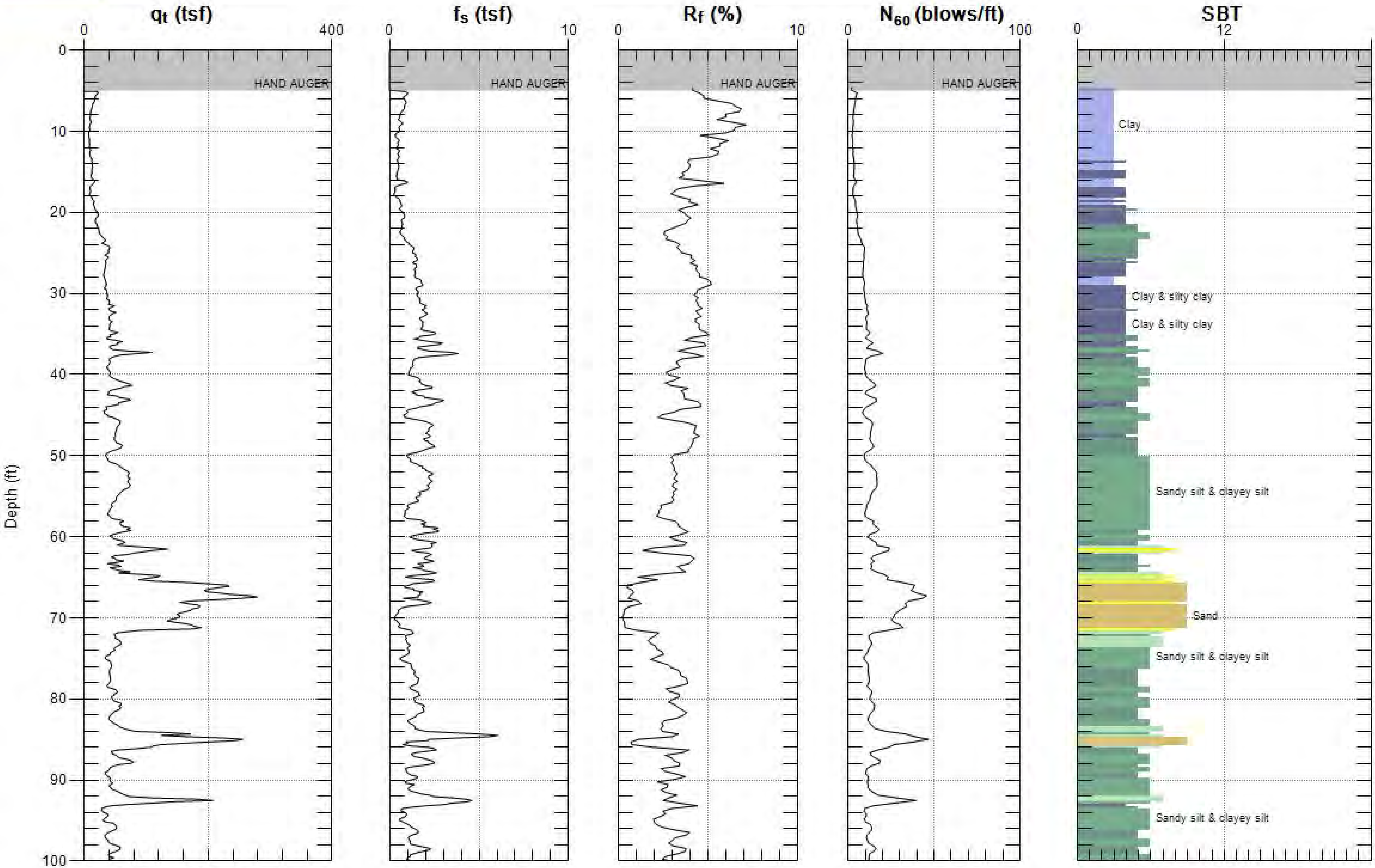
DWR

Site: PROSPECT ISLAND

Sounding: PI-4

Engineer: M.SOUVERVILLE

Date: 9/16/2011 08:47

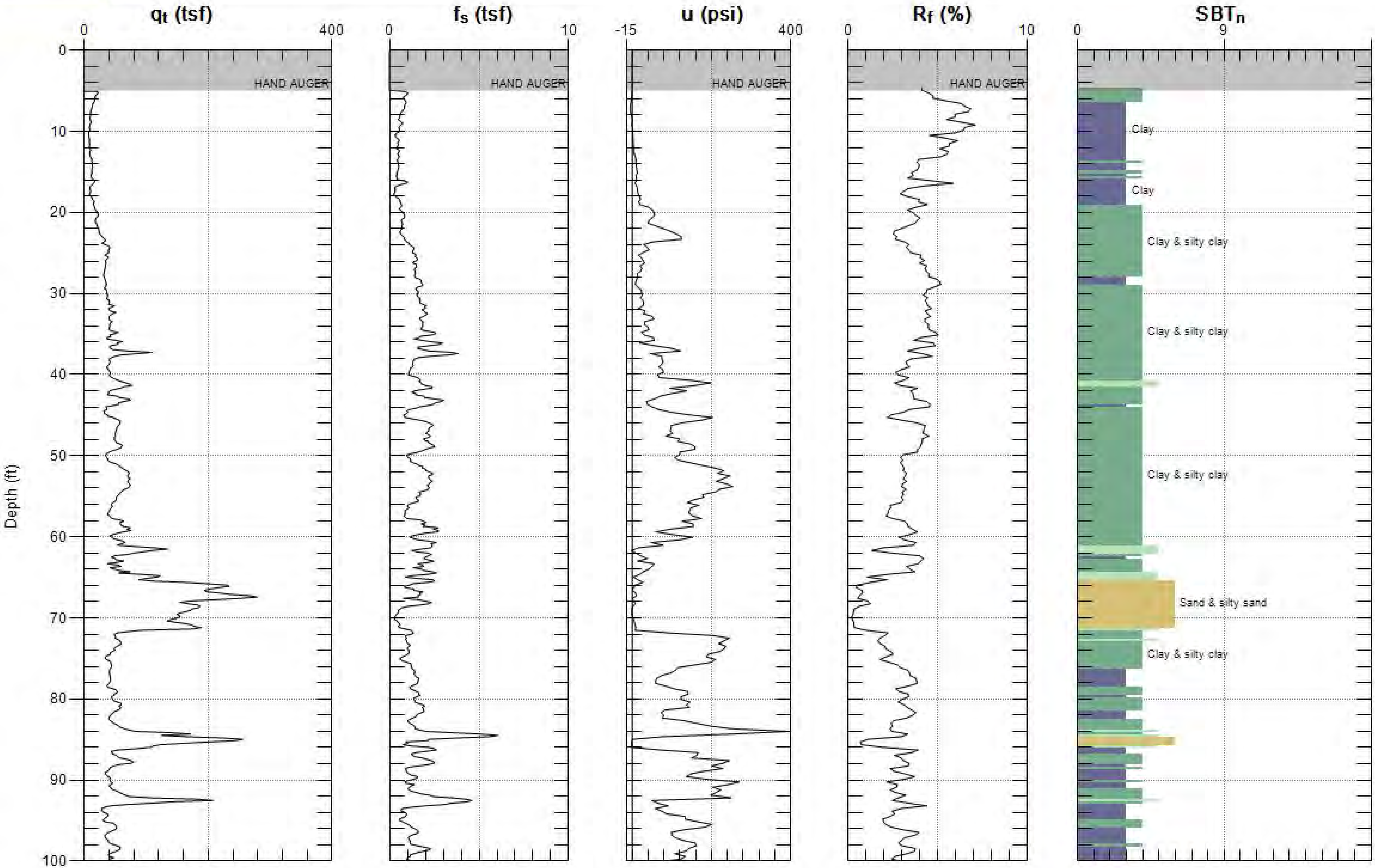



Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**GREGG** DWR

Site: PROSPECT ISLAND | Engineer: M.SOUVERVILLE
Sounding: PI-4 | Date: 9/16/2011 08:47



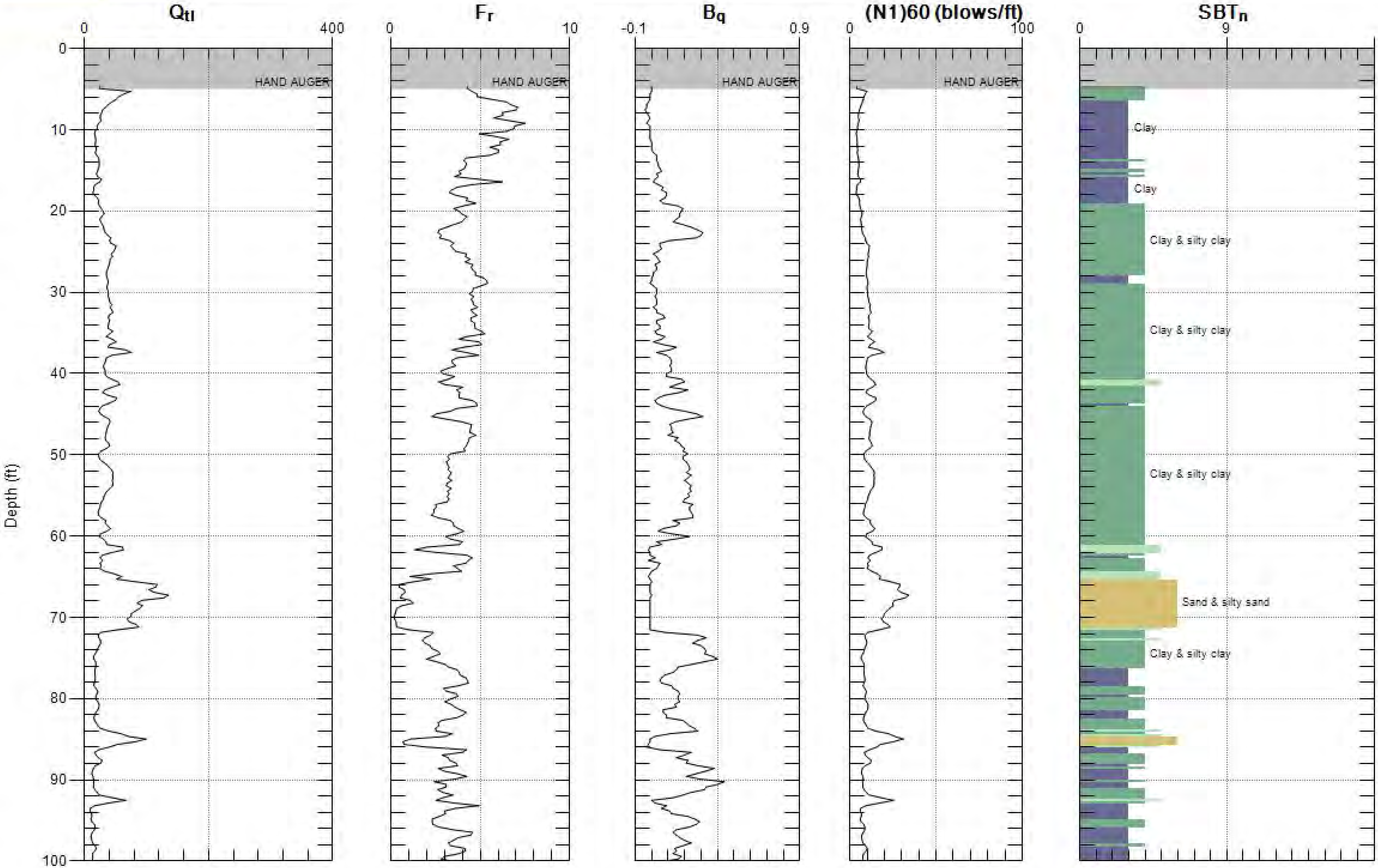

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**DWR**

**Site: PROSPECT ISLAND**
**Sounding: PI-4**

**Engineer: M.SOUVERVILLE**
**Date: 9/16/2011 08:47**



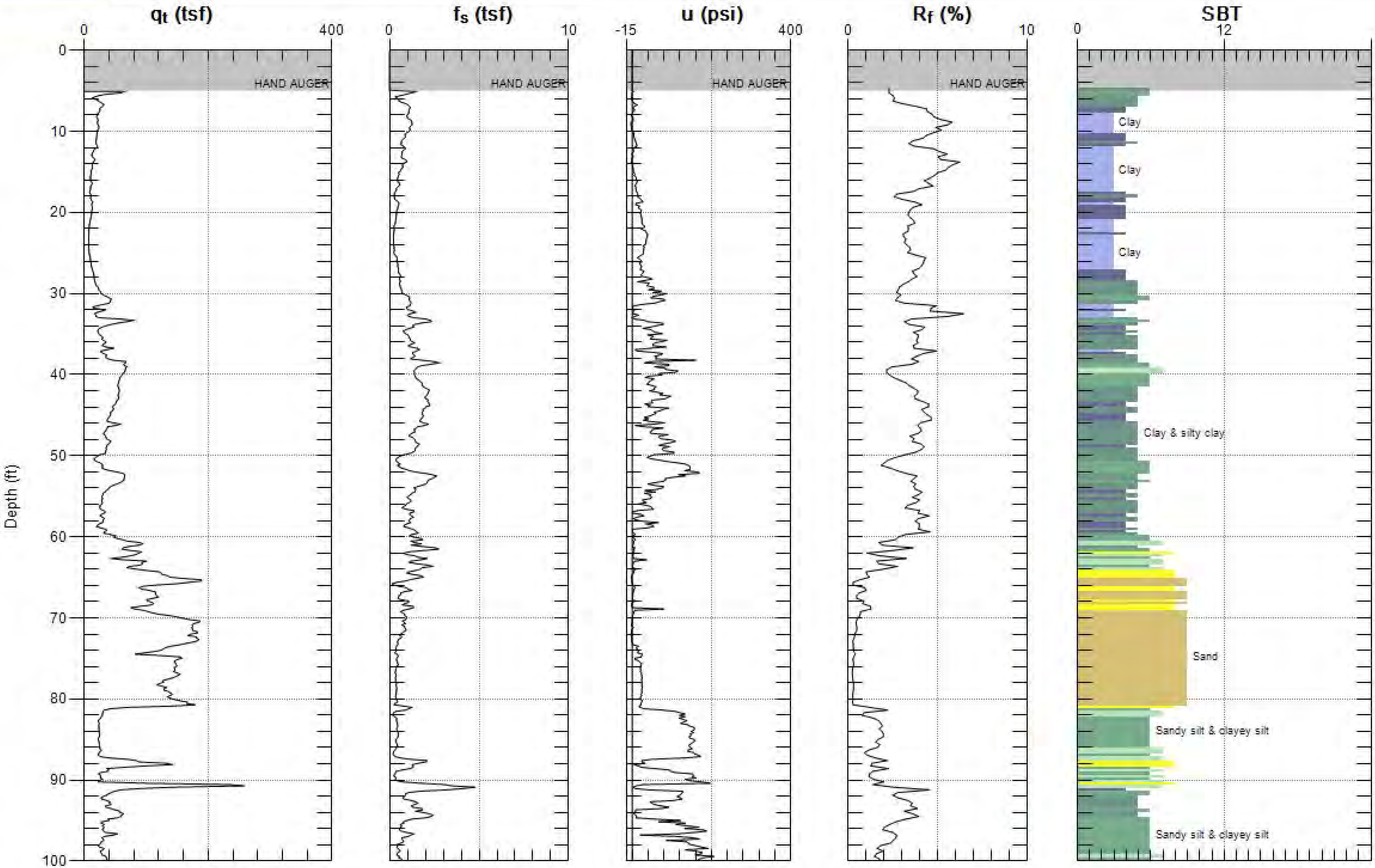

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

**Site: PROSPECT ISLAND** **Engineer: M.SOUVERVILLE**

**Sounding: PI-5** **Date: 9/16/2011 11:42**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

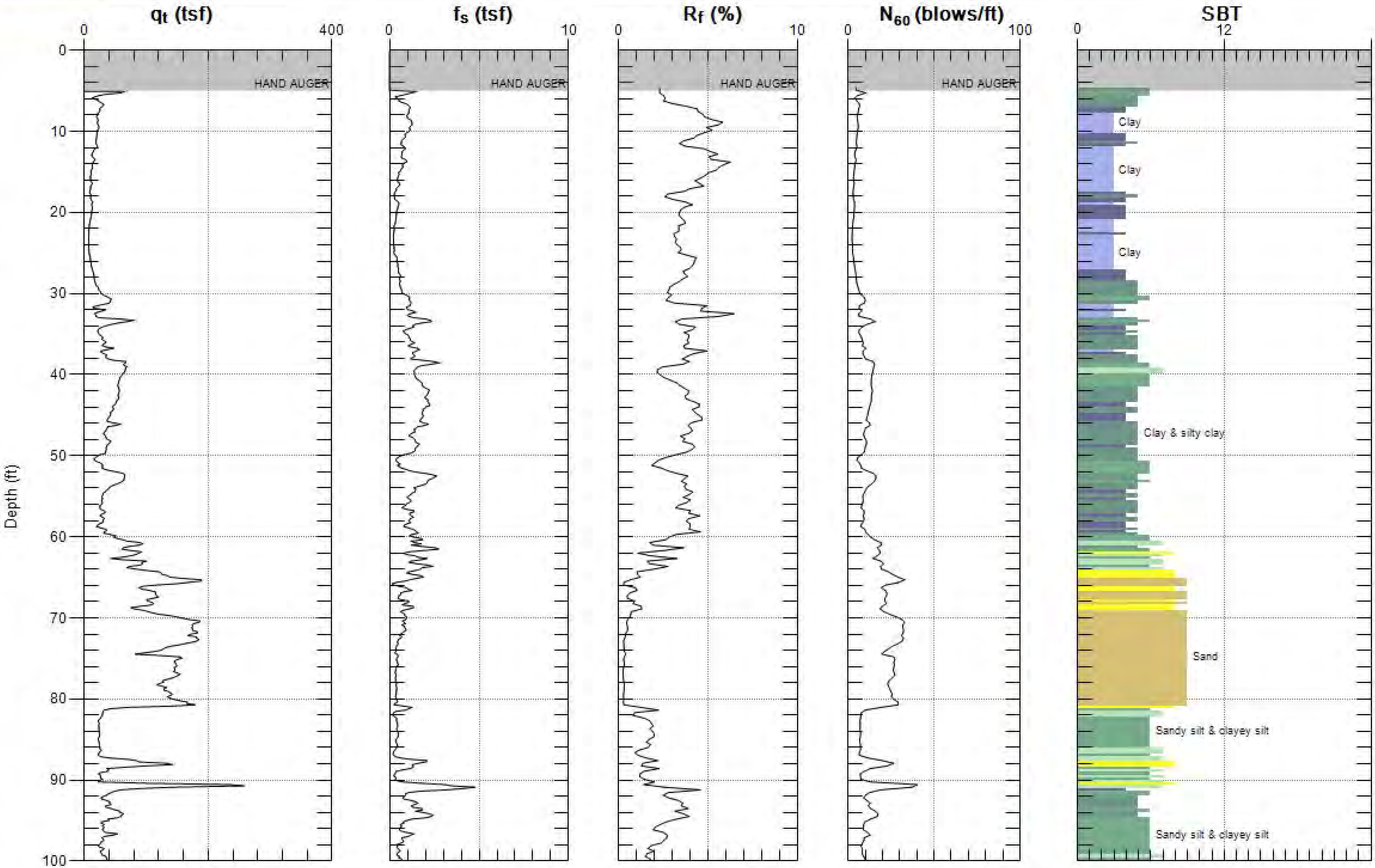
**DWR**

**Site: PROSPECT ISLAND**

**Sounding: PI-5**

**Engineer: M.SOUVERVILLE**

**Date: 9/16/2011 11:42**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

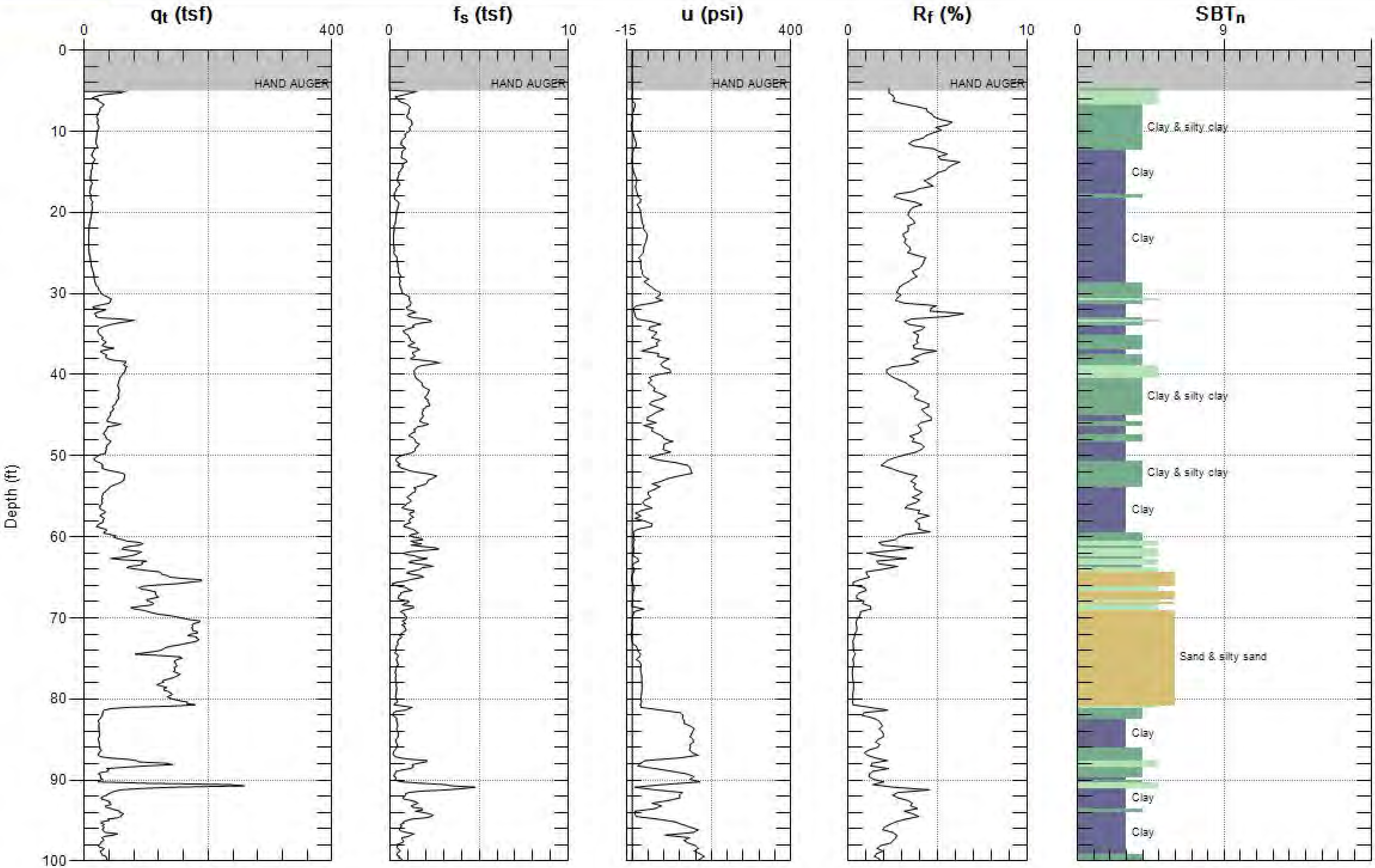
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

Site: PROSPECT ISLAND
Sounding: PI-5

Engineer: M.SOUVERVILLE
Date: 9/16/2011 11:42




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

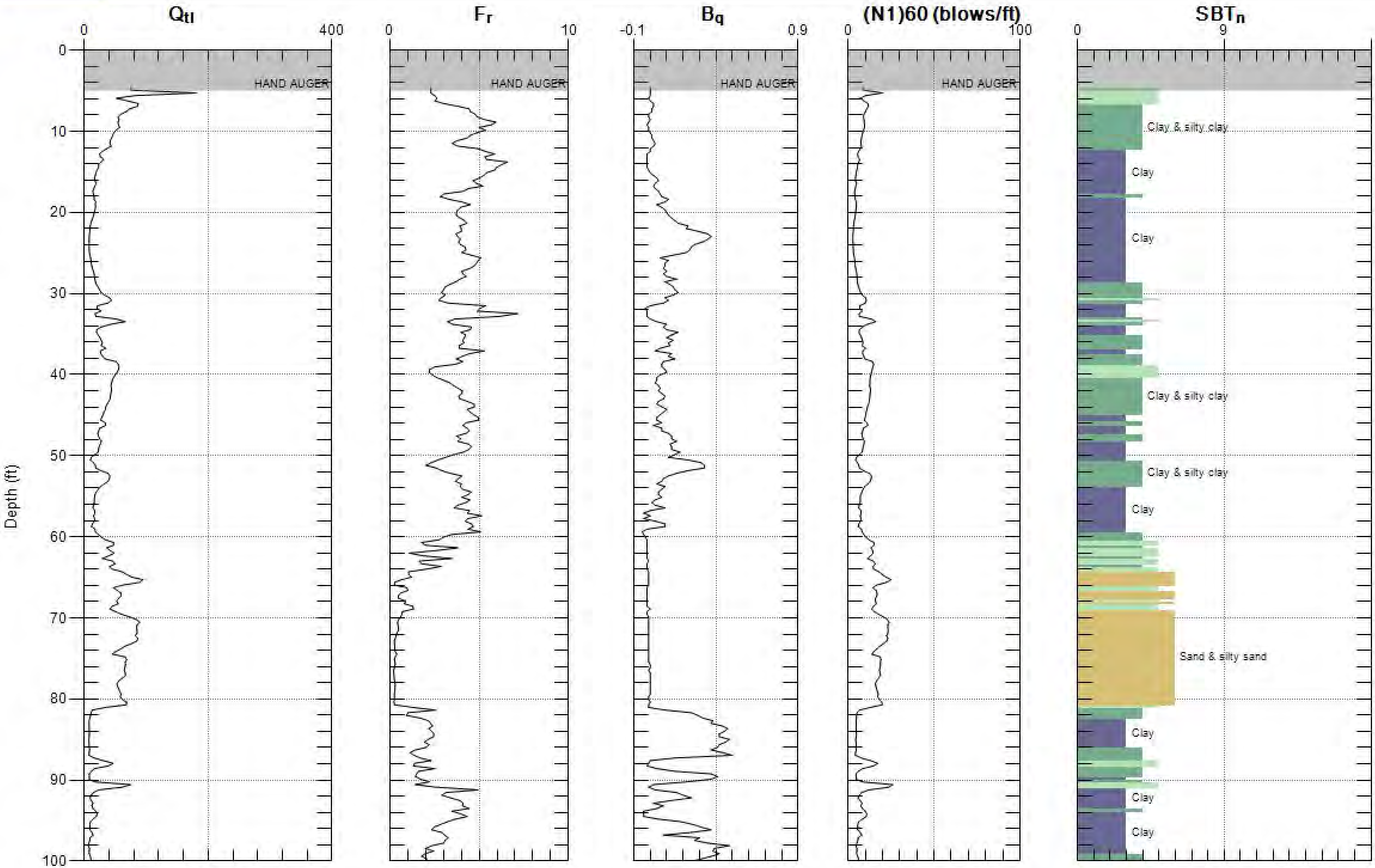
DWR

Site: PROSPECT ISLAND

Sounding: PI-5

Engineer: M.SOUVERVILLE

Date: 9/16/2011 11:42



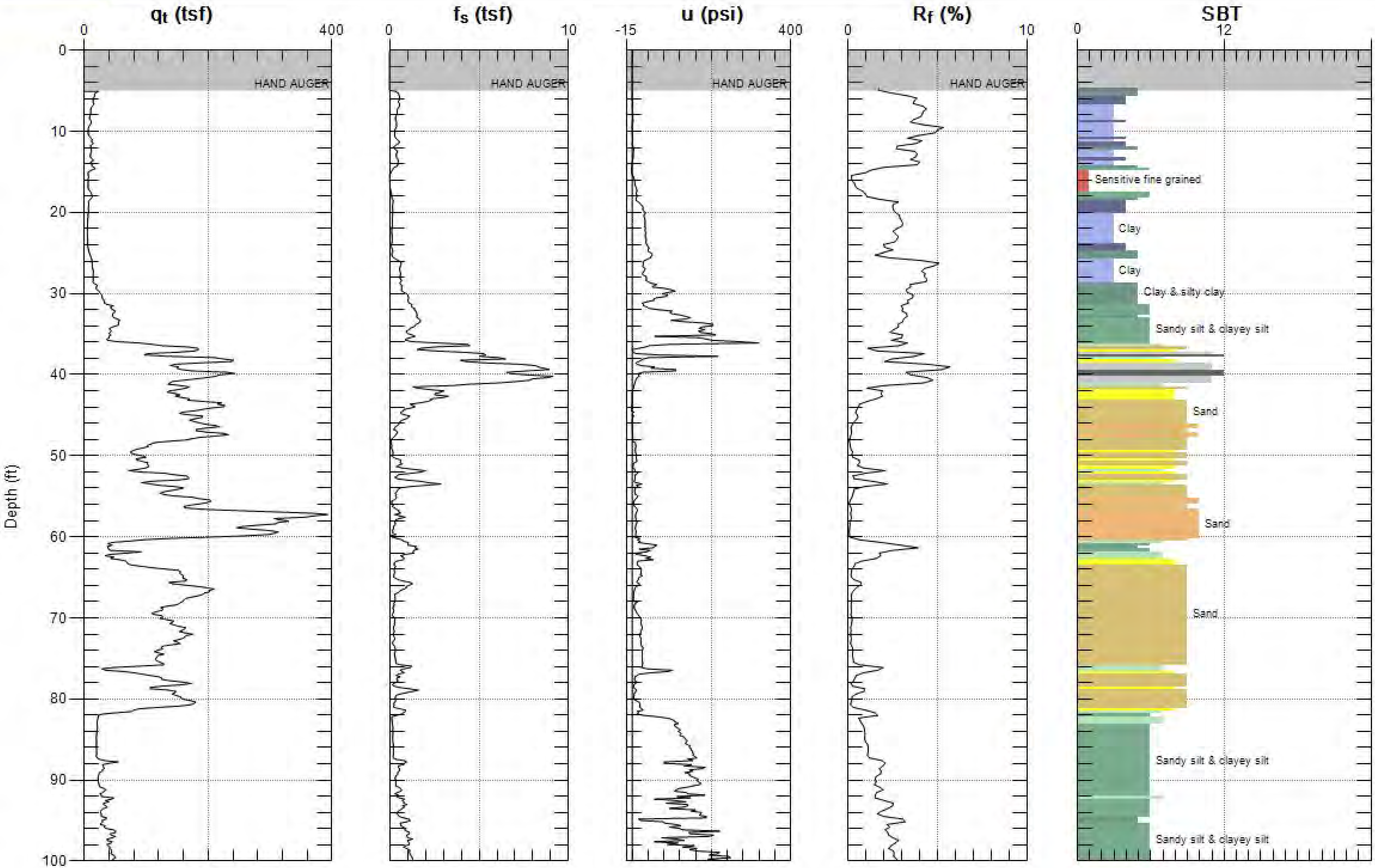

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

Site: PROSPECT ISLAND
Sounding: PI-6

Engineer: M.SOUVERVILLE
Date: 9/16/2011 02:10




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

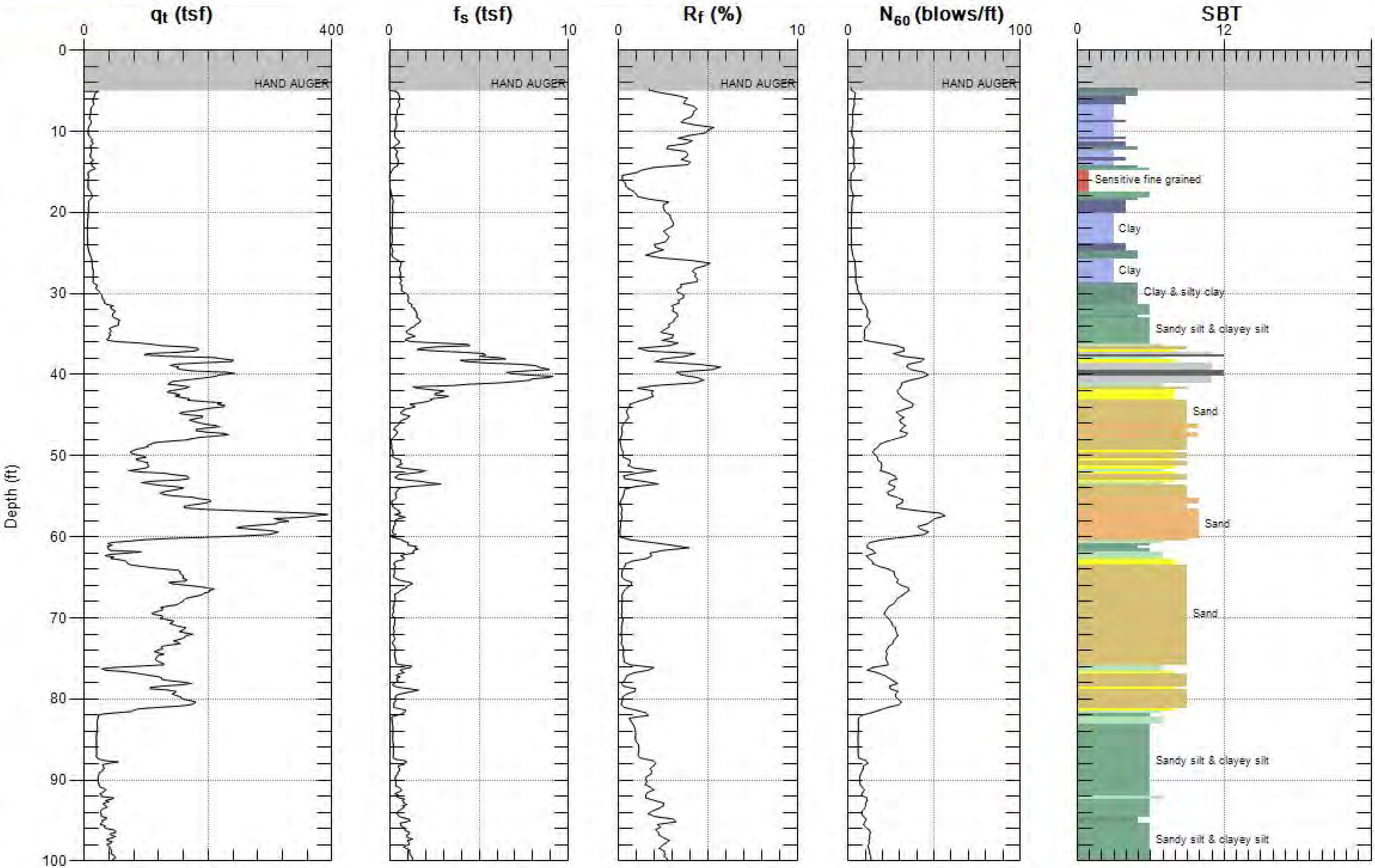
# DWR

Site: PROSPECT ISLAND

Sounding: PI-6

Engineer: M.SOUVERVILLE

Date: 9/16/2011 02:10




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

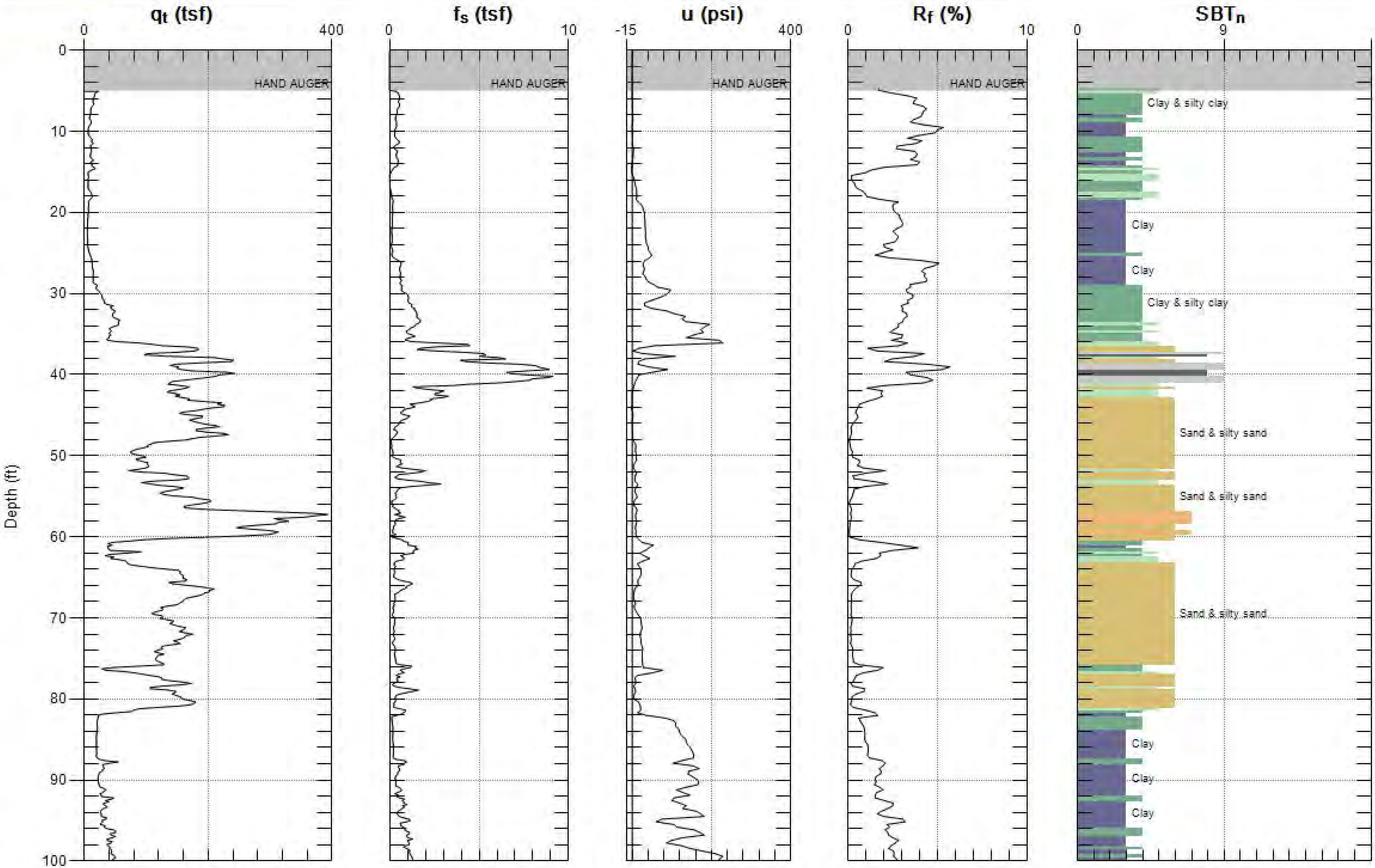
DWR

Site: PROSPECT ISLAND

Sounding: PI-6

Engineer: M.SOUVERVILLE

Date: 9/16/2011 02:10




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

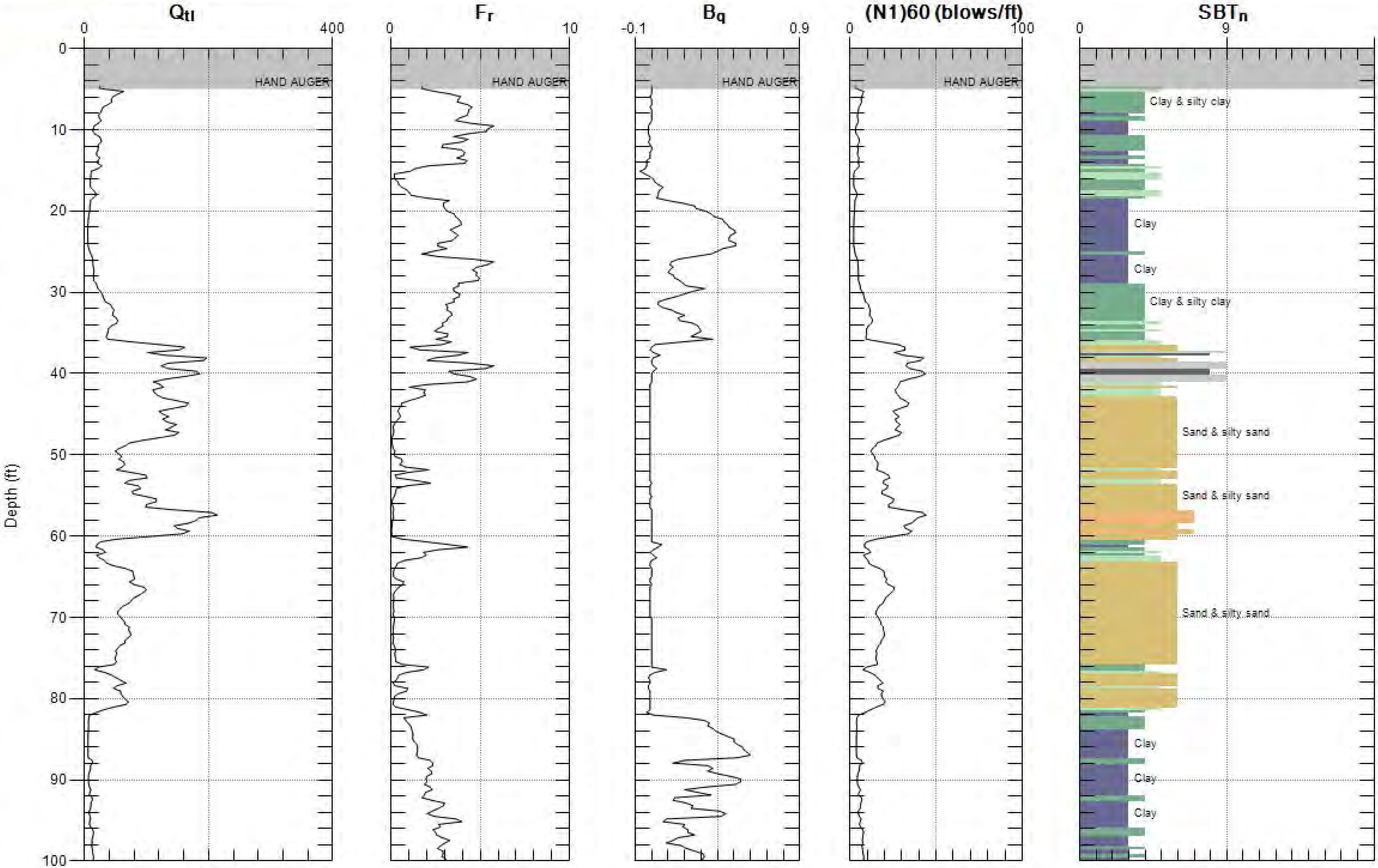
# DWR

Site: PROSPECT ISLAND

Sounding: PI-6

Engineer: M.SOUVERVILLE

Date: 9/16/2011 02:10




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

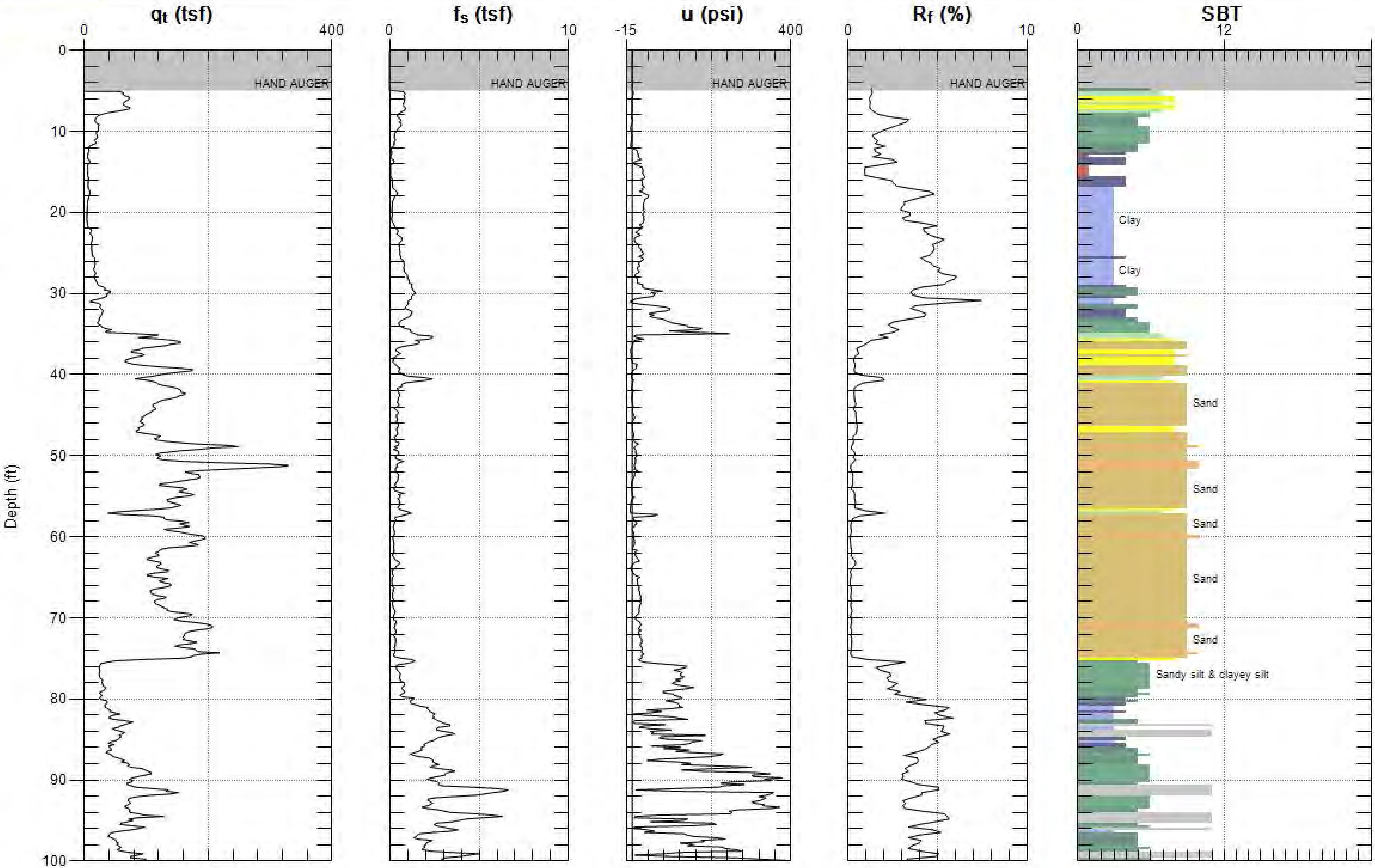
DWR

Site: PROSPECT ISLAND

Sounding: PI-7

Engineer: M.SOUVERVILLE

Date: 9/20/2011 08:59




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

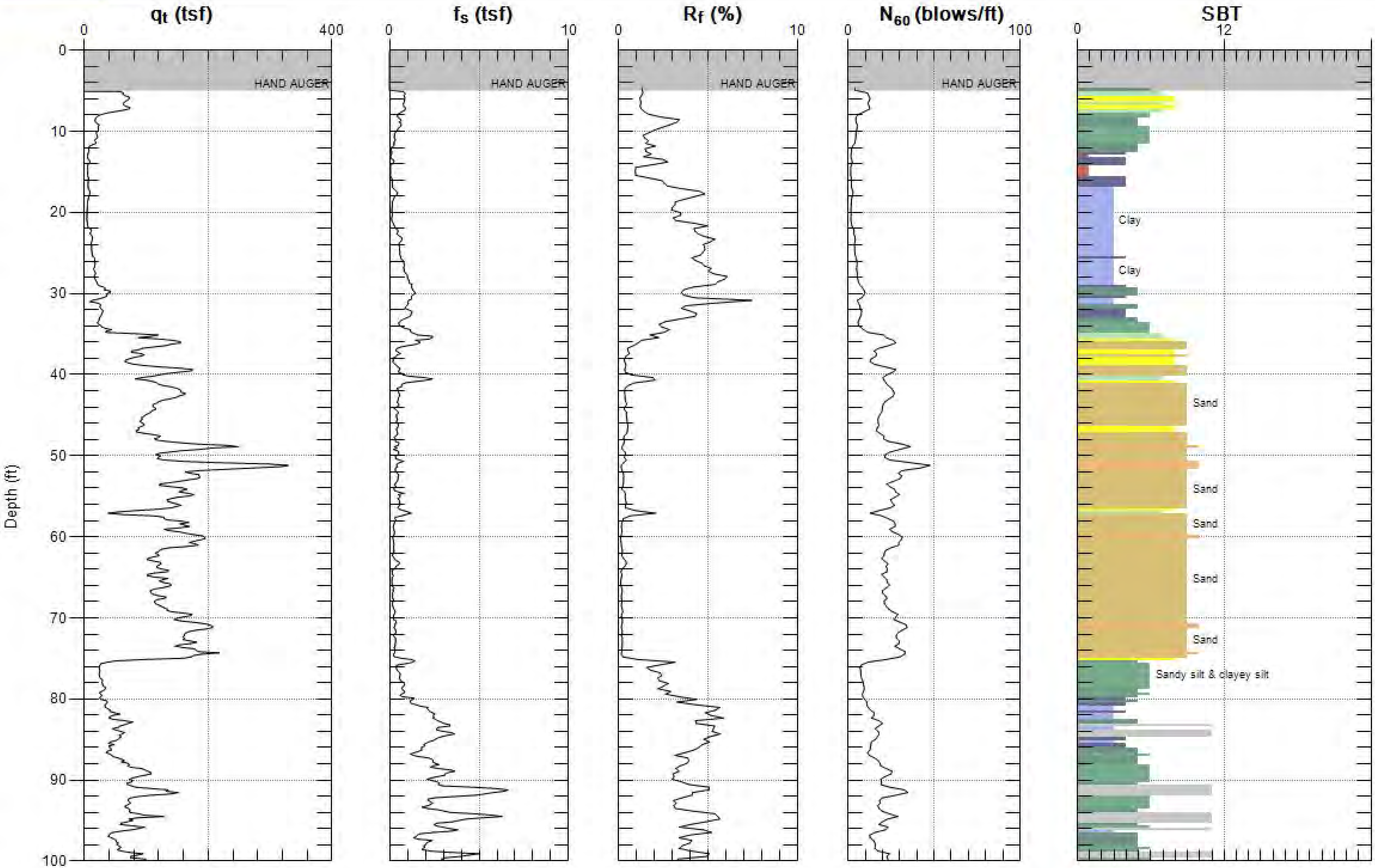
# DWR

Site: PROSPECT ISLAND

Sounding: PI-7

Engineer: M.SOUVERVILLE

Date: 9/20/2011 08:59




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

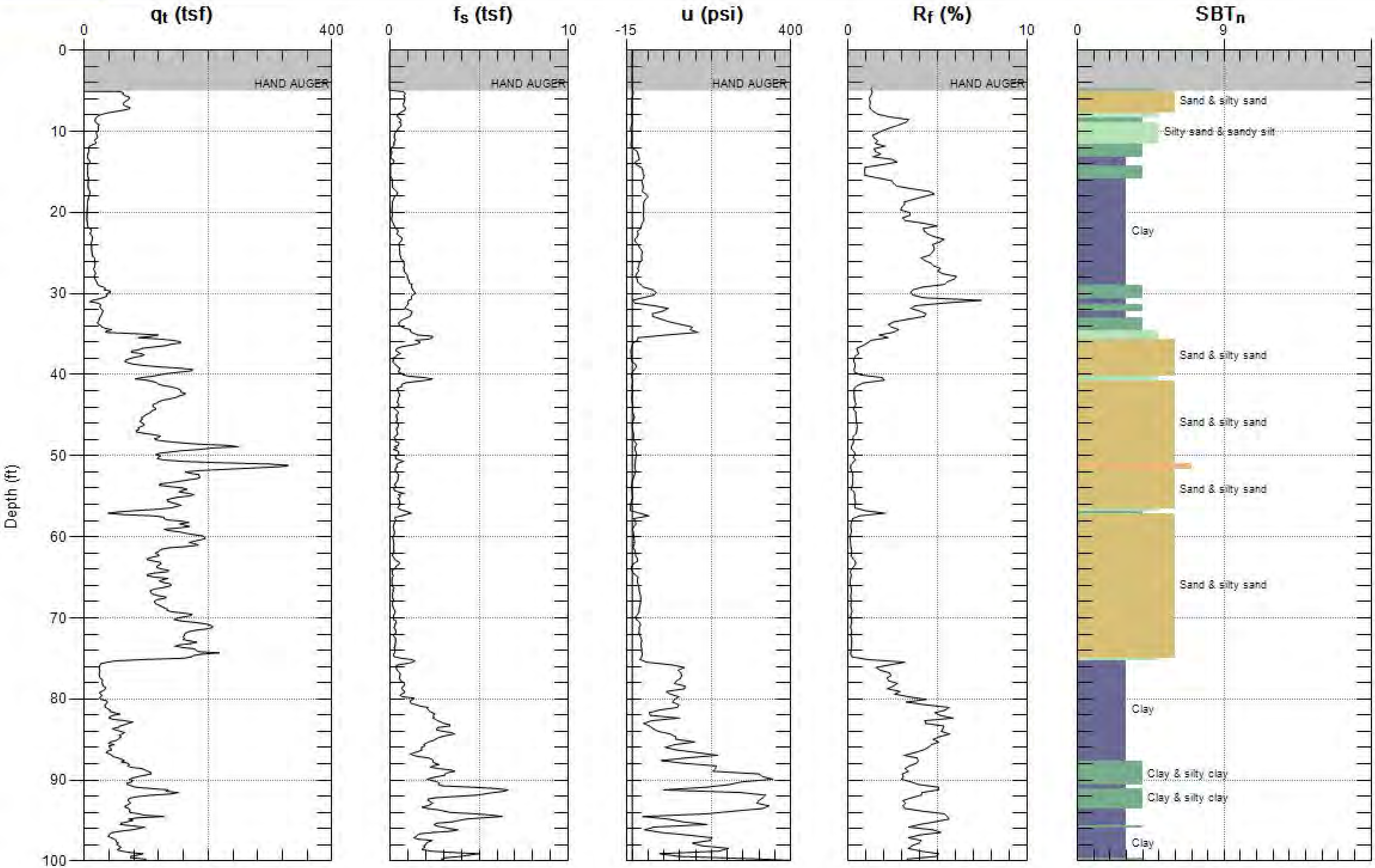
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

**Site: PROSPECT ISLAND** **Engineer: M.SOUVERVILLE**

**Sounding: PI-7** **Date: 9/20/2011 08:59**



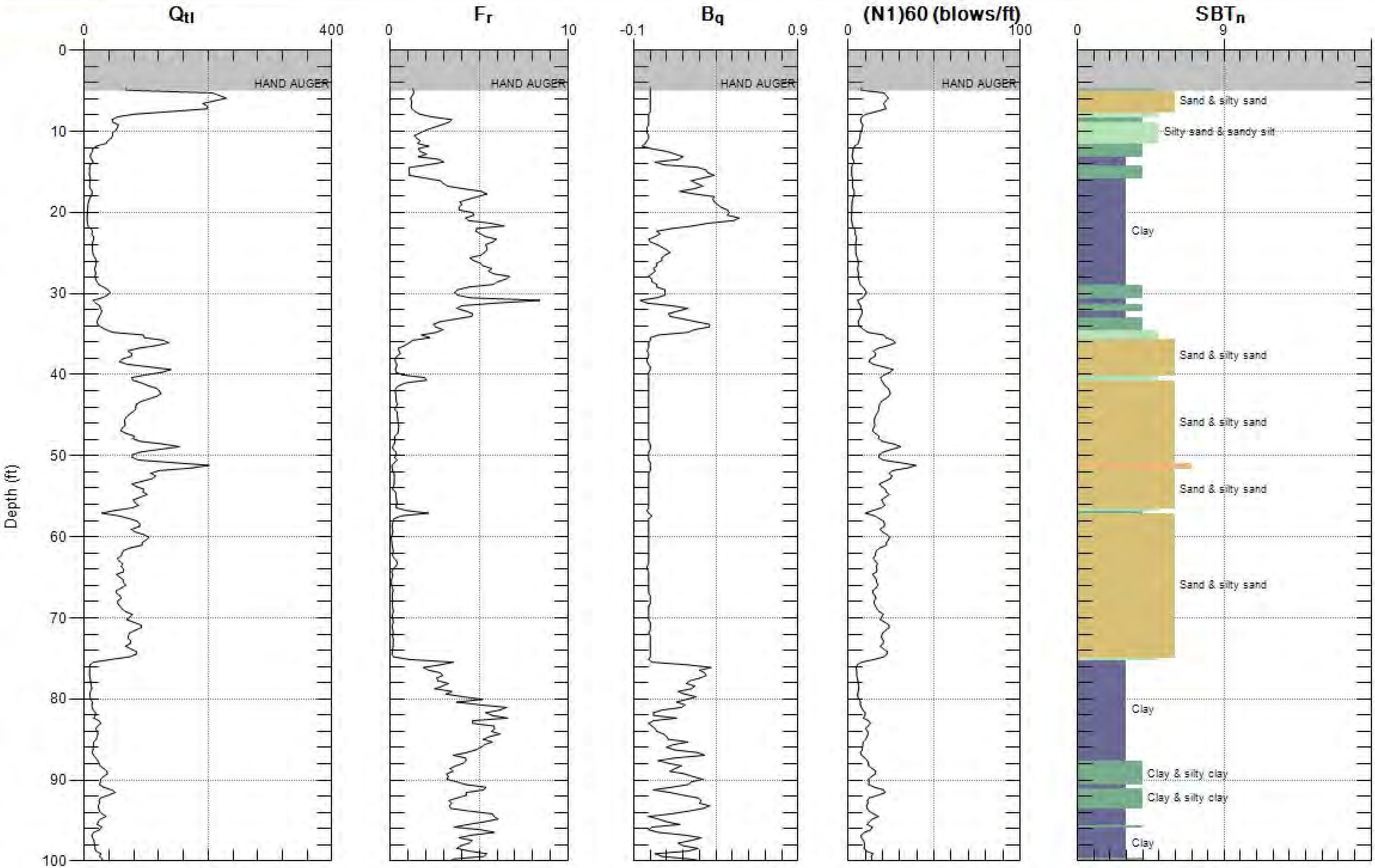

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**DWR**

**Site: PROSPECT ISLAND**
**Sounding: PI-7**

**Engineer: M.SOUVERVILLE**
**Date: 9/20/2011 08:59**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

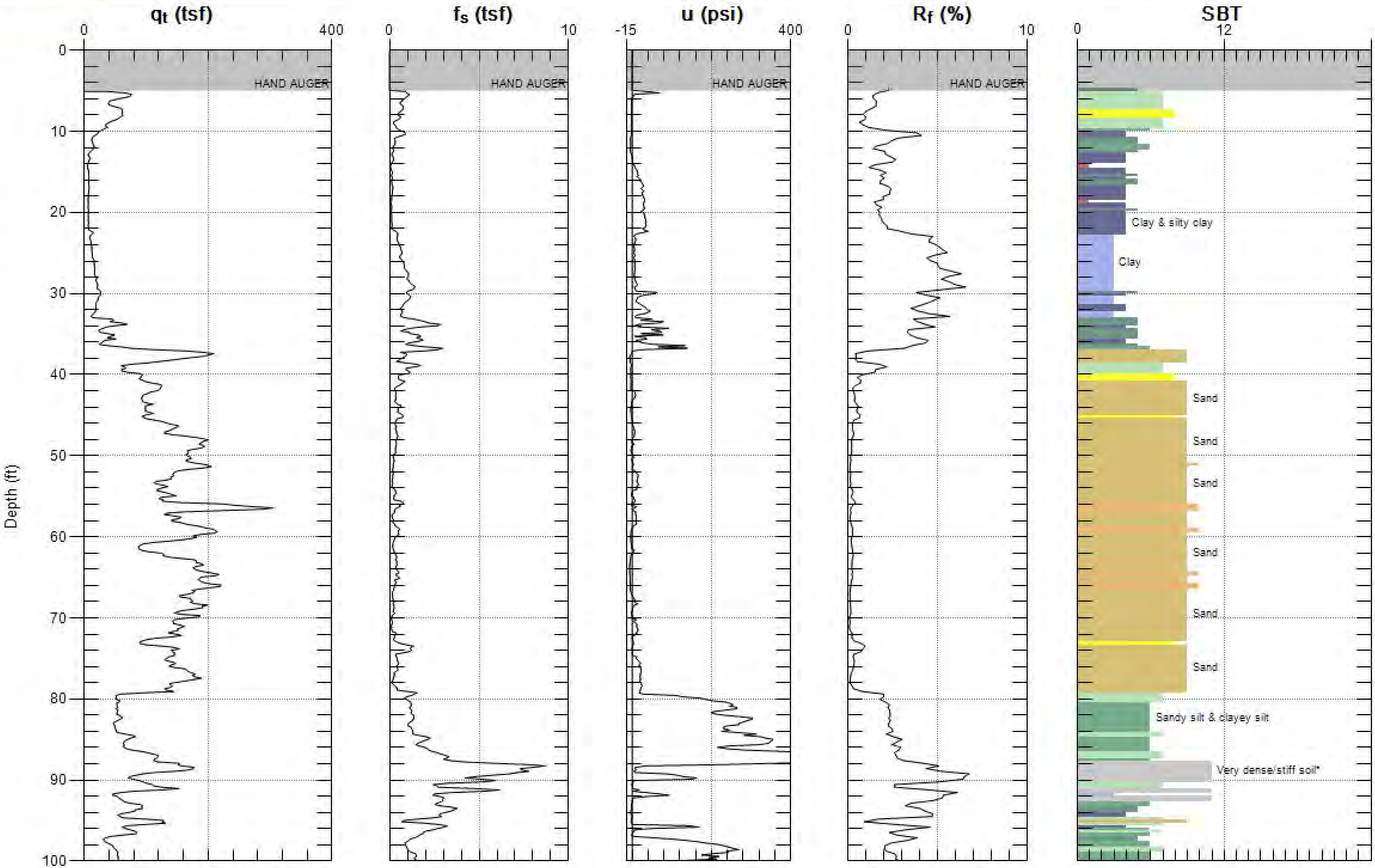
DWR

Site: PROSPECT ISLAND

Sounding: PI-8

Engineer: M.SOUVERVILLE

Date: 9/19/2011 09:30



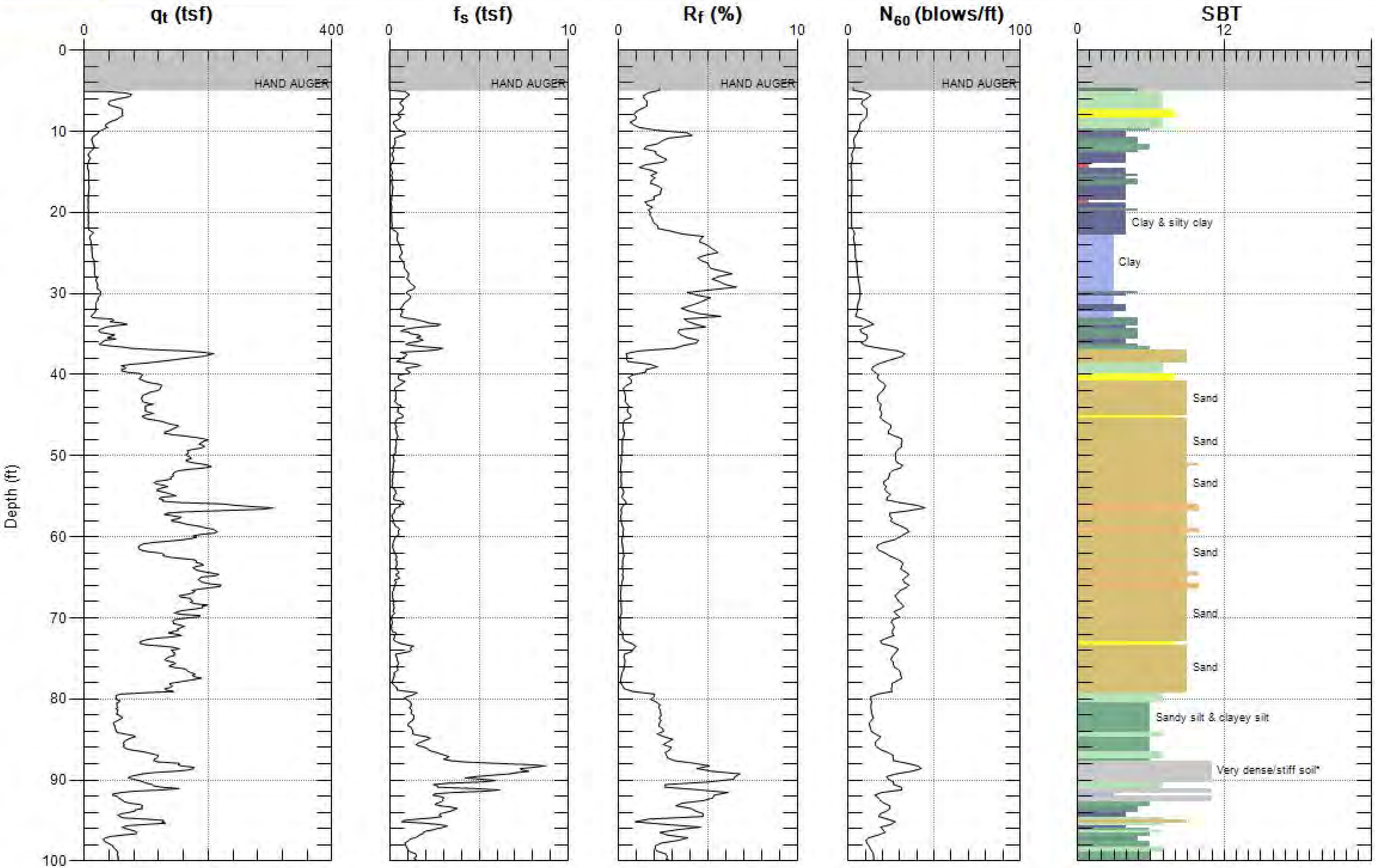

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**GREGG** **DWR**

Site: PROSPECT ISLAND
Sounding: PI-8

Engineer: M.SOUVERVILLE
Date: 9/19/2011 09:30




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

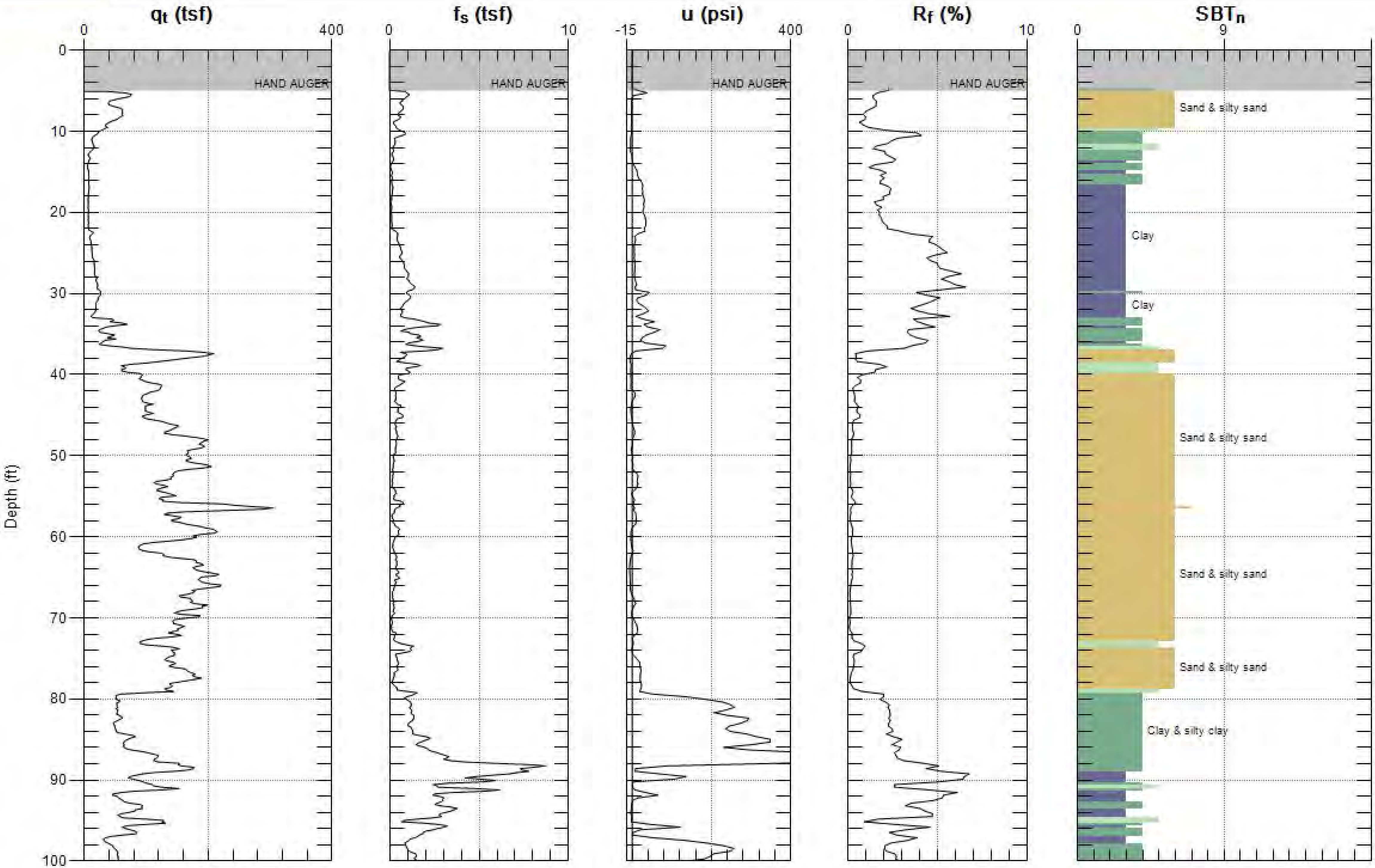
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

Site: PROSPECT ISLAND
Sounding: PI-8

Engineer: M.SOUVERVILLE
Date: 9/19/2011 09:30




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

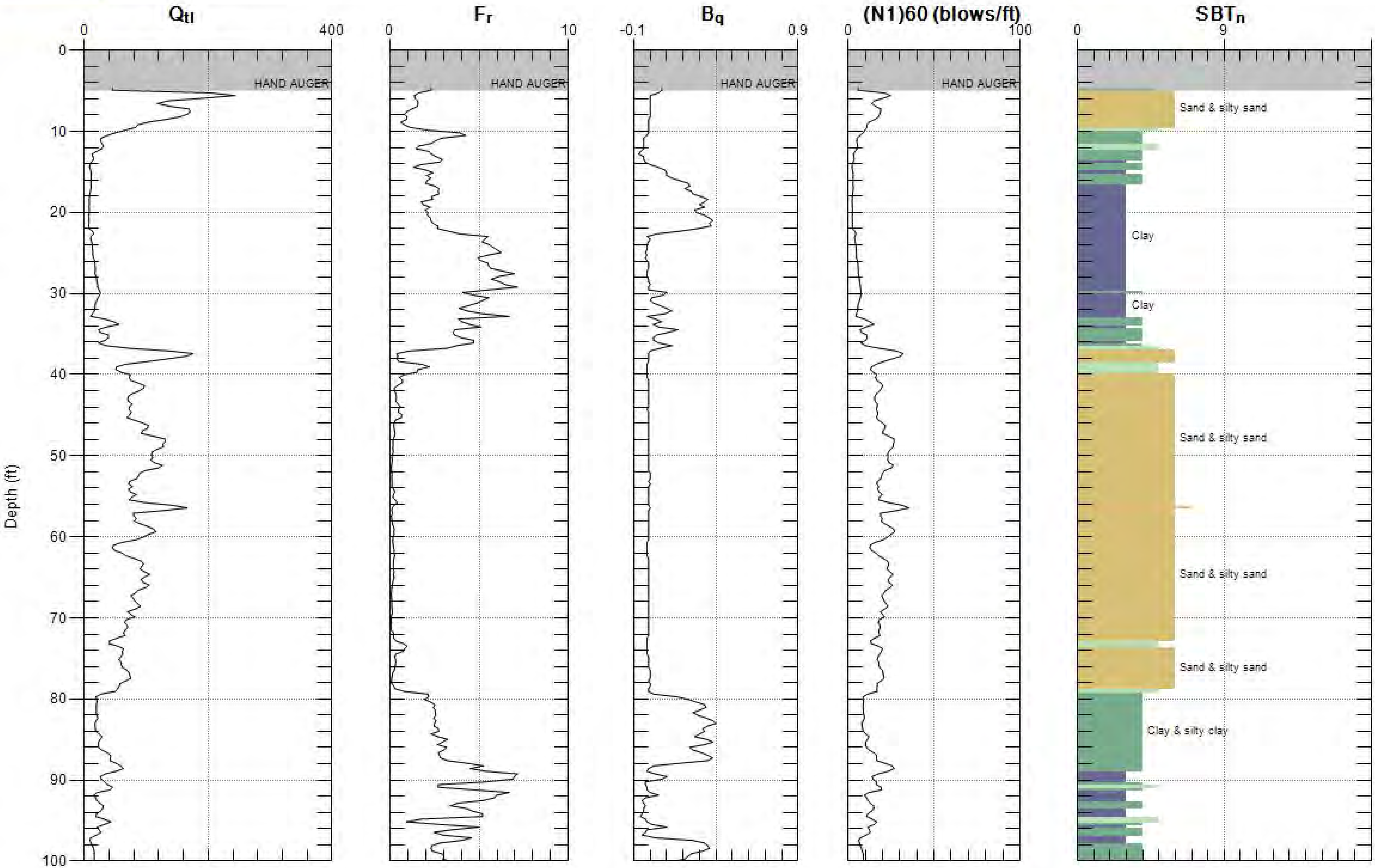
DWR

Site: PROSPECT ISLAND

Sounding: PI-8

Engineer: M.SOUVERVILLE

Date: 9/19/2011 09:30




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

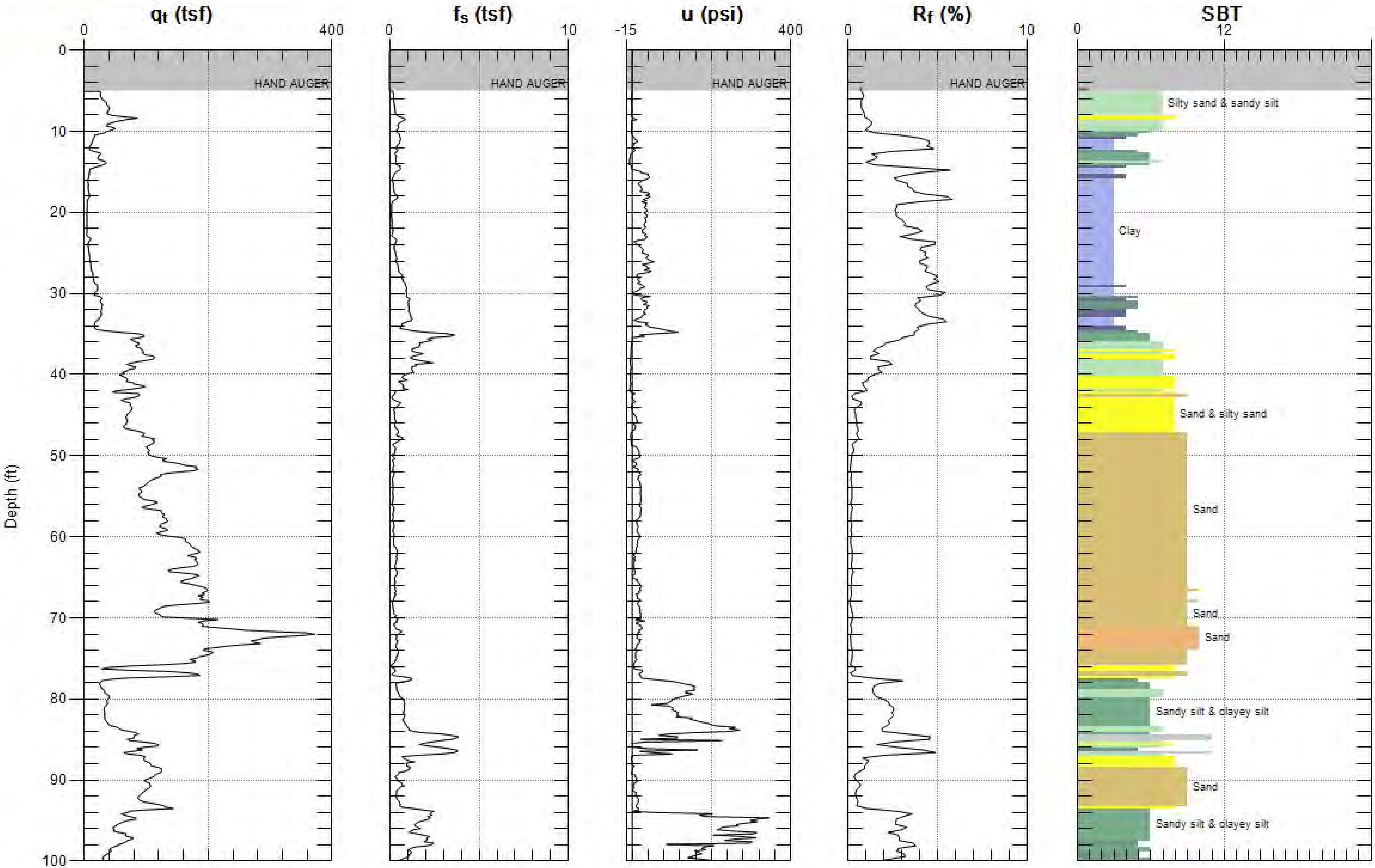
DWR

Site: PROSPECT ISLAND

Sounding: PI-9

Engineer: M.SOUVERVILLE

Date: 9/19/2011 12:06



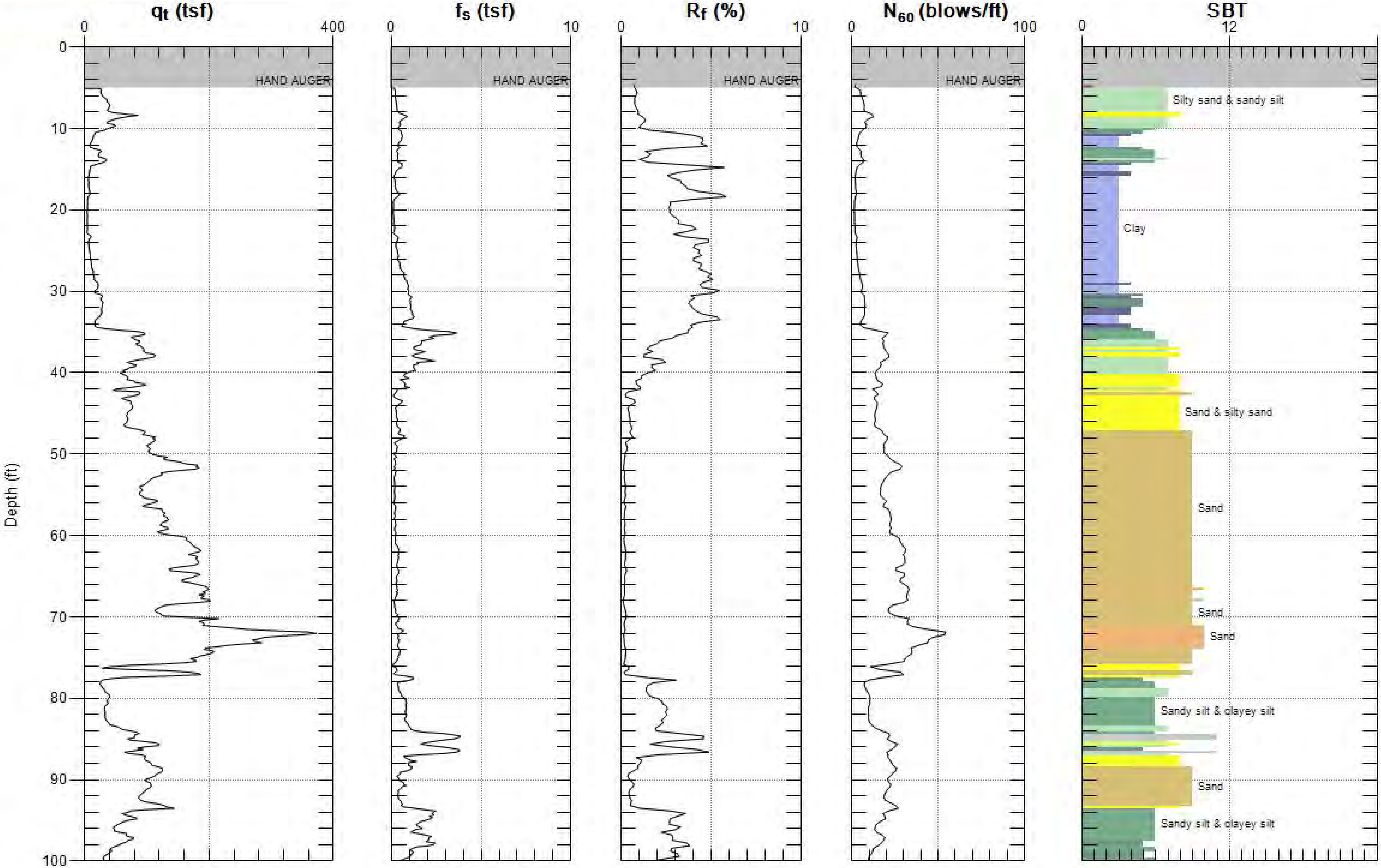

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

Site: PROSPECT ISLAND
Sounding: PI-9

Engineer: M.SOUVERVILLE
Date: 9/19/2011 12:06




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

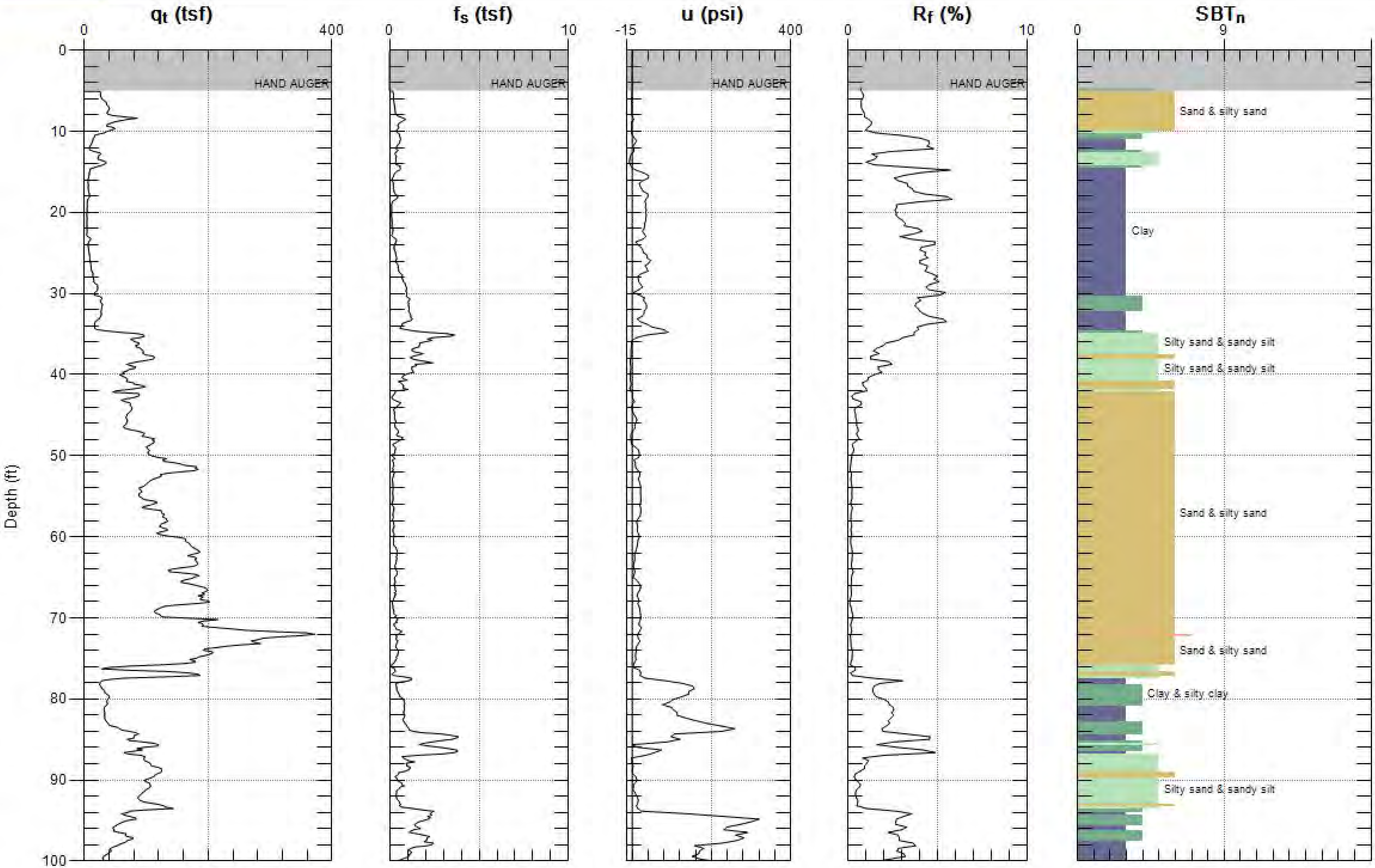
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

Site: PROSPECT ISLAND
Sounding: PI-9

Engineer: M.SOUVERVILLE
Date: 9/19/2011 12:06



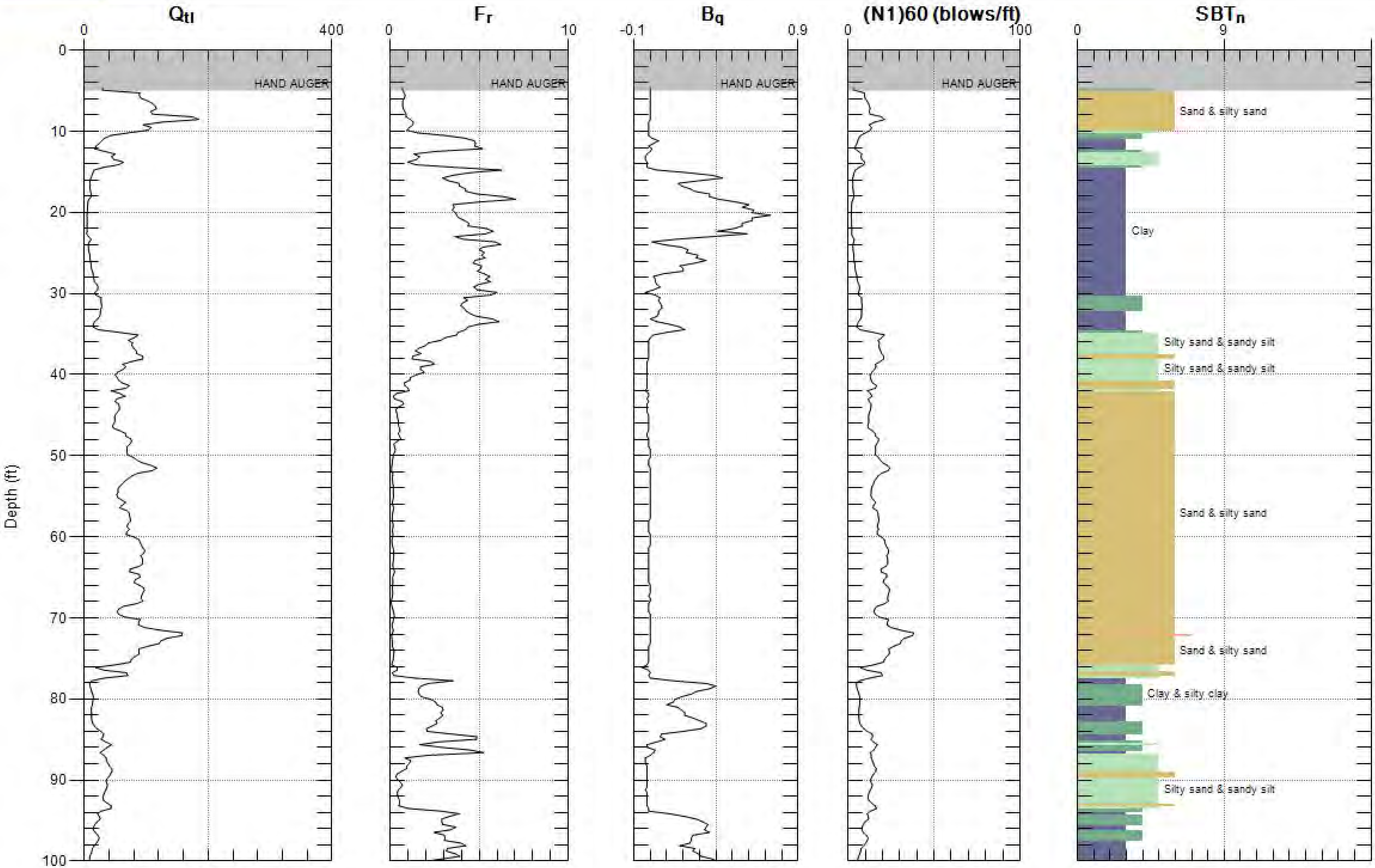

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG DWR

Site: PROSPECT ISLAND
Sounding: PI-9

Engineer: M.SOUVERVILLE
Date: 9/19/2011 12:06




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

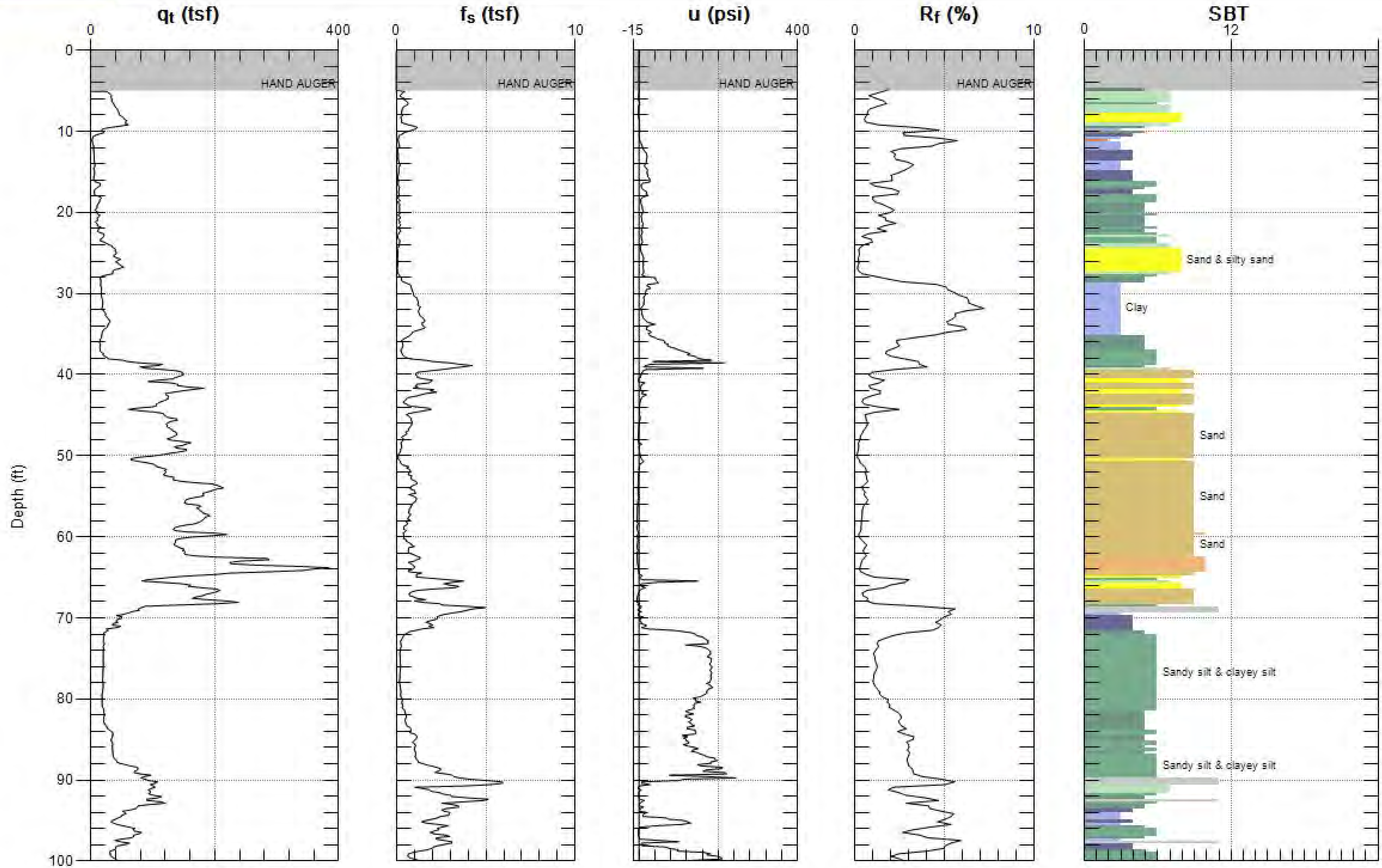
DWR

Site: PROSPECT ISLAND

Sounding: PI-10

Engineer: M.SOUVERVILLE

Date: 9/19/2011 03:24



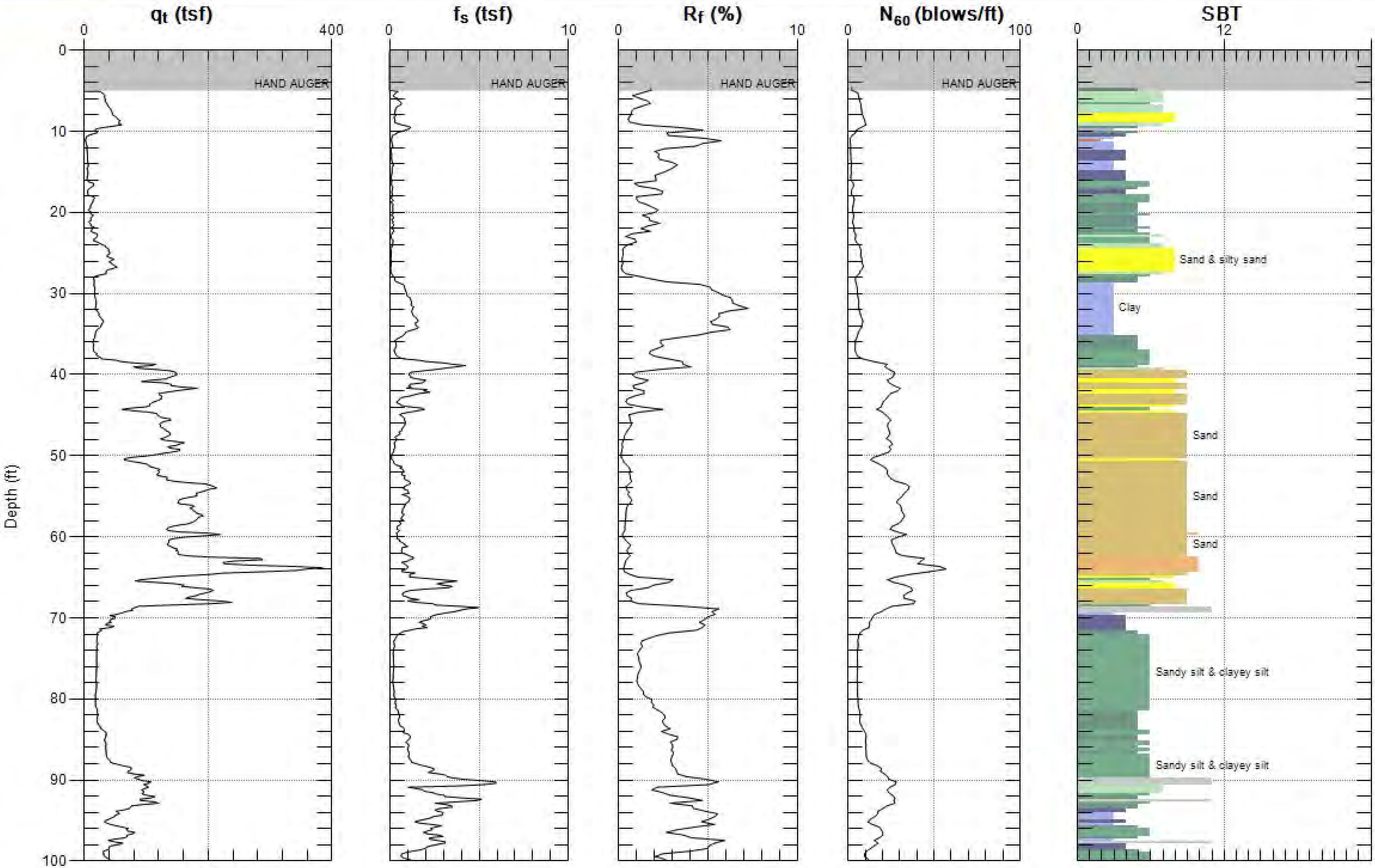

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**DWR**

**Site: PROSPECT ISLAND** | **Engineer: M.SOUVERVILLE**

**Sounding: PI-10** | **Date: 9/19/2011 03:24**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

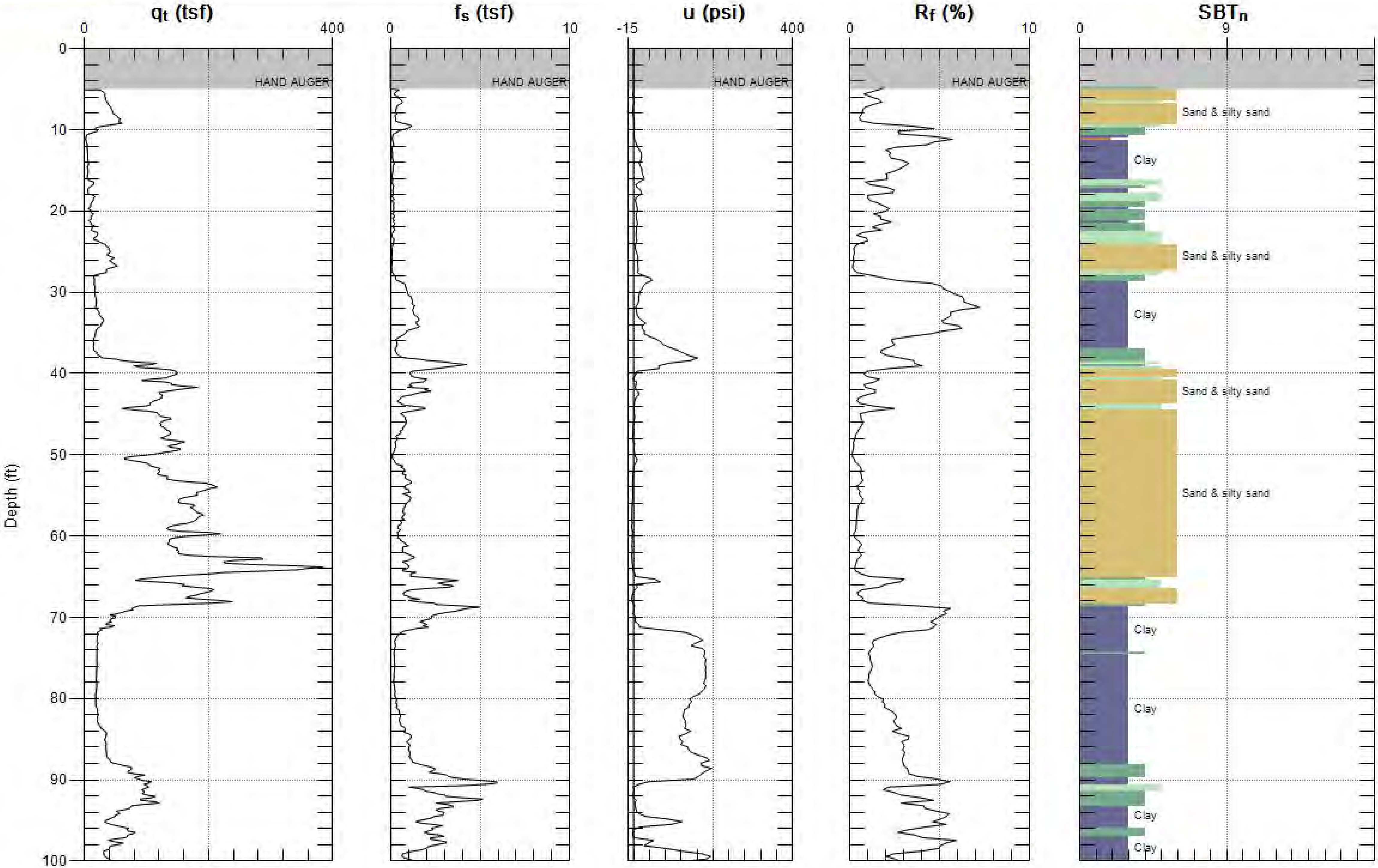
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

**Site: PROSPECT ISLAND**
**Sounding: PI-10**

**Engineer: M.SOUVERVILLE**
**Date: 9/19/2011 03:24**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

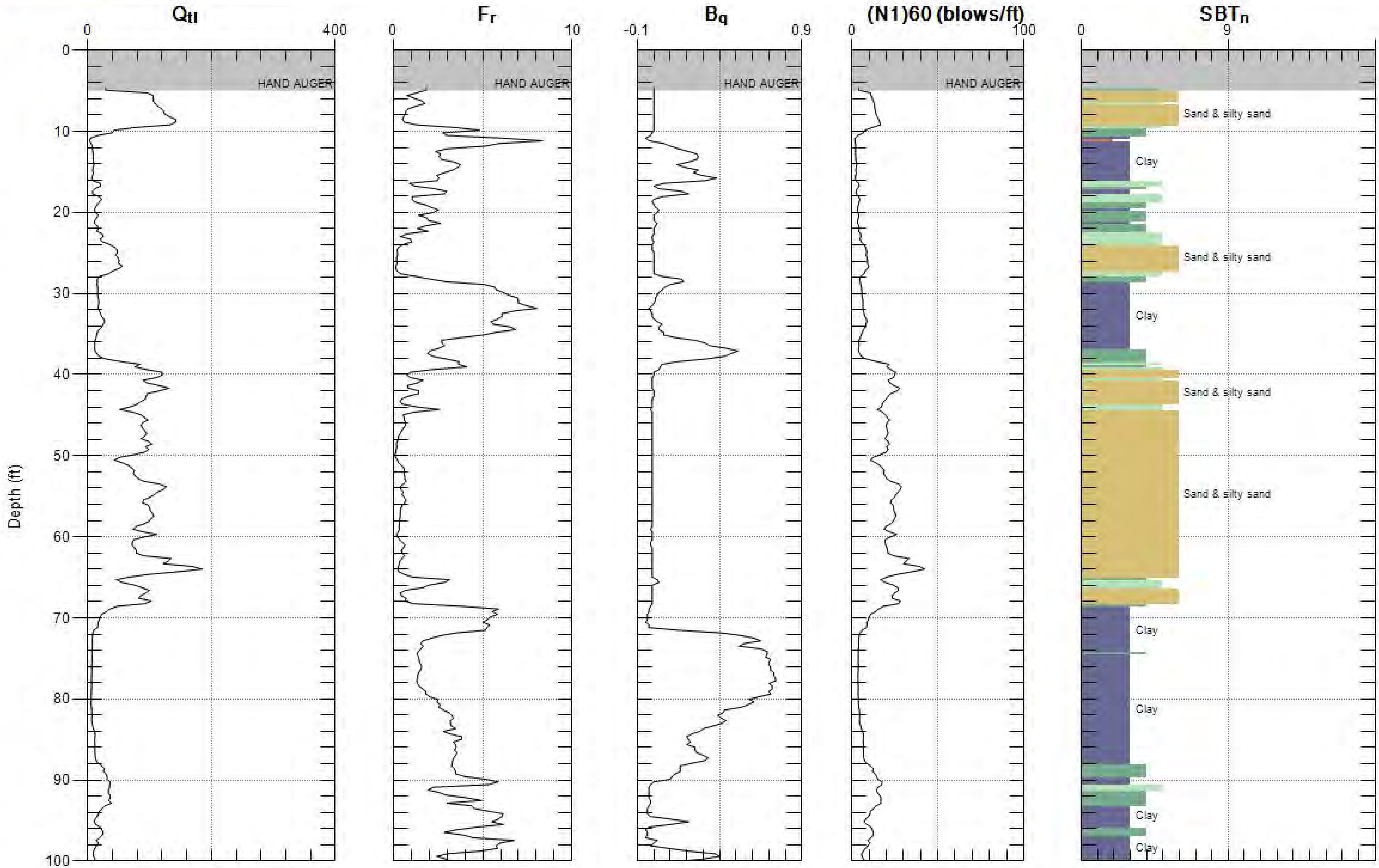
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

**Site: PROSPECT ISLAND**
**Sounding: PI-10**

**Engineer: M.SOUVERVILLE**
**Date: 9/19/2011 03:24**



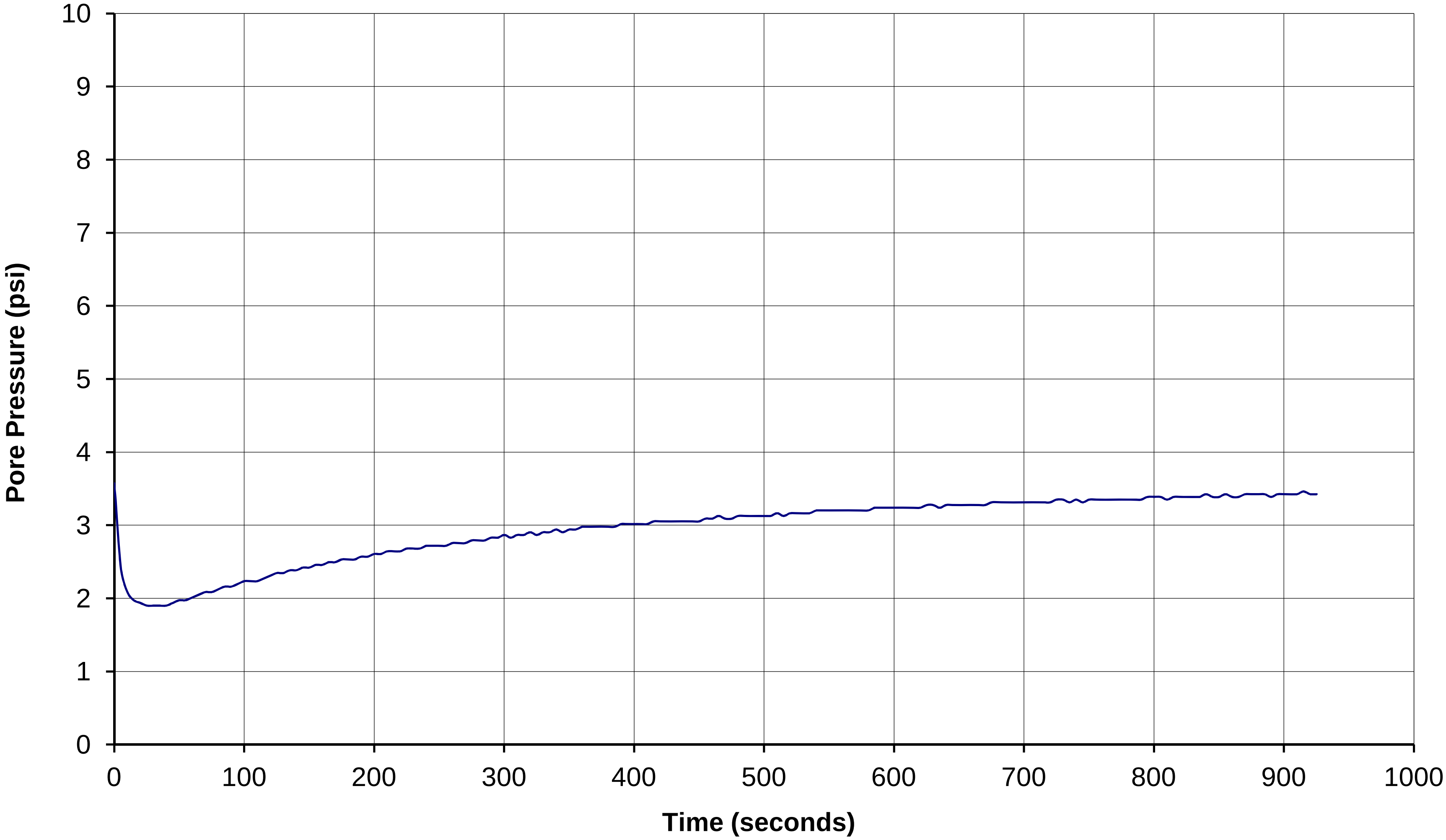

Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

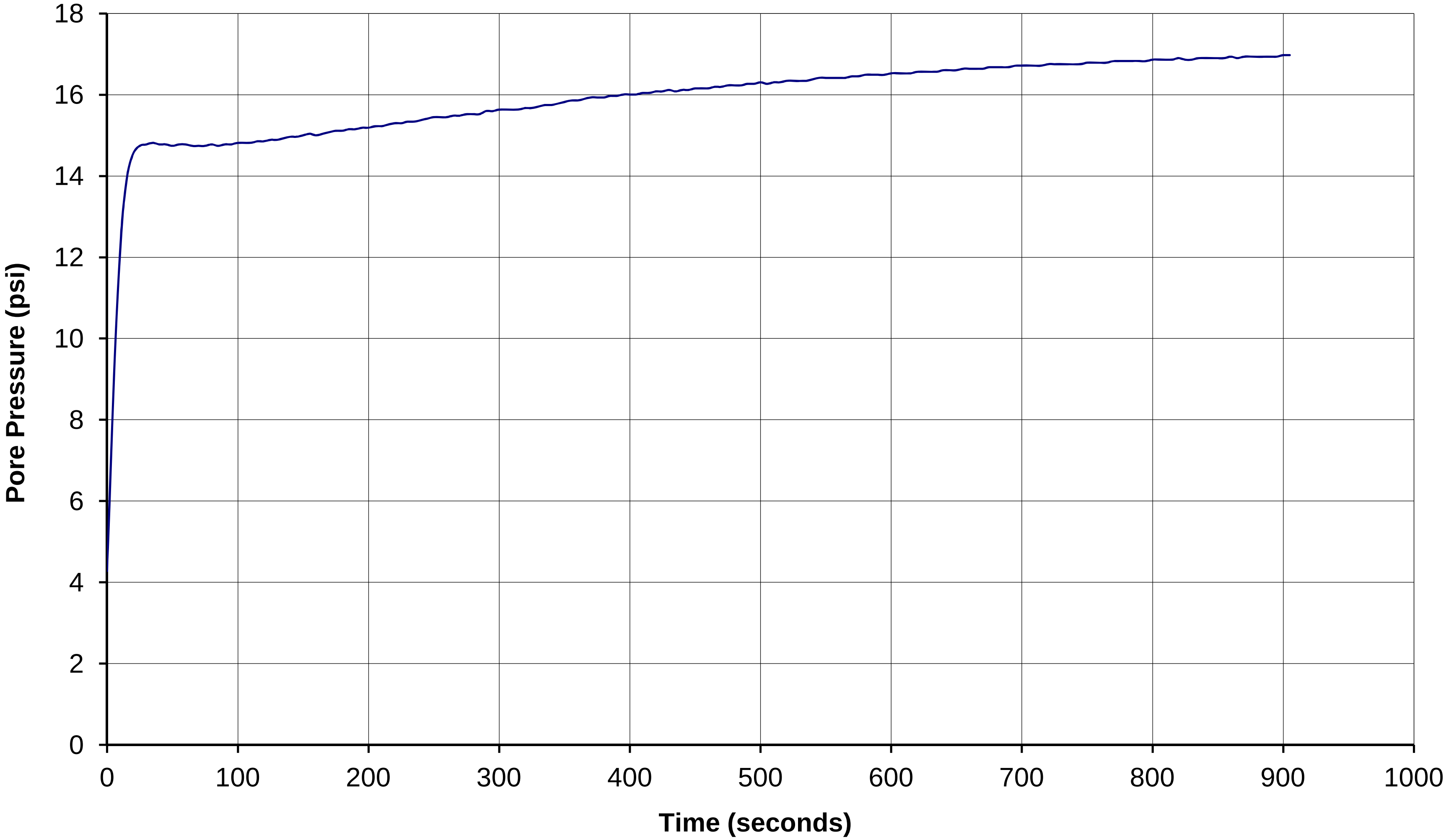
Sounding: PI-1 PPD
Depth: 15.091818
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

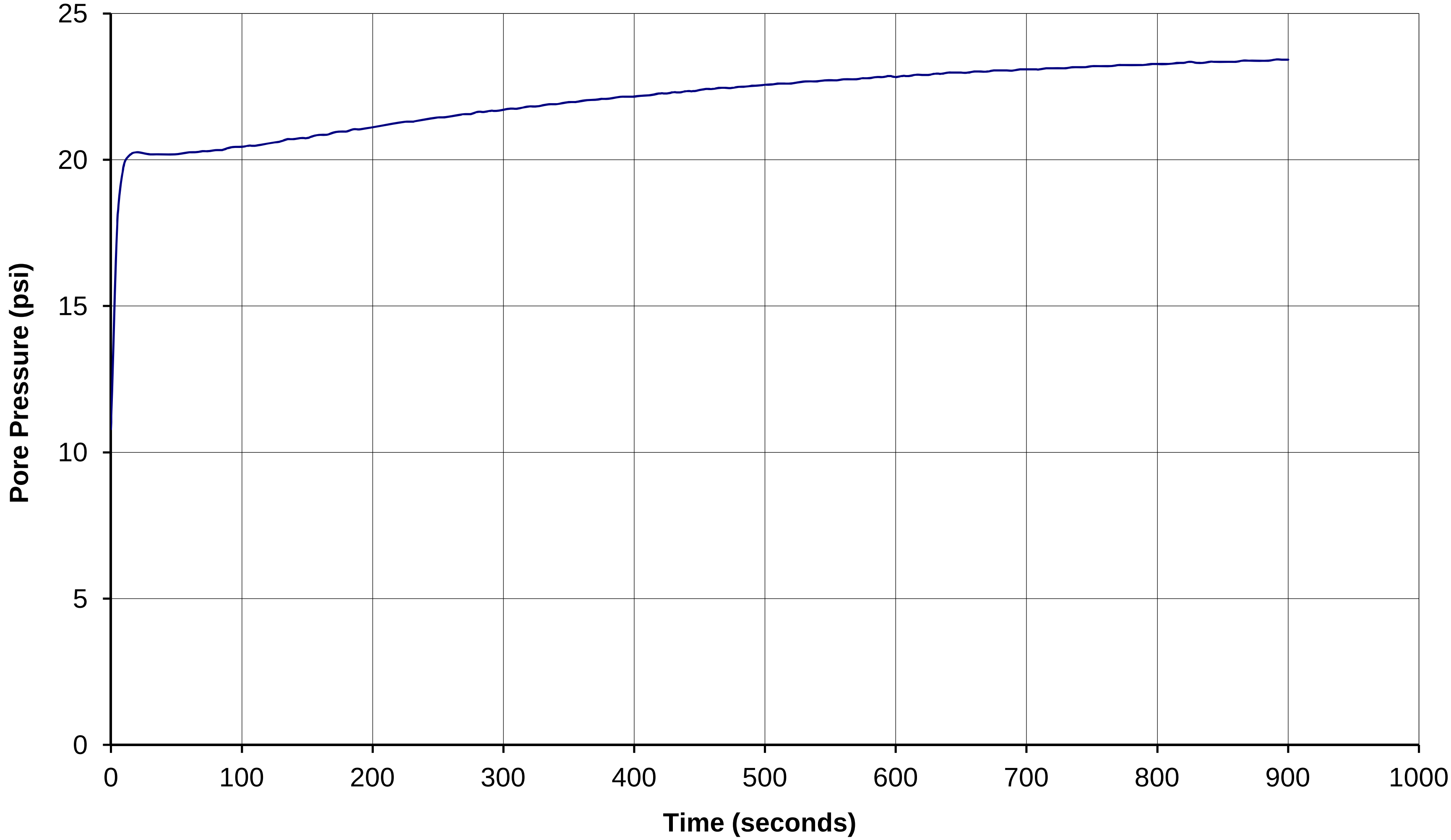
Sounding: PI-1
Depth: 40.026126
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

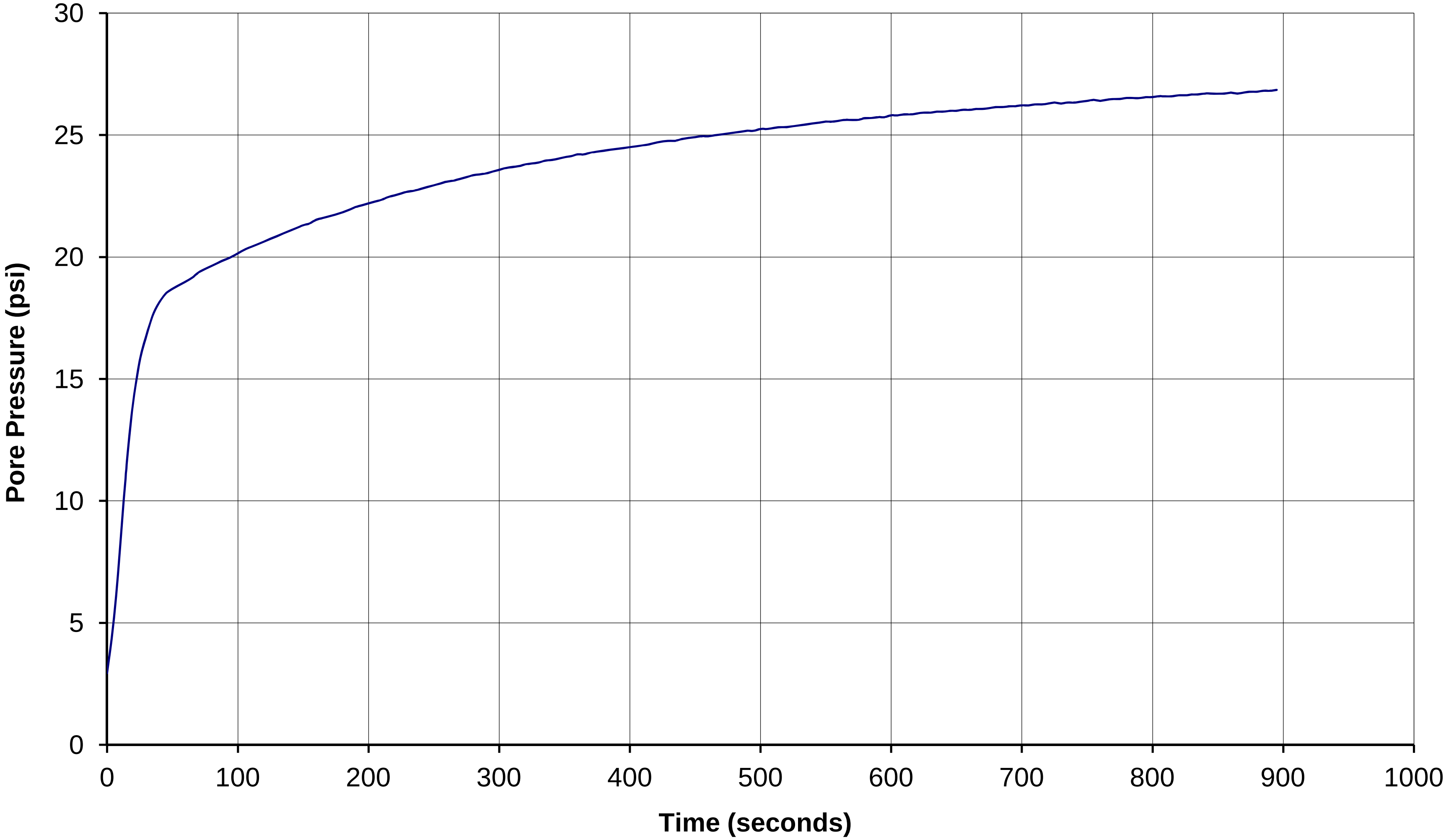
Sounding: PI-1
Depth: 55.117944
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

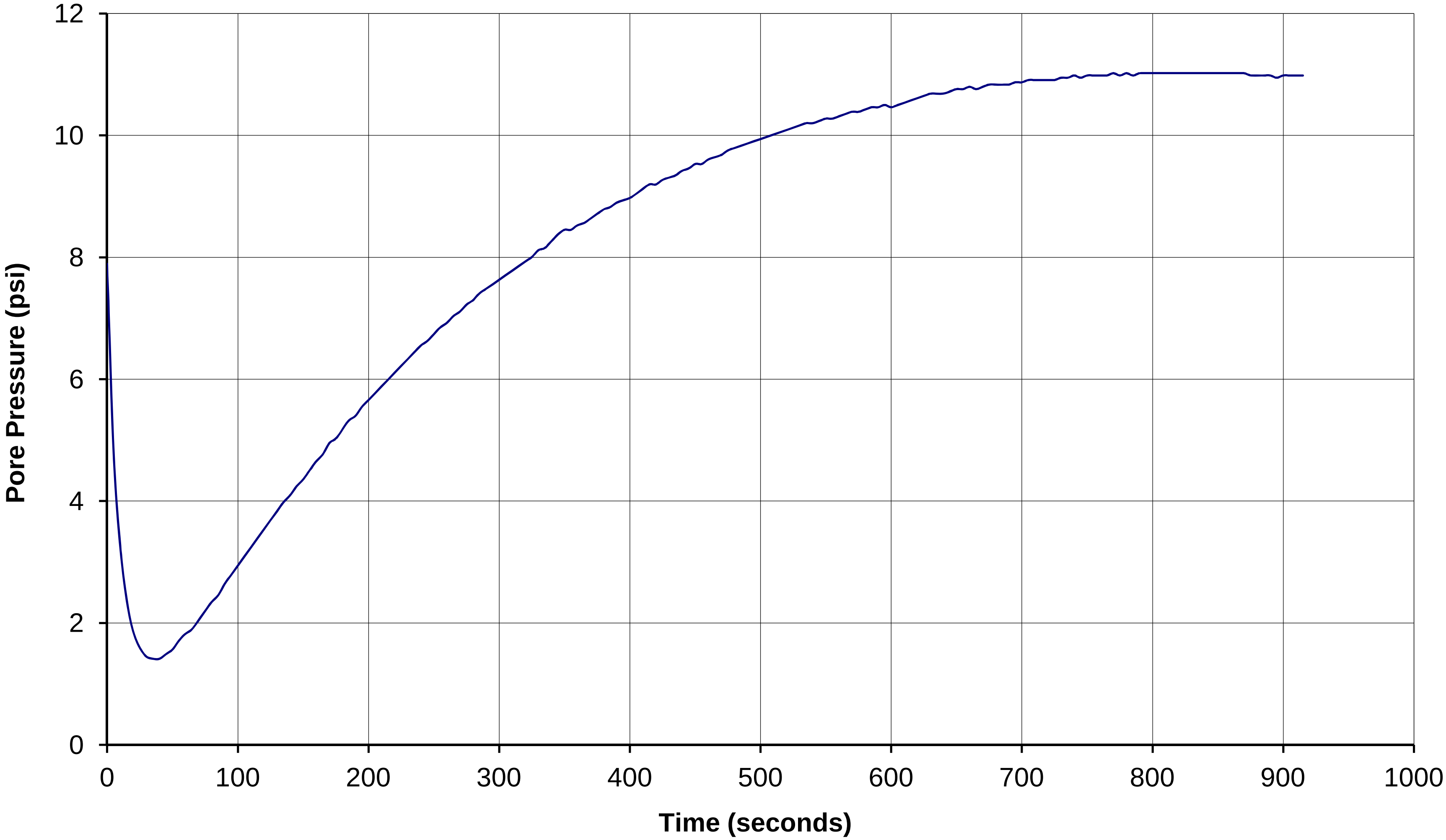
Sounding: PI-1
Depth: 65.1244755
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

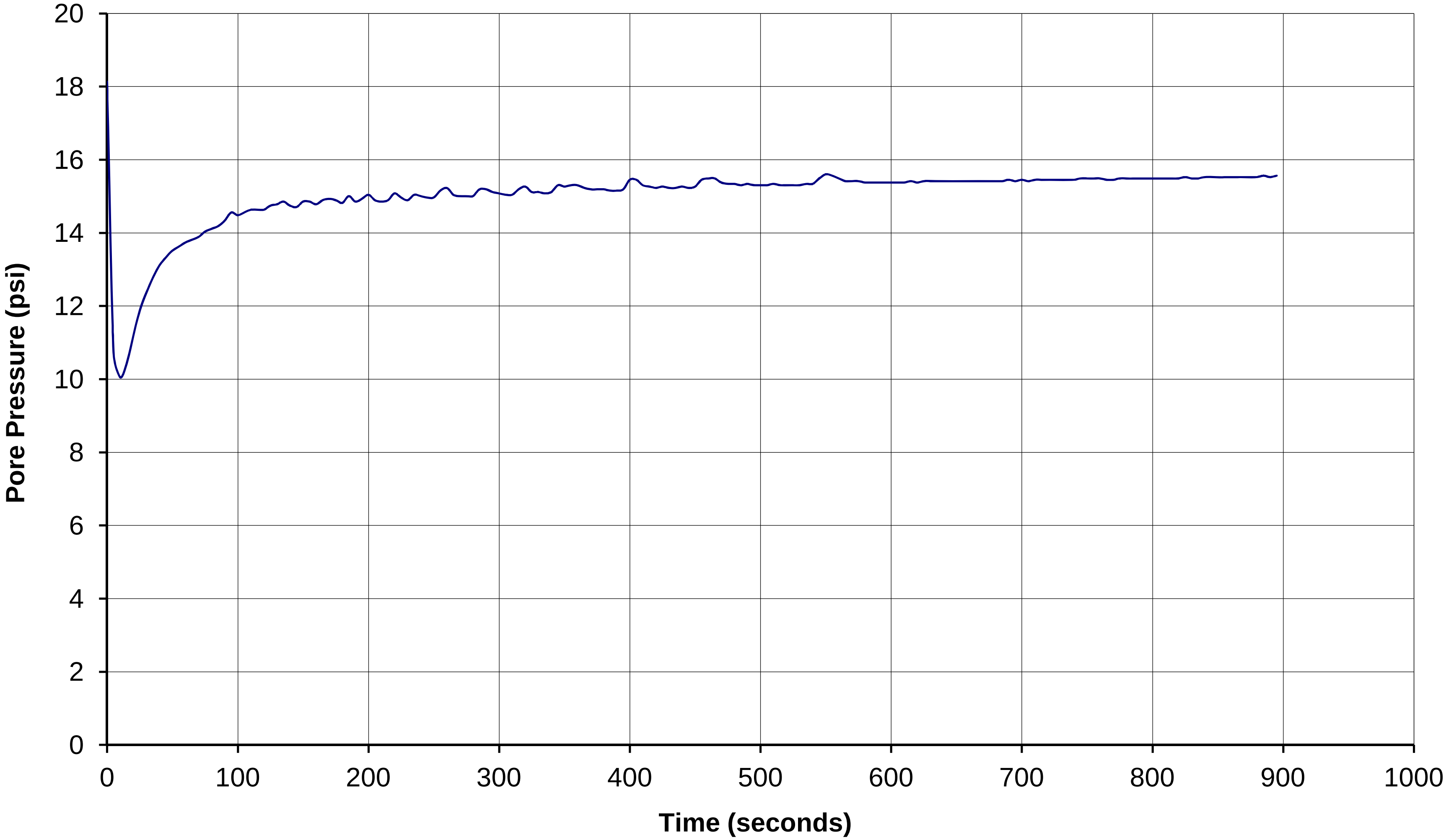
Sounding: PI-2
Depth: 10.0065315
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

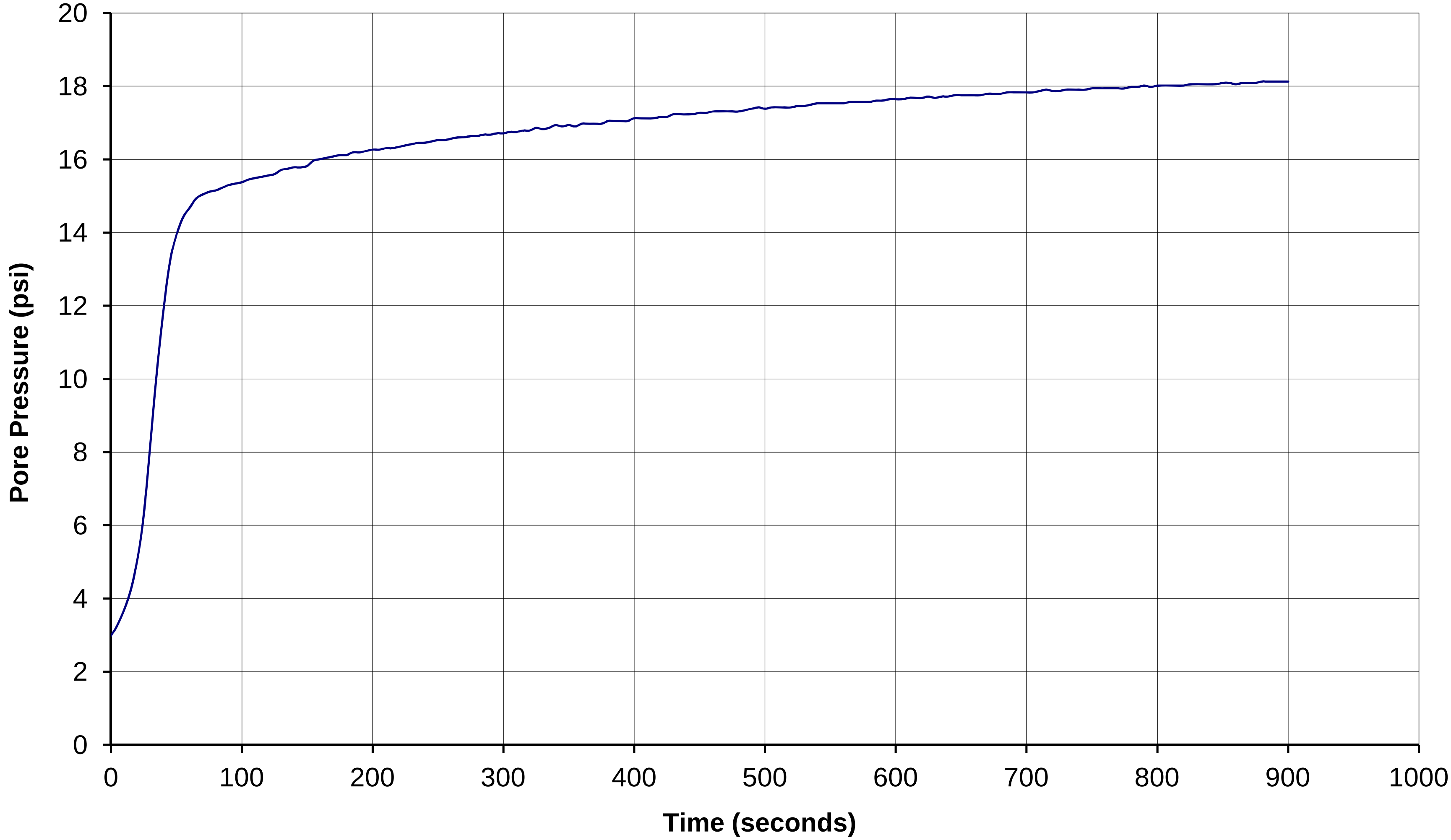
Sounding: PI-2
Depth: 40.026126
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

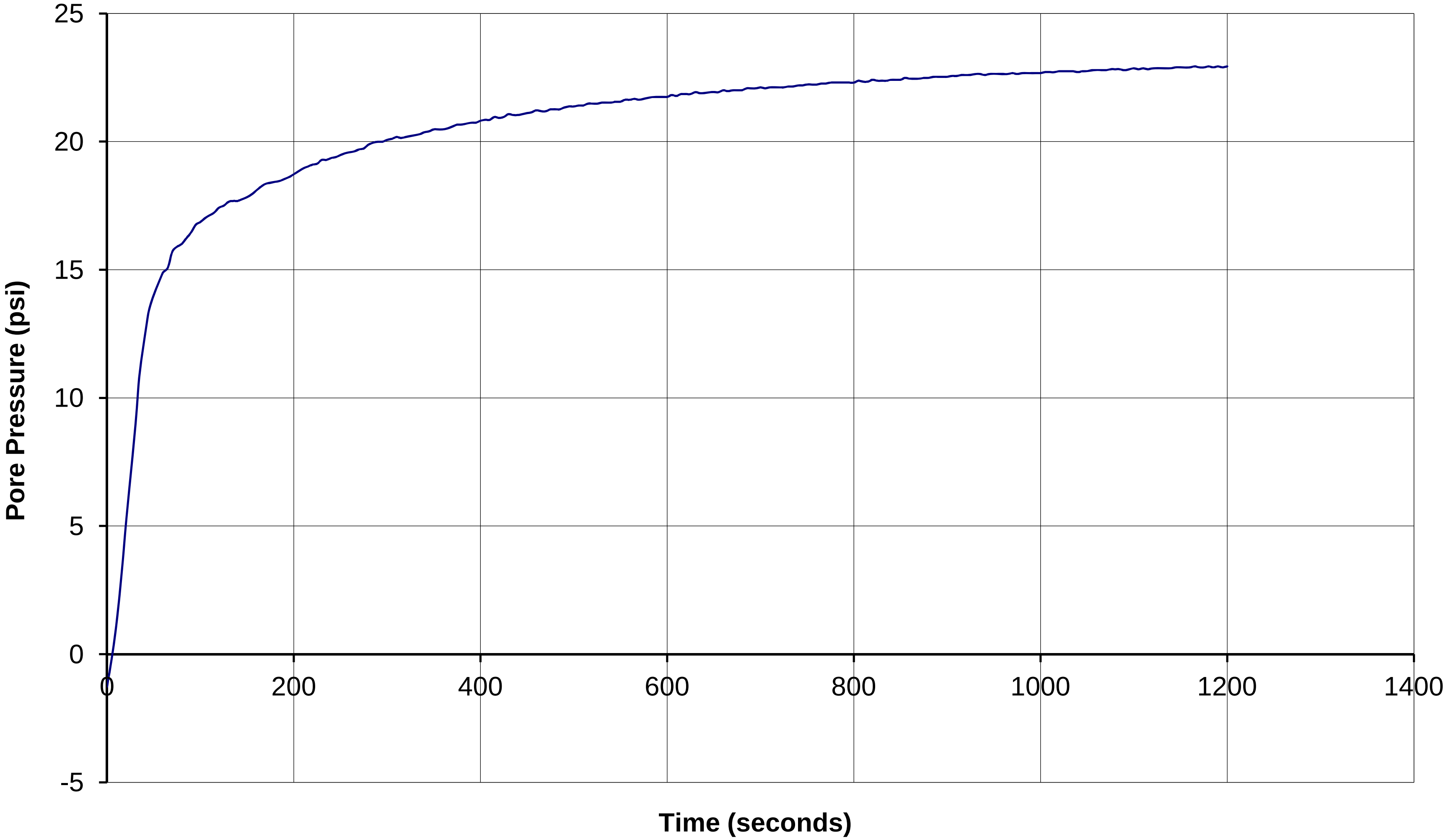
Sounding: PI-2
Depth: 47.243952
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

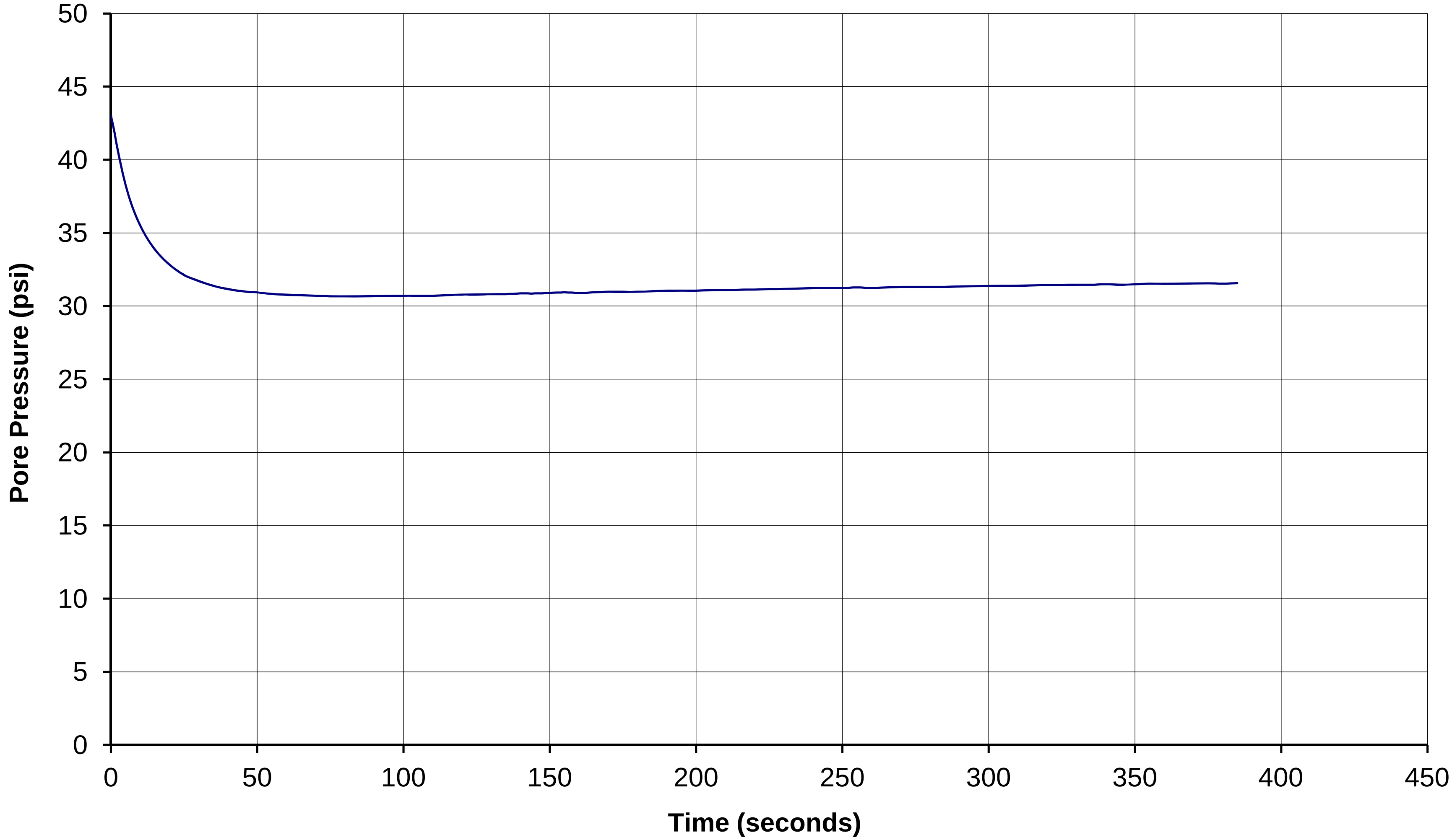
Sounding: PI-2
Depth: 58.070691
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

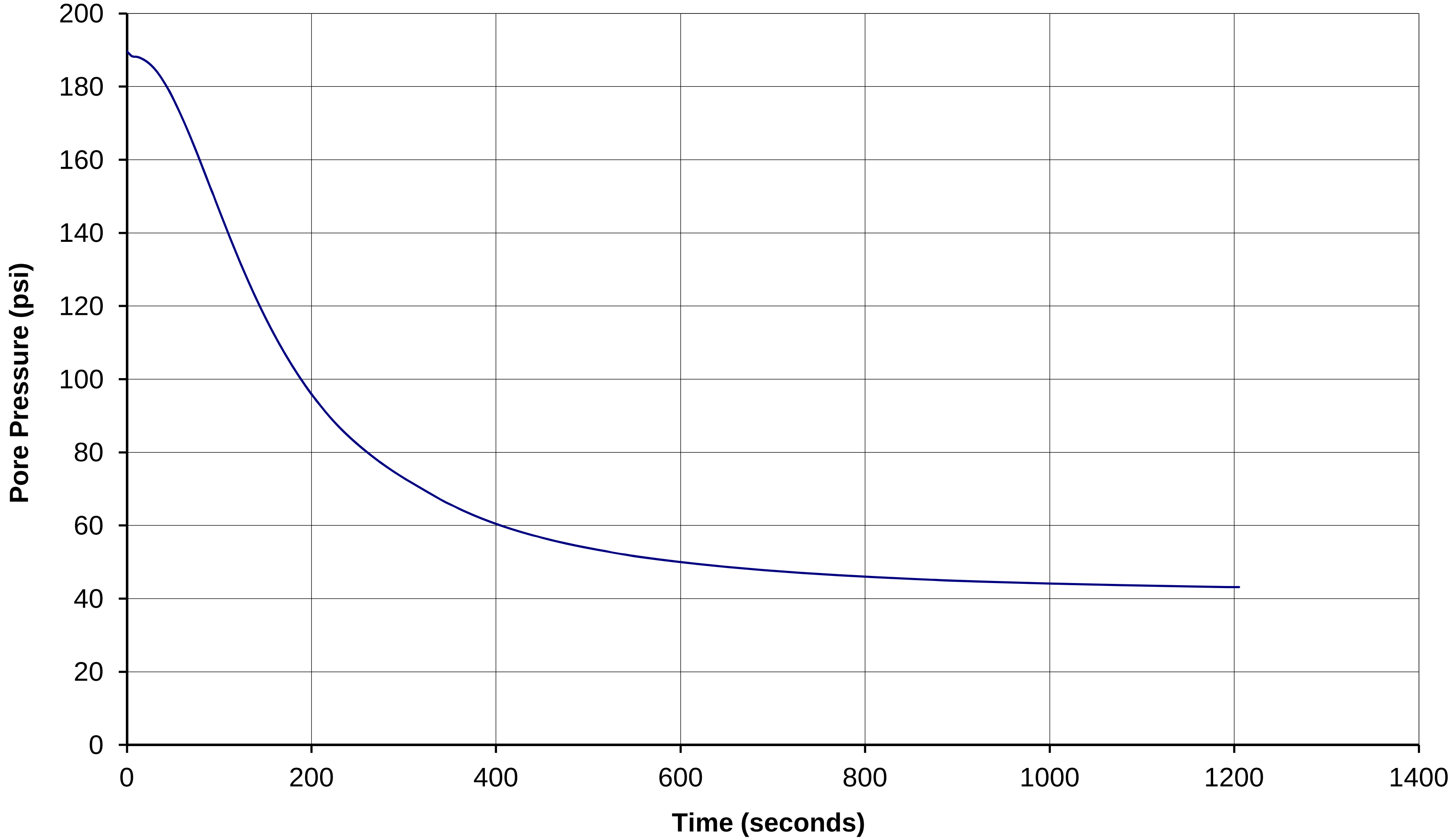
Sounding: PI-2
Depth: 83.1690405
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

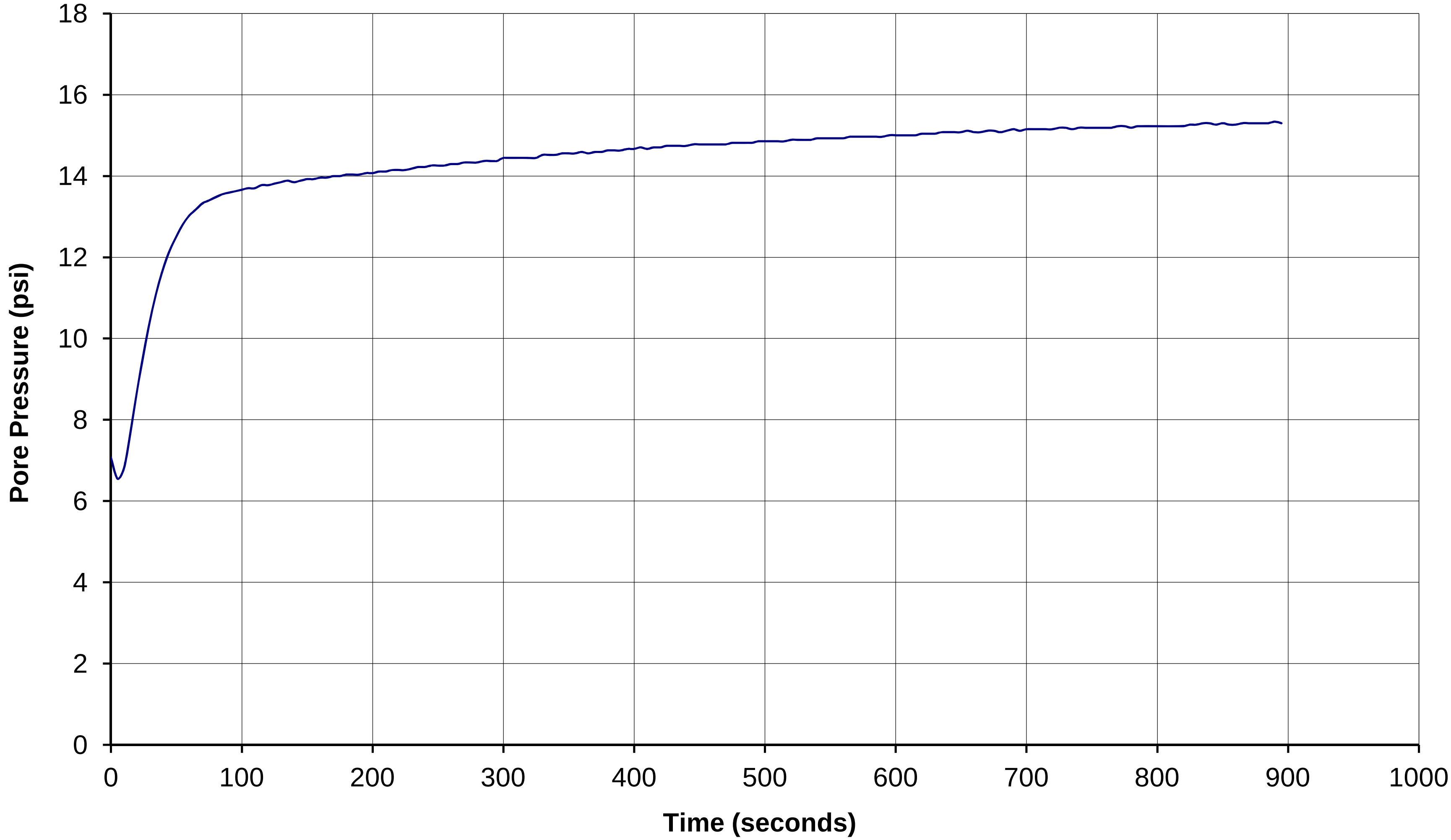
Sounding: PI-2
Depth: 100.2293565
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

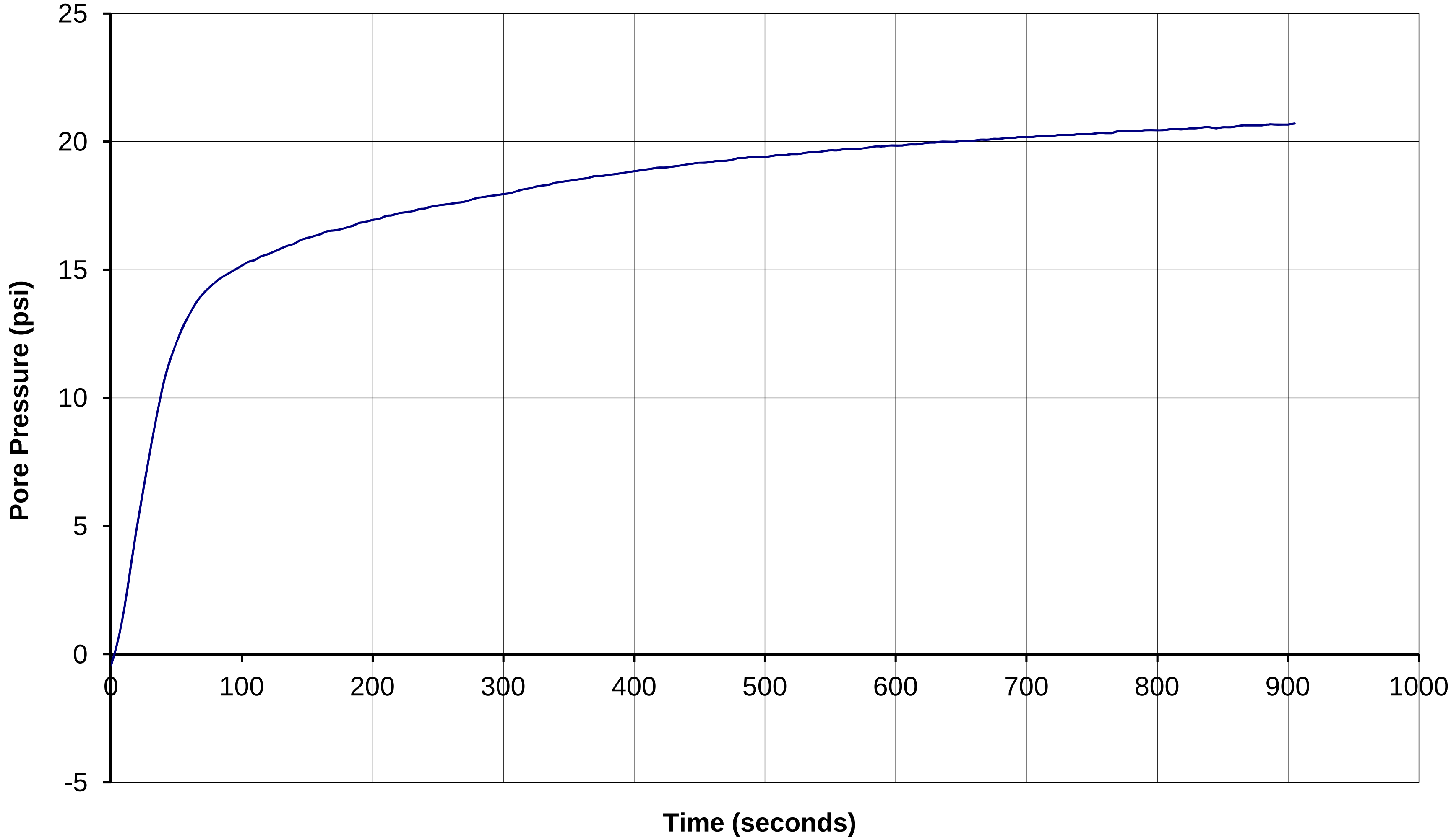
Sounding: PI-3
Depth: 36.9093375
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

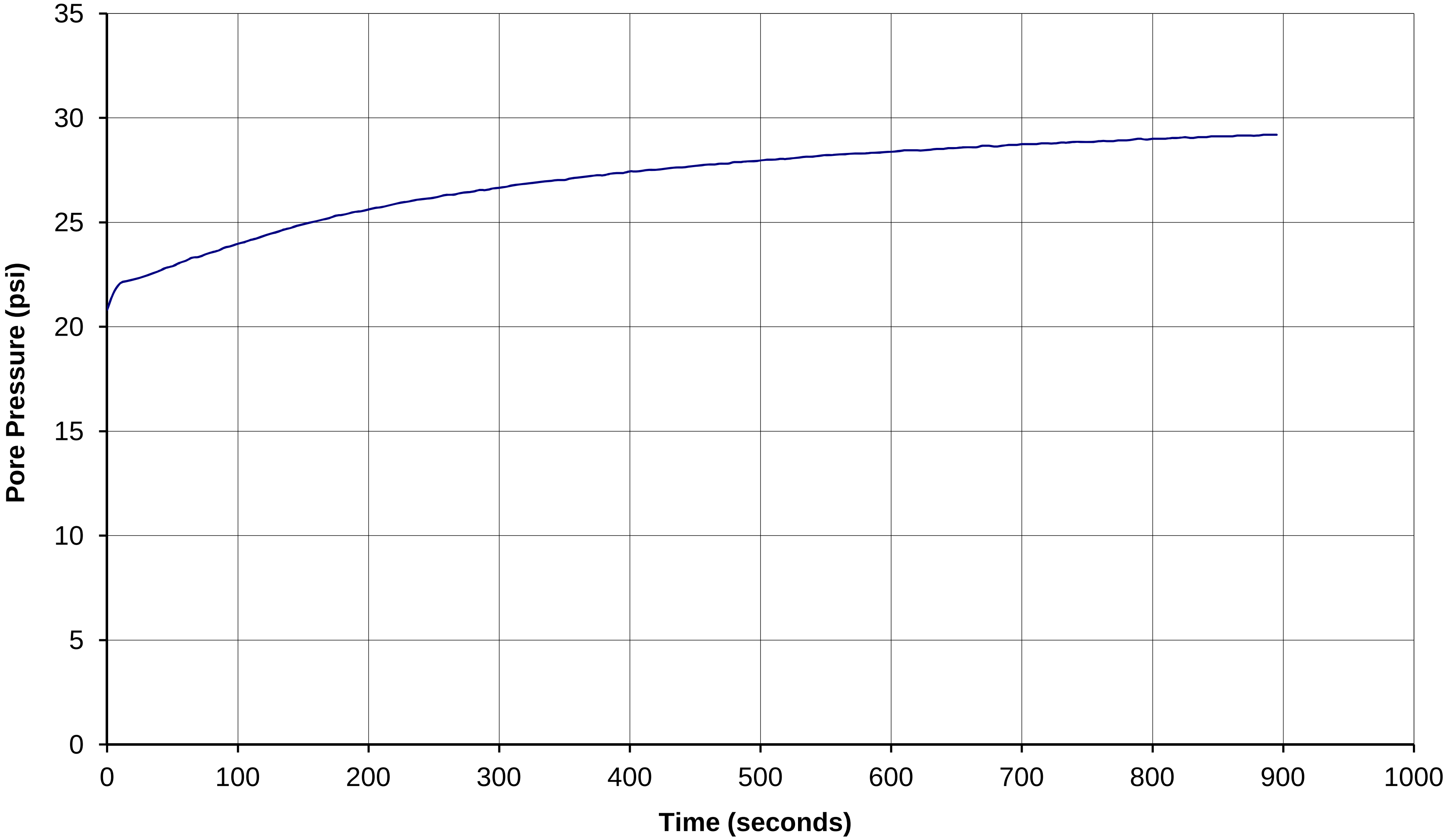
Sounding: PI-3
Depth: 51.180948
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

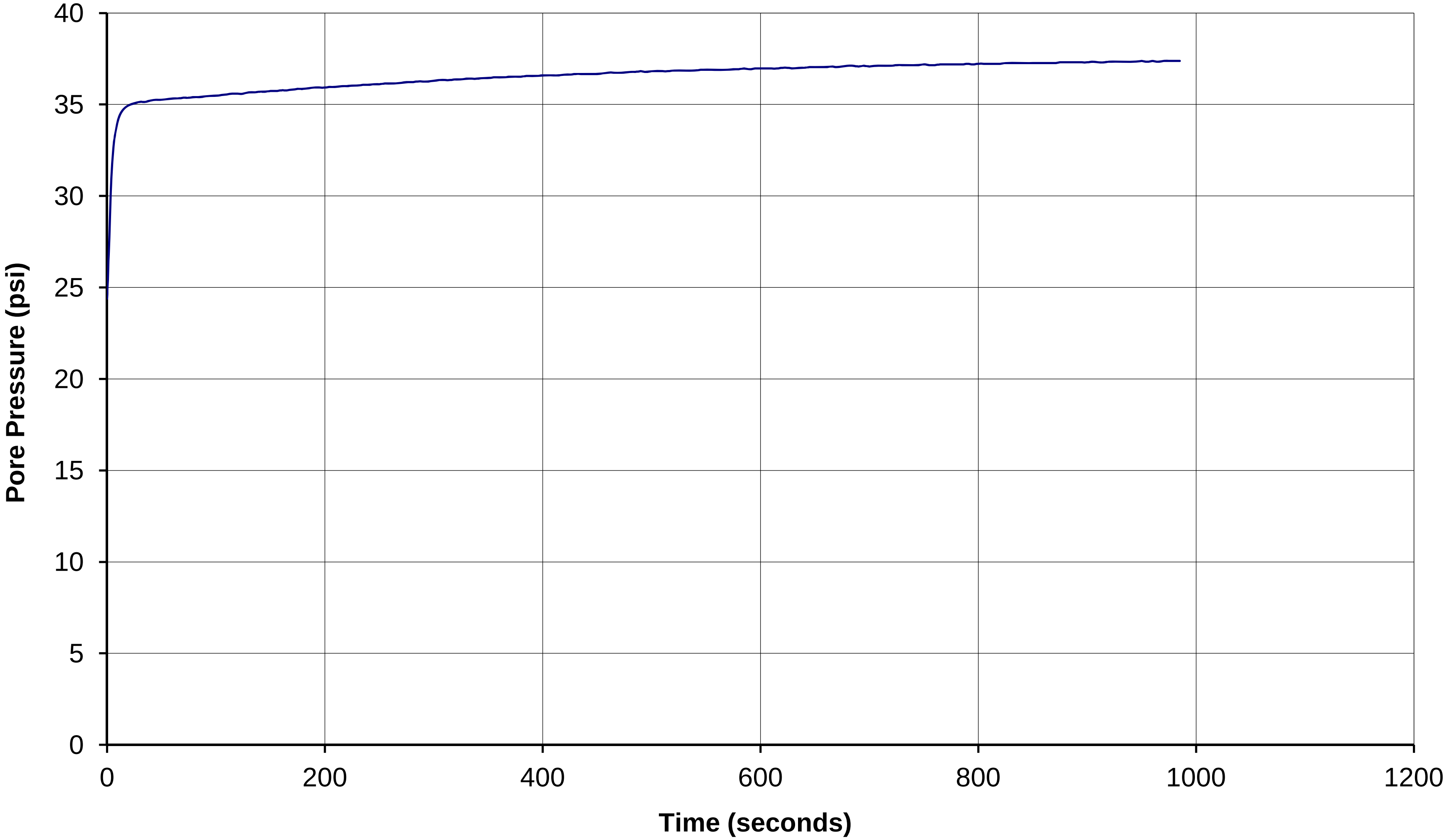
Sounding: PI-3
Depth: 70.0457205
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

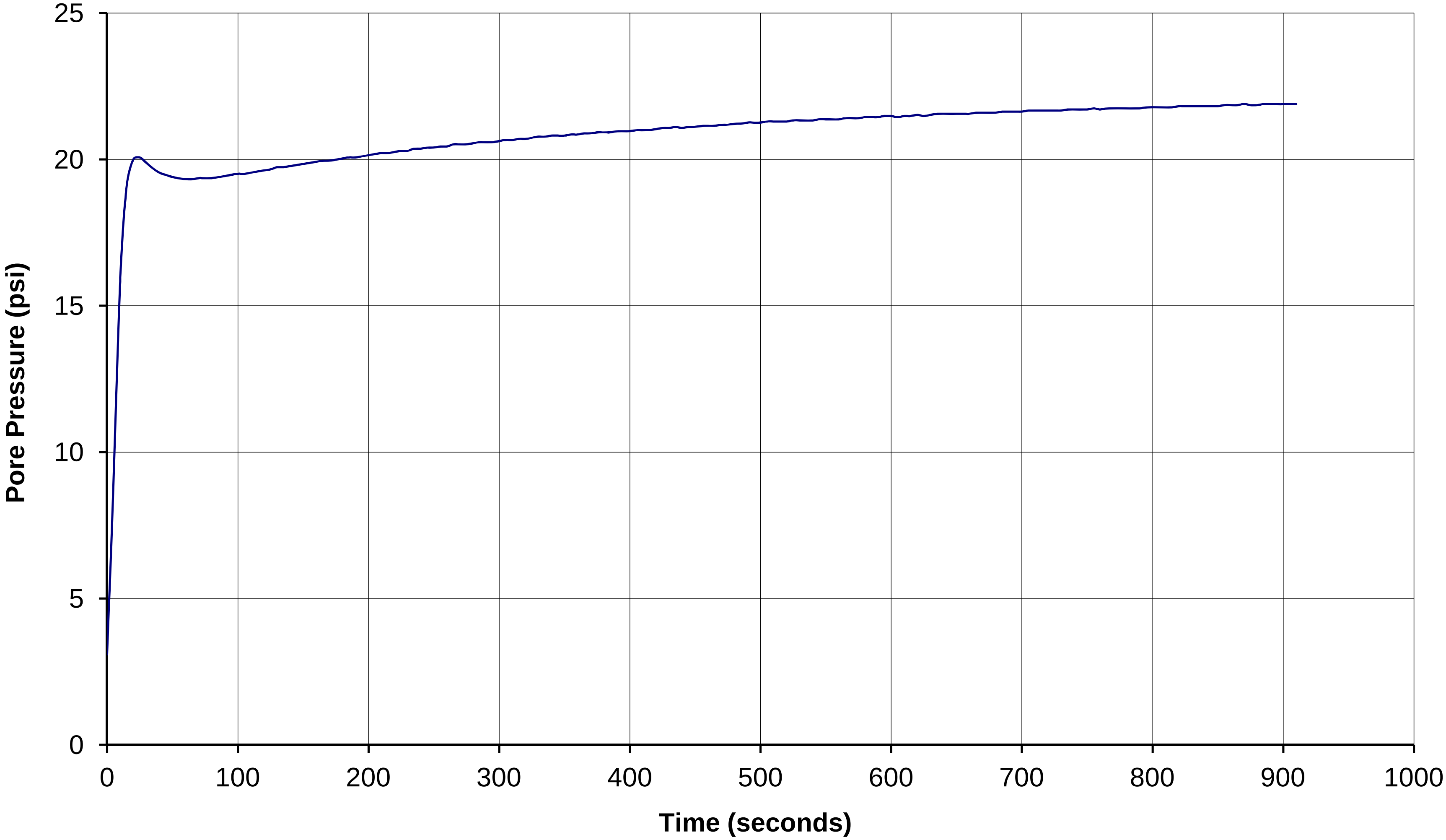
Sounding: PI-3
Depth: 88.910493
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

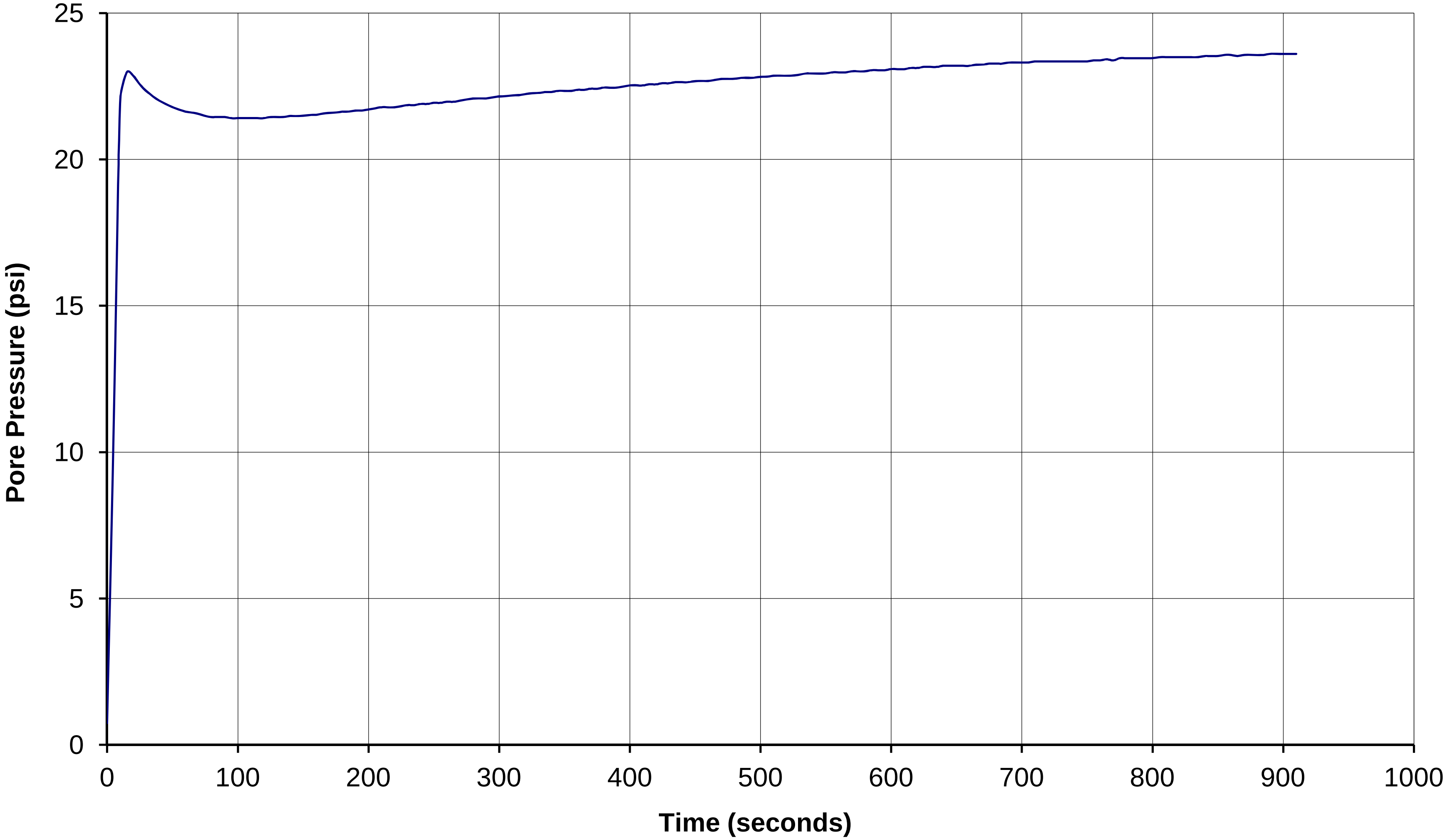
Sounding: PI-4
Depth: 61.8436455
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

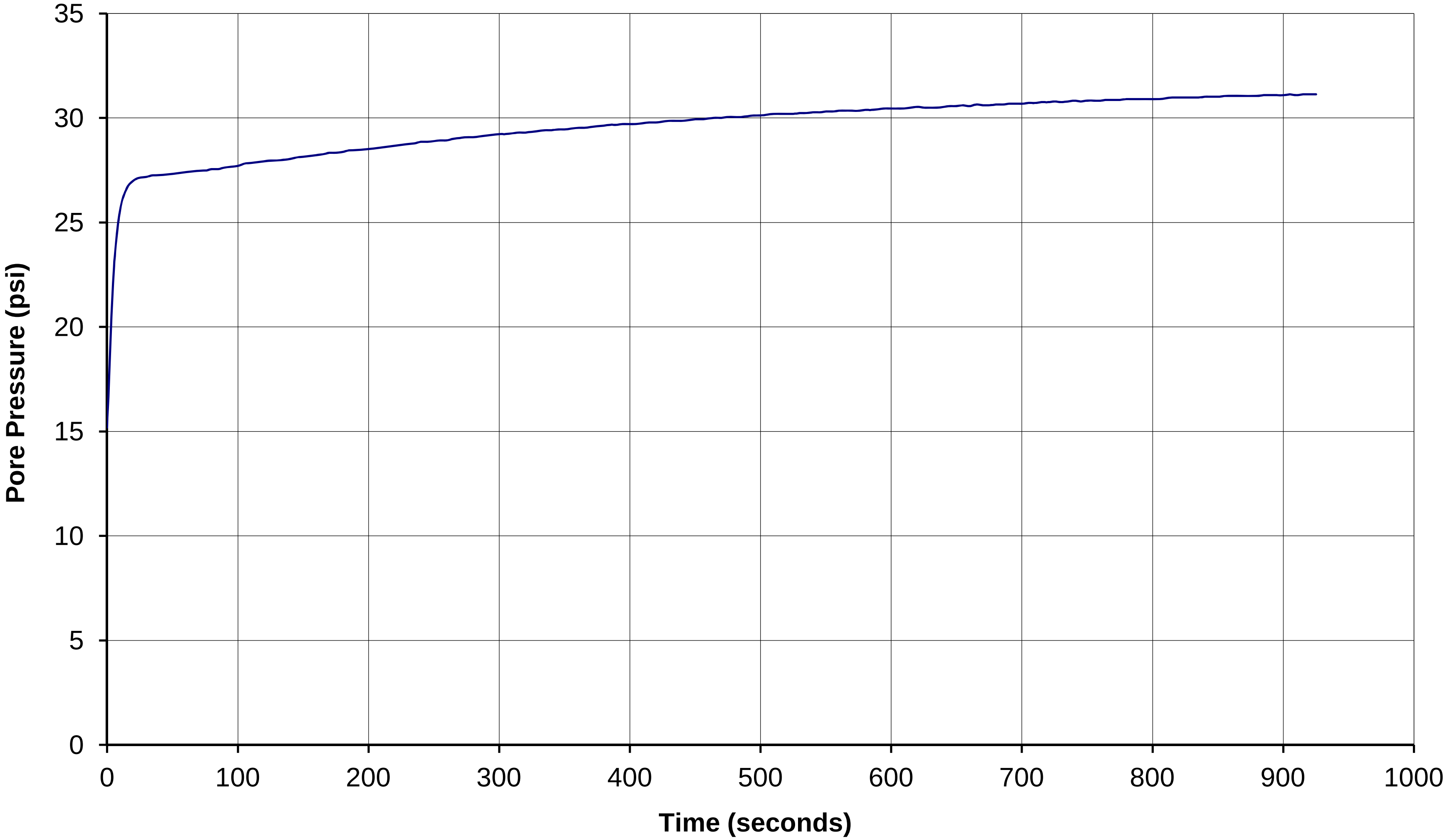
Sounding: PI-4
Depth: 66.272766
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

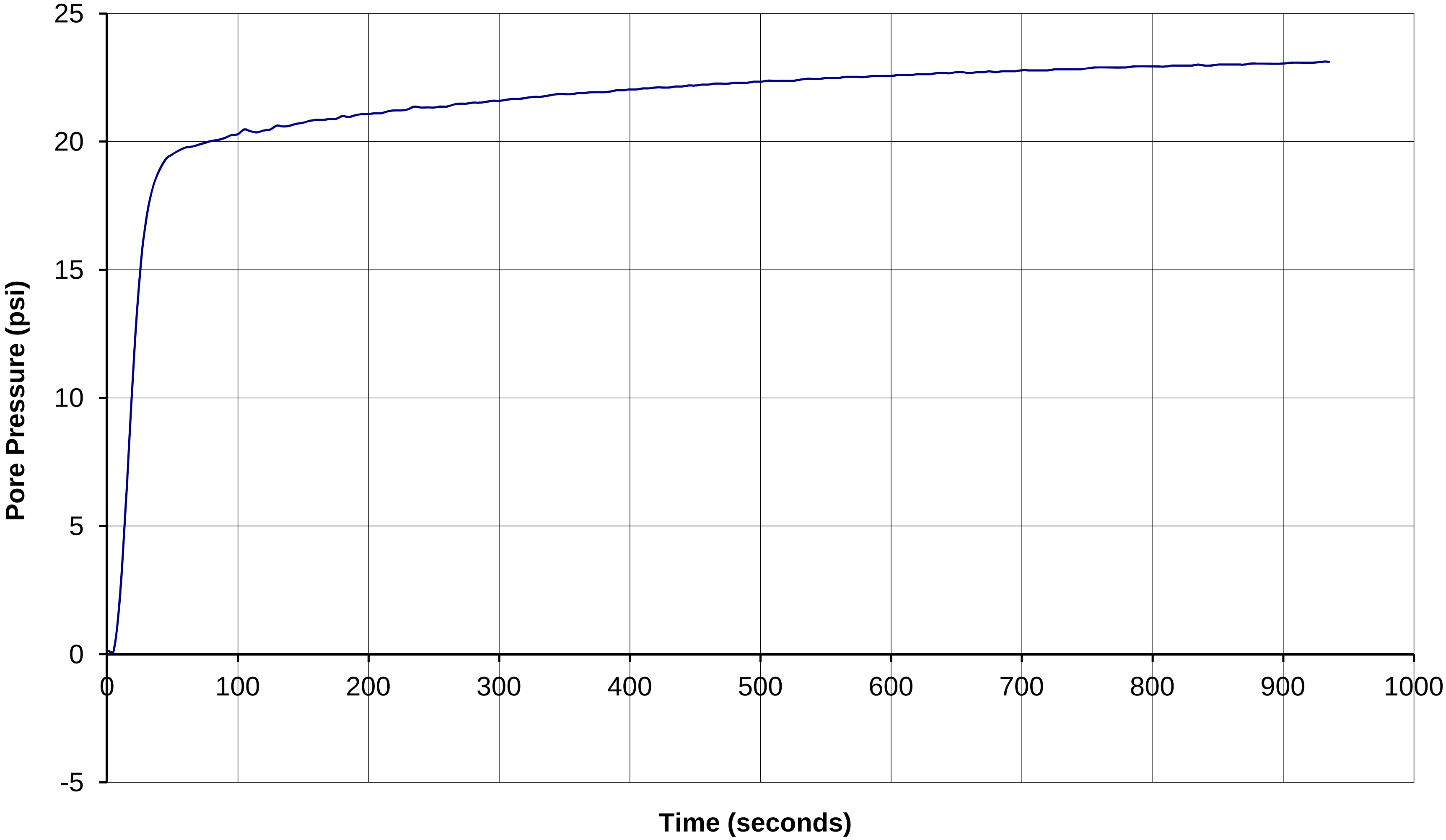
Sounding: PI-4
Depth: 85.4656215
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

Sounding: PI-5
Depth: 64.4683095
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE

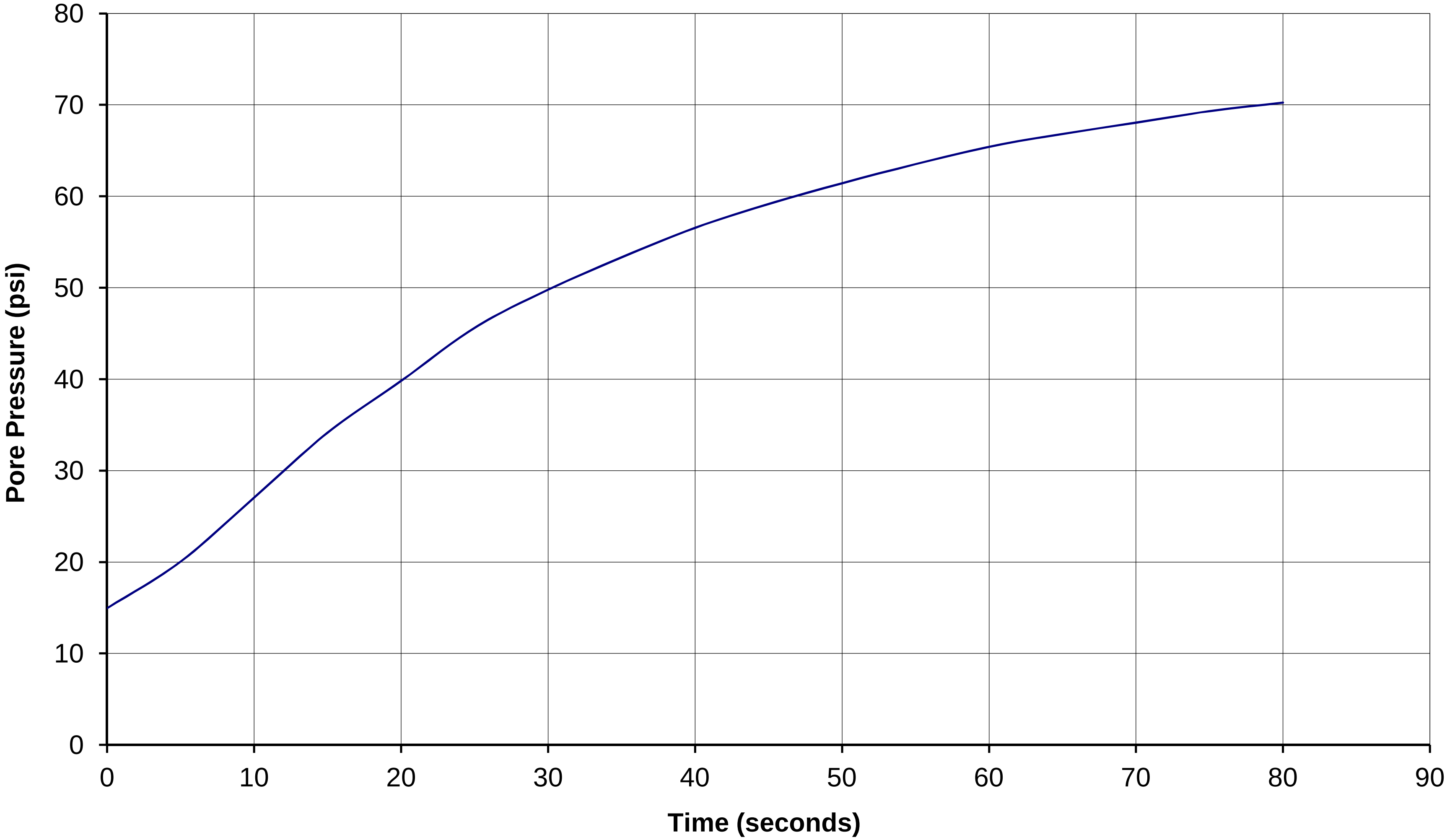


GREGG

# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

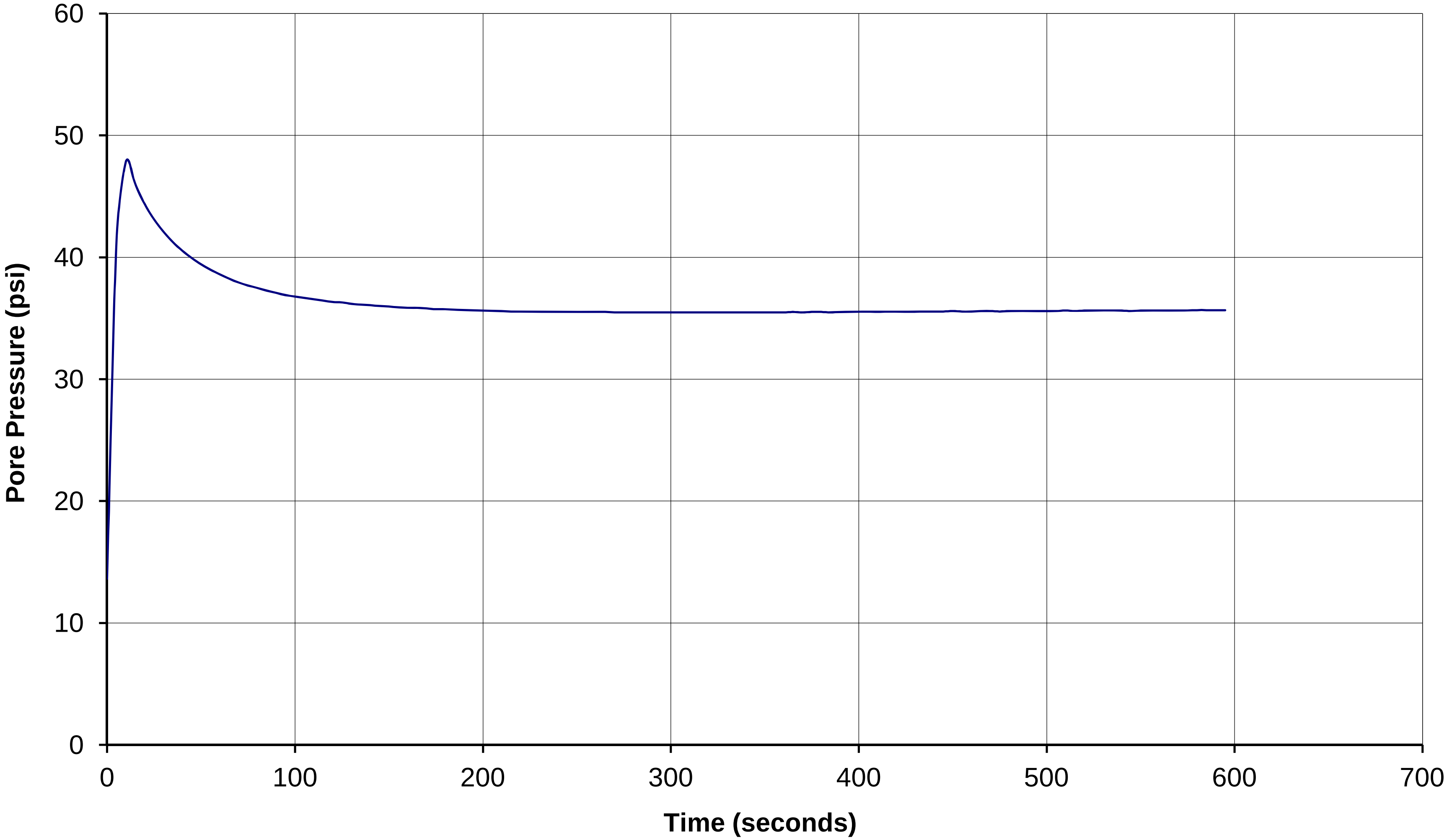
Sounding: PI-5
Depth: 81.364584
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

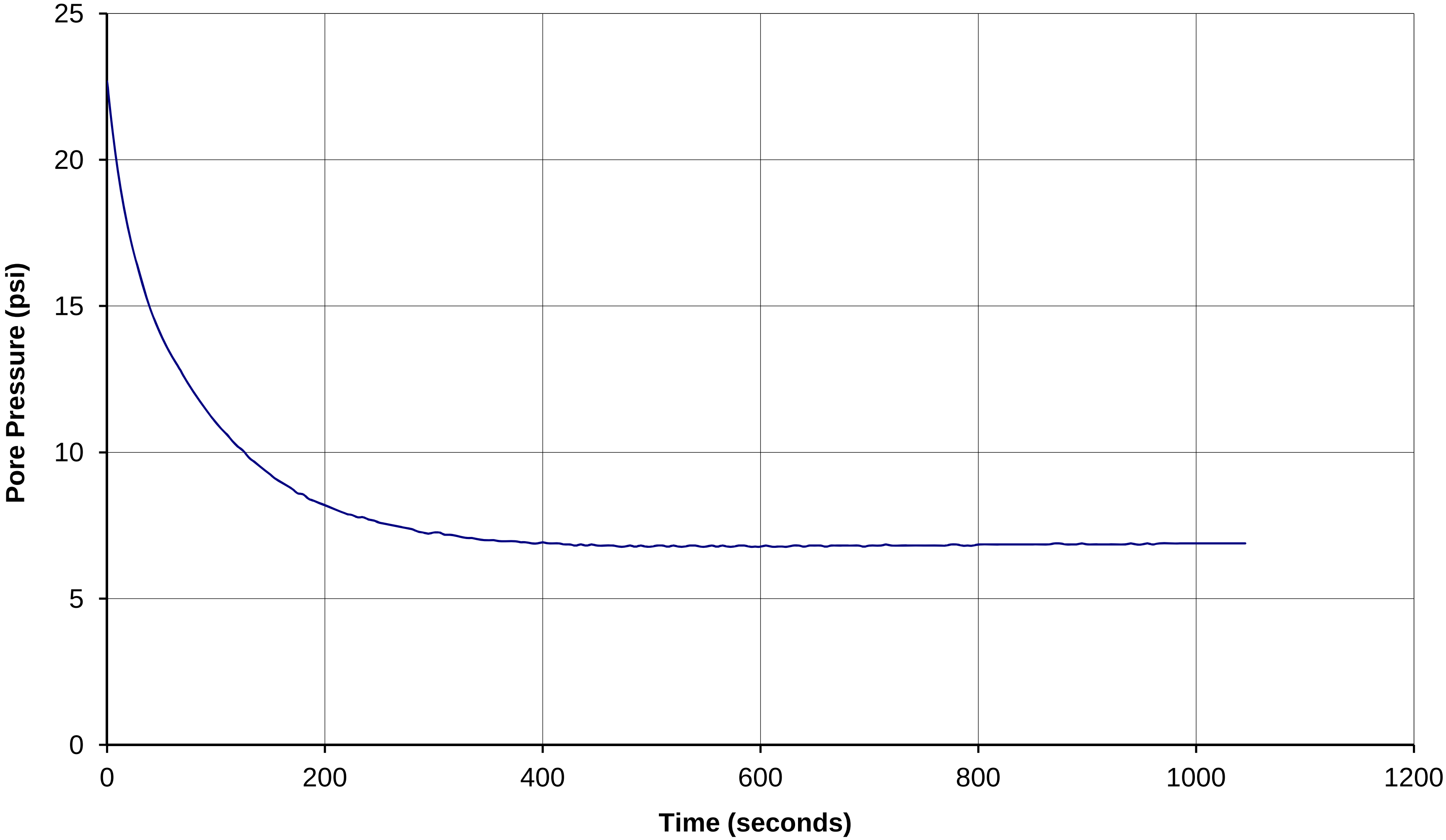
Sounding: PI-5
Depth: 90.7149495
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

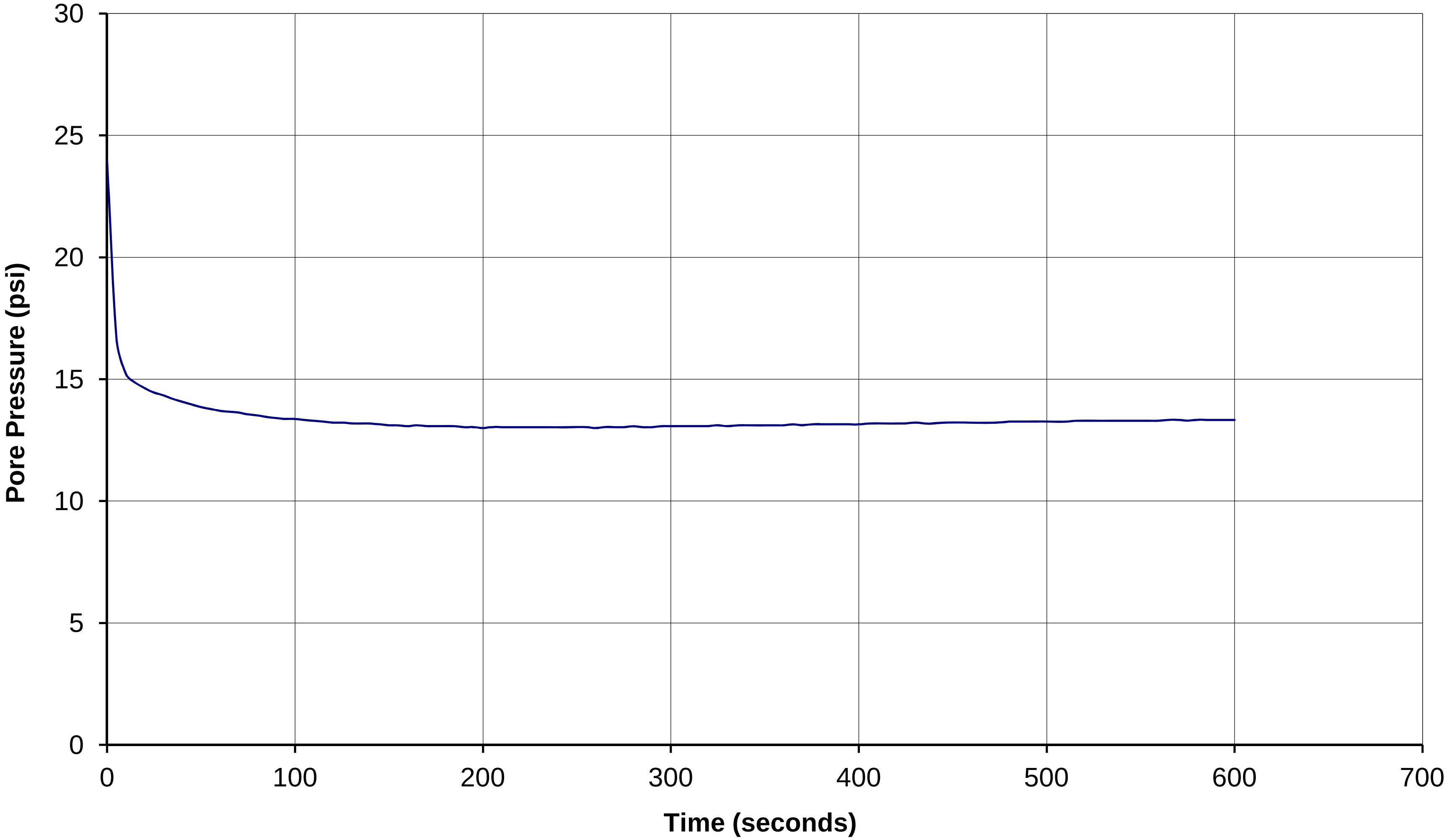
Sounding: PI-6PPD
Depth: 16.076067
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

Sounding: PI-6
Depth: 36.745296
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE

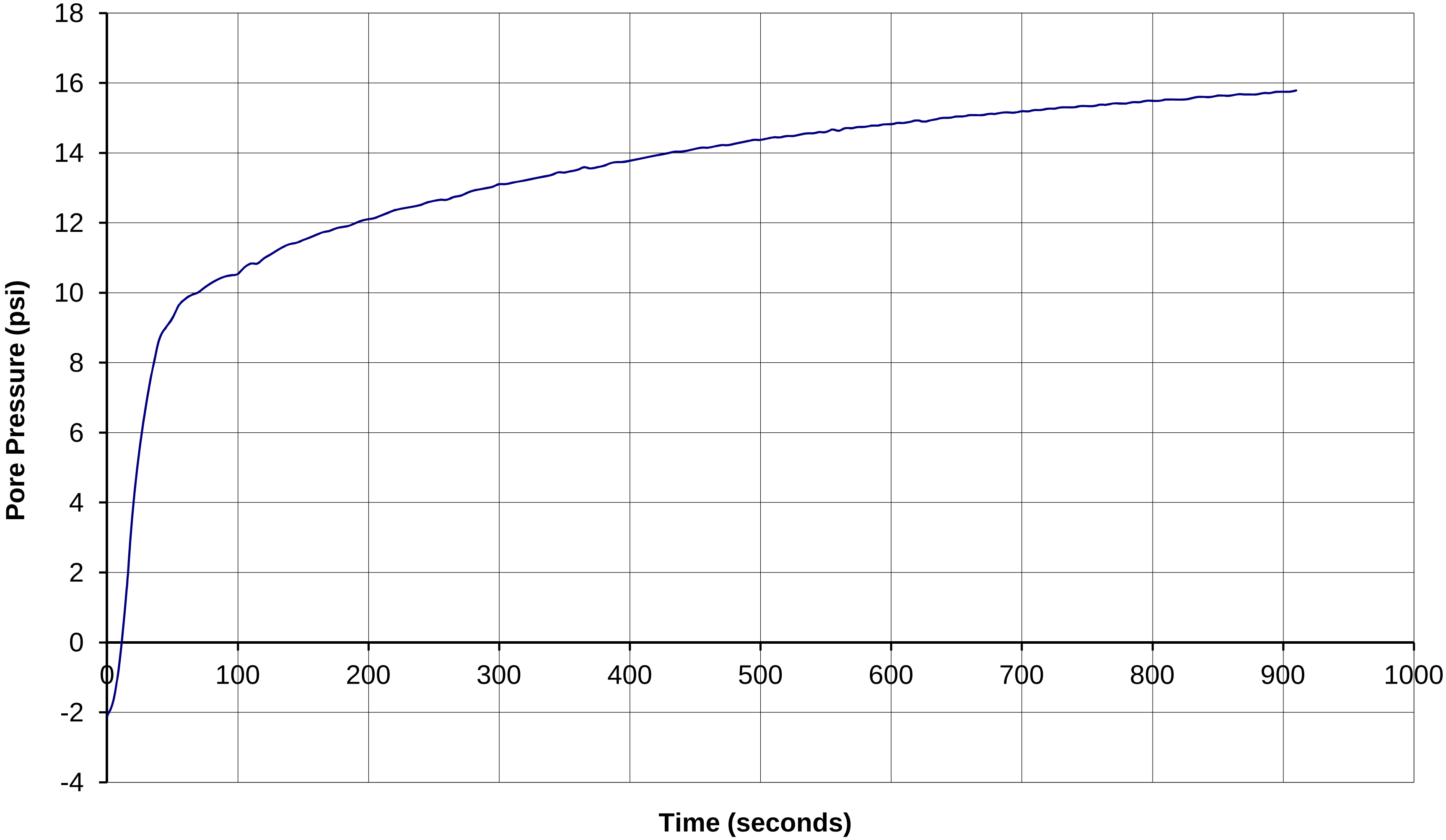


GREGG

# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

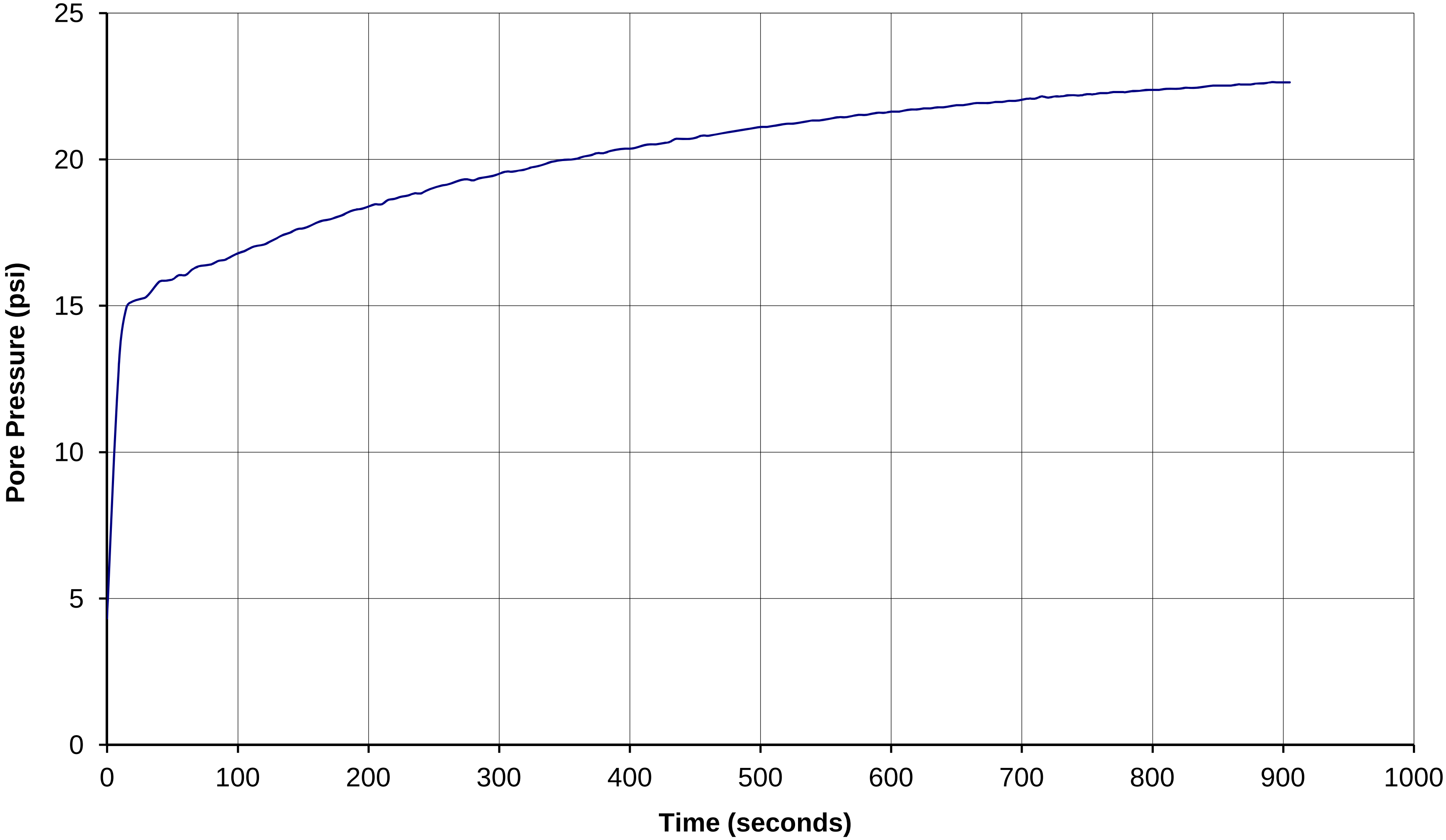
Sounding: PI-6
Depth: 44.4552465
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

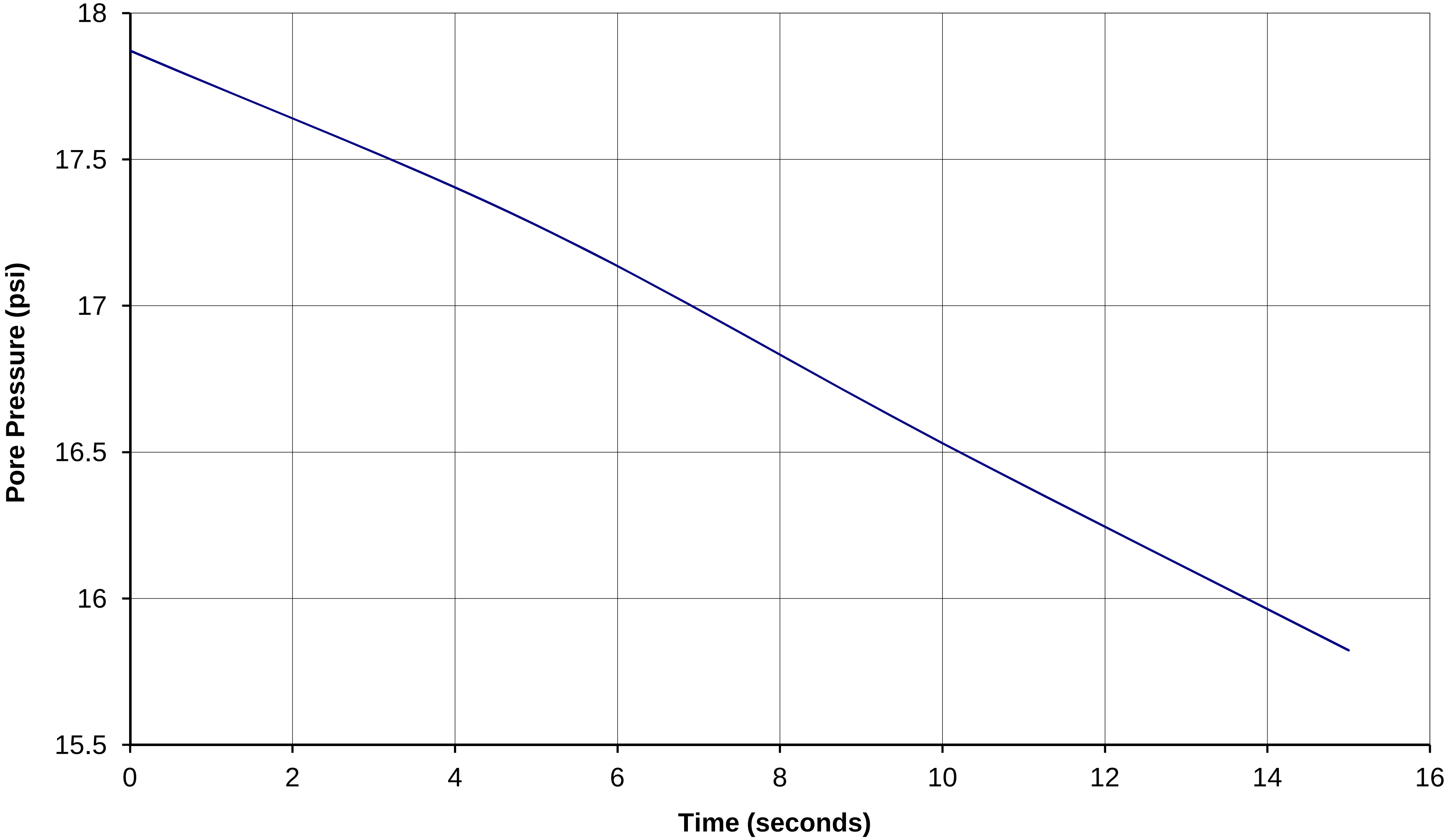
Sounding: PI-6
Depth: 60.039189
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

Sounding: PI-7PPD
Depth: 13.2873615
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE

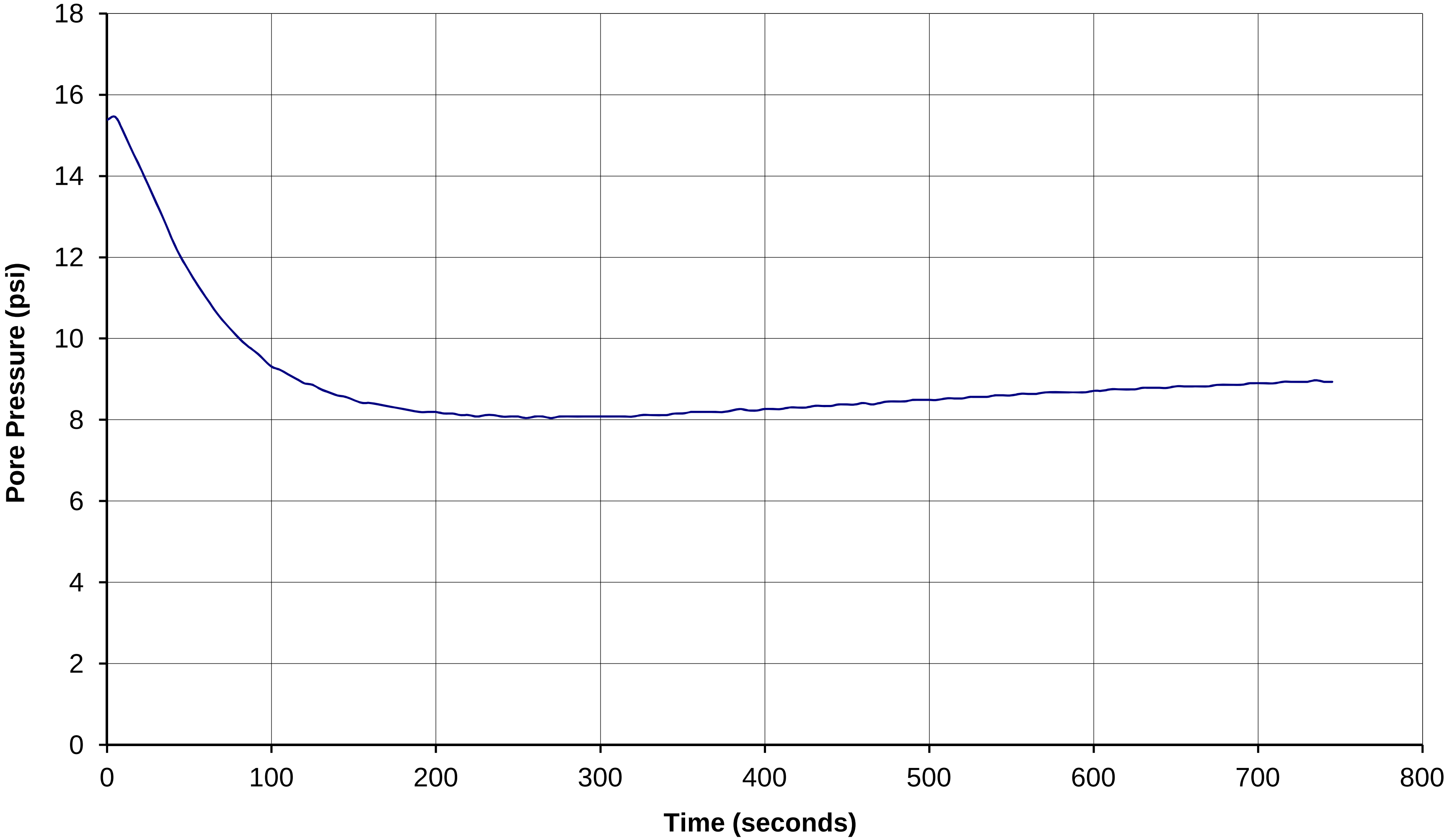


GREGG

# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

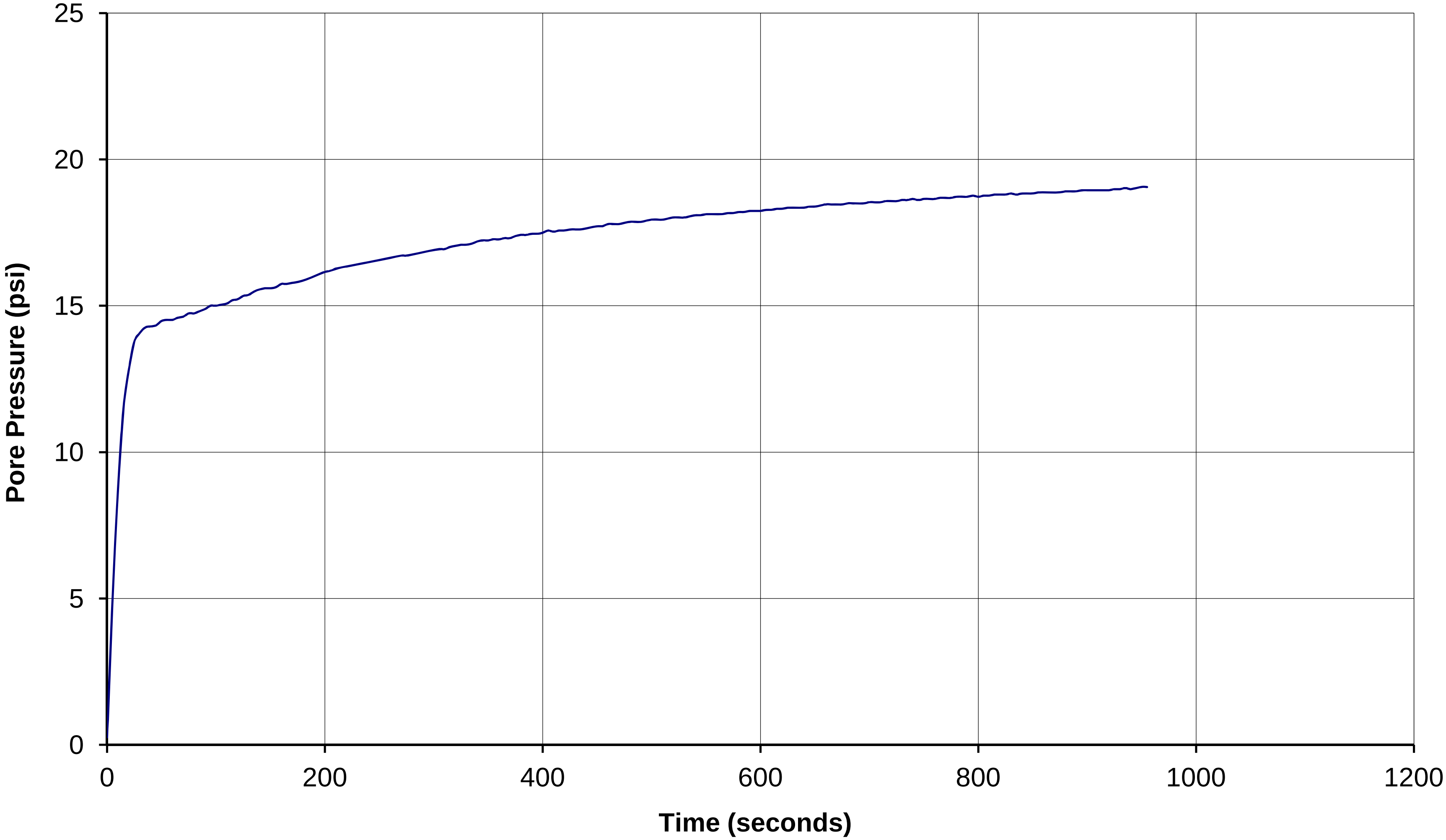
Sounding: PI-7PPD
Depth: 13.451403
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

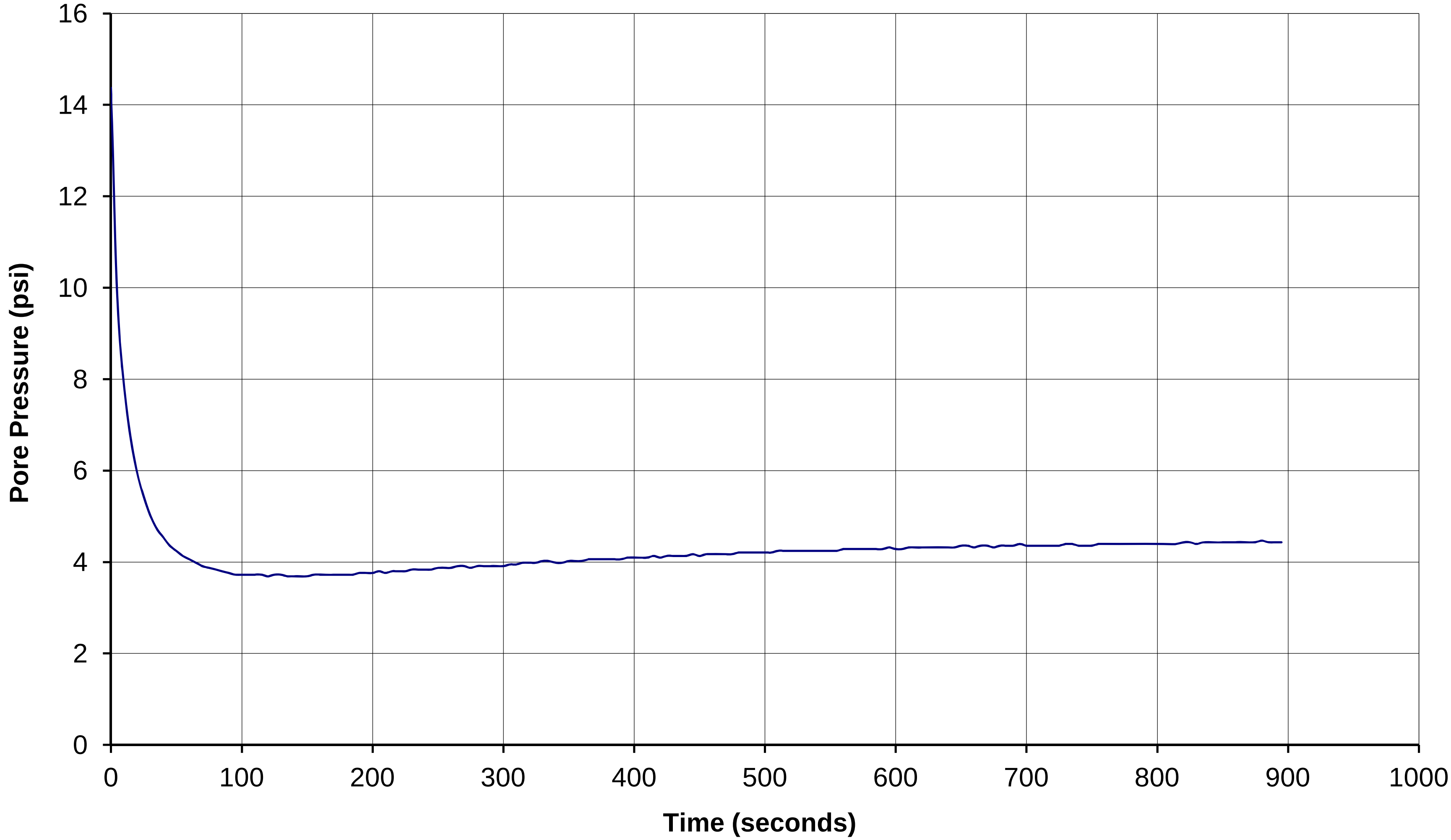
Sounding: PI-7PPD
Depth: 44.1271635
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

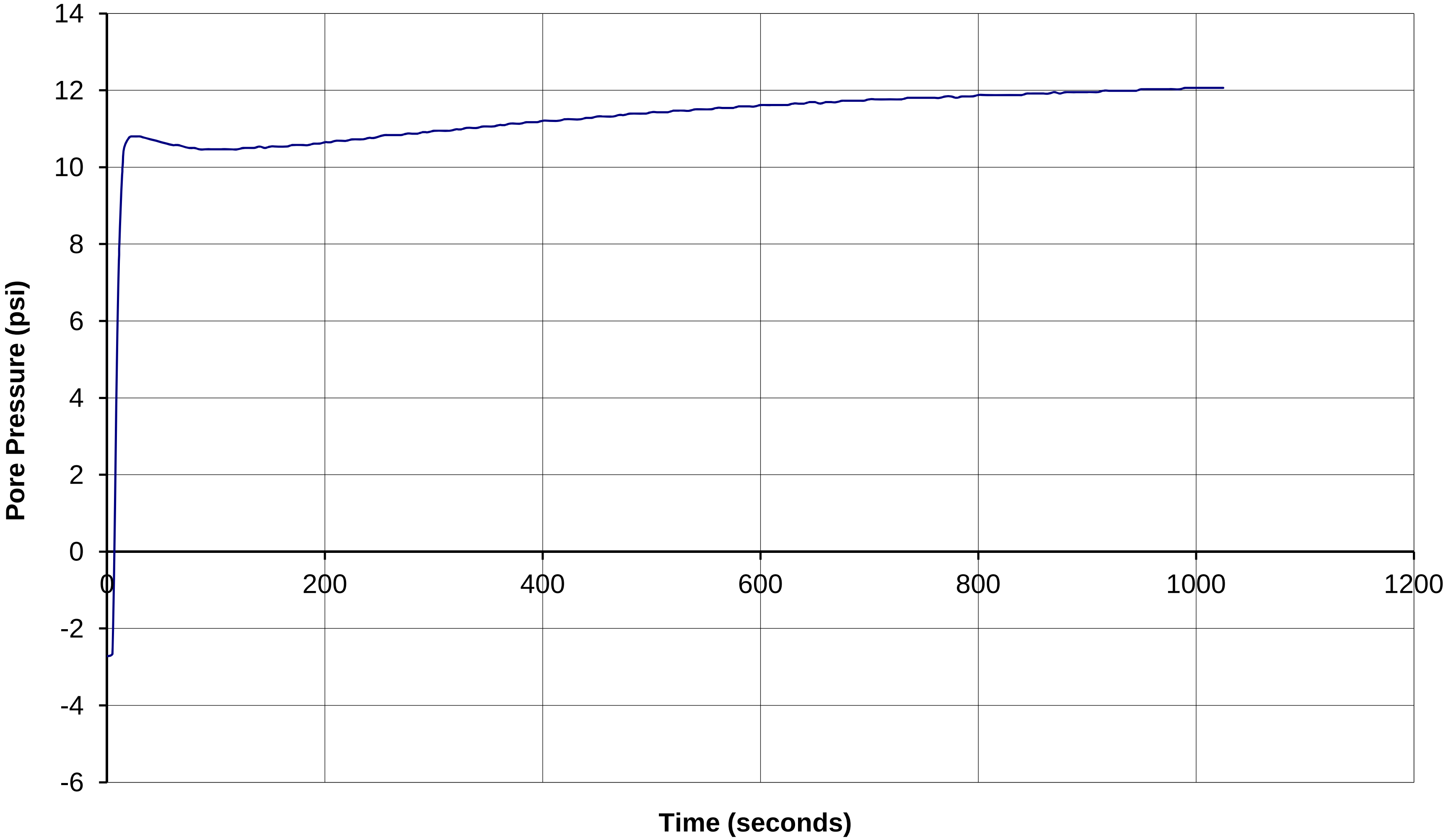
Sounding: PI-8 PPD
Depth: 16.076067
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

Sounding: PI-8
Depth: 37.401462
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE

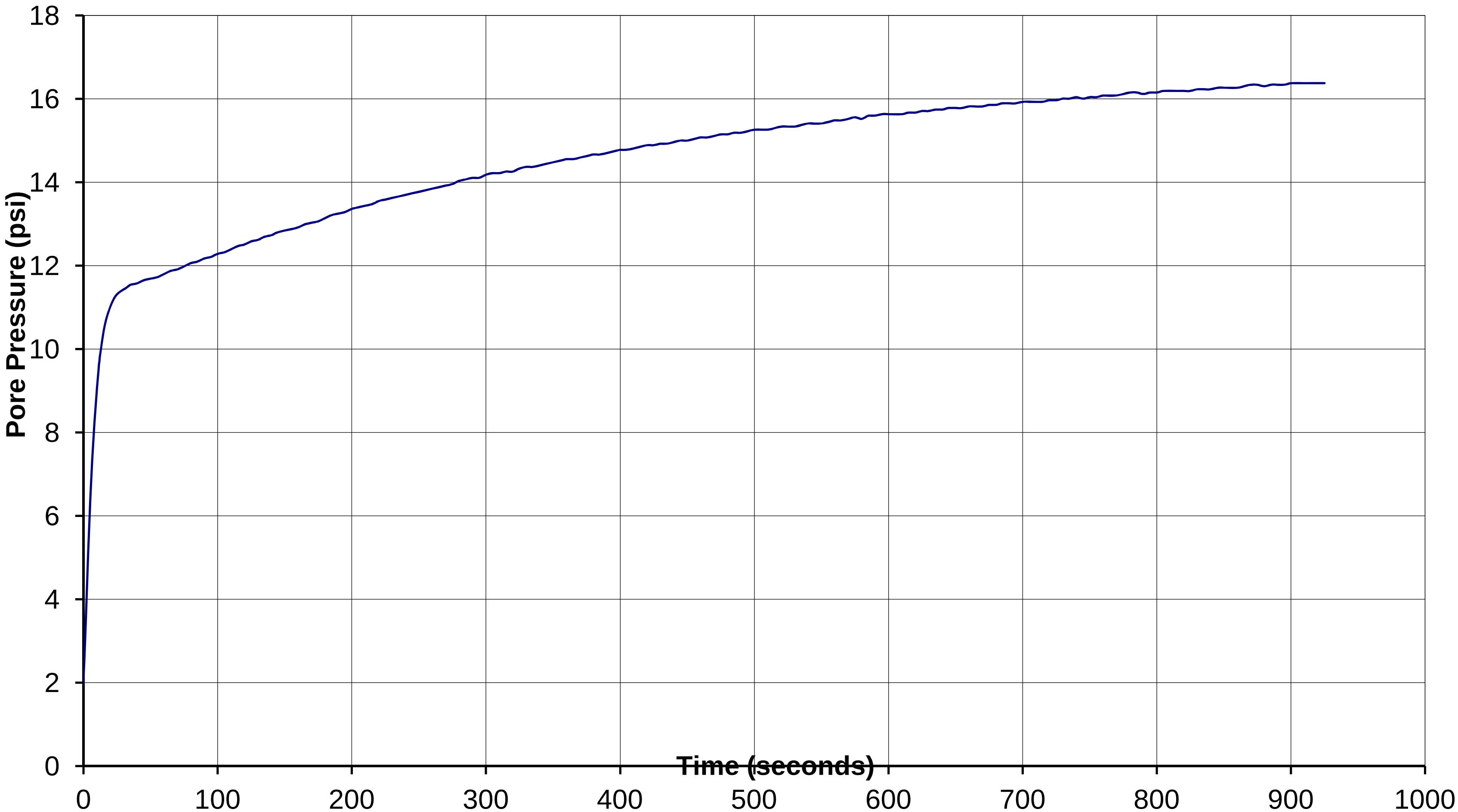


GREGG

# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

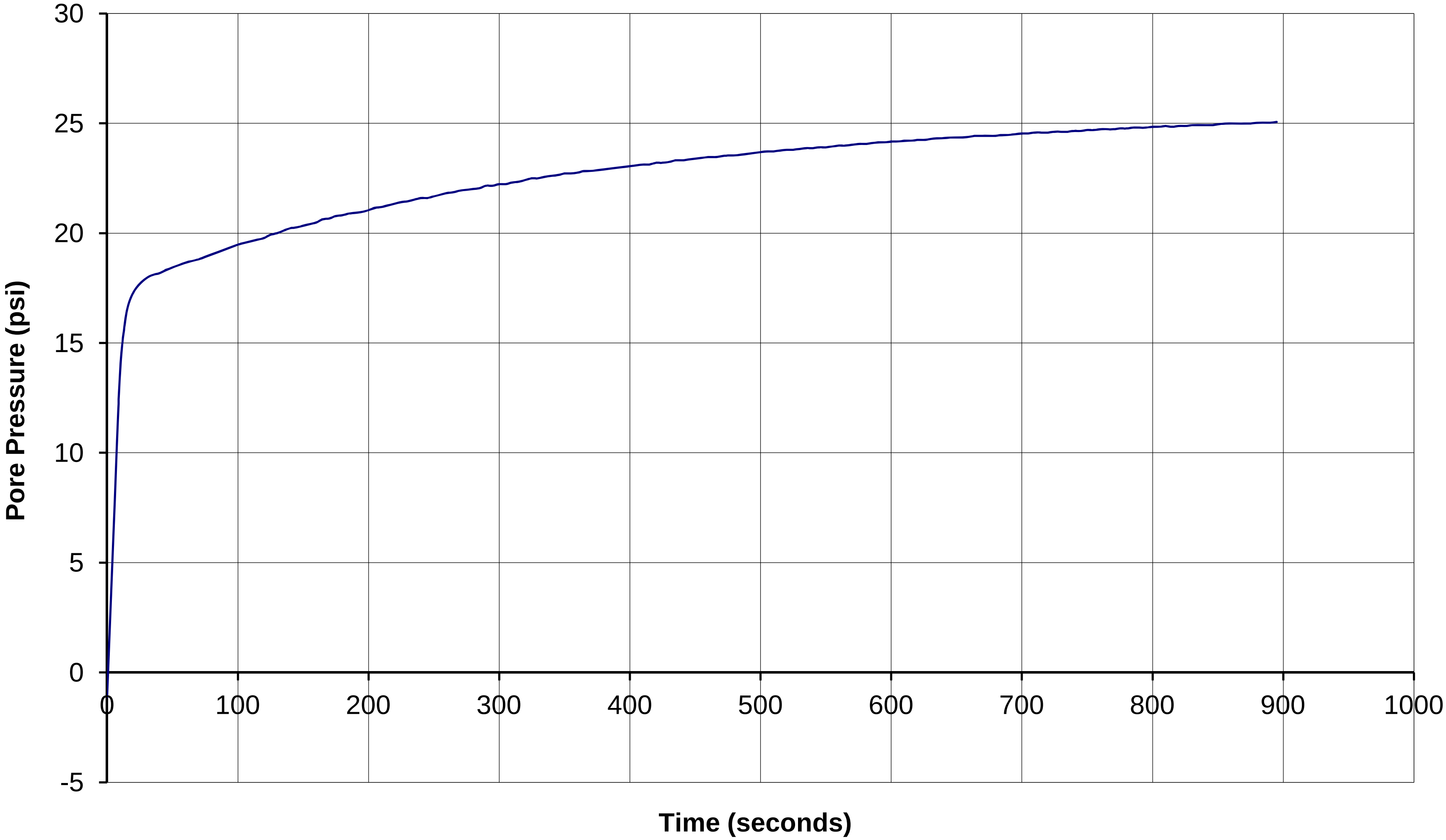
Sounding: PI-8
Depth: 50.0326575
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

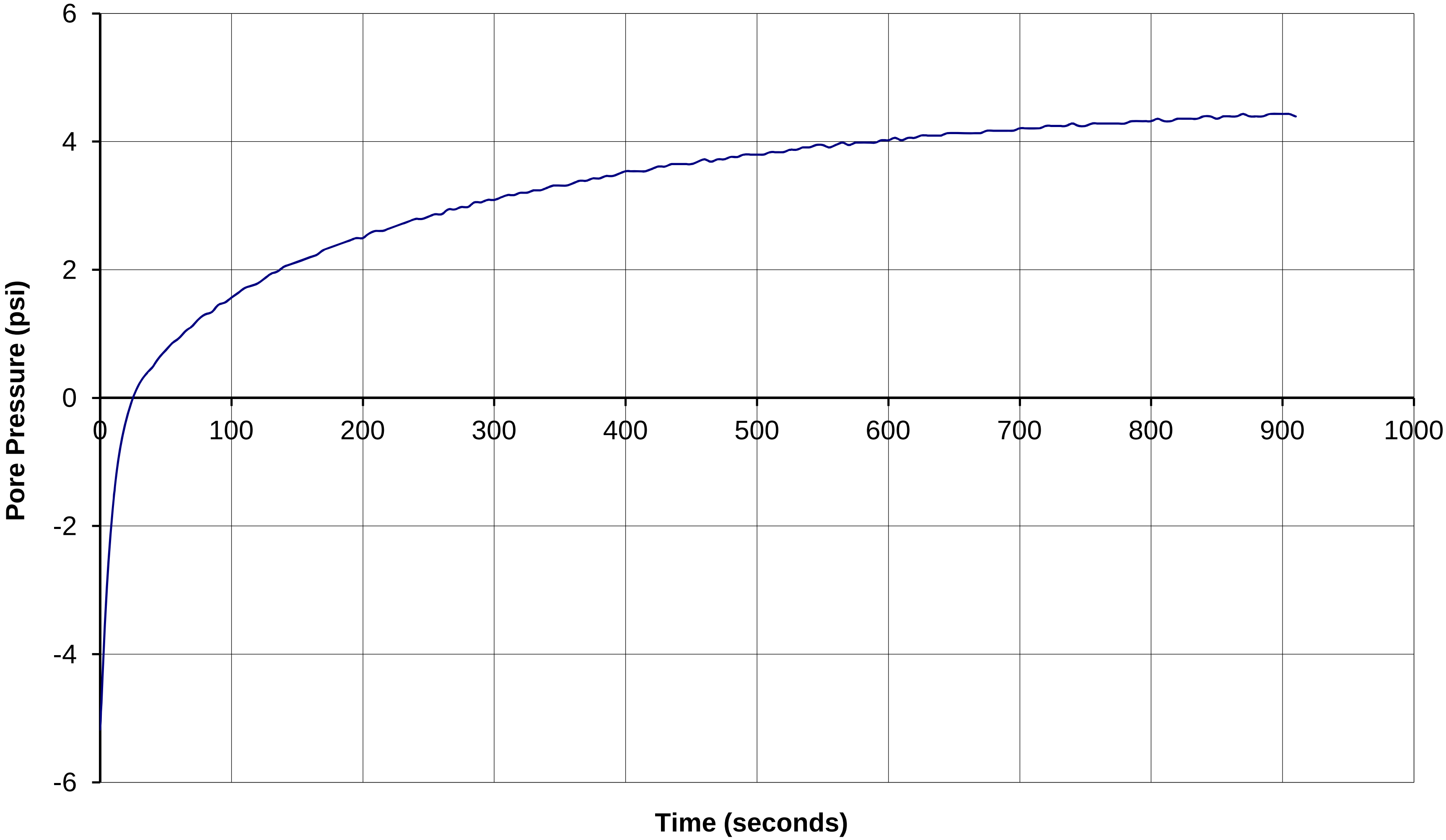
Sounding: PI-8
Depth: 70.0457205
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

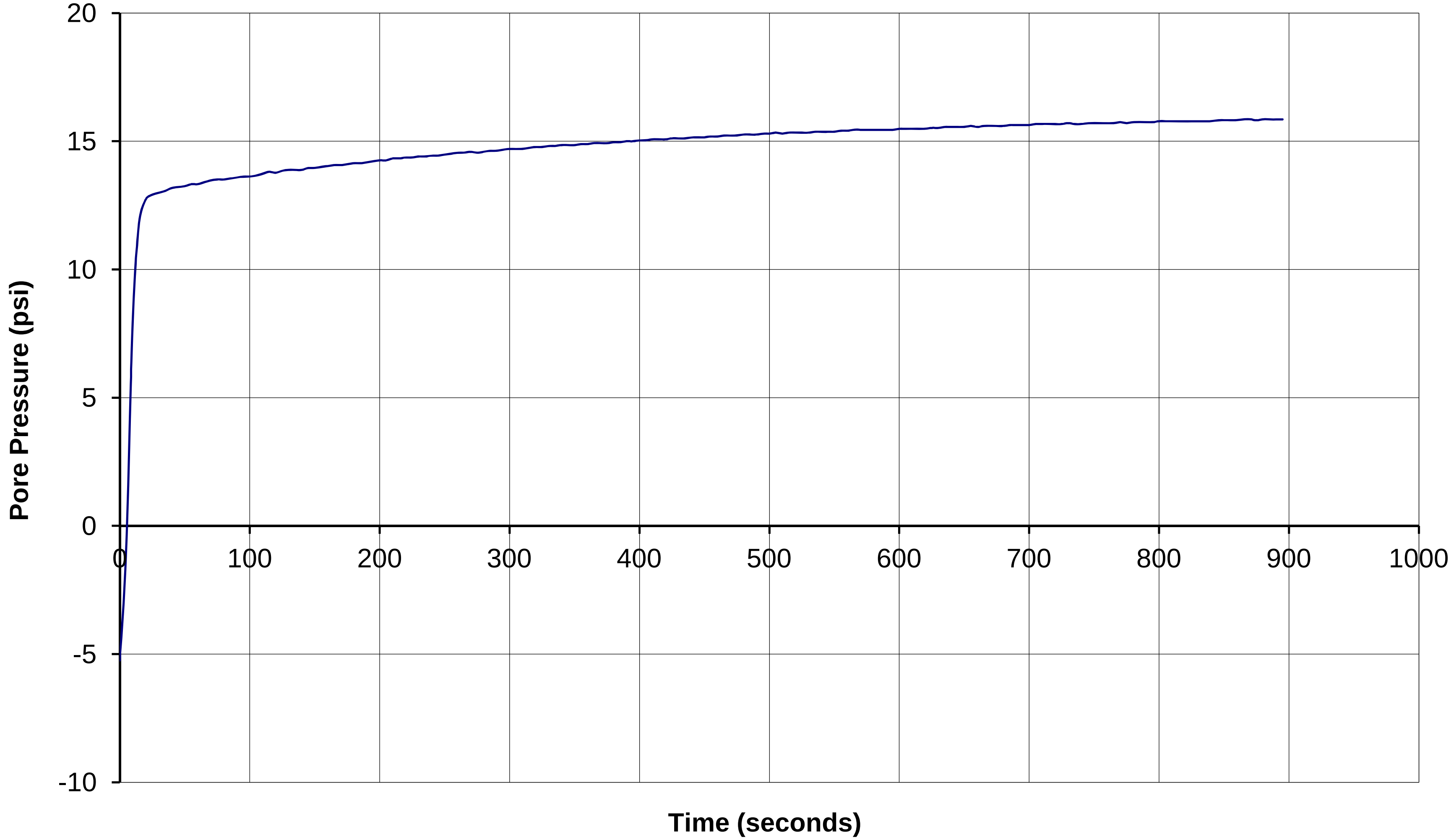
Sounding: PI-9
Depth: 14.107569
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

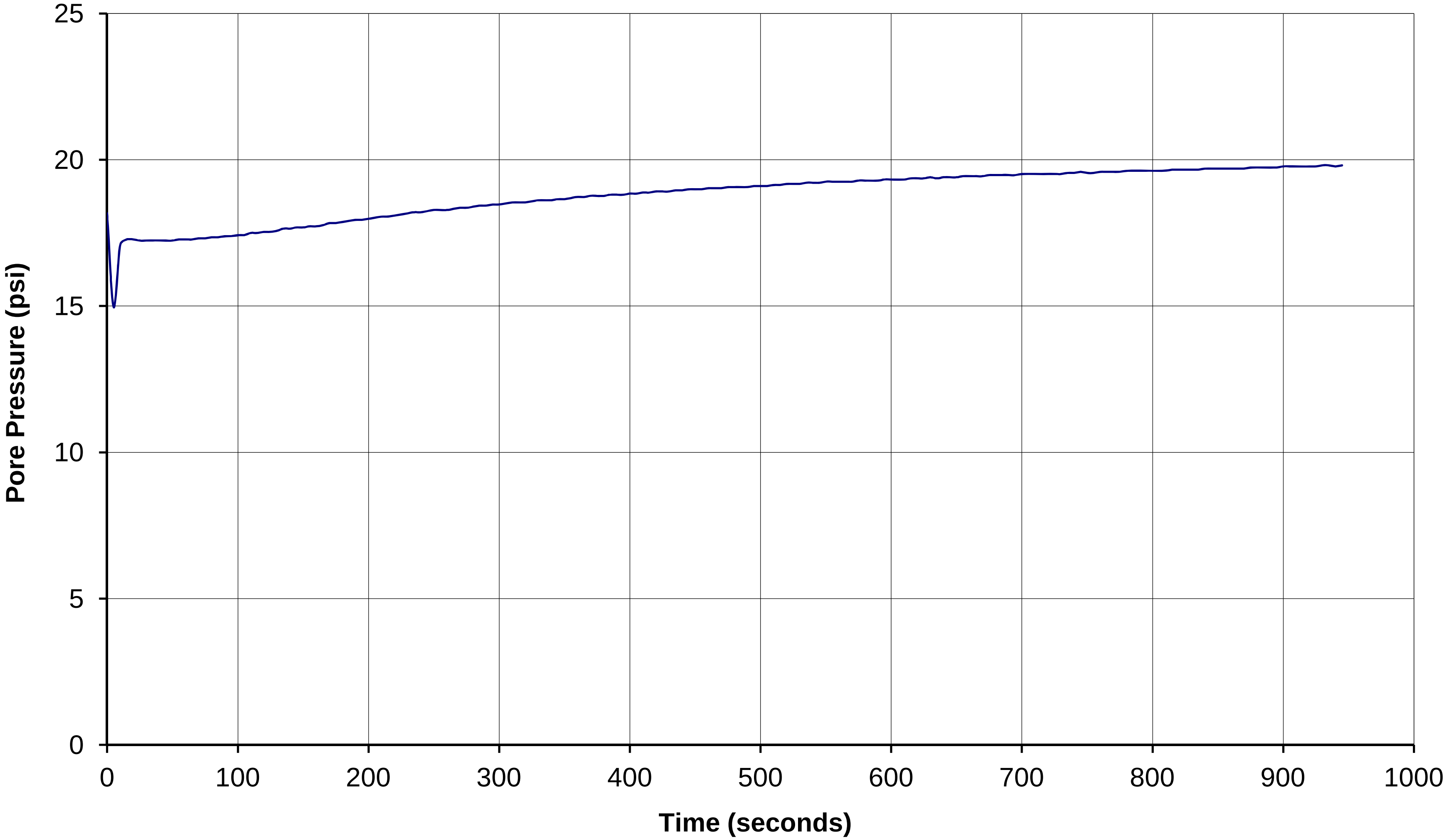
Sounding: PI-9
Depth: 41.010375
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

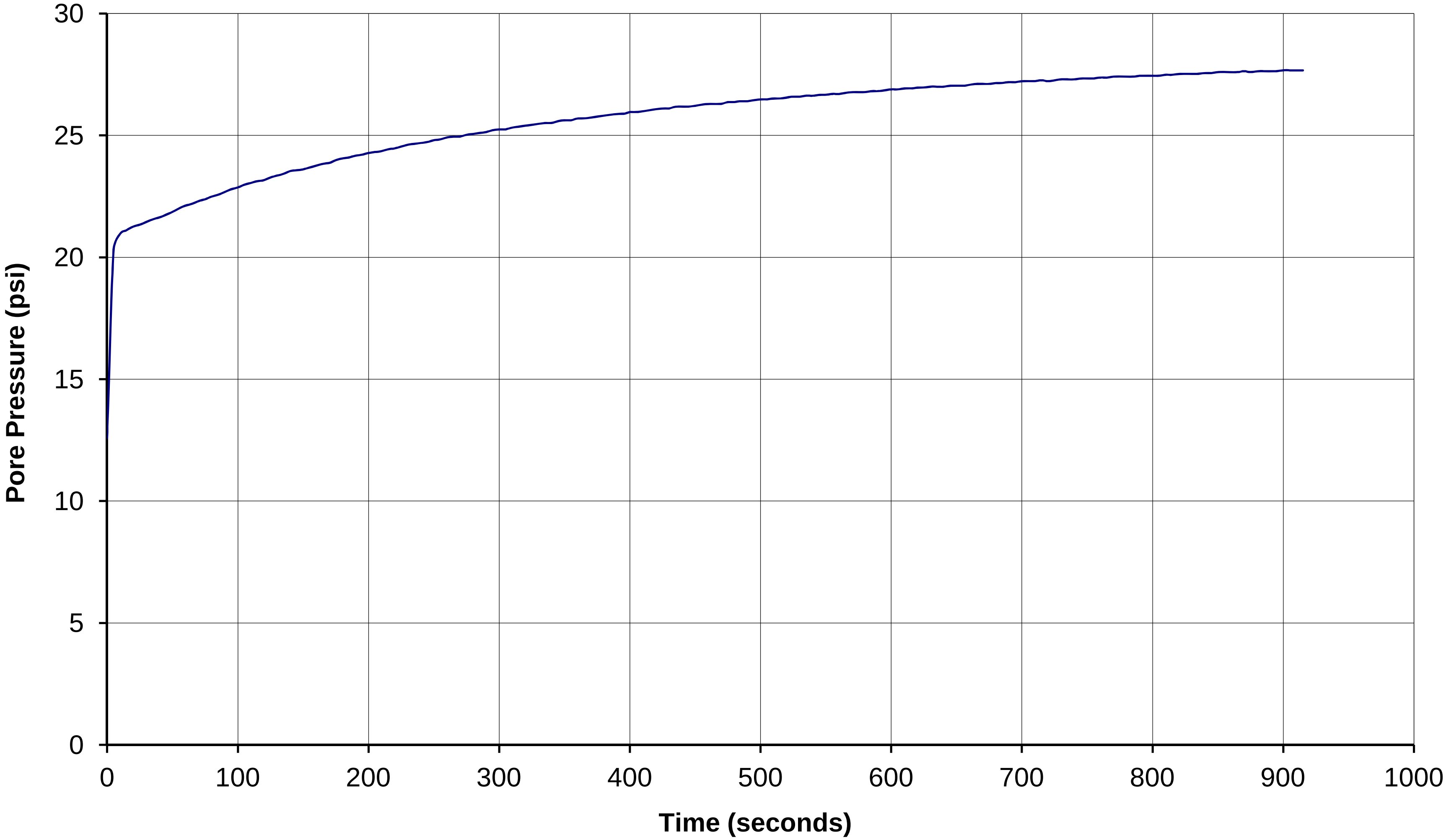
Sounding: PI-9
Depth: 50.0326575
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

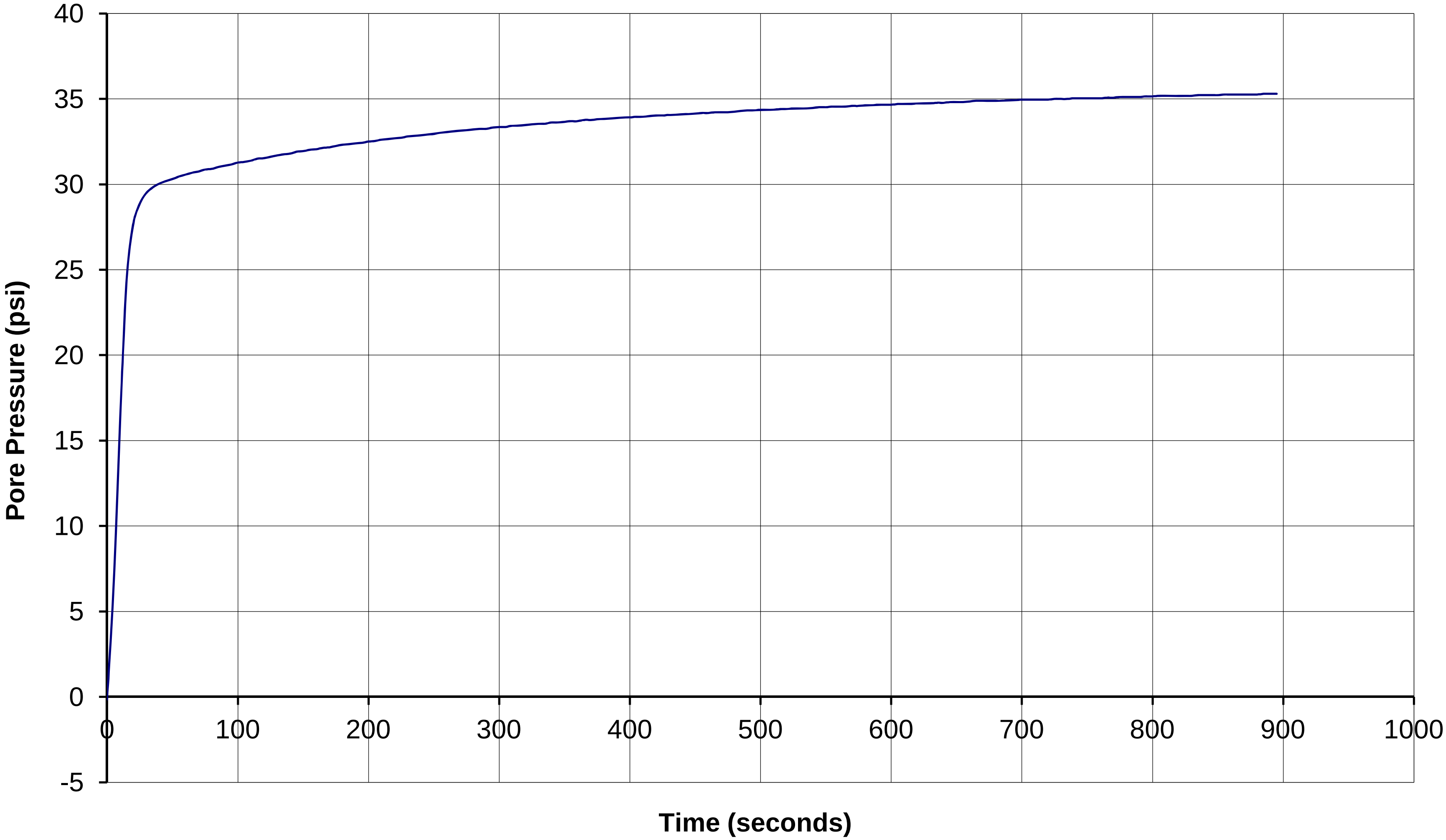
Sounding: PI-9
Depth: 70.0457205
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

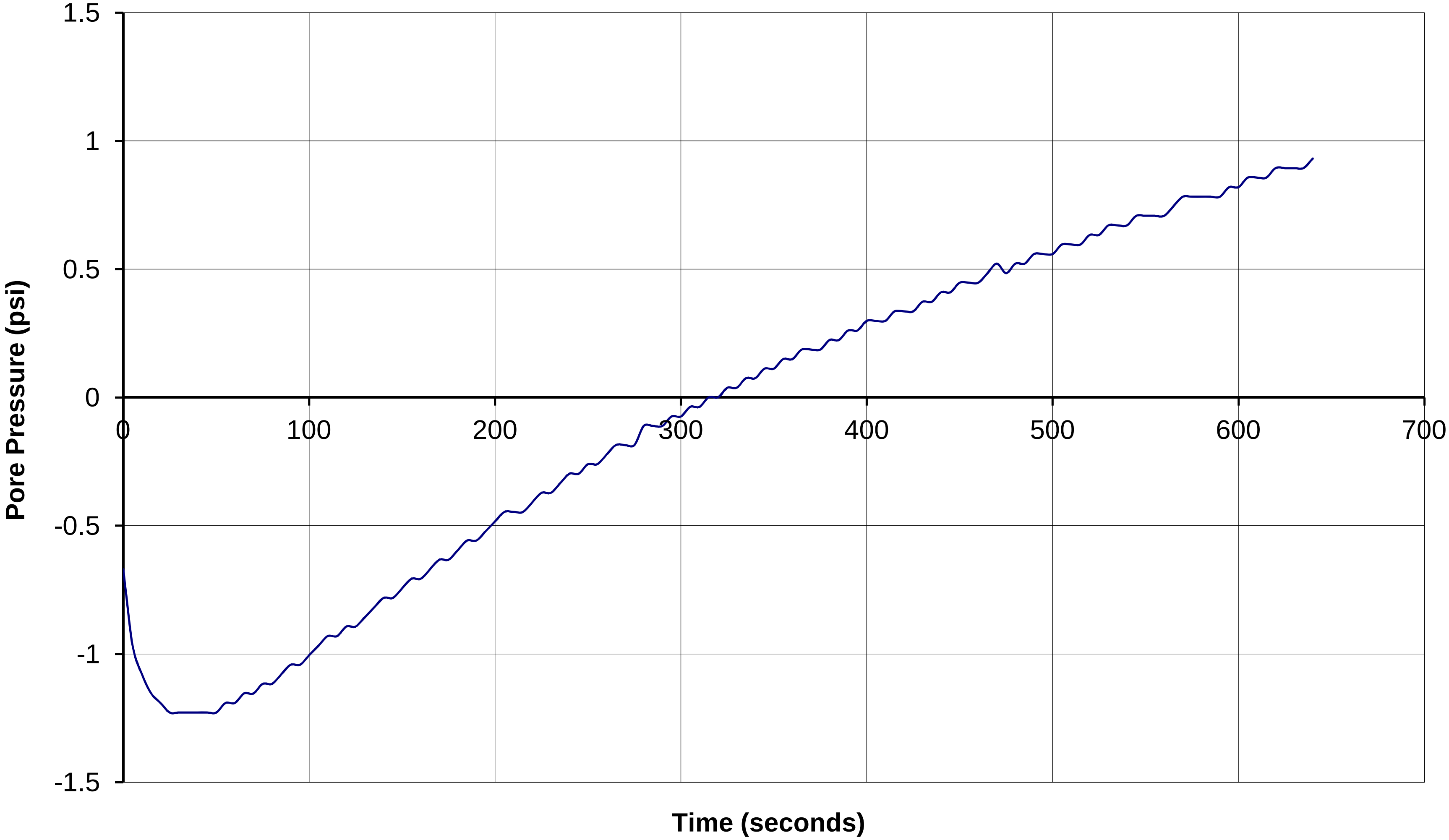
Sounding: PI-9
Depth: 89.238576
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

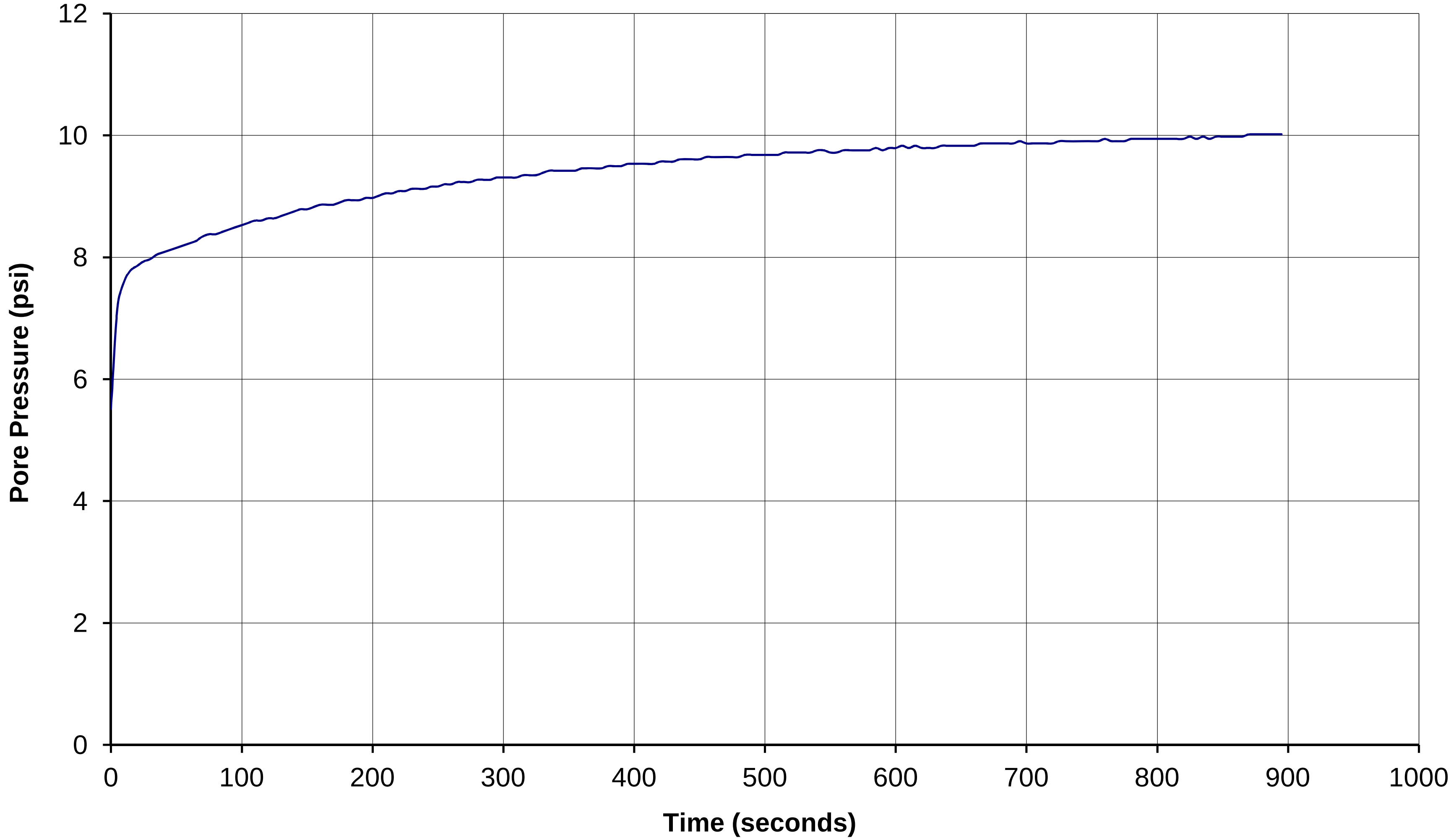
Sounding: PI-10
Depth: 8.3661165
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

Sounding: PI-10
Depth: 20.5051875
Site: PROSPECT ISLAND
Engineer: M.SOUVERVILLE



GREGG DRILLING & TESTING, INC.
GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

August 2, 2012

DWR
Attn: Mark Souverville

Subject: CPT Site Investigation
Ryer Island
California
GREGG Project Number: 12-040MA

Dear Mr. Souverville:

The following report presents the results of GREGG Drilling & Testing's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

| | | | |
|---|---|---|---|
| 1 | Cone Penetration Tests | (CPTU) | ☒ |
| 2 | Pore Pressure Dissipation Tests | (PPD) | ☒ |
| 3 | Seismic Cone Penetration Tests | (SCPTU) | ☐ |
| 4 | UVOST Laser Induced Fluorescence | (UVOST) | ☐ |
| 5 | Groundwater Sampling | (GWS) | ☐ |
| 6 | Soil Sampling | (SS) | ☒ |
| 7 | Vapor Sampling | (VS) | ☐ |
| 8 | Pressuremeter Testing | (PMT) | ☐ |
| 9 | Vane Shear Testing | (VST) | ☐ |
| 10 | Dilatometer Testing | (DMT) | ☐ |

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (925) 313-5800.

Sincerely,
GREGG Drilling & Testing, Inc.

Mary Walden

Mary Walden
Operations Manager

Cone Penetration Test Sounding Summary

-Table 1-

| CPT Sounding Identification | Date | Termination Depth (Feet) | Depth of Groundwater Samples (Feet) | Depth of Soil Samples (Feet) | Depth of Pore Pressure Dissipation Tests (Feet) |
|---|---|---|---|---|---|
| RI-2 | 3/15/12 | 110 | - | 37, 58 | 52.0, 76.0 |
| RI-4 | 3/13/12 | 85 | - | 13, 25, 35, 52 | 25.9, 37.9 |
| RIS-4 | 3/13/12 | 85 | - | 10, 20, 35 | 17.1 |
| RI-5 | 3/21/12 | 91 | - | 12, 25, 36, 60, 81 | 11.8, 24.9, 40.4, 79.9, 90.1 |
| RIS-5 | 3/22/12 | 85 | - | 12, 19, 31, 42 | 12.1, 19.0, 35.1, 43.8, 70.2 |
| RI-3 | 3/27/12 | 95 | - | 18, 37, 50, 85, 90 | 13.6, 38.1, 50.0, 87.1 |
| RIS-1 | 3/28/12 | 85 | - | 12, 39 | 10.2, 32.8, 50.0 |
| RIS-6 | 3/26/12 | 85 | - | 10, 26, 35 | 12.8, 25.6, 35.8, 77.4 |
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# Bibliography

Lunne, T., Robertson, P.K. and Powell, J.J.M., "Cone Penetration Testing in Geotechnical Practice" E & FN Spon. ISBN 0 419 23750, 1997

Roberston, P.K., "Soil Classification using the Cone Penetration Test", Canadian Geotechnical Journal, Vol. 27, 1990 pp. 151-158.

Mayne, P.W., "NHI (2002) Manual on Subsurface Investigations: Geotechnical Site Characterization", available through www.ce.gatech.edu/~geosys/Faculty/Mayne/papers/index.html, Section 5.3, pp. 107-112.

Robertson, P.K., R.G. Campanella, D. Gillespie and A. Rice, "Seismic CPT to Measure In-Situ Shear Wave Velocity", Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8, 1986 pp. 791-803.

Robertson, P.K., Sully, J., Woeller, D.J., Lunne, T., Powell, J.J.M., and Gillespie, D.J., "Guidelines for Estimating Consolidation Parameters in Soils from Piezocone Tests", Canadian Geotechnical Journal, Vol. 29, No. 4, August 1992, pp. 539-550.

Robertson, P.K., T. Lunne and J.J.M. Powell, "Geo-Environmental Application of Penetration Testing", Geotechnical Site Characterization, Robertson & Mayne (editors), 1998 Balkema, Rotterdam, ISBN 90 5410 939 4 pp 35-47.

Campanella, R.G. and I. Weemees, "Development and Use of An Electrical Resistivity Cone for Groundwater Contamination Studies", Canadian Geotechnical Journal, Vol. 27 No. 5, 1990 pp. 557-567.

DeGroot, D.J. and A.J. Lutenegger, "Reliability of Soil Gas Sampling and Characterization Techniques", International Site Characterization Conference - Atlanta, 1998.

Woeller, D.J., P.K. Robertson, T.J. Boyd and Dave Thomas, "Detection of Polyaromatic Hydrocarbon Contaminants Using the UVIF-CPT", 53rd Canadian Geotechnical Conference Montreal, QC October pp. 733-739, 2000.

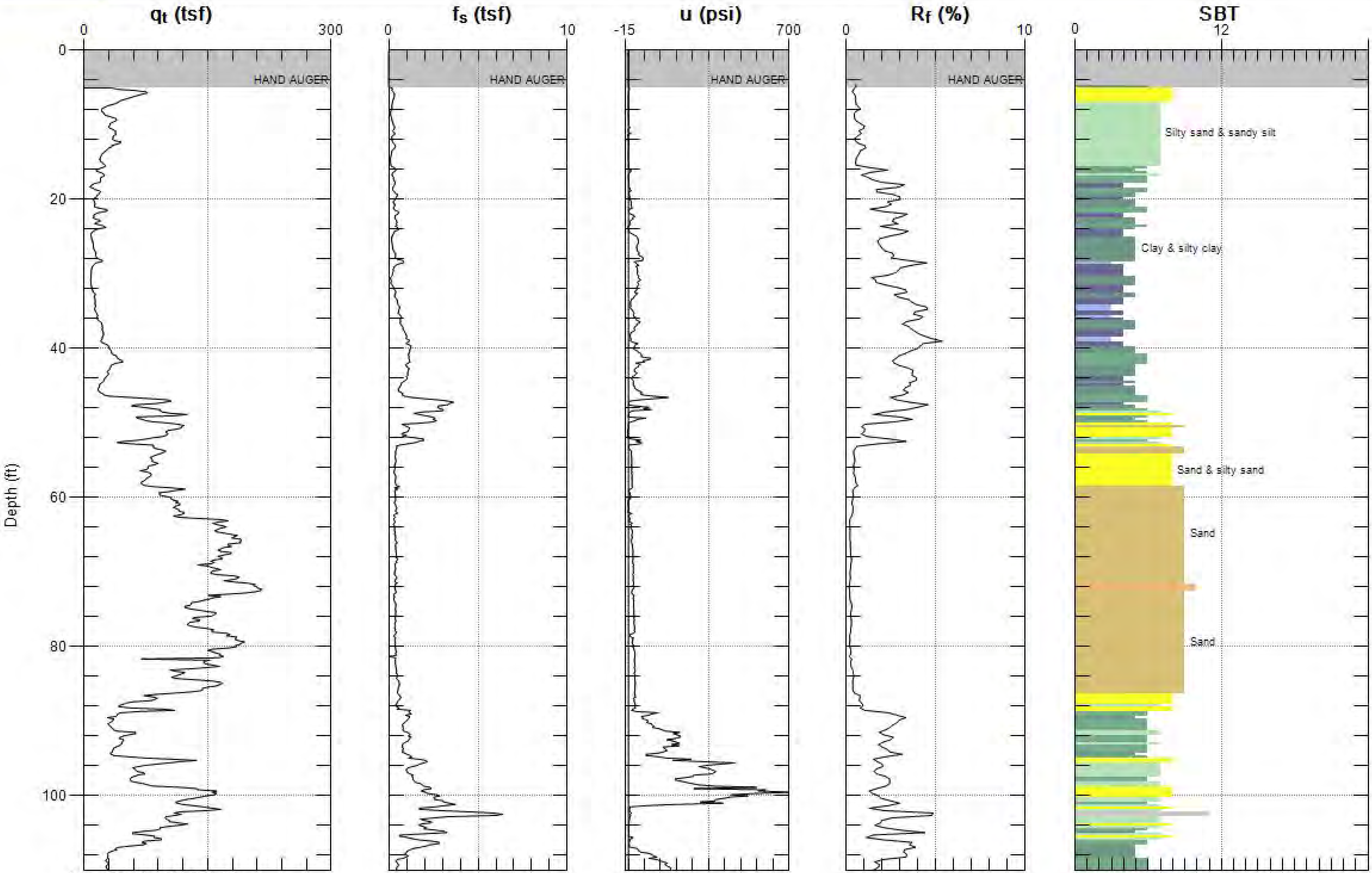
Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, "Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers" BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

GREGG DWR

Site: RYER ISLAND
Sounding: RI-2

Engineer: M.SOUVERVILLE
Date: 3/15/2012 09:17




Max. Depth: 110.564 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

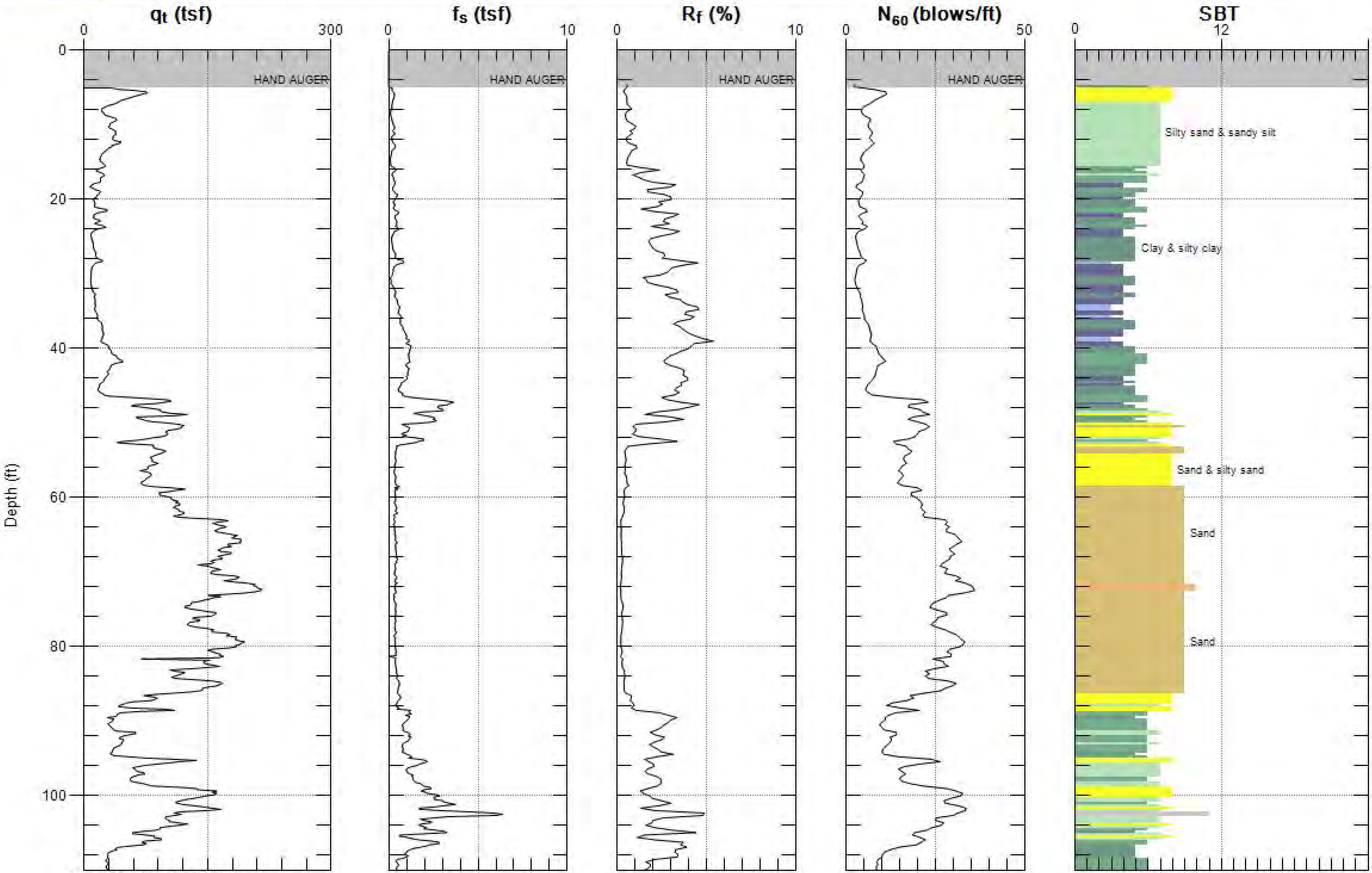
**DWR**

Site: RYER ISLAND

Sounding: RI-2

Engineer: M.SOUVERVILLE

Date: 3/15/2012 09:17



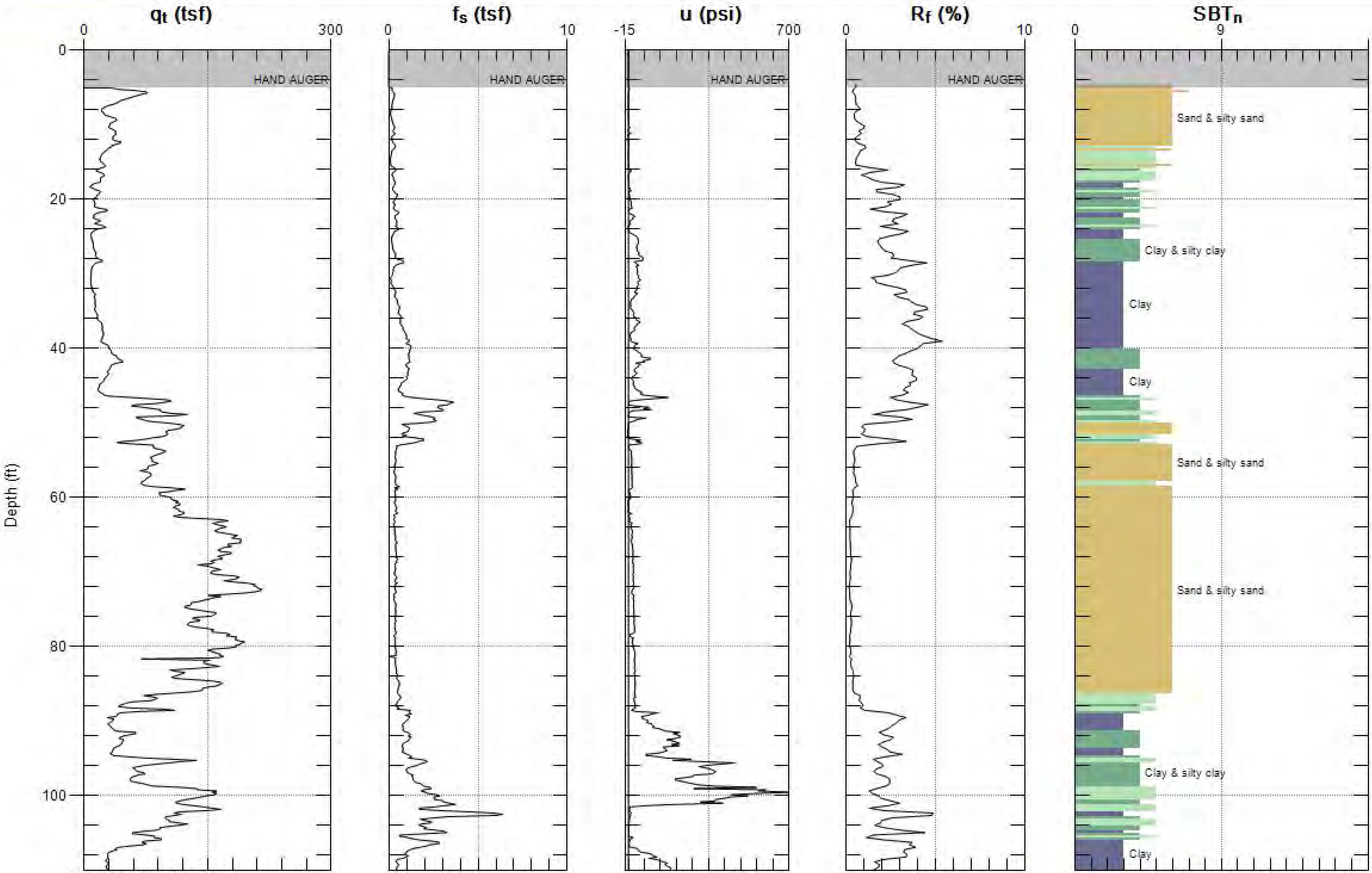

Max. Depth: 110.564 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**DWR**

**Site: RYER ISLAND**
**Sounding: RI-2**

**Engineer: M.SOUVERVILLE**
**Date: 3/15/2012 09:17**




Max. Depth: 110.564 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

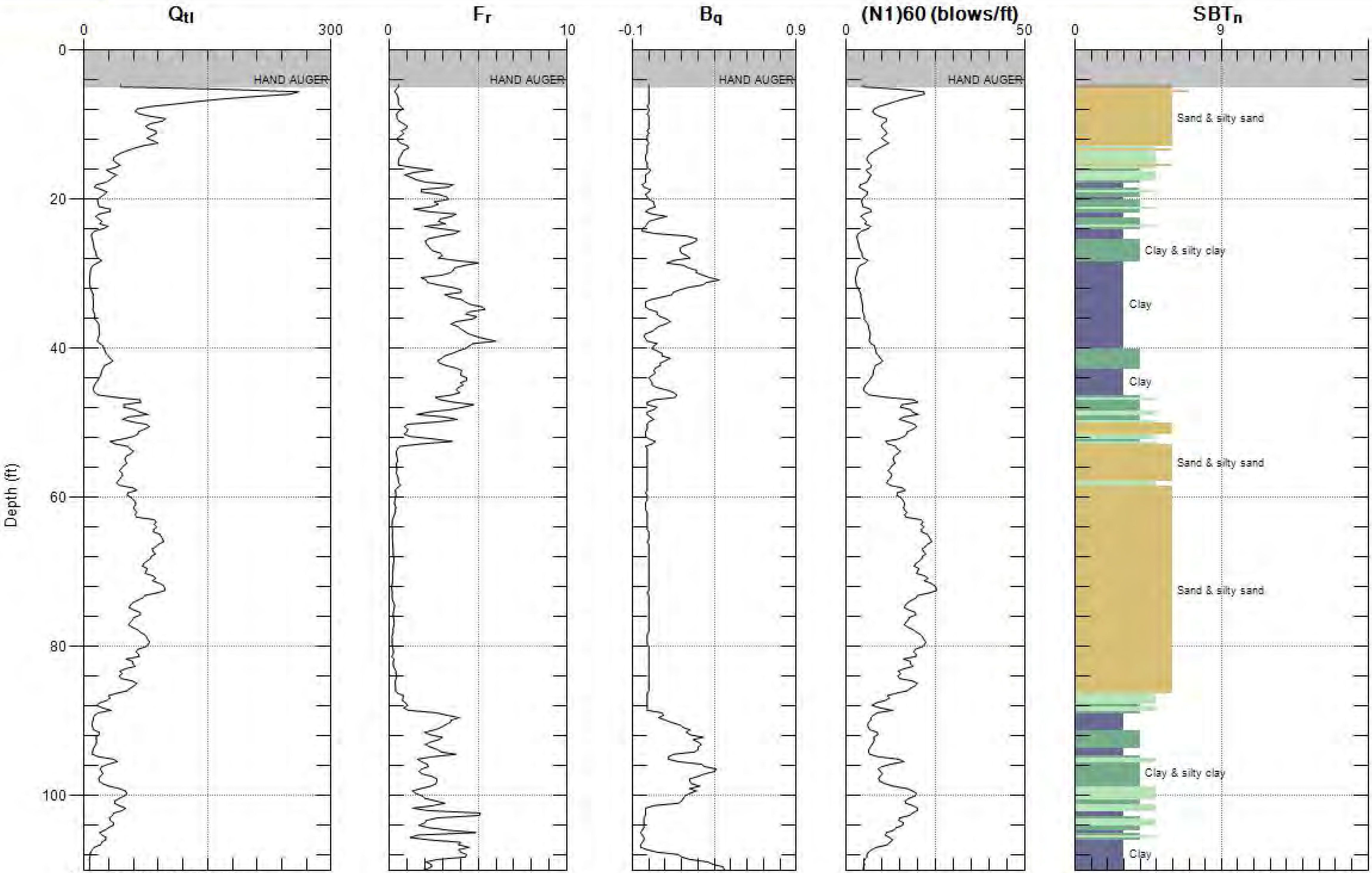
DWR

Site: RYER ISLAND

Sounding: RI-2

Engineer: M.SOUVERVILLE

Date: 3/15/2012 09:17




Max. Depth: 110.564 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

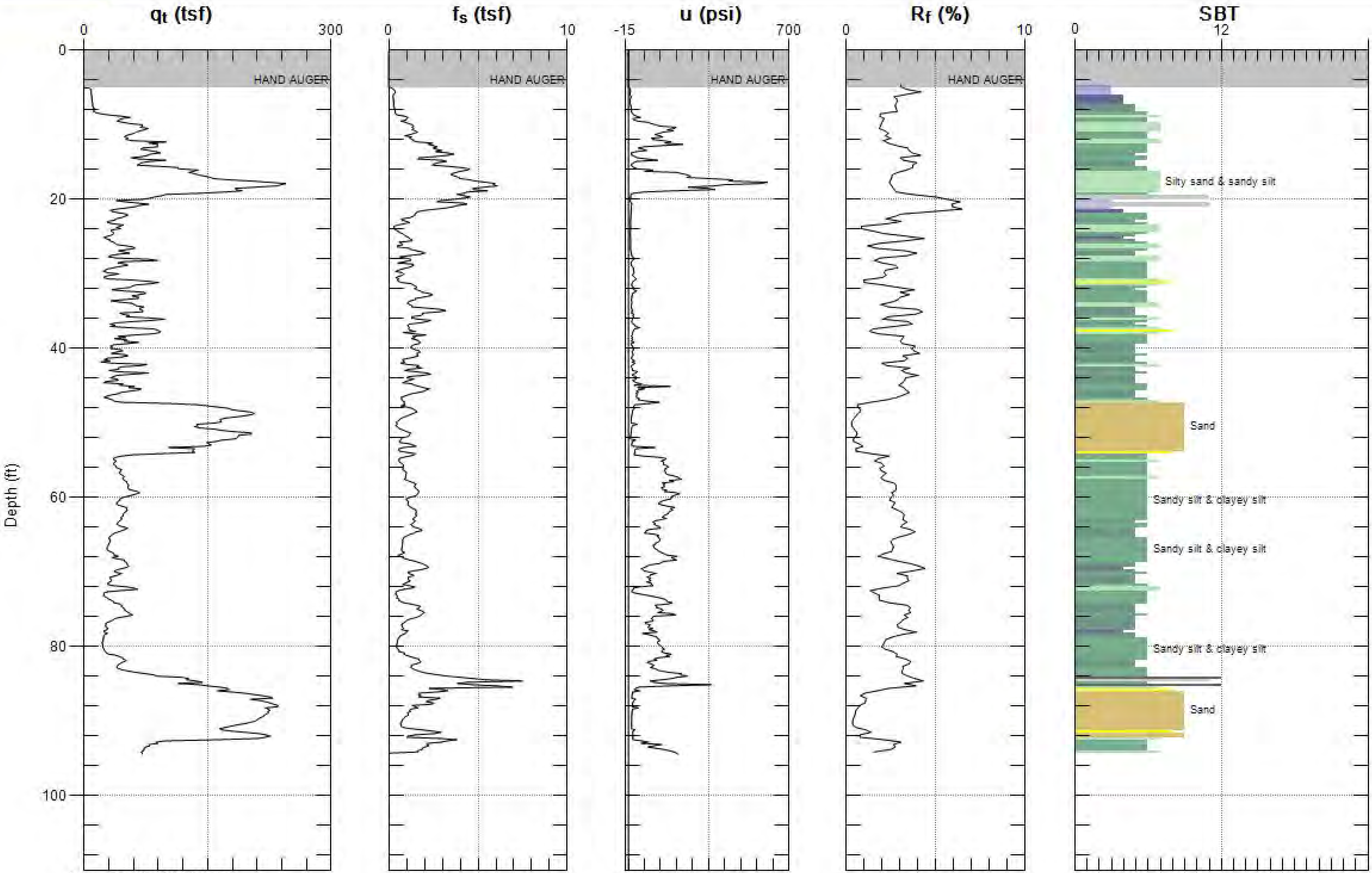
DWR

Site: RYER ISLAND

Sounding: RI-3

Engineer: M.SOUVERVILLE

Date: 3/27/2012 10:18




Max. Depth: 94.488 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

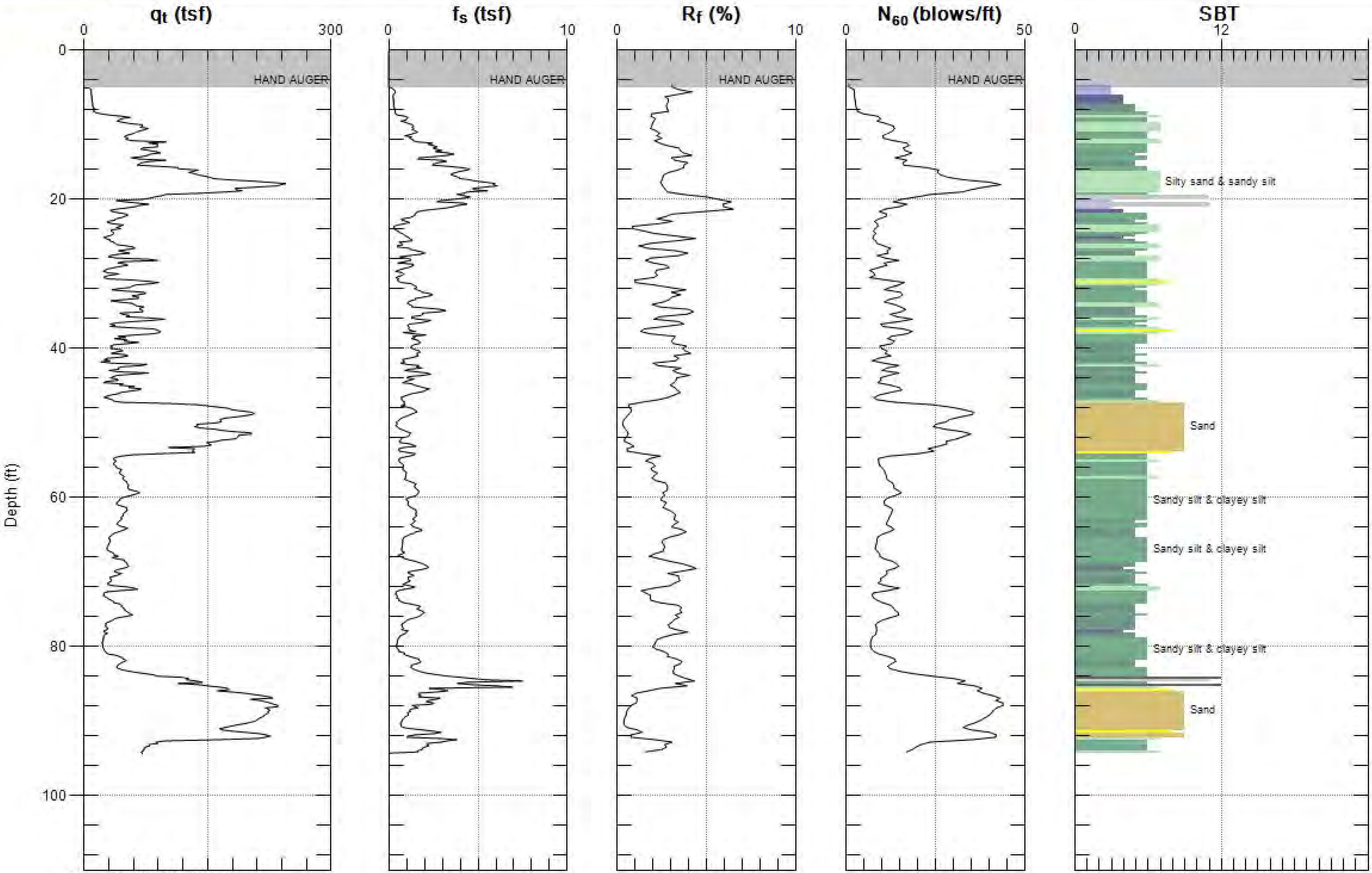
DWR

Site: RYER ISLAND

Sounding: RI-3

Engineer: M.SOUVERVILLE

Date: 3/27/2012 10:18




Max. Depth: 94.488 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

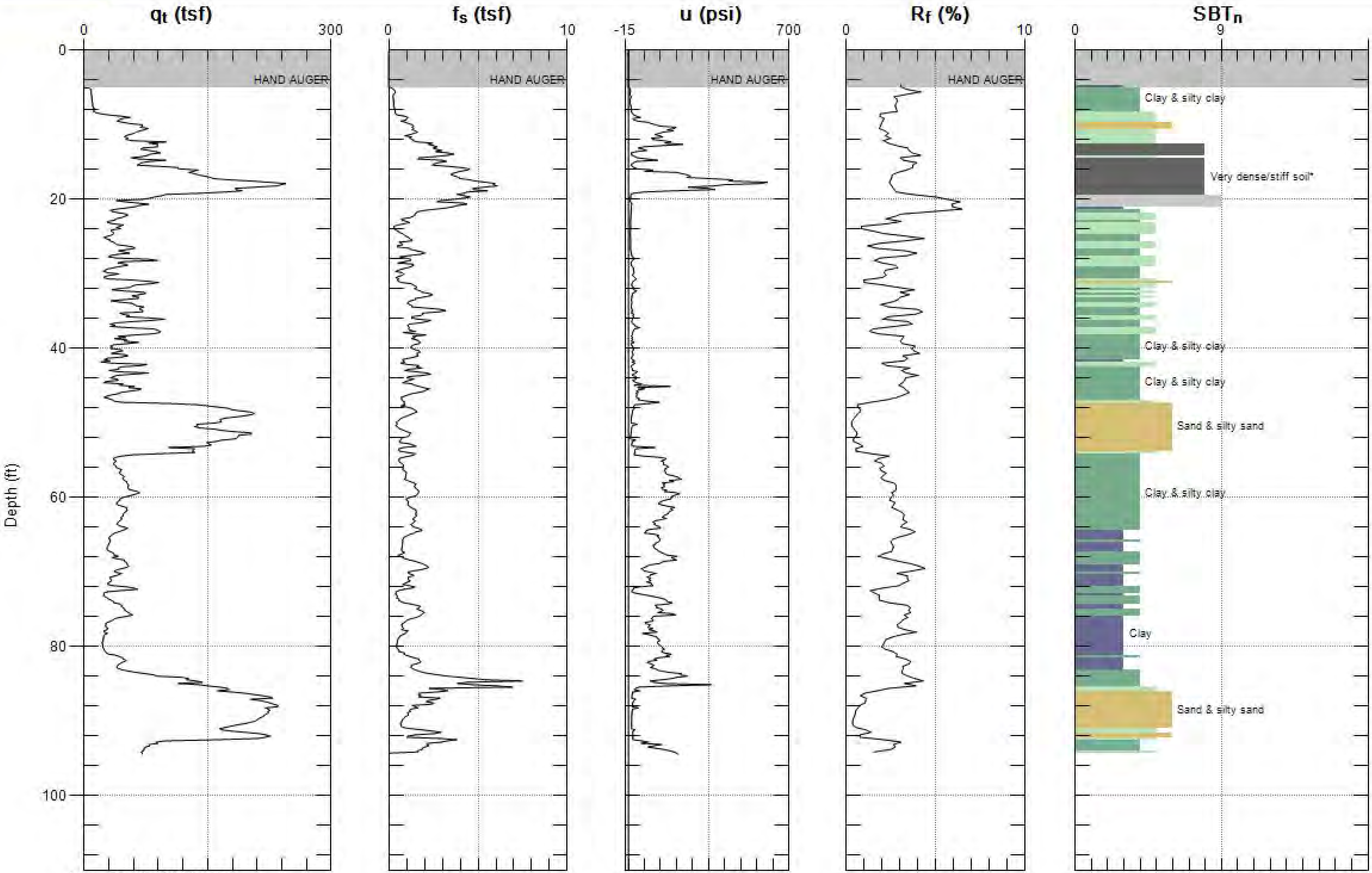
**DWR**

Site: RYER ISLAND

Sounding: RI-3

Engineer: M.SOUVERVILLE

Date: 3/27/2012 10:18




Max. Depth: 94.488 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

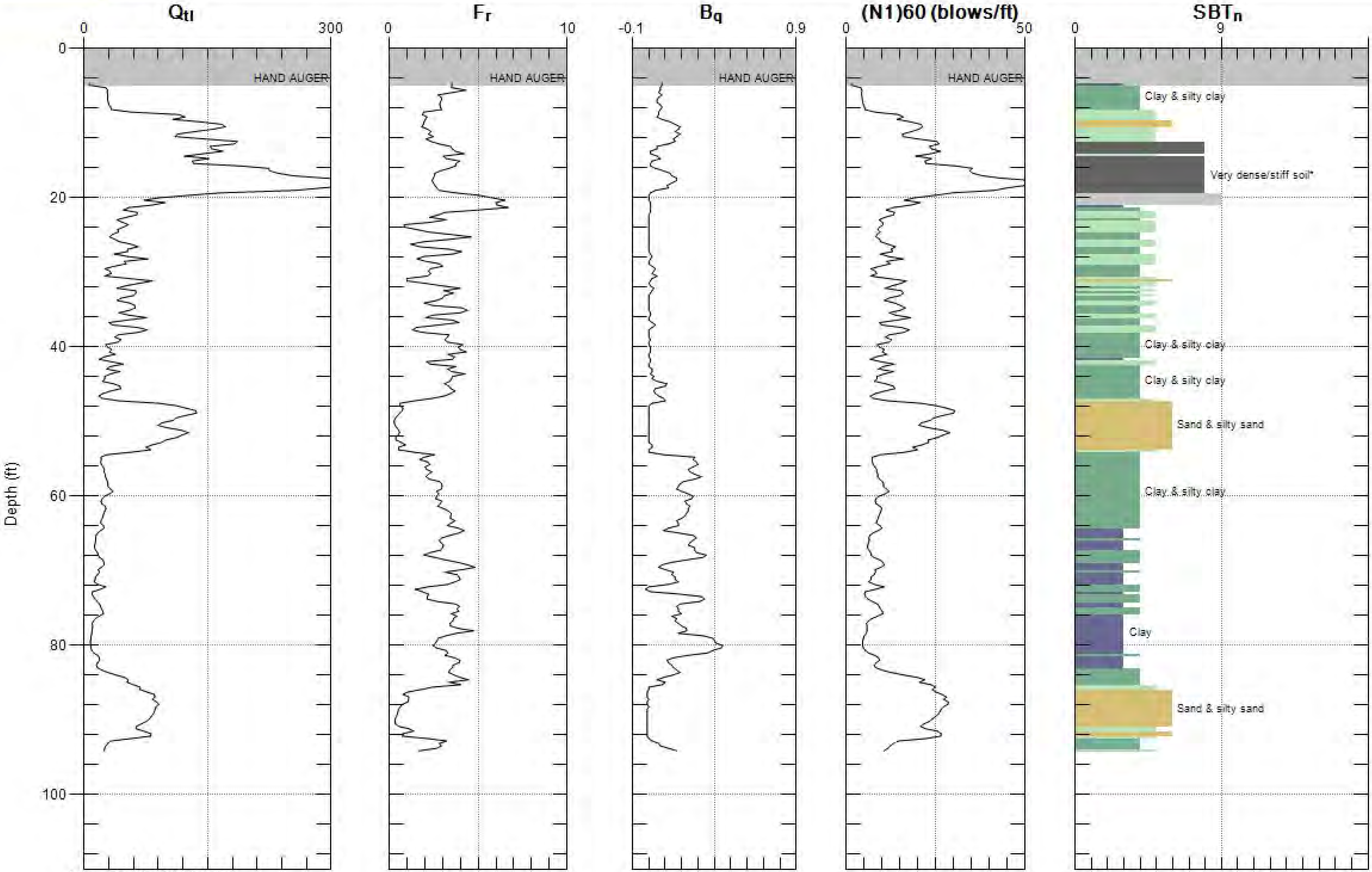
# DWR

Site: RYER ISLAND

Sounding: RI-3

Engineer: M.SOUVERVILLE

Date: 3/27/2012 10:18




Max. Depth: 94.488 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

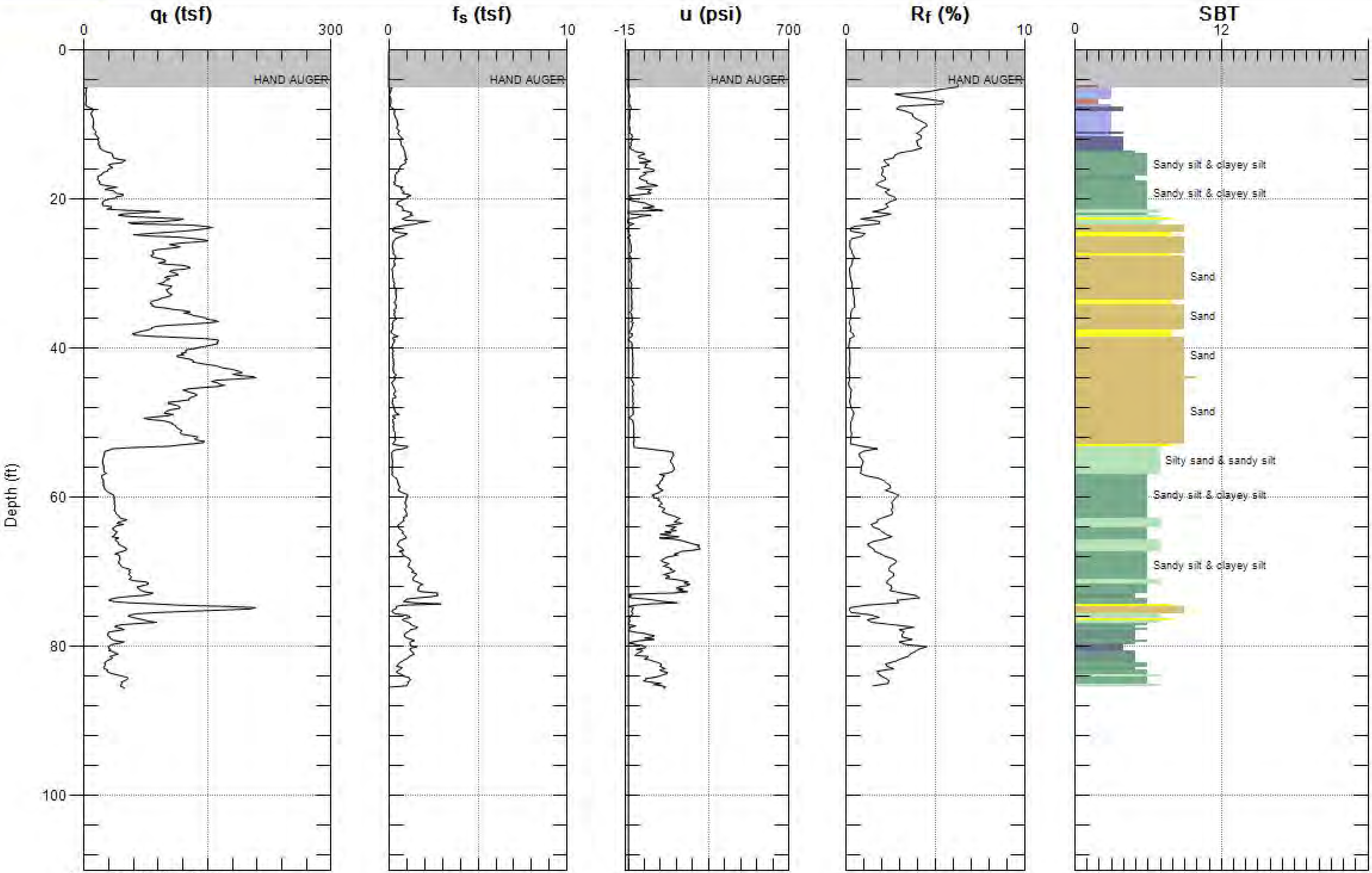
**DWR**

Site: RYER ISLAND

Sounding: RI-4

Engineer: M.SOUVERVILLE

Date: 3/13/2012 03:05




Max. Depth: 85.630 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

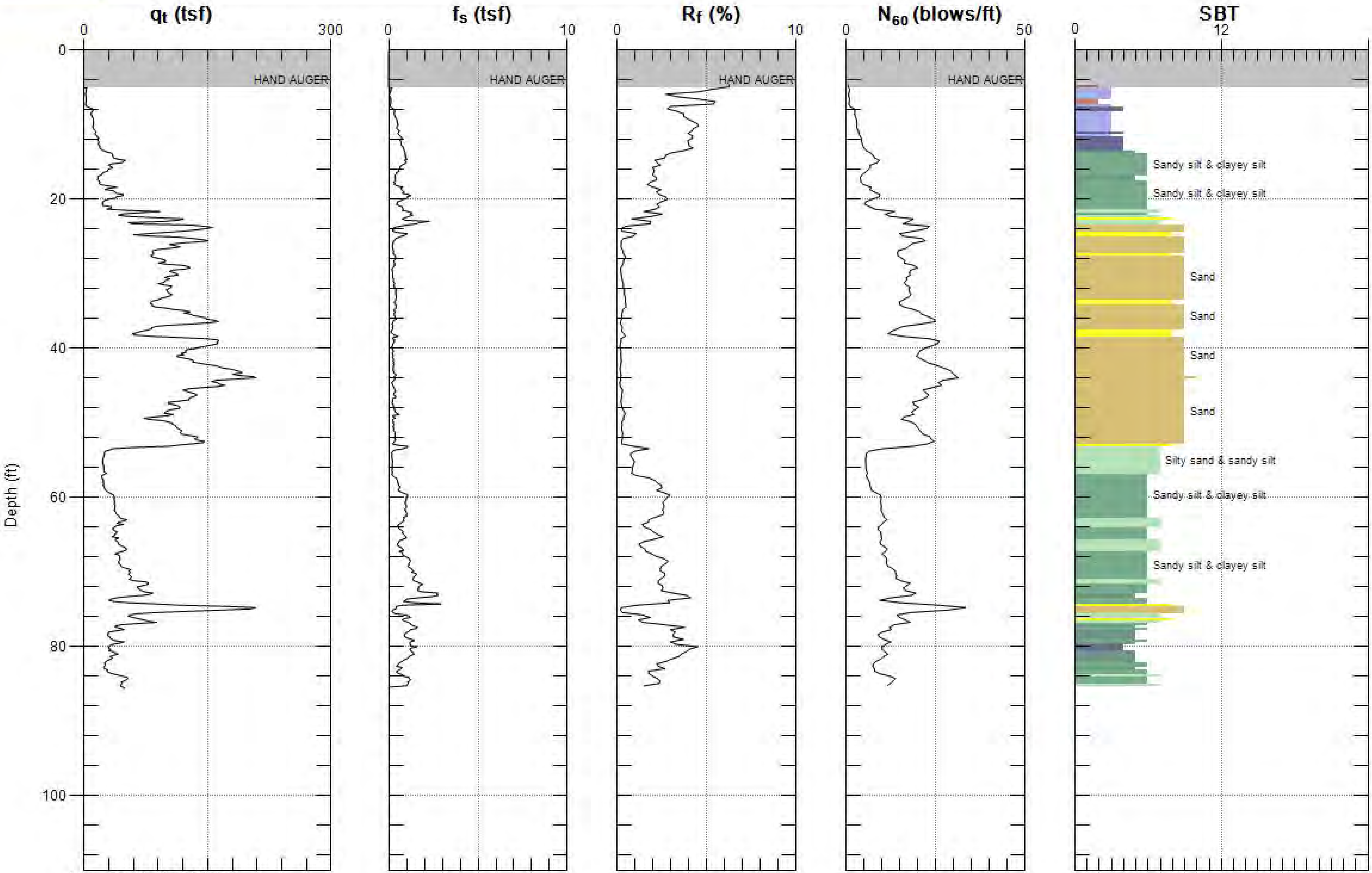
# DWR

Site: RYER ISLAND

Sounding: RI-4

Engineer: M.SOUVERVILLE

Date: 3/13/2012 03:05




Max. Depth: 85.630 (ft)
Avg. Interval: 0.328 (ft)

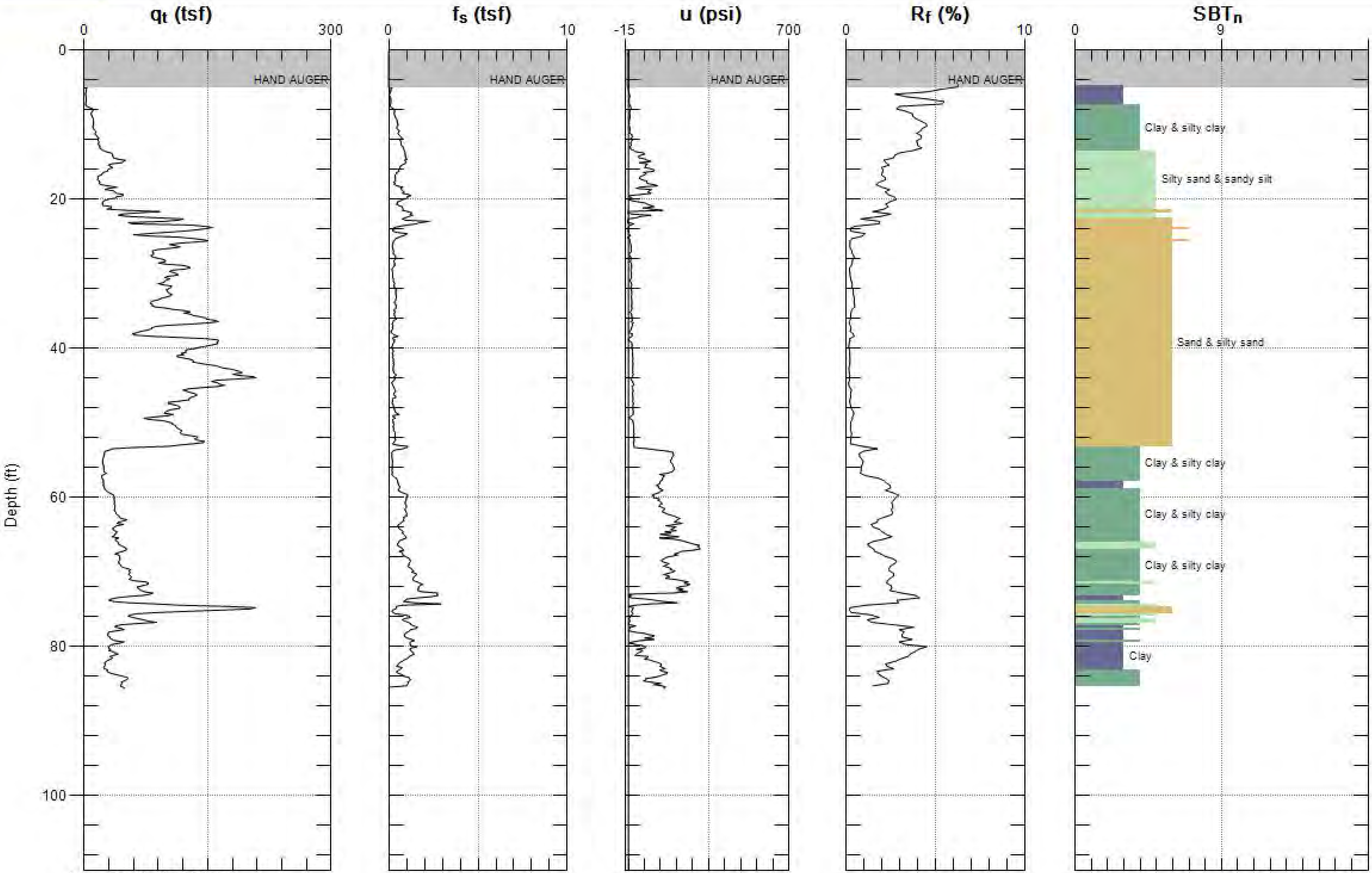
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

Site: RYER ISLAND
Sounding: RI-4

Engineer: M.SOUVERVILLE
Date: 3/13/2012 03:05




Max. Depth: 85.630 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

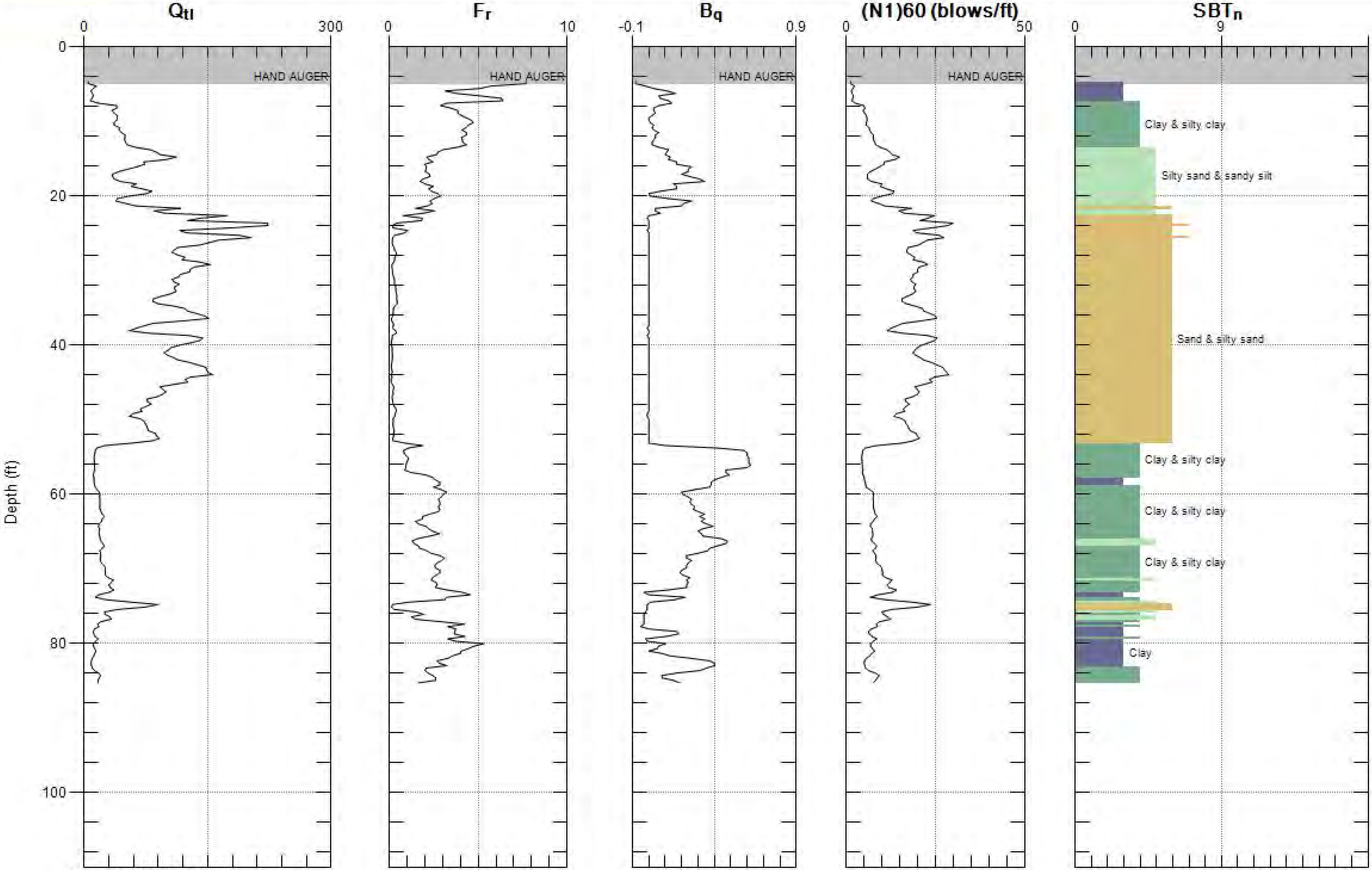
# DWR

Site: RYER ISLAND

Sounding: RI-4

Engineer: M.SOUVERVILLE

Date: 3/13/2012 03:05




Max. Depth: 85.630 (ft)
Avg. Interval: 0.328 (ft)

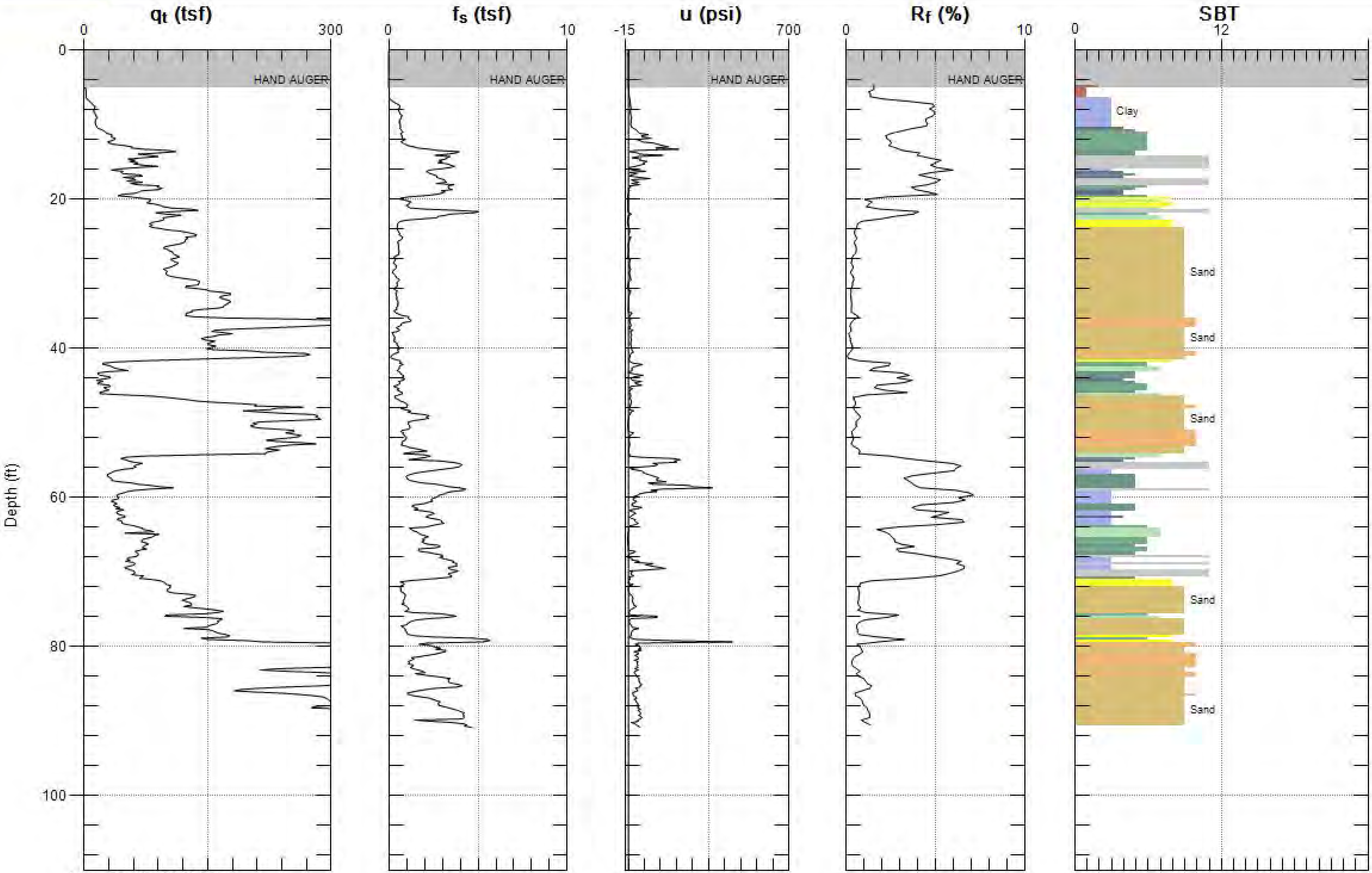
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

Site: RYER ISLAND
Sounding: RI-5

Engineer: M.SOUVERVILLE
Date: 3/21/2012 02:44



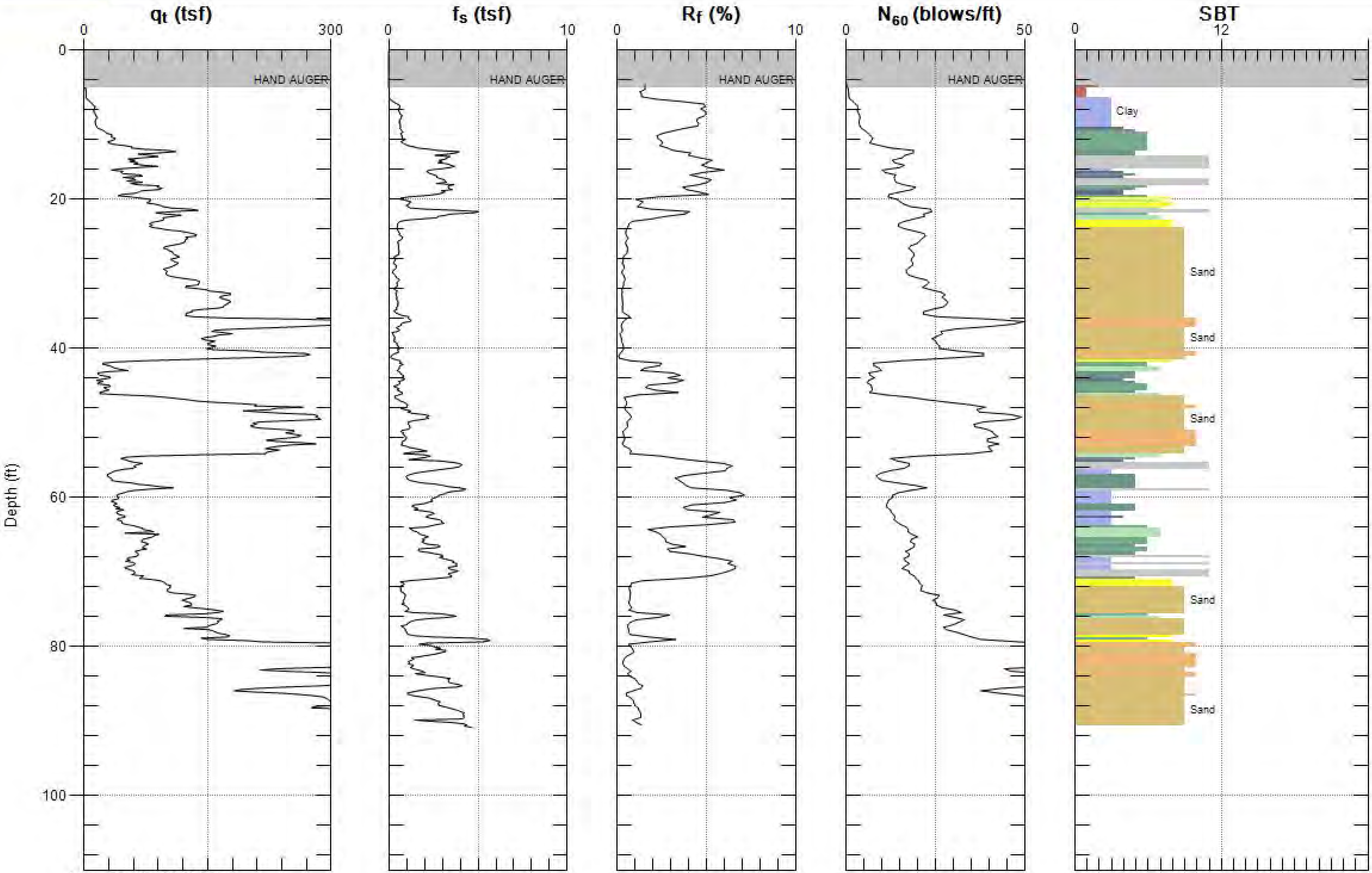

Max. Depth: 90.879 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**GREGG** **DWR**

**Site: RYER ISLAND**
**Sounding: RI-5**

**Engineer: M.SOUVERVILLE**
**Date: 3/21/2012 02:44**




Max. Depth: 90.879 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

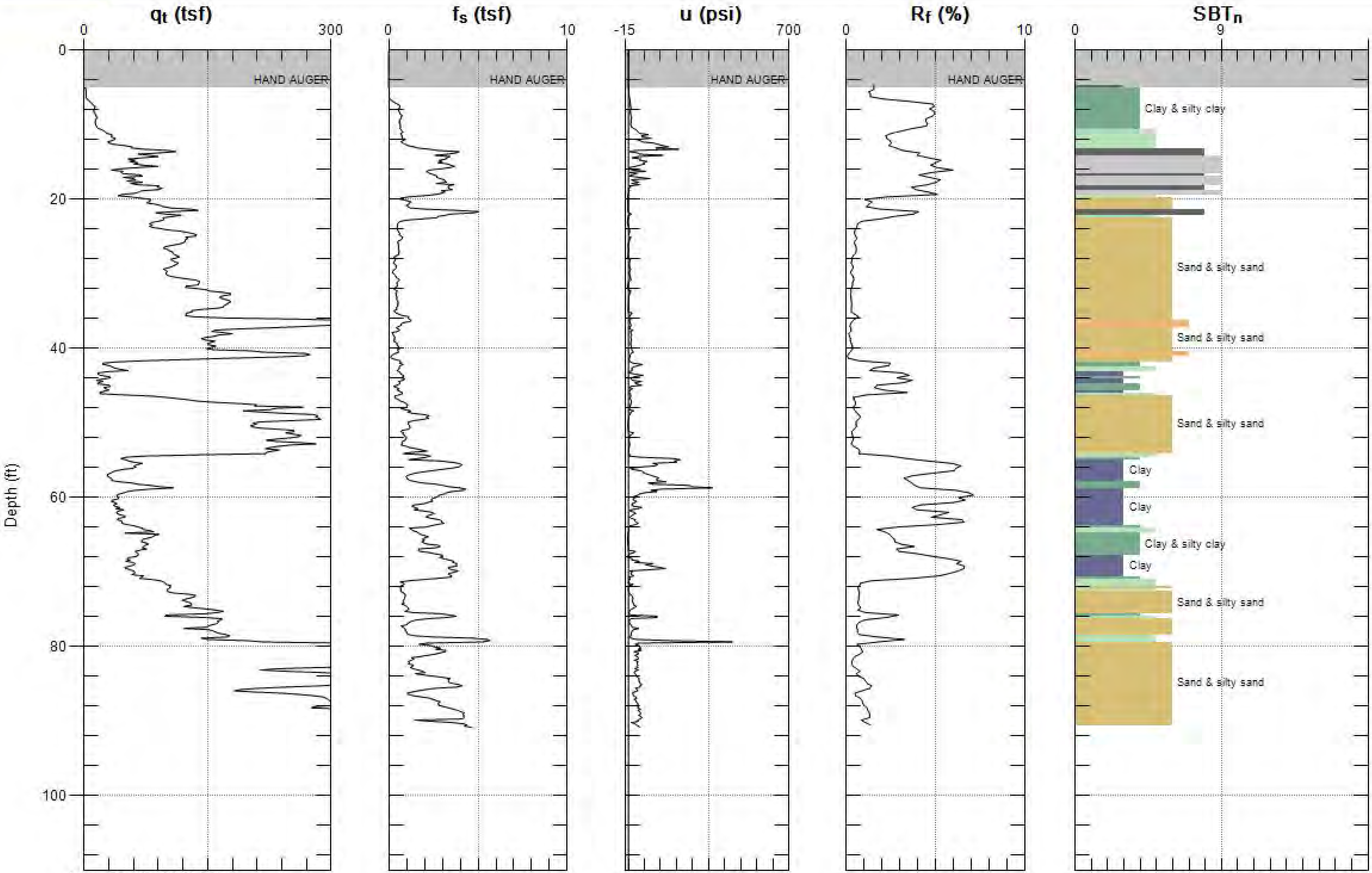
# DWR

Site: RYER ISLAND

Sounding: RI-5

Engineer: M.SOUVERVILLE

Date: 3/21/2012 02:44




Max. Depth: 90.879 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

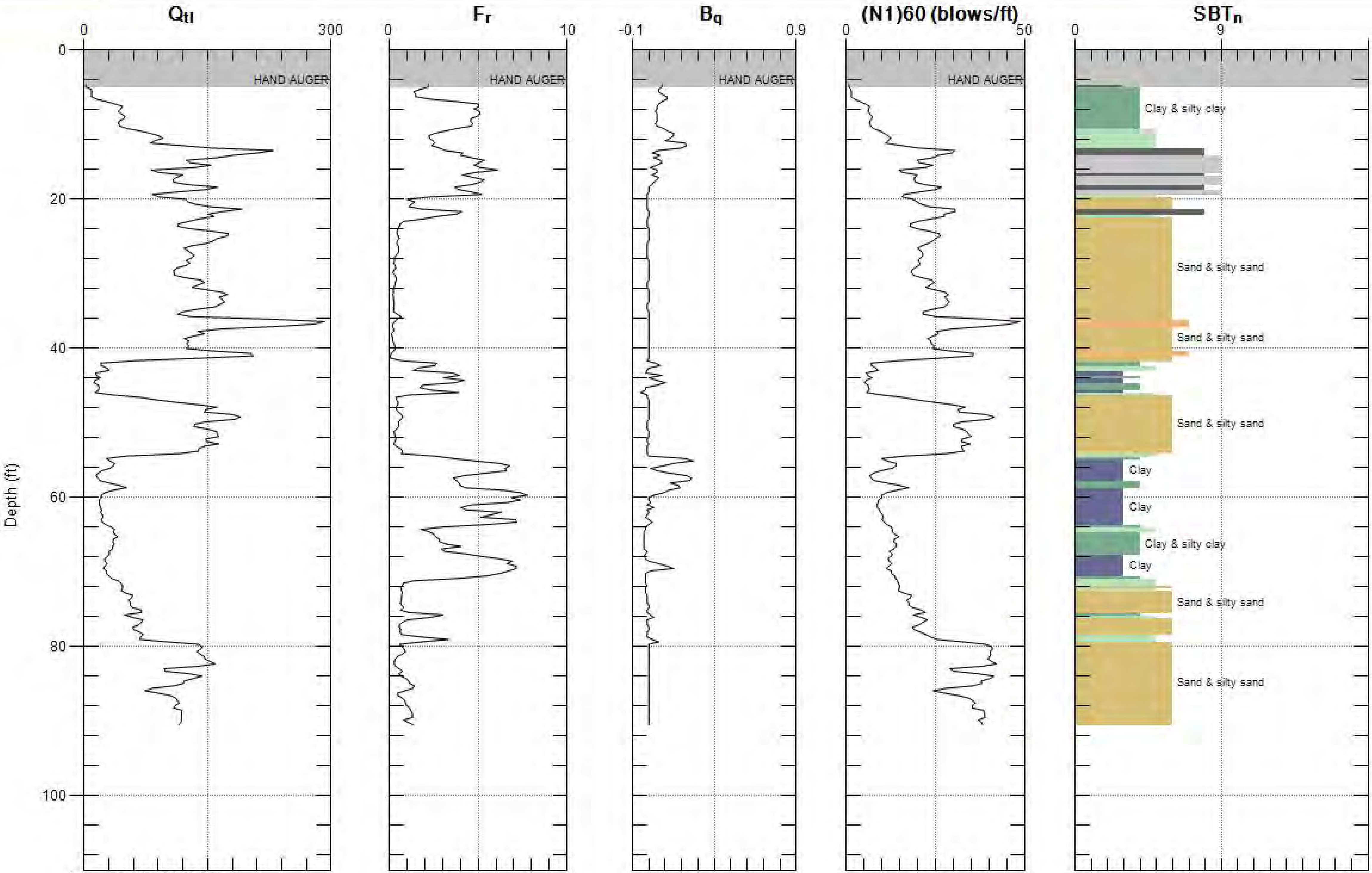
DWR

Site: RYER ISLAND

Sounding: RI-5

Engineer: M.SOUVERVILLE

Date: 3/21/2012 02:44




Max. Depth: 90.879 (ft)
Avg. Interval: 0.328 (ft)

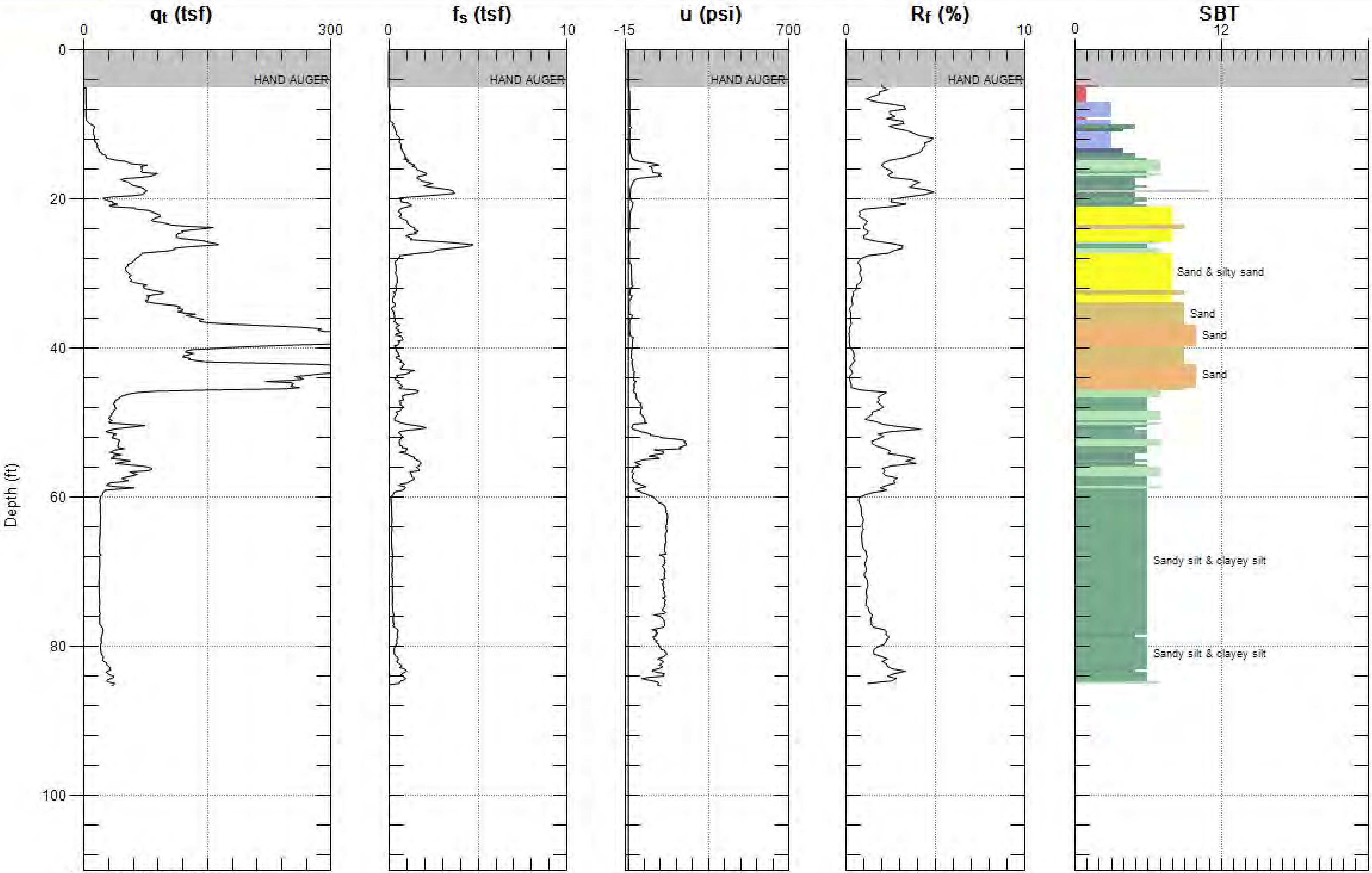
SBT: Soil Behavior Type (Robertson 1990)

GREGG

# DWR

Site: RYER ISLAND
Sounding: RIS-1

Engineer: M.SOUVERVILLE
Date: 3/28/2012 10:43



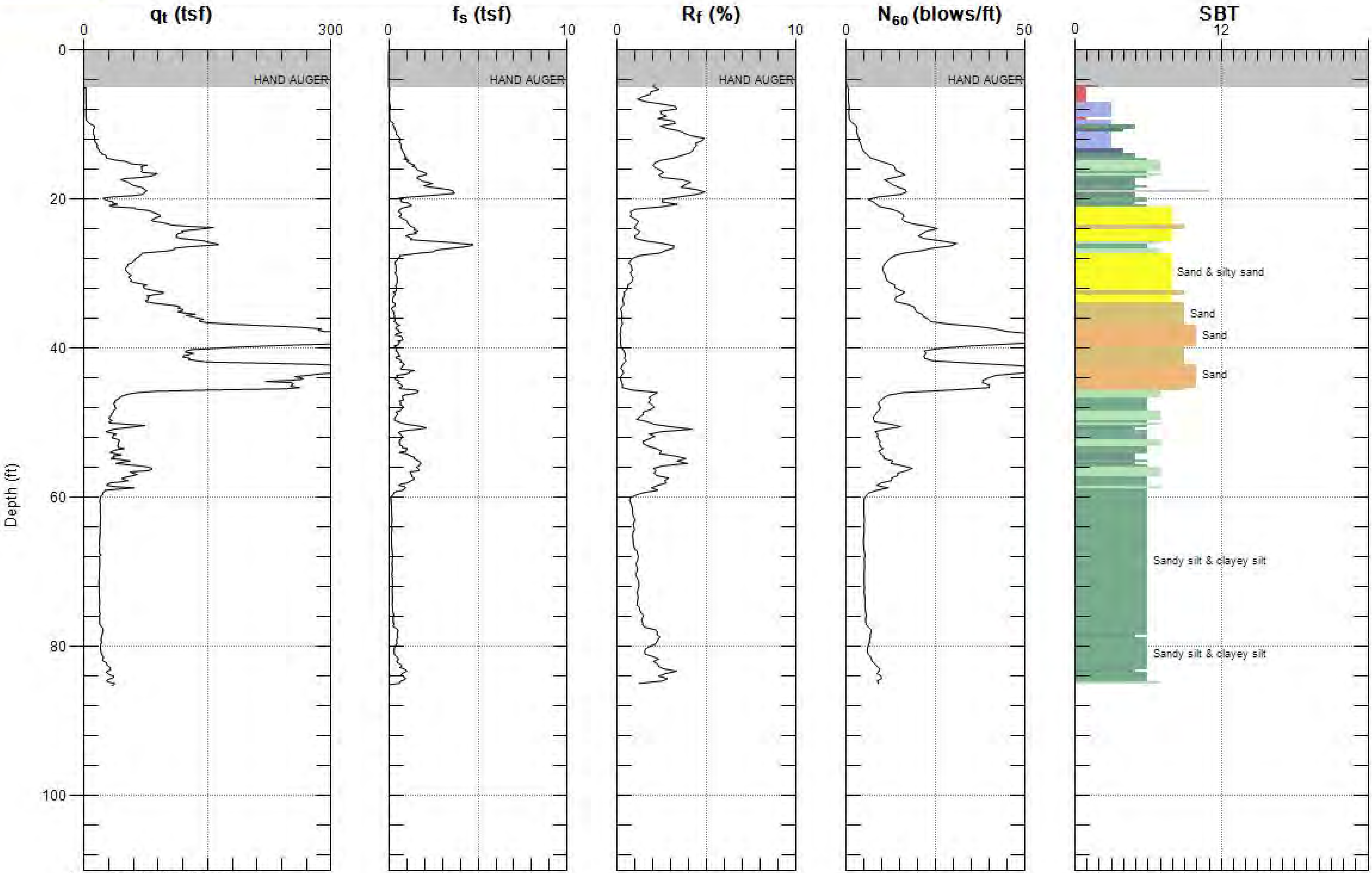

Max. Depth: 85.302 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**DWR**

**Site: RYER ISLAND** | **Engineer: M.SOUVERVILLE**

**Sounding: RIS-1** | **Date: 3/28/2012 10:43**



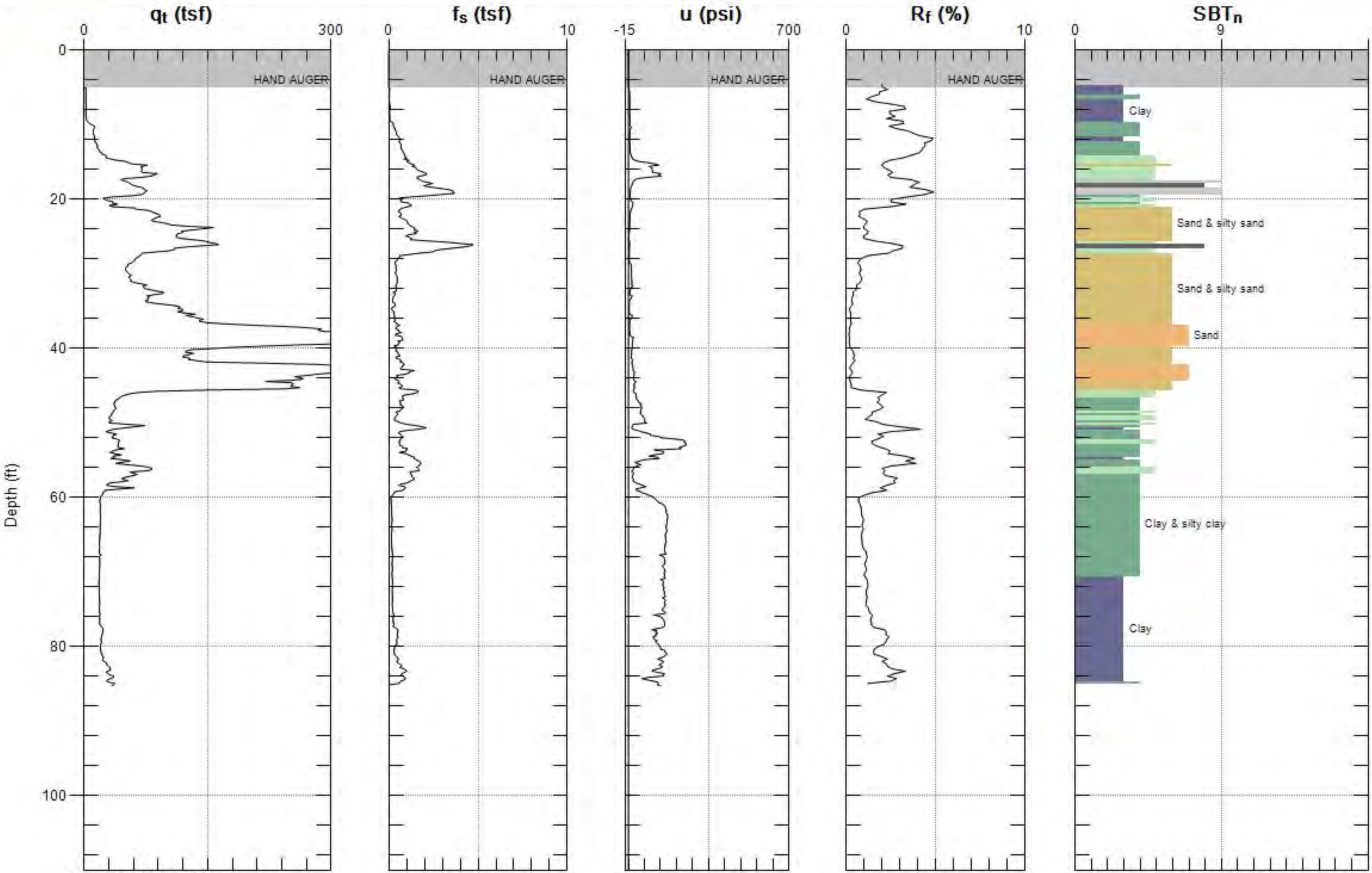

Max. Depth: 85.302 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

Site: RYER ISLAND
Sounding: RIS-1

Engineer: M.SOUVERVILLE
Date: 3/28/2012 10:43




Max. Depth: 85.302 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

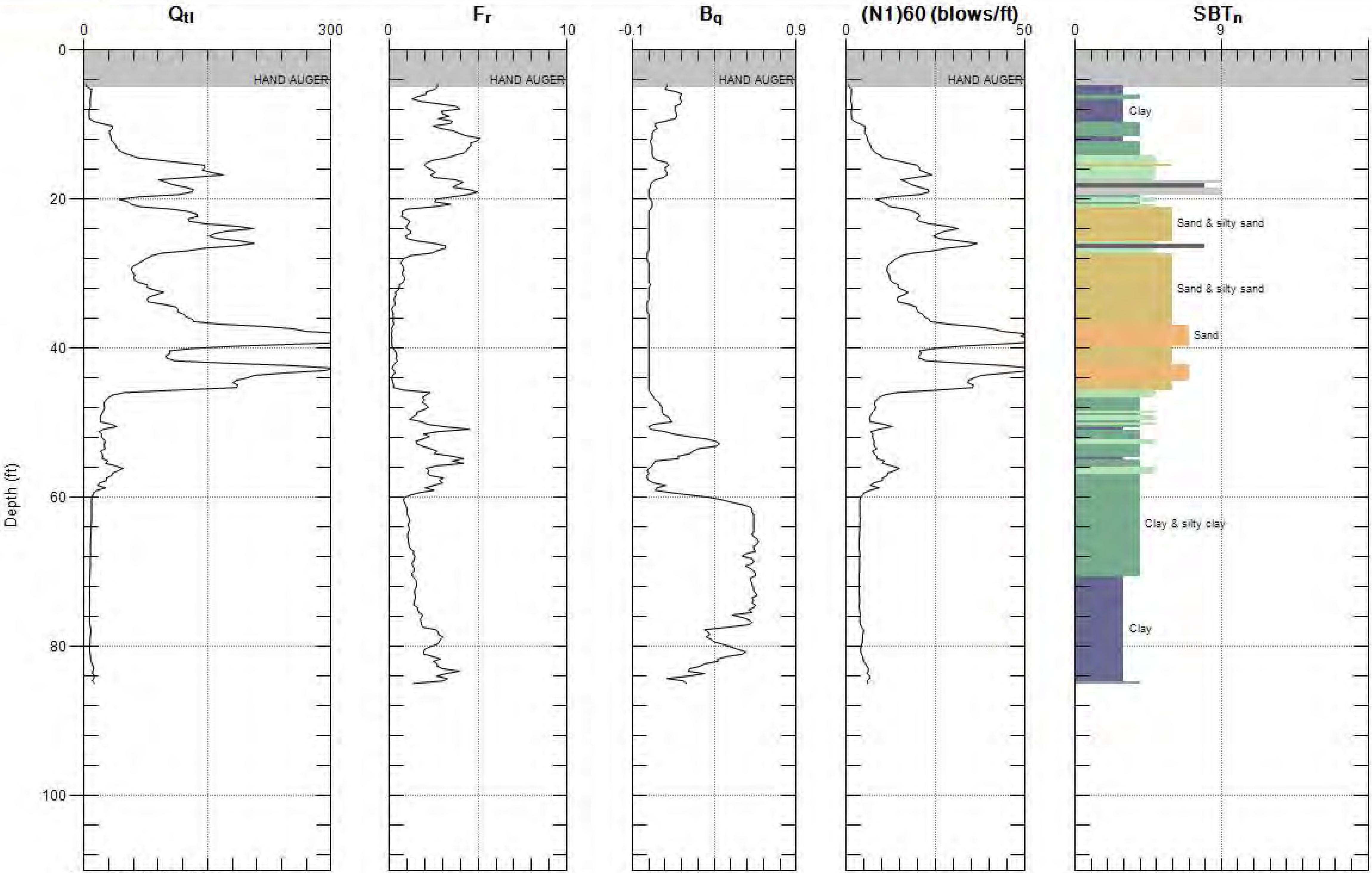
# DWR

**Site: RYER ISLAND**

**Sounding: RIS-1**

**Engineer: M.SOUVERVILLE**

**Date: 3/28/2012 10:43**




Max. Depth: 85.302 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

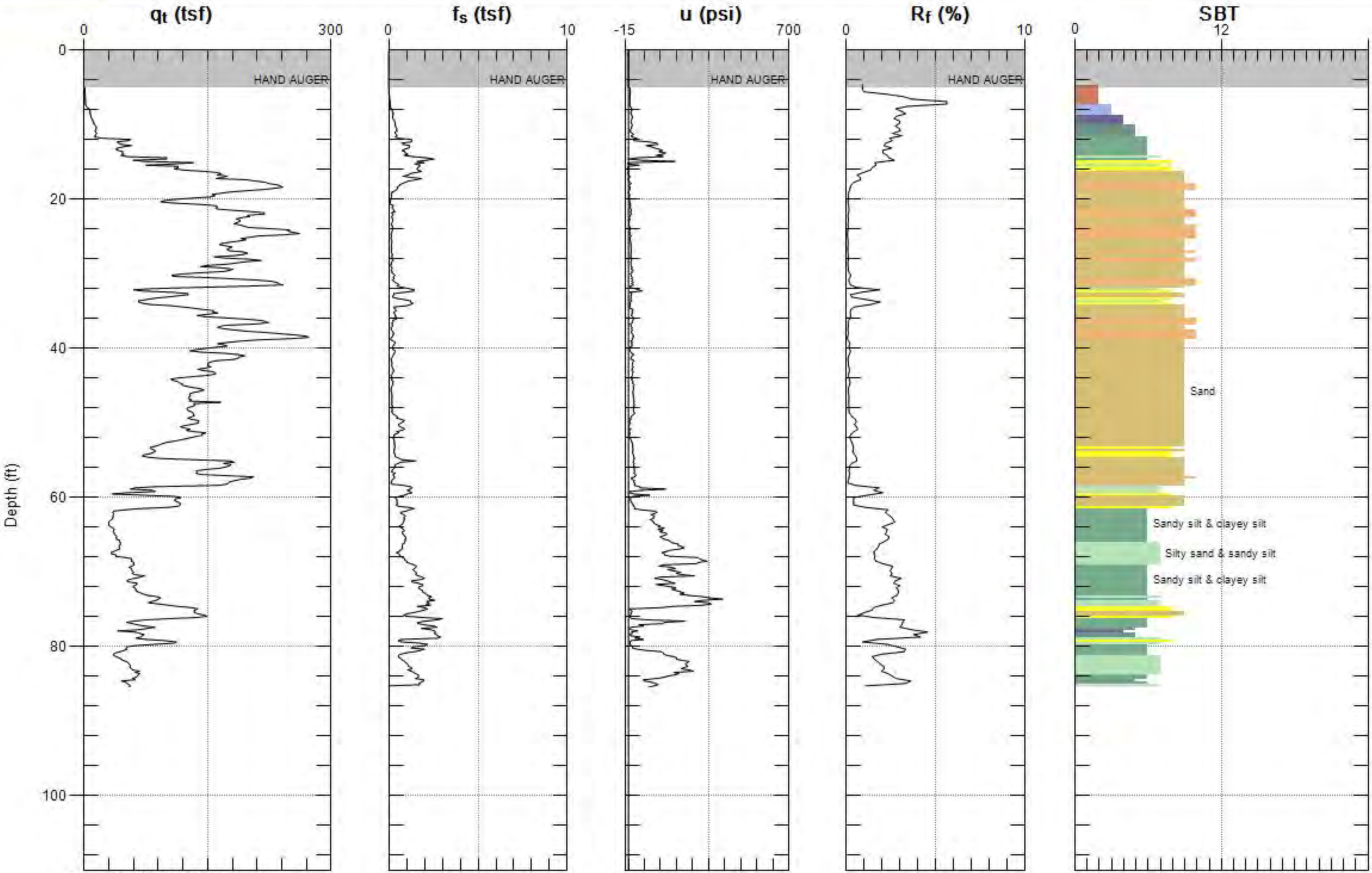
# DWR

Site: RYER ISLAND

Sounding: RIS-4

Engineer: M.SOUVERVILLE

Date: 3/13/2012 09:31



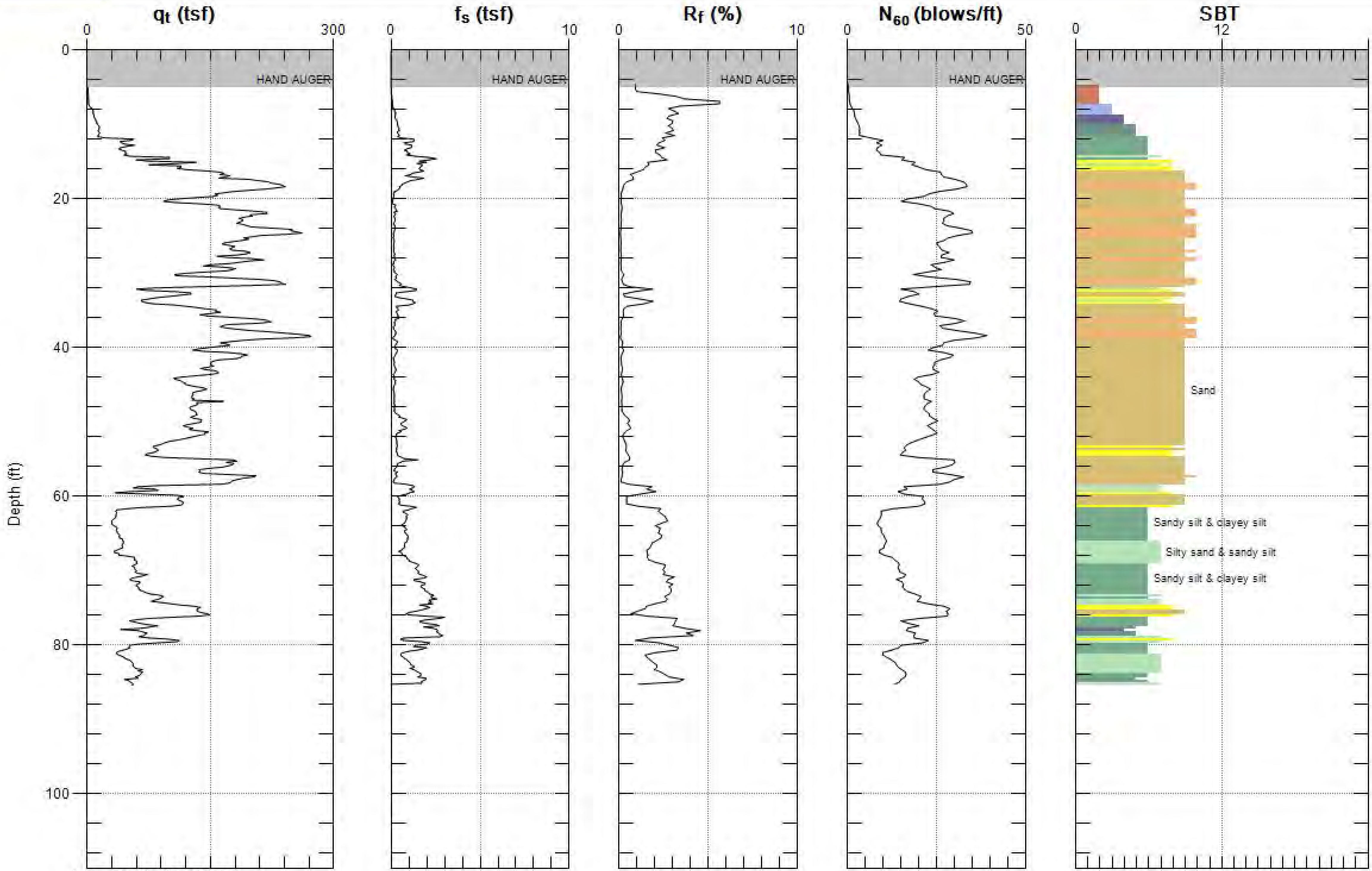

Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**DWR**

**Site: RYER ISLAND** **Engineer: M.SOUVERVILLE**

**Sounding: RIS-4** **Date: 3/13/2012 09:31**



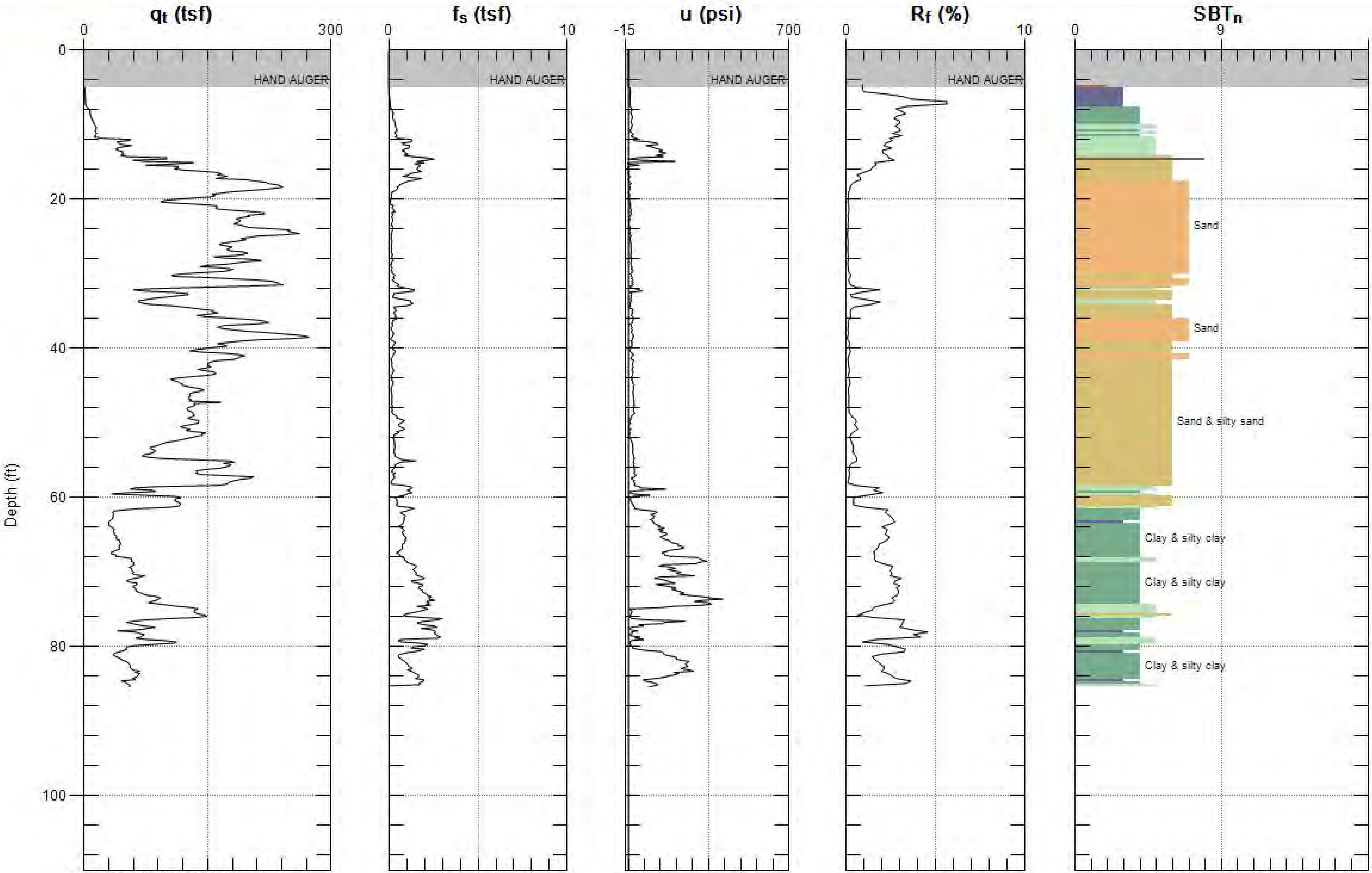

Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

Site: RYER ISLAND
Sounding: RIS-4

Engineer: M.SOUVERVILLE
Date: 3/13/2012 09:31




Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

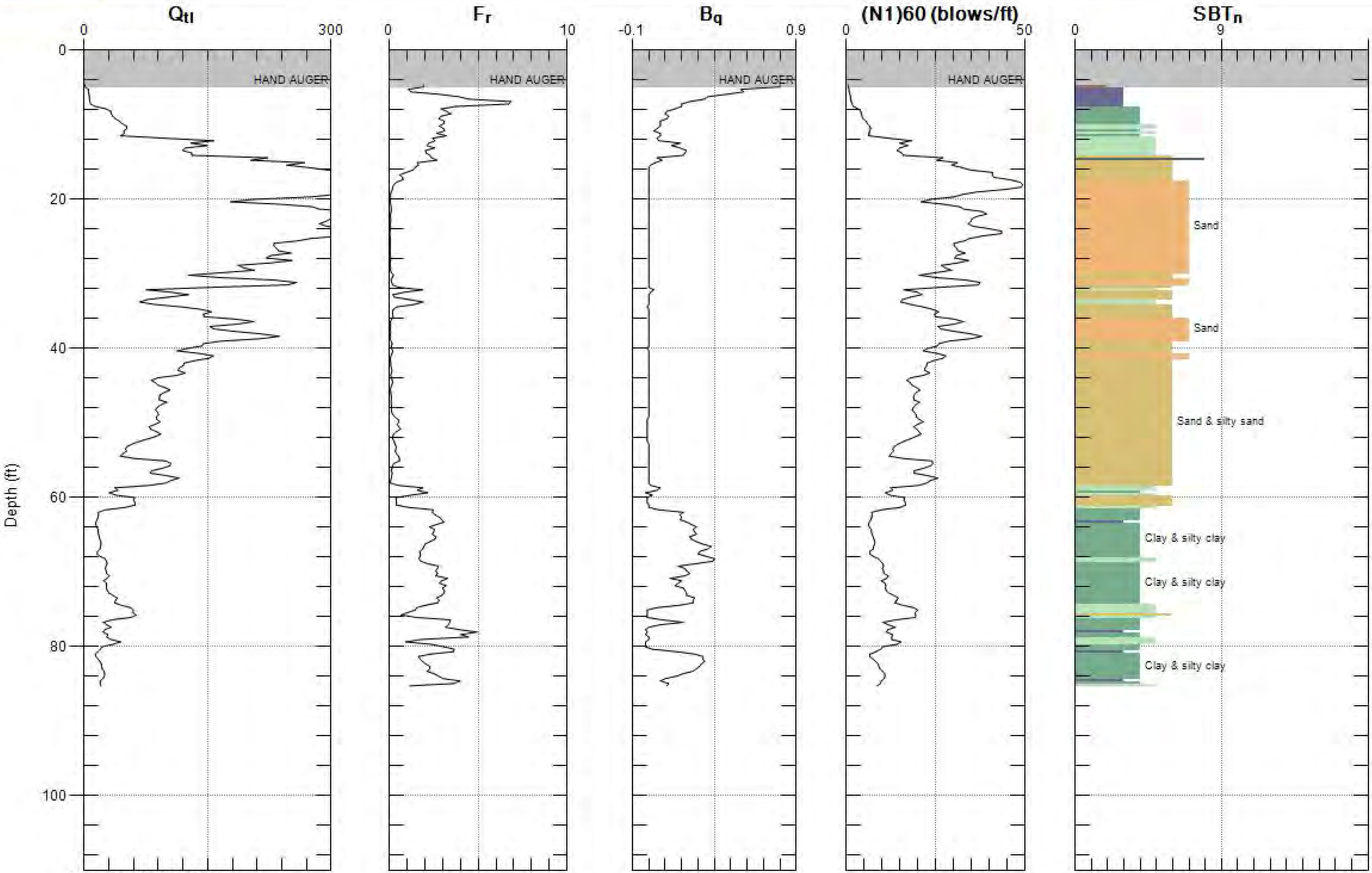
GREGG **DWR**

Site: RYER ISLAND

Sounding: RIS-4

Engineer: M.SOUVERVILLE

Date: 3/13/2012 09:31




Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

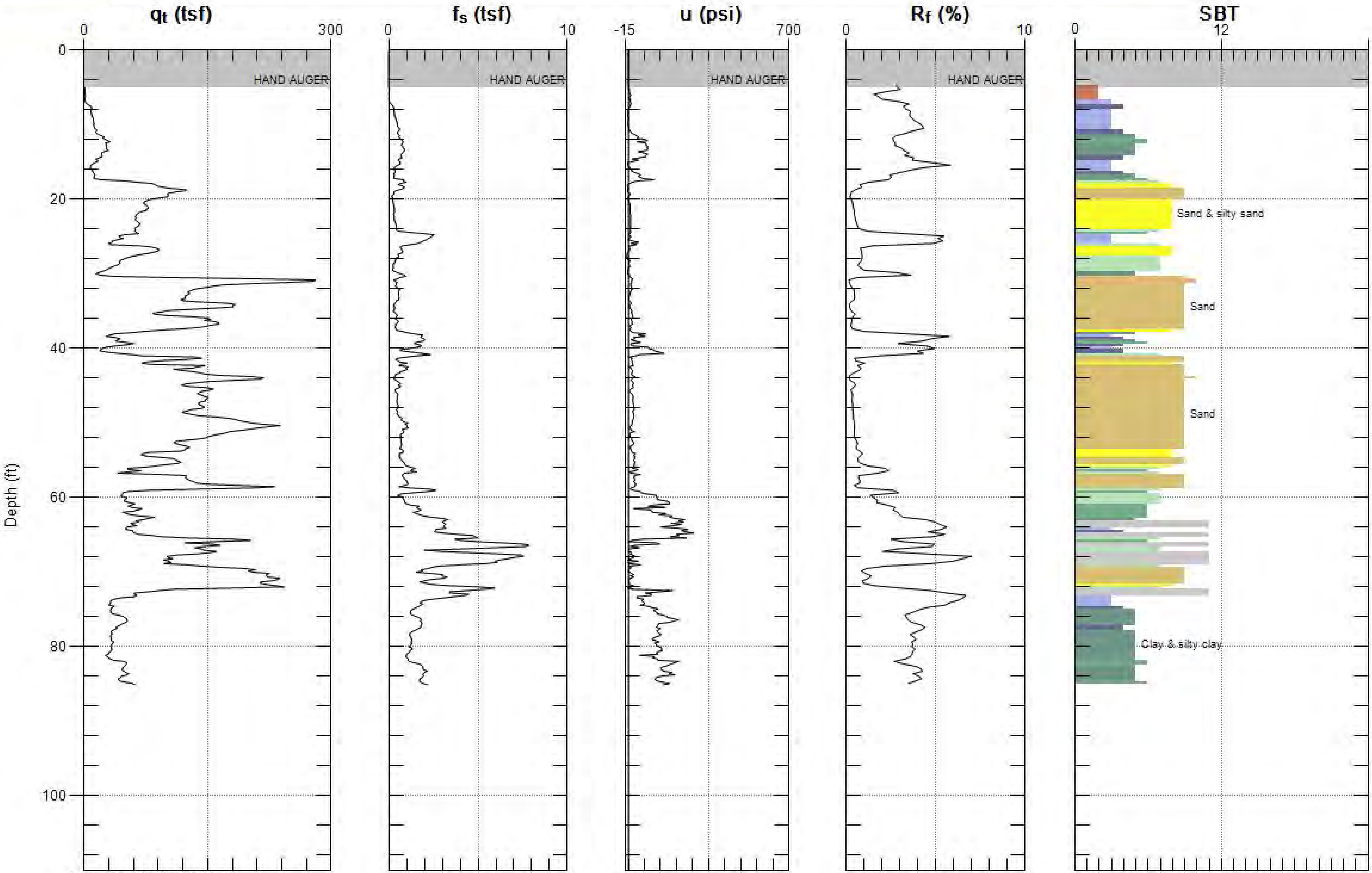
# DWR

Site: RYER ISLAND

Sounding: RIS-5

Engineer: M.SOUVERVILLE

Date: 3/22/2012 11:34

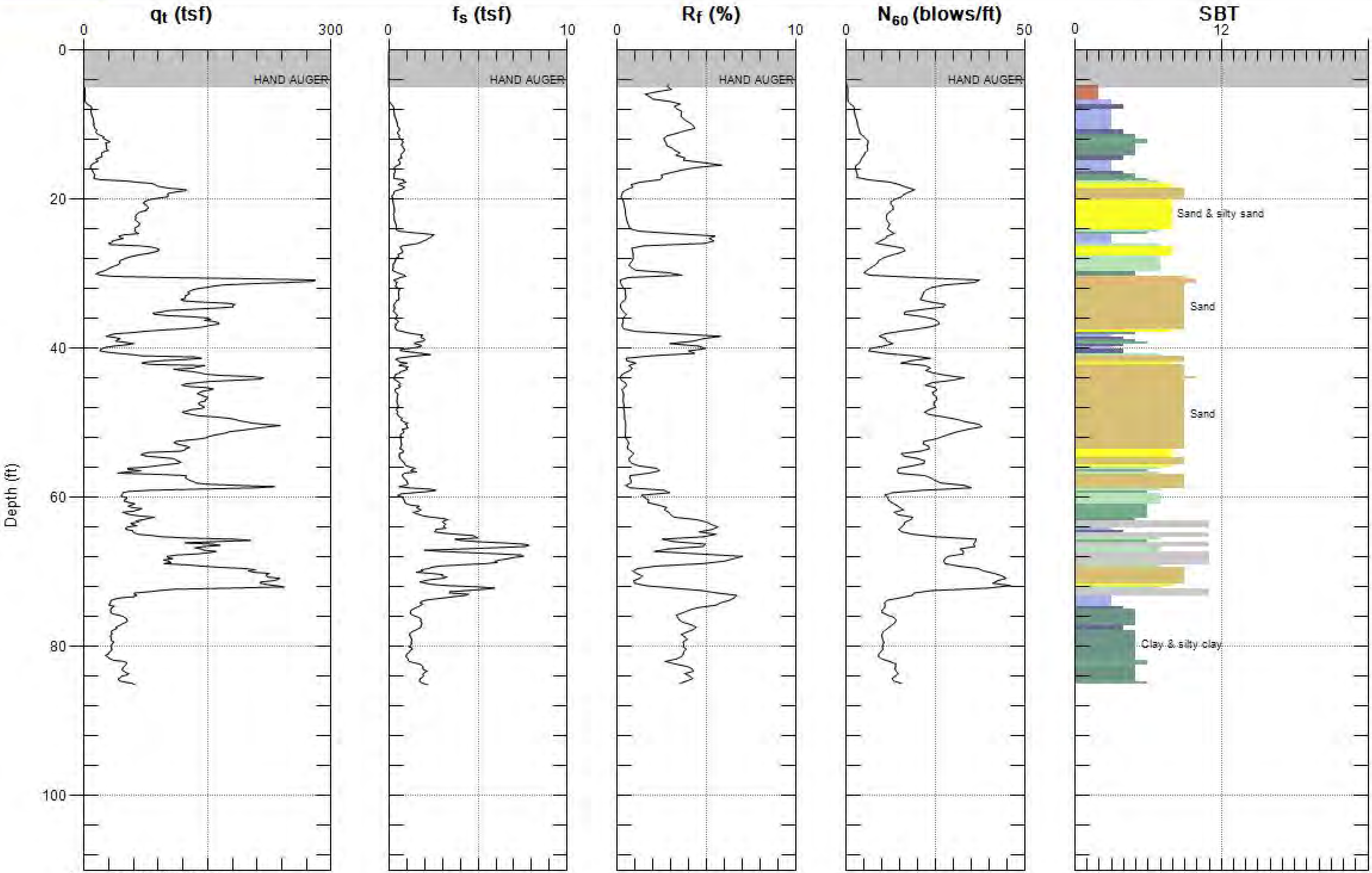



Max. Depth: 85.138 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

**GREGG** **DWR**

Site: RYER ISLAND | Engineer: M.SOUVERVILLE
Sounding: RIS-5 | Date: 3/22/2012 11:34




Max. Depth: 85.138 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

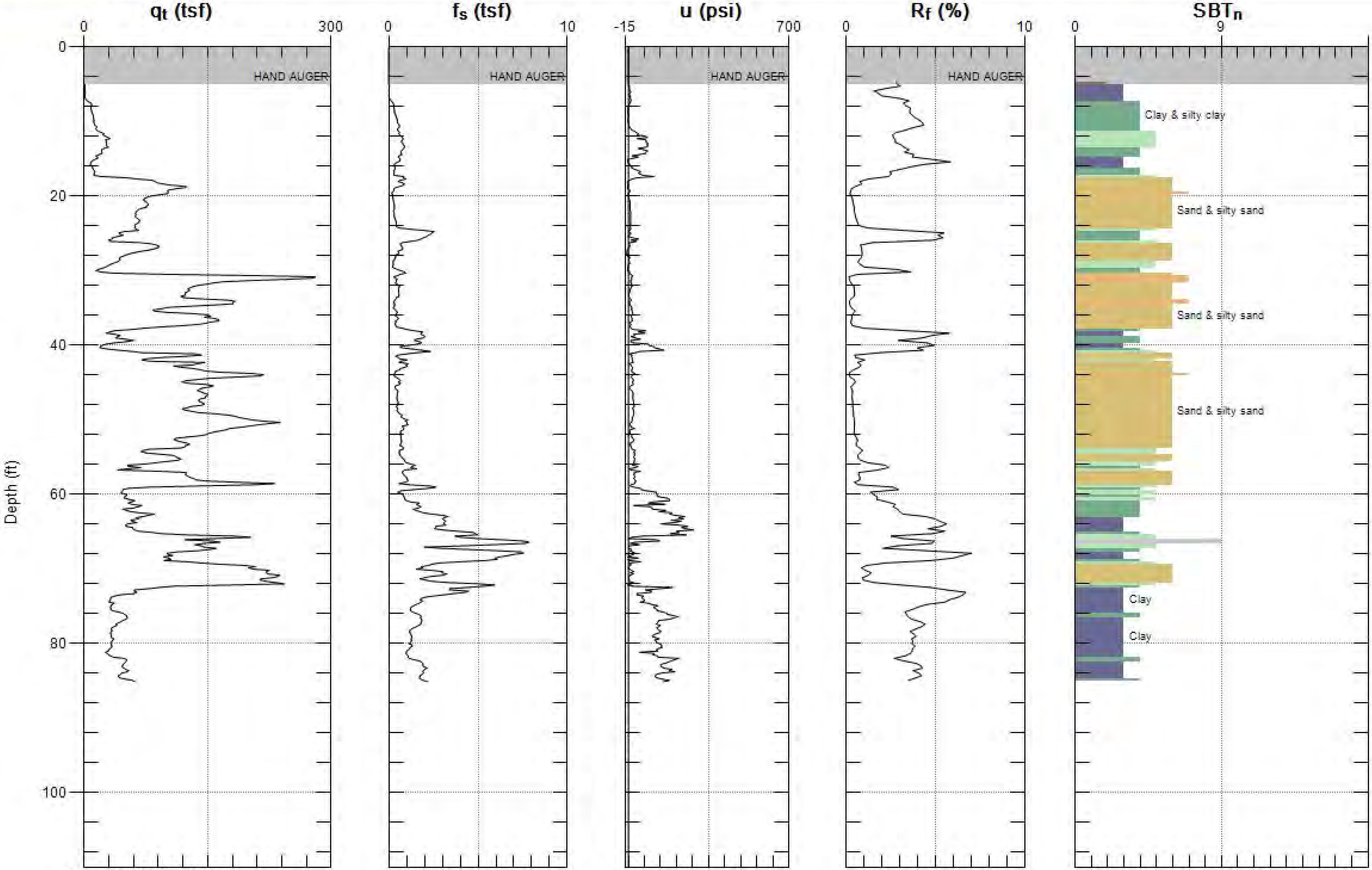
# DWR

Site: RYER ISLAND

Sounding: RIS-5

Engineer: M.SOUVERVILLE

Date: 3/22/2012 11:34




Max. Depth: 85.138 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

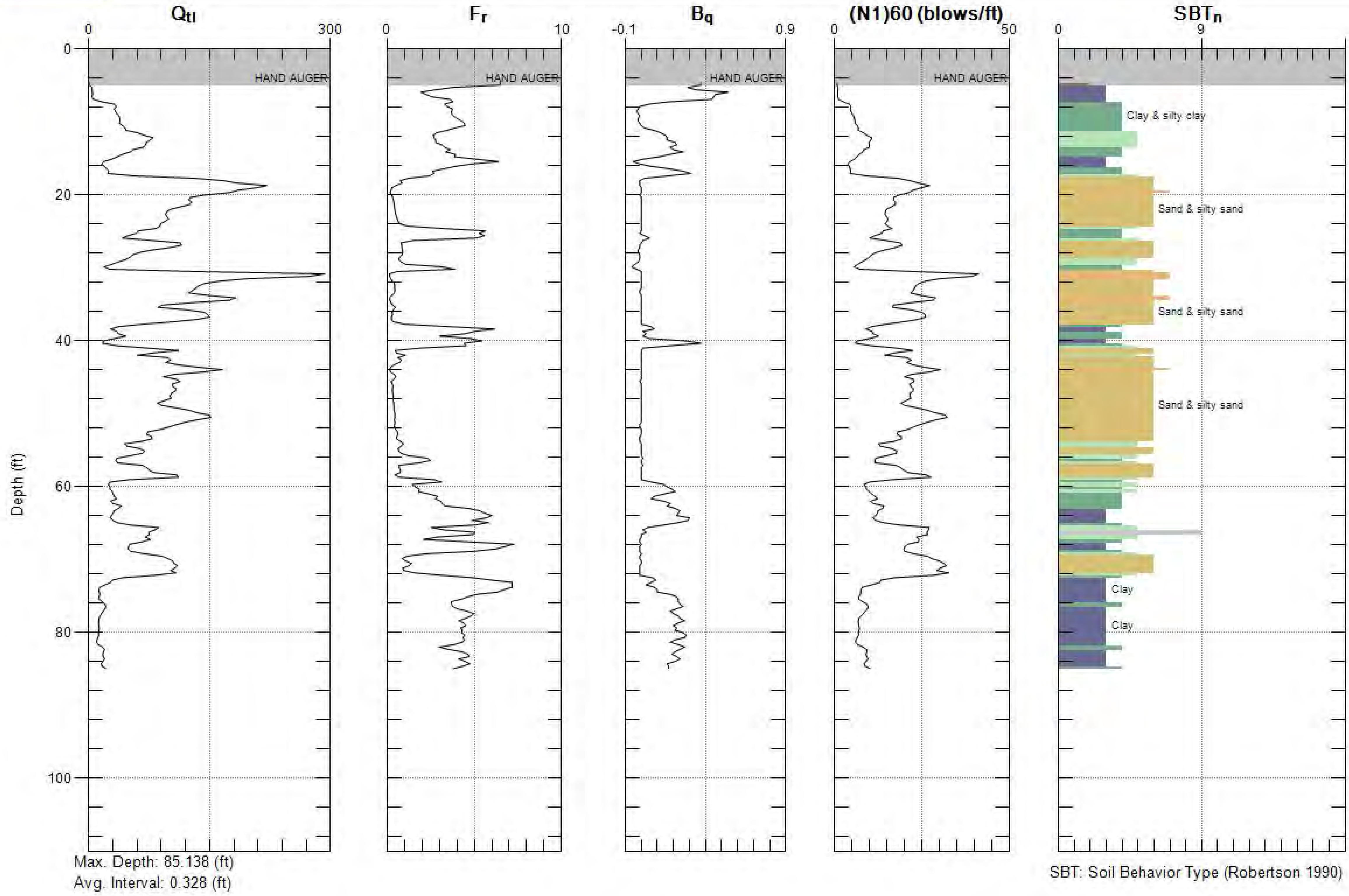
**DWR**

**Site: RYER ISLAND**

**Sounding: RIS-5**

**Engineer: M.SOUVERVILLE**

**Date: 3/22/2012 11:34**

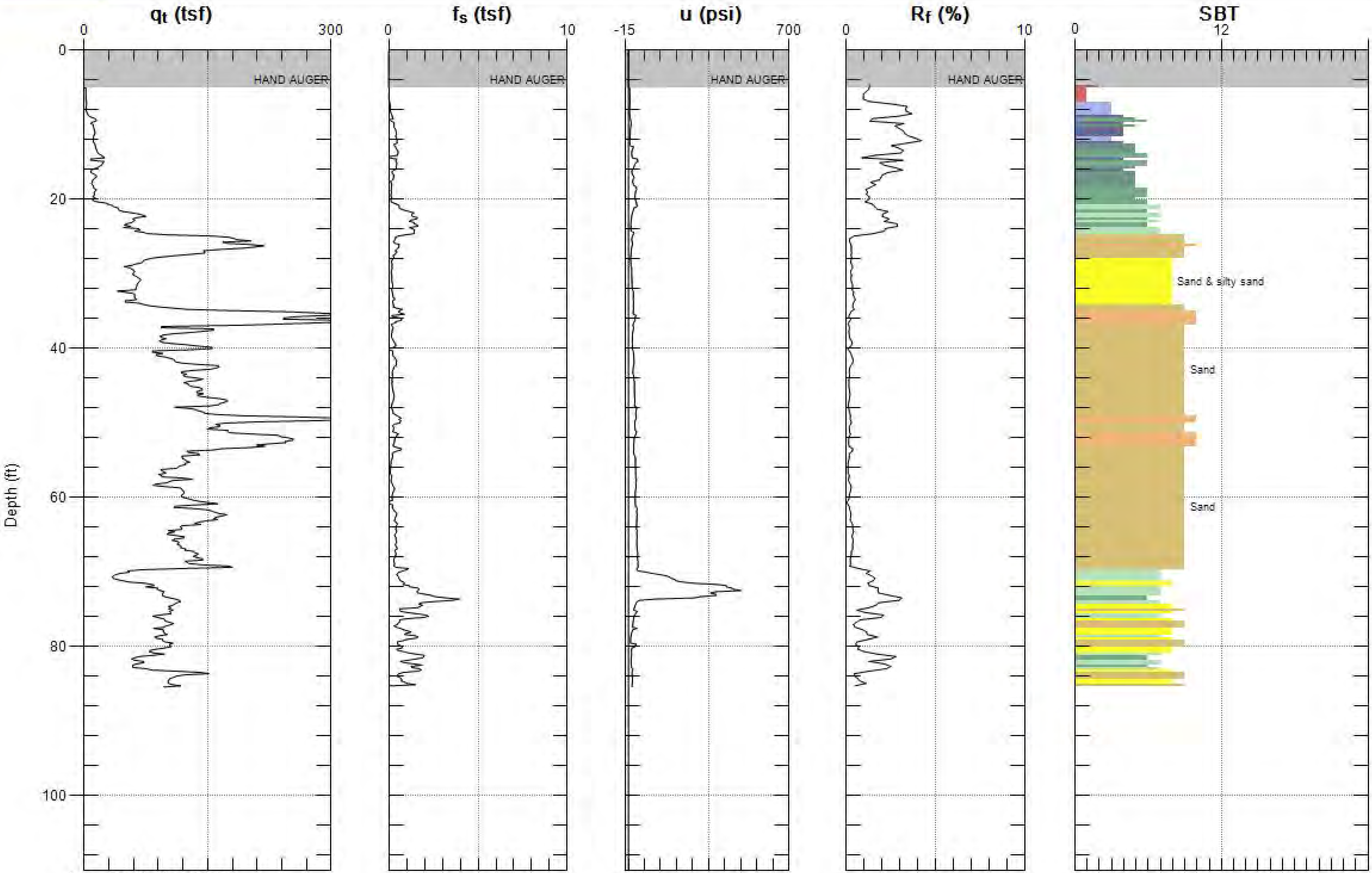


GREGG

# DWR

Site: RYER ISLAND
Sounding: RIS-6

Engineer: M.SOUVERVILLE
Date: 3/26/2012 10:36



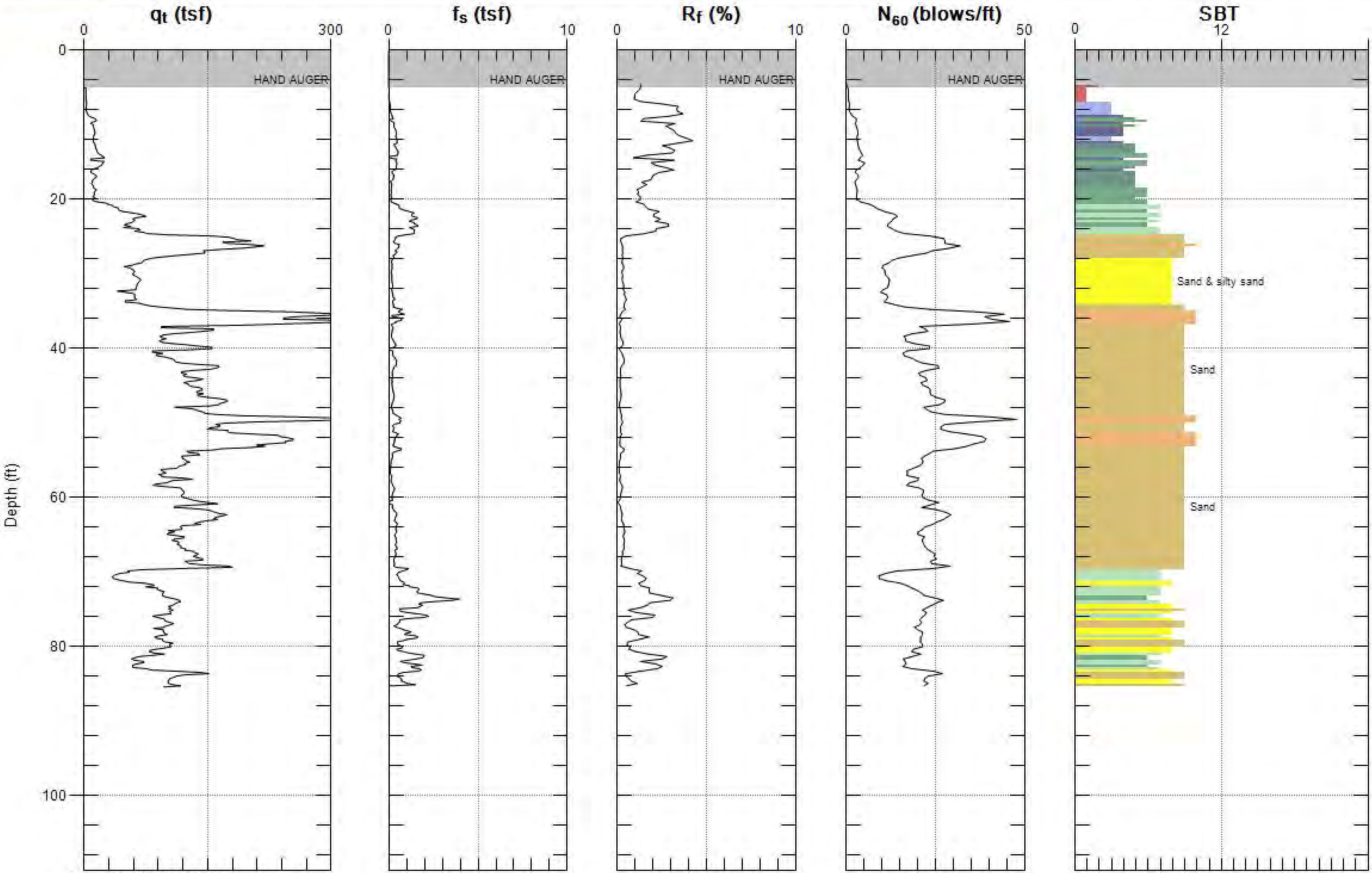

Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG **DWR**

**Site: RYER ISLAND**
**Sounding: RIS-6**

**Engineer: M.SOUVERVILLE**
**Date: 3/26/2012 10:36**




Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

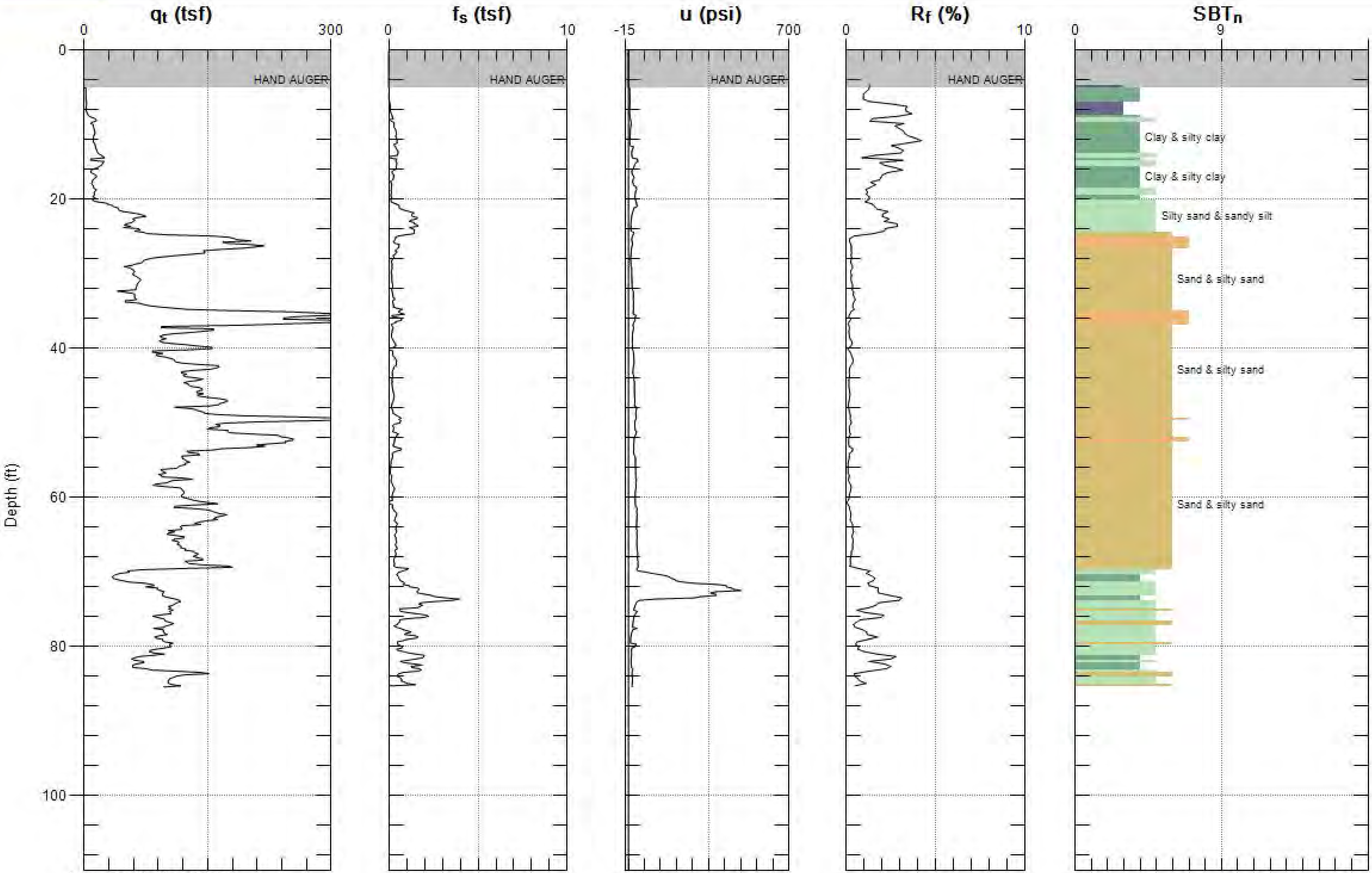
# DWR

Site: RYER ISLAND

Sounding: RIS-6

Engineer: M.SOUVERVILLE

Date: 3/26/2012 10:36




Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

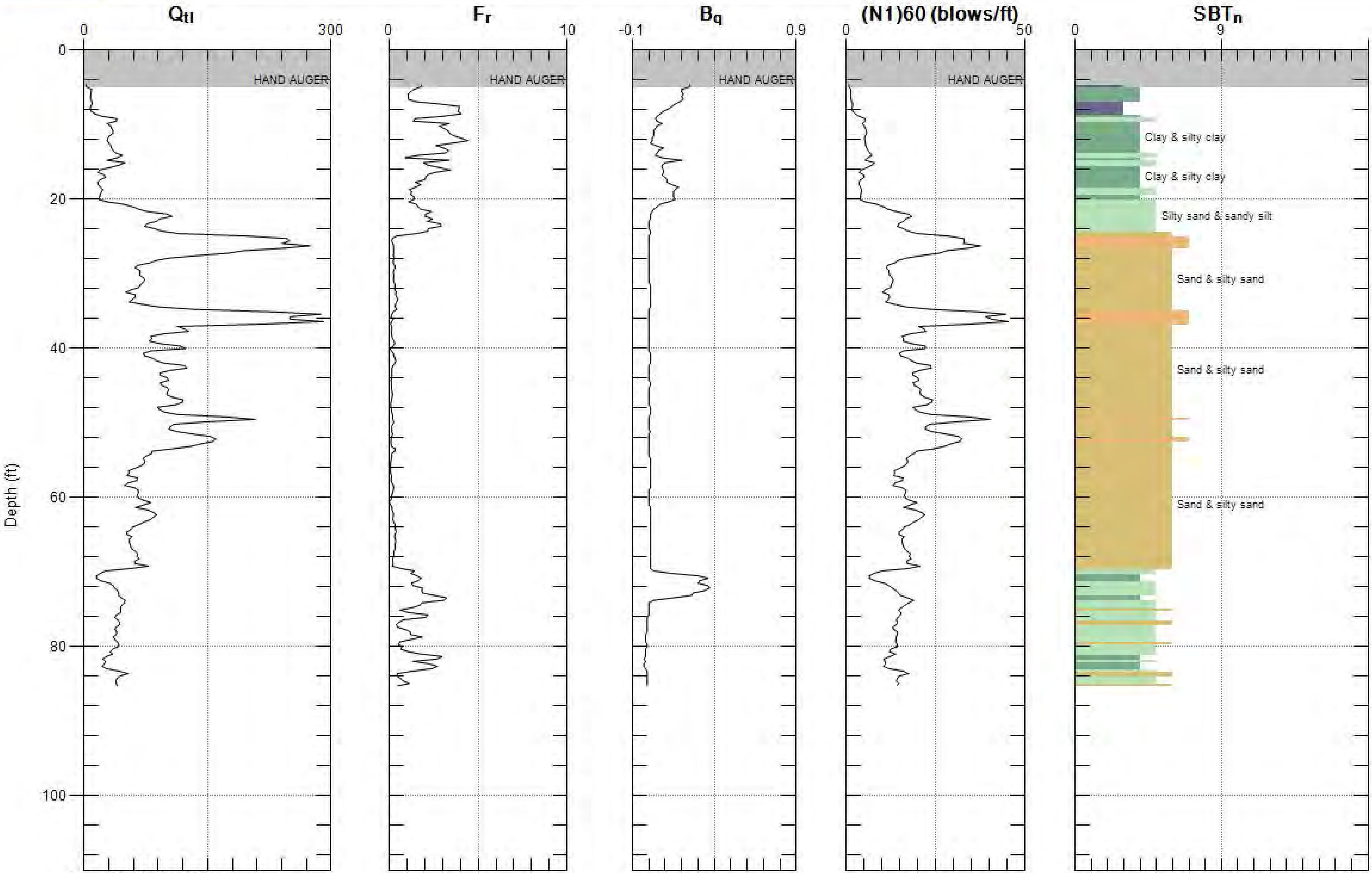
GREGG DWR

Site: RYER ISLAND

Sounding: RIS-6

Engineer: M.SOUVERVILLE

Date: 3/26/2012 10:36



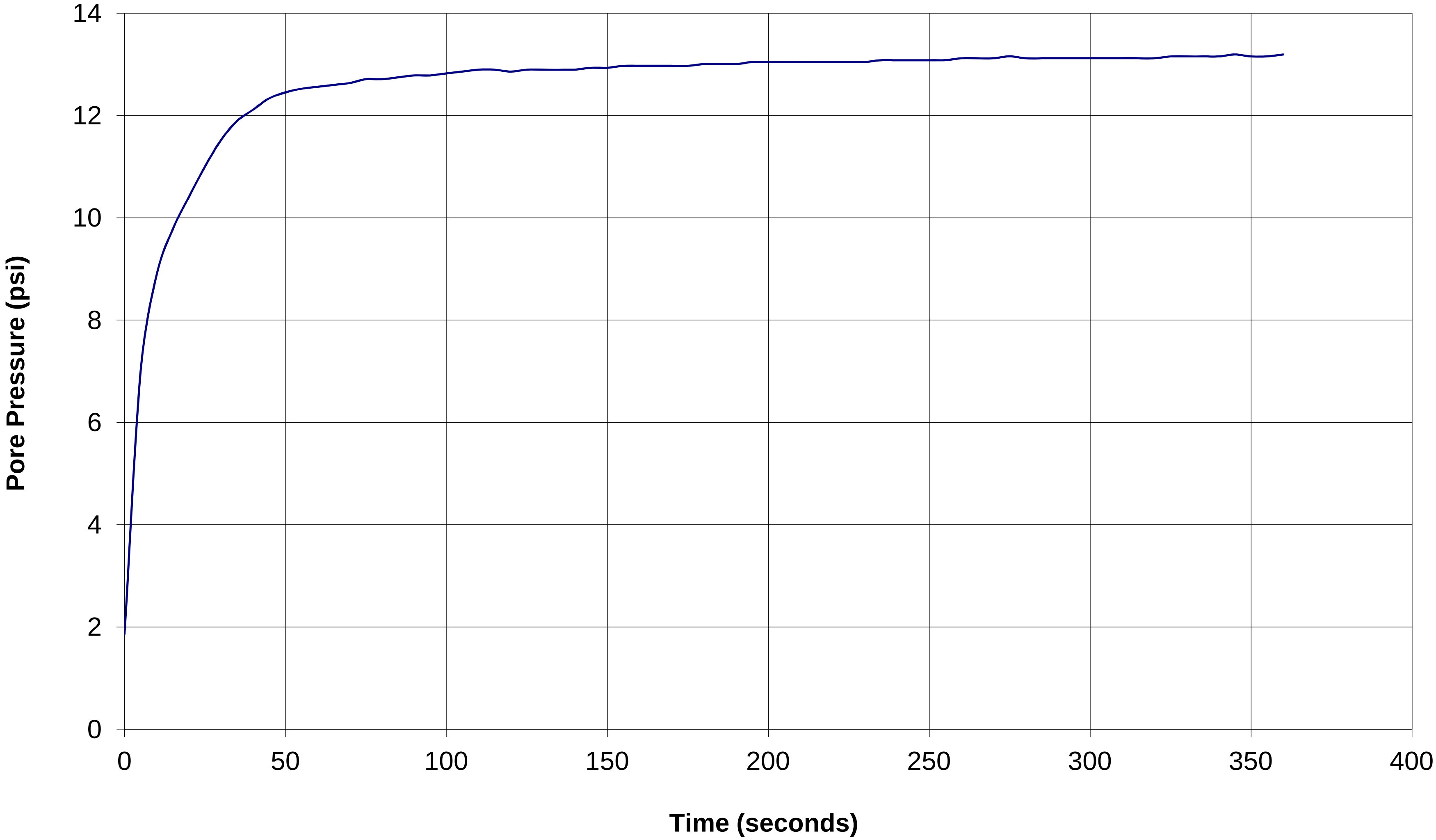

Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

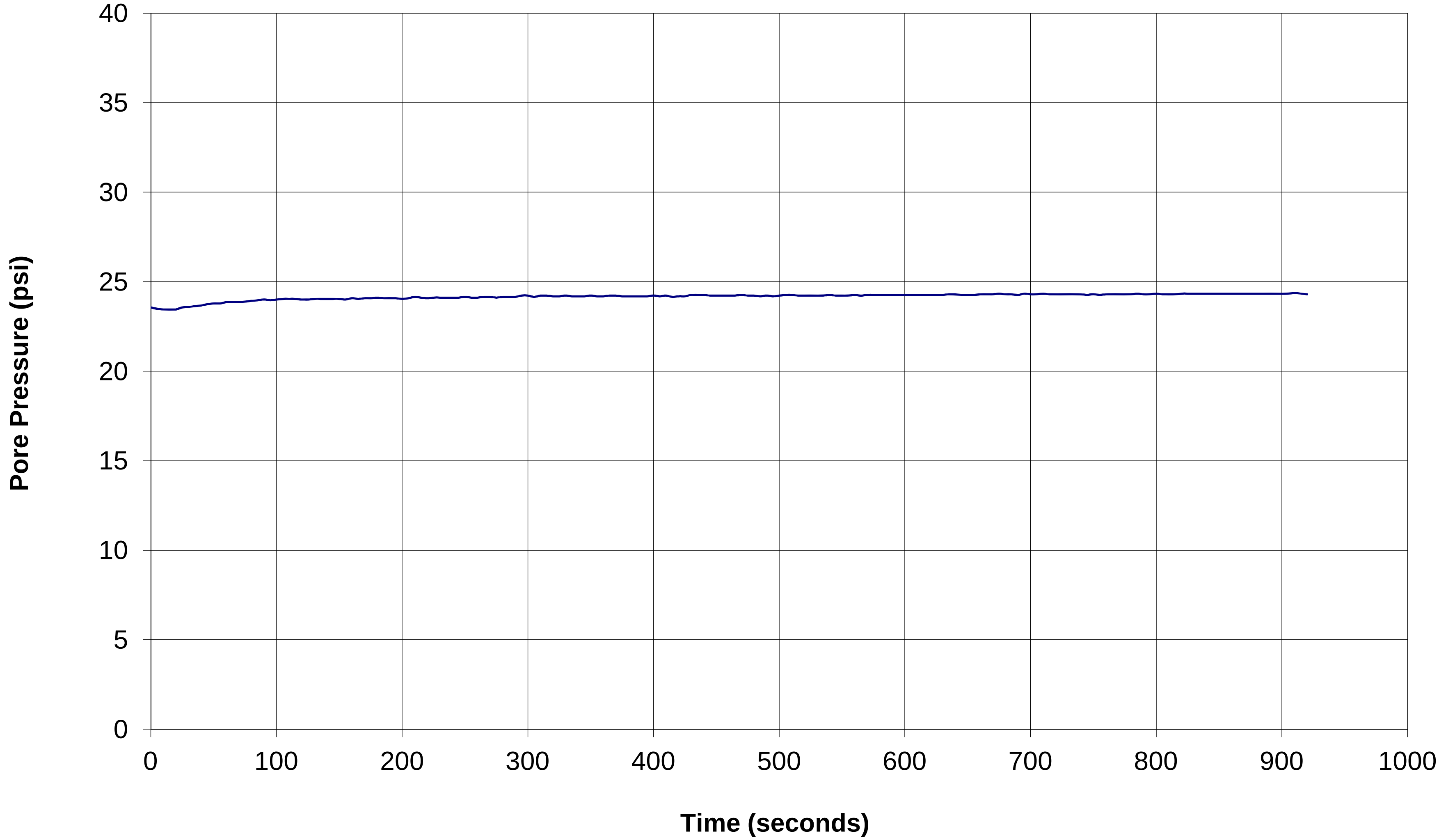
Sounding: RI-2
Depth: 52.0011555
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

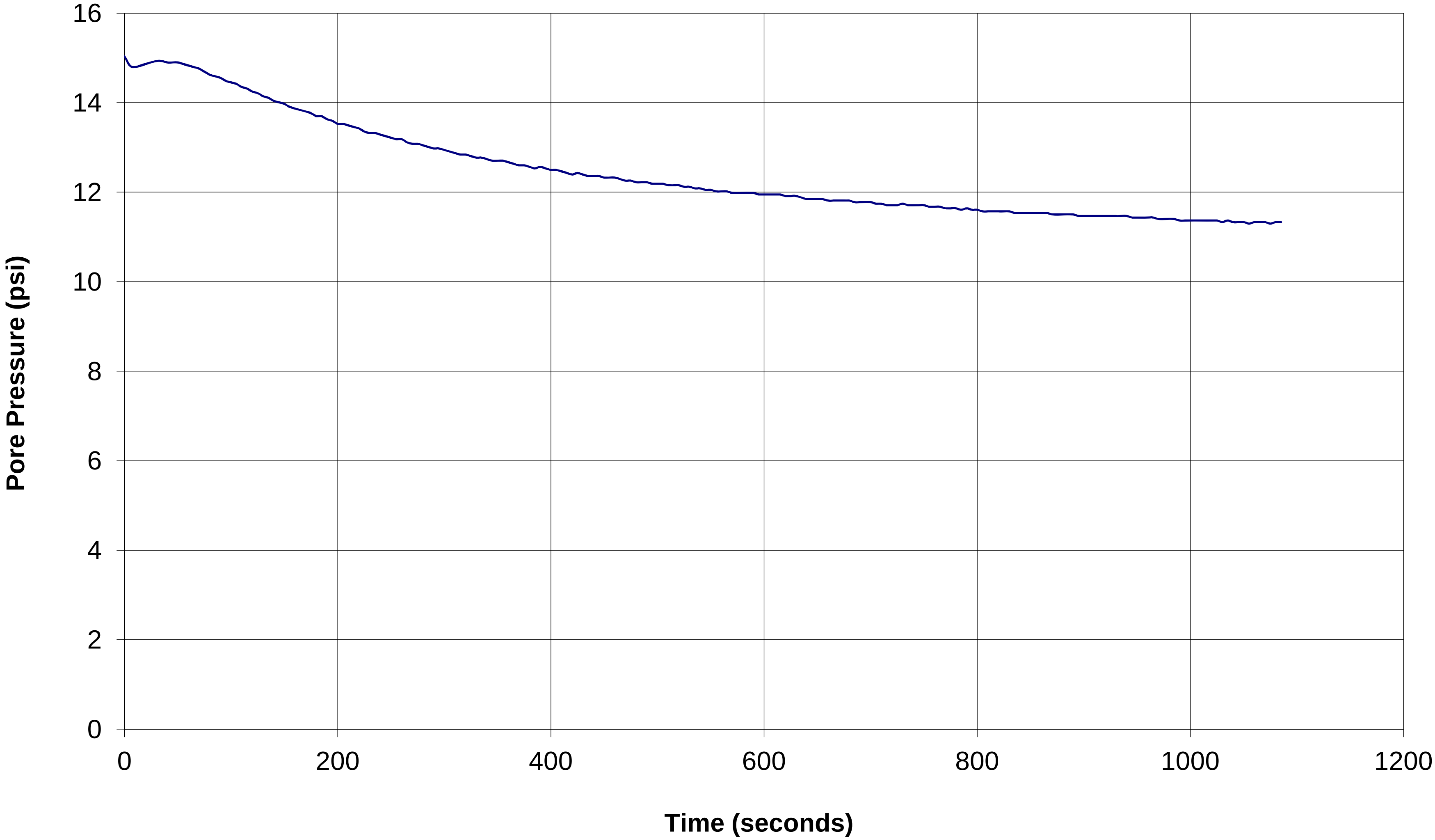
| | |
|---|---|
| Sounding: | RI-2 |
| Depth: | 75.9512145 |
| Site: | RYER ISLAND |
| Engineer: | M.SOUVERVILLE |



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

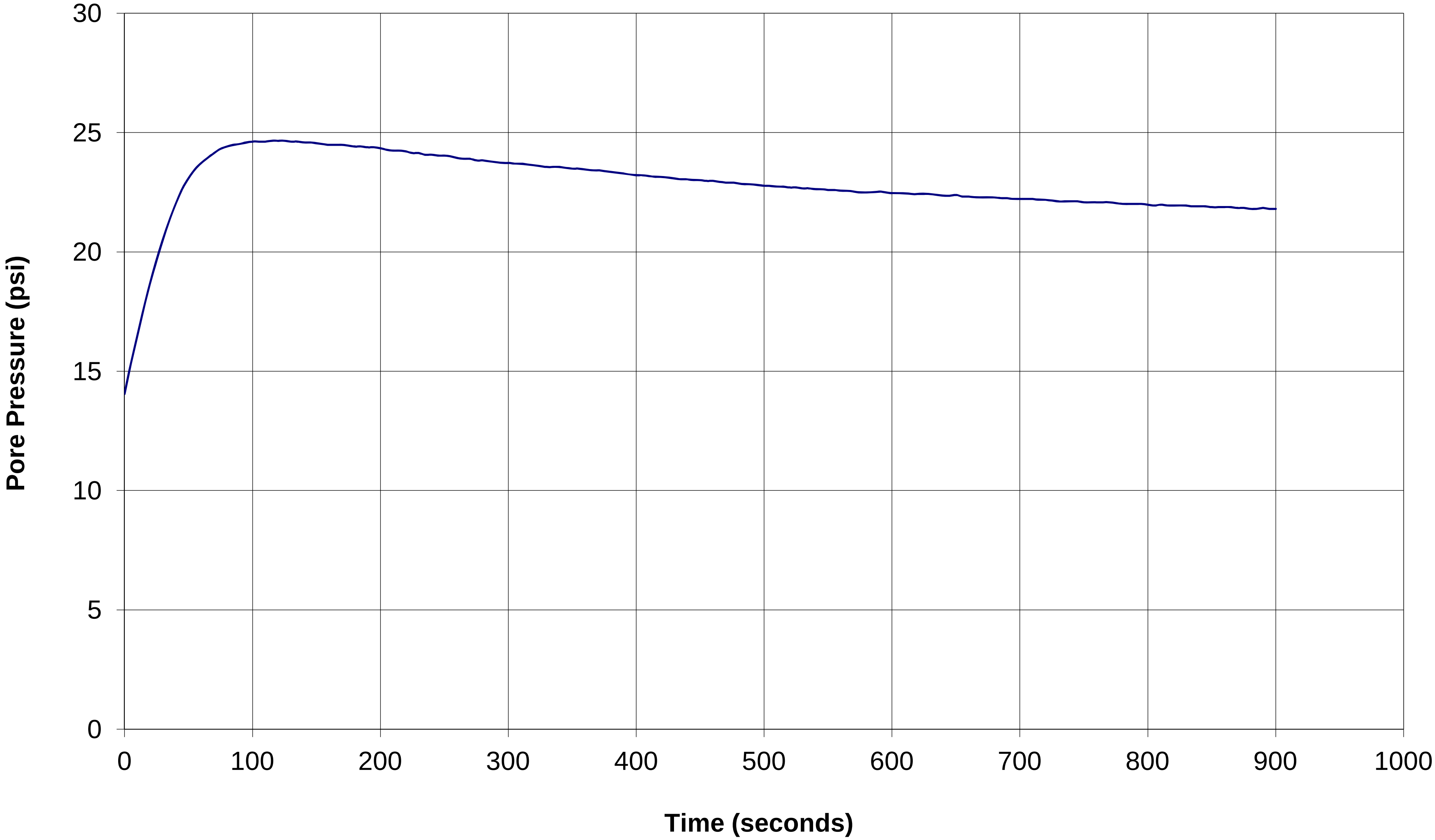
Sounding: RI-3
Depth: 13.6154445
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

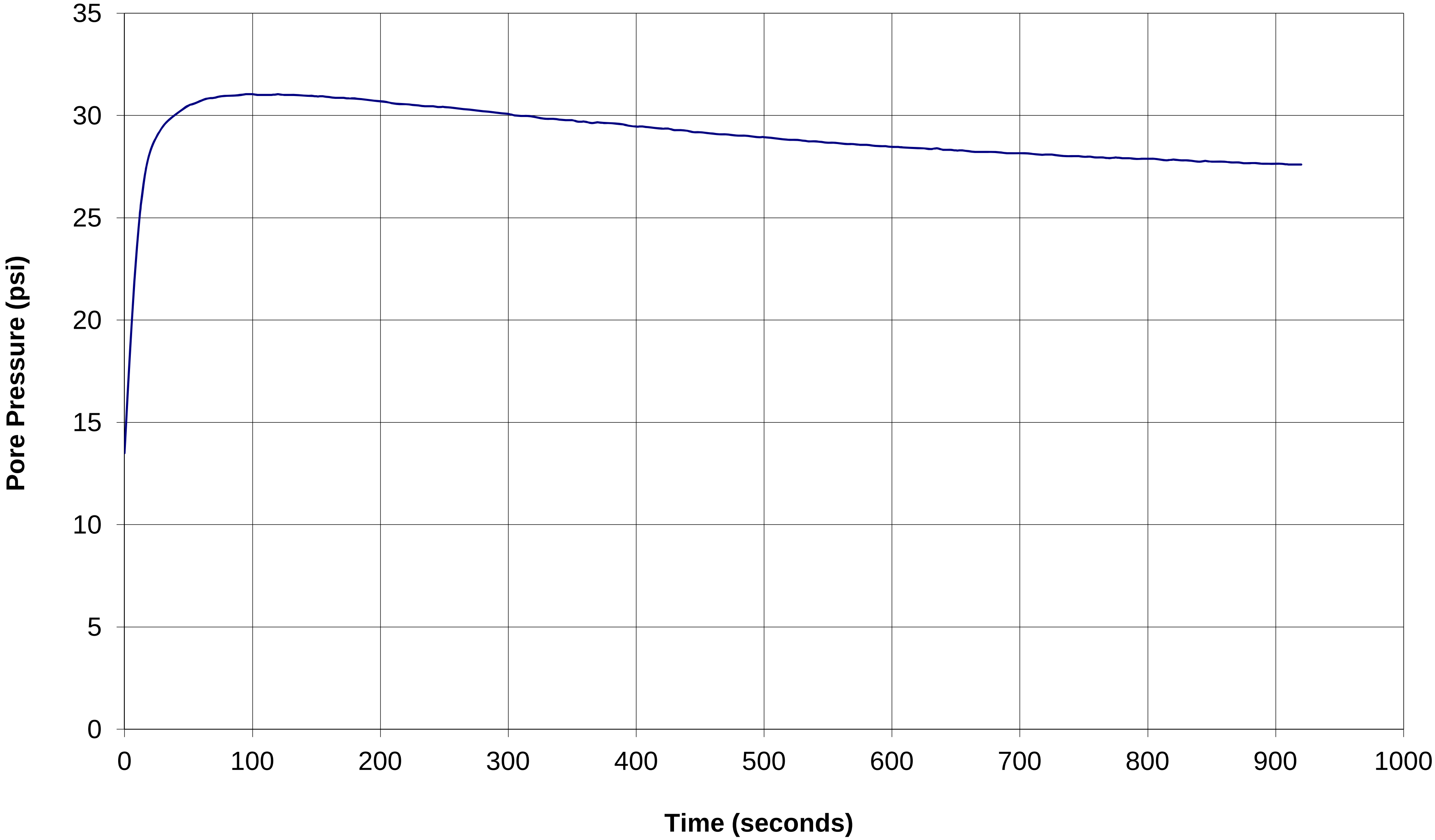
Sounding: RI-3
Depth: 38.057628
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

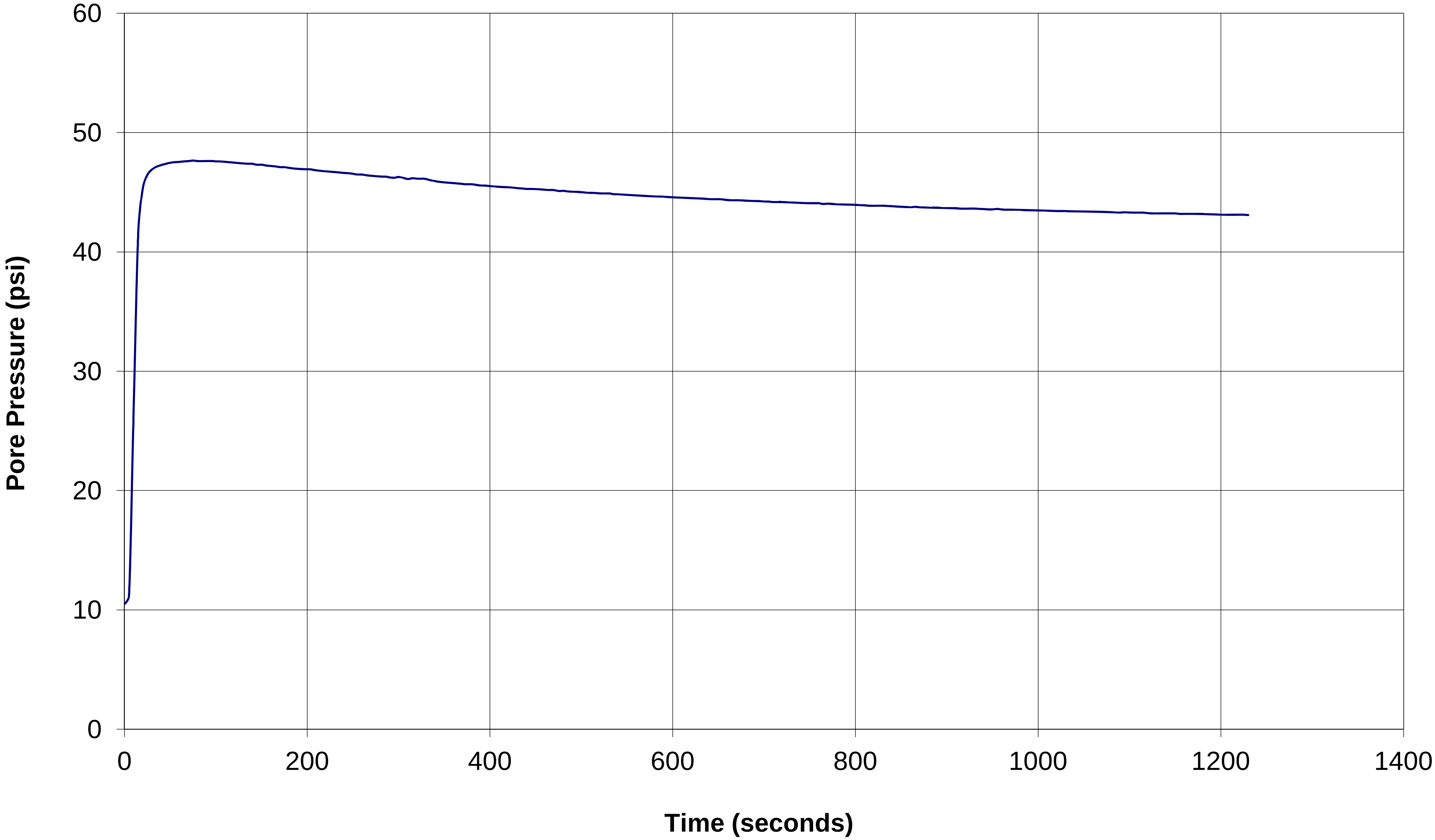
Sounding: RI-3
Depth: 50.0326575
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

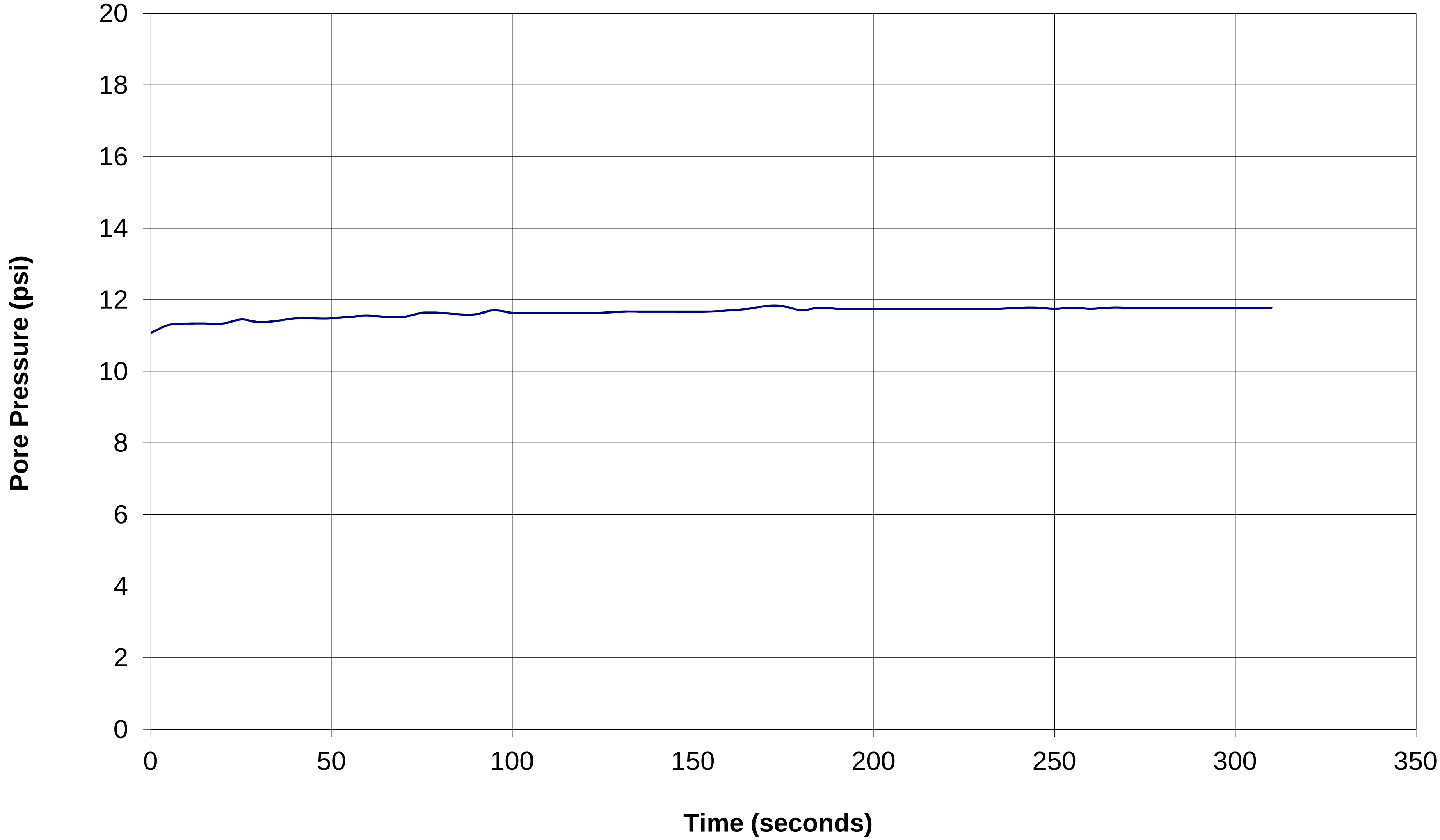
Sounding: RI-3
Depth: 87.1060365
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

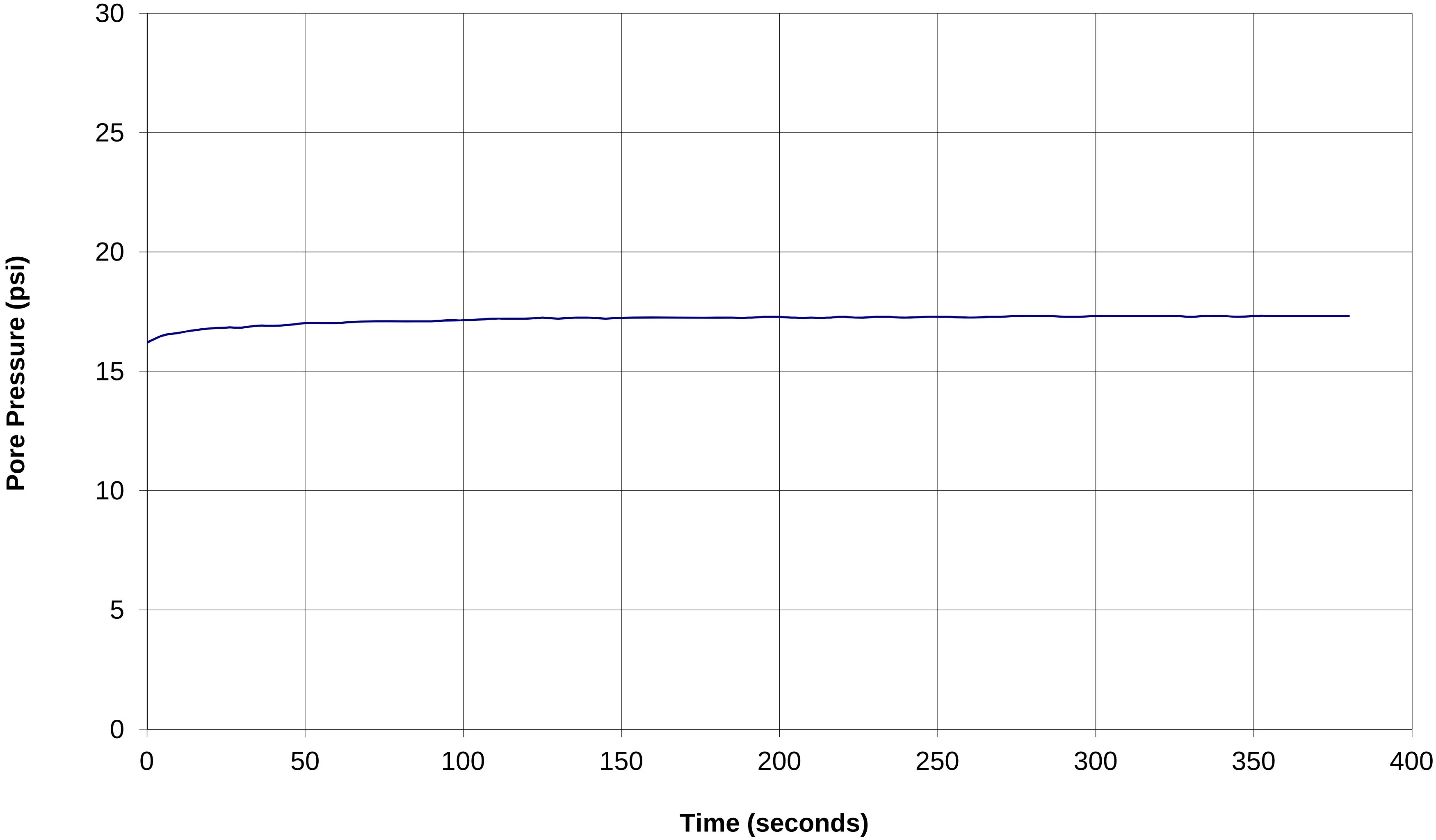
Sounding: RI-4
Depth: 25.918557
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

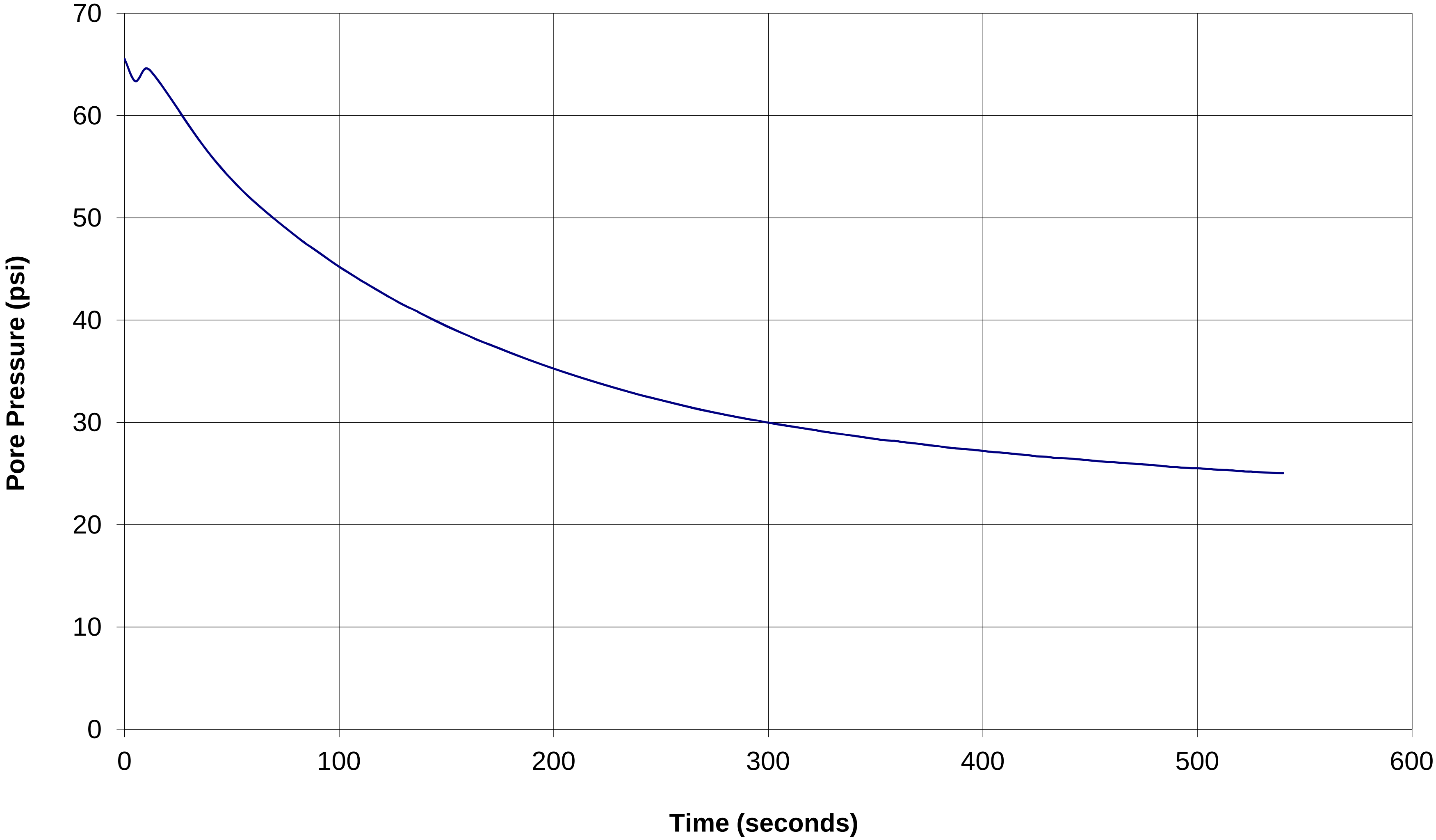
Sounding: RI-4
Depth: 37.8935865
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

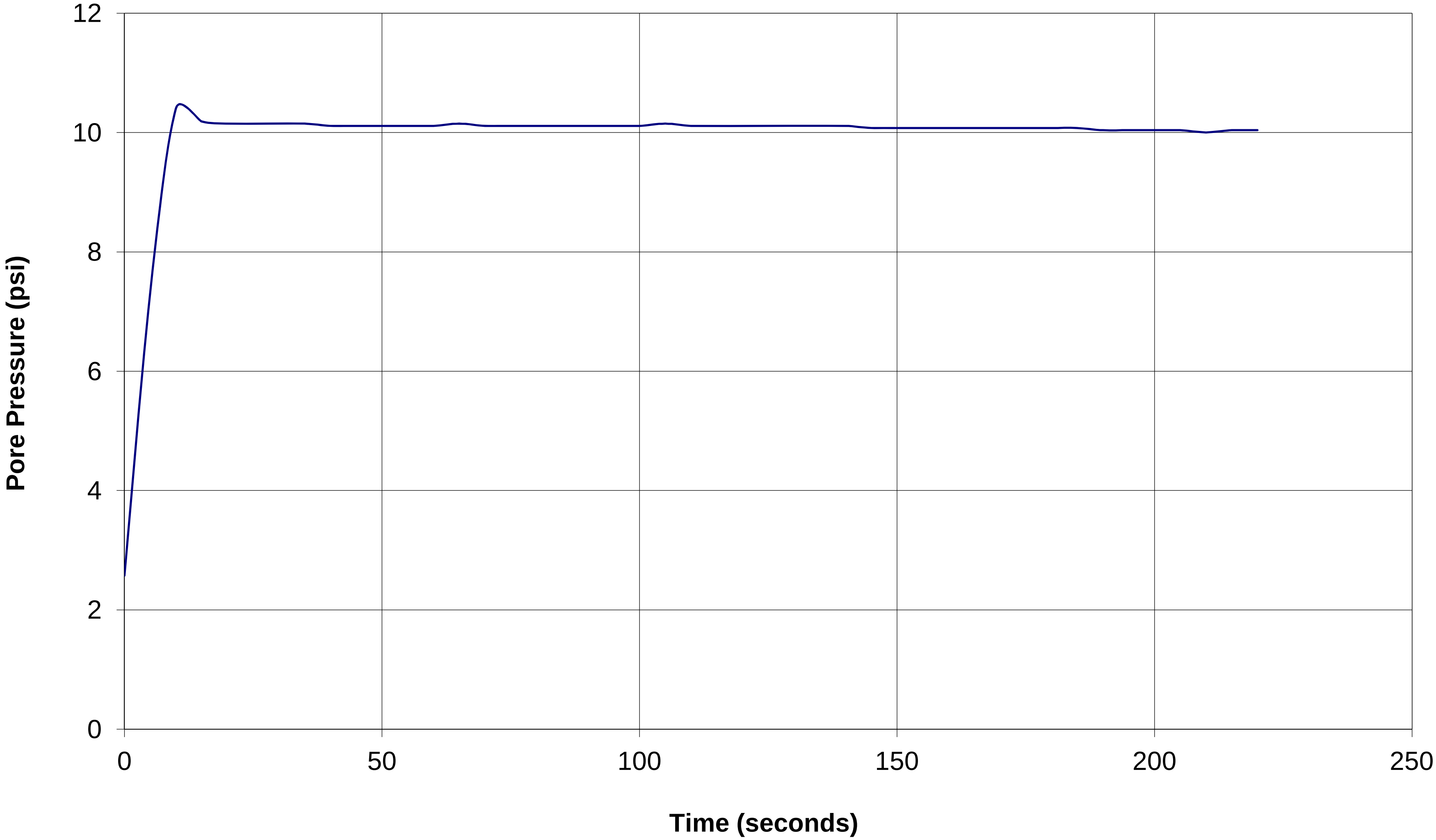
Sounding: RI-5
Depth: 11.810988
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

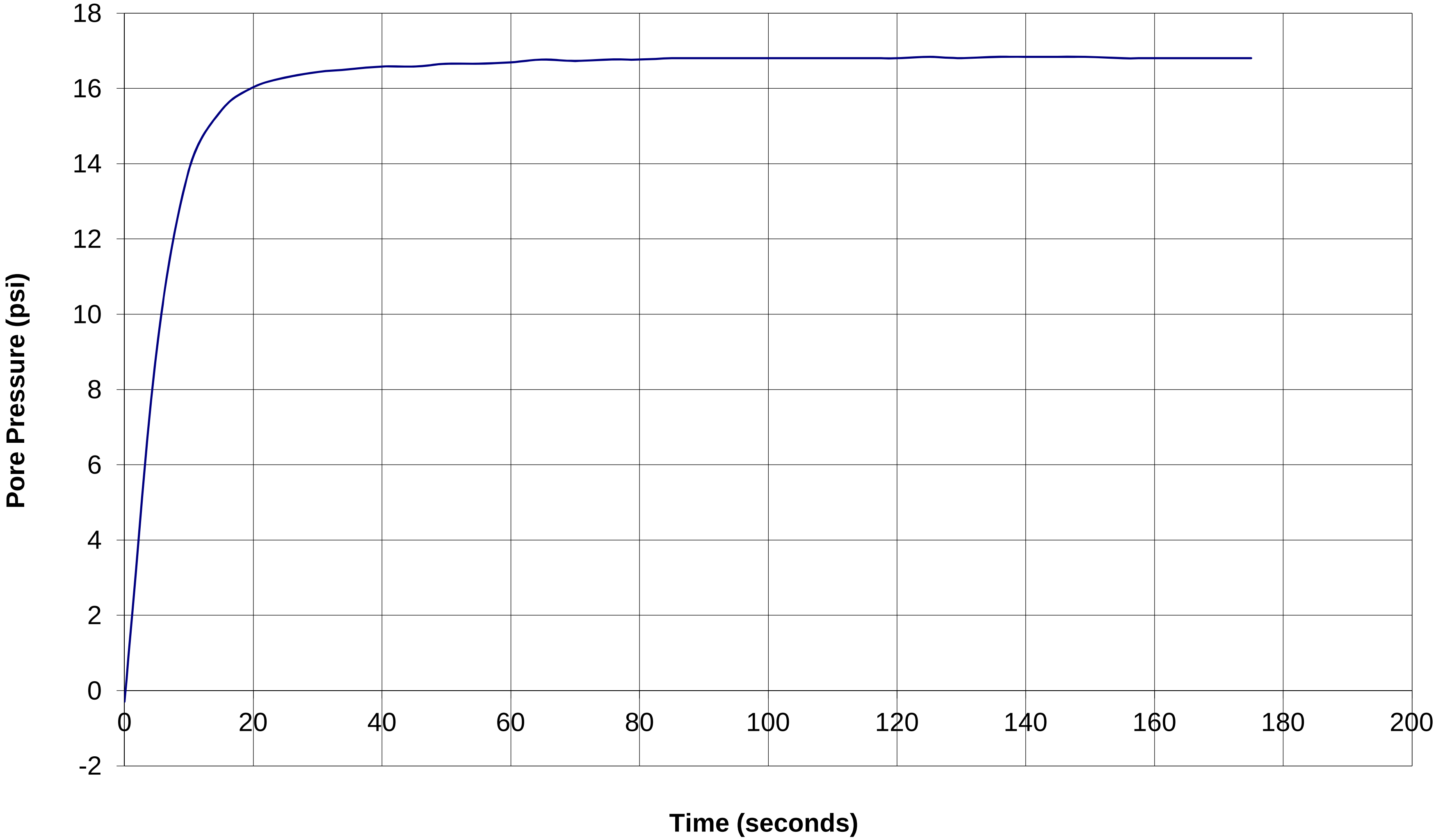
Sounding: RI-5
Depth: 24.934308
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

| | |
|---|---|
| Sounding: | RI-5 |
| Depth: | 40.354209 |
| Site: | RYER ISLAND |
| Engineer: | M.SOUVERVILLE |

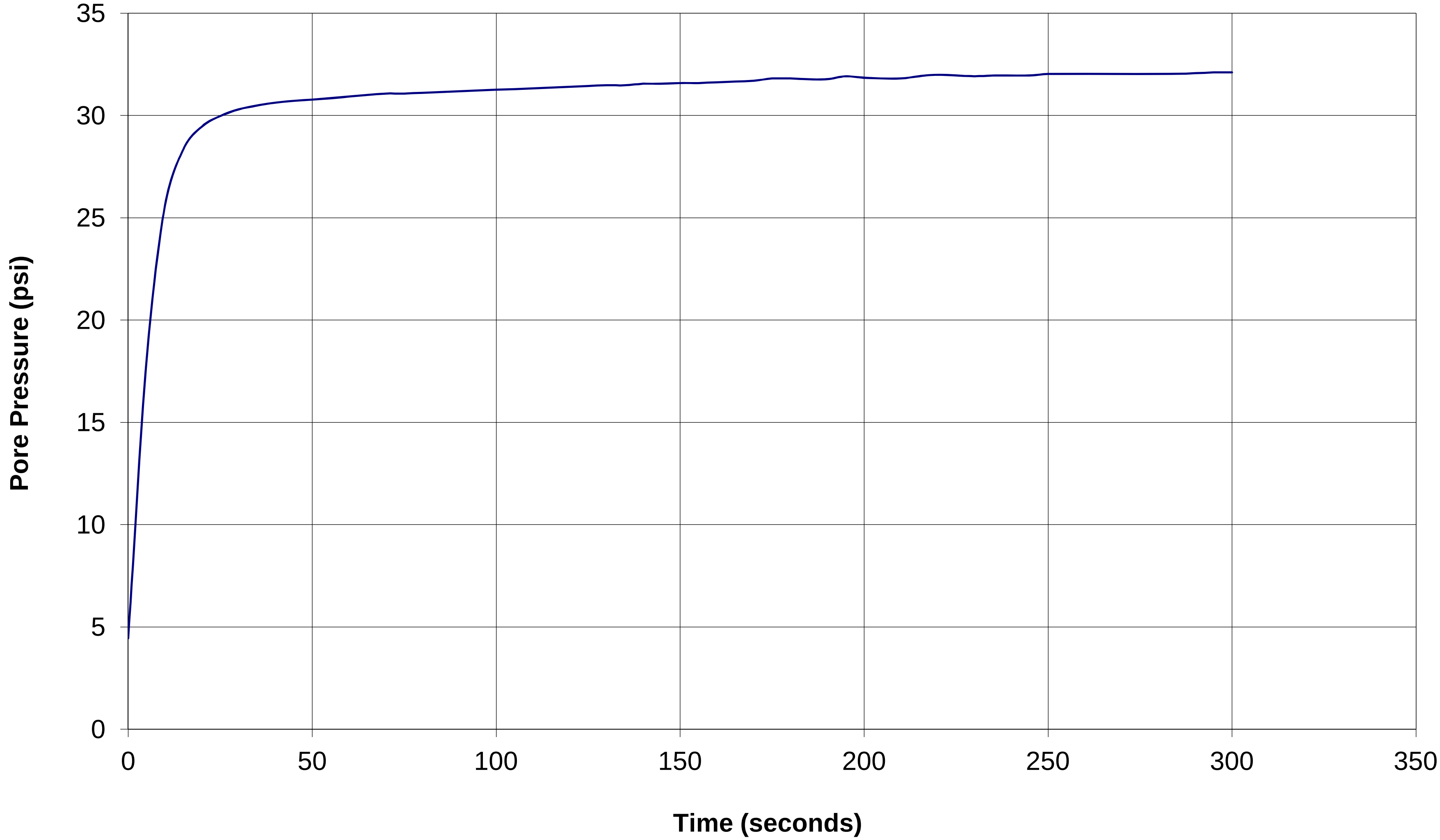


GREGG

# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

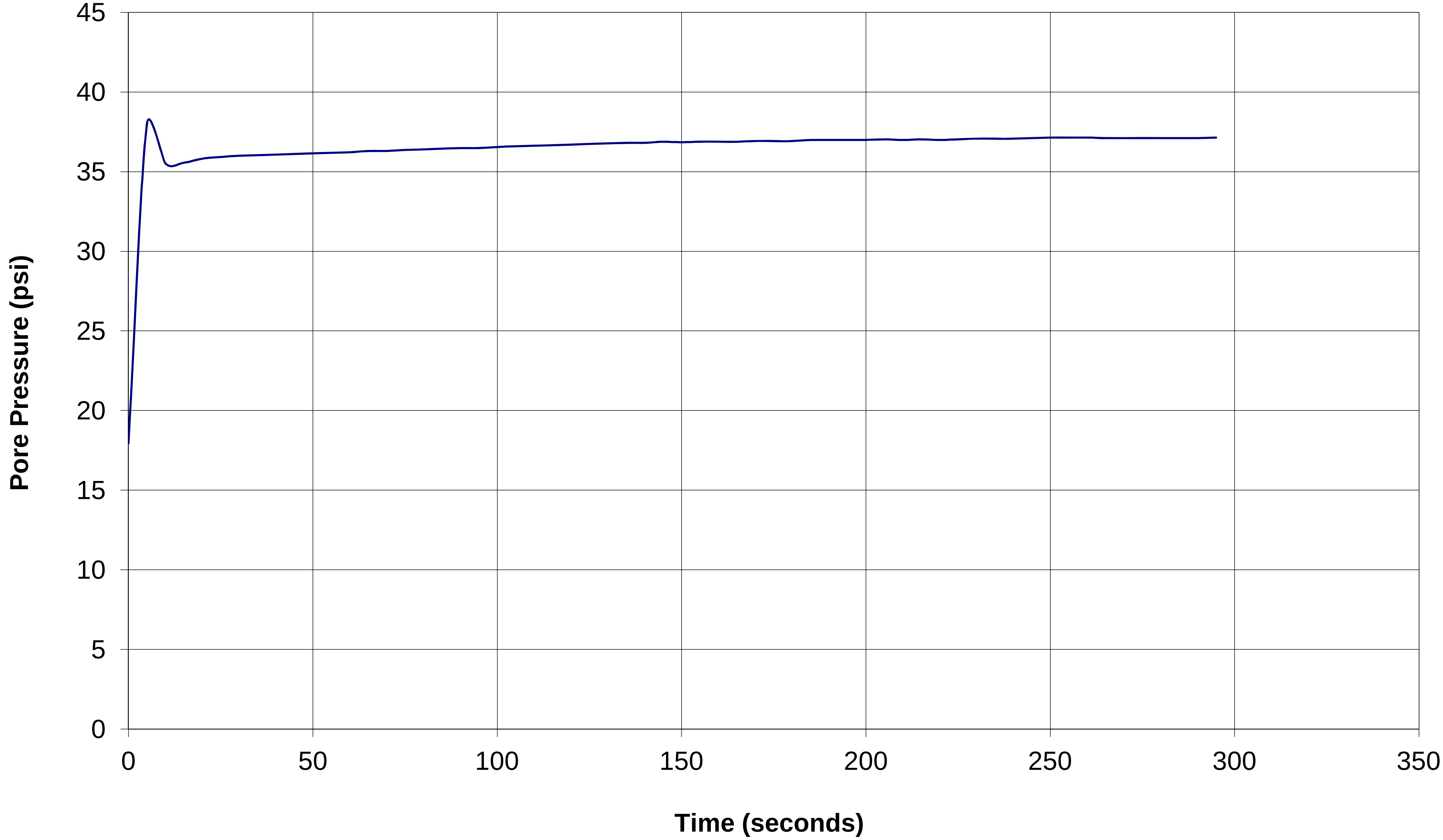
Sounding: RI-5
Depth: 79.8882105
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

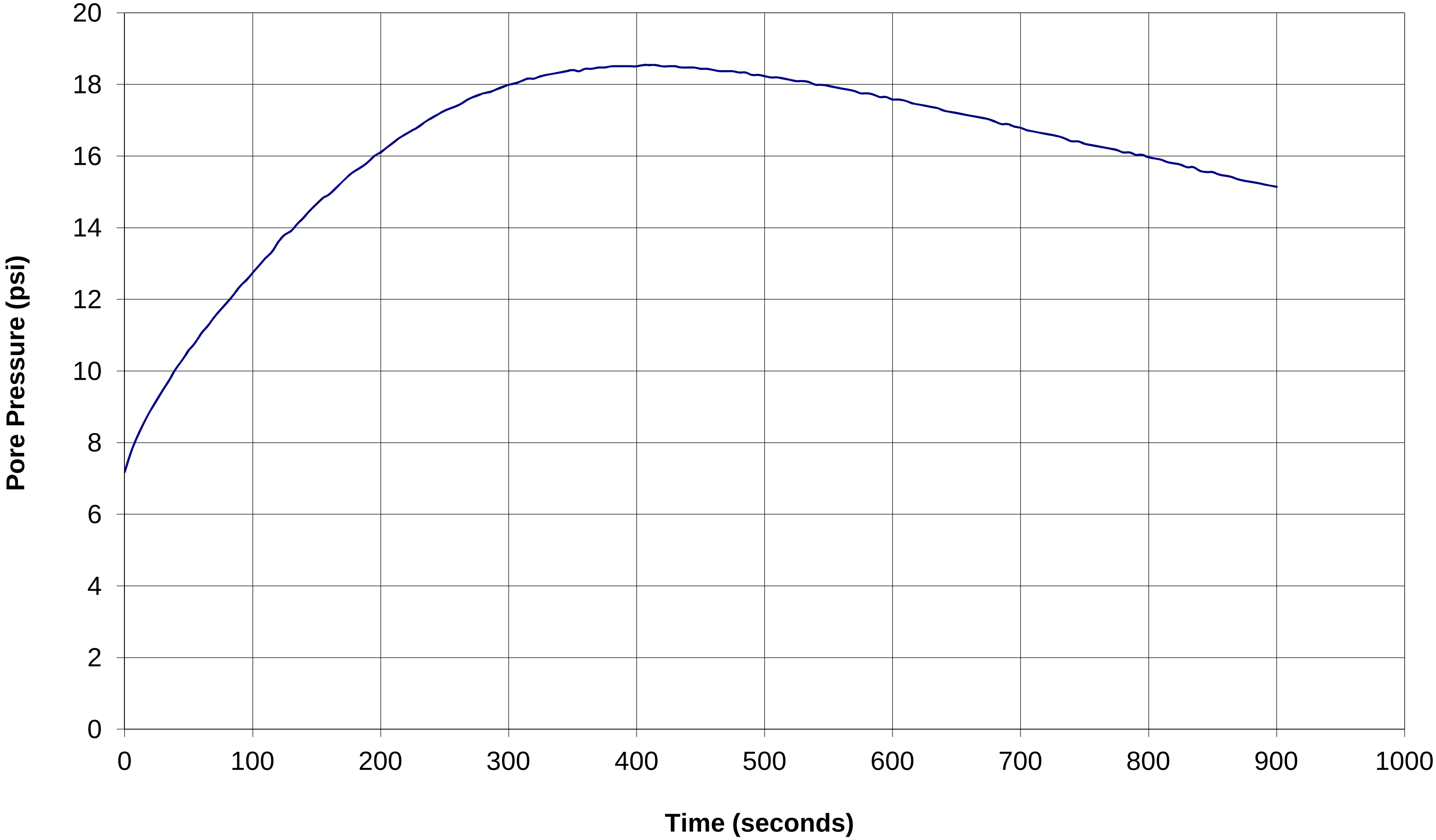
Sounding: RI-5
Depth: 90.0587835
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

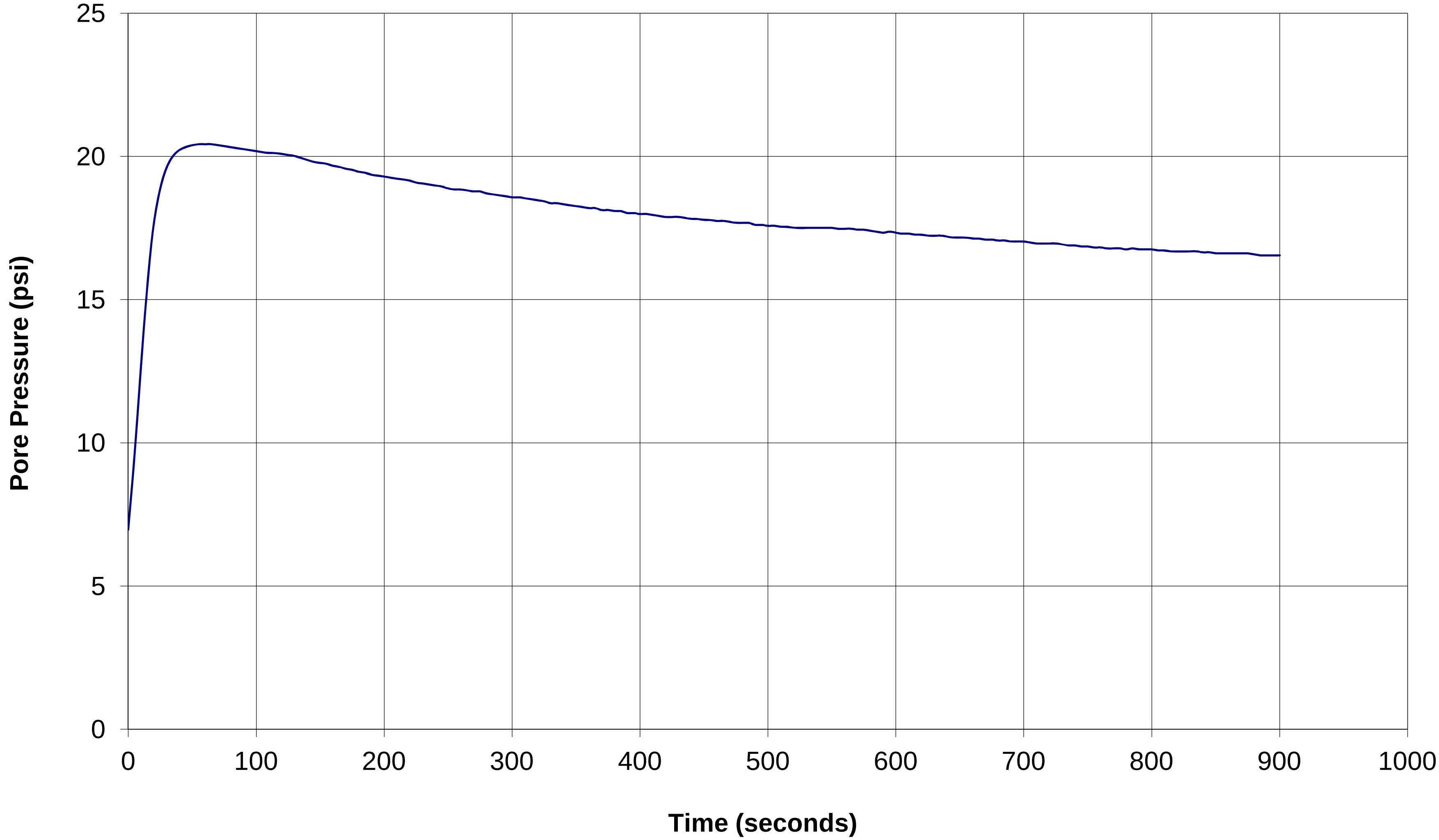
Sounding: RIS-1
Depth: 10.170573
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

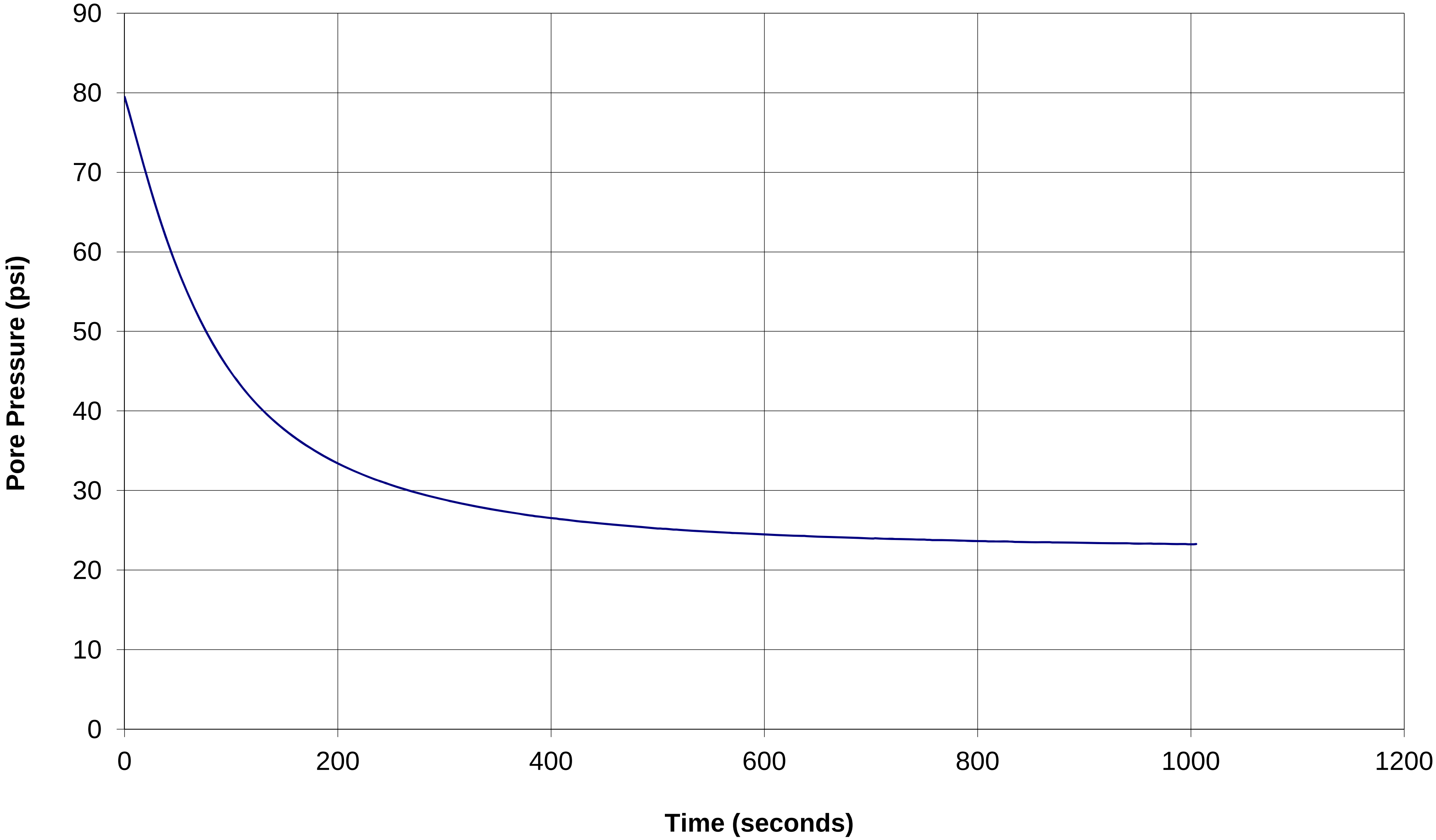
Sounding: RIS-1
Depth: 32.8083
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

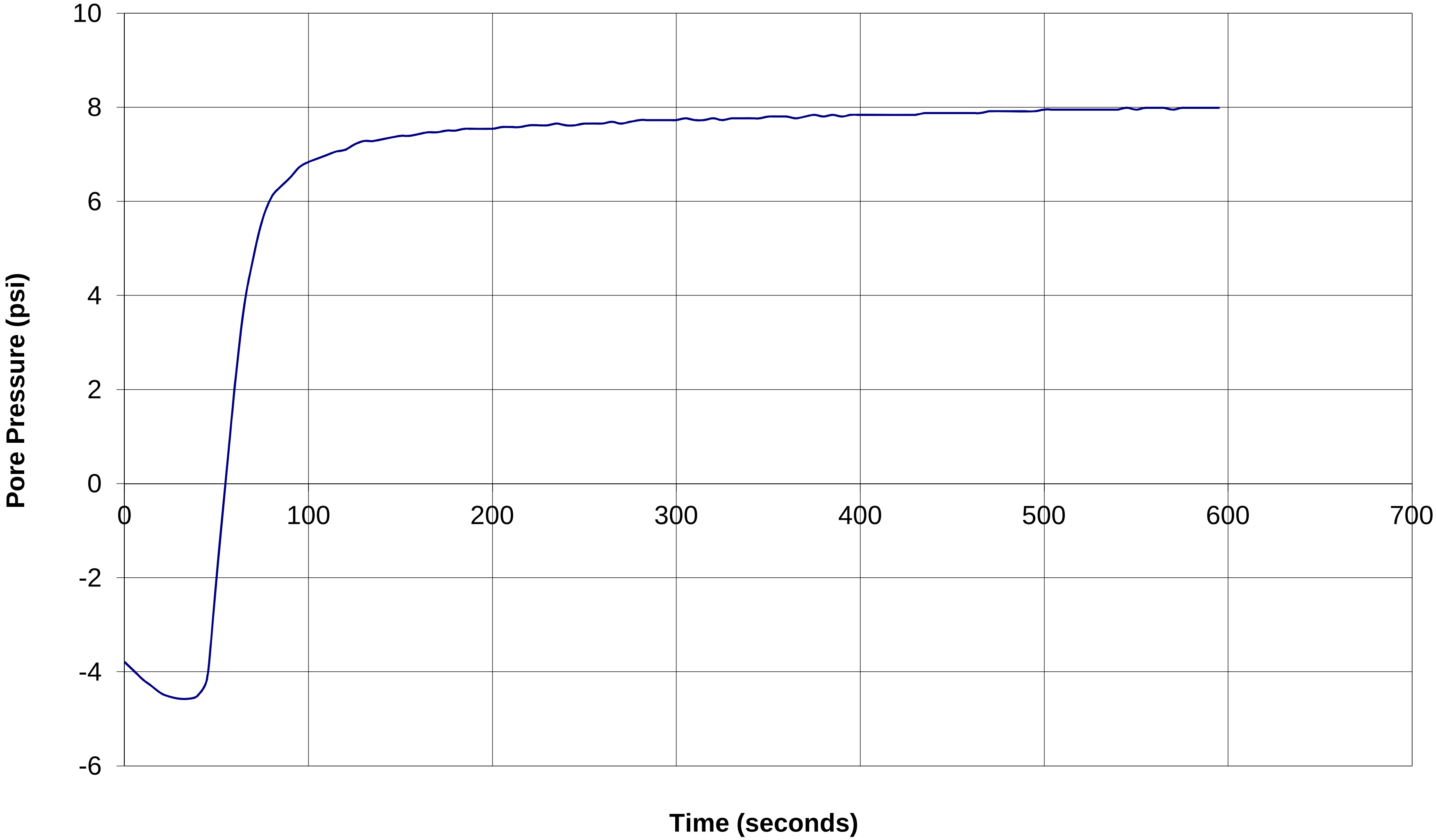
Sounding: RIS-1
Depth: 50.0326575
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

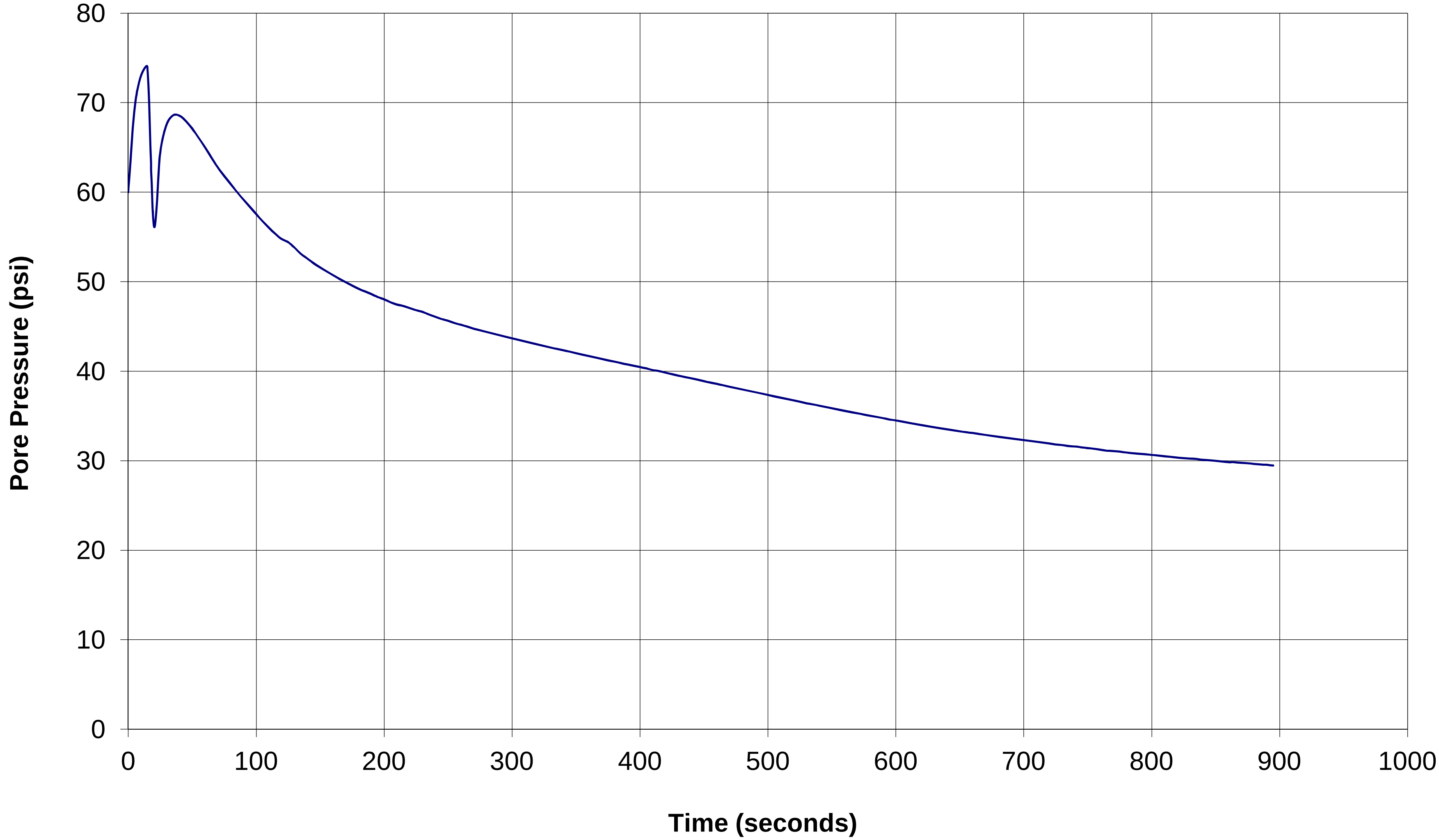
Sounding: RIS-4
Depth: 17.060316
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

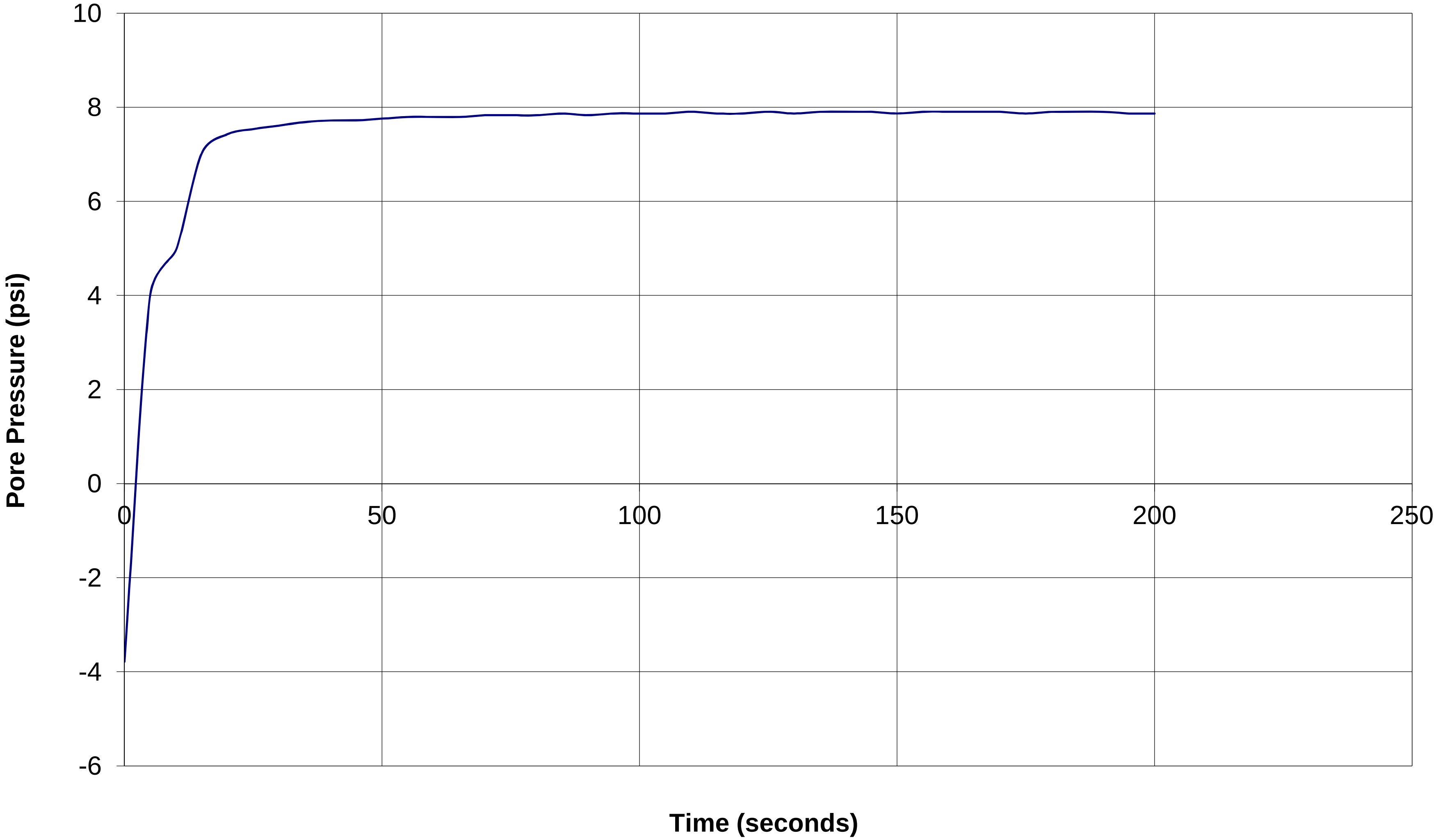
Sounding: RIS-5
Depth: 12.139071
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

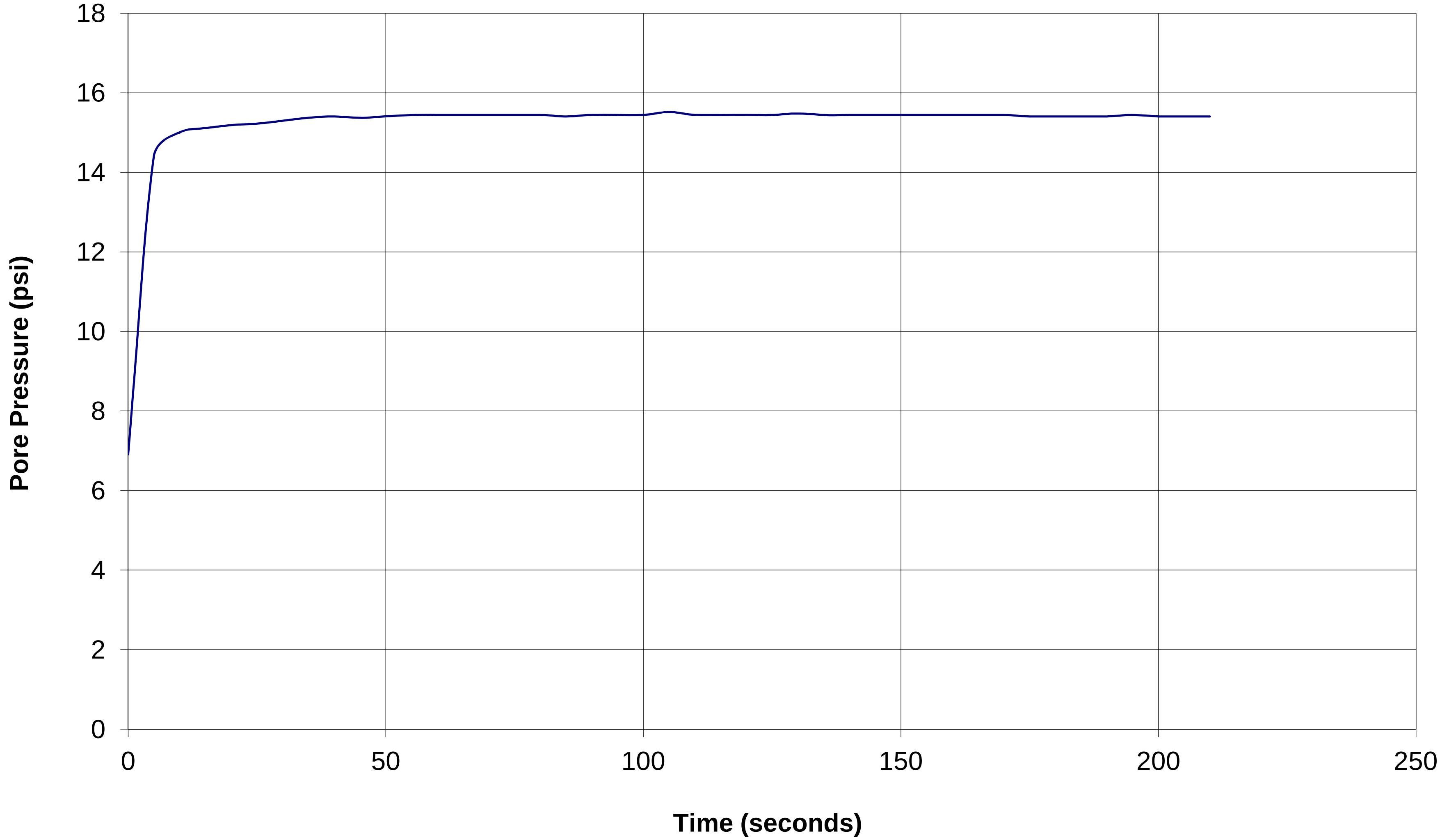
Sounding: RIS-5
Depth: 19.028814
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

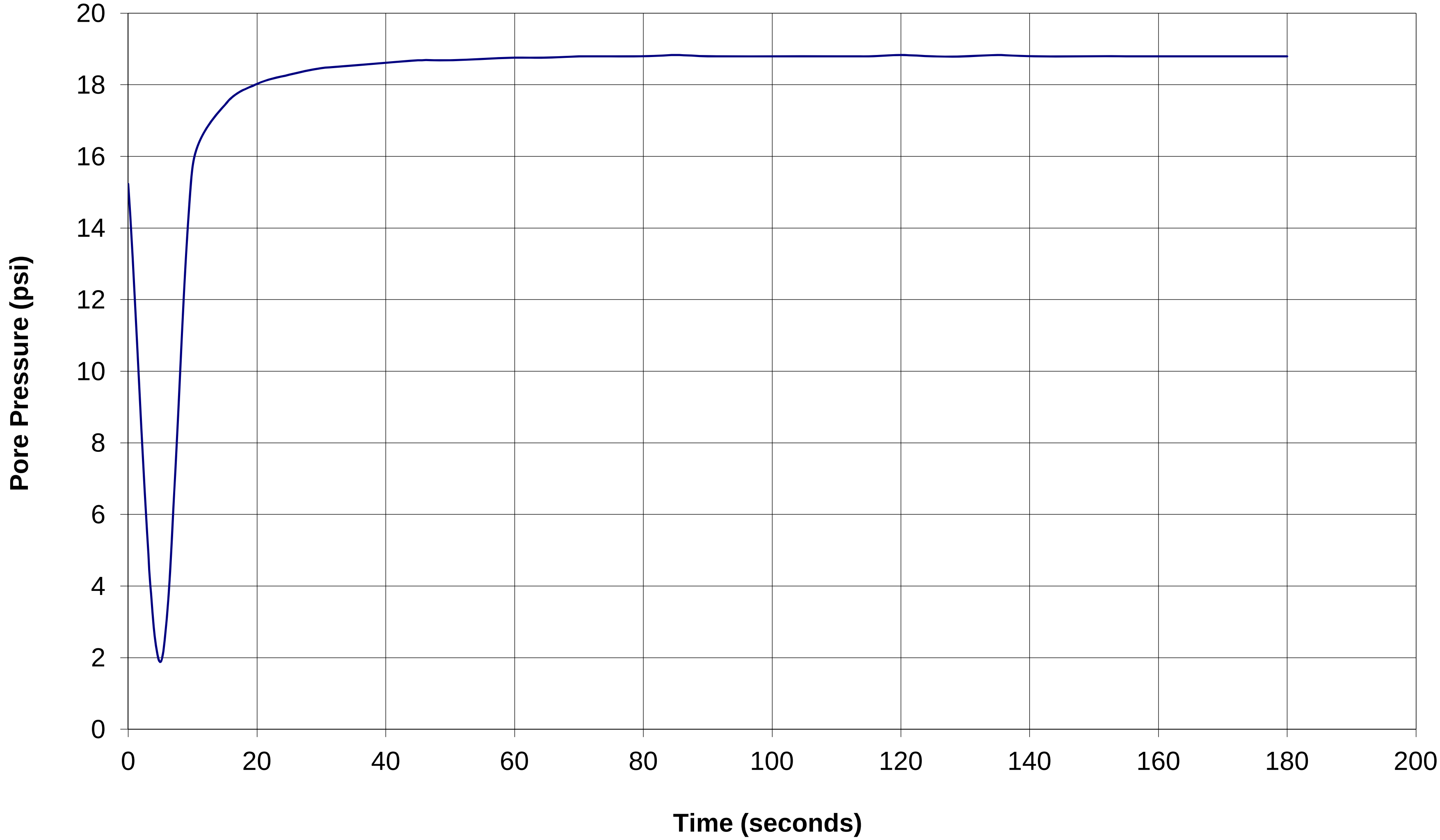
| | |
|---|---|
| Sounding: | RIS-5 |
| Depth: | 35.104881 |
| Site: | RYER ISLAND |
| Engineer: | M.SOUVERVILLE |



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

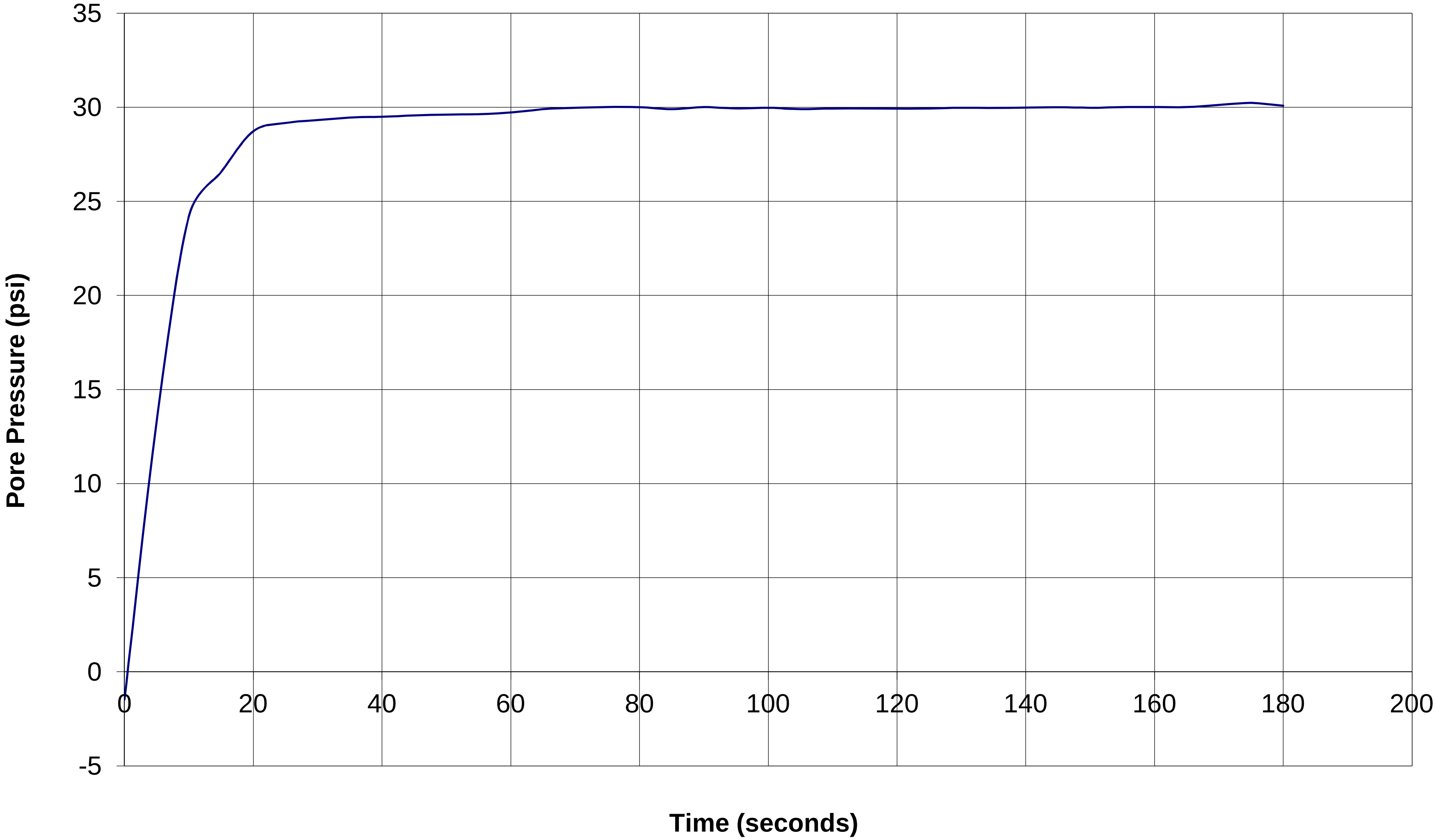
Sounding: RIS-5
Depth: 43.7990805
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

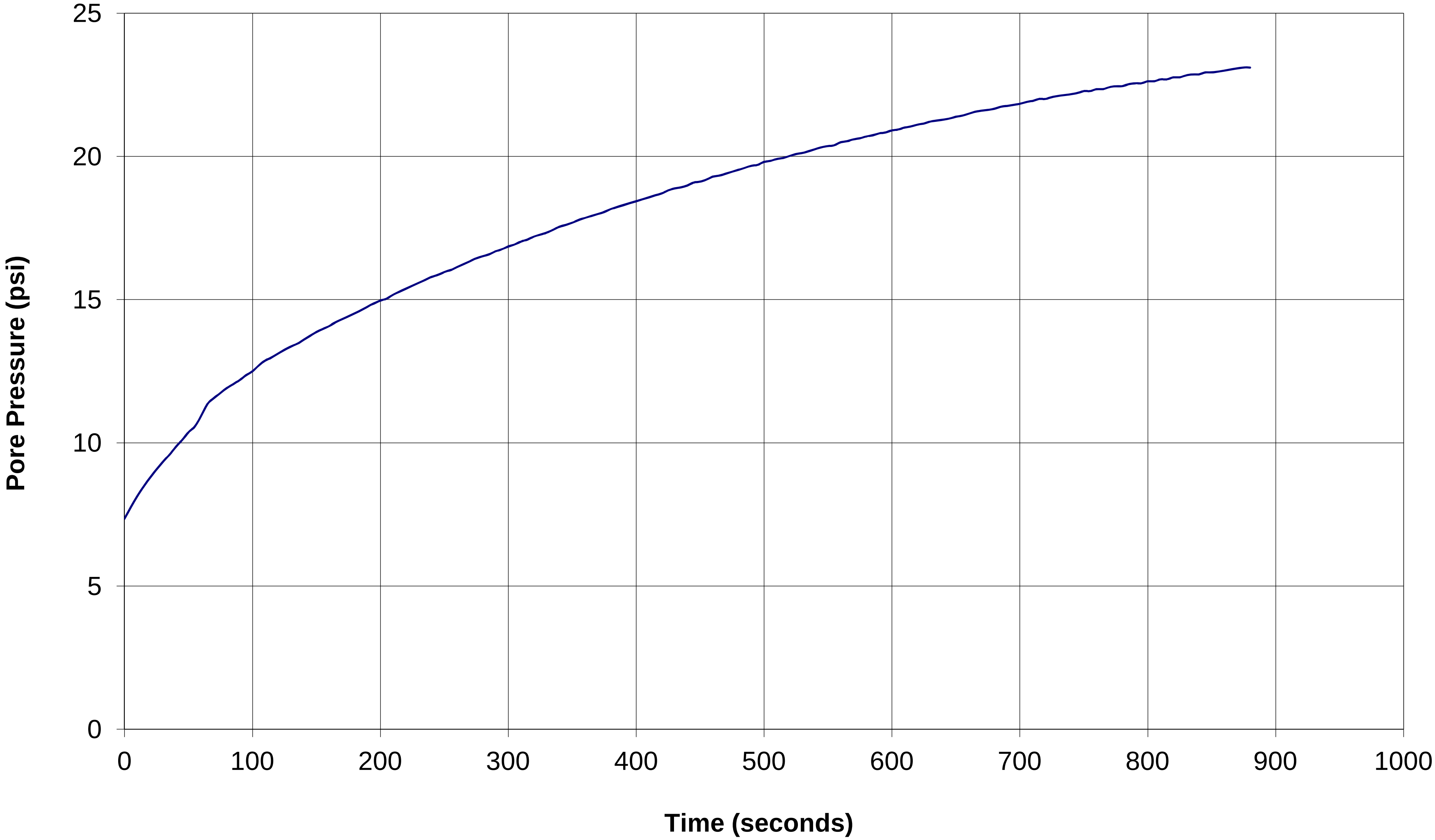
Sounding: RIS-5
Depth: 70.209762
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

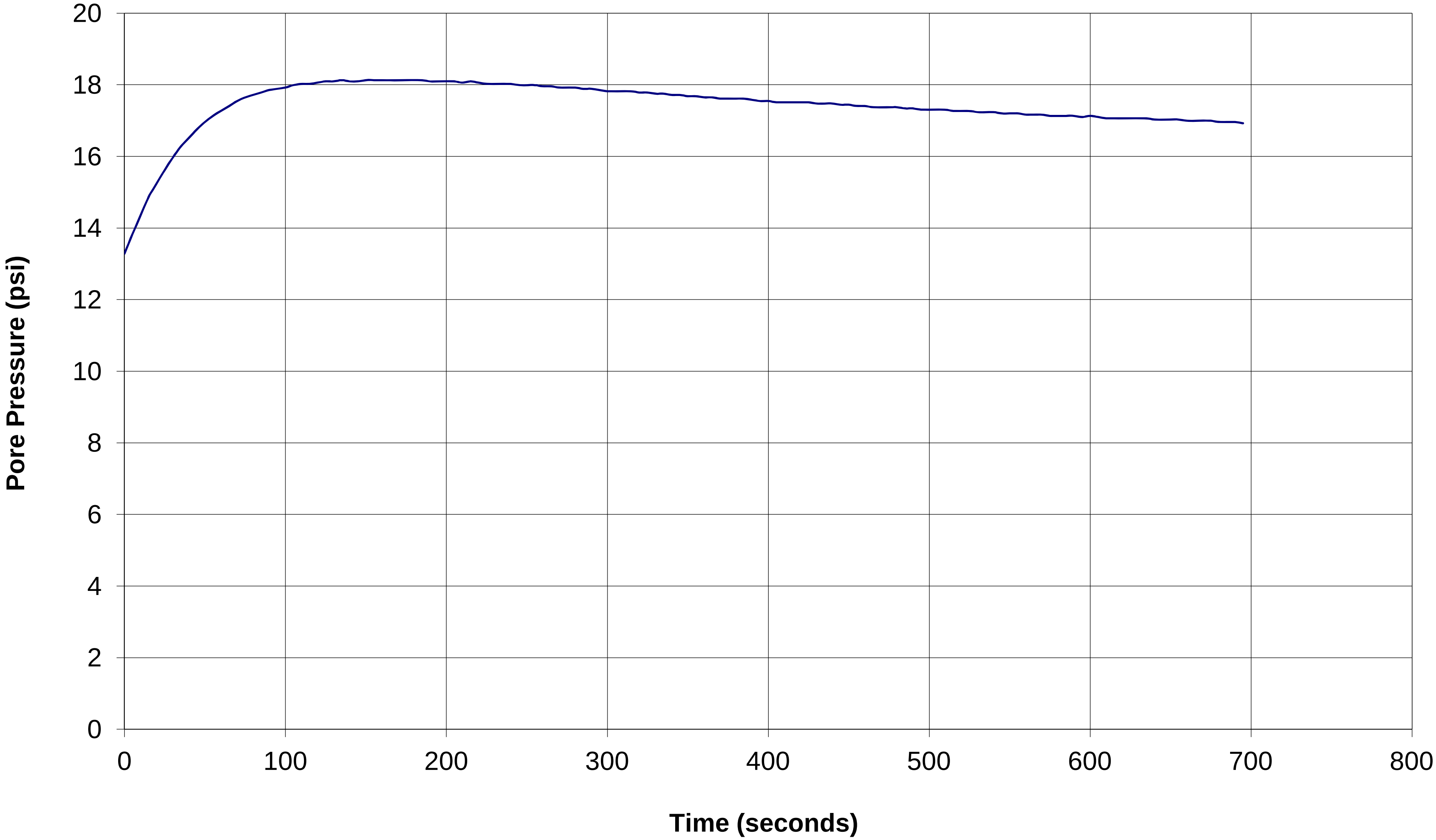
Sounding: RIS-6
Depth: 12.795237
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

## Pore Pressure Dissipation Test

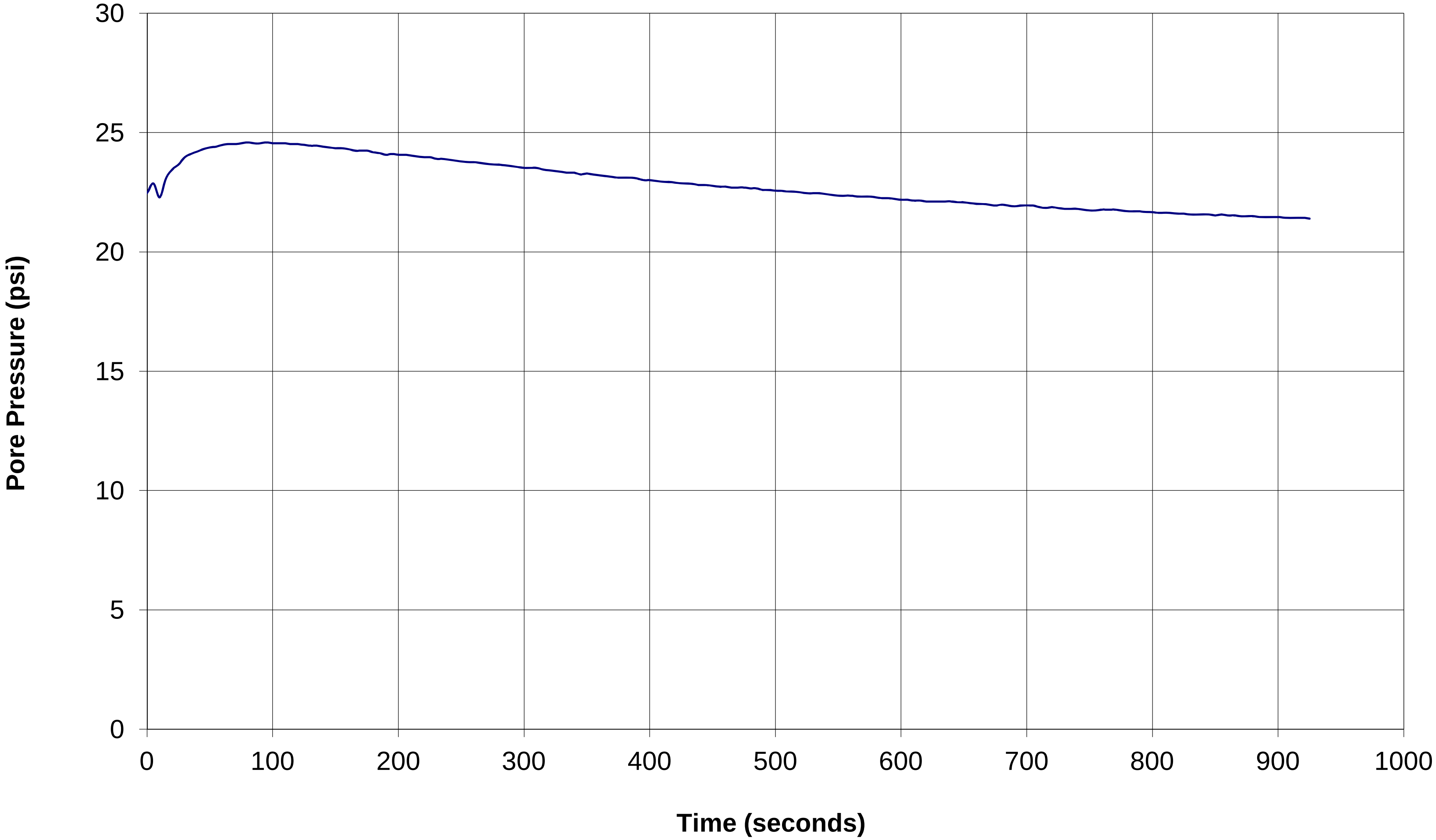
Sounding: RIS-6
Depth: 25.590474
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

**Pore Pressure Dissipation Test**

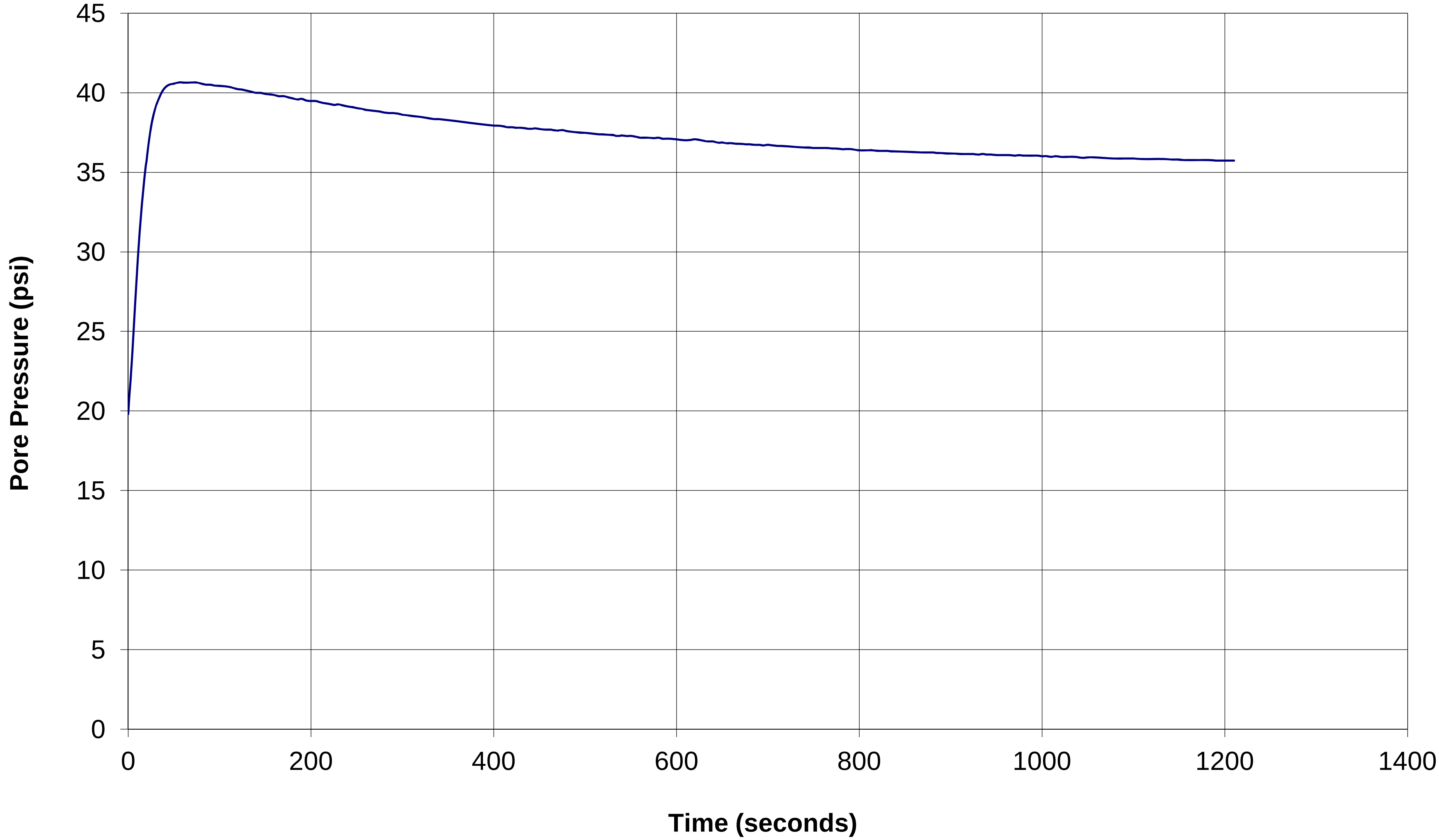
Sounding: RIS-6
Depth: 35.761047
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# GREGG DRILLING & TESTING

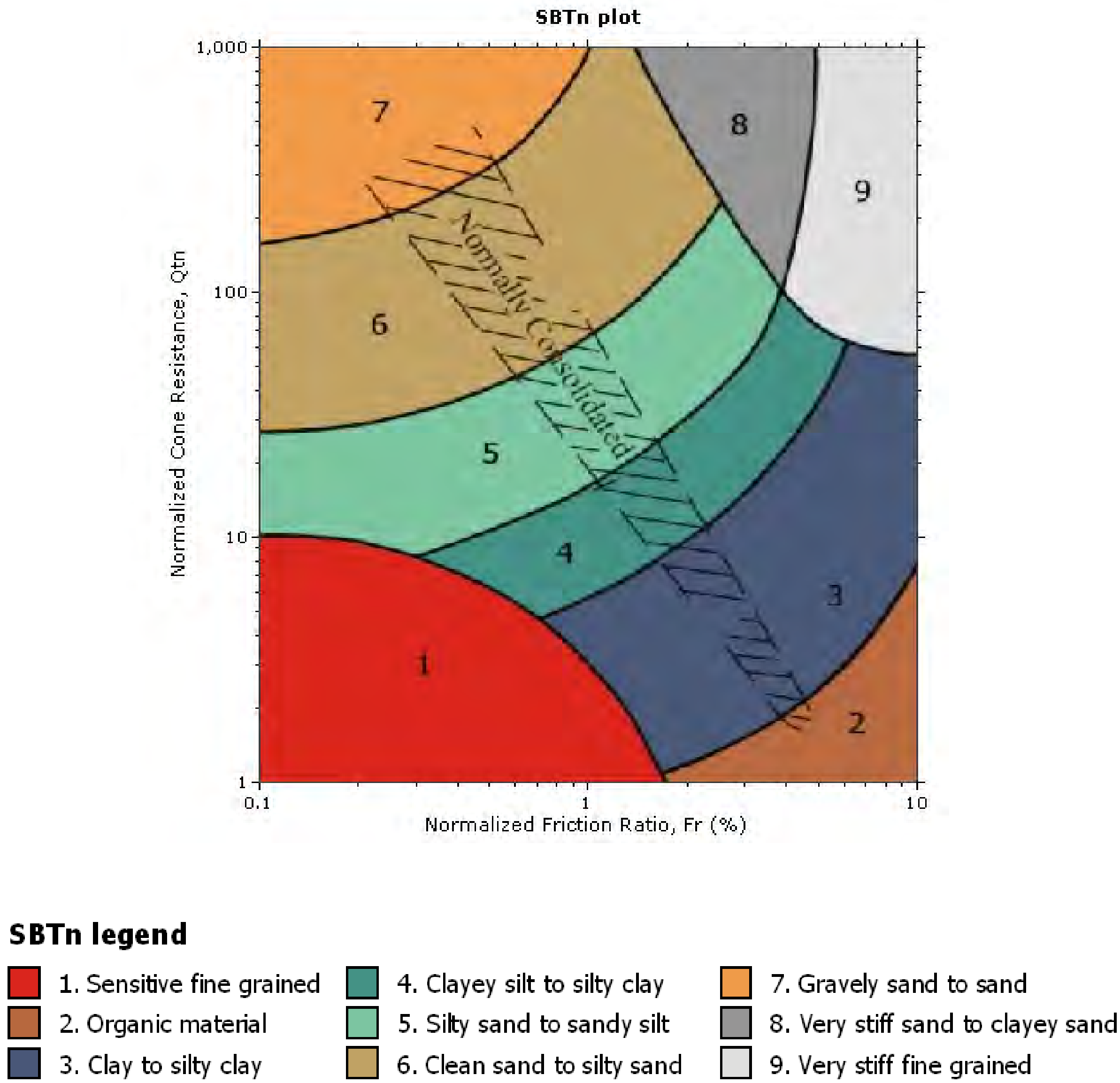
## Pore Pressure Dissipation Test

Sounding: RIS-6
Depth: 77.427588
Site: RYER ISLAND
Engineer: M.SOUVERVILLE



# Appendix E

# DWR CPT Summary Plots

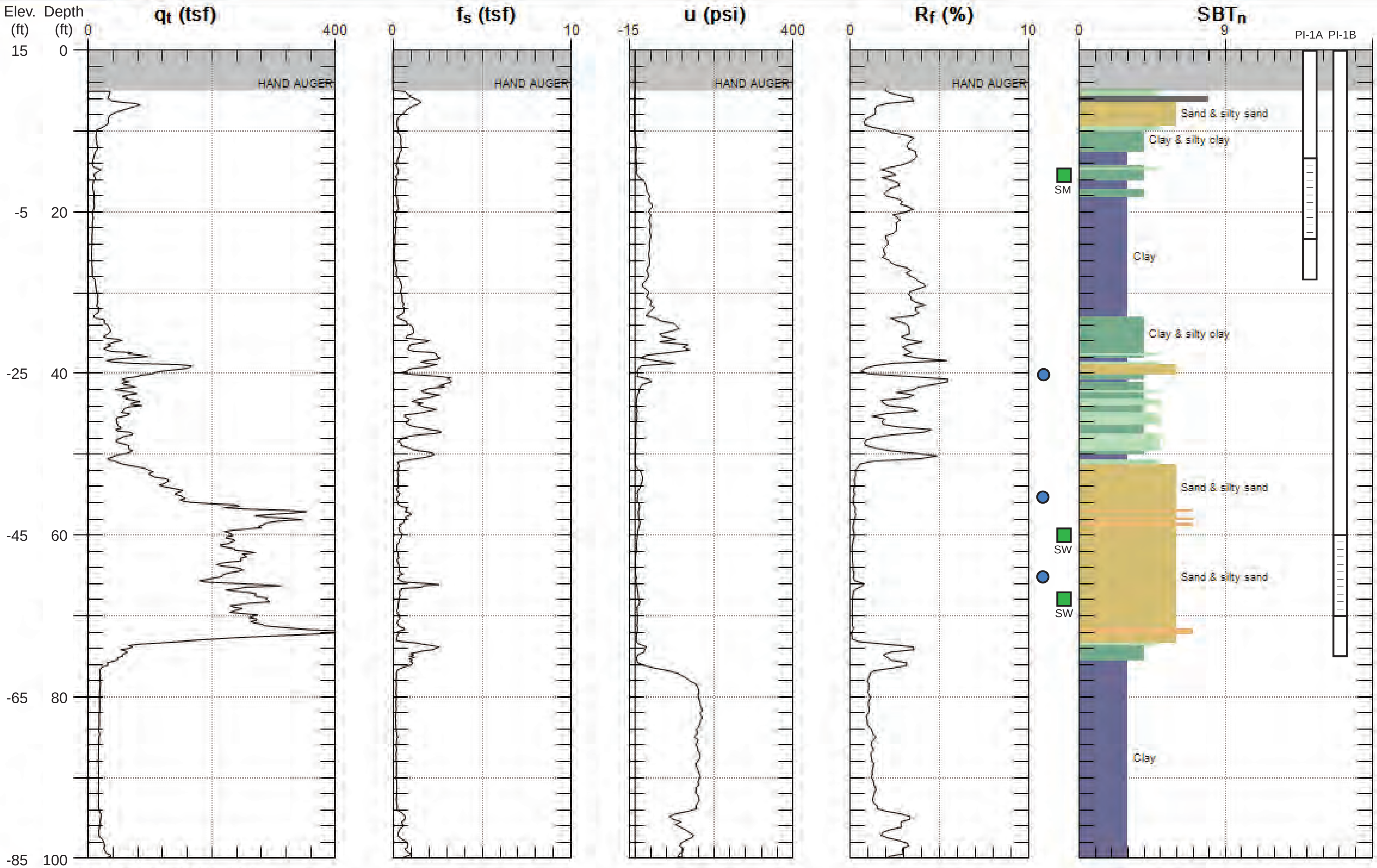



Charts from Robertson 1990

**DEPARTMENT OF WATER RESOURCES**
Division of Integrated Regional Water Management
**NORTH CENTRAL REGION OFFICE**
*Geology and Groundwater Investigations Section*

GREGG

| | | | |
|---|---|---|---|
| **Site: PROSPECT ISLAND** | **Engineer: M. SOUVERVILLE** | **Lat/Long (NAD 83): 38.2530612/-121.6567239** | ● **Dissipation Tests** |
| **Sounding: PI-1** | **Date: 9/20/2011 11:37** | **GSE (NAVD 88 FT): 14.97** | ■ **Soil Sample with USCS Classification** |




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

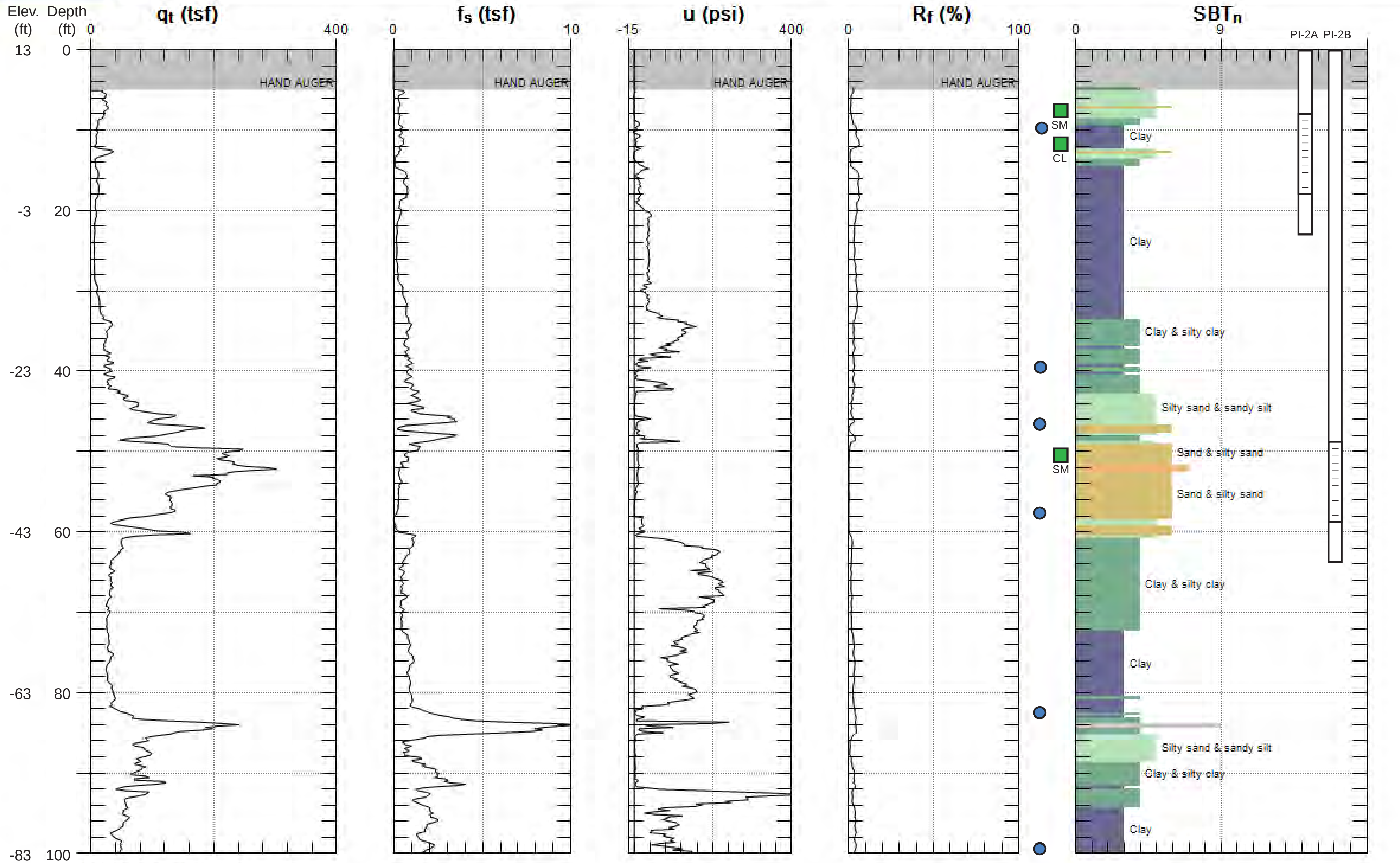
SBT: Soil Behavior Type (Robertson 1990)

DEPARTMENT OF WATER RESOURCES
Division of Integrated Regional Water Management
NORTH CENTRAL REGION OFFICE
*Geology and Groundwater Investigations Section*

GREGG

**Site: PROSPECT ISLAND** **Engineer: M. SOUVERVILLE** **Lat/Long (NAD 83): 38.2532428/-121.6665146**
**Sounding: PI-2** **Date: 9/15/2011 12:02** **GSE (NAVD 88 FT): 12.98**

● **Dissipation Tests**
■ **Soil Sample with USCS Classification**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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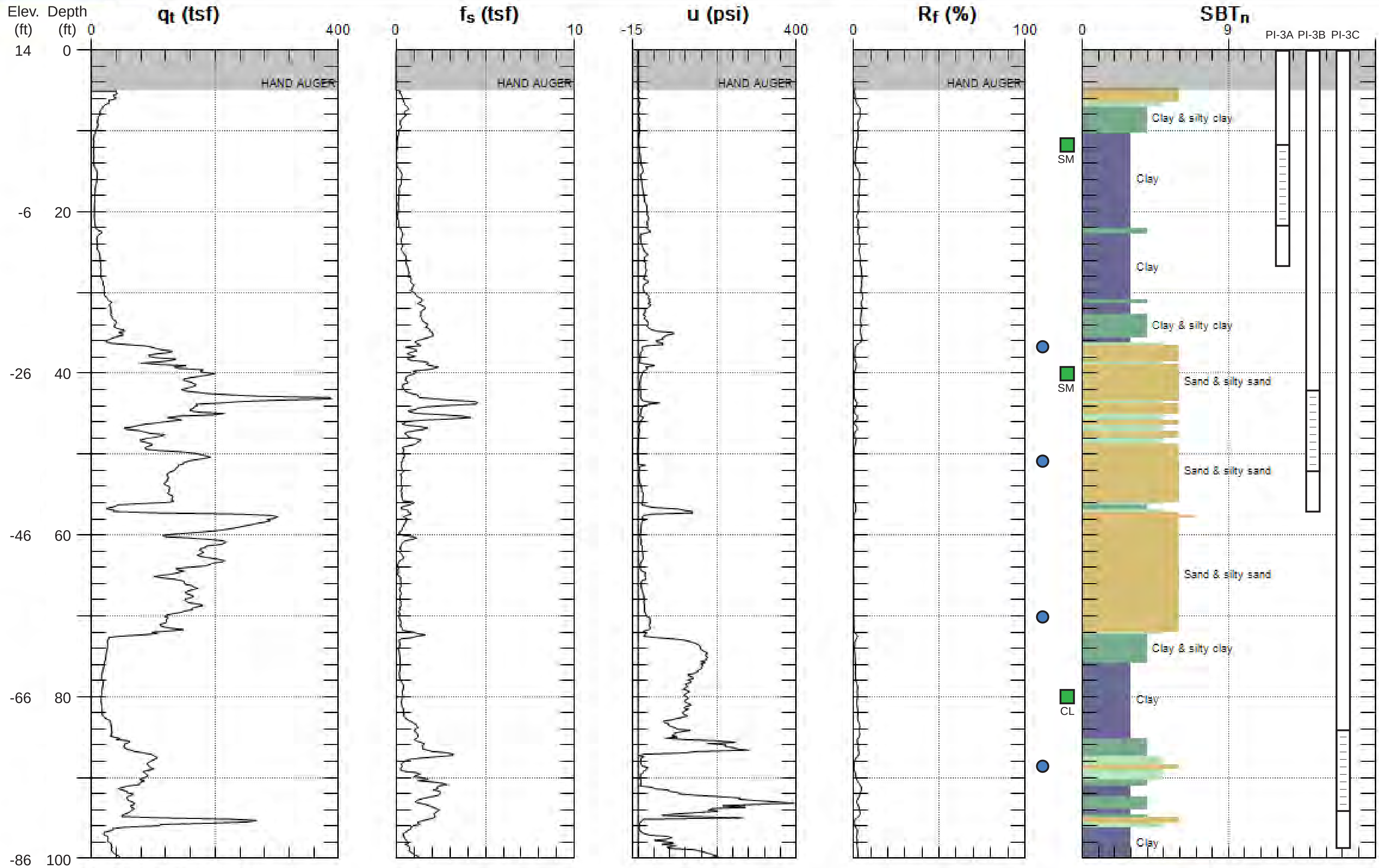
GREGG

Site: PROSPECT ISLAND | Engineer: M. SOUVERVILLE | Lat/Long (NAD 83): 38.2703001/-121.6613516
Sounding: PI-3 | Date: 9/15/2011 15:47 | GSE (NAVD 88 FT): 13.93

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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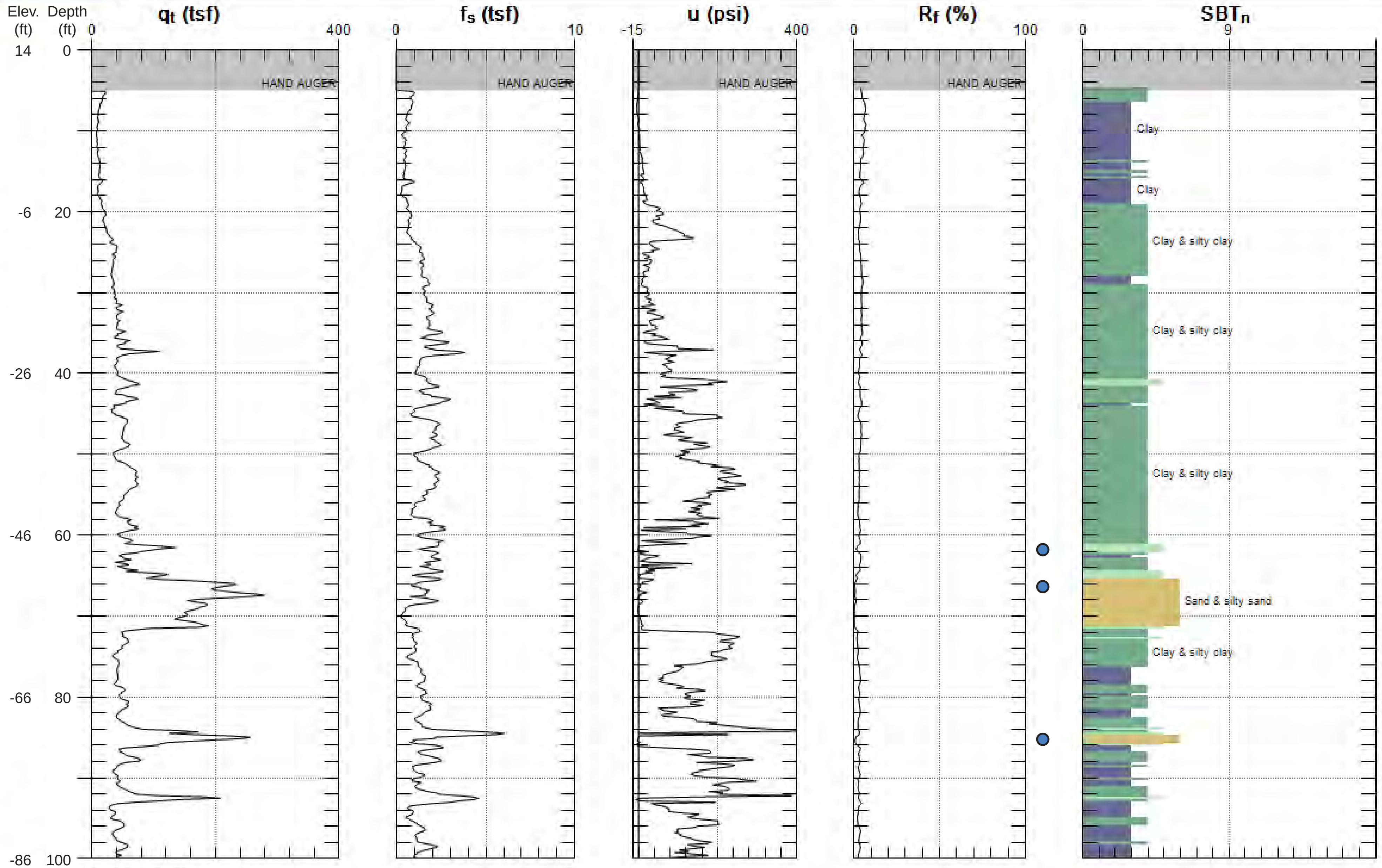
**Site: PROSPECT ISLAND** | **Engineer: M. SOUVERVILLE** | **Lat/Long (NAD 83): 38.2869233/-121.6569905**
**Sounding: PI-4** | **Date: 9/16/2011 08:47** | **GSE (NAVD 88 FT): 13.83**

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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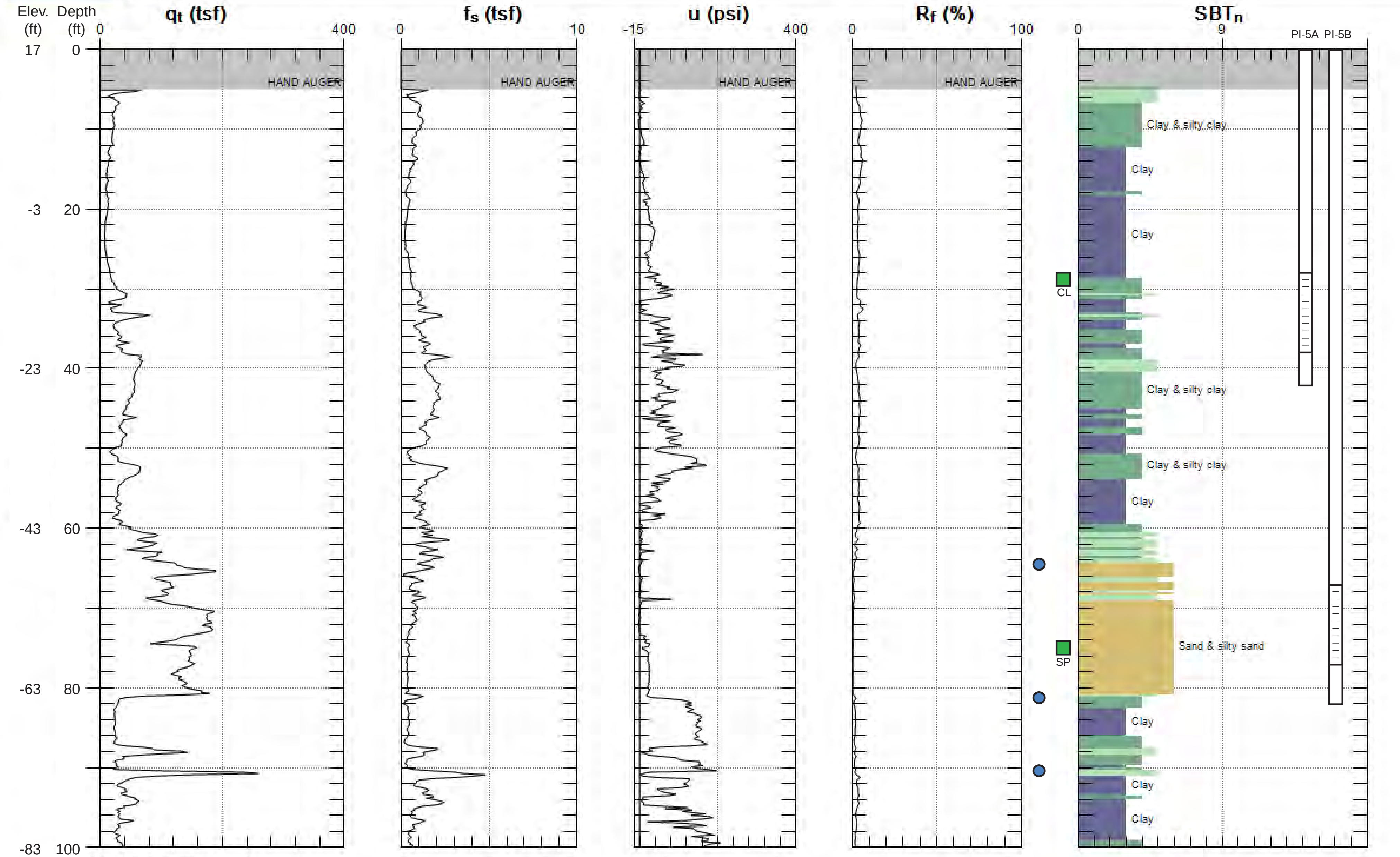
**Site: PROSPECT ISLAND** | **Engineer: M. SOUVERVILLE** | **Lat/Long (NAD 83): 38.2902019/-121.6473477**
**Sounding: PI-5** | **Date: 9/16/2011 11:42** | **GSE (NAVD 88 FT): 17.89**

Dissipation Tests
Soil Sample with USCS Classification




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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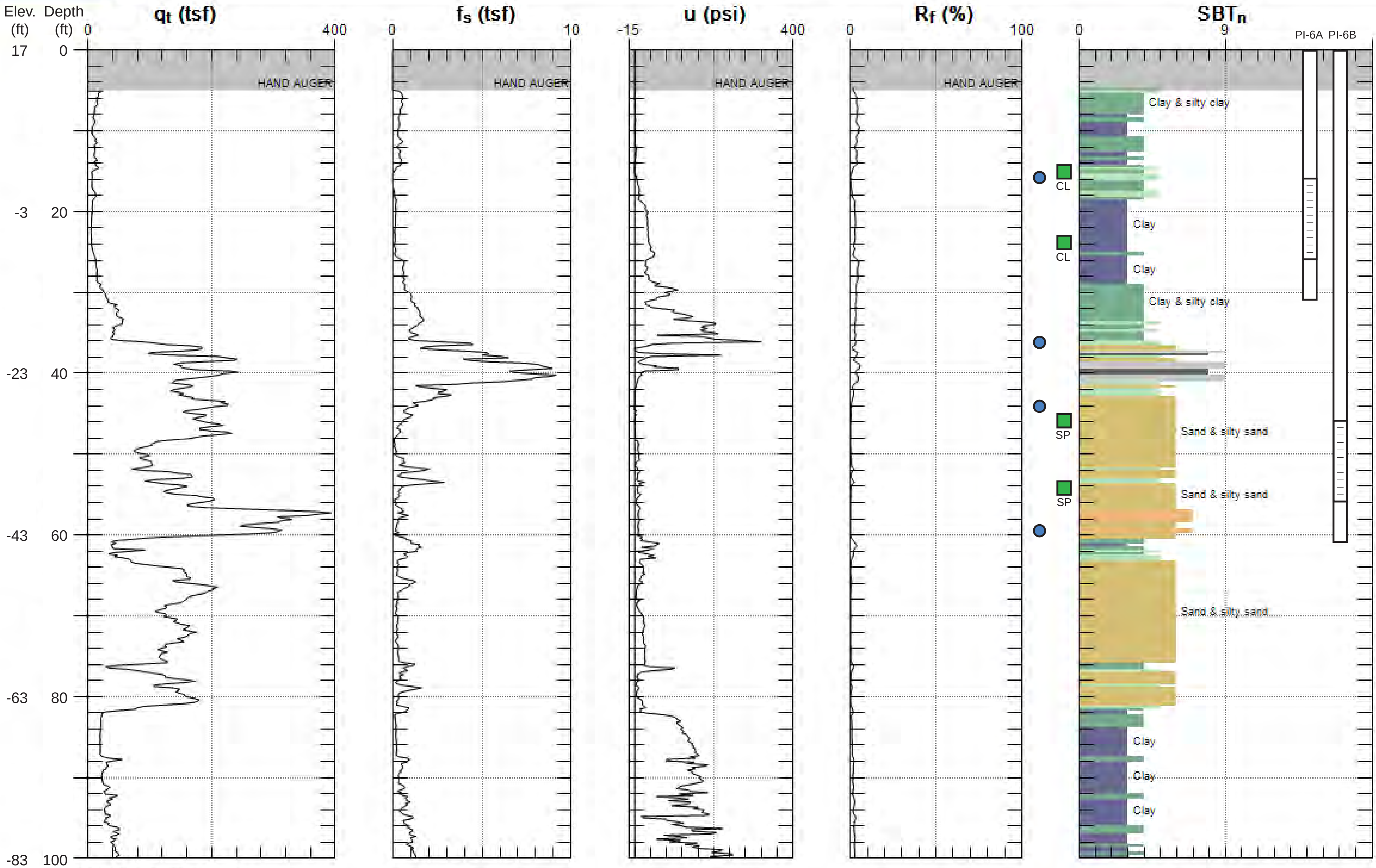
**Site: PROSPECT ISLAND** **Engineer: M. SOUVERVILLE** **Lat/Long (NAD 83): 38.2847234/-121.6442552**
**Sounding: PI-6** **Date: 9/16/2011 14:10** **GSE (NAVD 88 FT): 16.55**

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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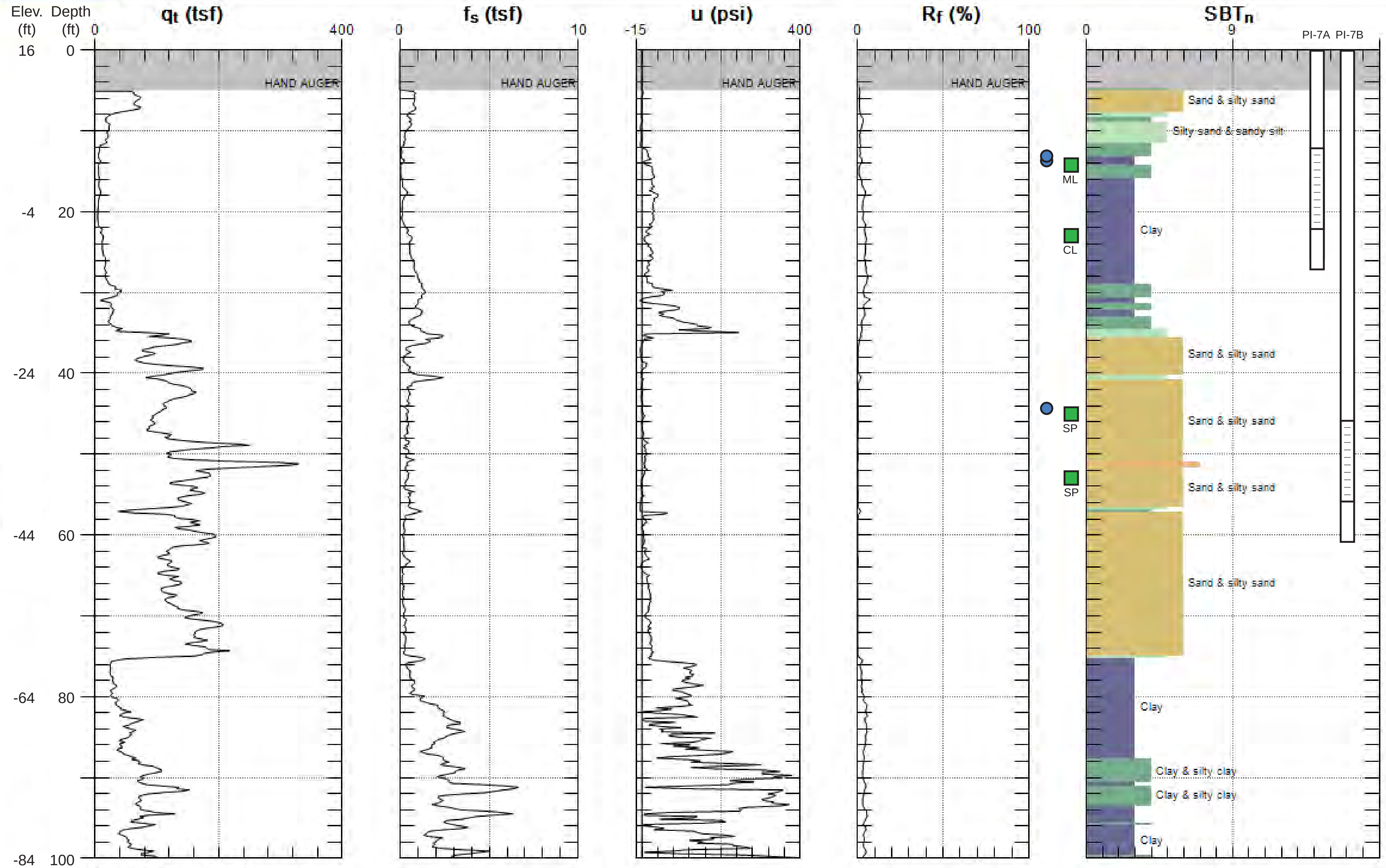
**Site: PROSPECT ISLAND** **Engineer: M. SOUVERVILLE** **Lat/Long (NAD 83): 38.2789300/-121.6403141**
**Sounding: PI-7** **Date: 9/20/2011 8:59** **GSE (NAVD 88 FT): 15.95**

● **Dissipation Tests**
■ **Soil Sample with USCS Classification**




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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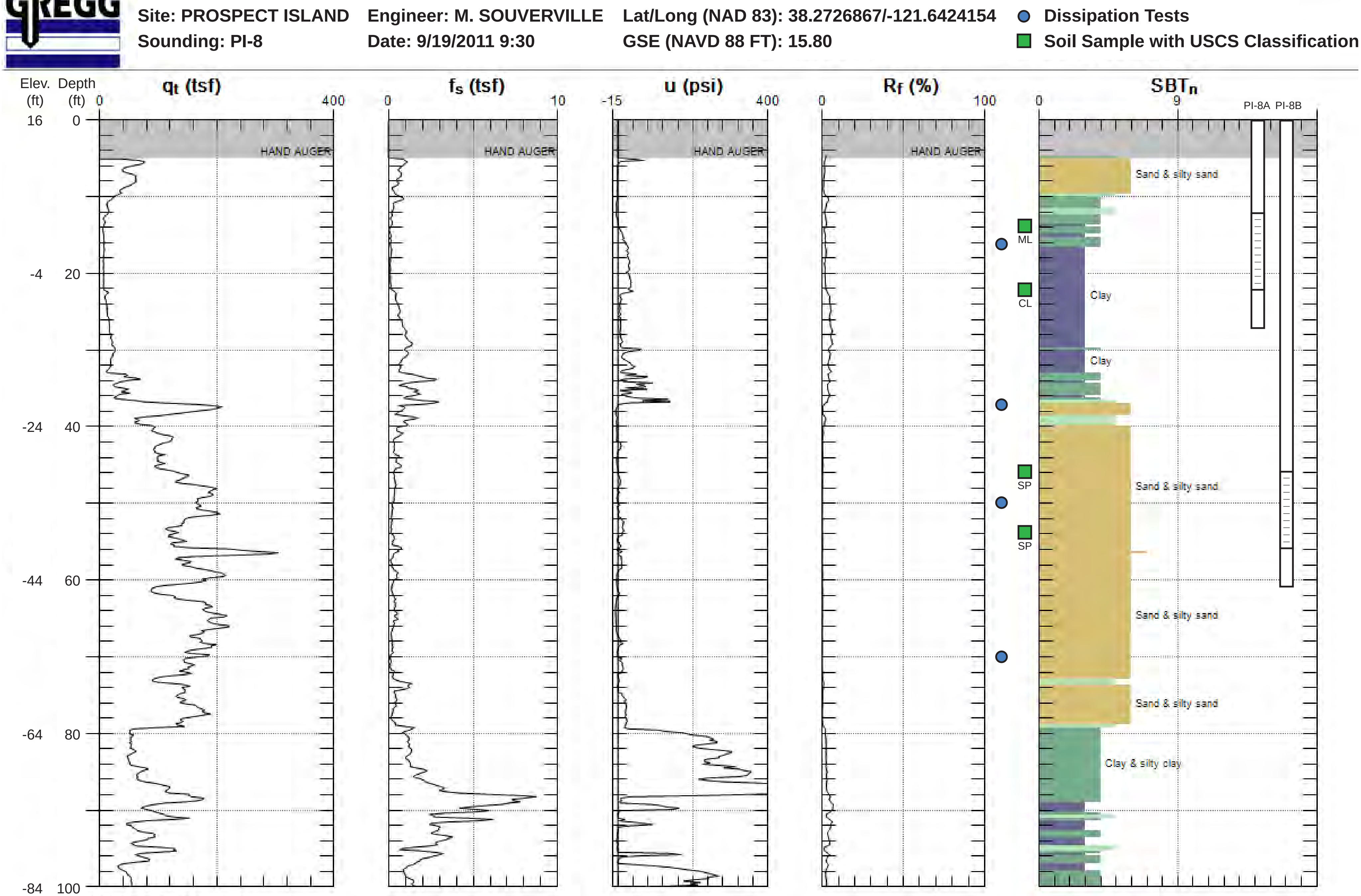
Site: PROSPECT ISLAND | Engineer: M. SOUVERVILLE | Lat/Long (NAD 83): 38.2726867/-121.6424154
Sounding: PI-8 | Date: 9/19/2011 9:30 | GSE (NAVD 88 FT): 15.80




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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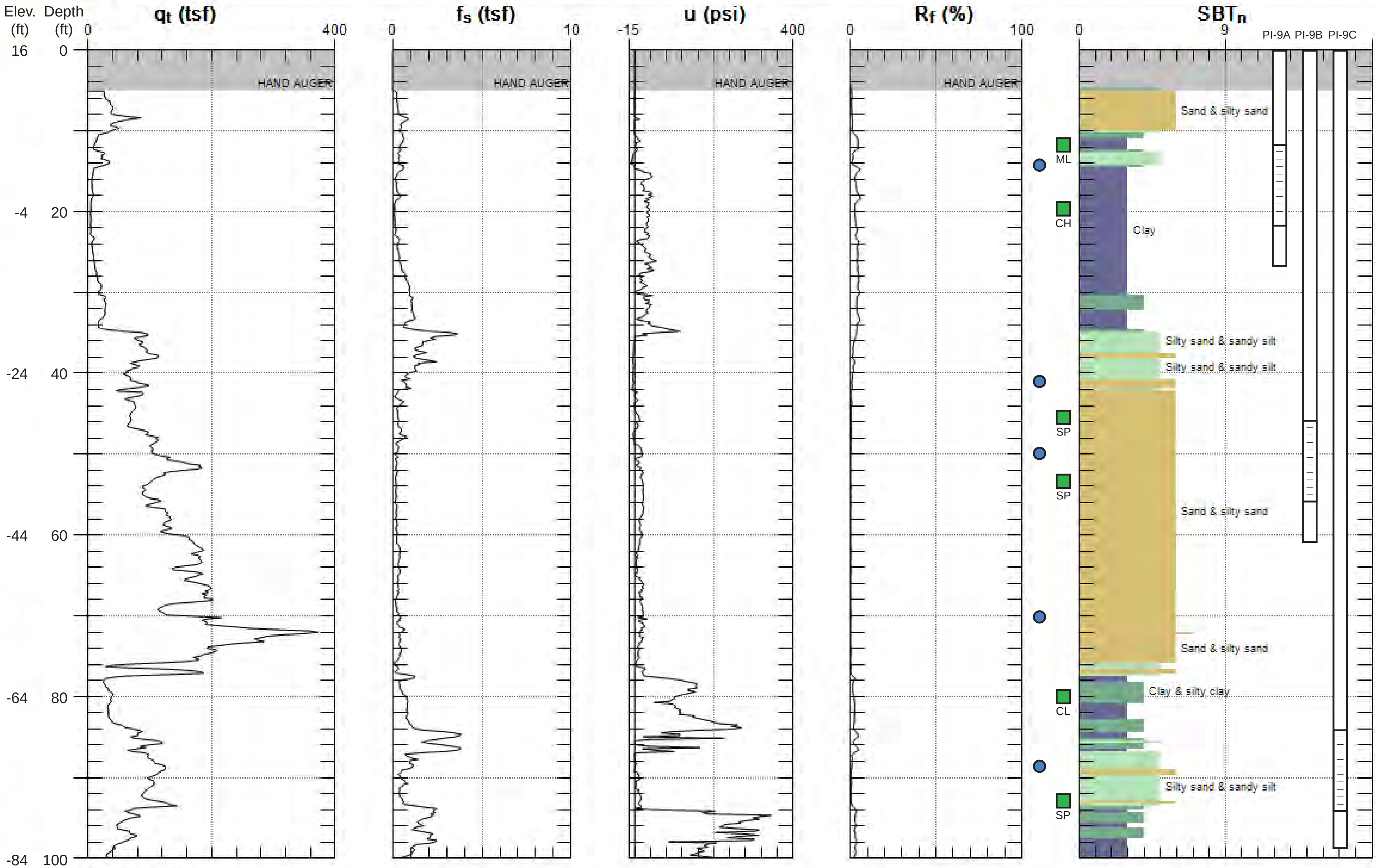
**Site: PROSPECT ISLAND** | **Engineer: M. SOUVERVILLE** | **Lat/Long (NAD 83): 38.2665277/-121.6429200**
**Sounding: PI-9** | **Date: 9/19/2011 12:06** | **GSE (NAVD 88 FT): 15.62**

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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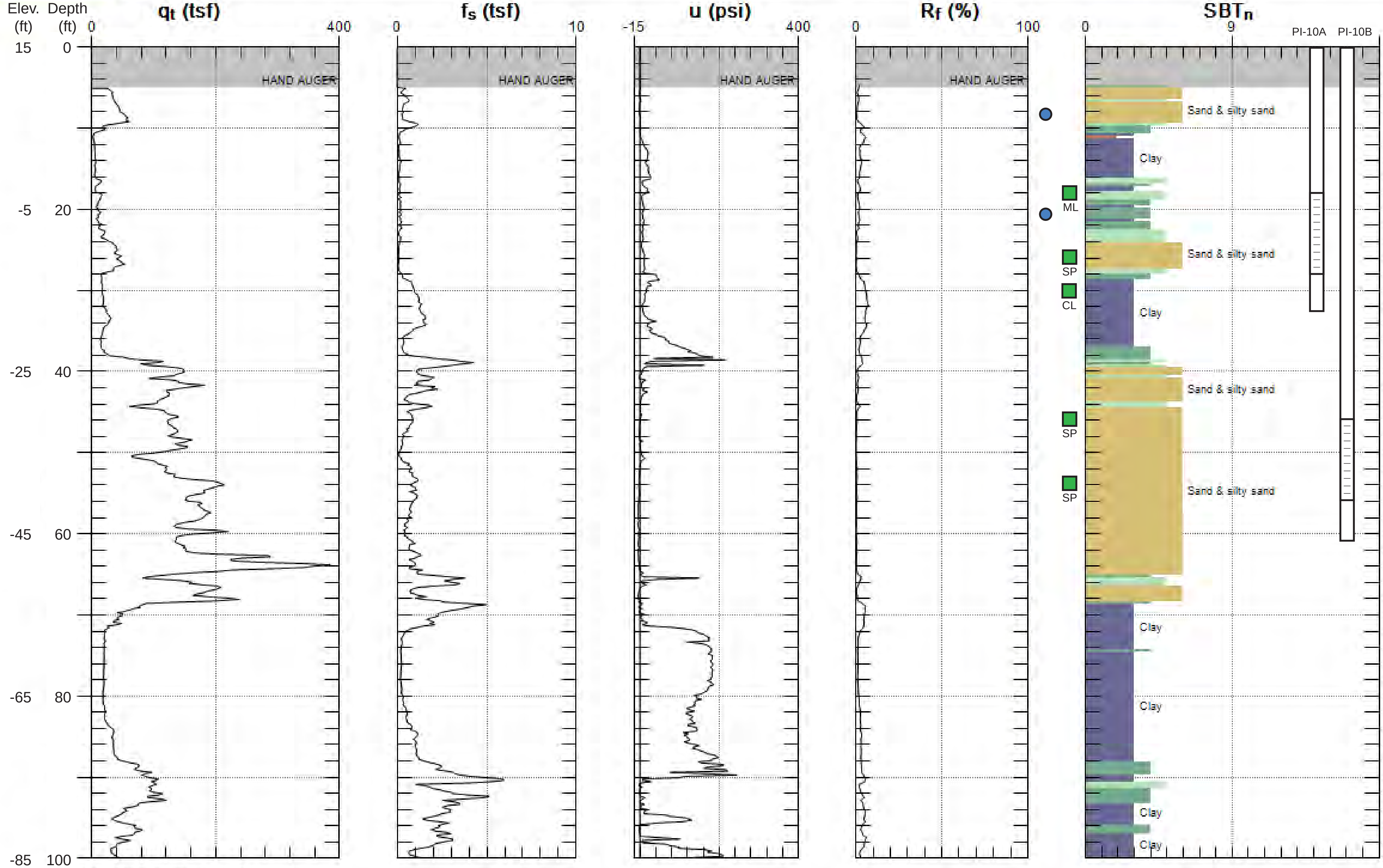
Site: PROSPECT ISLAND | Engineer: M. SOUVERVILLE | Lat/Long (NAD 83): 38.2623090/-121.6502872
Sounding: PI-10 | Date: 9/19/2011 12:06 | GSE (NAVD 88 FT): 14.83

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 100.230 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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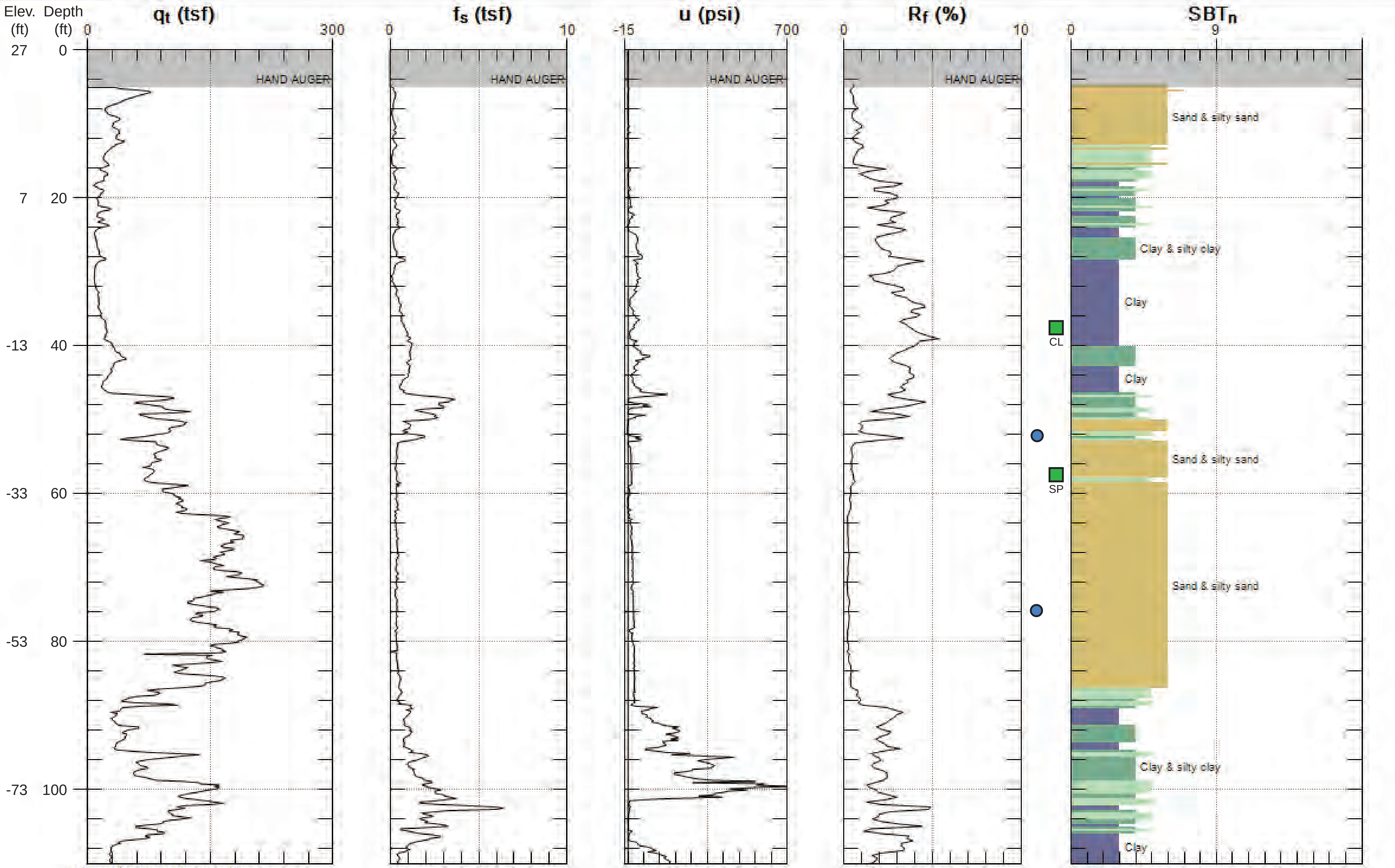
GREGG

Site: RYER ISLAND | Sounding: RI-2
Engineer: M. SOUVERVILLE | Date: 3/15/2012 09:17
Lat/Long (NAD 83): 38.2711299/-121.6419145 | GSE (NAVD 88 FT): 27.11




Max. Depth: 110.564 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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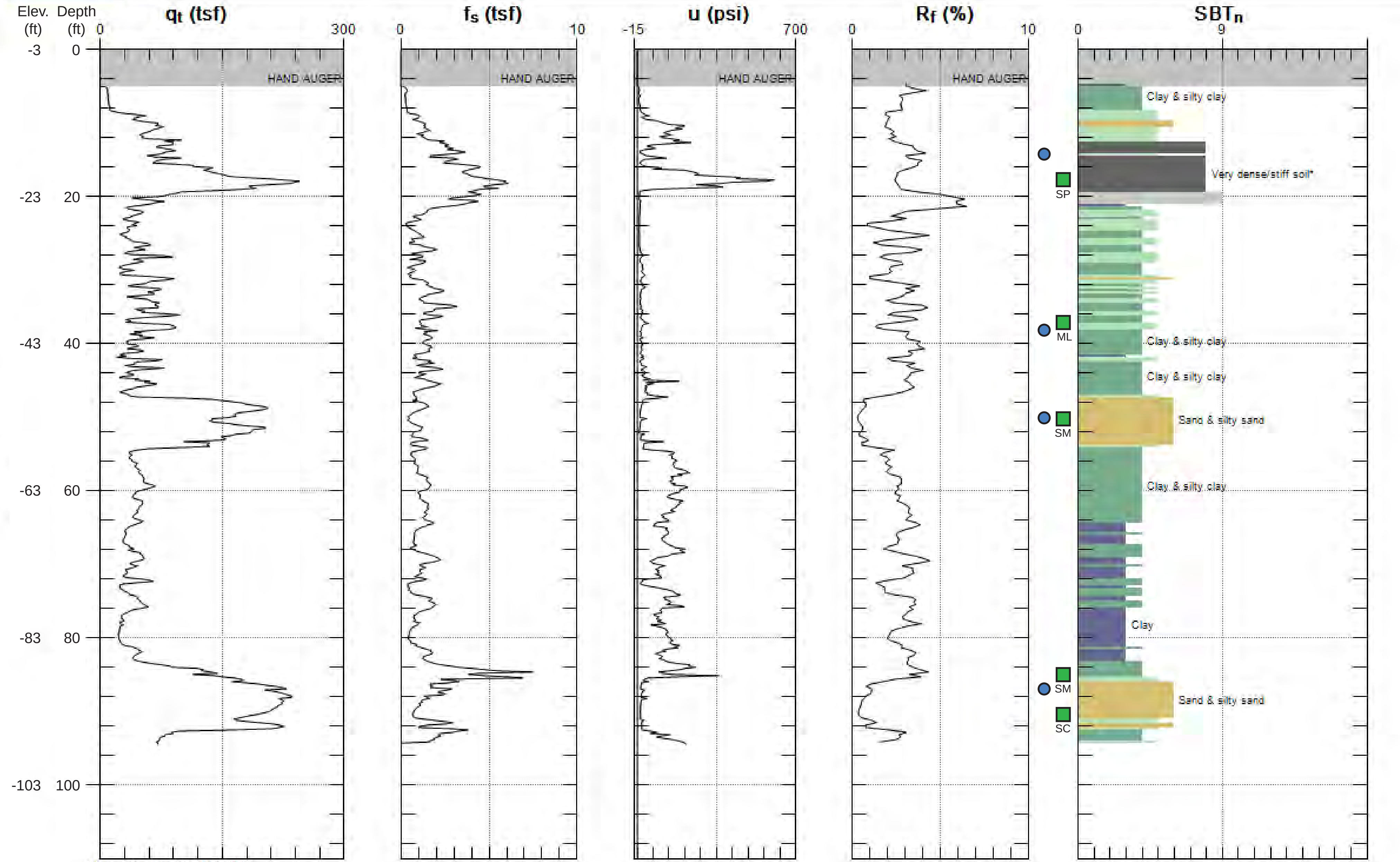
GREGG

Site: RYER ISLAND
Sounding: RI-3

Engineer: M. SOUVERVILLE
Date: 3/27/2012 10:18

Lat/Long (NAD 83): 38.2728295/-121.6298624
GSE (NAVD 88 FT): -3.15

Dissipation Tests
Soil Sample with USCS Classification




Max. Depth: 94.488 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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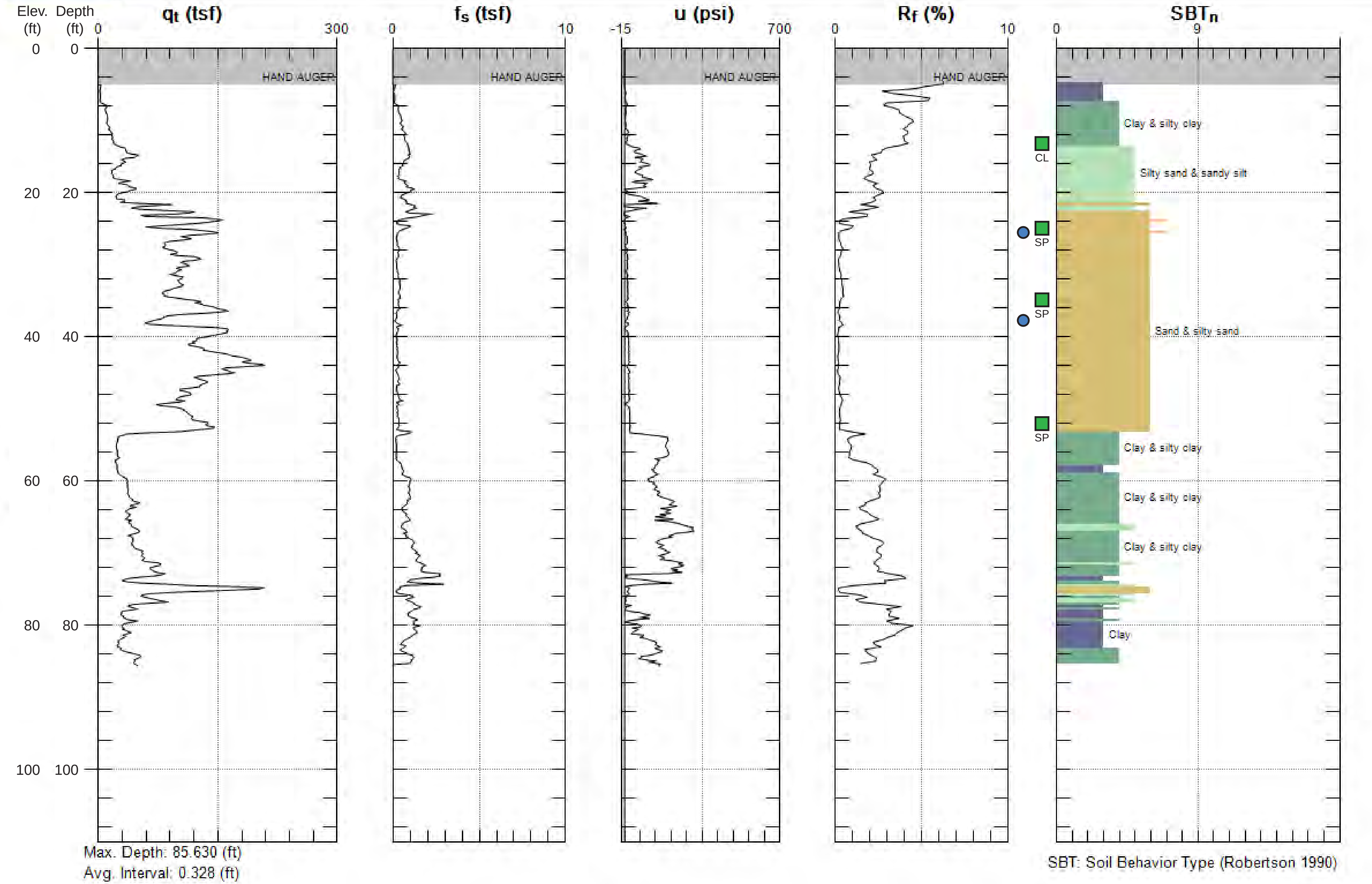
GREGG

**Site: RYER ISLAND** | **Engineer: M. SOUVERVILLE** | **Lat/Long (NAD 83): 38.2741467/-121.6399176**

**Sounding: RI-4** | **Date: 3/13/2012 15:03** | **GSE (NAVD 88 FT): 0.29**

● Dissipation Tests
■ Soil Sample with USCS Classification



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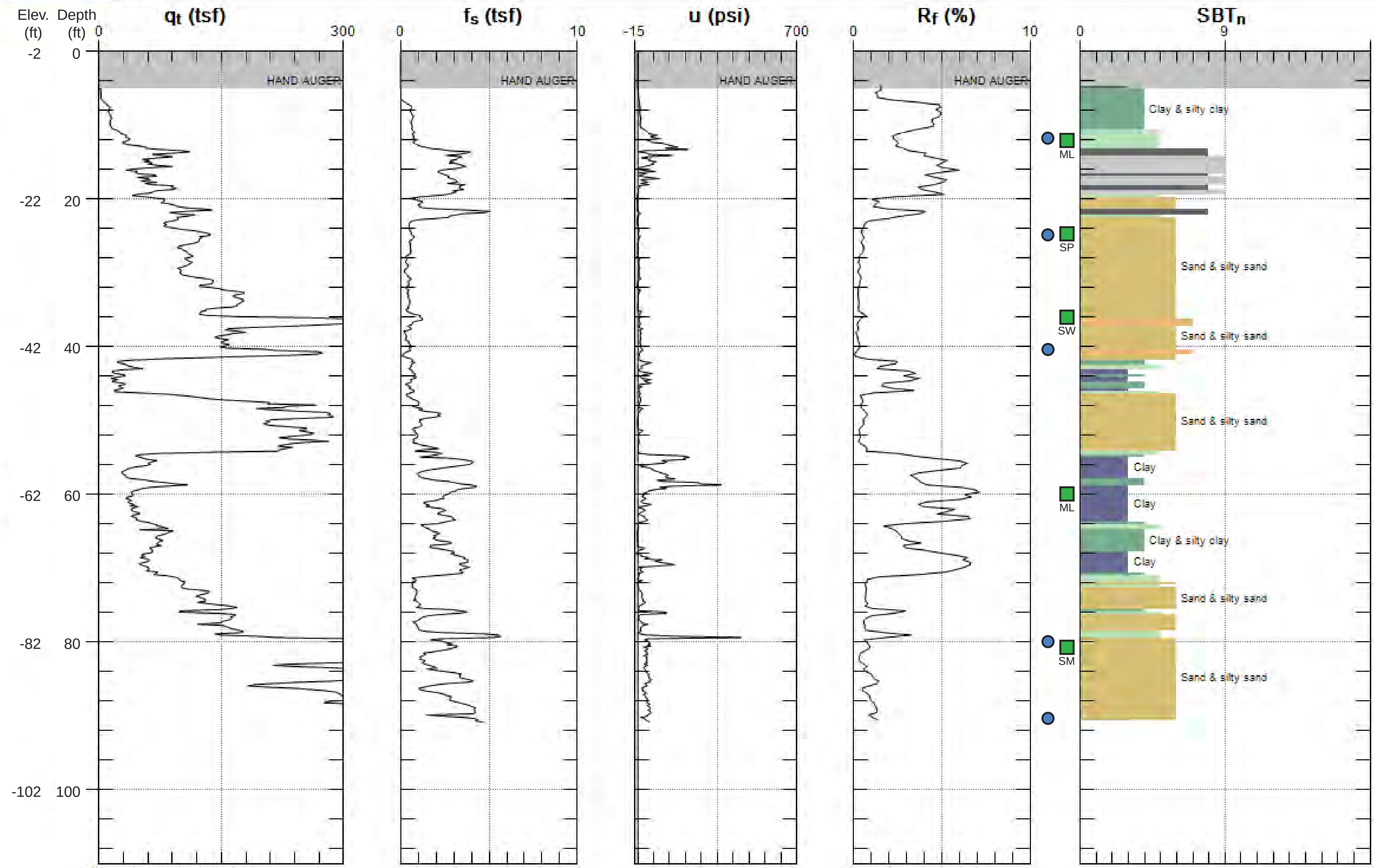
GREGG

**Site: RYER ISLAND** **Engineer: M. SOUVERVILLE** **Lat/Long (NAD 83): 38.2796773/-121.6323782**
**Sounding: RI-5** **Date: 3/21/2012 14:44** **GSE (NAVD 88 FT): -1.68**

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 90.879 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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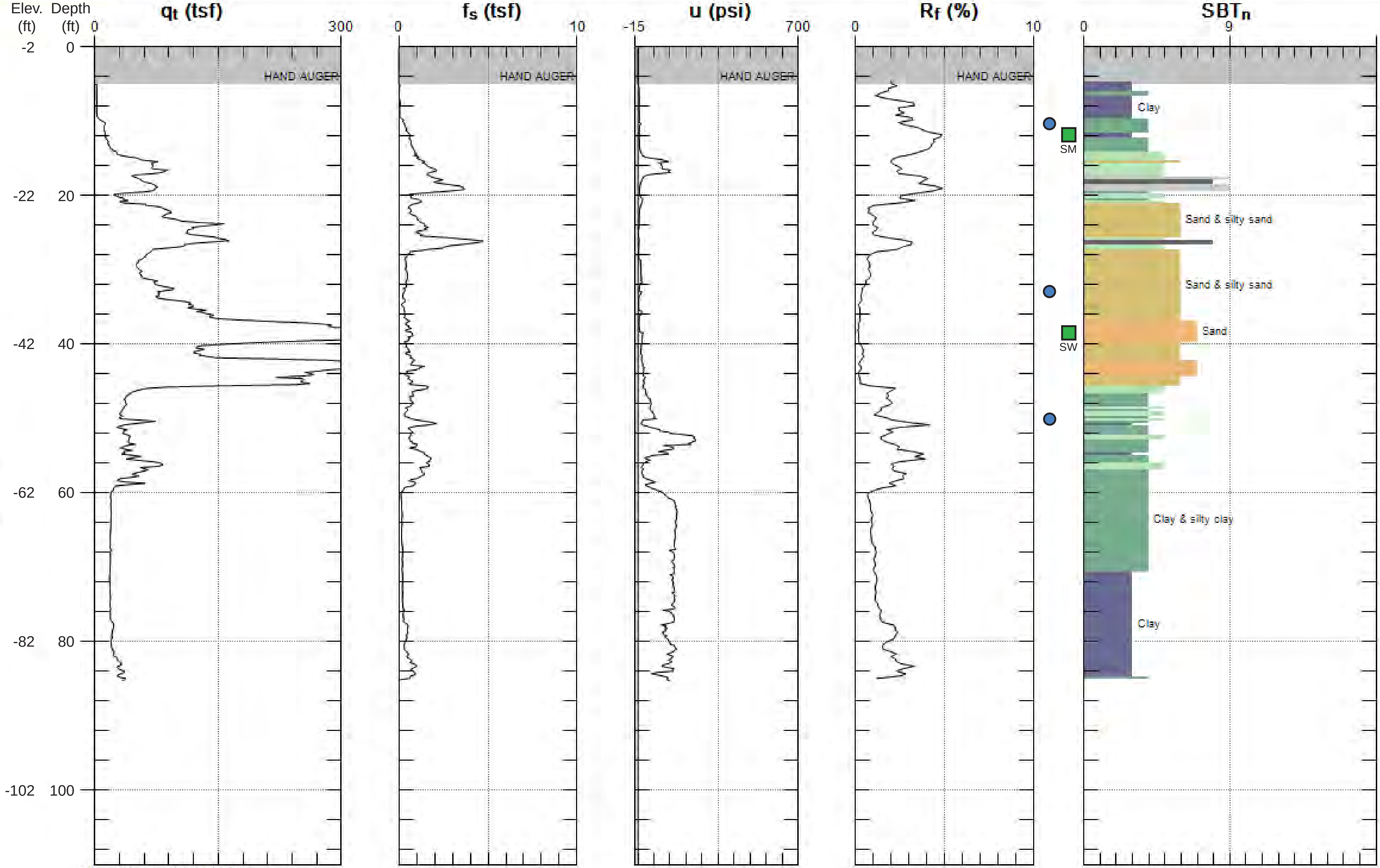
GREGG

Site: RYER ISLAND
Sounding: RIS-1

Engineer: M. SOUVERVILLE
Date: 3/28/2012 10:43

Lat/Long (NAD 83): 38.2533311/-121.6530021
GSE (NAVD 88 FT): -1.69

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 85.302 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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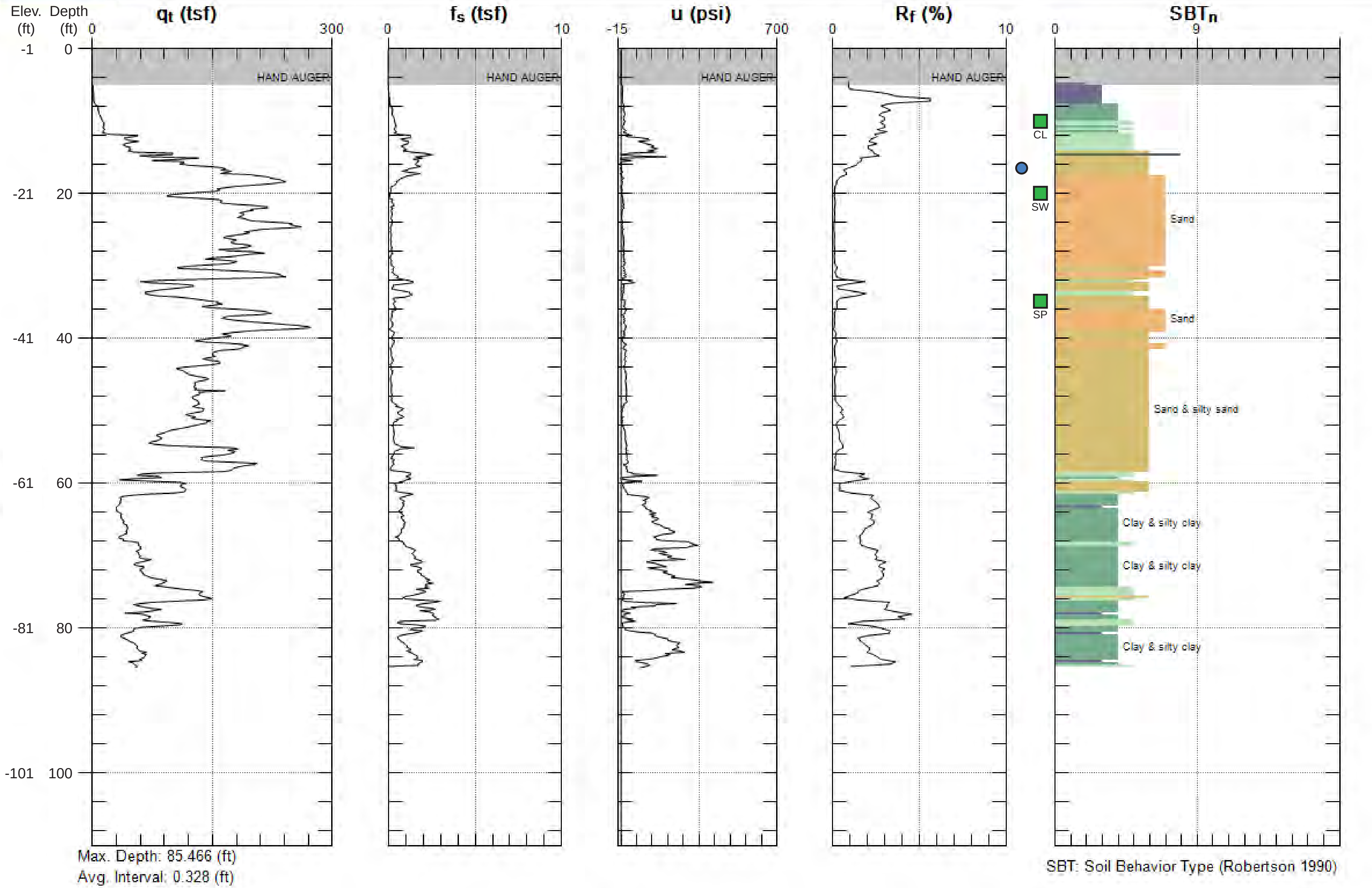
GREGG

**Site: RYER ISLAND** | **Sounding: RIS-4**

**Engineer: M. SOUVERVILLE** | **Date: 3/13/2012 09:31**

**Lat/Long (NAD 83): 38.2704582/-121.6376184** | **GSE (NAVD 88 FT): -1.28**

● **Dissipation Tests**
■ **Soil Sample with USCS Classification**



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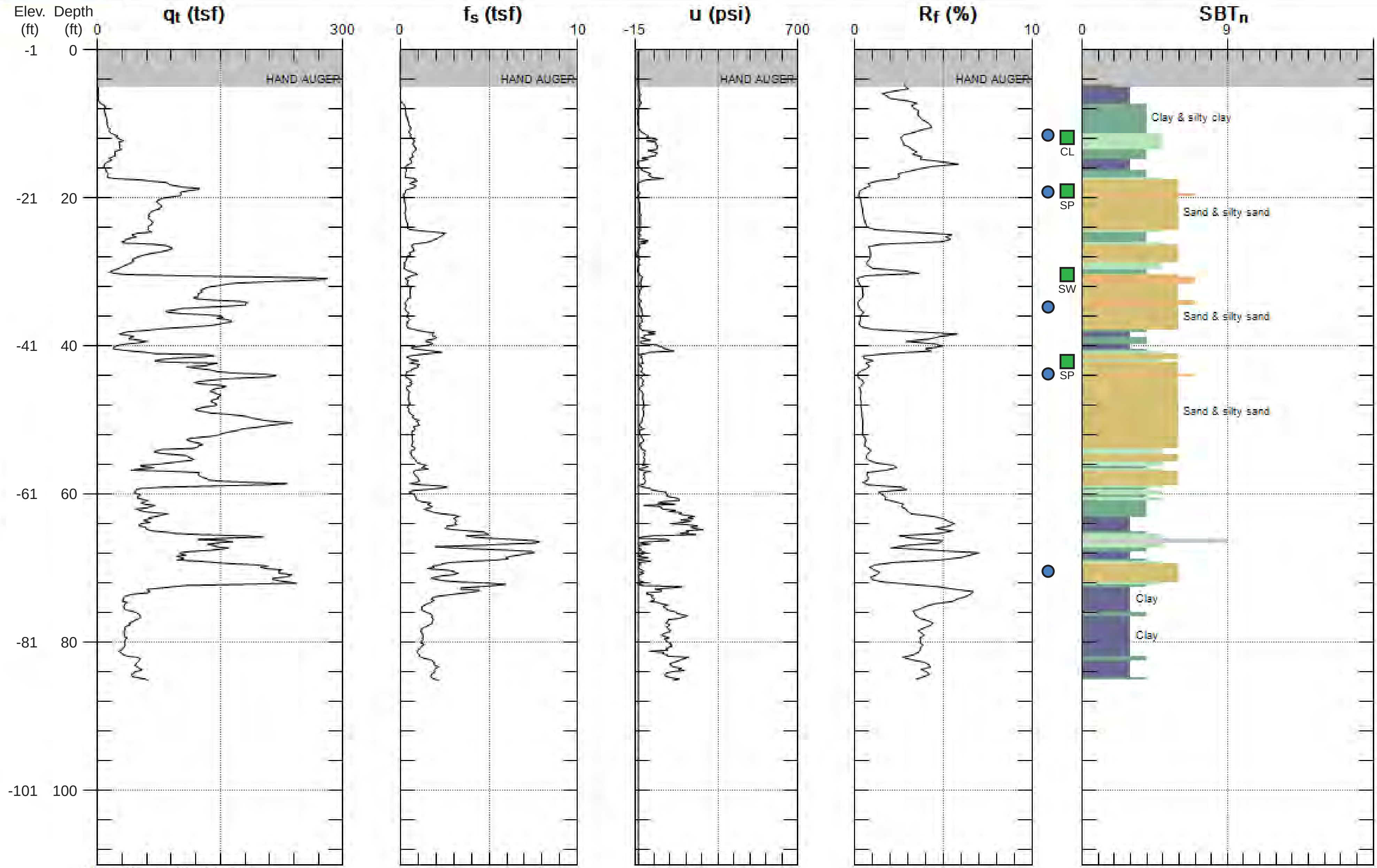
NORTH CENTRAL REGION OFFICE
*Geology and Groundwater Investigations Section*

GREGG

**Site: RYER ISLAND** | **Engineer: M. SOUVERVILLE** | **Lat/Long (NAD 83): 38.2777516/-121.6355622**
**Sounding: RIS-5** | **Date: 3/22/2012 11:34** | **GSE (NAVD 88 FT): -0.65**

● Dissipation Tests
■ Soil Sample with USCS Classification




Max. Depth: 85.138 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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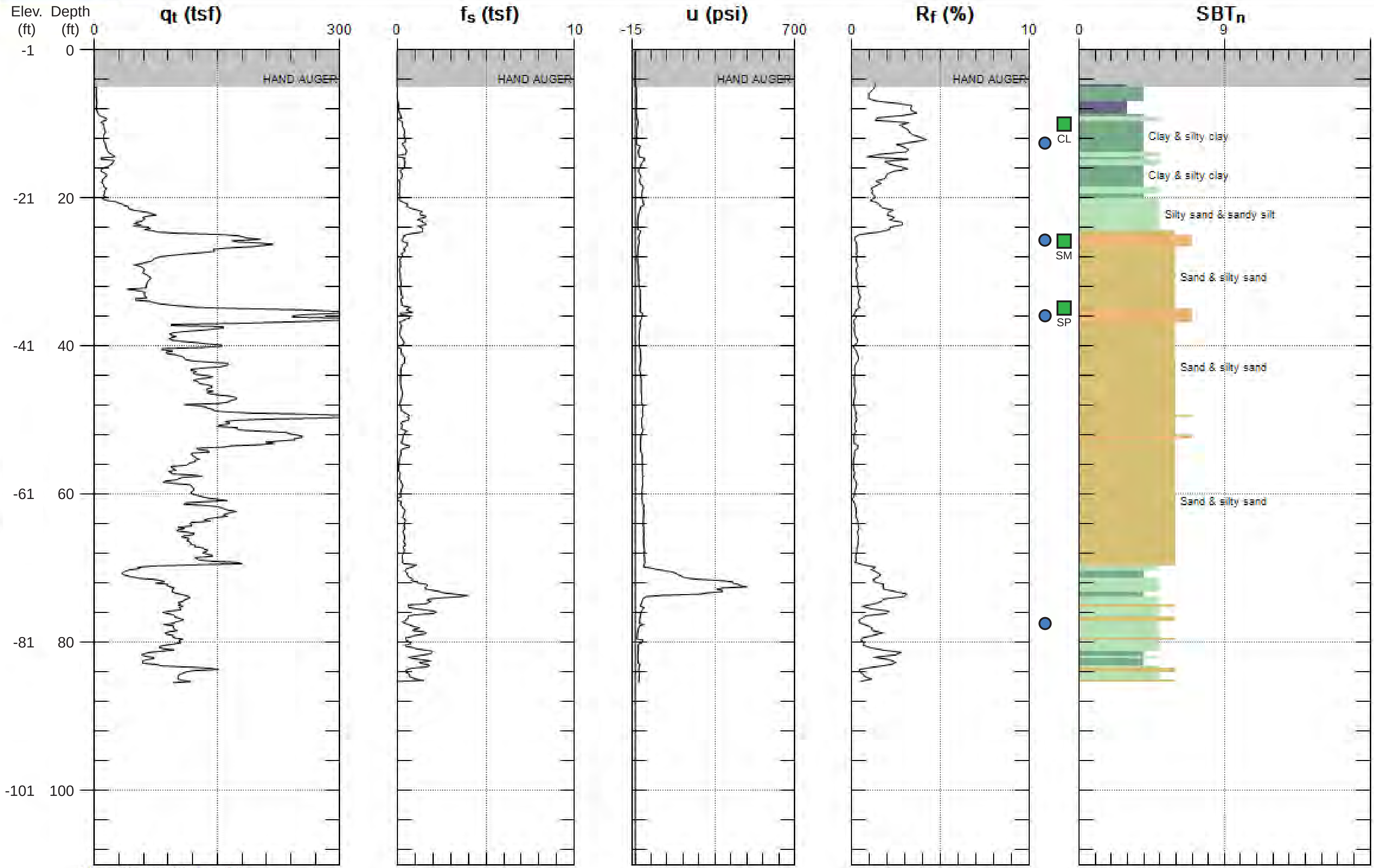
Geology and Groundwater Investigations Section

GREGG

Site: RYER ISLAND | Engineer: M. SOUVERVILLE | Lat/Long (NAD 83): 38.2853928/-121.6368196
Sounding: RIS-6 | Date: 3/26/2012 10:36 | GSE (NAVD 88 FT): -0.65

Dissipation Tests
Soil Sample with USCS Classification




Max. Depth: 85.466 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

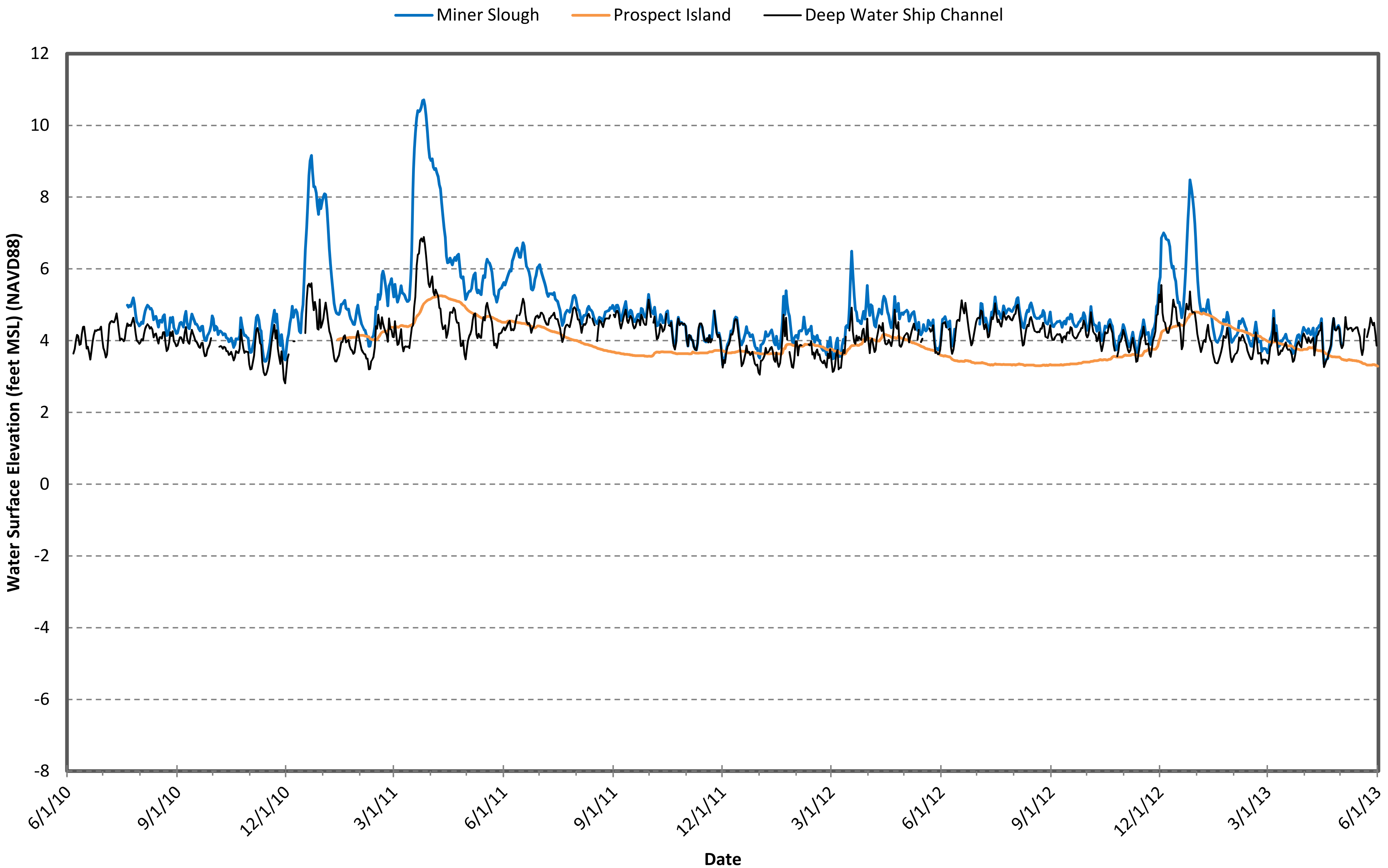
# Appendix F

# Prospect Island and Ryer Island Hydrographs

# Appendix F-1

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage**

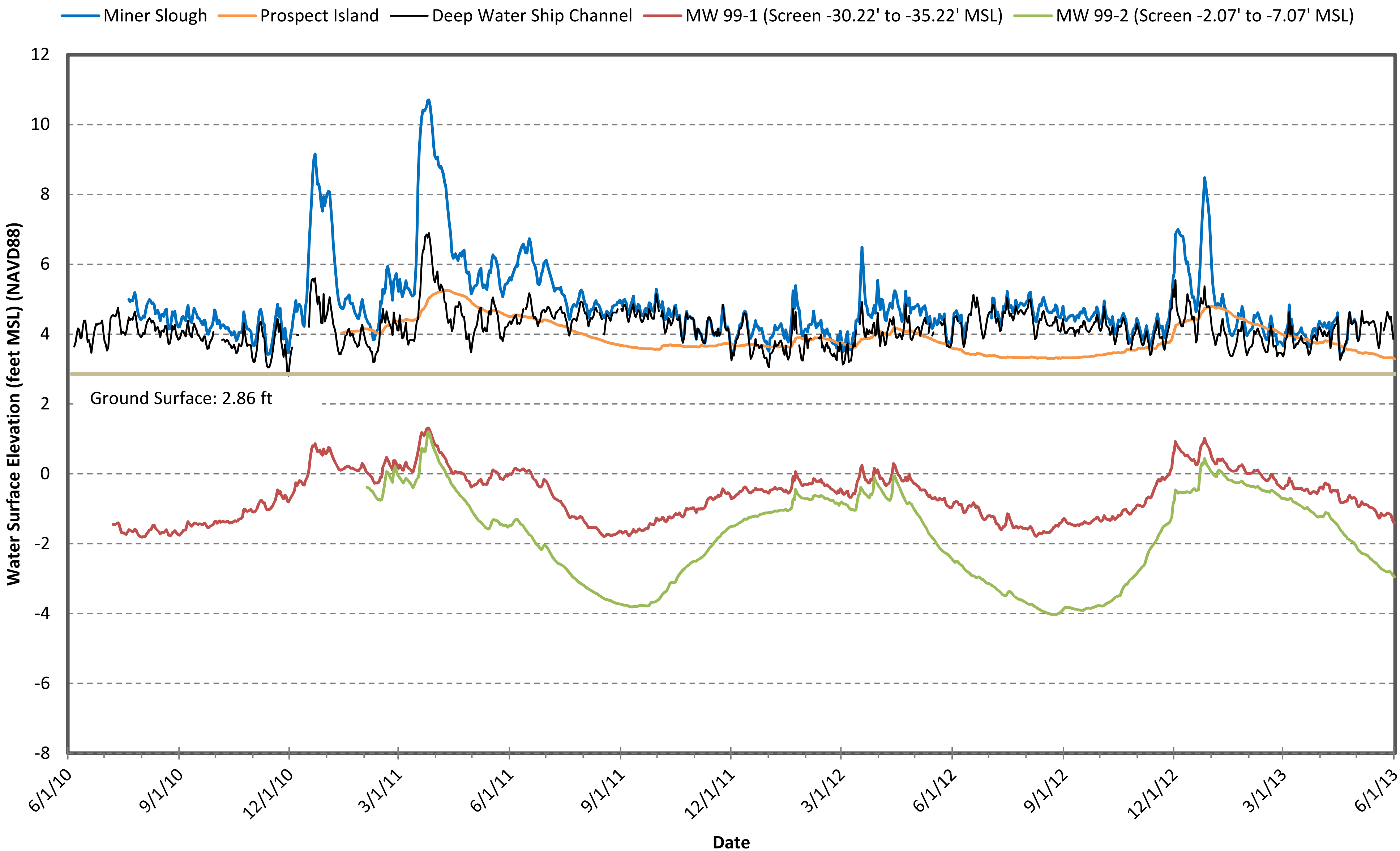
**June 1, 2010 to June 1, 2013**



# Appendix F-2

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Ryer Island MW 99-1 and MW 99-2 Groundwater Levels**

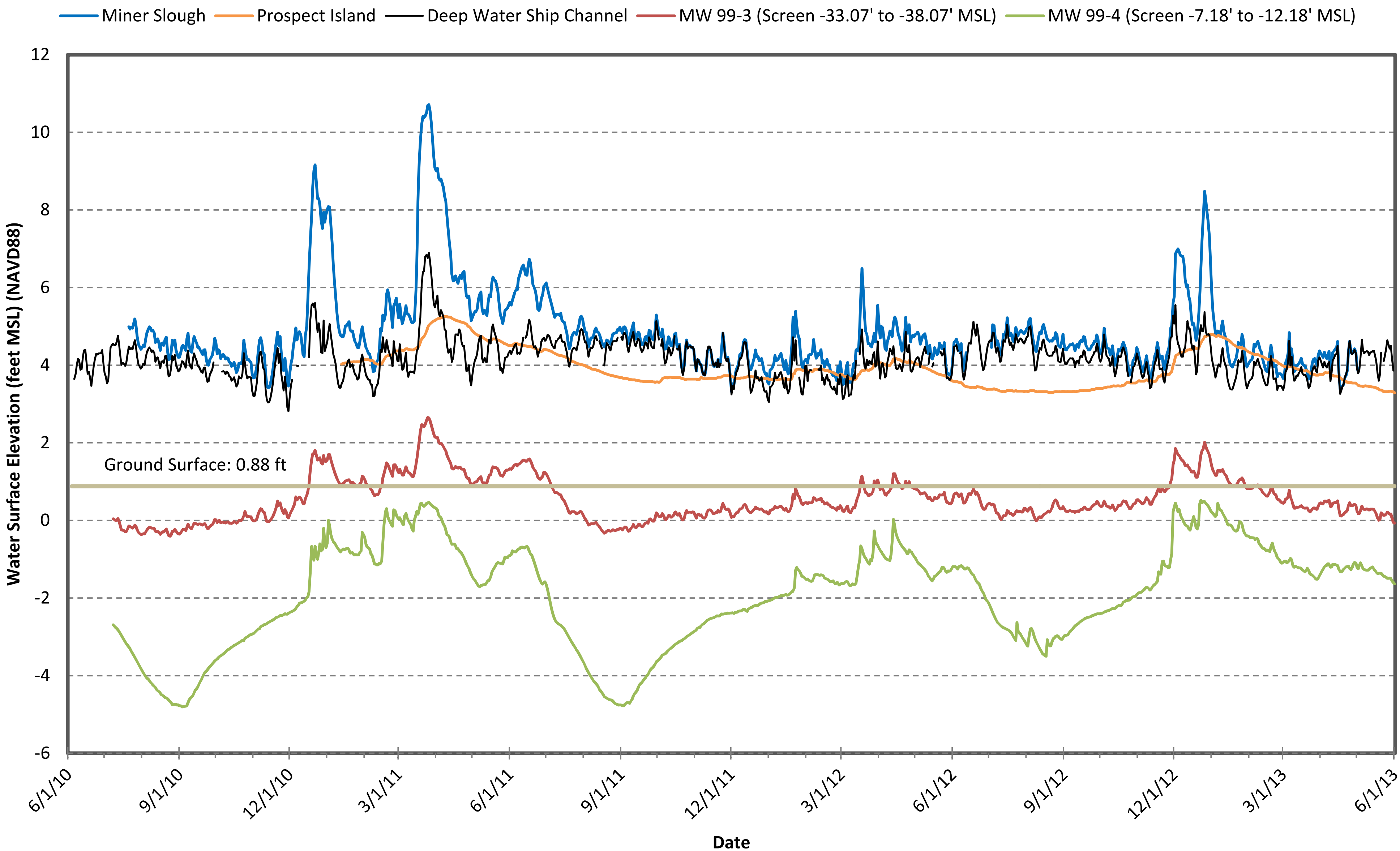
**June 1, 2010 to June 1, 2013**



# Appendix F-3

## Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Ryer Island MW 99-3 and MW 99-4 Groundwater Levels

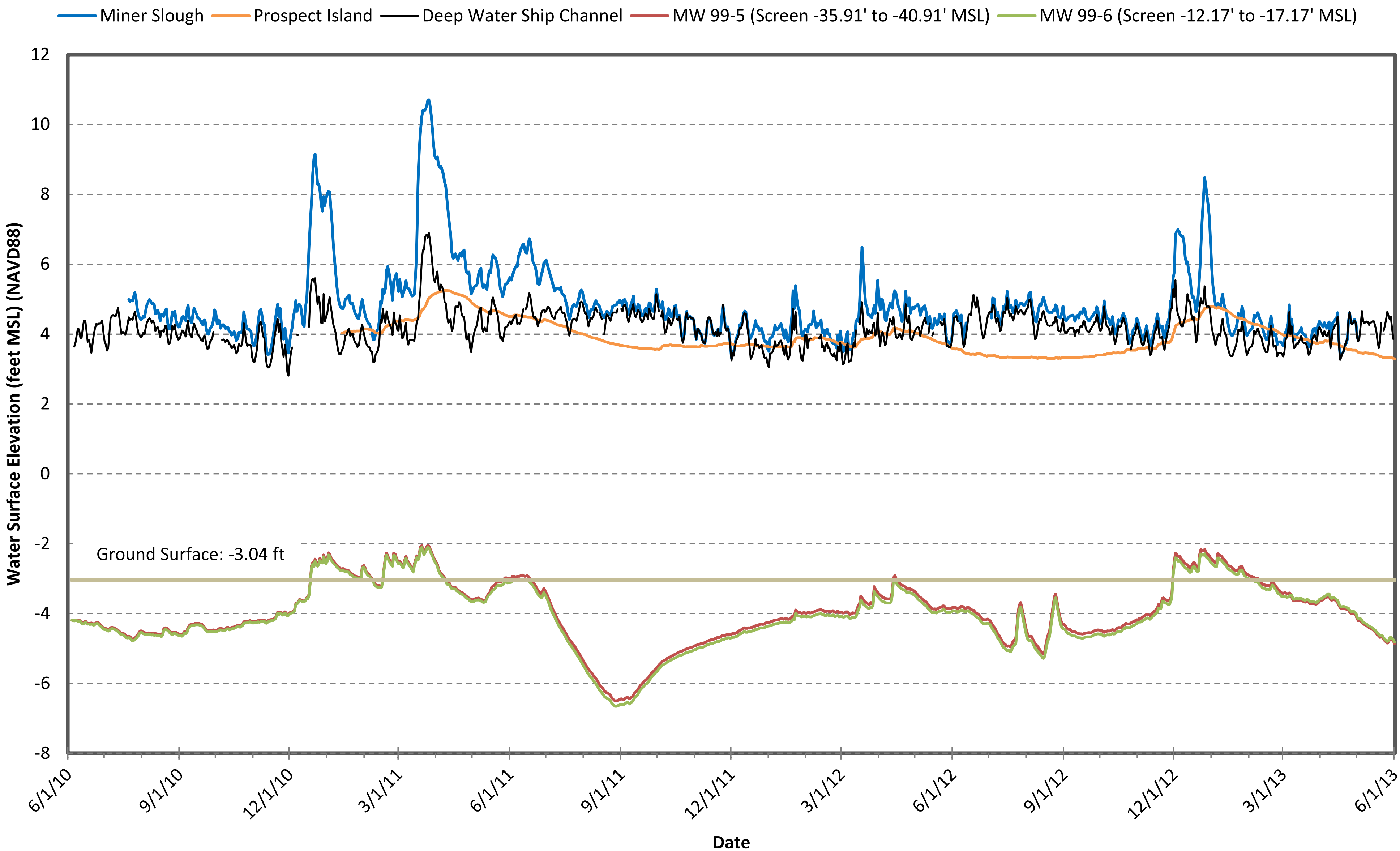
**June 1, 2010 to June 1, 2013**



# Appendix F-4

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Ryer Island MW 99-5 and MW 99-6 Groundwater Levels**

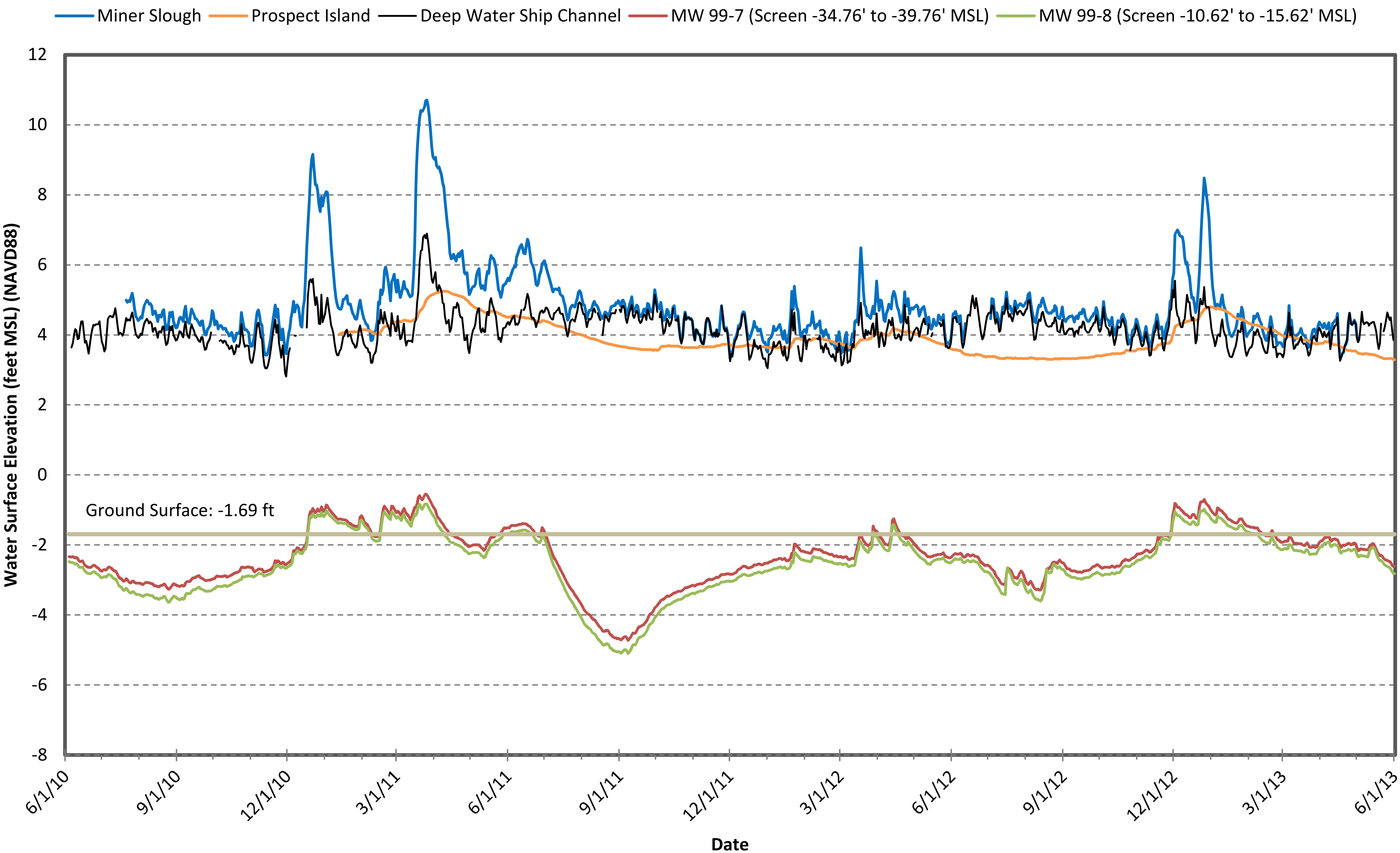
**June 1, 2010 to June 1, 2013**



# Appendix F-5

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Ryer Island MW 99-7 and MW 99-8 Groundwater Levels**

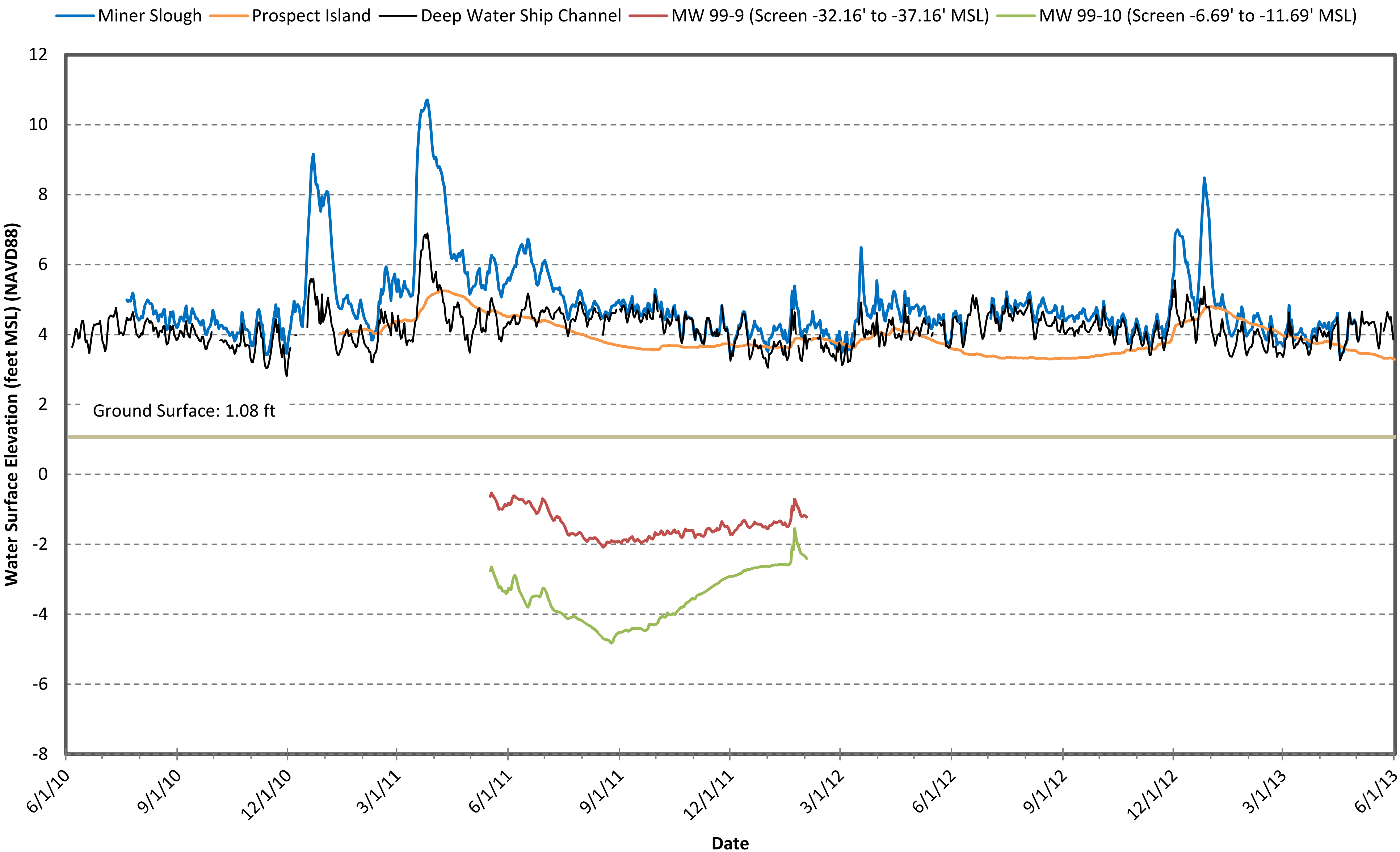
**June 1, 2010 to June 1, 2013**



# Appendix F-6

## Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Ryer Island MW 99-9 and MW 99-10 Groundwater Levels

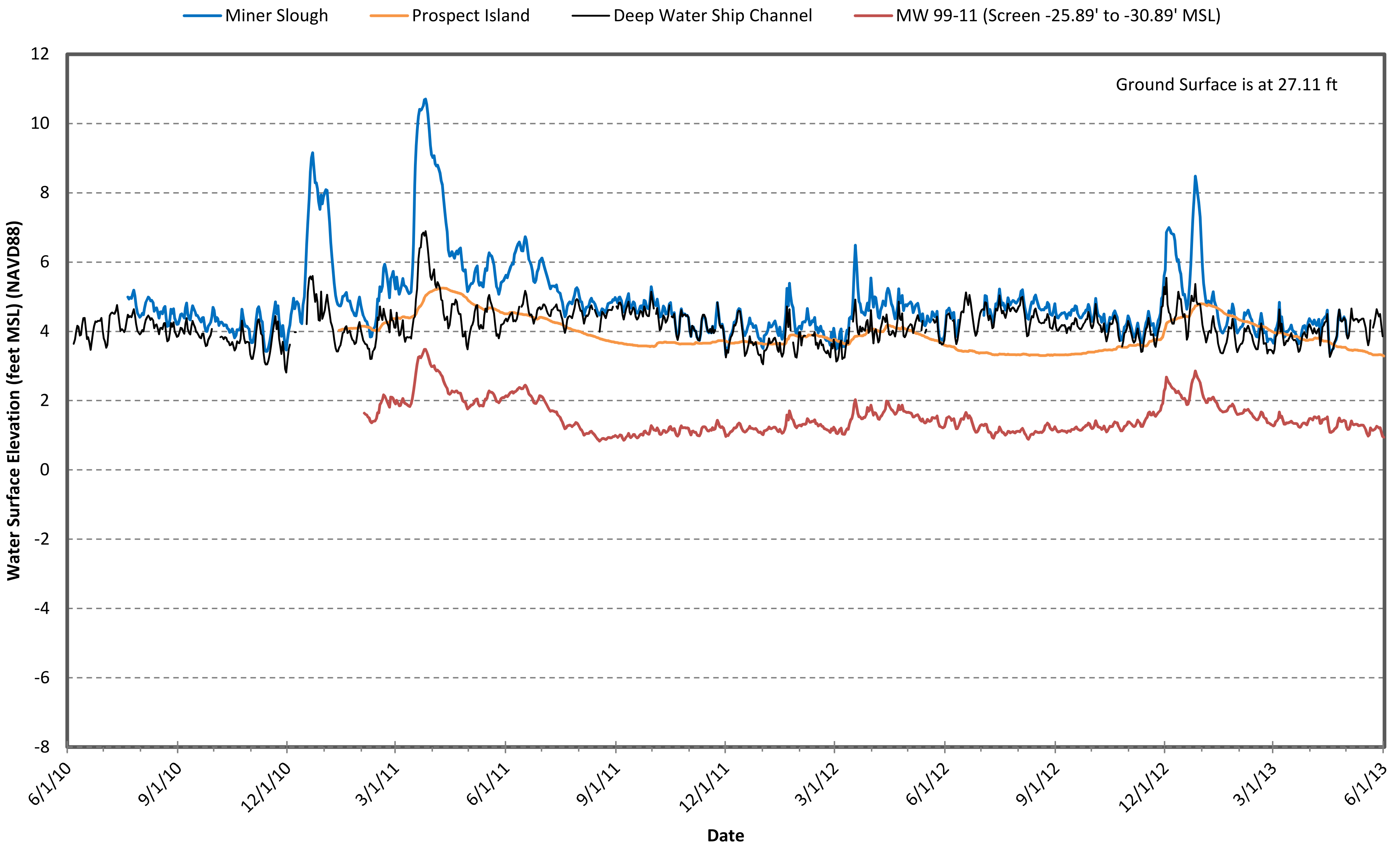
### June 1, 2010 to June 1, 2013



# Appendix F-7

## Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Ryer Island MW 99-11 Groundwater Levels

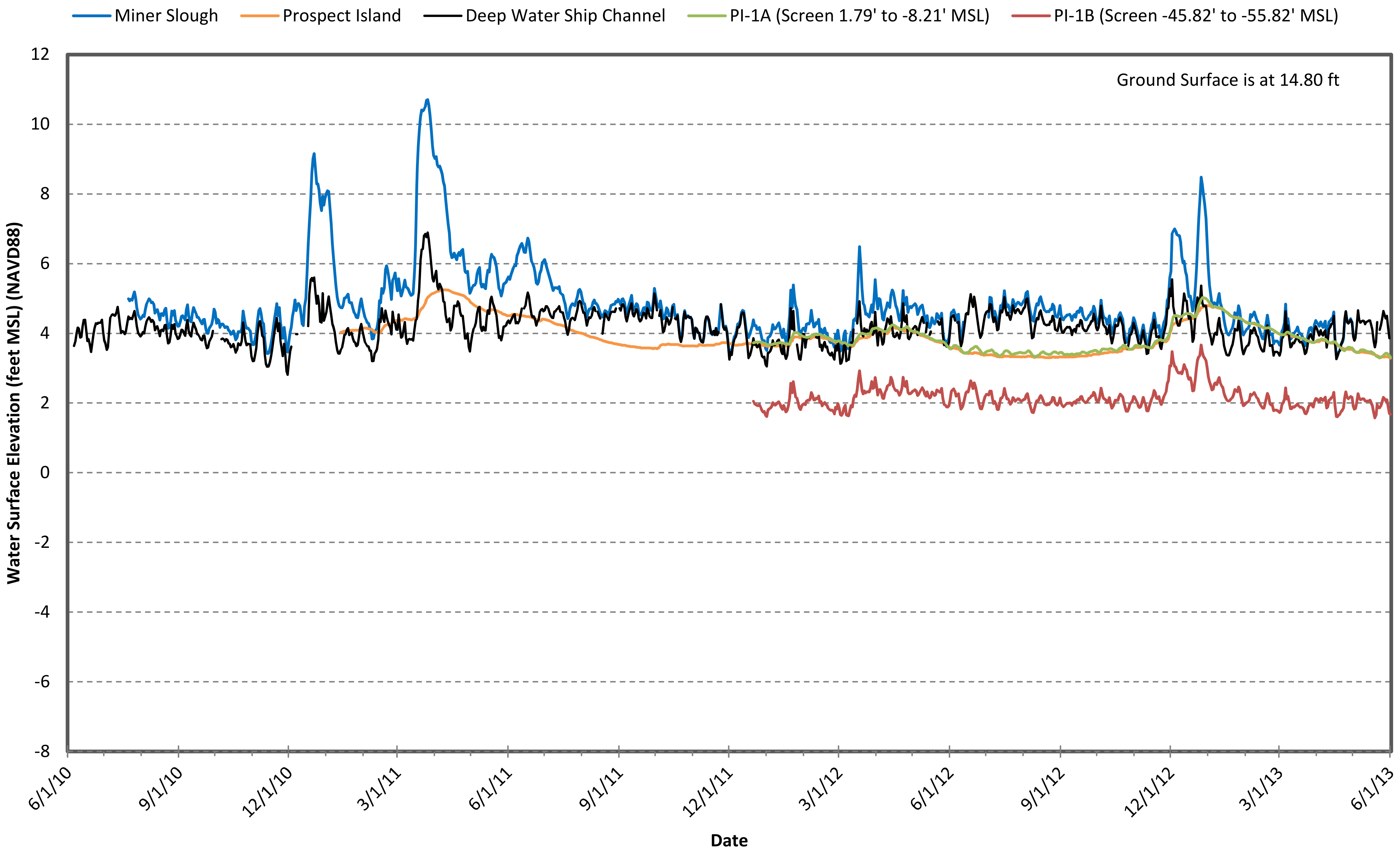
**June 1, 2010 to June 1, 2013**



# Appendix F-8

## Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-1A and PI-1B Groundwater Levels

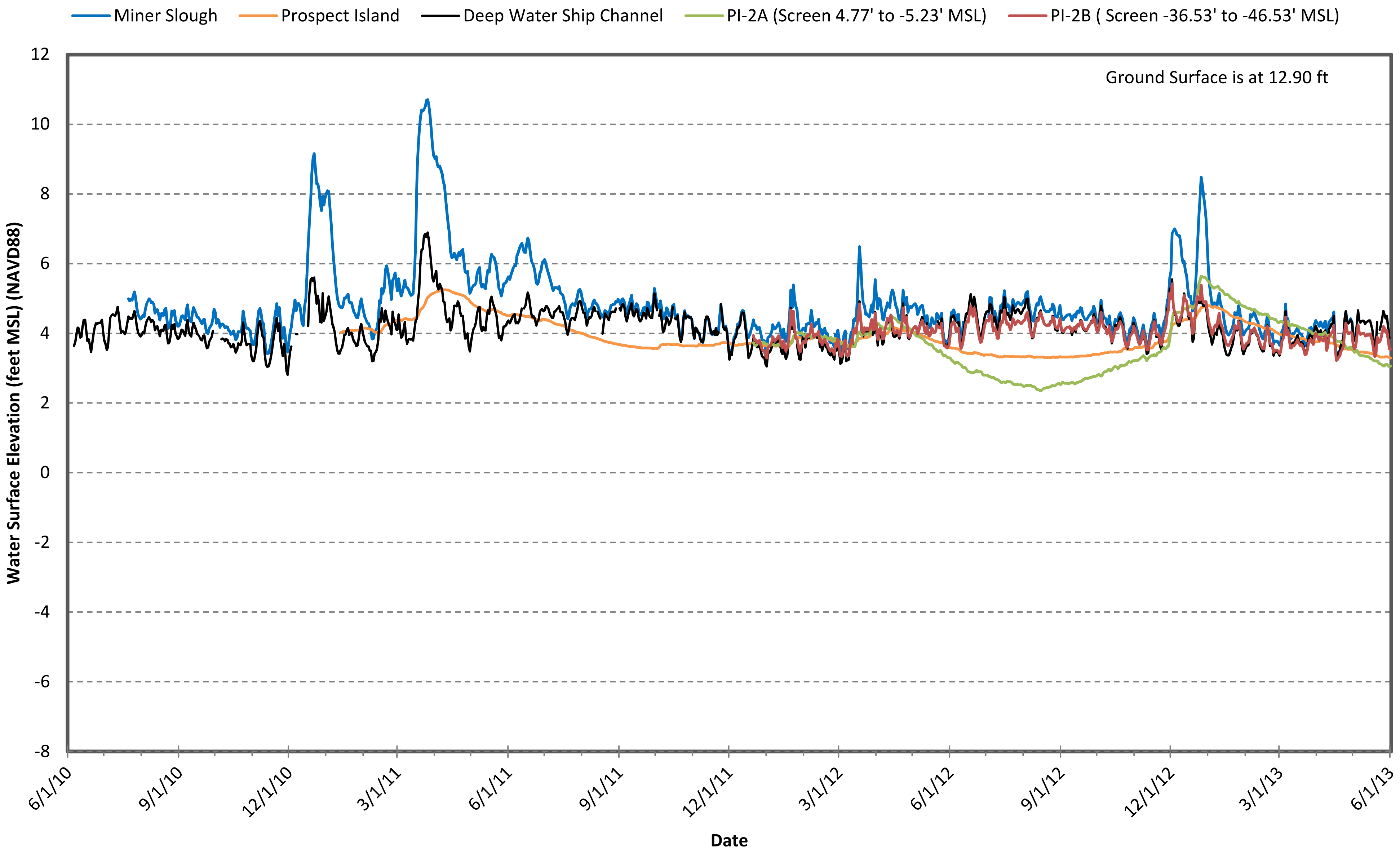
**June 1, 2010 to June 1, 2013**



# Appendix F-9

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-2A and PI-2B Groundwater Levels**

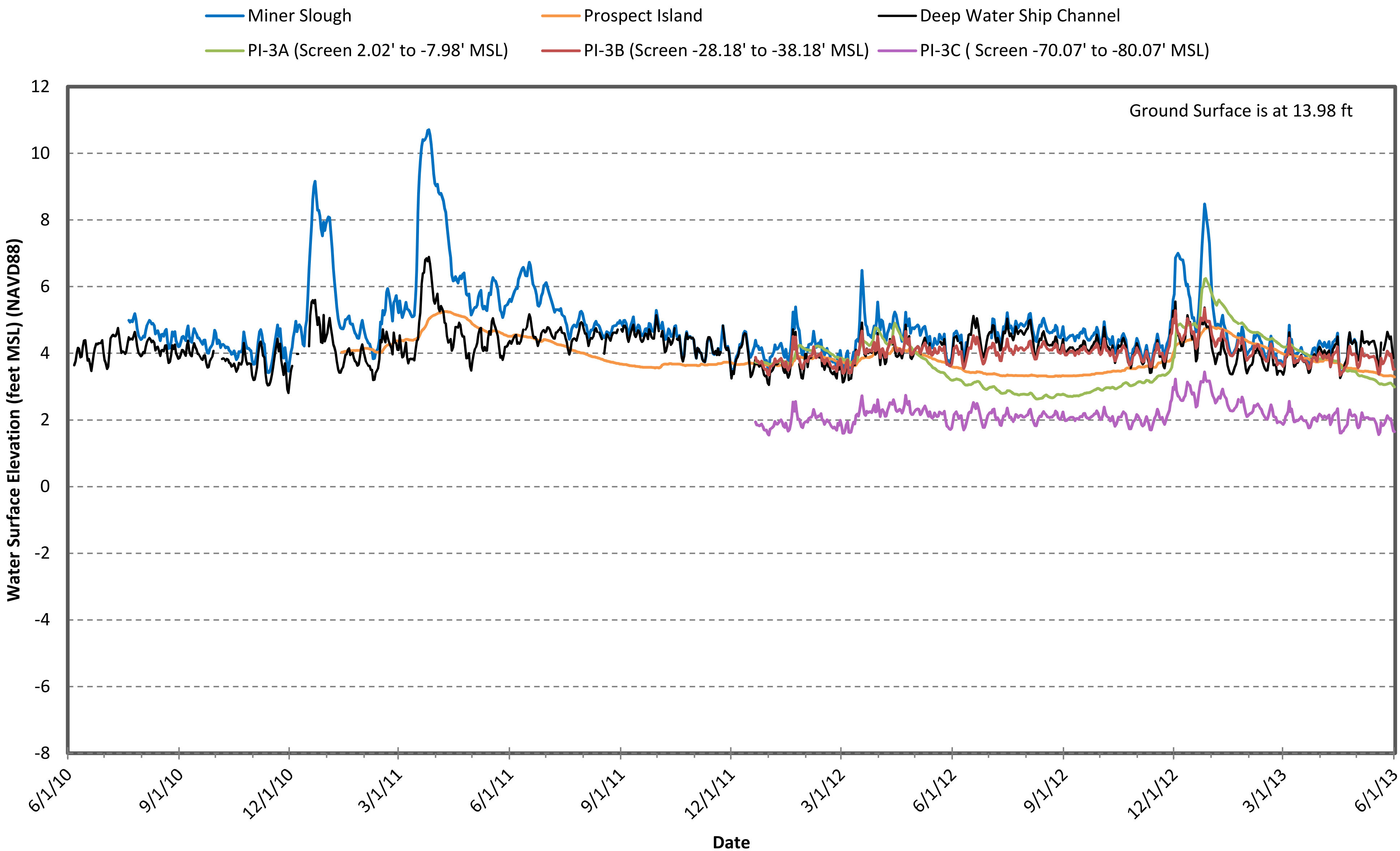
**June 1, 2010 to June 1, 2013**



# Appendix F-10

## Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-3A and PI-3B Groundwater Levels

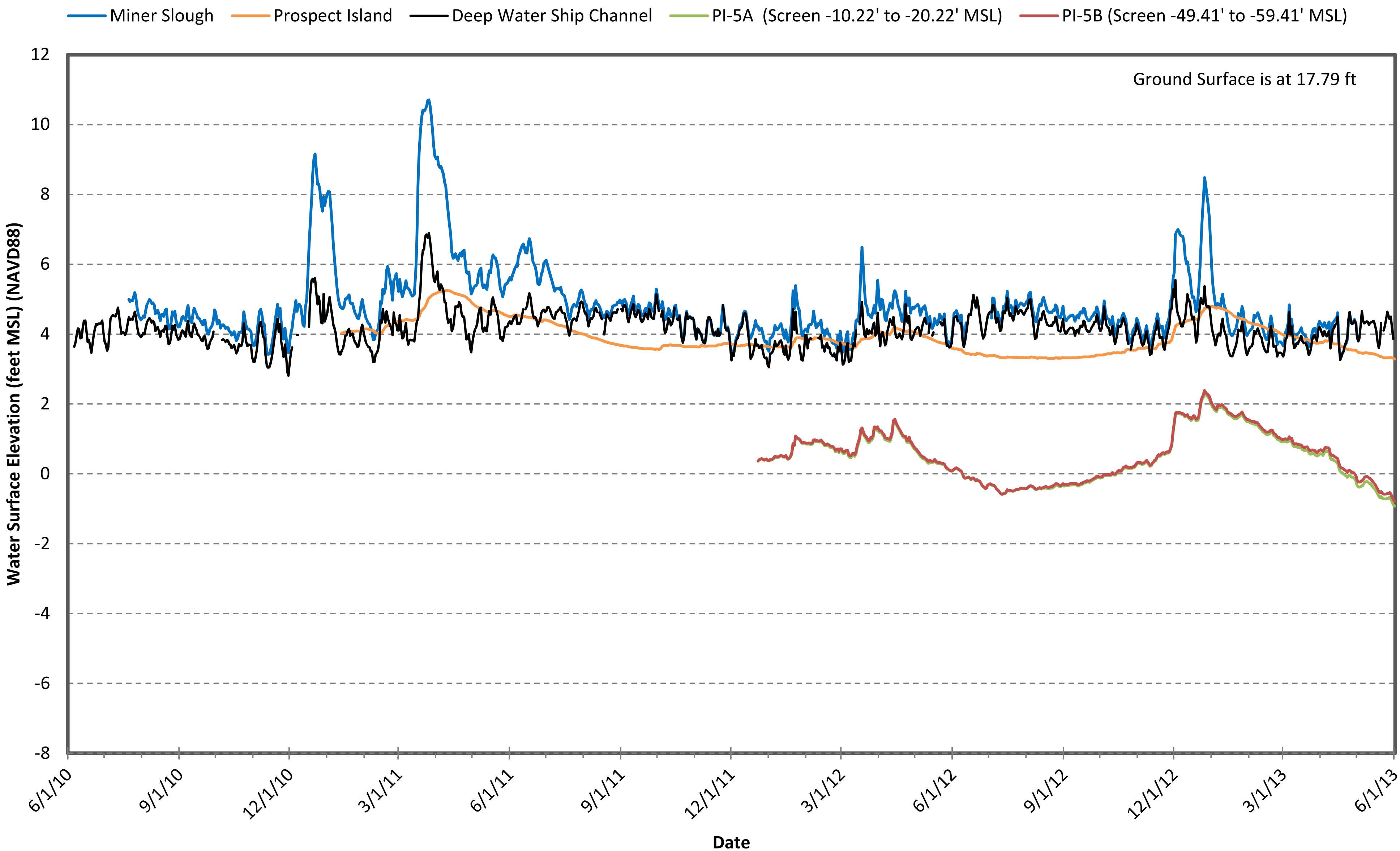
**June 1, 2010 to June 1, 2013**



# Appendix F-11

## Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-5A and PI-5B Groundwater Levels

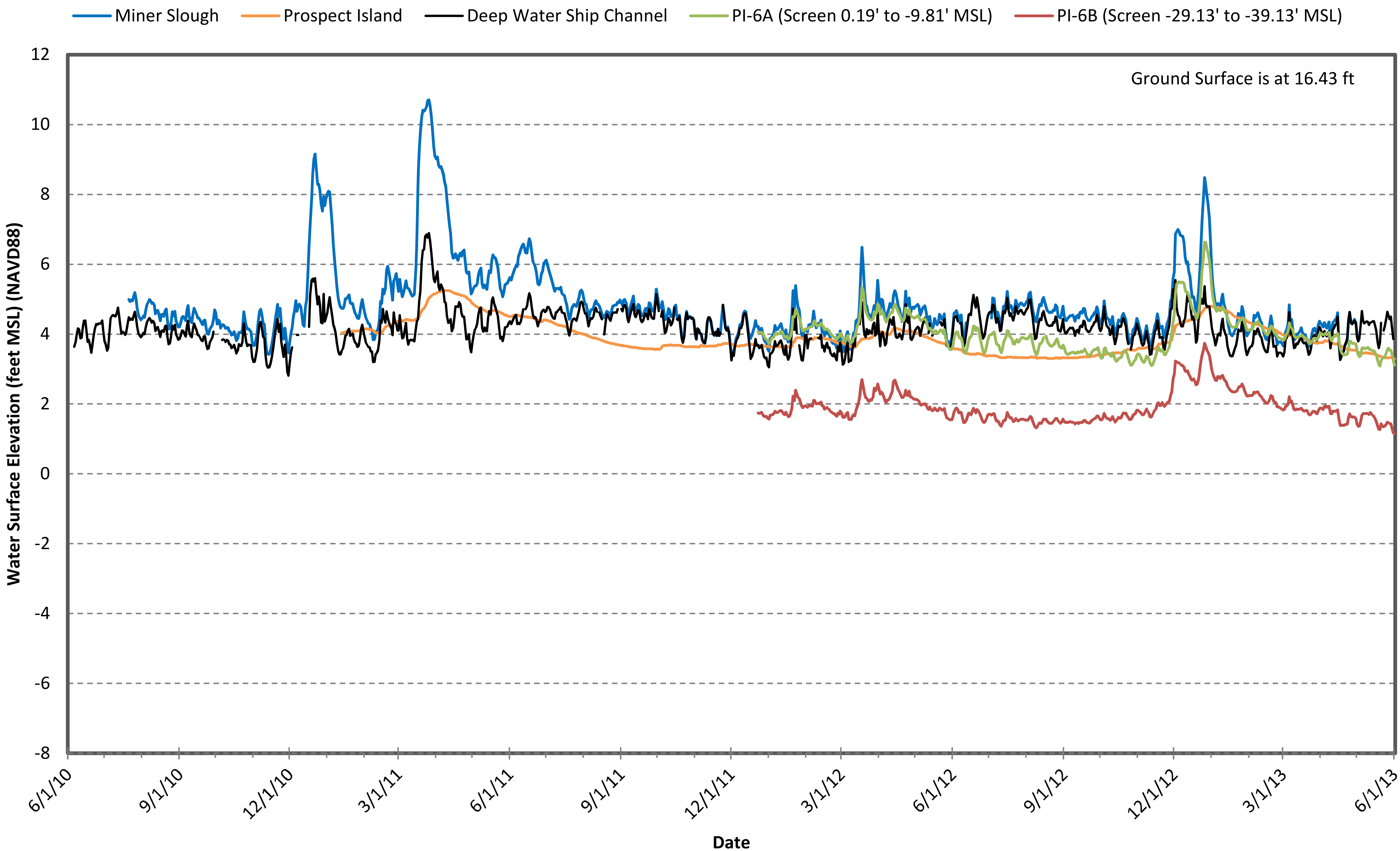
### June 1, 2010 to June 1, 2013



# Appendix F-12

## Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-6A and PI-6B Groundwater Levels

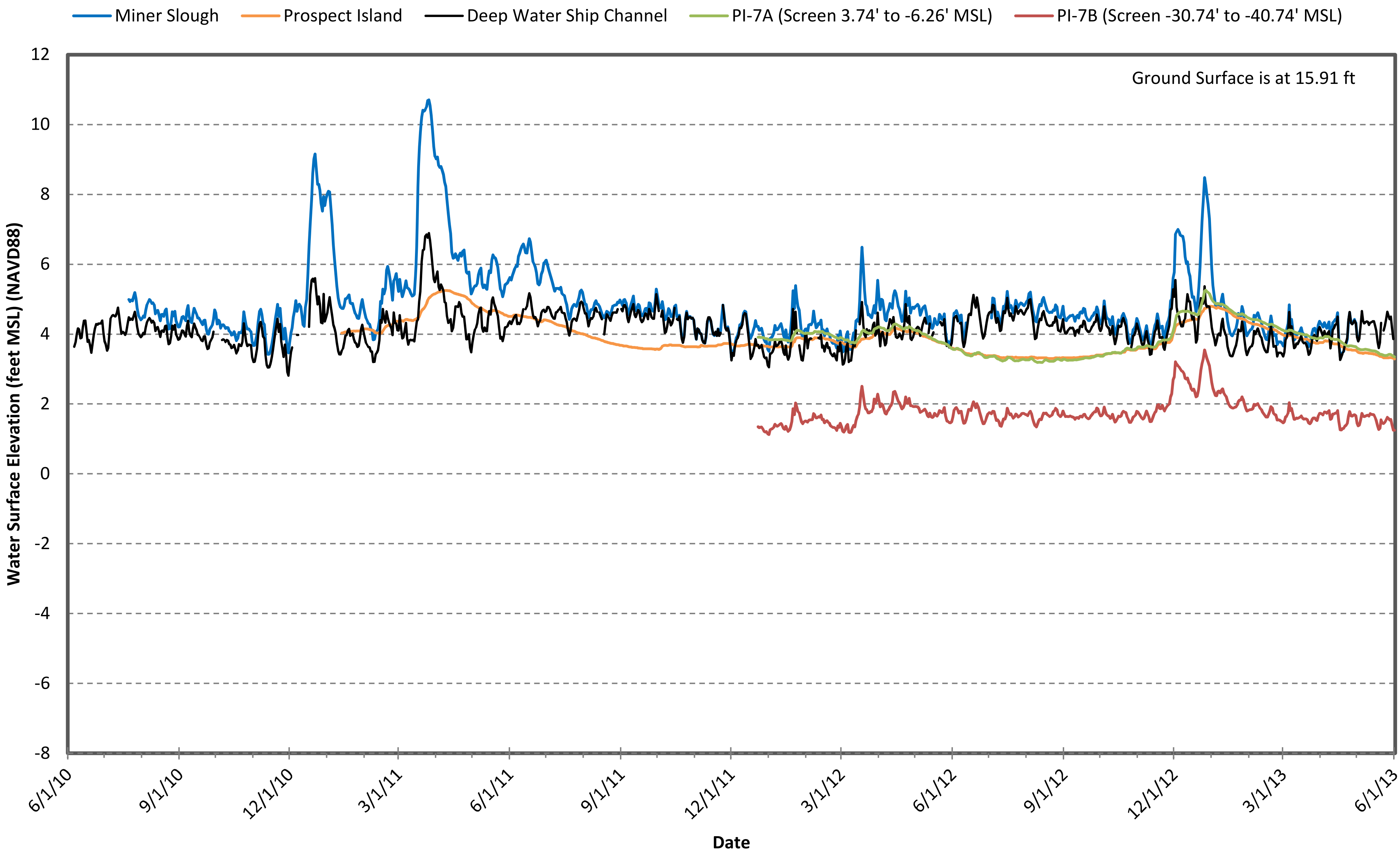
**June 1, 2010 to June 1, 2013**



# Appendix F-13

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-7A and PI-7B Groundwater Levels**

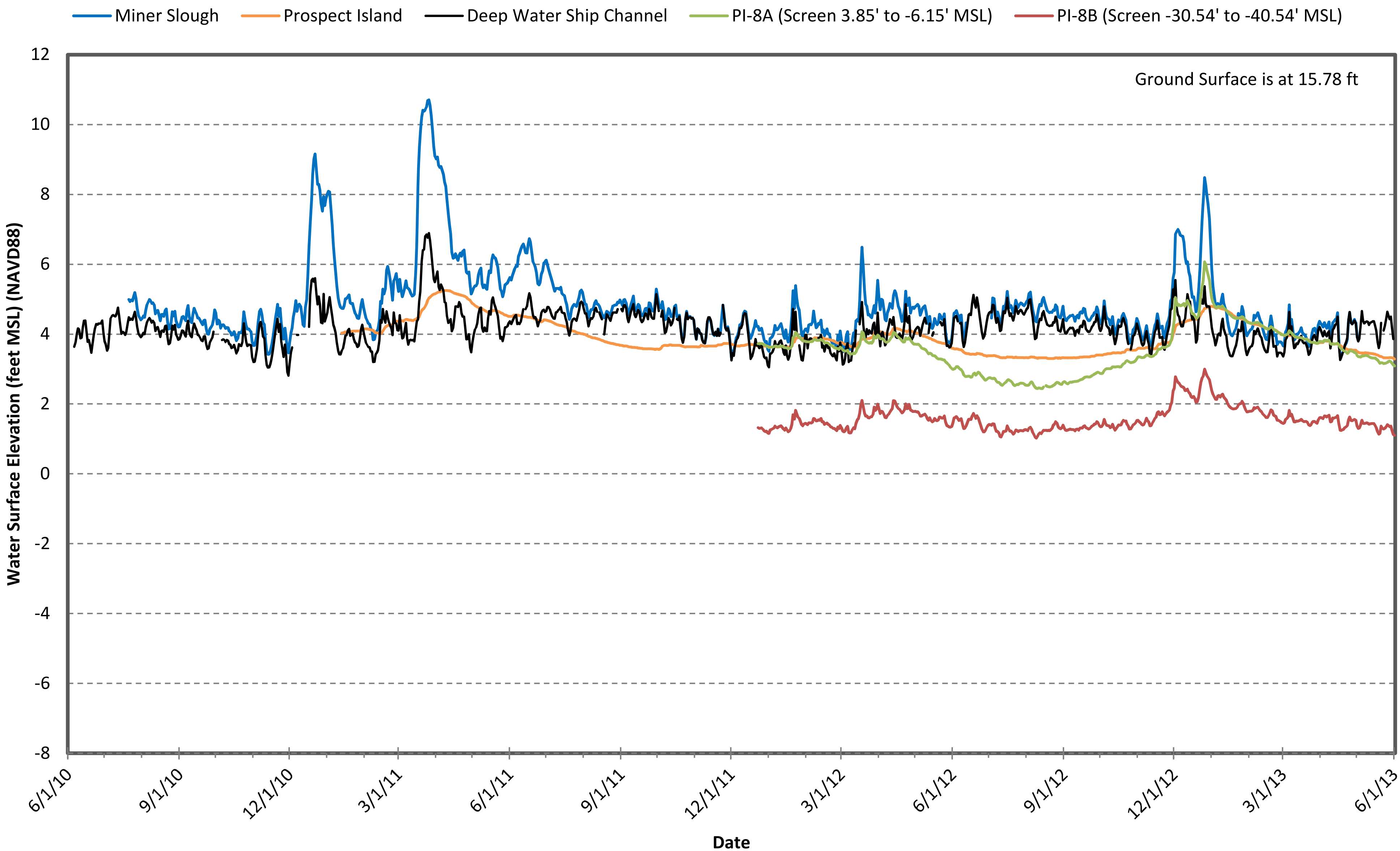
**June 1, 2010 to June 1, 2013**



# Appendix F-14

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-8A and PI-8B Groundwater Levels**

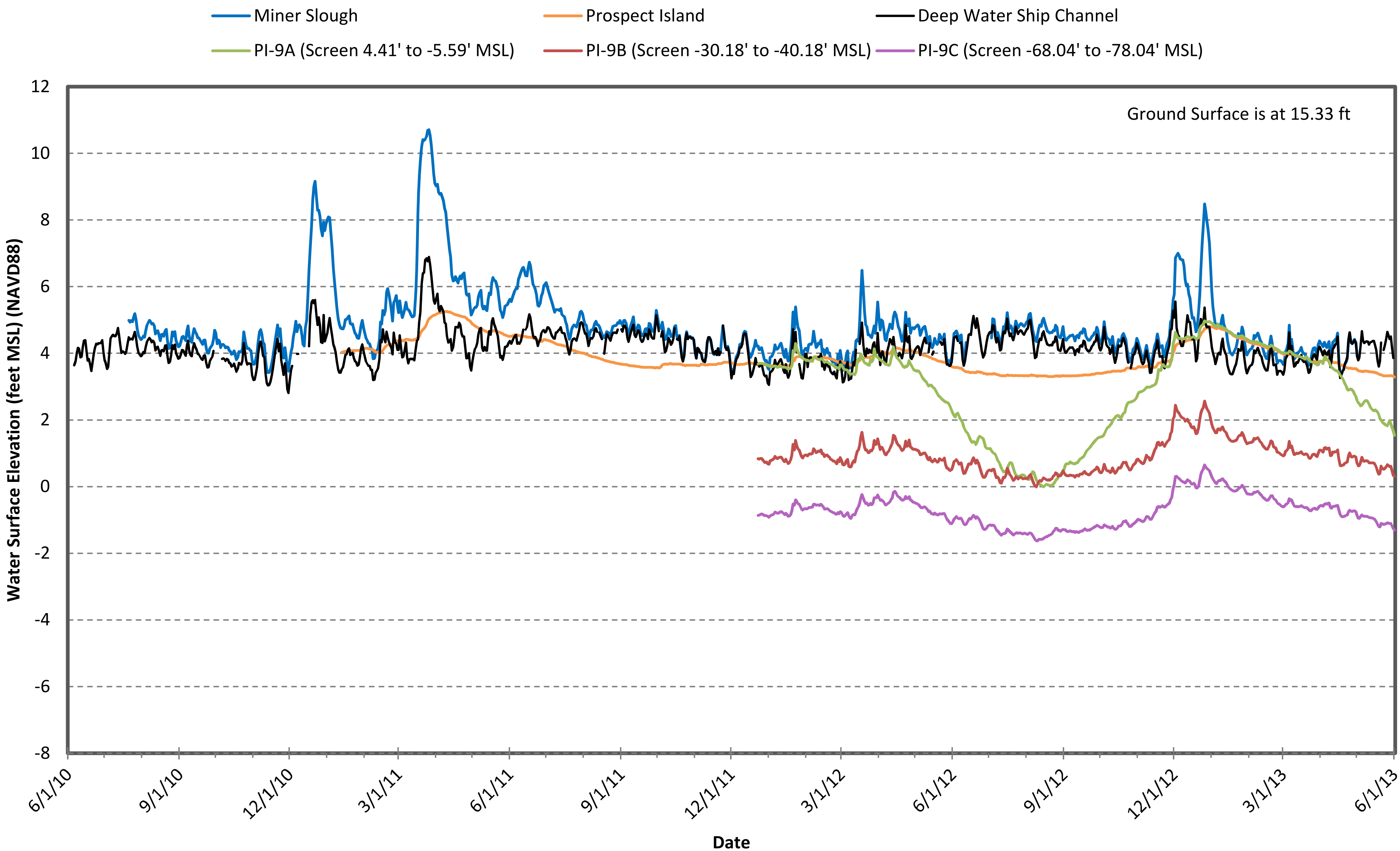
**June 1, 2010 to June 1, 2013**



# Appendix F-15

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island PI-9A and PI-9B Groundwater Levels**

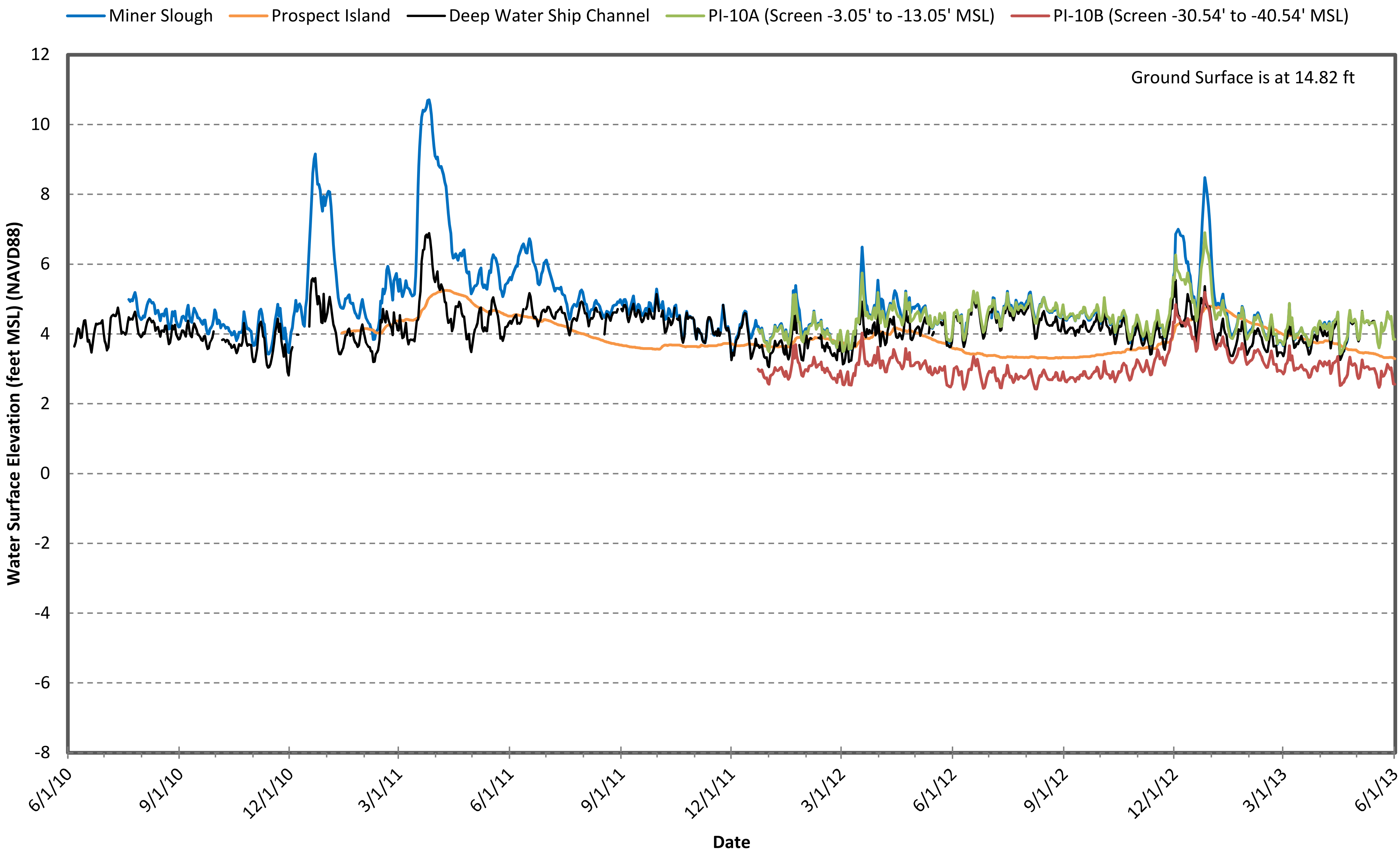
**June 1, 2010 to June 1, 2013**



# Appendix F-16

**Hydrographs of Miner Slough, Prospect Island, and Deep Water Ship Channel Surface Water Stage and Prospect Island 10A and 10B Groundwater Levels**

**June 1, 2010 to June 1, 2013**



# Appendix G

# Prospect Island 2011 DEM Update Data Collection and Processing Final Report Wetlands and Water Resources, Inc.

Wetlands and Water Resources, Inc.

818 Fifth Avenue, Suite 208
San Rafael, CA 94901
Tel/Fax 415.457.0250
www.swampthing.org

# Prospect Island 2011 DEM Update
# Data Collection and Processing Final Report

**20 December 2011**

**Prepared for:**
Department of Water Resources, Division of Environmental Services
Mitigation and Restoration Branch
3500 Industrial Blvd.
West Sacramento, CA 95691
www.water.ca.gov

**Prepared by:**
Wetlands and Water Resources, Inc.
818 Fifth Avenue, Suite 208
San Rafael, California 94901
www.swampthing.org

**Project No. 1149**

Planning | Assessment | Design | Implementation | Applied Science

# Prospect Island 2011 DEM Update

# Data Collection and Processing Final Report

20 December 2011

## Table of Contents



## Tables



## Figures (follow text)



## Appendices

# Prospect Island 2011 DEM Update

# Data Collection and Processing Final Report

20 December 2011

## 1 Introduction

In October and November 2011, Wetlands and Water Resources, Inc. (WWR) collected topographic and bathymetric data throughout the southern diked portion of Prospect Island for the purpose of updating and resolving vegetation-derived discrepancies in the digital elevation model (DEM) produced by Department of Water Resources (DWR) at this site. Prospect Island is located in unincorporated Solano County, California, in the Sacramento-San Joaquin Delta, within the Yolo Bypass, and between the Sacramento Deep Water Ship Channel to the west and Miner Slough to the east (Figure 1). This work was performed on behalf of DWR. This report summarizes the data collection methods and data processing activities employed to produce an updated DEM.

## 2 Field Data Collection

This section describes the field data collection methods. WWR collected field topographic data using both topographic and bathymetric survey methodologies.

### 2.1 Topographic Surveys

WWR staff performed the topographic surveys on multiple site visits spanning October 18 to November 1, 2011. Leica System 1200 Real-Time Kinematic GPS (RTK-GPS) rovers were used to survey the topography throughout the marsh edge and flooded areas with dense vegetation or woody debris (where bathymetric survey methods were not reliable or possible to reach). A Topcon GTS 330B total station was used in areas with tall riparian vegetation, where RTK-GPS rovers could not maintain satellite connections.

#### 2.1.1 RTK-GPS Surveys

The RTK-GPS system was used for data collection in the following areas of the site: (1) tule and cattail vegetation stands on the terrestrial edge, (2) the 'flooded forest' (inundated areas of extensive, shallow large woody debris) accessed by kayak, and (3) flooded tules and thick mats of aquatic and subaquatic vegetation (i.e., *Ludwigia* spp. and *Ceratophyllum demersum*) accessed by airboat. The GPS rover positions were referenced to a Leica System 1200 RTK Base Station, which was set up over a temporary, onsite benchmark (CP1). The elevation of CP1 was determined using the RTK-GPS rover on the first day of site reconnaissance (October 18), during which the GPS base was set up over a known National Geodetic Survey (NGS) benchmark (JS4374) for 7 hours (Figure **2**). Thirty data points were collected over CP1 while the rover was supported by a level bipod. Once the base station data were processed, the rover data were processed and corrected to provide the horizontal and vertical position of CP1 in the project coordinate system and vertical datum (California State Plane Zone 2, NAD 83-ft; NAVD 88-ft).

### 2.1.2 Total Station

In areas of dense vegetation (e.g., riparian woodland areas), the total station was used to collect topographic point data. Horizontal and vertical control for the total station survey was provided by a control point network that was established utilizing RTK-GPS. The total station was set up over a control point and oriented (back sighted) to a second control point. Total station raw data (prism distances, azimuth angles and vertical angles) were collected by a Carlson Survey Explorer data collector which calculated and recorded northings, eastings, elevations, and point codes.

### 2.1.3 Survey QA/QC

On most RTK-GPS survey days, two first-order vertical NGS benchmarks were surveyed to ensure the vertical accuracy of all other topographic data collected (Figure 2). Of the two occupied NGS benchmarks (JS4374 and JS2070), the surveys were held to JS4374. The benchmark datasheets are included in Appendix A. The reported and surveyed elevations for each of these benchmarks on independent survey dates are reported in Table 1, below. The topographic data collected on each survey date were held to JS4374 by adjusting the entire day's dataset by the value listed in the "Difference" column in Table 1. To ensure survey consistency throughout each day, we set a second temporary benchmark (CP2) that we checked into periodically throughout the day. No NGS benchmarks were surveyed during the 10/20/2011 survey. On this date, all data were held to the previously determined elevation for CP2.

**Table 1. Reported and surveyed elevations of NGS benchmarks**

| Survey Date | NGS PID | Elevation (ft NAVD88) | | Difference (ft) |
|---|---|---|---|---|
| | | Reported | Surveyed | |
| 10/18/2011 | JS4374 | 24.70 | 24.70 | 0.00 |
| | JS2070 | 22.40 | 22.46 | 0.06 |
| 10/19/2011 | JS4374 | 24.70 | 24.70 | 0.00 |
| 10/21/2011 | JS4374 | 24.70 | 24.71 | 0.01 |
| 11/1/2011 | JS4374 | 24.70 | 24.73 | 0.03 |

All RTK-GPS survey points with coordinate quality (3-D error estimate) greater than 0.2ft were removed from the final dataset.

## 2.2 Bathymetric Survey

The bathymetric survey of the flooded site interior was performed where water depth exceeded 2 feet and where subaquatic vegetation (SAV) and woody debris had minimal impact on navigability. This was primarily used along the western edge of the inundated site and in the open water in the northwest portion of the property.

### 2.2.1 Hydrographic Survey Equipment

The survey crew utilized a 17-ft Jon Boat-based survey vessel, compliant with all U.S. Coast Guard safety regulations, to perform the survey. A graph displaying the results from a squat correction test conducted for the vessel in March 2006 is aboard the vessel (per U.S. Army Corps of Engineers' specifications).

The hydrographic surveys utilized Class 1 methods and accuracies as outlined in the Army Corps of Engineers' January 2002 Hydrographic Surveying Manual (EM 1110-2-1003). Bathymetric data were collected using an *Odom CVM* survey-grade fathometer with a 3-degree 200-kHz transducer. The transducer is mounted within a mineral oil bath in a fathometer well, located mid-ship through the hull in the keel of the vessel.

The hydrographers anticipated the potential for sub-aquatic vegetation (SAV) and mobilized specially-designed singlebeam sonar that is able to penetrate SAV: a Teledyne *Odom Model CVM* fathometer. The *Odom CVM* records individual sonar returns from each surface that is encountered. Thus, the full spectrum of each sonar ping return is recorded. This includes the first return form the top of the SAV stand, and subsequent returns – from the actual pond bottom.

Position data (geographic coordinates) were collected using a Leica System 1200 RTK-GPS receiver mounted above the fathometer. Survey vessel motion (heave) was measured using a TSS 335B motion sensor attached to the top of the fathometer well. Vessel motion data were logged separately for inspection during data processing. Heave data were then applied to the raw sounding data during data reduction. Squat corrections were added automatically to the raw sounding data depending on vessel speed and fuel consumption.

Horizontal position control data were collected in geographic coordinates (latitude and longitude in decimal degrees) based on the North American Datum of 1983 (NAD83) using the RTK-GPS system. CorpsCon Version 6.0 was used to convert the geographic coordinates to California State Plane Zone 2 (NAD83, U.S. Survey feet) coordinates.

The on-board data stream was collected using a Dell CPU running Hypack Max (Version 8.0) survey planning, data collection and reduction software.

### 2.2.2 Water Level Monitoring

The southern portion of Prospect Island experiences muted tides via seepage through the levee breach repair located on the east side of the property. In order to correct raw sounding data for changes in the water surface elevation (WSE), WSE time series were recorded at six minute intervals at the survey site. WSE fluctuations were monitored within southern Prospect Island utilizing a vented pressure transducer (water level gage) manufactured by *In-Situ Inc*. (*Mini Troll 4000*) deployed within the intertidal zone. The water level gage was placed inside a stilling well to facilitate the physical calibration of the water surface elevation (the stilling well ensures a stable water surface during calibration). The stilling well top was surveyed into the project vertical datum (ft NAVD88) using a Leica digital level and WSE calibration measurements were made to the top of the well using a well sounding probe. All calibrations were within ± 0.05' of the pressure transducer measurements.

### 2.2.3 Speed of Sound Measurements

Fathometers calculate water depth by using algorithms based on the speed of sound through the water column. The survey crew utilized an *Odom Digibar Pro* speed of sound probe to measure sound velocity multiple times during each survey day.

Mounted near the end of the sound velocity probe is a high frequency "sing-around" transducer and its associated reflector. This precisely spaced pair is used to measure the velocity of sound in water by transmitting and receiving a signal across their known separation distance.

### 2.2.4 Barcheck QA/QC

The second QA/QC protocol is a barcheck calibration which is performed on the fathometer before and after each survey. This procedure consists of lowering a 36-inch diameter, weighted steel plate below the fathometer transducer and recording the actual depth of the disc (via markings on a cable) and the fathometer output (output was corrected for the transducer depth offset).

# 3 Digital Elevation Model Update

The final topographic and bathymetric survey coverage is displayed in Figure **3**. The ultimate goal of this data collection effort was to generate an updated DEM of southern Prospect Island to augment the existing 2010 DEM of northern Prospect Island created by DWR.

The updated DEM of southern Prospect Island was constructed using the following input topographic data:

- The post-processed and benchmark corrected survey data collected in this effort

- Topographic survey data within the southern Prospect Island wetland "basin" (non-levee points) collected by DWR in 2010
- Levee contour lines from the current 2010 Prospect Island DEM (generated by DWR from 2007 DWR LiDAR data and 2009-2010 DWR survey data )

The input data listed above were used to generate a triangulated irregular network (TIN) surface using the 3-D Analyst extension in ArcView 3.2, from which 1-ft contour lines were generated. These contour lines were then edited in ArcGIS 9.3.1 to account for interpolation irregularities/anomalies (artifacts of input data density and TIN interpolation methodology) and to better represent the true nature of the ground surface based on air photo interpretation and knowledge of the site. These edited contour lines were used as hard breaklines to supplement the existing topographic datasets and an updated TIN was generated. This process of TIN generation and breakline editing was continued iteratively until all major interpolation irregularities/anomalies were resolved and a satisfactory surface was created. The final TIN was converted into a raster DEM grid with 2x2 ft cell size (the same as the original 2010 DWR DEM). The final southern Prospect Island DEM is displayed in Figure **4**.

The final raster DEM of southern Prospect Island was clipped to the crest of the perimeter levee and merged with the original 2010 DWR DEM of the entire Prospect Island (north and south combined) using the Merge to New Raster tool in ArcGIS 9.3.1, thus replacing the original south Prospect Island DEM data with the updated data (Figure **5**). The cell size and extent of the original 2010 DEM were retained. Contour lines representing the elevations of mean higher-high water (MHHW; 6.5 ft NAVD88), mean lower-low water (MLLW; 2 ft NAVD88), and 3 ft below MLLW (-1 ft NAVD88) were created from the updated whole-island DEM. These tide range values are taken from field data-based tidal datum reckoning conducted for the nearby Lower Yolo Restoration Project; those data are currently undergoing peer review which may result in a modification of tidal datum estimates for the area. In addition, WWR is working with DWR to develop a Delta-wide tidal datums data set and the results of those efforts may replace values for Prospect Island restoration planning.

In summary, the following data products were generated in this effort.

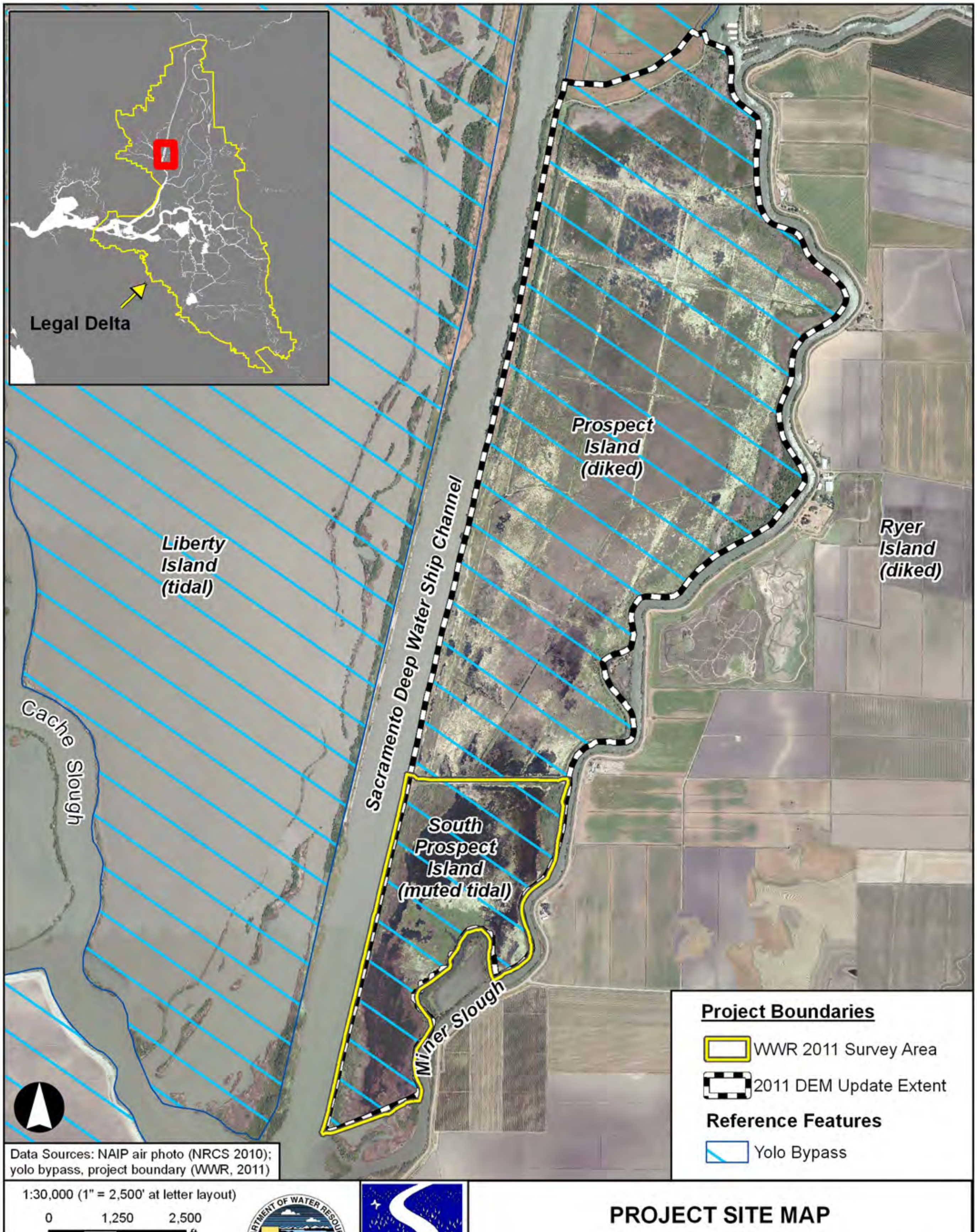
- Point shapefile of WWR 2011 topographic survey data at southern Prospect Island
- TIN surface of south Prospect Island topography
- Raster DEM of south Prospect Island topography
- Combined raster DEM of north and south Prospect Island topography
- Contour lines of MHHW, MLLW, and -3 ft MLLW from updated whole-island DEM

# 4 Change Detection

The southern Prospect Island DEMs from 1994 (prepared by the Corps of Engineers using aerial photogrammetry methods and done prior to the island being flooded), 2010 (DWR), and 2011 (current WWR work) are displayed in Figure **6**. The 2010 and 2011 DEMs show a much greater extent of subtidal habitat within the site than the 1994 DEM, with intertidal habitat confined mostly to the site perimeter. The 1994 and 2011 DEMs of the entire Prospect Island site are shown in Figure **7**. There has been a general increase in the amount of subtidal habitat from 1994 to 2011. Figure **8** depicts the elevation change within Prospect Island between the 1994 and 2011 DEMs. In general, land elevations in the 2011 DEM are from 0.5 to 2 ft below those in the 1994 DEM, with the greatest decrease occurring in south Prospect Island. The western levee along the Sacramento Deep Water Ship Channel has increased in elevation, due presumably to levee maintenance activities. The overall average elevation change from 1994 to 2011 is -0.67 ft.

Southern Prospect Island is owned by the Port of Sacramento and has been used over the course of many years for periodic dredge material placement associated with dredging of the Sacramento Deep Water Ship Channel. Northern Prospect Island is owned by DWR and prior to its acquisition by the U.S. Bureau of Reclamation in the late 1990s for restoration purposes had been in agricultural use. These differences in long-term historical land use may contribute to the different amounts of elevation change between 1994 and 2011 experienced in northern and southern Prospect Island.

# Figures

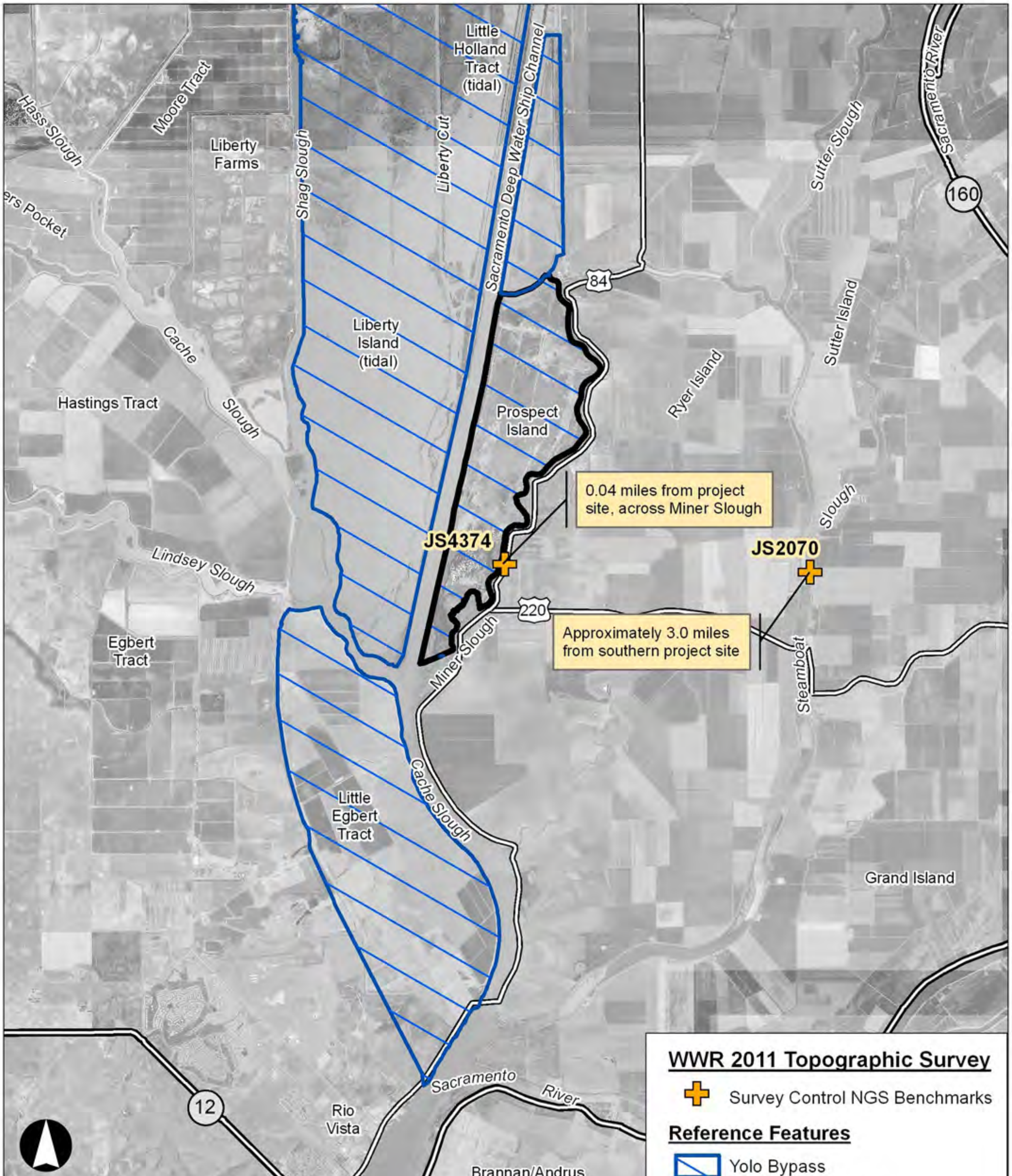



Produced by WWR, December 2011
Map File: vicinity-map_AP_1149_2011-1208mdl.mxd

**PROJECT SITE MAP**

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

| December 2011 | Project1149 | **Figure 1** |
|---|---|---|




Data Sources: NAIP air photos (NRCS, 2010); yolo bypass, project site (WWR, 2010); NGS benchmarks (WWR, 2011)

1:95,040 (1" = 1.5mi at letter size)

0 0.75 1.5 mi

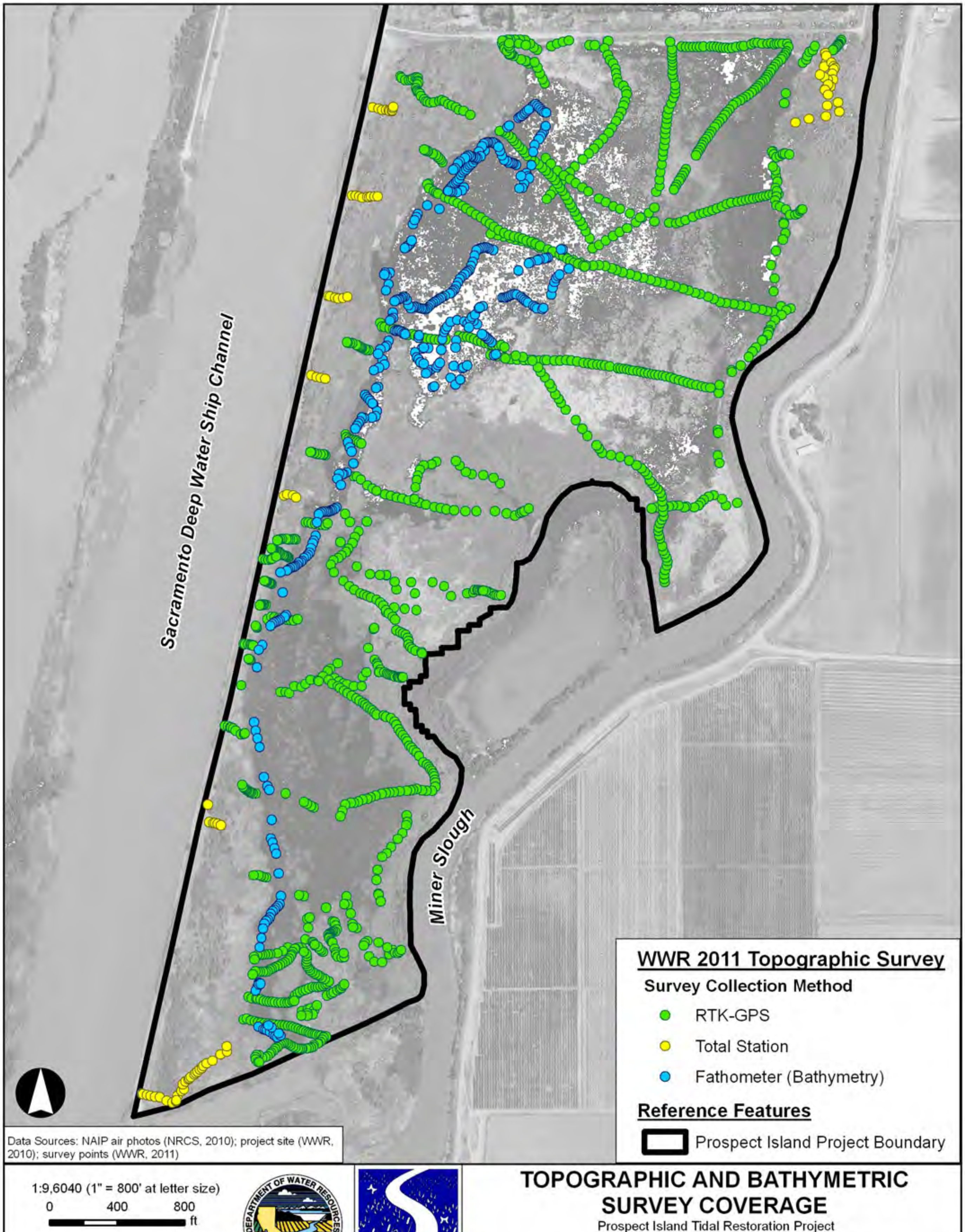
0 1 2 km

Produced by WWR: December 2011
Map File: benchmarksNGS-prospect_AP_1149_2011-1209mdl.mxd

# NGS BENCHMARKS
# TOPOGRAPHIC SURVEY CONTROL POINTS

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

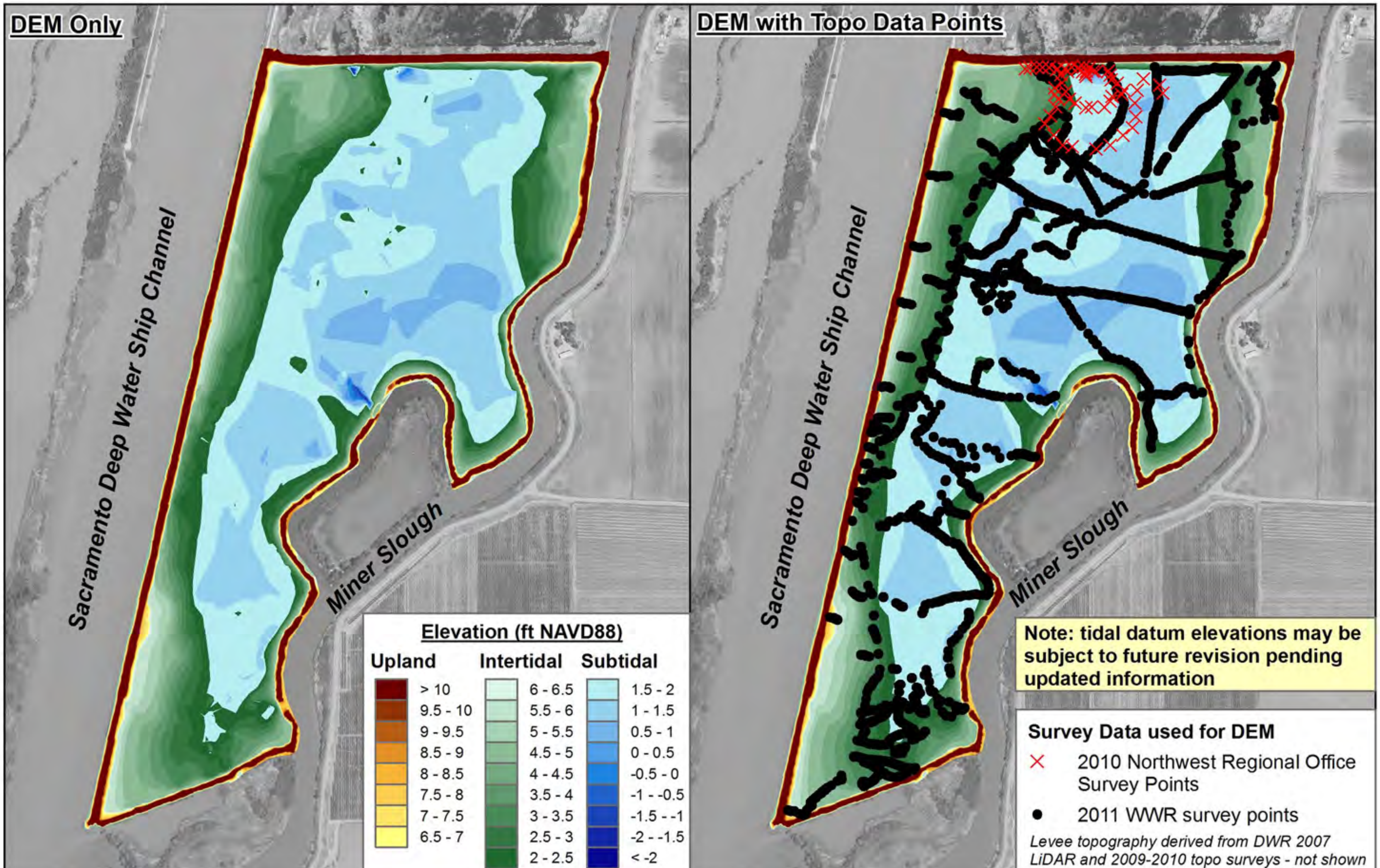
| December 2011 | Project 1149 | **Figure 2** |
|---|---|---|




# TOPOGRAPHIC AND BATHYMETRIC SURVEY COVERAGE

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

December 2011 | Project 1149 | **Figure 3**




1:14,400 (1" = 1,200' at letter size)

0 600 1,200 ft

0 200 400 m

Data Sources: DEM (WWR, 2011); topo data (DWR, 2011; WWR, 2011); air photo (NAIP, 2010)
Produced by WWR: December 2011
Map File: 2011-s-prospect-DEM_1149_2011-1209dag.mxd

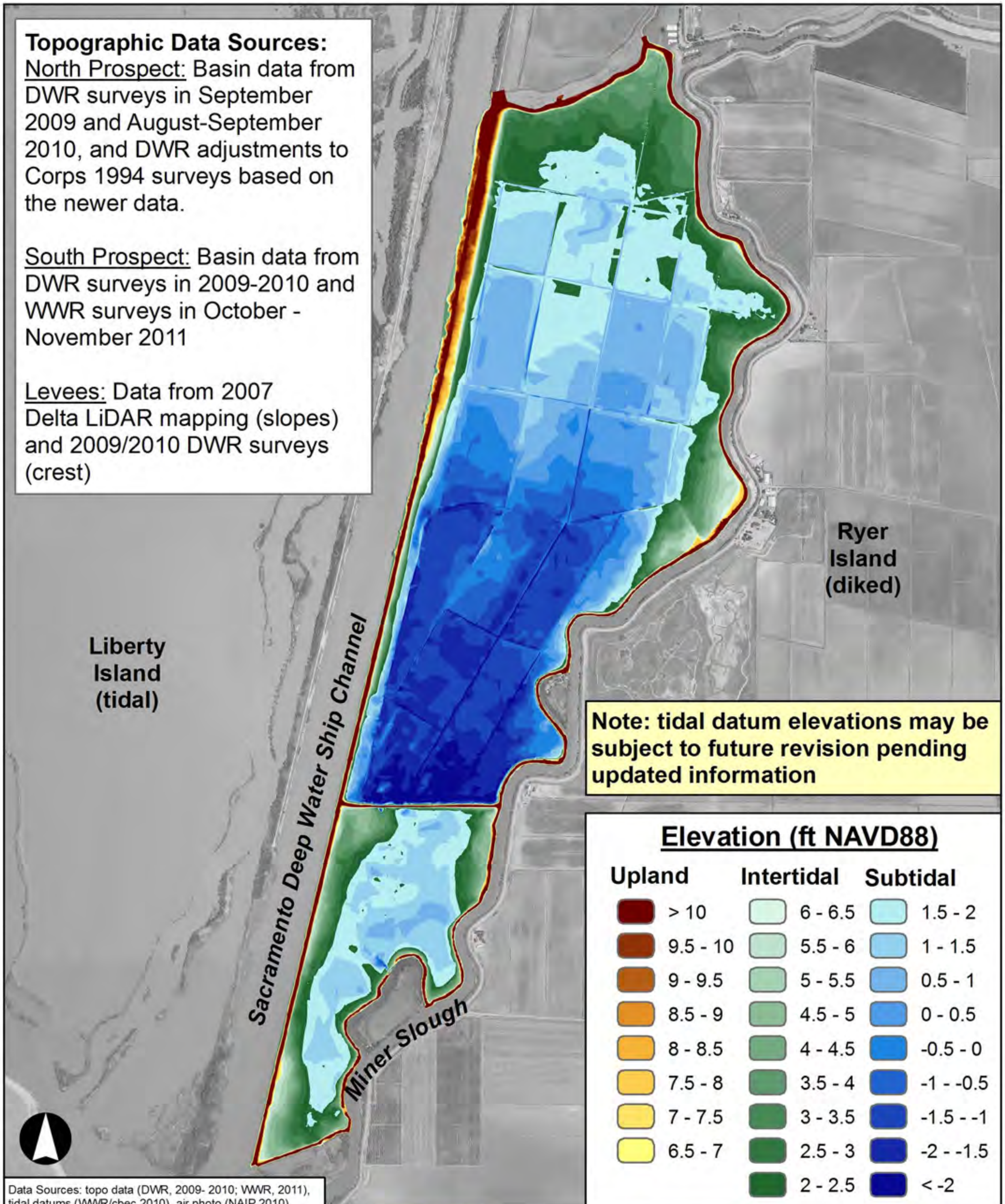
DEPARTMENT OF WATER RESOURCES · STATE OF CALIFORNIA

WETLANDS AND WATER RESOURCES

# 2011 SOUTH PROSPECT ISLAND DEM

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

| December 2011 | Project No. 1149 | **Figure 4** |
|---|---|---|




1:30,000 (1" = 2,500' at letter layout)

0 1,250 2,500 ft

0 400 800 m

Produced by WWR, December 2011
Map File: 2011-prospect-DEM_1149_2011-1209dag.mxd

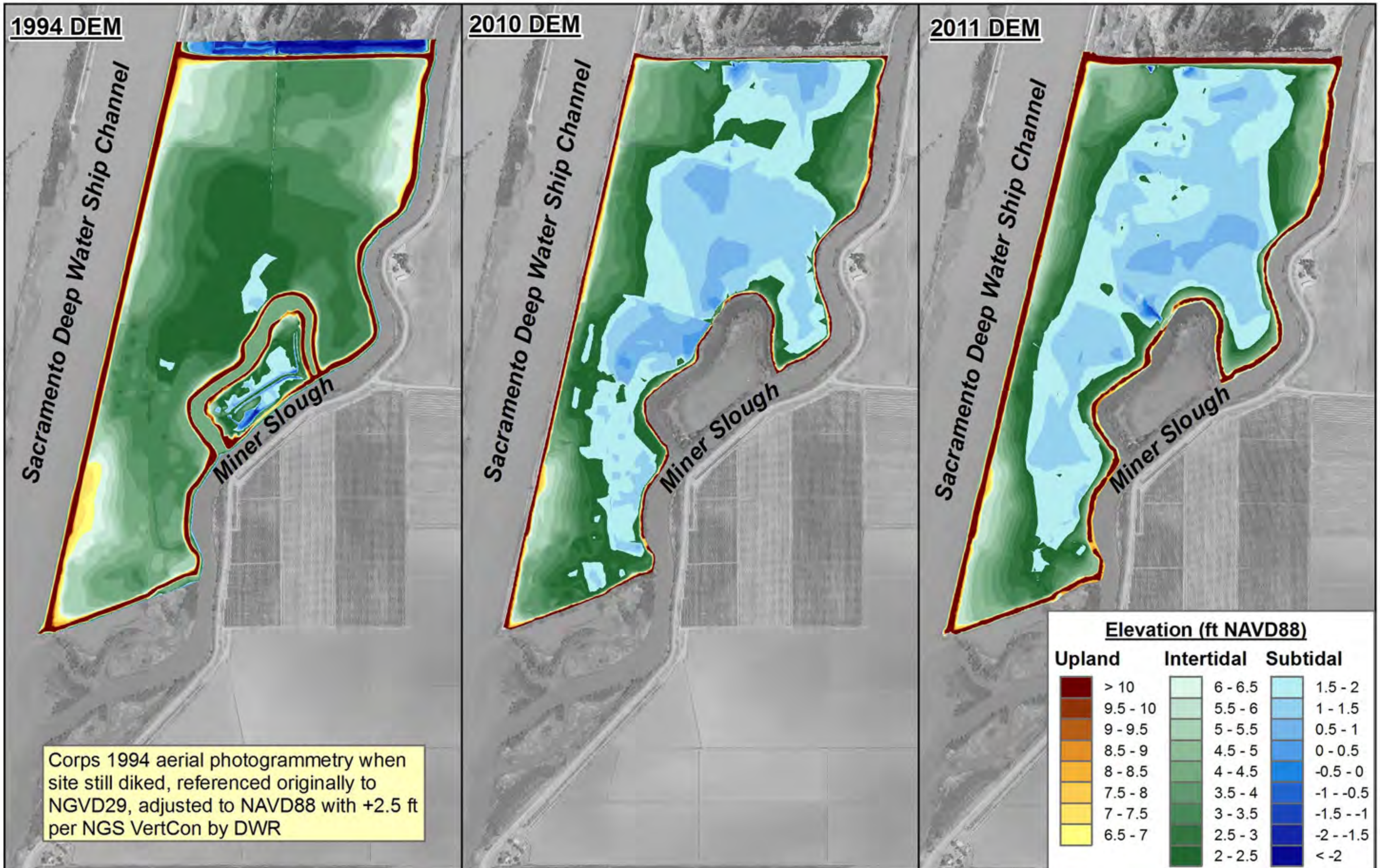
DEPARTMENT OF WATER RESOURCES · STATE OF CALIFORNIA

WETLANDS AND WATER RESOURCES

**UPDATED PROSPECT ISLAND DEM**

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

| December 2011 | Project No. 1149 | **Figure 5** |
|---|---|---|




1:19,200 (1" = 1,600' at letter size)

0 800 1,600 ft

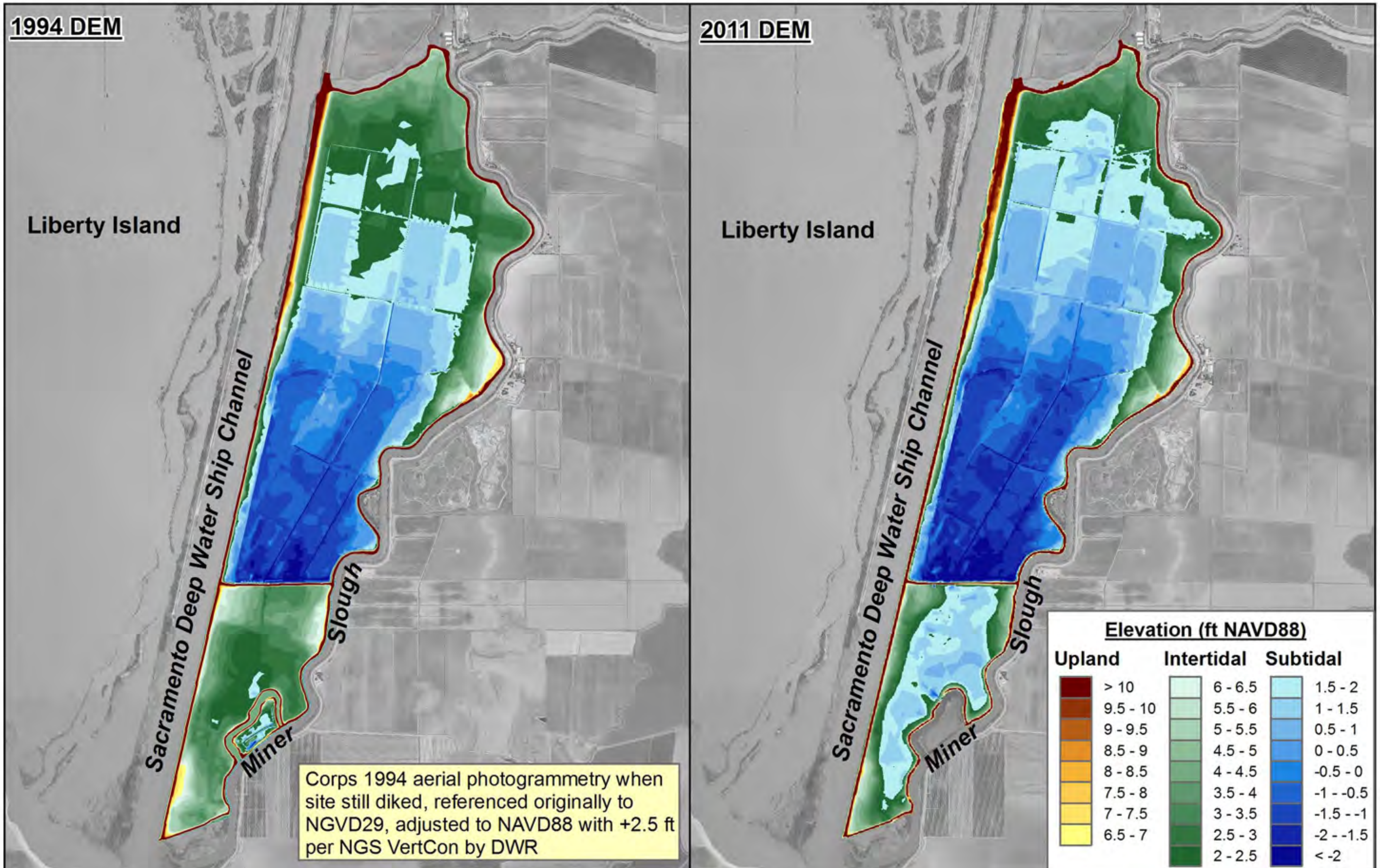
0 250 500 m

Data Sources: DEM (WWR, 2011; DWR, 2010; Corps, 1994), air photo (NAIP, 2010)
Produced by WWR: December 2011
Map File: s-prospect-DEM-change-series_1149_2011-1209dag.mxd

# SOUTH PROSPECT ISLAND DEM
# 1994 - 2010 - 2011 COMPARISON

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

| December 2011 | Project No. 1149 | **Figure 6** |
|---|---|---|




1:43,200 (1" = 3,600' at letter size)

0 1,800 3,600 ft

0 600 1,200 m

Data Sources: DEM (WWR, 2011; DWR, 2010; Corps, 1994), air photo (NAIP, 2010)

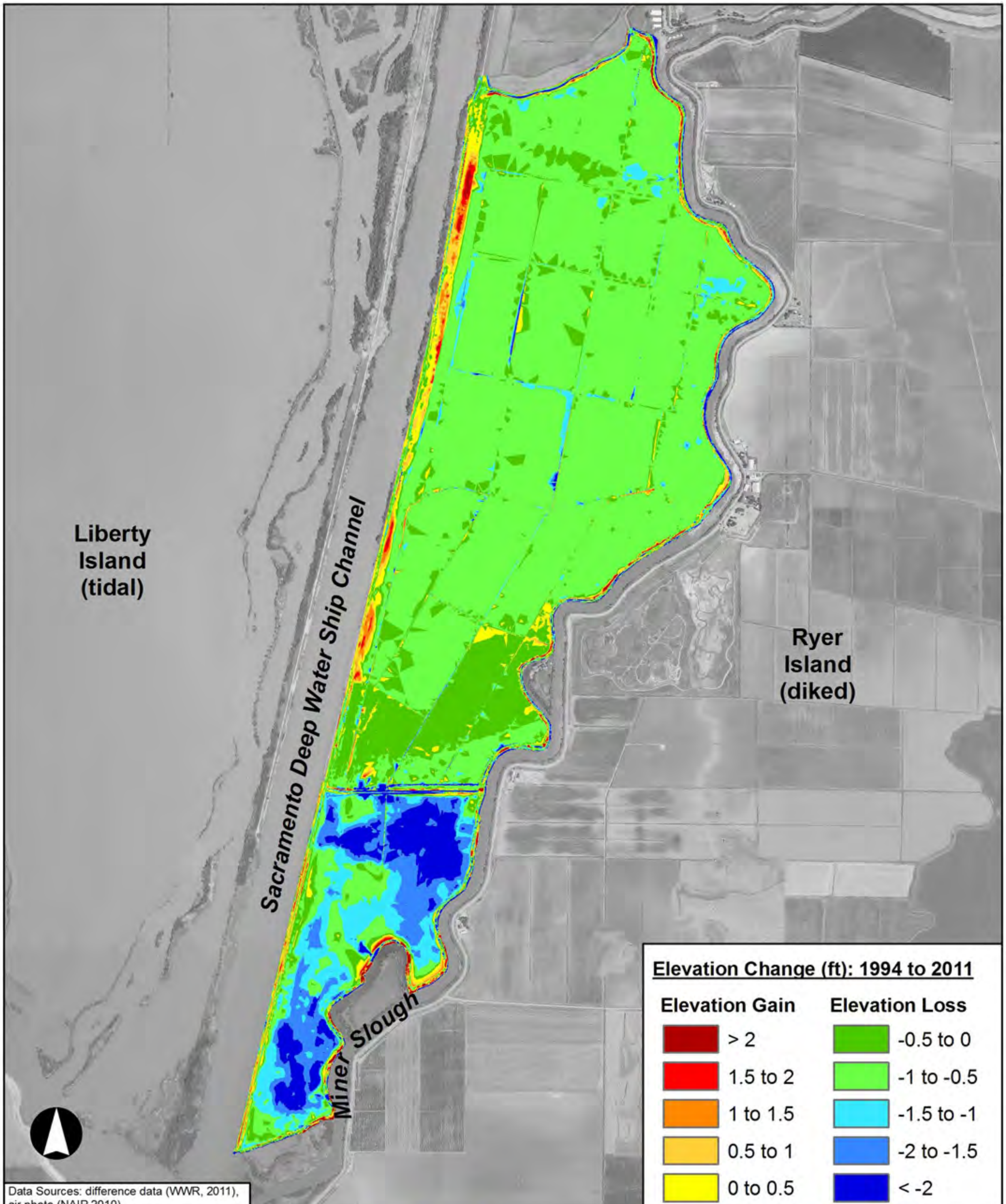
Produced by WWR: December 2011

Map File: prospect-DEM-change-94-11_1149_2011-1209dag.mxd

# PROSPECT ISLAND DEM 1994 - 2011 COMPARISON

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

| December 2011 | Project No. 1149 | Figure 7 |
|---|---|---|




1:30,000 (1" = 2,500' at letter layout)

0 1,250 2,500 ft

0 400 800 m

Produced by WWR, December 2011

Map File: 1994-2011-DEM-difference_1149_2011-1206dag.mxd

# ELEVATION DIFFERENCE
# 1994 DEM VS. 2011 DEM

Prospect Island Tidal Restoration Project
Solano County, California
California Department of Water Resources

| December 2011 | Project No. 1149 | **Figure 8** |
|---|---|---|

# Appendix A:

# NGS Benchmark Data Sheets

DATASHEETS

The NGS Data SheetSee file  dsdata.txt for more information about the datasheet.

```
DATABASE =  ,PROGRAM = datasheet, VERSION = 7.85
 JS2070 ***********************************************************************
 JS2070  HT_MOD       -  This is a Height Modernization Survey Station.
 JS2070  DESIGNATION -  SUTTER RESET
 JS2070  PID         -  JS2070
 JS2070  STATE/COUNTY-  CA/SACRAMENTO
 JS2070  USGS QUAD   -  ISLETON (1993)
 JS2070
 JS2070                         *CURRENT SURVEY CONTROL
 JS2070  ___________________________________________________________________
 JS2070* NAD 83(2007)-  38 14 51.69271(N)    121 36 03.38844(W)     ADJUSTED
 JS2070* NAVD 88     -         6.92   (meters)      22.7    (feet)  GPS OBS
 JS2070  ___________________________________________________________________
 JS2070  EPOCH DATE  -       2007.00
 JS2070  X           -  -2,628,088.052 (meters)                     COMP
 JS2070  Y           -  -4,271,738.920 (meters)                     COMP
 JS2070  Z           -   3,927,057.073 (meters)                     COMP
 JS2070  LAPLACE CORR-           5.59  (seconds)                    DEFLEC09
 JS2070  ELLIP HEIGHT-         -24.984 (meters)         (02/10/07) ADJUSTED
 JS2070  GEOID HEIGHT-         -31.85  (meters)                     GEOID09
 JS2070
 JS2070  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 JS2070  Type    PID    Designation                      North   East  Ellip
 JS2070  -------------------------------------------------------------------
 JS2070  NETWORK JS2070 SUTTER RESET                      0.25   0.27   0.88
 JS2070  -------------------------------------------------------------------
 JS2070
 JS2070.The horizontal coordinates were established by GPS observations
 JS2070.and adjusted by the National Geodetic Survey in February 2007.
 JS2070
 JS2070.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
 JS2070.See National Readjustment for more information.
 JS2070.The horizontal coordinates are valid at the epoch date displayed above.
 JS2070.The epoch date for horizontal control is a decimal equivalence
 JS2070.of Year/Month/Day.
 JS2070
 JS2070.The orthometric height was determined by GPS observations and a
 JS2070.high-resolution geoid model using precise GPS observation and
 JS2070.processing techniques.
 JS2070
 JS2070.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 JS2070
 JS2070.The Laplace correction was computed from DEFLEC09 derived deflections.
 JS2070
 JS2070.The ellipsoidal height was determined by GPS observations
 JS2070.and is referenced to NAD 83.
 JS2070
 JS2070.The geoid height was determined by GEOID09.
 JS2070
 JS2070;                    North         East     Units Scale Factor Converg.
 JS2070;SPC CA 2     -   564,575.179 2,034,932.699   MT  1.00002052   +0 15 05.7
 JS2070;SPC CA 2     - 1,852,277.07  6,676,275.03   sFT  1.00002052   +0 15 05.7
 JS2070;UTM  10      - 4,234,222.983   622,422.196   MT  0.99978458   +0 51 58.4
 JS2070
 JS2070!             -  Elev Factor  x  Scale Factor =   Combined Factor
 JS2070!SPC CA 2     -   1.00000392  x   1.00002052  =   1.00002444
 JS2070!UTM  10      -   1.00000392  x   0.99978458  =   0.99978850
 JS2070
 JS2070                          SUPERSEDED SURVEY CONTROL
 JS2070
```

```
JS2070  NAD 83(1998)-  38 14 51.69257(N)    121 36 03.38594(W) AD(2002.86) B
JS2070  ELLIP H (10/28/05)  -24.967  (m)                       GP(2002.86) 4 1
JS2070  NAD 83(1998)-  38 14 51.69295(N)    121 36 03.38659(W) AD(2004.69) A
JS2070  ELLIP H (09/13/05)  -24.978  (m)                       GP(2004.69) 4 1
JS2070  NAD 83(1992)-  38 14 51.69055(N)    121 36 03.38291(W) AD(1997.30) 1
JS2070  ELLIP H (07/10/98)  -24.980  (m)                       GP(1997.30) 4 1
JS2070  NAD 83(1992)-  38 14 51.69019(N)    121 36 03.38336(W) AD(1997.30) 1
JS2070  ELLIP H (05/14/98)  -24.891  (m)                       GP(1997.30) 3 1
JS2070  NGVD 29 (08/19/04)    6.16   (m)           20.2    (f) RESET       3
JS2070
JS2070.Superseded values are not recommended for survey control.
JS2070.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JS2070.See file dsdata.txt to determine how the superseded data were derived.
JS2070
JS2070_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SFH2242234222(NAD 83)
JS2070_MARKER: DS = TRIANGULATION STATION DISK
JS2070_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
JS2070_SP_SET: SET IN TOP OF CONCRETE MONUMENT
JS2070_STAMPING: SUTTER 1931 1970
JS2070_MARK LOGO: CGS
JS2070_MAGNETIC: N = NO MAGNETIC MATERIAL
JS2070_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
JS2070+STABILITY: SURFACE MOTION
JS2070_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
JS2070+SATELLITE: SATELLITE OBSERVATIONS - October 05, 2004
JS2070
JS2070  HISTORY     - Date     Condition        Report By
JS2070  HISTORY     - 1970     MONUMENTED       CGS
JS2070  HISTORY     - 19970829 GOOD             NGS
JS2070  HISTORY     - 20021105 GOOD             CADWR
JS2070  HISTORY     - 20021122 GOOD             CADWR
JS2070  HISTORY     - 20030820 GOOD             CADT
JS2070  HISTORY     - 20041005 GOOD             CADT
JS2070
JS2070                          STATION DESCRIPTION
JS2070
JS2070'DESCRIBED BY COAST AND GEODETIC SURVEY 1970
JS2070'4 MI NW FROM RYDE.
JS2070'2.75 MILES WEST ALONG A COUNTY PAVED ROAD FROM THE POST OFFICE
JS2070'AT RYDE, THENCE 1.25 MILES NORTH ALONG A PAVED LEVEE ROAD,
JS2070'0.8 MILE NORTH OF THE EAST END OF THE HOWARD LANDING FERRY
JS2070'(RYER ISLAND FERRY), 119 YARDS NORTH OF THE JUNCTION OF A
JS2070'FARM DRIVEWAY LEADING NORTHEAST, 20.0 FEET WEST OF AND ABOUT
JS2070'2 FEET LOWER THAN THE LEVEE ROAD, 2.0 FEET SOUTHWEST OF A
JS2070'METAL WITNESS POST, AND SET IN THE TOP OF A CONCRETE POST
JS2070'PROJECTING 0.1 FOOT ABOVE THE GROUND.
JS2070
JS2070                          STATION RECOVERY (1997)
JS2070
JS2070'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (JDD)
JS2070'THE STATION WAS RECOVERED AND SOME ADDITIONAL INFORMATION FOLLOWS. THE
JS2070'STATION IS ABOUT 5.5 MI (8.9 KM) NORTH OF ISLETON, 5.5 MI (8.9 KM)
JS2070'SOUTH OF COURTLAND, 5 MI (8.0 KM) WEST OF WALNUT GROVE AND ABOUT 3 MI
JS2070'(4.8 KM) WEST OF THE SMALL COMMUNITY OF RYDE.  TO REACH THE STATION
JS2070'FROM THE INTERSECTION OF STATE HIGHWAYS 220 AND 160 IN RYDE GO
JS2070'WESTERLY ON HIGHWAY 220 FOR ABOUT 3 MI (4.8 KM) TO A T-INTERSECTION,
JS2070'GRAND ISLAND ROAD.  TURN RIGHT AND GO NORTH ON GRAND ISLAND ROAD FOR
JS2070'0.45 MI (0.72 KM) TO THE HOWARD LANDING FERRY. CONTINUE NORTH ON GRAND
JS2070'ISLAND ROAD FOR 0.8 MI (1.3 KM) TO THE STATION ON THE LEFT.  THE
JS2070'STATION IS ABOUT 235 FT (71.6 M) SOUTH OF A GUYED TELEPHONE POLE, 200
JS2070'FT (61.0 M) SOUTH OF THE EXTENDED CENTERLINE OF A GRAVEL DRIVEWAY,
JS2070'20.5 FT (6.2 M) WEST OF THE CENTERLINE OF GRAND ISLAND ROAD, 1.7 FT
JS2070'(0.5 M) EAST OF A CARSONITE WITNESS POST AND ABOUT 2 FT (0.6 M) LOWER
```

```
JS2070'THAN THE ROAD. NOTE-REFERENCE MARKS 2 AND 3 WERE RECOVERED.  REFERENCE
JS2070'MARK 2 IS 36.3 FT (11.1 M) SOUTH-SOUTHEAST OF THE STATION.  REFERENCE
JS2070'MARK 3 IS 27.1 FT (8.3 M) SOUTH OF THE STATION.  THE STATION WAS
JS2070'OCCUPIED AS PART OF THE SAN JOAQUIN-SACRAMENTO RIVER DELTA
JS2070'GPS/VERTICAL PROJECT.
JS2070
JS2070                          STATION RECOVERY (2002)
JS2070
JS2070'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
JS2070'RECOVERED AS DESCRIBED. THE STATION WAS OBSERVED AS PART OF THE DWR
JS2070'DELTA 2002 SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
JS2070
JS2070                          STATION RECOVERY (2002)
JS2070
JS2070'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
JS2070'RECOVERED AS DESCRIBED. THE STATION WAS OBSERVED AS PART OF THE DWR
JS2070'DELTA 2002 SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
JS2070
JS2070                          STATION RECOVERY (2003)
JS2070
JS2070'RECOVERY NOTE BY CALTRANS 2003 (RLM)
JS2070'THE STATION, REFERENCE MARK NO. 2, AND REFERENCE MARK NO. 3 WERE
JS2070'RECOVERED AS  DESCRIBED AND FOUND IN GOOD CONDITION. THIS STATION WAS
JS2070'OCCUPIED AS PART OF A CALTRANS  NORTH REGION OFFICE OF SURVEYORS GPS
JS2070'HEIGHT MODERNIZATION PROJECT.
JS2070
JS2070                          STATION RECOVERY (2004)
JS2070
JS2070'RECOVERY NOTE BY CALTRANS 2004 (RLM)
JS2070'THE STATION, REFERENCE MARK NO. 2, AND REFERENCE MARK NO. 3 WERE
JS2070'RECOVERED AS  DESCRIBED AND FOUND IN GOOD CONDITION. THIS STATION WAS
JS2070'OCCUPIED AS PART OF A CALTRANS  NORTH REGION OFFICE OF SURVEYORS GPS
JS2070'HEIGHT MODERNIZATION PROJECT.
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The NGS Data Sheet
See file dsdata.txt for more information about the datasheet.
DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4.2
1        National Geodetic Survey,   Retrieval Date = OCTOBER 13, 2011
JS4374 ***********************************************************************
JS4374  HT_MOD       -  This is a Height Modernization Survey Station.
JS4374  DESIGNATION -  MINER RESET
JS4374  PID          -  JS4374
JS4374  STATE/COUNTY-  CA/SOLANO
JS4374  USGS QUAD    -  RIO VISTA (1993)
JS4374
JS4374                         *CURRENT SURVEY CONTROL
JS4374  ___________________________________________________________________
JS4374* NAD 83(2007)-  38 14 58.02481(N)    121 39 22.98902(W)     ADJUSTED
 JS4374* NAVD 88     -         7.54   (meters)      24.7    (feet)  GPS OBS
 JS4374  ___________________________________________________________________
JS4374  EPOCH DATE   -       2007.00
JS4374  X            -  -2,632,157.345 (meters)                    COMP
JS4374  Y            -  -4,269,091.240 (meters)                    COMP
JS4374  Z            -   3,927,210.755 (meters)                    COMP
JS4374  LAPLACE CORR-           4.33  (seconds)                    DEFLEC09
JS4374  ELLIP HEIGHT-         -24.413 (meters)         (02/10/07) ADJUSTED
JS4374  GEOID HEIGHT-         -32.00  (meters)                     GEOID09
JS4374
JS4374  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
JS4374  Type    PID    Designation                      North   East  Ellip
JS4374  -------------------------------------------------------------------
JS4374  NETWORK JS4374 MINER RESET                       0.41   0.37   1.06
JS4374  -------------------------------------------------------------------
JS4374
JS4374.The horizontal coordinates were established by GPS observations
JS4374.and adjusted by the National Geodetic Survey in February 2007.
JS4374
JS4374.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
JS4374.See National Readjustment for more information.
JS4374.The horizontal coordinates are valid at the epoch date displayed above.
JS4374.The epoch date for horizontal control is a decimal equivalence
JS4374.of Year/Month/Day.
JS4374
JS4374.The orthometric height was determined by GPS observations and a
JS4374.high-resolution geoid model using precise GPS observation and
JS4374.processing techniques.
JS4374
JS4374.The X, Y, and Z were computed from the position and the ellipsoidal ht.
JS4374
JS4374.The Laplace correction was computed from DEFLEC09 derived deflections.
JS4374
JS4374.The ellipsoidal height was determined by GPS observations
JS4374.and is referenced to NAD 83.
JS4374
JS4374.The geoid height was determined by GEOID09.
JS4374
JS4374;                    North         East     Units Scale Factor Converg.
JS4374;SPC CA 2     -   564,750.591 2,030,078.491   MT  1.00002008   +0 12 59.9
JS4374;SPC CA 2     - 1,852,852.56  6,660,349.18   sFT  1.00002008   +0 12 59.9
JS4374;SPC CA 3     -   694,785.575 1,898,782.720   MT  0.99996694   -0 42 28.7
JS4374;SPC CA 3     - 2,279,475.67  6,229,589.64   sFT  0.99996694   -0 42 28.7
JS4374;UTM  10      - 4,234,346.257   617,567.565   MT  0.99977023   +0 49 54.9
JS4374
JS4374!             -  Elev Factor  x  Scale Factor =   Combined Factor
JS4374!SPC CA 2     -   1.00000383  x   1.00002008  =   1.00002391
JS4374!SPC CA 3     -   1.00000383  x   0.99996694  =   0.99997077
JS4374!UTM  10      -   1.00000383  x   0.99977023  =   0.99977406
```

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JS4374
JS4374:                Primary Azimuth Mark                        Grid Az
JS4374:SPC CA 2     -  RYDE WATER TANK                             098 41 02.2
JS4374:SPC CA 3     -  RYDE WATER TANK                             099 36 30.8
JS4374:UTM  10      -  RYDE WATER TANK                             098 04 07.2
JS4374
JS4374|---------------------------------------------------------------------|
JS4374| PID    Reference Object                     Distance      Geod. Az  |
JS4374|                                                           dddmmss.s |
JS4374| JS4320 WEST CUT W STEEL POWER POLE         APPROX. 8.0 KM 0061002.8 |
JS4374| JS4317 WEST CUT E STEEL POWER POLE         APPROX. 8.0 KM 0072228.1 |
JS4374| JS4291 SAN FRAN RENO AWY BCN 5             APPROX.15.6 KM 0130607.7 |
JS4374| JS4318 MINER SLOUGH W WOOD PWR POLE        APPROX. 2.1 KM 0304801.8 |
JS4374| JS4322 MINER SLOUGH E WOODEN PWR POLE      APPROX. 2.1 KM 0335308.6 |
JS4374| JS4302 UPPER SNODGRASS NE TRANS TOWER      APPROX.15.1 KM 0501605.8 |
JS4374| JS4300 UPPER SNODGRASS SW TRANS TOWER      APPROX.14.9 KM 0502922.8 |
JS4374| JS4308 NE TRANSM TOWER NW OF VORDEN        APPROX. 9.6 KM 0591716.9 |
JS4374| JS4301 SW TRANS TOWER NW OF VORDEN         APPROX. 9.4 KM 0595108.3 |
JS4374| JS4307 LIBBY MC NEIL WATER TANK            APPROX.12.3 KM 0850920.6 |
JS4374| DB4825 MINER RM 1 AZIMUTH                                 0872301.1 |
JS4374| JS4341 RYDE WATER TANK                     APPROX. 8.6 KM 0985402.1 |
JS4374| JS4337 HOWARD LANDNG E STEEL POWER POLE    APPROX. 5.3 KM 1134156.6 |
JS4374| DB4826 MINER RM 2                            18.649 METERS 15826     |
JS4374| JS4375 RYER IS FERRY E WOOD PWR POLE       APPROX. 6.8 KM 1815333.6 |
JS4374| JS4377 RYER IS FERRY W WOOD PWR POLE       APPROX. 6.8 KM 1834831.7 |
JS4374| JS4384 LINDSEY SLOUGH S POWER POLE         APPROX. 4.4 KM 2652223.9 |
JS4374| JS4385 LINDSEY SLOUGH N POWER POLE         APPROX. 4.4 KM 2685956.5 |
JS4374| JS4319 SAN FRAN RENO RED AIRWAY BCN 4      APPROX. 7.2 KM 2785833.5 |
JS4374| DB4827 MINER RM 3                             4.087 METERS 33829     |
JS4374|---------------------------------------------------------------------|
JS4374
JS4374                          SUPERSEDED SURVEY CONTROL
JS4374
JS4374  NAD 83(1998)-  38 14 58.02492(N)    121 39 22.98666(W) AD(2002.86) 1
JS4374  ELLIP H (10/28/05)  -24.396  (m)                       GP(2002.86) 4 1
JS4374  NAD 83(1992)-  38 14 58.02286(N)    121 39 22.98351(W) AD(1997.30) 1
JS4374  ELLIP H (07/10/98)  -24.409  (m)                       GP(1997.30) 4 1
JS4374  NAD 83(1992)-  38 14 58.02250(N)    121 39 22.98397(W) AD(1997.30) 1
JS4374  ELLIP H (05/14/98)  -24.320  (m)                       GP(1997.30) 3 1
JS4374  NAD 83(1992)-  38 14 58.02055(N)    121 39 22.97940(W) AD(1991.35) 1
JS4374  ELLIP H (03/08/94)  -24.260  (m)                       GP(1991.35) 4 1
JS4374  NAD 83(1986)-  38 14 58.01745(N)    121 39 22.98149(W) AD(1984.00) 1
JS4374  NAD 27      -  38 14 58.32600(N)    121 39 19.13700(W) AD(       ) 1
JS4374  NAVD 88 (10/28/05)    7.62   (m)           25.0    (f) GPS OBS
 JS4374  NAVD 88 (07/10/98)    7.58   (m)           24.9    (f) GPS OBS
 JS4374  NAVD 88 (05/14/98)    7.57   (m)           24.8    (f) GPS OBS
 JS4374  NGVD 29 (11/03/92)    7.0    (m)           23.     (f) GPS OBS
 JS4374
JS4374.Superseded values are not recommended for survey control.
JS4374.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JS4374.See file dsdata.txt to determine how the superseded data were derived.
JS4374
JS4374_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SFH1756734346(NAD 83)
JS4374_MARKER: DS = TRIANGULATION STATION DISK
JS4374_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
JS4374_SP_SET: SURROUNDED BY MASS OF CONCRETE
JS4374_STAMPING: MINER 1931 1963
JS4374_MARK LOGO: CGS
 JS4374_PROJECTION: RECESSED 20 CENTIMETERS
JS4374_MAGNETIC: N = NO MAGNETIC MATERIAL
JS4374_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
JS4374+STABILITY: SURFACE MOTION
JS4374_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
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JS4374+SATELLITE: SATELLITE OBSERVATIONS - April 01, 2011
JS4374
JS4374  HISTORY     - Date     Condition        Report By
JS4374  HISTORY     - 1963     MONUMENTED       CGS
JS4374  HISTORY     - 1932     SEE DESCRIPTION  CGS
JS4374  HISTORY     - 1962     SEE DESCRIPTION  CGS
JS4374  HISTORY     - 1963     SEE DESCRIPTION  CGS
JS4374  HISTORY     - 19911223 GOOD             NOS
JS4374  HISTORY     - 19920110 GOOD
JS4374  HISTORY     - 19970829 GOOD             NGS
JS4374  HISTORY     - 20021122 GOOD             CADWR
JS4374  HISTORY     - 20070329 GOOD             JCLS
JS4374  HISTORY     - 20101110 GOOD             PG+E
JS4374  HISTORY     - 20110401 GOOD             CADWR
JS4374
JS4374                          STATION DESCRIPTION
JS4374
JS4374'DESCRIBED BY COAST AND GEODETIC SURVEY 1932
JS4374'ABOUT 6-1/2 MILES NORTH OF RIO VISTA, 1-1/2 MILES NORTHEAST OF
JS4374'JUNCTION OF MINER AND CACHE SLOUGHS, ON WEST SIDE OF RYER ISLAND,
JS4374'ON EAST LEVEE OF MINER SLOUGH, ONE-HALF MILE NORTH OF ROAD
JS4374'CROSSING RYER ISLAND TO HOWARD LANDING FERRY, 5 METERS (16 FEET)
JS4374'WEST OF CENTER LINE OF LEVEE ROAD, AND 9.5 METERS (31 FEET) SOUTH
JS4374'OF DITCH LINE EXTENDED.  TO REACH FROM WEST END OF RIO VISTA
JS4374'BRIDGE, GO NORTH ALONG RIVER 2.2 MILES TO FERRY, CROSS CACHE SLOUGH
JS4374'BY FERRY TO RYER ISLAND, TURN LEFT ONTO LEVEE ROAD, AND GO
JS4374'5.0 MILES TO STATION SITE.  SURFACE AND UNDERGROUND MARKS
JS4374'ARE STANDARD STATION DISKS IN CONCRETE, NOTES 1A AND 7A.
JS4374'REFERENCE MARKS ARE STANDARD REFERENCE DISKS IN CONCRETE, NOTE
JS4374'11A.  NO. 1 IS ON SOUTH SIDE OF ROAD RUNNING ACROSS ISLAND
JS4374'AND ABOUT ONE-HALF MILE FROM STATION IN AZIMUTH 267 DEG 23 MIN
JS4374'02 SEC.  NO. 2 IS ON LEVEE AND 18.60 METERS (61.0 FEET)
JS4374'FROM STATION IN AZIMUTH 338 DEG 28 MIN.  GABLE OF SMALL PUMP
JS4374'HOUSE IS 10.2 METERS (33 FEET) FROM STATION IN AZIMUTH 45 DEG
JS4374'00 MIN.
JS4374
JS4374                          STATION RECOVERY (1962)
JS4374
JS4374'RECOVERY NOTE BY COAST AND GEODETIC SURVEY 1962 (IRR)
JS4374'THE TOP OF THE SURFACE-STATION MARK CONCRETE POST WAS FOUND BROKEN
JS4374'OFF AND MISSING SO THE POST WAS REMOVED AND THE UNDERGROUND-STATION
JS4374'MARK WAS RECOVERED IN GOOD CONDITION.  THE SURFACE-STATION MARK
JS4374'POST WAS THEN REPLACED AND A DISK WAS CEMENTED IN A DRILL HOLE
JS4374'IN THE TOP OF THE POST DIRECTLY OVER THE UNDERGROUND-STATION
JS4374'MARK.  REFERENCE MARK NUMBER 2 WAS RECOVERED IN GOOD CONDITION BUT
JS4374'REFERENCE MARK NUMBER 1 WAS NOT FOUND AND HAS PROBABLY
JS4374'BEEN DESTROYED BY WORK ON THE IRRIGATION DITCH IT WAS
JS4374'NEAR.  REFERENCE MARK NUMBER 3 WAS SET ON THIS DATE.
JS4374'
JS4374'THE STATION IS LOCATED ABOUT 6-1/2 MILES NORTH OF RIO VISTA,
JS4374'1-1/2 MILES NORTHEAST OF THE JUNCTION OF MINER AND CACHE
JS4374'SLOUGHS, 1/2 MILE NORTH OF THE ROAD CROSSING RYER ISLAND EAST TO
JS4374'HOWARD LANDING FERRY, ON THE WEST SIDE OF RYER ISLAND, AND ON
JS4374'THE EAST LEVEE OF MINER SLOUGH.
JS4374'
JS4374'TO REACH THE STATION FROM THE WEST END OF THE RIO VISTA BRIDGE
JS4374'GO NORTHEAST ALONG THE NORTHWEST SIDE OF THE SACRAMENTO RIVER
JS4374'2.3 MILES TO THE RYER FERRY.  CROSS OVER THE RIVER TO RYER ISLAND
JS4374'AND GO NORTH ALONG THE LEVEE ROAD 5.3 MILES TO A WITNESS POST
JS4374'AND THE STATION ON THE LEFT.
JS4374'
JS4374'THE SURFACE-STATION MARK IS A COAST AND GEODETIC SURVEY TRIANGULATION
JS4374'STATION DISK STAMPED MINER 1931 1962 CEMENTED IN A DRILL HOLE IN
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JS4374'A DEPRESSION IN THE TOP OF A 12-INCH SQUARE CONCRETE POST FLUSH
JS4374'WITH THE GROUND.  IT IS 33.1 FEET NORTHEAST OF THE NORTHEAST
JS4374'CORNER OF A SMALL CORRUGATED METAL COVERED PUMP HOUSE, 50 FEET
JS4374'NORTHEAST OF THE INTERSECTION OF A FARM ROAD, AND 15.5 FEET WEST
JS4374'OF THE CENTERLINE OF THE ROAD.
JS4374'
JS4374'REFERENCE MARK NUMBER 2 IS A COAST AND GEODETIC SURVEY REFERENCE
JS4374'MARK DISK STAMPED MINER NO 2 1931 SET IN THE TOP OF AN 8-INCH
JS4374'SQUARE CONCRETE POST THAT PROJECTS 2 INCHES ABOVE THE GROUND.  IT
JS4374'IS 21.2 FEET SOUTH OF A 10-INCH PIPE RUNNING UNDER THE ROAD,
JS4374'13.3 FEET EAST OF THE CENTERLINE OF THE ROAD, AND ABOUT 1 FOOT
JS4374'LOWER THAN THE STATION MARK.
JS4374'
JS4374'REFERENCE MARK NUMBER 3 IS A COAST AND GEODETIC SURVEY REFERENCE
JS4374'MARK DISK STAMPED MINER NO 3 1931 1962 SET IN THE TOP OF A 12-INCH
JS4374'CONCRETE CYLINDER THAT IS FLUSH WITH THE GROUND.  IT IS 41.6
JS4374'FEET NORTH OF THE NORTHEAST CORNER OF THE PUMP HOUSE, 21.5 FEET
JS4374'WEST OF THE CENTERLINE OF THE ROAD, ABOUT THE SAME ELEVATION AS
JS4374'THE STATION, 1.7 FEET NORTH OF A WOODEN WITNESS POST, AND
JS4374'DIRECTLY ON LINE WITH THE STATION MARK AND REFERENCE MARK
JS4374'NUMBER 2.
JS4374
JS4374                          STATION RECOVERY (1963)
JS4374
JS4374'RECOVERY NOTE BY COAST AND GEODETIC SURVEY 1963 (SJD)
JS4374'THE SURFACE STATION MARK WAS FOUND TILTED SHARPLY TO ONE SIDE.  IT
JS4374'WAS REMOVED AND THE UNDERGROUND STATION MARK WAS RECOVERED IN GOOD
JS4374'CONDITION.  A NEW SURFACE STATION MARK WAS SET ON THIS DATE
JS4374'DIRECTLY OVER THE UNDERGROUND STATION MARK.  REFERENCE MARKS
JS4374'NUMBER 2 AND 3 WERE RECOVERED IN GOOD CONDITION.  THE 1962
JS4374'DESCRIPTION IS ADEQUATE WITH THE FOLLOWING ADDITIONS--
JS4374'
JS4374'THE UNDERGROUND STATION MARK IS A COAST AND GEODETIC SURVEY
JS4374'TRIANGULATION STATION DISK STAMPED MINER 1931 SET IN THE TOP OF
JS4374'A BLOCK OF CONCRETE 2.7 FEET BELOW THE SURFACE OF THE GROUND.
JS4374'
JS4374'THE SURFACE STATION MARK IS A COAST AND GEODETIC SURVEY
JS4374'TRIANGULATION STATION DISK STAMPED MINER 1931 1963 SET IN THE
JS4374'TOP OF A 12-INCH CONCRETE CYLINDER 0.4 FEET BELOW THE SURFACE
JS4374'OF THE GROUND.
JS4374
JS4374                          STATION RECOVERY (1991)
JS4374
JS4374'RECOVERY NOTE BY NATIONAL OCEAN SERVICE 1991
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (1992)
JS4374
JS4374'RECOVERED 1992
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (1997)
JS4374
JS4374'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (JDD)
JS4374'THE STATION WAS RECOVERED AND AN ALTERNATIVE TO REACH FOLLOWS.  TO
JS4374'REACH THE STATION FROM THE COMMUNITY OF RYDE ON GRAND ISLAND GO
JS4374'SOUTHWESTERLY ON STATE HIGHWAY 220 FOR 3.0 MI (4.8 KM) TO A
JS4374'T-INTERSECTION, GRAND ISLAND ROAD.  TURN RIGHT AND GO NORTH ON GRAND
JS4374'ISLAND ROAD FOR ABOUT 0.5 MI (0.8 KM) TO THE HOWARD LANDING FERRY.
JS4374'TAKE THE HOWARD LANDING FERRY TO RYER ISLAND.  CONTINUE WEST ON
JS4374'HIGHWAY 220 FOR 3.05 MI (4.91 KM) TO A T-INTERSECTION, HIGHWAY 84.
JS4374'TURN RIGHT AND GO NORTH ON HIGHWAY 84 FOR 0.5 MI (0.8 KM) TO THE
JS4374'STATION ON THE LEFT.  THE CORRUGATED METAL SHACK INDICATED IN THE

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JS4374'ORIGINAL DESCRIPTION IS MOSTLY COLLAPSED.  THE STATION IS 7 FT (2.1 M)
JS4374'EAST OF A WITNESS POST.  IT IS ABOUT 1 FT (0.3 M) LOWER THAN THE ROAD
JS4374'AND ABOUT 0.5 FT (0.2 M) BELOW THE SURFACE.  THE STATION WAS OCCUPIED
JS4374'AS PART OF THE SAN JOAQUIN-SACRAMENTO RIVER DELTA GPS/VERTICAL
JS4374'PROJECT.
JS4374
JS4374                          STATION RECOVERY (2002)
JS4374
JS4374'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
JS4374'RECOVERED AS DESCRIBED. THE STATION WAS OBSERVED AS PART OF THE DWR
JS4374'DELTA 2002 SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
JS4374
JS4374                          STATION RECOVERY (2007)
JS4374
JS4374'RECOVERY NOTE BY JOHN CHANCE LAND SURVEYS INC 2007 (MRY)
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (2010)
JS4374
JS4374'RECOVERY NOTE BY PACIFIC GAS AND ELECTRIC COMPANY 2010 (DPM)
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (2011)
JS4374
JS4374'RECOVERY NOTE BY CA DEPT OF WATER RES 2011 (GS)
JS4374'RECOVERED AS DESCRIBED.

*** retrieval complete.
Elapsed Time = 00:00:02
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# Appendix H

# Prospect and Ryer Islands Monitoring Well and CPT Survey

State of California — DEPARTMENT OF WATER RESOURCES — California Natural Resources Agency

**OFFICE MEMO**

| | | | |
|---|---|---|---|
| **TO:** | Mark Souverville<br>Engineering Geologist<br>DIRWM - NCRO | **DATE:** | June 12, 2013 |
| **FROM:** | Fred Vonderscheer<br>Chief, Field Surveys | **SUBJECT:** | Prospect and Ryer Islands Monitoring Well and CPT Survey (SR 12-08). |

The land surveying work for this project included determining adjacent ground or top of concrete pad elevations along with horizontal and vertical positions at the tops of well enclosures and pvc casings for approximately twenty monitoring well locations on Prospect Island and for seven monitoring well locations on Ryer Island. In addition miscellaneous ground and water surface elevations were determined for Prospect Island and approximately sixteen CPT locations were surveyed on Ryer Island.

The horizontal project datum used is NAD 83. State plane values are CCS 83, Zone 2. The vertical project datum that elevations are based on is NAVD 88. Units are US Survey Feet and the epoch date for the published control values is 2007.00.

Five NGS control points surrounding this project were used:

B 474 (PID JS2048)
MINER RESET (PID JS4374)
SUTTER RESET (PID JS2070)
RYER (PID AE9850)
SHAG (PID AE9858)

All positions were determined by utilizing real time surveying procedures, which incorporated the use of an existing RTK calibration from DOE Field Survey's project SR 09-22. The coordinate transformation from autonomous GPS derived positions to NGS published values was performed, resulting in a maximum horizontal residual of 0.052 ft. In addition, a plane height adjustment was performed, resulting in a maximum vertical residual of 0.126 ft.

The convergence angle at the project center is 0° 12' 54.475". For CCS 83 values, ground distances can be determined by dividing grid distances by a combined factor of 1.000018824.

A table of observations is attached. Supporting documents are available upon request.

This report represents a field survey made by me or under my direction.

Louis (Fred) Vonderscheer, PLS 4655

# SR12-08_PROSPECT AND RYER ISLAND MONITORING WELL AND CPT SURVEY

| PT ID | LATITUDE (N) | LONGITUDE (W) | ELEV. | DESCRIPTION |
|---|---|---|---|---|
| PI BEAM CALC | 38.2534189 | 121.6569287 | 13.17 | SURFACE WATER BEAM CL END OF BEAM @ PI SW |
| PI SW | 38.2534171 | 121.6569275 | 16.26 | SURFACE WATER TOP OF PVC CASING ON DECK |
| PI 1 CPT | 38.2530612 | 121.6567239 | 14.97 | CENTER OF GROUT |
| PI 1A | 38.2530582 | 121.6567402 | 14.94 | PI 1A MW RIM SHOT N'LY SIDE |
| PI 1A TOC | 38.2530582 | 121.6567402 | 14.69 | PI 1A N'LY SIDE TOP OF CASING |
| 7004 | 38.2530595 | 121.6567399 | 14.81 | GS N'LY SIDE OF WELL PI 1A |
| PI 1B | 38.2530711 | 121.6567103 | 14.89 | PI 1B MW RIM SHOT N'LY SIDE |
| PI 1B TOC | 38.2530711 | 121.6567103 | 14.68 | PI 1B N'LY SIDE TOP OF CASING |
| 7005 | 38.2530725 | 121.6567099 | 14.79 | GS N'LY SIDE OF WELL PI 1B |
| PI 2 CPT | 38.2532428 | 121.6665146 | 12.98 | CENTER OF GROUT |
| PI 2A | 38.2532359 | 121.6664966 | 13.10 | PI 2A MW RIM SHOT N'LY SIDE |
| PI 2A TOC | 38.2532359 | 121.6664966 | 12.87 | PI 2A N'LY SIDE TOP OF CASING |
| 7002 | 38.2532368 | 121.6664963 | 12.95 | GS N'LY SIDE OF WELL PI 2A |
| PI 2B | 38.2532589 | 121.6665114 | 13.08 | PI 2B MW RIM SHOT N'LY SIDE |
| PI 2B TOC | 38.2532589 | 121.6665114 | 12.87 | PI 2B N'LY SIDE TOP OF CASING |
| 7001 | 38.2532600 | 121.6665108 | 12.85 | GS N'LY SIDE OF WELL PI 2B |
| PI 3 CPT | 38.2703001 | 121.6613516 | 13.93 | CENTER OF GROUT |
| PI 3A | 38.2702847 | 121.6613492 | 14.10 | PI 3A MW RIM SHOT N'LY SIDE |
| PI 3A TOC | 38.2702847 | 121.6613492 | 13.96 | PI 3A N'LY SIDE TOP OF CASING |
| 7022 | 38.2702859 | 121.6613490 | 13.85 | GS N'LY SIDE OF PI 3A |
| PI 3B | 38.2703108 | 121.6613403 | 14.15 | PI 3B MW RIM SHOT N'LY SIDE |
| PI 3B TOC | 38.2703108 | 121.6613403 | 13.93 | PI 3B N'LY SIDE TOP OF CASING |
| 7023 | 38.2703117 | 121.6613402 | 13.99 | GS N'LY SIDE OF PI 3B |
| PI 3C | 38.2703247 | 121.6613366 | 14.25 | PI 3C MW RIM SHOT N'LY SIDE |
| PI 3C TOC | 38.2703247 | 121.6613366 | 13.93 | PI 3C N'LY SIDE TOP OF CASING |
| 7024 | 38.2703261 | 121.6613363 | 13.96 | GS N'LY SIDE OF PI 3C |
| PI 4 CPT | 38.2869233 | 121.6569905 | 13.83 | CENTER OF GROUT |
| PI 5 CPT | 38.2902019 | 121.6473477 | 17.89 | CENTER OF GROUT |
| PI 5A | 38.2902060 | 121.6473309 | 17.77 | PI 5A MW RIM SHOT N'LY SIDE |
| PI 5A TOC | 38.2902060 | 121.6473309 | 17.48 | PI 5A N'LY SIDE TOP OF CASING |
| 7019 | 38.2902075 | 121.6473306 | 17.61 | GS N'LY SIDE OF PI 5A |
| PI 5B | 38.2901976 | 121.6473628 | 18.14 | PI 5B MW RIM SHOT N'LY SIDE |

| | | | | |
|---|---|---|---|---|
| PI 5B TOC | 38.2901976 | 121.6473628 | 17.89 | PI 5B N'LY SIDE TOP OF CASING |
| 7020 | 38.2901989 | 121.6473636 | 17.97 | GS N'LY SIDE OF PI 5B |
| PI 6 CPT | 38.2847234 | 121.6442552 | 16.55 | CENTER OF GROUT |
| PI 6A | 38.2847104 | 121.6442571 | 16.57 | PI 6A MW RIM SHOT N'LY SIDE |
| PI 6A TOC | 38.2847104 | 121.6442571 | 16.22 | PI 6A N'LY SIDE TOP OF CASING |
| 7017 | 38.2847115 | 121.6442571 | 16.41 | GS N'LY SIDE OF PI 6A |
| PI 6B | 38.2847369 | 121.6442530 | 16.67 | PI 6B MW RIM SHOT N'LY SIDE |
| PI 6B TOC | 38.2847369 | 121.6442530 | 16.42 | PI 6B N'LY SIDE TOP OF CASING |
| 7018 | 38.2847380 | 121.6442538 | 16.45 | GS N'LY SIDE OF PI 6B |
| PI 7 CPT | 38.2789300 | 121.6403141 | 15.95 | CENTER OF GROUT |
| PI 7A | 38.2789211 | 121.6403016 | 16.08 | PI 7A RIM SHOT N'LY SIDE |
| PI 7A TOC | 38.2789211 | 121.6403016 | 15.89 | PI 7A N'LY SIDE TOP OF CASING |
| 7015 | 38.2789217 | 121.6403031 | 15.87 | GS N'LY SIDE OF PI 7A |
| PI 7B | 38.2789382 | 121.6403283 | 16.15 | PI 7B MW RIM SHOT N'LY SIDE |
| PI 7B TOC | 38.2789382 | 121.6403283 | 15.90 | PI 7B N'LY SIDE TOP OF CASING |
| 7016 | 38.2789391 | 121.6403300 | 15.94 | GS N'LY SIDE OF PI 7B |
| PI 8 CPT | 38.2726867 | 121.6424154 | 15.80 | CENTER OF GROUT |
| PI 8A | 38.2726716 | 121.6424158 | 15.96 | PI 8A MW RIM SHOT N'LY SIDE |
| PI 8A TOC | 38.2726716 | 121.6424158 | 15.60 | PI 8A N'LY SIDE TOP OF CASING |
| 7025 | 38.2726728 | 121.6424149 | 15.70 | GS N'LY SIDE OF PI 8A |
| PI 8B | 38.2726972 | 121.6423996 | 15.85 | PI 8B MW RIM SHOT N'LY SIDE |
| PI 8B TOC | 38.2726972 | 121.6423996 | 15.56 | PI 8B N'LY SIDE TOP OF CASING |
| 7026 | 38.2726972 | 121.6423996 | 15.85 | GS N'LY SIDE OF PI 8B |
| PI 9 CPT | 38.2665277 | 121.6429200 | 15.62 | CENTER OF GROUT |
| PI 9A | 38.2665200 | 121.6429347 | 15.61 | PI 9A MW RIM SHOT N'LY SIDE |
| PI 9A TOC | 38.2665200 | 121.6429347 | 15.41 | PI 9A N'LY SIDE TOP OF CASING |
| 7012 | 38.2665211 | 121.6429335 | 15.34 | GS N'LY SIDE OF PI 9A |
| PI 9B | 38.2665424 | 121.6429141 | 15.59 | PI 9B MW RIM SHOT N'LY SIDE |
| PI 9B TOC | 38.2665424 | 121.6429141 | 15.32 | PI 9B N'LY SIDE TOP OF CASING |
| 7013 | 38.2665436 | 121.6429132 | 15.33 | GS N'LY SIDE OF PI 9B |
| PI 9C | 38.2665623 | 121.6428953 | 15.61 | PI 9C MW RIM SHOT N'LY SIDE |
| PI 9C TOC | 38.2665623 | 121.6428953 | 15.26 | PI 9C N'LY SIDE TOP OF CASING |
| 7014 | 38.2665632 | 121.6428946 | 15.33 | GS N'LY SIDE OF PI 9C |
| PI 10 CPT | 38.2623090 | 121.6502872 | 14.83 | CENTER OF GROUT |

| | | | | |
|---|---|---|---|---|
| PI 10A | 38.2623045 | 121.6503044 | 14.98 | PI 10A MW RIM SHOT N'LY SIDE |
| PI 10A TOC | 38.2623045 | 121.6503044 | 14.75 | PI 10A N'LY SIDE TOP OF CASING |
| 7006 | 38.2623053 | 121.6503037 | 14.79 | GS N'LY SIDE OF PI 10A |
| PI 10B | 38.2623043 | 121.6502694 | 14.96 | PI 10B MW RIM SHOT N'LY SIDE |
| PI 10B TOC | 38.2623043 | 121.6502694 | 14.76 | PI 10B N'LY SIDE TOP OF CASING |
| 7007 | 38.2623049 | 121.6502684 | 14.85 | GS N'LY SIDE OF PI 10B |
| RIS 1 CPT | 38.2533311 | 121.6530021 | -1.69 | CENTER OF GROUT |
| RIS 1 SAMPLE | 38.2533310 | 121.6530075 | -1.70 | CENTER OF GROUT |
| RI 2 CPT | 38.2711204 | 121.6418767 | 25.68 | CENTER OF GROUT |
| RI 2 | 38.2711299 | 121.6419145 | 27.11 | RI 2 MW RIM SHOT |
| RI 2 TOC | 38.2711299 | 121.6419145 | 27.00 | RI 2 N'LY SIDE TOP OF CASING |
| 7036 | 38.2711292 | 121.6419125 | 26.87 | GS SE'LY SIDE OF RI 2 |
| RI 3 CPT | 38.2728295 | 121.6298624 | -3.15 | CENTER OF GROUT |
| RI 3 SAMPLE | 38.2728279 | 121.6298513 | -3.29 | CENTER OF GROUT |
| RI 3A | 38.2728014 | 121.6298837 | 0.86 | RI 3A MW RIMSHOT N'LY SIDE |
| RI 3A TOC | 38.2728014 | 121.6298837 | 0.81 | RI 3A N'LY SIDE TOP OF CASING |
| 7030 | 38.2728018 | 121.6298827 | -3.17 | GS NE'LY SIDE OF RI 3A |
| RI 3B | 38.2728006 | 121.6298577 | 1.41 | RI 3B MW RIMSHOT N'LY SIDE |
| RI 3B TOC | 38.2728006 | 121.6298577 | 1.06 | RI 3B N'LY SIDE TOP OF CASING |
| 7031 | 38.2728008 | 121.6298570 | -2.91 | GS NE'LY SIDE OF RI 3B |
| RIS-4 CPT | 38.2704582 | 121.6376184 | -1.28 | CENTER OF GROUT |
| RIS-4 SAMPLE | 38.2704504 | 121.6376188 | -1.20 | CENTER OF GROUT |
| RI 4 CPT | 38.2741467 | 121.6399176 | 0.29 | CENTER OF GROUT |
| RI 4 SAMPLE | 38.2741484 | 121.6399017 | 0.39 | CENTER OF GROUT |
| RI 4A | 38.2741707 | 121.6399062 | 4.23 | RI 4A MW RIM SHOT N'LY SIDE |
| RI 4A TOC | 38.2741707 | 121.6399062 | 4.16 | RI 4A N'LY SIDE TOP OF CASING |
| 7034 | 38.2741702 | 121.6399063 | 0.82 | TOP CONC PAD S'LY SIDE RI 4A |
| RI 4B | 38.2741718 | 121.6398880 | 4.29 | RI 4B MW RIM SHOT N'LY SIDE |
| RI 4B TOC | 38.2741718 | 121.6398880 | 4.26 | RI 4B N'LY SIDE TOP OF CASING |
| 7035 | 38.2741725 | 121.6398878 | 0.93 | TOP CONC PAD N'LY SIDE RI 4B |
| RI 5 CPT | 38.2796773 | 121.6323782 | -1.68 | CENTER OF GROUT |
| RI 5 SAMPLE | 38.2796754 | 121.6323945 | -1.78 | CENTER OF GROUT |
| RI 5A | 38.2796482 | 121.6323878 | 2.22 | RI 5A MW RIMSHOT N'LY SIDE |
| RI 5A TOC | 38.2796482 | 121.6323878 | 2.12 | RI 5A N'LY SIDE TOP OF CASING |

| | | | | |
|---|---|---|---|---|
| 7032 | 38.2796474 | 121.6323870 | -1.62 | GS SE'LY SIDE OF RI 5A |
| RI 5B | 38.2796509 | 121.6323683 | 2.18 | RI 5B MW RIMSHOT N'LY SIDE |
| RI 5B TOC | 38.2796509 | 121.6323683 | 2.18 | RI 5B N'LY SIDE TOP OF CASING |
| 7033 | 38.2796514 | 121.6323677 | -1.76 | GS NE'LY SIDE OF RI 5B |
| RIS 5 CPT | 38.2777516 | 121.6355622 | -0.65 | CENTER OF GROUT |
| RIS 5 SAMPLE | 38.2777509 | 121.6355468 | -0.68 | CENTER OF GROUT |
| RIS 6 CPT | 38.2853928 | 121.6368196 | -0.63 | CENTER OF GROUT |
| RIS 6 SAMPLE | 38.2854091 | 121.6368210 | -0.32 | CENTER OF GROUT |

***DATUM: HORIZONTAL: NAD 83, VERTICAL: NAVD 88 FEET***

**ALL VALUES ARE FROM GPS LOCATIONS OR CALCULATED FROM GPS LOCATIONS.**

# Appendix I

# Miner Slough and Sacramento Deep Water Ship Channel Bathymetry Report

# Final Draft Multibeam Bathymetry Project Report

## Miner Slough & Sacramento Deep Water Ship Channel near Prospect Island

### Introduction

The Bathymetry and Technical Support Section / North Central Region Office, collected bathymetric data at the request of the Division of Environmental Services. The project area was: Miner Slough downstream of HWY-84 and in the Sacramento Deep Water Ship Channel south of Arrowhead Harbor [Figure 1]. The purpose of the project was to provide high resolution, accurate bathymetry data for hydraulic models near Prospect Island. These models will help evaluate alternative designs to create beneficial wetlands on the island. The data will also be used to support seepage analyses on neighboring islands. Field work was conducted in January and February of 2012 using RTK GPS and multibeam sonar technology. Single beam sonar with RTK GPS was also employed in shallow or poorly accessible areas to aid in constructing a more complete underwater surface model of the area.

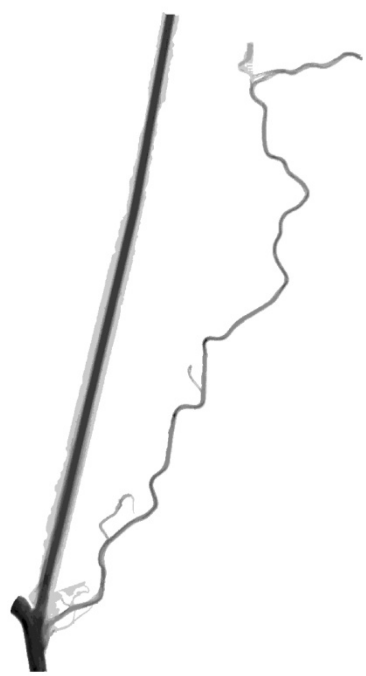


**Figure 1. Bathymetric Data Coverage**

## Geodetic Settings

All data are referenced horizontally to the North American Datum1983 (NAD83), projected to California State Plane Zone II. The data are referenced vertically to the North American Vertical Datum 1988 (NAVD88). The GEOID09 model was used for this project. All reported units are in feet.

## Instrumentation and Equipment

The instruments and equipment that NCRO employed for this project were:

- R2Sonic 2022 multibeam echo sounder
- Odom Hydrotrac II HT97001 singlebeam sounder – 340kHz
- Ohmex Instrumentation Sonarmite v3 singlebeam sounder
- Trimble R-8 GNSS GPS real time kinematic (RTK) positioning system
- Hemisphere Crescent VS100 GPS heading device
- SMC IMU-108 motion reference unit (MRU)
- Odom Hydrographic Digibar Pro sound velocimeter
- Trimble Trimark 3 radio modem
- Vessels used: North River Seahawk OB24[Figure 2] R2Sonic multibeam), G3 1966CC (for Odom sounder), Tarpon120 Kayak (for Sonarmite sounder)

  (See Appendix A for all instrument details)


**Figure 2. Multibeam Measurement Vessel North River Seahawk**

## Survey Procedures

### Pre-Survey

Prior to deploying the survey vessel, temporary benchmarks were established along the study area using RTK GPS technology. The temporary bench marks are used for daily verification checks of the base station setup. National Geodetic Survey (NGS) monument “Miner Reset” was used as the horizontal and vertical datum control. A photo of its marker is in Appendix E. The RTK base station occupied this monument on every field day of the measurement. Prior to the bathymetric survey, NGS monuments (Ryer, B474, and Sutter Reset) were used to help establish more convenient temporary benchmarks. Locations of the various benchmarks used in this project are in Appendix B.

Prior to starting the survey, the multibeam sonar system was calibrated to ensure accuracy. Multibeam sonar is a complex system that requires complete synchronization of all of its individual component instruments. In order for the multibeam sonar to collect accurate bathymetric data, the alignment of the following instruments must be calibrated collectively: the sonar head, heading device, and motion reference unit. The Hypack Hydrographic Survey Software multibeam system Patch Test performs this task. During this calibration, data is collected on specific terrain types at different speeds and directions of travel in order to measure the alignment of the sonar system’s instruments. Once the Patch Test is completed the system is corrected for pitch, roll, yaw, and latency and the results are entered into Hypack as offsets.

Sound velocity measurements were taken daily and entered into Hypack to further calibrate the multibeam sonar system. These measurements were taken with the Odom Hydrographic Digibar Pro Sound Velocimeter.

### Survey

The objective of this bathymetric survey was to provide the best representation of the channel bottom surface elevations that could be safely gathered in a month and a half of field work. Multibeam sonar[Figure 3] was selected as the primary source of data because of its detailed and accurate output.

**Figure 3 R2Sonic 2022 Sonar Head for Multibeam Measurements**

Shallow water conditions and navigational obstructions limited the amount of multibeam data coverage. In these shallow areas, single beam sonar data was collected to safely and efficiently complete the bathymetric representation. Two types of equipment setups were used for the single beam measurements:

1. Kayak-based: employed a Ohmex Sonarmite sounder[Figure 5]
2. Boat-based (small, flat-bottomed, aluminum): employed a Odom Hydrotrac sounder

All of our bathymetric measurement platforms employed RTK-GPS (Trimble R8 GNSS)

**Figure 4. Arriving at the site with the kayaks. The kayaks allowed improved access to shallow areas and shorelines.**

**Figure 5. Wyatt Pearsall conducting Sonarmite singlebeam data measurements near the Southern Tip of Prospect Island.**

Structures such as bridges, pump platforms, and submerged pipes occasionally caused data gaps. These areas were generally avoided in order to ensure the safety of the survey staff and survey equipment. Submerged aquatic vegetation can also interfere with the sonar's ability to record reliable bathymetric information. This type of vegetation was not a significant problem in this project because the bathymetric survey was conducted during winter months. This made surveying shallow areas and water near the water's edge significantly easier than is typical.

To ensure a timely completion of the project, a better than 20% swath overlap was used throughout the survey. While this level of overlap is sufficient to obtain an accurate surface of the channel bottom, a limited amount of data coverage was missed as a result. Additional field days were added to make corrections and refinements when either deficiency in the data density or uncertainty about data accuracy was encountered.

The base station was located at Miner Reset throughout the survey because the entire project area was within a 3.2 mile radius. (When a project is larger than a 5 miles radius, multiple base station sites are used to increase positional accuracy and radio signal reliability.)

### Data Processing

Multibeam Processing: HYSWEEP EDITOR (Hysweep), an extension in the Hypack Hydrographic Survey Software, was used to process raw information gathered from each instrument including the following data inputs: sonar, heading, GPS, MRU, sound velocity, instrument offsets, and collective time stamps. Using Hysweep, elevation data is filtered to reject the rare impossible value. Then, each survey line is individually examined for inconsistent and irregular values. At this point during data processing, anomalies are rejected and cleaned from the data set. Once the data set is thoroughly cleaned in Hysweep, it is exported from the Hypack software as a grid in an ascii XYZ text file format.

The final data quality review and analysis is completed using the ESRI ArcGIS 10 Desktop software. The ascii XYZ text file is imported into ArcGIS and converted to a Point Feature Class and Raster dataset. The final density level of the data points in the main channels is a 3 foot grid that was derived from data on a 1 foot grid. Raster and point data are reviewed for any remaining anomalies and exported as the final data set. Metadata is applied to the final ArcGIS geodatabase.

Singlebeam Hypack Processing: Using the Single Beam Editor in the Hypack Hydrographic Survey software (Hypack) the survey parameters entered in the "Read Parameter" are applied to the data collected during the survey. Read parameters include information about: sound velocity, instrumentation coordination and settings, instrumentation offsets, data sorting, and RTK tide values. Once the parameters are applied to the raw data, each survey line is examined individually for erroneous data or abnormalities. Survey lines are saved into an "Edited" folder in Hypack after erroneous data is deleted.

All of the edited survey lines are then opened together in Single Beam Editor and the "Read Parameters" are confirmed. All the single beam survey data is thinned to 1 point per 3 linear feet and exported as an XYZ text file. The text file is imported into Microsoft Access (Access) and the data is reviewed again for proper positional extents. The Access table is imported into ESRI ArcMap as a point feature class and checked for positional consistency and accuracy. If any inconsistencies exist, the raw data is extensively reexamined in Hypack Single Beam Editor and the inconsistency is resolved. The data is then re-exported as a text file and imported back into ArcMap and reviewed again.

The final data consistency review process involves a comparison of the Multibeam bathymetry and Single Beam bathymetry. If there is any inconsistency between the datasets, each is re-evaluated in Hypack. In locations where multiple data set exists only the multibeam data is retained. Once the Single Beam dataset passes the review process, a final XYZ text file and point feature class is exported and metadata is applied.

Singlebeam Sonarmite Processing: After exporting data from the instrumentention, outliers in the Sonarmite elevation (as determined by GPS positioning) were determined through semiovariogram analysis and a cluster and outlier analysis using Anselin Local Moran's I. Outliers in elevation of the bottom of the slough were also determined using Anselin Local Moran's I. Outliers for each of these datasets were located on aerial imagery and cross-referenced with field notes and, as such, could be attributed to local conditions at the individual points (overhanging trees, debris in shallow water, etc). Where these outliers were meaningful they were kept, and where reflecting inaccuracies they were discarded.

**Data Products**

The final products for the multibeam bathymetric survey include:

- Ascii XYZ files for both the single beam data "SB_All.txt" and multibeam data "MB_All.txt"
- A series of bathymetric maps. "MinerSlu_BathMapSeries_03292012"
- A metadata report "Metadata.pdf"
- ArcGIS File Geodatabase in both ArcGIS versions 10 "GIS_DATA.gdb.zip" and 9.3 "GIS_DATA_v9_3.gdb.zip" These include:
    - Point feature classes
    - Multipoint feature classes, and a
    - Raster dataset
- ArcGIS file geodatabase containing the raster of the combined multibeam and singlebeam data sets "Interpolated_GIS_DATA.gdb.zip"

The primary data files were delivered digitally on March 2, 2012.

## Quality Control Documentation

Quality control was insured by following equipment manufacturer recommendations and by conducting checks and measurements:

1. Equipment list and manufacturer specifications. (See Appendix A.)
2. Daily checks of RTK system accuracy. (See Appendix B.)
3. Sound velocity measurements. (See Appendix B.)
4. Bar checks. (See Appendix B.)
5. Tie Line checks of multibeam data consistency. (See Appendix C)
6. Patch test. (See Appendix D)
7. NGS Data Sheets for Local Benchmarks (See Appendix E)

**Appendix A:**

**Echosounder Equipment List and Manufacturer Specifications**
**CADWR-NCRO Bathymetry and Technical Support Section**
**February 27, 2012**

- **R2Sonic 2022 multibeam echo sounder**
- **SMC IMU-108 motion sensor**
- **Hemisphere Cresent VS100 Series GPS heading device**
- **Odom Hydrographic Digibar Pro sound velocity probe**
- **Trimble R-8 GNSS GPS-RTK system**
- **Trimble Trimmark 3 repeater radio**
- **Trimble TSC2 Survey Controller**
- **Odom Hydrotrac II HT97001 singlebeam sounder – 340kHz**
- **Ohmex Instrumentation Sonarmite v3 singlebeam sounder**

**Manufacturer specification sheets follow.**

High Resolution Multibeam Systems for:

**Hydrography**

**Offshore**

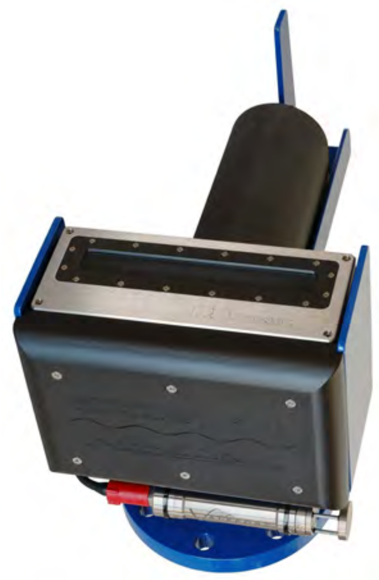
**Dredging**

**Defense**

**Research**

# SONIC 2022

## Multibeam Echo Sounder



### Features:

- Ultra Compact
- Focused 1° Beam Width
- Selectable Frequencies 200-400kHz
- Selectable Swath Sector 10° to 160°
- System Range to 500m
- Embedded Processor/Controller
- Equiangular or Equidistant Beams
- Roll Stabilization
- Rotate Swath Sector

### Applications:

- Hydrographic Survey
- Offshore Site Survey
- Pre & Post Dredge Survey
- Defense & Security
- Marine Research

### System Description:

The Sonic 2022 is a compact wideband shallow water multibeam echo sounder, suitable for a wide variety of general mapping applications.

As with the higher resolution Sonic 2024 system, the Sonic 2022 provides over 20 selectable operating frequencies to chose from within the 200 to 400 kHz band, with unparalleled flexibility to trade off resolution and range and controlling interference from other active acoustic systems.

In addition to selectable operating frequencies, the Sonic 2024 provides variable swath coverage selections from 10° to 160° as well as ability to rotate the swath sector. Both the frequency and swath coverage may be selected 'on-the-fly', in real-time during survey operations.

The Sonar consists of the outboard projector and receiver modules, and the inboard Sonar Interface Module (SIM). Third party auxiliary sensors are connected to the SIM. The sonar data is tagged with GPS time.

The sonar operation is controlled from a graphical user interface on a PC or laptop which is typically equipped with navigation, data collection and storage applications software.

The operator sets the sonar parameters in the sonar control window, while depth, imagery and other sensor data are captured and displayed by the applications software.

Commands are transmitted through an Ethernet interface to the Sonar Interface Module. The Sonar Interface Module supplies power to the sonar heads, synchronizes multiple heads, time tags sensor data, and relays data to the applications workstation and commands to the sonar head.

The receiver head decodes the sonar commands, triggers the transmit pulse, receives, amplifies, beamforms, bottom detects, packages and transmits the data through the Sonar Interface Module via Ethernet to the control PC.

The compact size, low weight, low power consumption of 35W and elimination of separate topside processors make Sonic 2022 *very well suited* for small survey vessel or ROV/AUV operations.

**R2Sonic LLC**
1503-A Cook Pl.
Santa Barbara
California,
USA 93117

T: 805 967 9192
F: 805 967 8611

www.r2sonic.com

# Sonic 2022 Multi Beam Echo Sounder

## Systems Specification:

| | |
|---|---|
| Frequency | 200kHz-400kHz |
| Beamwidth, across track | 1.0° |
| Beamwidth, along track | 1.0° |
| Number of beams | 256 |
| Swath sector | Up to 160° |
| Max Range setting | 500m |
| Pulse Length | 15µs-500µs |
| Pulse Type | Shaped CW |
| Ping Rate | Up to 60 Hz |
| Depth rating | 100m |
| Operating Temperature | 0°C to 50°C |
| Storage Temperature | -30°C to 55°C |

## Electrical Interface

| | |
|---|---|
| Mains | 90-260 VAC, 45-65Hz |
| Power consumption | 35W |
| Uplink/Downlink: | 10/100/1000Base-T Ethernet |
| Data interface | 10/100/1000Base-T Ethernet |
| Sync In, Sync out | TTL |
| GPS | 1PPS, RS-232 |
| Auxiliary Sensors | RS-232 |
| Deck cable length | 15m |

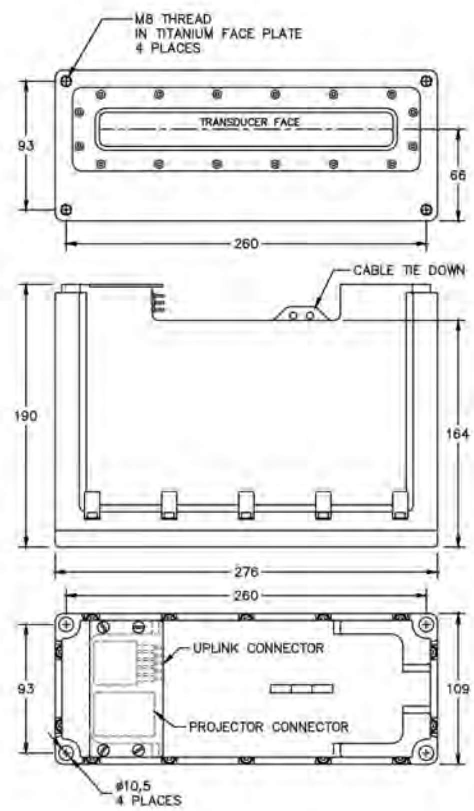
## Mechanical:

| | |
|---|---|
| Receiver Dim (LWD) | 276 x 109 x 190 mm |
| Receiver Mass | 7 kg |
| Projector Dim (LWD) | 273 x 108 x 86 mm |
| Projector Mass | 3.3 kg |
| Sonar Interface Module Dim (LWH) | 280 x 170 x 60 mm |
| Sonar Interface Module Mass | 2.4 kg |

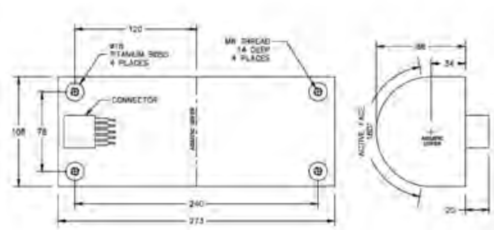
## Sonar Options:

Snippets Imagery Output
Switchable Forward Looking Sonar Output
Mounting Frame & Hardware
Over-the-side Pole Mount
Sound Velocity Probe & Profiler
Extended Sonar Deck Cable, 25m or 50m
3000m Depth Immersion Depth

Sonar Interface Module




Sonic 2022 Receiver



Sonic 2022 Projector

High Resolution Multibeam Systems for:

**Hydrography**

**Offshore**

**Dredging**

**Defense**

**Research**

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# SMC IMU
## Motion Sensors

SMC has developed its IMU range of Motion Sensors to meet the requirements of the hydrographic and marine sectors. The IMU range provides high accuracy motion measurement data in dynamic environment in all areas from small hydrographic vessels to large oil rigs in all weather conditions.

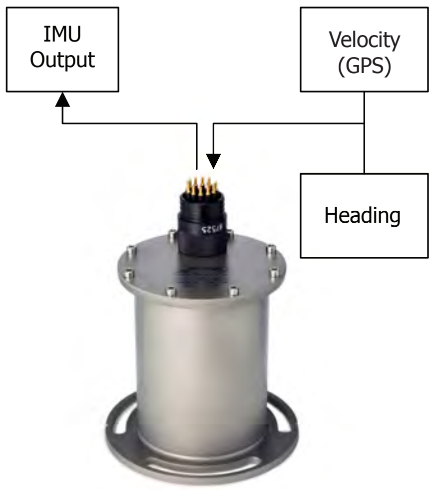
Key Specifications
- Roll & Pitch 0.03° (RMS) Dynamic Accuracy
- Heave 5 cm or 5 %
- Accelerations / Velocities
- Velocity Input Formats RMC, RMA, VTG, VBV, VHW
- Heading Input Formats NMEA 0183, HDT, HDG
- Various Industry Protocols NMEA
- 2 years warranty

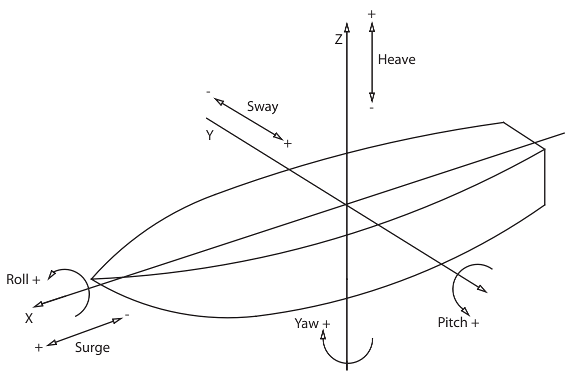
The SMC IMU uses solid state gyros and accelerometers to provide real time motion measurements with high dynamic accuracy even during accelerations. RS232 or RS422 outputs with RS232 velocity and heading inputs for aiding furing vessel turns. High quality titanium design, construction and assembly produce an IMU with an extremely high reliability in the most demanding marine environment.

Every SMC IMU is individually calibrated and tested for roll, pitch & heave as well as all directions of acceleration, inside a calibration machine with a controlled temperature environment between 0 and +55 degrees Celsius.

The SMC IMU is supplied with a data distribution unit, cables and windows based software for ease of set up and configuration. The configuration software enables the user to configure the IMU parameters for the installation.

The SMC IMU is available in a variety of design and depth options.



# SMC IMU Motion Sensors

Datasheet

*IMU-10x-30*

*IMU-10x-30 with cable*

*IMU-10x*

*IMU-10xb-30 with cable*

*IMU-10xb-30*

| Technical Specifications | IMU-106 | IMU-107 | IMU-108 |
|---|---|---|---|
| **Roll / Pitch** | N/A | Yes | Yes |
| **Accelerations X, Y, Z** | N/A | Yes | Yes |
| **Heave** | Yes | N/A | Yes |

| Performance | | | |
|---|---|---|---|
| **Angle Accuracy static** | N/A | 0.02° RMS | 0.02° RMS |
| **Angle Accuracy Dynamic** @ ±5° simultaneous roll and pitch | N/A | 0.03° RMS | 0.03° RMS |
| **Resolution Angle** | N/A | 0.001° | 0.001° |
| **Resolution Heave** | 0.01m | N/A | 0.01m |
| **Angle range Roll/Pitch** | ± 30° | ± 30° | ± 30° |
| **Heave range** | ±10m | N/A | ±10m |
| **Heave Accuracy** | 5cm or 5% | N/A | 5cm or 5% |
| **Acceleration accuracy** | N/A | 0.01 $m/s^2$ RMS | 0.01 $m/s^2$ RMS |

## Communications

| | |
|---|---|
| **IMU Configuration Software** | The IMU is shipped with SMC configuration windows software allowing on site setup |
| **Output Signal Protocol** | Multiple, user selectable Output Protocols ASCII NMEA and binary |
| **Communications Interface** | Output RS422 and RS232. Analog with remote converter (optional)<br>2 x RS232 External inputs, (not available on all models)<br>Velocity input formats RMC, RMA, VTG, VBV, VHW; Heading input formats HDT, HDG |

## Physical

| | |
|---|---|
| **Dimensions for IMU-10x (W x H)** | Ø89 (mounting plate Ø134, flange for IMU-10x-30 Ø110) x 120mm excl connector |
| **Weight** | ~2 kg |
| **Housing Material** | Titanium |

## Environmental

| | |
|---|---|
| **Temperature (absolute max)** | 0° to +55° Celsius (-10° to +65°); Storage Temperature -40° to +65° Celsius |
| **Mounting Orientation** | Vertical or Horizontal mounting (factory set) |
| **Power requirements** | 12 - 30 VDC; 2 W |
| **MTBF (computed)** | 50 000 hours |
| **Depth rating** | IP66 (standard); IP68 30 meter depth rated (optional) |
| **Standard** | Complies with the IEC 60945 |

## Warranty & Support

| | |
|---|---|
| **Warranty** | 2-year Limited Hardware & Software Warranty |
| **Support** | Free Technical & Hardware support |

## Bundled Delivery

| | |
|---|---|
| **Junction Box** | Multiple Input & Output Connection Case, including 10 m cable |

SMC SHIP MOTION CONTROL

**Contact:** Phone: +46 8 644 50 10 | Email: info@shipmotion.se | Web: www.shipmotion.se

# Crescent® VS100 Series GPS Compass

## Professional Heading and Positioning Receiver


Precise applications demand the heading and positioning performance of the Crescent VS100 Series GPS Compass. Ideal for professional machine control and navigation applications, the Crescent VS100 delivers reliable accuracy at significantly less cost than competitors products or traditional methods. The Crescent VS100 receiver with its display and user interface can be conveniently installed near the operator. The two antennas are mounted separately and with a distance between them to meet the desired accuracy.

*Powered by* Crescent

The latest Hemisphere GPS products are powered by Crescent Receiver Technology, the future of precision GPS.

## Key Crescent VS100 Series Advantages

- Affordable solution delivers 2D GPS heading accuracy better than 0.1 degree rms
- Differential positioning accuracy of less than 60 cm, 95% of the time
- Integrated gyro and tilt sensor deliver fast start-up times and provide heading updates during temporary loss of GPS
- Fast heading and positioning output rates up to 20 Hz
- Differential options including SBAS (WAAS, EGNOS, etc.) and optional beacon differential
- COAST™ technology maintains accurate solutions for 40 minutes or more after loss of differential signal
- The status lights and menu system make the VS100 Series easy to monitor and configure

# Crescent VS100 Series GPS Compass

## GPS Sensor Specifications

| | |
|---|---|
| Receiver Type: | L1, C/A code, with carrier phase smoothing |
| Channels: | Two 12-channel, parallel tracking (Two 10-channel when tracking SBAS) |
| Update Rate: | Standard 10 Hz, optional 20 Hz (position and heading) |

Horizontal Accuracy:
- < 0.6 m 95% confidence (DGPS)*
- < 2.5 m 95% confidence (autonomous, no SA)**

Heading Accuracy:
- < 0.30° rms @ 0.5 m antenna separation
- < 0.15° rms @ 1.0 m antenna separation
- < 0.10° rms @ 2.0 m antenna separation

Pitch / Roll Accuracy:
- < 1 ° rms @ 0.5 m antenna separation

| | |
|---|---|
| Rate of Turn: | 90° / s max |
| Cold Start: | 60 s (No almanac or RTC) |
| Heading Fix: | < 20 s |
| Satellite Reacquisition: | < 1 s |
| Antenna Input Impedance: | 50Ω |

## Beacon Sensor Specifications (VS110 version)

| | |
|---|---|
| Channels: | 2-channel, parallel tracking |
| Frequency Range: | 283.5 to 325 kHz |
| Operating Modes: | Automatic (signal strength), Database and Manual |
| Compliance: | IEC 61108-4 beacon standard |

## Communications

| | |
|---|---|
| Serial ports: | 2 full duplex |
| Interface Level: | RS-232C |
| Baud Rates: | 4800 - 57600 |

Correction I/O Protocol:
- RTCM SC-104, L-Dif (Hemisphere GPS proprietary)

| | |
|---|---|
| Data I/O Protocol: | NMEA 0183, Crescent binary, L-Dif (Hemisphere GPS proprietary) |
| Timing Output: | 1 PPS (HCMOS, active high, rising edge sync, 10 kΩ, 10 pF load) |
| 1 PPS Accuracy: | 50 ns |

## Power

| | |
|---|---|
| Input Voltage: | 9 to 36 VDC |
| Power Consumption: | < 5 W |
| Current Consumption: | < 360 mA @ 12 VDC |
| Antenna Voltage Output: | 5 VDC |
| Antenna Short Circuit Protection: | Yes |

## Environmental

| | |
|---|---|
| Operating Temperature: | -32°C to +74°C (-25°F to +165°F) |
| Storage Temperature: | -40°C to +85°C (-40°F to +185°F) |
| Humidity: | 95% non-condensing |
| Shock and Vibration: | EP 455 |
| EMC: | FCC Part 15, Subpart B, Class B, CISPR22, CE |

## Mechanical

| | |
|---|---|
| Dimensions: | 189 mm L x 114 mm W x 71 mm H (7.4” L x 4.5” W x 2.8” H) |
| Weight: | 0.86 kg (1.9 lb) |
| Status Indication: | Power, primary GPS lock, secondary GPS lock, differential lock, and heading lock |
| Power Switch: | Miniature push-button |
| Power Connector: | 2-pin, micro-Conxall |
| Data Connectors: | DB9-female |
| Antenna Connectors: | TNC-male |

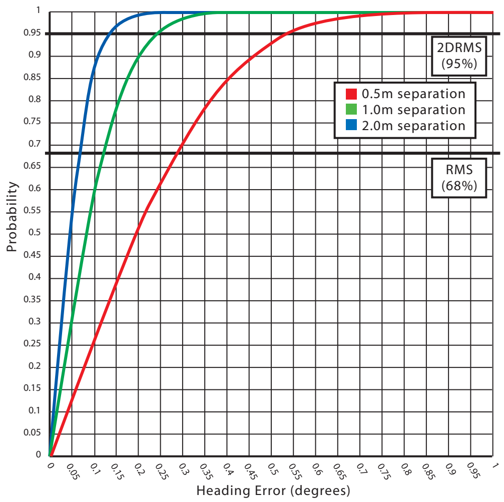
## Aiding Devices

| | |
|---|---|
| Gyro: | Single axis gyro provides reliable <1° heading for periods up to 3 minutes when loss of GPS lock has occurred |
| Tilt Sensor: | Assists in fast start up of RTK solution |

* Depends on multipath environment, number of satellites in view, satellite geometry, baseline length (for local services), and ionospheric activity

** Depends on multipath environment, number of satellites in view, and satellite geometry

### Crescent® VS100 Series Heading Performance vs. Antenna Separation



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# DIGIBAR PRO™

## FOR SEAFLOOR OR RIVERBED SURVEYS

The Digibar Pro is the most cost-efficient and accurate means of determining water column sound velocities. It quickly calibrates acoustic systems regardless of sea state or current and is faster and safer than the traditional bar check method. Digibar Pro uses "sing-around" technology, which automatically compensates for all factors influencing sound velocity, including salinity, depth and temperature.

### GENERAL SPECIFICATIONS

**Velocity Range**
- 1400 - 1600 m/sec (4595 - 5250 ft/sec)

**Velocity Resolution**
- 0.1 m/sec (0.1 ft/sec)

**Temperature Range**
- 4° C - 40° C (39° F - 104° F) Typical

**Communications**
- RS232, selectable baud rate and choice of output formats
- Display and download/logging SW included

### PROBE SPECIFICATIONS

**Sing-Around Frequency**
- 11 kHz

**Velocity Accuracy**
- +/- 0.3 m/sec (+/- 1 ft/sec)

**Sample Rate**
- 10 Hz

**Depth Sensor Accuracy**
- 31.0 cm (1.0 ft)

**Communications**
- RS485, 19.2 Baud (two way between handset and probe)

**Dimensions**
- 37.3 L x 5.0 D cm (14.7 L x 2.0 D in)

**Weight**
- 1.9 kg (4.2 lbs) in air

### HAND UNIT SPECIFICATIONS

**Power Requirement**
- Three "C" cell alkaline batteries in hand unit powers both hand unit and probe
- External DC power supply available as an option for continuous SV output applications.

**Dimensions**
- 29.0 L x 14.0 W x 9.4 D cm (11.4 L x 5.5 W x 3.7 D in)

**Weight**
- 1.2 kg (2.6 lbs)

### CABLE SPECIFICATIONS
- 4-conductor, Polyethylene-jacketed with Kevlar strength member
- Breaking Strength - 182 kg (400 lbs)
- Standard Cable length - 20m
- Maximum Cable length - 100m

### FEATURES

- Velocity profiles downloaded to a computer
- Handheld display/logger with computer interface
- Battery operated
- Detachable cable (in lengths up to 100 meters)
- Sampling by depth or time
- Stainless steel probe
- Waterproof
- Lightweight
- Portable
- Optional transit cases
- Optional Cable Reel
- Optional Kellems grip

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

- See our entire product line at: **odomhydrographic.com**

# DIGIBAR PRO™

## FOR SEAFLOOR OR RIVERBED SURVEYS


**MODEL DB1200**

PROFILING SOUND VELOCIMETER

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

DATASHEET

# TRIMBLE R8 GNSS RECEIVER

**The Trimble® R8 GNSS Receiver sets the new standard for full-featured GNSS (Global Navigation Satellite System) receiver technology. This integrated system delivers unmatched power, accuracy and performance in a rugged, compact unit.**

## KEY FEATURES

- Advanced Trimble R-Track technology
- Unmatched GNSS tracking performance
- Includes Trimble Maxwell 6 chip with 220 channels
- Remote configuration and access
- Base and rover communications options to suit any application

### ADVANCED TRIMBLE R-TRACK TECHNOLOGY

The Trimble R8 GNSS delivers the latest advancements in R-Track™ technology, designed to deliver reliable, precise positioning performance. In challenging areas for GNSS surveying, such as tree cover or limited sky view, Trimble R-Track provides unmatched tracking performance of GNSS satellite signals.

Trimble R-Track with Signal Prediction™ compensates for intermittent or marginal RTK correction signals, enabling extended precision operation after an RTK signal is interrupted.

The new CMRx communications protocol provides unprecedented correction compression for optimized bandwidth and full utilization all of the satellites in view, giving you the most reliable positioning performance.

Featuring the Trimble Maxwell™ 6 chip, the Trimble R8 GNSS advances the industry with more memory and more GNSS channels. Trimble delivers business confidence with a sound GNSS investment for today and into the future.

#### Broad GNSS Support

The Trimble R8 GNSS supports a wide range of satellite signals, including GPS L2C and L5 and GLONASS L1/L2 signals. In addition, Trimble is committed to the next generation of modernized GNSS configurations by providing Galileo-compatible products available for customers well in advance of Galileo system availability[1,2]. In support of this plan, the new Trimble R8 GNSS is capable of tracking the experimental GIOVE-A and GIOVE-B test satellites for signal evaluation and test purposes.

### FLEXIBLE SYSTEM DESIGN

The Trimble R8 GNSS receiver combines the most comprehensive feature set into an integrated and flexible system for demanding surveying applications. The Trimble R8 GNSS includes a built-in transmit/receive UHF radio, enabling ultimate flexibility for rover or base operation. As a base station, the internal NTRIP caster provides you with customized access[3] to base station corrections via the internet.

Trimble's exclusive, Web UI™ eliminates travel requirements for routine monitoring of base station receivers. Now you can assess the health and status of base receivers and perform remote configurations from the office. Likewise, you can download post-processing data through Web UI and save additional trips out to the field.

### ENABLING THE CONNECTED SITE

Pair the speed and accuracy of the Trimble R8 GNSS receiver with flexibility and collaboration tools of Trimble Access™ software. Trimble Access brings field and office teams closer by enabling data sharing and collaboration in a secure, web-based environment. With optional streamlined workflows, Trimble Access further empowers surveyors and survey teams for success. Now it is easier than ever to realize the potential of the Trimble Connected Site. Connecting the right tools, techniques, services and relationships enables surveying businesses to achieve more every day.

1 ***Galileo Commercial Authorization***
*Receiver technology having Galileo capability to operate in the Galileo frequency bands and using information from the Galileo system for future operational satellites is restricted in the publicly available Galileo Open Service Signal-In-Space Interface Control Document (GAL OS SIS ICD) and is not currently authorized for commercial use.*
*Receiver technology that tracks the GIOVE-A and GIOVE-B test satellites uses information that is unrestricted in the public domain in the GIOVE A + B Navigation Signals-In-Space Interface Control Document. Receiver technology having developmental GIOVE-A and B capability is intended for signal evaluation and test purposes.*

2 *For more information about Trimble and GNSS modernization, please visit* ***http://www.trimble.com/srv_new_era.shtml****.*

3 *Cellular modem required.*

Trimble.

## PERFORMANCE SPECIFICATIONS

### Measurements

- Trimble R-Track technology
- Advanced Trimble Maxwell 6 Custom Survey GNSS chip with 220 channels
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Signal-to-Noise ratios reported in dB-Hz
- Proven Trimble low elevation tracking technology
- Satellite signals tracked simultaneously:
  - GPS: L1C/A, L2C, L2E (Trimble method for tracking L2P), L5
  - GLONASS: L1C/A, L1P, L2C/A (GLONASS M only), L2P
  - SBAS: L1C/A, L5
  - Galileo GIOVE-A and GIOVE-B

### Code differential GNSS positioning[1]

| | |
|---|---|
| Horizontal | 0.25 m + 1 ppm RMS |
| Vertical | 0.50 m + 1 ppm RMS |
| WAAS differential positioning accuracy[2] | typically <5 m 3DRMS |

### Static and FastStatic GNSS surveying[1]

| | |
|---|---|
| Horizontal | 3 mm + 0.1 ppm RMS |
| Vertical | 3.5 mm + 0.4 ppm RMS |

### Kinematic surveying[1]

| | |
|---|---|
| Horizontal | 10 mm + 1 ppm RMS |
| Vertical | 20 mm + 1 ppm RMS |
| Initialization time[3] | typically <10 seconds |
| Initialization reliability[4] | typically >99.9% |

## HARDWARE

### Physical

| | |
|---|---|
| Dimensions (W×H) | 19 cm × 11.2 cm (7.5 in x 4.4 in), including connectors |
| Weight | 1.34 kg (2.95 lb) with internal battery, internal radio, standard UHF antenna. 3.70 kg (8.16 lb) entire RTK rover including batteries, range pole, controller and bracket |
| Temperature[5] | |
| Operating | –40 °C to +65 °C (–40 °F to +149 °F) |
| Storage | –40 °C to +75 °C (–40 °F to +167 °F) |
| Humidity | 100%, condensing |
| Water/dustproof | IP67 dustproof, protected from temporary immersion to depth of 1 m (3.28 ft) |
| Shock and vibration | Tested and meets the following environmental standards: |
| Shock | Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth |
| Vibration | MIL-STD-810F, FIG.514.5C-1 |

### Electrical

- Power 11 to 28 V DC external power input with over-voltage protection on Port 1 (7-pin Lemo)
- Rechargeable, removable 7.4 V, 2.4 Ah Lithium-Ion battery in internal battery compartment. Power consumption is 3.2 W, in RTK rover mode with internal radio. Operating times on internal battery:
  - 450 MHz receive only option .......... 5.8 hours[7]
  - 450 MHz receive/transmit option .......... 3.7 hours[8]
  - GSM/GPRS .......... 4.1 hours[7]
- Certification Class B Part 15, 22, 24 FCC certification, 850/1900 MHz. Class 10 GSM/GPRS module. CE Mark approval, and C-tick approval

### Communications and Data Storage

- 3-wire serial (7-pin Lemo) on Port 1. Full RS-232 serial on Port 2 (Dsub 9 pin)
- Fully Integrated, fully sealed internal 450 MHz receiver/transmitter option:
  - Transmit power: 0.5 W
  - Range[6]: 3–5 km typical / 10 km optimal
- Fully integrated, fully sealed internal GSM/GPRS option[7]
- Fully integrated, fully sealed 2.4 GHz communications port (Bluetooth®)[9]
- External cellphone support for GSM/GPRS/CDPD modems for RTK and VRS operations
- Data storage on 57 MB internal memory: 40.7 days of raw observables (approx. 1.4 MB /Day), based on recording every 15 seconds from an average of 14 satellites
- 1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz positioning
- CMR+, CMRx, RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM 3.1 Input and Output
- 16 NMEA outputs, GSOF, RT17 and RT27 outputs. Supports BINEX and smoothed carrier

*1 Accuracy and reliability may be subject to anomalies due to multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended survey practices.*
*2 Depends on WAAS/EGNOS system performance.*
*3 May be affected by atmospheric conditions, signal multipath, obstructions and satellite geometry.*
*4 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.*
*5 Receiver will operate normally to –40 °C, internal batteries are rated to –20 °C.*
*6 Varies with terrain and operating conditions.*
*7 Varies with temperature.*
*8 Varies with temperature and wireless data rate.*
*9 Bluetooth type approvals are country specific. Contact your local Trimble Authorized Distribution Partner for more information.*

*Specifications subject to change without notice.*


*PN 022543-079J (11/09)*

*TRIMBLE AUTHORIZED DISTRIBUTION PARTNER*

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www.trimble.com

DATA SHEET

# TRIMMARK 3 RADIO MODEM

## KEY FEATURES

Versatile: Use as base, repeater or rover

Flexible: 2 W, 10 W, or 25 W power output

Channel spacing programmable at 12.5 kHz or 25 kHz

Easy to use and configure

Built-in channel selector and monitor

Rugged and weatherproof


## RUGGED AND VERSATILE MULTICHANNEL RADIO MODEM

The TRIMMARK™ 3 radio modem provides a convenient, versatile means of establishing a robust wireless data broadcast network for real-time, high-precision GPS survey and telemetry applications.

The rugged, compact TRIMMARK 3 radio modem is designed for use in tough environments and in a variety of situations. The single unit is usable as a base station, repeater station, or rover receiver for maximum versatility. However you use it, you'll appreciate its simplicity and famous Trimble reliability and quality.

## SELECT THE POWER YOU NEED

The TRIMMARK 3 radio modem provides selectable power outputs of 2 W, 10 W, or 25 W to support both short and long-range operations, conserve battery life and minimize risk of interference with other systems.

A 25 W base unit broadcasts up to 15 km (8 miles) line-of-sight, under optimal conditions. Path obstructions and terrain can reduce the typical effective range to 10 km to 12 km (6 miles to 7 miles). One or two additional units can be networked as repeater stations to extend range, minimize base station moves, and provide seamless coverage around local obstacles such as large buildings or hills. The typical range of a 2 W repeater is 5 km to 8 km (3 miles to 5 miles).

A TRIMMARK 3 radio modem broadcasts or repeats data to Trimble survey-grade GPS receivers, such as the Trimble R8, 5800, Trimble R7, and 5700, that either contain an internal radio modem or are being used with an external rover radio. The TRIMMARK 3 is fully backward compatible with the TRIMMARK IIe radio modem, so it can be used in both new and existing systems.

## CONFIGURE IT TO YOUR NEEDS

The TRIMMARK 3 radio modem can be configured completely and easily in the office by using the supplied WinFLASH utility on your computer. Many functions also can be configured in the field from the front panel or from the Trimble Survey Controller™ software used with your GPS survey receivers. The serial port communication settings are easily set to match the default settings on the GPS receiver.

You can configure each broadcast network to operate on one of up to 20 programmed channels via a built-in channel selector. Channel spacing of either 12.5 kHz or 25 kHz is programmable at the factory or by a service provider.

To reduce the risk of interference in a congested RF environment, you can use the built-in audio speaker to monitor activity on the selected channel. The unit also can automatically monitor the channel using its software selectable carrier detect function to detect other users on the channel before transmitting.

The TRIMMARK 3 radio modem is available as a stand-alone product as well as in convenient base and repeater equipment sets. Available in three frequency bands, the TRIMMARK 3 radio modem is designed to meet the licensing requirements of many countries around the world.

Trimble

# TRIMMARK 3 RADIO MODEM

**STANDARD FEATURES**

- Selectable 20-channel capacity
- Rugged weatherproof construction
- Configurable from front panel, survey controller, or from supplied WinFLASH utility on your computer
- Up to 15 km line-of-sight range
- Same unit can function as base station, repeater station, or rover receiver
- Selectable power outputs of 2 W, 10 W, or 25 W
- Programmable channel spacing of 12.5 kHz or 25 kHz
- Built-in channel selector
- Supports up to two repeaters in a network
- 4800, 9600 and 19200 baud rate over the air
- Retrievable/storable radio diagnostic information

**TRIMMARK 3 BASE/REPEATER**

**Physical**

Size . . . . . . . . . . . . 12.5 cm W x 22.9 cm D x 7.9 cm H (4.9" W x 9.0" D x 3.1" H)
Weight . . . . . . . . . . . . 1.59 kg (3.5 lb)

**Electrical**

Power:
Input . . . . . . . . . . . . 12 V DC to 16 V DC, nominal
Connectors:
Power . . . . . . . . . . . . 2-pin LEMO (+VDC, GND)
Data . . . . . . . . . . . . 7-pin female LEMO (supports RXD, TXD and SGND)
Antenna . . . . . . . . . . . . TNC female

**Environmental**

Temperature:
Operating . . . . . . . . . . . . –40 °C to +65 °C (–40 °F to +149 °F)
Storage . . . . . . . . . . . . –55 °C to +75 °C (–67 °F to +167 °F)
Humidity . . . . . . . . . . . . 100%, fully sealed, weatherproof

**TECHNICAL SPECIFICATIONS**

Transmit Power[1] . . . . . . . . . . . . 2 W, 10 W, 25 W
Wireless Data Rate . . . . . . . . . . . . 4800 bps, 9600 bps, 19200 bps
Frequency Bands . . . . . . . 410–420 MHz, 430–450 MHz, or 450–470 MHz (Only one band per radio modem)
Channel Spacing . . . . . . . . . . . . 12.5 kHz or 25 kHz (Only one spacing per radio modem)
Number of Channels[2] . . . . . . Can be ordered with up to 20 programmed frequencies, internally stored
RF Modulation Format . . . . . . . . Gaussian Minimum Shift Keying (GMSK)

**Range (typical)[3]**

25 W Base . . . . . . . . . . . . 10 km to 12 km (6 miles to 7 miles)
2 W Repeater . . . . . . . . . . . . 5 km to 8 km (3 miles to 5 miles)

| Power Consumption[4] | Voltage | Current | Nominal Load |
|---|---|---|---|
| 2 W mode | 12.6 V | 0.8 A | ~10 W |
| 10 W mode | 12.6 V | 3.6 A | ~45 W |
| 25 W mode | 12.6 V | 8.0 A | ~75 W |

Serial Port . . . . . . . . . . . . One set of RS-232 signals available. Data is 8 bits with selectable parity and 1 stop bit. Supported data rates are 9600 bps, 19200 bps, and 38400 bps[5]

| ANTENNA PHYSICAL SPECIFICATIONS | LENGTH (TYPICAL) | WEIGHT |
|---|---|---|
| ***Standard antenna*** | | |
| 0 dB UHF omni whip | 47 cm (18.5 in) | 0.5 kg (1.1 lb) |
| 5 dB UHF omni whip | 99 cm (39 in) | 0.5 kg (1.1 lb) |

*1. Radios are configured as 25-W units at the factory.*
*2. Use the same frequency for all radio modems in the same wireless data network.*
*3. Varies with terrain and operational conditions. Up to 2 repeaters can be used to extend range.*
*4. Power consumption and battery life depend on the broadcast information content and wireless data rate (e.g., CMR versus RTCM SC-104 Ver 2.x packets at 1-Hz epoch rates).*
*5. Communications rate between the radio and GPS receiver; not wireless rate.*

*Specifications subject to change without notice.*



*TRIMBLE DISTRIBUTION PARTNER*

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# DATASHEET

# TRIMBLE TSC2 CONTROLLER

## KEY FEATURES

- Exceptional performance in the field–even in extreme temperatures
- Full keyboard, 8-way spider key and touch screen
- Bright-color, daylight-readable display
- Large 512 MB memory capacity, 128 MB RAM and 516 MHz processor quickly handles large projects
- Integrated Bluetooth wireless technology eliminates the need for cables
- Integrated 2.4 GHz radio for robotic operation on Trimble total stations
- Integrated WiFi for fast wireless networking
- Ergonomic design fits comfortably in your hand

### RUGGED HANDHELD CONTROLLER FOR TOTAL STATION OR GPS OPERATION

The Trimble® TSC2™ Controller is a rugged, adaptable handheld data collector powered by Trimble SCS900 Site Controller Software. Running on a Microsoft® Pocket PC® operating system, the Trimble TSC2 offers an intuitive, easy-to-use interface for a wide range of site positioning applications, and has the power to hold information for multiple large jobsites to suit your needs.

### Rugged, durable design

The Trimble TSC2 is water and dust-resistant to withstand the toughest weather and jobsite conditions. The controller has an illuminated keyboard and display for operation in low light conditions. The Trimble TSC2 operates in temperatures ranging from –30 °C to +60 °C (–22 °F to +140 °F).

### Keyboard, touch screen, and 8 way spider key

The Trimble TSC2 controller gives you a choice of operating the Trimble SCS900 Site Controller Software using the full alphanumeric keyboard and 8-way spider key, or using the easy-to-use color touch screen for maximum data control efficiency. The touch screen provides instant results and simplifies navigation, data selection, positioning, and stakeout.

### Color graphic display

The Trimble TSC2 color graphic display is clearly readable in a wide range of field conditions. The display's reflective LCD technology makes it easy to read in bright sunlight and is back lit to operate in low light levels, such as on dark winter days. The display makes it easier to read simple text, as well as complex maps and technical drawings. Having color graphics right at your fingertips facilitates navigating and positioning, and speeds up stakeout and data selection. Additionally, you'll significantly improve management and quality assurance, as well as minimize errors and omissions because you can thoroughly check your data in the field.

### Large memory and portable data capability

The Trimble TSC2 controller comes standard with 512 MB of Flash memory and 128MB RAM. It also comes standard with two compact flash expansion card slots, and one SD card slot. It also supports USB memory sticks. This large storage capacity means that you can work with data for the largest projects, and can work in the field longer without backup storage. Measured surface or design data can easily be transferred between Trimble SCS900 and Trimble GCS900 Grade Control Systems. You can get machines up and running with data without returning to the office.

### Trimble SCS900 Site Controller Software

Designed for construction site measurement and stakeout Trimble SCS900 Site Controller Software measures, computes volumes, and loads CAD and surface model files for jobsite stakeout and grade checking applications. Using the Trimble TSC2 with SCS900 Site Controller software gives supervisors, foremen, grade checkers, and site engineers total control of site operations.

### Cable-free operation

The Trimble TSC2 controller with Trimble SCS900 software is designed to operate with all Trimble Site Positioning Systems, including Trimble SPS781, SPS881, SPS751, SPS851 GPS Receivers and Trimble SPS610, SPS730 and SPS930 Total Stations. Integrated Bluetooth® wireless technology, delivers cable-free communication between the Trimble TSC2 and SPS GPS receivers. The Trimble TSC2 is also available with integrated 2.4 GHz radio, providing an ergonomic solution to total station measurement, further eliminating components and cables from the rod.

### Connectivity

As part of the Trimble Connected Construction Site solutions, the Trimble TSC2 controller comes standard with integrated 802.11 WiFi capability to deliver instant network access wherever a wireless network is available. WiFi provides the ability to rapidly send and retrieve data from the network and additionally send / receive email without the need for additional components or plug in cards.

### Pocket PC operating system

The Trimble TSC2 PC operating system offers familiar Microsoft Office applications such as Pocket Excel and Pocket Word for viewing reports generated by Trimble SCS900.

Trimble

# TRIMBLE TSC2 CONTROLLER

## PHYSICAL CHARACTERISTICS

Length . . . . . 28.2 cm (11.1")
Width . . . . . 10.5 cm (4.1")
Height . . . . . 4.4 cm (1.7")
Handgrip . . . . . 7.6 cm (3")
Weight . . . . . 1.1 kg including battery, radio, and radio whip antenna
Memory . . . . . 512 MB flash disk; 128 MB SDRAM
Processor . . . . . Intel® Bulverde PX-A27 at 516 MHz
Power . . . . . Li-Ion rechargeable pack, 6600 mAh, battery life of 30 hours under normal operating conditions. Fast charge to 80% in 2 hours; full charge in 4.5 hours. Battery charge status LED indicator
Certification . . . . . Class B FCC certification, CE Mark approval, CSA, and C-tick approval
Bluetooth type approvals and regulations are country specific
Controller type . . . . . Handheld controller. Can be connected to the Trimble SPS781, SPS881, SPS751, and SPS851 GPS Receivers, the Trimble SPS610 Total Station and Trimble SPS730 and SPS930 Universal Total Stations, and robotic remote control radios.

## INTERFACE CHARACTERISTICS

Display . . . . . 320 x 240 pixel QVGA reflective color TFT, LED back-lit illuminated display
Touch Screen . . . . . Passive touch screen, works with stylus or finger
Keyboard . . . . . 52-key tactile action with separate navigation, alpha and numeric keypads, 8-way spider key
Audio . . . . . Integrated speaker and microphone for audio events, warnings and notifications, recording
Operating system . . . . . Microsoft® Windows Pocket PC 5.0

## INPUT / OUTPUT CHARACTERISTICS

Serial Port . . . . . COM1, 9-pin D-Sub RS232 (115 kB/s) with 5 V (250 mA) on pin 9
USB Port 1 . . . . . USB client connector v2.0
USB Port 2 . . . . . USB host connector v2.0
Compact Flash 1 . . . . . Compact Flash Card slot v1.2 Type 1
Compact Flash 2 . . . . . Compact Flash Card slot v1.2 Type 2
SD I/O . . . . . Secure Digital Card slot
Integrated Bluetooth . . . . . Bluetooth v1.2

## ENVIRONMENTAL CHARACTERISTICS

Operating Temperature . . . . . –30 °C to +60 °C (–22 °F to +140 °F)
Storage Temperature . . . . . –40 °C to +60 °C (–40 °F to +140 °F)
Sand and dust . . . . . IEC 529 IP6X, MIL-STD-810F, Method 510.3
Water . . . . . IEC 529 IPX7, MIL-STD-810F, Procedure I
Drops . . . . . 48" onto 2-inch plywood over concrete, 26 drops room temperature (all faces, edges, corners, one drop each), 6 face drops at +60 °C, 6 face drops at -20 °C
Vibration . . . . . MIL-STD-810F, Method 514.5, Procedure I; General Minimum Integrity Test
Altitude . . . . . MIL-STD-810F, Method 500.4

## INCLUDED SOFTWARE APPLICATIONS

- Trimble SCS900 Site Controller Software
- Microsoft Windows® Explorer®
- Pocket Internet Explorer
- Microsoft Wordpad®
- Microsoft Windows Media Player®
- Microsoft ActiveSync®
- Microsoft Windows Mobile 2003, Second Edition
- Microsoft Pocket Excel
- Microsoft Outlook®
- File transfer (remote)
- File viewers for Microsoft Image® and Word



*Specifications subject to change without notice.*

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# HYDROTRAC™ II


## SINGLE FREQUENCY PORTABLE HYDROGRAPHIC ECHO SOUNDER

- Ideal for small boats and harsh conditions
- Ethernet LAN interface
- Frequency agile
- High resolution thermal printer
- Internal GPS
- Waterproof (with front cover in place)
- Flash upgradeable
- Side scan option

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

# HYDROTRAC™ II

Specifically designed for work in less-than-ideal circumstances on small survey boats and inflatable watercraft, the Hydrotrac™ II offers compact portability and the confidence of knowing you're using a proven Odom product. It is completely waterproof and comes equipped with the same advanced features you've come to trust and depend on in Odom echo sounders.

## GENERAL SPECIFICATIONS

**Frequency Agile**
- Operator selectable through menu – 24, 28, 33, 40, 100, 120, 200, 210 and 340 kHz

**Output Power**
- 600 watts

**Power Requirement**
- 11-28 V DC

**Resolution**
- 0.1 ft / 0.01m

**Accuracy**
- 200 kHz – 1cm (0.1% of depth value (corrected for sound velocity)
- 33 kHz – 10cm 0.1% of depth value (corrected for sound velocity)

**Maximum Depth Range**
- 600m or 1800 ft.

**Environmental Operating Conditions**
- 0° - 50° C

**Communication**
- 2 RS232 ports or 1 RS232 and 1 RS422
- Ethernet port
  - 8 bit data
  - 1600 samples/ping

**Printer**
- High resolution 8 dot/mm (203 dpi), 16 gray shades
- 216mm (8.5 in) wide thermal paper
- External ON/OFF switch
- Paper advance control

**Dimensions**
- 368 mm (14.5 in) H x 419 mm (16.5 in) W x 203 mm (8 in) D

**Weight**
- 22.5 lbs (10.2 kg)

**Display Panel Layout**
- 4 Line x 20 Character display
- OFF/STBY/LOW/MED/HI Power Settings
- Chart ON/OFF with LED inside
- Chart Advance
- Sensitivity
- Chart Feed
- Separate Panel Overlays for
  - Display and Chart controls
  - Keypad (arrow keys)
  - Power
  - Gain

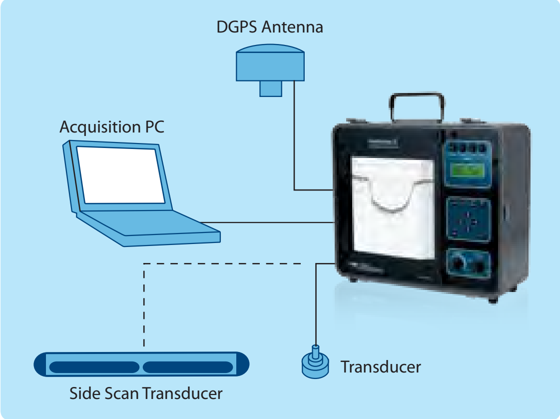
**Sensor I/O**
- GPS
  - Annotates chart
  - Embeds position in Ethernet packet
- PPS
  - Embeds UTC time in output string
- MRU
  - Heave corrects data
  - Outputs MRU data in Ethernet packet
- Remote Display
  - RS 422 interface

**Internal GPS with WAAS differential corrections and PPS reference signal**
- 16-Channel, L1(1575.42 MHz) GPS receiver
- SBAS (WAAS and EGNOS) supported
- Position Accuracy: 0.63 meters, CEP 50% (24hr static)
- 1.31 meters, 95% (24hr static)
- Typical dynamic accuracy 3-5 meters
- Time (PPS): +/-62ns synchronized to UTC time
- Standard NMEA0183 output message

**Features**
- 8.5 in / 216mm thermal printer (fax paper)
- Annotation printed on chart
- LCD display (1 in. high)
- Sealed keypad controls
- Manual/remote mark command
- Auto scale change (phasing)
- Separate adjustment for power and pulse width
- External GPS input
- Heave input from motion sensor
- Integrated OEM DGPS receiver
- UTC time stamp capability
- TVG curve for side scan and bathymetry
- Output: NMEA, ECHOTRAC, DESO 25, etc.
- Waterproof (with front cover in place)
- Fix mark annotation: date, time, fix no., depth and GPS (if input)
- Flash memory upgradeable
- Waterproof DB9 connector serial ports (standard serial interface cables)
- Built-in simulator
- Serial port function test
- Robust firmware upgrades by SD Card
- E-chart Software included
- Operation and installation manuals provided on CD

**Options**
- 200 kHz or 340 kHz side scan transducer
- Remote display

**CONFIGURATION EXAMPLE:** HYDROTRAC

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11/10

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OHMEX INSTRUMENTATION

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HydroLite XT
Trimble SCS900
HydroLite MAX
HydroLite X7

# SonarMite v3 Echo Sounder

DOWNLOAD DATASHEET

**'SP' = Serial Port version**

**'BT' = Serial + Bluetooth version**

The SonarMite Echo Sounder is the result of nearly two years research and development to further extend the boundaries of shallow water hydrographic surveying equipment. The introduction by Ohmex in 1997 of the SonarLite, the worlds first truly portable echo sounder system, has been a hard act to follow and it remains the portable instrument of choice in many survey companies around the world. The release of the SonarMite instrument marks the next stage introducing a series of equipment designed around the WinSTRUMENT concept making use of the latest portable computers integrated with new measurement technologies.


## SonarMite Main Features

- Bluetooth technology integrated with Windows Pocket PC devices
- Proven 'Smart' transducer design with QA output
- Internal rechargeable battery for all day use in the field
- Easily integrated with other modern software and GPS technology

Throughout the Hydrographic world the term 'Black Box' has become a euphemism for a device that has a minimal user interface and normally requires connection to a PC to be of any use ! In most cases these boxes are a cut down version of a more conventional instrument without all the features of the full system. The SonarMite extends this idea of a rugged design and minimalist interface to produce a 'Blue Box' system where the user interface is provided by integrated software running on a portable computer connected via a Bluetooth link. The use of wireless technology enables the instrument to be waterproof and used in a hostile environment while the more sensitive computer features can be located in a more user friendly environment up to 50m away from the instrument.

## SonarMite Measurements

The SonarMite instrument uses the same 'Smart' integrated transducer technology used in the SonarLite system, in addition to highly reliable bottom tracking algorithms using DSP techniques the system also outputs a quality value associated with every depth measurement made. The popular SonarXP software has been updated to SonarVista, in addition to the standard post-processing and editing features found in the SonarLite software the program now includes extended features to implement the additional measurements produced by the SonarMite. Software for the 'front end' of the SonarMite is available to run on a wide range of devices from Pocket PCs through to the full range of desktop systems running the Windows operating system.

## Active Transducer Technology

The SonarLite uses active transducer technology manufactured exclusively for use with the Ohmex Instruments range of survey quality equipment. All the signal generation, data processing and filtering is performed digitally within the transducer element, thus overcoming problems associated with old analogue technology ...

- **Low Signal Drift** — High immunity to temperature and environmental induced drift
- **Low EMC** — Transducer cable carries only power supply and data
- **Smart Filtering** — Smart filtering algorithms controlled by external processor
- **Low drop out** — Drop out rate ten times lower than analogue devices

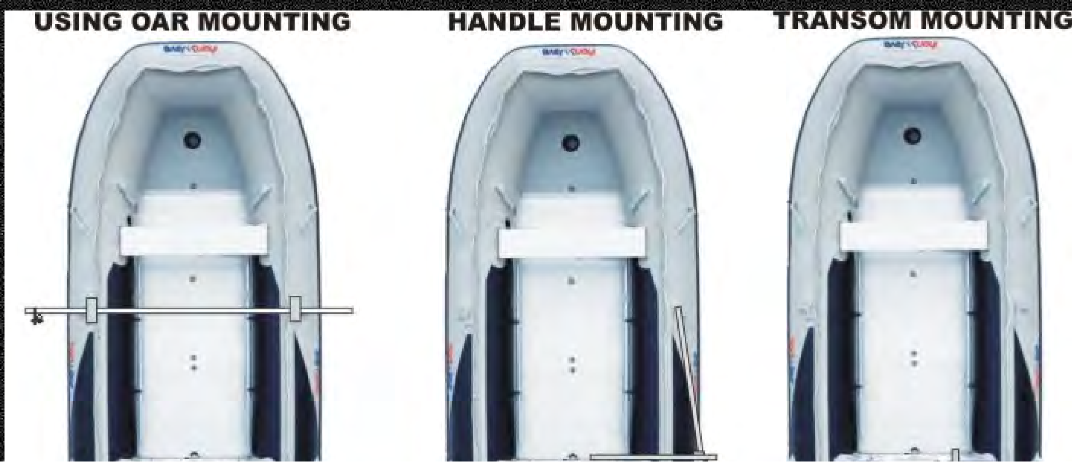
The Active Transducers are available in the standard 'Boat' shape transducer using a 'Knock-off' body design patented by Airmar, this allows a transducer shoe to be mounted on the rear transom of a boat alongside outboard motors, the active transducer tracking and filtering algorithms are not effected by the acoustic noise generated by the motor. The Airmar patent design allows the transducer to kick its mounting if grounded and thus avoid serious damage.

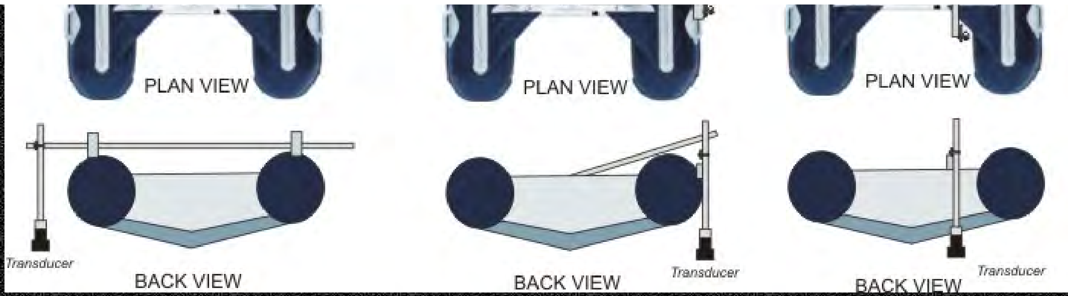
### New P66 Transducer

The standard SonarLite 'Smart' transducer has been updated using the new Airmar P66 shell and ceramic element. This design offers an improved 'slipstream' design together with a simple 'clip-on' fixing clamp enabling easier transducer mounting/removal. The active processor has been updated to a flash memory processor which enables the later reprogramming of the transducer to incorporate new firmware features as they arrive. The SonarLite active transducer is a specially designed Ohmex transducer with firmware designed for survey applications to IMO standards, IT IS NOT THE SAME TRANSDUCER AS THE AIRMAR SMART NMEA DEVICE although it uses the same shell.

## Transducer Mounting

The SonarMite system is a portable hydrographic survey system so by definition the boat used will be either a light portable boat or a vessel of opportunity. The SonarMite transducer mounting is designed to fit on to a vertical pole although the actual fitting will vary with the numerous different types of vessel






The above illustration shows typical arrangements to mount the transducer in a small inflatable craft, care should be taken to ensure that the mount is firm enough for reliable readings but flexible enough to avoid damage if the transducer collides with the bottom surface.

## System Specification

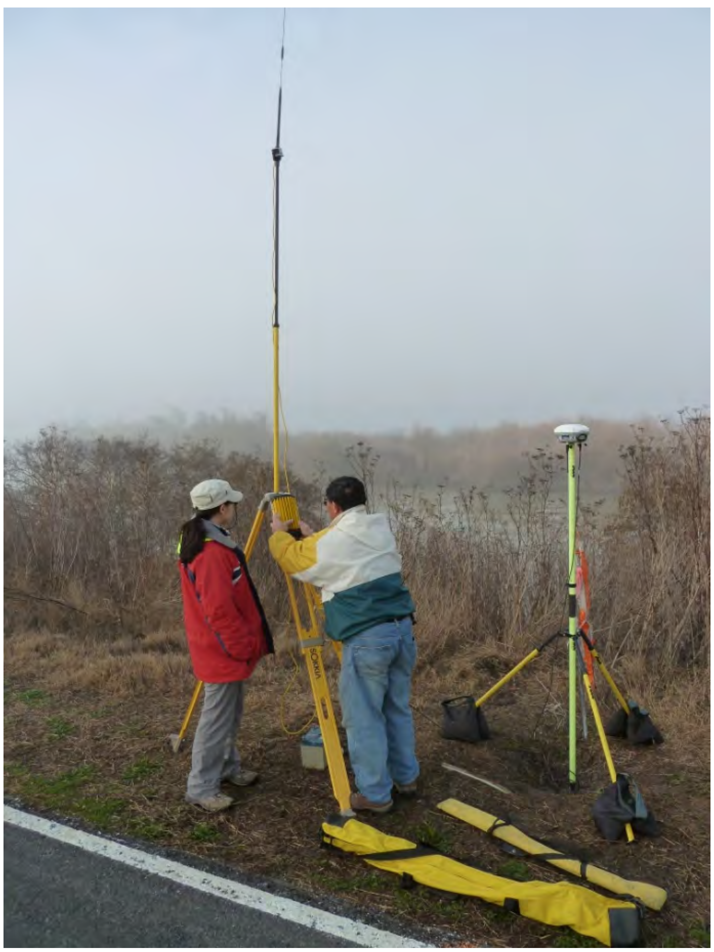
| | |
|---|---|
| **Transducer Frequency** | 235KHz Active Transducer |
| **Beam Spread** | 8 to 10 Degrees |
| **Depth Range** | 0.30m to 75.00m (Software limited) |
| **Accuracy** | +/-0.025m (RMS) |
| **Sound Velocity Range** | 1400 to 1600 m/sec |
| **Data Output Range** | 2Hz |
| **Ultrasonic Ping Rate** | 3 to 6 Hz (Depth dependent ) |
| **Internal Power** | 10.0v x 1.5AHr Internal Nickel Metal Hydride sealed battery (NiMh) |
| **Power Consumption** | 70ma to 120ma (temp dependent) |
| **Usable Battery Life** | 8Hrs to 12Hrs between charging |
| **Stand-By Battery Life** | 10000 Hours |
| **Battery Charge** | Switch mode charger for 90..250vac, 40..60Hz |
| **Work Anywhere** | 2/3 Round/Square pin charger adaptor |
| **Data Format** | RS232C 9600 baud 8 bit 1 stop bit No parity |
| **Operating Temperature** | 0 to 45 degree Centigrade |
| **Overall Dimensions** | 100w x 220h x 45d (mm) |
| **Weight** | 0.75Kg |

## Version 3 Updates

New release of the SonarMite v3 in a redesigned die-cast aluminum case. The SonarMite is the smallest, lightest, truly portable hydrographic echo sounder system available. A complete system which includes echo sounder, transducer, cables, battery charger all weighing just 5Kg shipped in its polypropylene transit case. The internal rechargeable NiMh batteries have been updated with an additional 20% capacity providing 12 hours working time from a full charge. Using the latest battery technology the device complies fully with modern environmental, safe transit and final disposal requirements. The instrument provides multiple communication interfaces including RS232, Bluetooth and USB. The new custom USB interface cable has been designed for the SonarMite to provide a sealed IP67 connector, avoiding non-waterproof USB connector problems in a marine environment. SonarMite can be configured to output over dual interfaces to enable data logging/display at two separate locations simultaneously. SonarMite application software is designed to work with a wide range of external Windows PC, Tablet and PDA equipment, the software has recently been updated and tested working with Windows Vista.

*"Some lead, others follow"* ... 

## Appendix B: Daily QA/QC Checks and RTK Control



Setting up the RTK radio at the Miner Reset Benchmark on February 6, 2012

**Daily QA Checks  Page 1/2**

**Horizontal Datum:** California StatePlane Zone II

**Vertical Datum:** NAVD88

Differences between the Original Measurement and the measurement checks for the RTK Base Station(in feet)

| Station Name | Original Measurement (ft) | | 1/10/2012 | 1/11/2012 | 1/12/2012 | 1/18/2012 | 1/24/2012 | 1/25/2012 | 1/26/2012 | 1/30/2012 |
|---|---|---|---|---|---|---|---|---|---|---|
| **5479A** | 1844999.179 | *North* | -0.012 | -0.008 | -0.029 | -0.043 | -0.036 | -0.021 | 0.009 | -0.042 |
| | 6655532.622 | *East* | 0.031 | 0.016 | 0.019 | 0.022 | 0.004 | 0.011 | -0.058 | -0.004 |
| | 18.380 | *Elev* | 0.003 | -0.009 | -0.004 | -0.006 | -0.004 | 0.033 | 0.024 | 0.008 |
| **D3** | 1849363.456 | *North* | -0.008 | -0.019 | -0.027 | -0.060 | -0.022 | -0.057 | -0.021 | -0.029 |
| | 6657950.920 | *East* | 0.013 | 0.020 | 0.045 | 0.053 | 0.024 | 0.035 | 0.038 | 0.033 |
| | 23.889 | *Elev* | -0.027 | -0.016 | -0.034 | -0.031 | -0.027 | 0.004 | 0.021 | -0.018 |
| **D2.5** | 1857290.031 | *North* | 0.058 | 0.054 | 0.014 | 0.022 | 0.038 | 0.035 | 0.047 | -0.020 |
| | 6661779.616 | *East* | -0.035 | -0.070 | -0.052 | -0.050 | -0.052 | -0.018 | -0.071 | -0.065 |
| | 26.107 | *Elev* | 0.012 | 0.023 | 0.030 | 0.007 | 0.006 | -0.033 | -0.014 | -0.023 |
| **D2_B** | 1860178.910 | *North* | -0.005 | 0.020 | -0.005 | - | - | - | - | - |
| Vandalized | 6664710.220 | *East* | -0.010 | -0.020 | 0.017 | - | - | - | - | - |
| after 1/12 | 28.369 | *Elev* | 0.001 | 0.006 | 0.019 | - | - | - | - | - |
| **D1** | 1866872.064 | *North* | 0.021 | 0.032 | - | - | - | - | - | - |
| Vandalized | 6663613.065 | *East* | 0.022 | 0.011 | - | - | - | - | - | - |
| after 1/11 | 27.789 | *Elev* | 0.009 | 0.001 | - | - | - | - | - | - |
| **GageSta_ Miner** | 1867657.416 | *North* | - | - | - | - | 0.025 | 0.032 | 0.015 | 0.051 |
| | 6663618.134 | *East* | - | - | - | - | 0.003 | 0.018 | 0.049 | -0.010 |
| | 13.836 | *Elev* | - | - | - | - | -0.068 | -0.080 | 0.024 | -0.246 * |
| **Avg Error** | - | *Horizontal* | 0.022 | 0.027 | 0.026 | 0.042 | 0.025 | 0.028 | 0.038 | 0.032 |
| | - | *Vertical* | 0.010 | 0.011 | 0.022 | 0.015 | 0.026 | 0.037 | 0.021 | 0.074 |
| **Sound Velocity Check (m/s)** | | | 1444 | 1444 | 1445 | 1441 | 1442.2 | 1444.2 | 1444.1 | - |

- A bar check was perfomred on 1/11 with a bar elevation of -2.30 and a Sonar Elevation of -2.31, resulting in a difference of 0.010 feet.
- R8 Rover checks were done on 1/18 and 1/24 with respective values of 8.79 for the Land Rover and 8.90 for the Sea Rover (a difference of -0.110) and 10.06 for the Land Rover and 10.03 of the Seas Rover (a difference of 0.030).
- Sound velocity checks were only performed on days that we collected multibeam data.

*- While the accuracy of this check is suspect, the RTK measurements are likely as accurate on 1/30/12 as the other days of the survey.

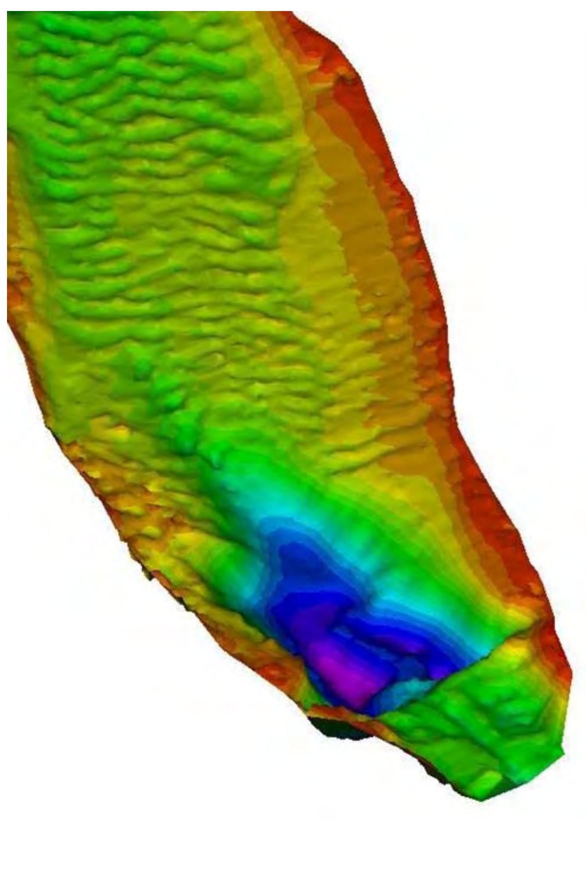
**Daily QA Checks  Page 2/2**

**Horizontal Datum:** California StatePlane Zone II

**Vertical Datum:** NAVD88

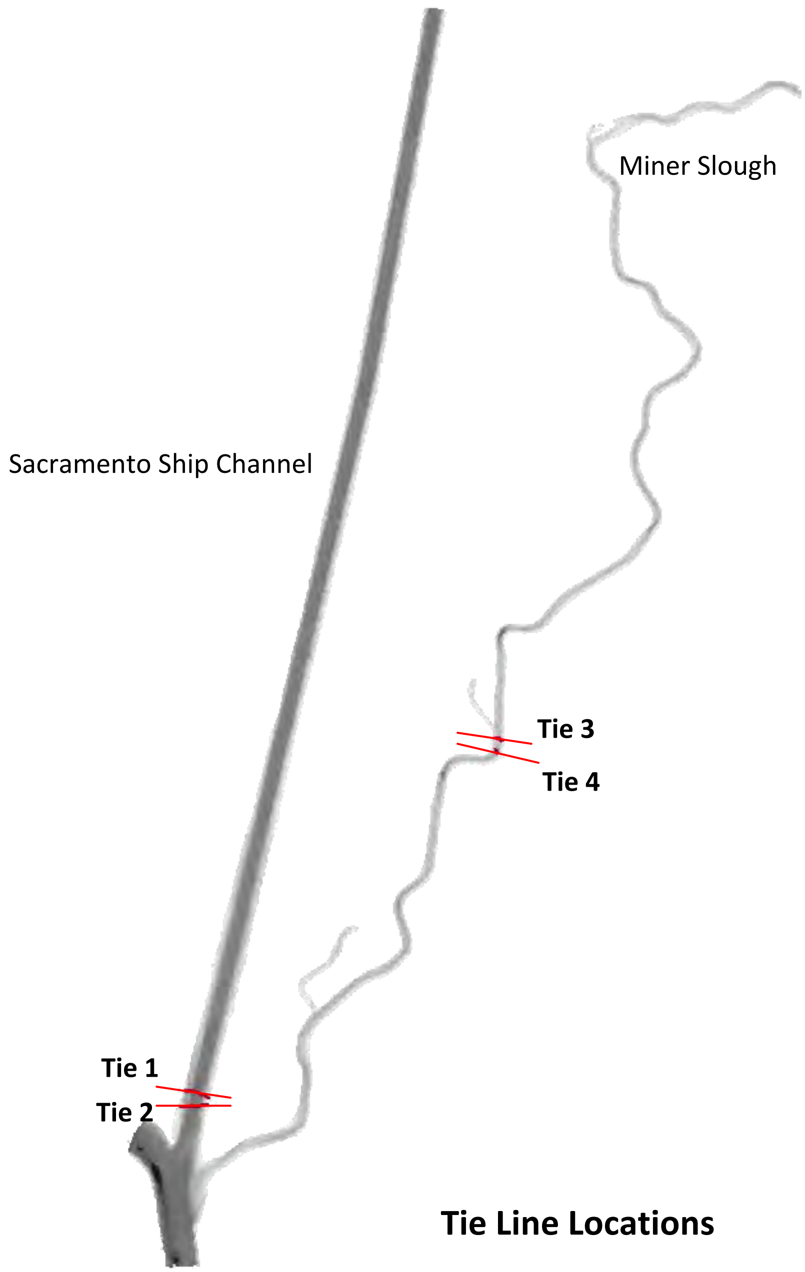
| Station Name | Original Measurement (ft) | | 1/31/2012 | 2/1/2012 | 2/2/2012 | 2/3/2012 | 2/14/2012 | 2/15/2012 | 2/16/2012 |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Differences between the Original Measurement and the measurement checks for the RTK Base Station(in feet)** | | | | | | |
| **5479A** | 1844999.179 | *North* | -0.030 | -0.027 | -0.042 | -0.015 | -0.033 | -0.009 | 0.050 |
| | 6655532.622 | *East* | -0.022 | -0.015 | -0.010 | -0.019 | -0.020 | 0.022 | -0.008 |
| | 18.380 | *Elev* | 0.020 | -0.001 | 0.022 | 0.011 | 0.028 | 0.050 | 0.028 |
| **D3** | 1849363.456 | *North* | 0.010 | 0.020 | -0.012 | - | - | - | - |
| | 6657950.920 | *East* | 0.018 | 0.003 | 0.059 | - | - | - | - |
| | 23.889 | *Elev* | -0.019 | -0.012 | -0.014 | - | - | - | - |
| **D2.5** | 1857290.031 | *North* | 0.049 | 0.044 | 0.017 | - | - | - | - |
| | 6661779.616 | *East* | -0.048 | -0.027 | -0.063 | - | - | - | - |
| | 26.107 | *Elev* | -0.019 | -0.007 | -0.014 | - | - | - | - |
| **D2_B** | 1860178.910 | *North* | - | - | - | - | - | - | - |
| Vandalized | 6664710.220 | *East* | - | - | - | - | - | - | - |
| after 1/12 | 28.369 | *Elev* | - | - | - | - | - | - | - |
| **D1** | 1866872.064 | *North* | - | - | - | - | - | - | - |
| Vandalized | 6663613.065 | *East* | - | - | - | - | - | - | - |
| after 1/11 | 27.789 | *Elev* | - | - | - | - | - | - | - |
| **GageSta_** | 1867657.416 | *North* | 0.022 | 0.069 | -0.007 | -0.037 | 0.049 | -0.019 | -0.036 |
| **Miner** | 6663618.134 | *East* | 0.013 | 0.073 | 0.035 | 0.055 | -0.044 | 0.049 | -0.016 |
| | 13.836 | *Elev* | -0.029 | 0.023 | -0.042 | -0.025 | 0.008 | -0.038 | 0.003 |
| **Avg Error** | - | *Horizontal* | 0.026 | 0.035 | 0.031 | 0.031 | 0.037 | 0.025 | 0.028 |
| | - | *Vertical* | 0.022 | 0.011 | 0.023 | 0.018 | 0.018 | 0.044 | 0.015 |
| **Sound Velocity Check (m/s)** | | | - | - | - | - | 1454 | 1454.8 | - |

## Appendix C. Tie Line Report



# Tie Line Report

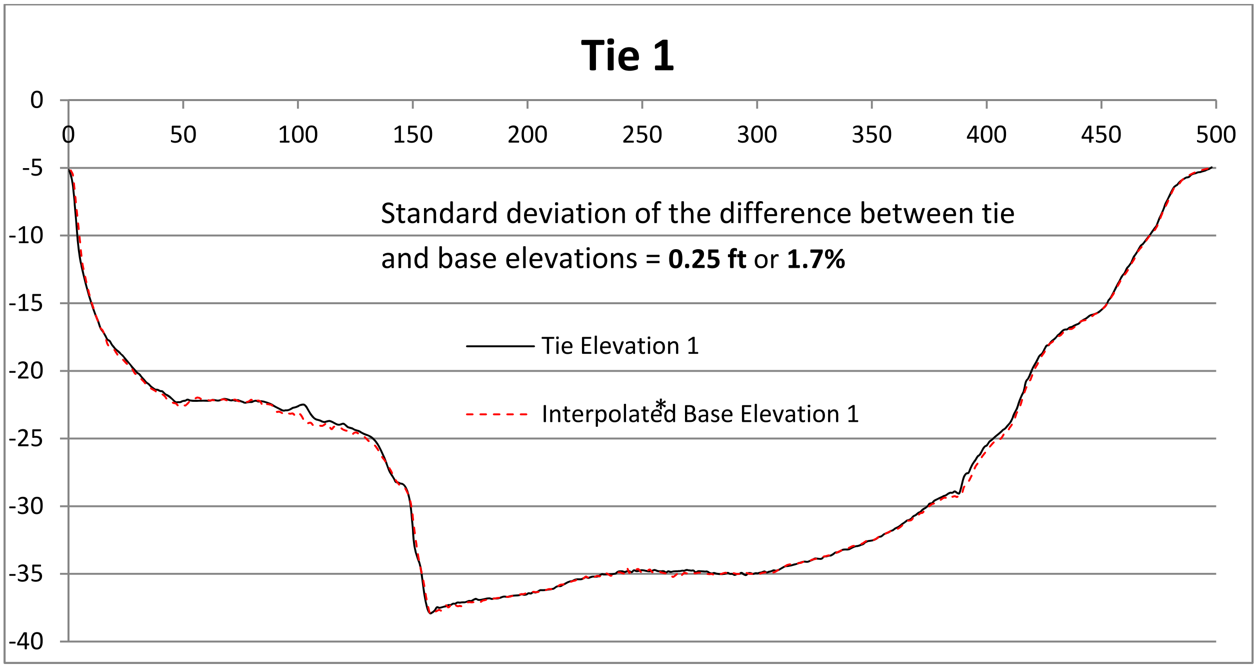
Tie lines are used to indicate multibeam data quality and repeatability. A tie line is a measurement line that is roughly perpendicular to the channel where base multibeam data was collected. Base survey lines, on the other hand, are typically parallel to the channel and are stitched together to make a continuous grid of data points that form the bathymetric product. If the base is correctly stitched it will closely match the tie lines. Four tie lines were collected and profiles for each were plotted. The standard deviation of the percent difference between tie and base elevations were calculated for each line and indicated on the charts below.



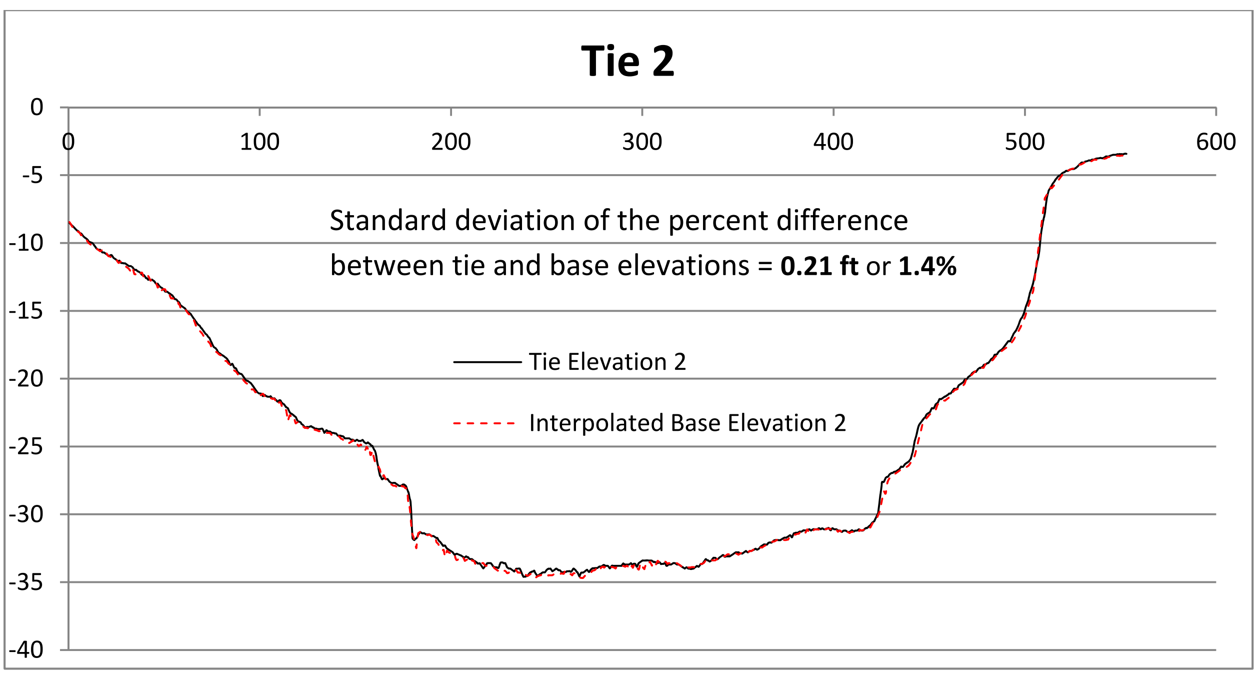

**Tie Line Locations**

# Tie Line Charts

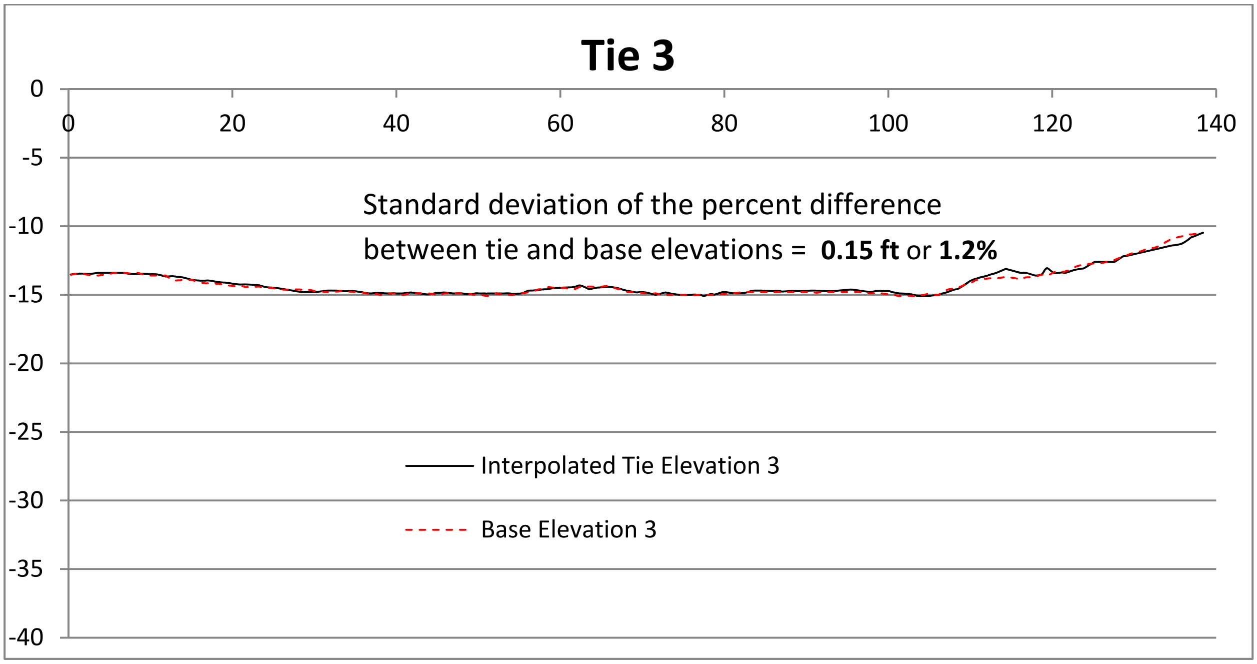
Elevations in feet NAVD 88

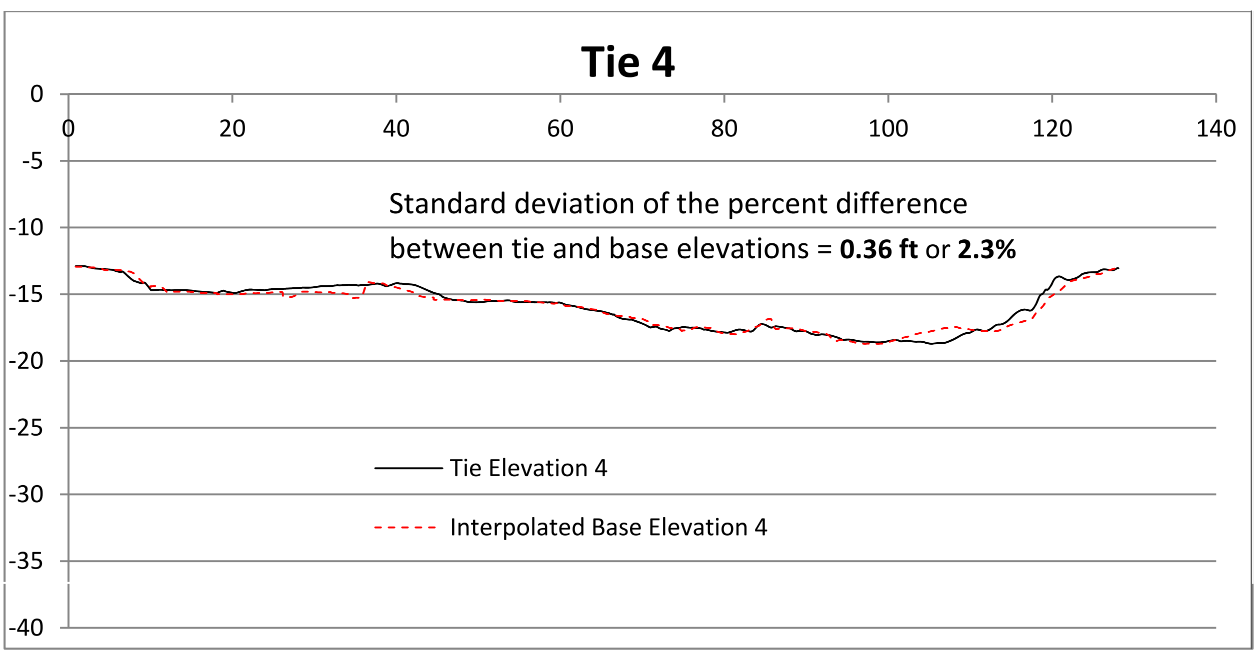



* - Elevations were interpolated to a common horizontal reference to allow for accurate difference and standard deviation calculations. The interpolated data are nearly identical to non-interpolated data because points are shifted a foot or less. Since bathymetry is positively autocorrelated this shift is not significant.



# Tie Line Charts (cont.)



## Appendix D: Patch Test for Miner Slough Project

In order for the multibeam sonar to collect accurate bathymetric data, the alignment of the following instruments must be calibrated collectively: the sonar head, heading device, and the motion reference unit. The Hypack Hydrographic Survey Software multibeam system Patch Test performs this task. During this calibration, data is collected on specific terrain types at different speeds and directions of travel in order to measure the alignment of the sonar system's instruments. Once the Patch Test is completed the system is corrected for pitch, roll, yaw, and latency and the results are entered into Hypack as offsets.

**Table D1. System Offsets**

| | ***GPS Latency*** *seconds* | ***Pitch*** *degrees* | ***Roll*** *degrees* | ***Yaw*** *degrees* |
|---|---|---|---|---|
| ***Offset*** | 0.00 | 4.00 | -0.30 | 10.00 |
| ***Date Measured*** | 1/4/12 | 1/4/12 | 1/4/12 | 1/18/12 |

Please note that these offsets are also applied in the processing stage after the work is completed. The Yaw offset was measured after a suitable feature was found to perform an accurate measurement.

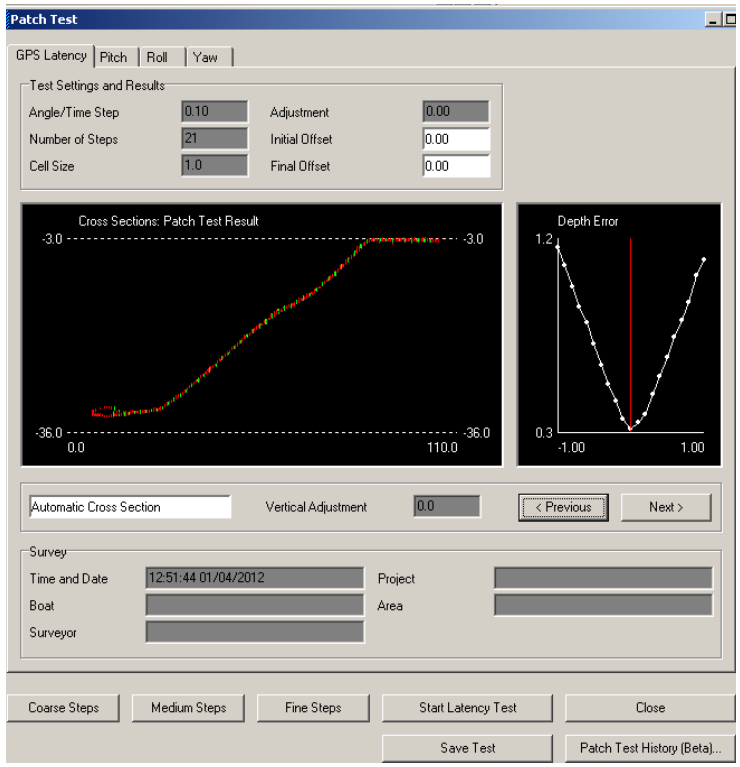



**Figure D1. Patch Test: GPS Latency 1/4/12**

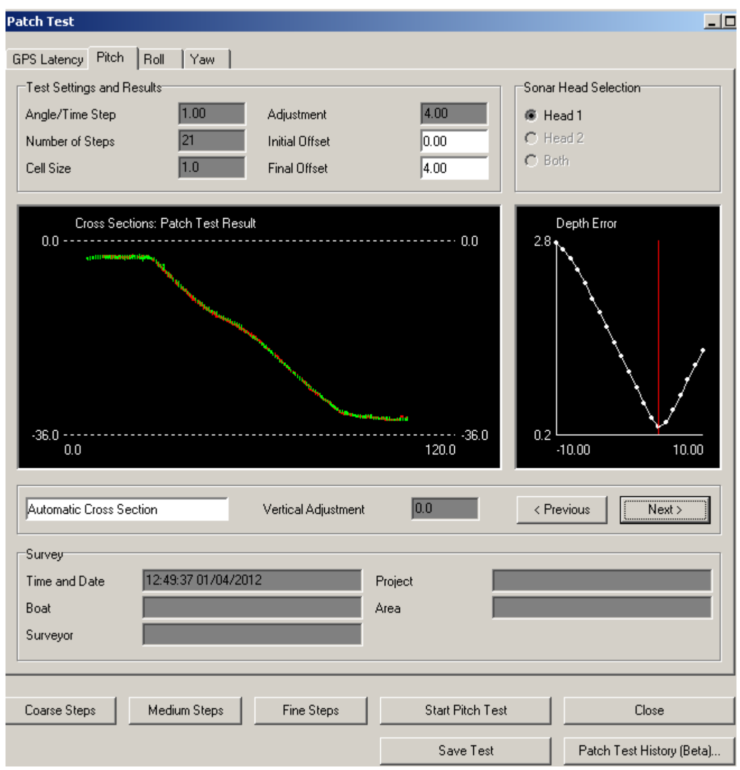



**Figure D2. Patch Test: Pitch 1/4/12**

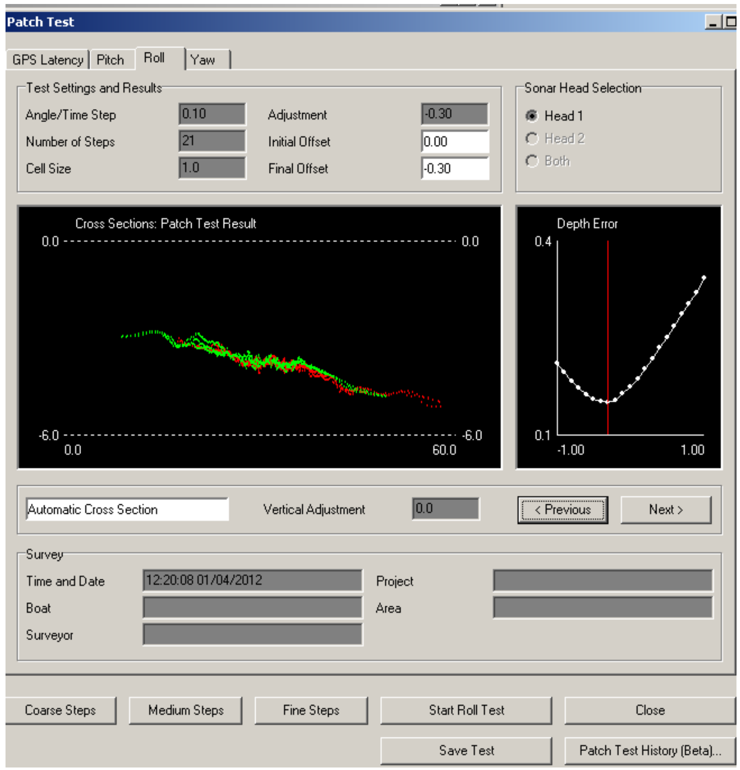



**Figure D3. Patch Test: Roll 1/4/12**

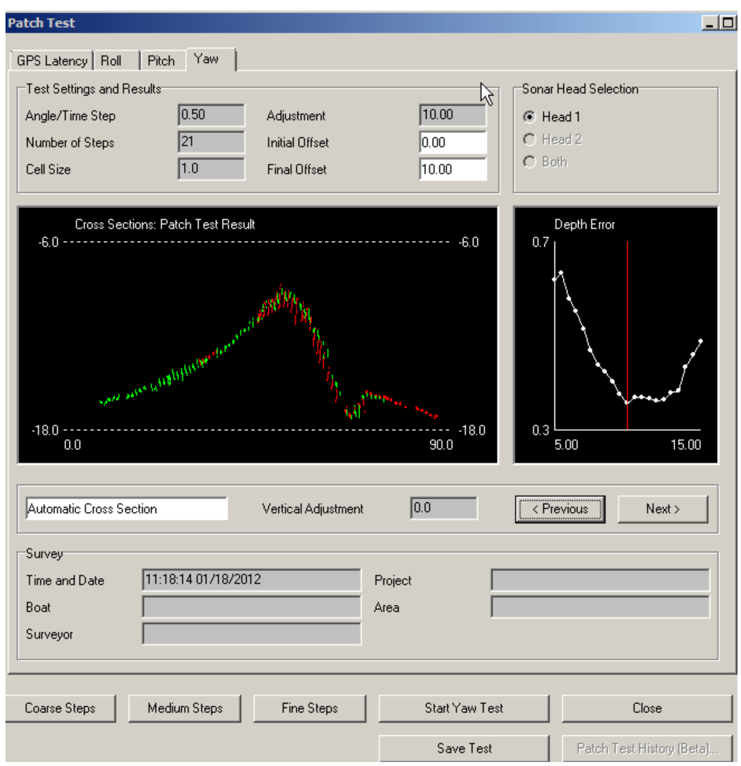



**Figure D4. Patch Test: Yaw 1/18/12**

## Appendix E:  NGS Data Sheets for Local Benchmarks


**MINER RESET Bench Mark**
**used as survey control.**


MINER NO 3 Bench Mark
was not used for this project
but it is nearby and may be
confused for “MINER RESET”

# The NGS Data Sheet

**See file dsdata.txt for more information about the datasheet.**

```
DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4.2
1        National Geodetic Survey,   Retrieval Date = DECEMBER 30, 2011
 JS4374 *********************************************************************
 JS4374  HT_MOD       -  This is a Height Modernization Survey Station.
 JS4374  DESIGNATION -  MINER RESET
 JS4374  PID         -  JS4374
 JS4374  STATE/COUNTY-  CA/SOLANO
 JS4374  USGS QUAD   -  RIO VISTA (1993)
 JS4374
 JS4374                         *CURRENT SURVEY CONTROL
 JS4374  ___________________________________________________________________
 JS4374* NAD 83(2007)-  38 14 58.02481(N)    121 39 22.98902(W)     ADJUSTED
 JS4374* NAVD 88     -         7.54   (meters)      24.7    (feet)  GPS OBS
 JS4374  ___________________________________________________________________
 JS4374  EPOCH DATE  -        2007.00
 JS4374  X           -  -2,632,157.345 (meters)                     COMP
 JS4374  Y           -  -4,269,091.240 (meters)                     COMP
 JS4374  Z           -   3,927,210.755 (meters)                     COMP
 JS4374  LAPLACE CORR-          4.33  (seconds)                     DEFLEC09
 JS4374  ELLIP HEIGHT-        -24.413 (meters)          (02/10/07) ADJUSTED
 JS4374  GEOID HEIGHT-        -32.00  (meters)                      GEOID09
 JS4374
 JS4374  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 JS4374  Type    PID    Designation                       North   East  Ellip
 JS4374  -------------------------------------------------------------------
 JS4374  NETWORK JS4374 MINER RESET                         0.41   0.37   1.06
 JS4374  -------------------------------------------------------------------
 JS4374
 JS4374.The horizontal coordinates were established by GPS observations
 JS4374.and adjusted by the National Geodetic Survey in February 2007.
 JS4374
 JS4374.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
 JS4374.See National Readjustment for more information.
 JS4374.The horizontal coordinates are valid at the epoch date displayed above.
 JS4374.The epoch date for horizontal control is a decimal equivalence
 JS4374.of Year/Month/Day.
 JS4374
 JS4374.The orthometric height was determined by GPS observations and a
 JS4374.high-resolution geoid model using precise GPS observation and
 JS4374.processing techniques.
 JS4374
 JS4374.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 JS4374
 JS4374.The Laplace correction was computed from DEFLEC09 derived deflections.
 JS4374
 JS4374.The ellipsoidal height was determined by GPS observations
 JS4374.and is referenced to NAD 83.
 JS4374
 JS4374.The geoid height was determined by GEOID09.
 JS4374
 JS4374;                   North         East     Units Scale Factor Converg.
```

```
JS4374;SPC CA 2     -   564,750.591 2,030,078.491   MT  1.00002008    +0 12 59.9
JS4374;SPC CA 2     - 1,852,852.56  6,660,349.18   sFT  1.00002008    +0 12 59.9
JS4374;SPC CA 3     -   694,785.575 1,898,782.720   MT  0.99996694    -0 42 28.7
JS4374;SPC CA 3     - 2,279,475.67  6,229,589.64   sFT  0.99996694    -0 42 28.7
JS4374;UTM  10      - 4,234,346.257   617,567.565   MT  0.99977023    +0 49 54.9
JS4374
JS4374!             - Elev Factor  x  Scale Factor =  Combined Factor
JS4374!SPC CA 2     -  1.00000383  x   1.00002008  =  1.00002391
JS4374!SPC CA 3     -  1.00000383  x   0.99996694  =  0.99997077
JS4374!UTM  10      -  1.00000383  x   0.99977023  =  0.99977406
JS4374
JS4374:               Primary Azimuth Mark                        Grid Az
JS4374:SPC CA 2     - RYDE WATER TANK                             098 41 02.2
JS4374:SPC CA 3     - RYDE WATER TANK                             099 36 30.8
JS4374:UTM  10      - RYDE WATER TANK                             098 04 07.2
JS4374
JS4374|---------------------------------------------------------------------|
JS4374| PID    Reference Object                     Distance      Geod. Az  |
JS4374|                                                           dddmmss.s |
JS4374| JS4320 WEST CUT W STEEL POWER POLE         APPROX. 8.0 KM 0061002.8 |
JS4374| JS4317 WEST CUT E STEEL POWER POLE         APPROX. 8.0 KM 0072228.1 |
JS4374| JS4291 SAN FRAN RENO AWY BCN 5            APPROX.15.6 KM 0130607.7 |
JS4374| JS4318 MINER SLOUGH W WOOD PWR POLE        APPROX. 2.1 KM 0304801.8 |
JS4374| JS4322 MINER SLOUGH E WOODEN PWR POLE      APPROX. 2.1 KM 0335308.6 |
JS4374| JS4302 UPPER SNODGRASS NE TRANS TOWER      APPROX.15.1 KM 0501605.8 |
JS4374| JS4300 UPPER SNODGRASS SW TRANS TOWER      APPROX.14.9 KM 0502922.8 |
JS4374| JS4308 NE TRANSM TOWER NW OF VORDEN        APPROX. 9.6 KM 0591716.9 |
JS4374| JS4301 SW TRANS TOWER NW OF VORDEN         APPROX. 9.4 KM 0595108.3 |
JS4374| JS4307 LIBBY MC NEIL WATER TANK            APPROX.12.3 KM 0850920.6 |
JS4374| DB4825 MINER RM 1 AZIMUTH                                0872301.1 |
JS4374| JS4341 RYDE WATER TANK                     APPROX. 8.6 KM 0985402.1 |
JS4374| JS4337 HOWARD LANDNG E STEEL POWER POLE    APPROX. 5.3 KM 1134156.6 |
JS4374| DB4826 MINER RM 2                           18.649 METERS 15826     |
JS4374| JS4375 RYER IS FERRY E WOOD PWR POLE       APPROX. 6.8 KM 1815333.6 |
JS4374| JS4377 RYER IS FERRY W WOOD PWR POLE       APPROX. 6.8 KM 1834831.7 |
JS4374| JS4384 LINDSEY SLOUGH S POWER POLE         APPROX. 4.4 KM 2652223.9 |
JS4374| JS4385 LINDSEY SLOUGH N POWER POLE         APPROX. 4.4 KM 2685956.5 |
JS4374| JS4319 SAN FRAN RENO RED AIRWAY BCN 4      APPROX. 7.2 KM 2785833.5 |
JS4374| DB4827 MINER RM 3                             4.087 METERS 33829     |
JS4374|---------------------------------------------------------------------|
JS4374
JS4374                          SUPERSEDED SURVEY CONTROL
JS4374
JS4374  NAD 83(1998)-  38 14 58.02492(N)    121 39 22.98666(W) AD(2002.86) 1
JS4374  ELLIP H (10/28/05)  -24.396  (m)                       GP(2002.86) 4 1
JS4374  NAD 83(1992)-  38 14 58.02286(N)    121 39 22.98351(W) AD(1997.30) 1
JS4374  ELLIP H (07/10/98)  -24.409  (m)                       GP(1997.30) 4 1
JS4374  NAD 83(1992)-  38 14 58.02250(N)    121 39 22.98397(W) AD(1997.30) 1
JS4374  ELLIP H (05/14/98)  -24.320  (m)                       GP(1997.30) 3 1
JS4374  NAD 83(1992)-  38 14 58.02055(N)    121 39 22.97940(W) AD(1991.35) 1
JS4374  ELLIP H (03/08/94)  -24.260  (m)                       GP(1991.35) 4 1
JS4374  NAD 83(1986)-  38 14 58.01745(N)    121 39 22.98149(W) AD(1984.00) 1
JS4374  NAD 27      -  38 14 58.32600(N)    121 39 19.13700(W) AD(       ) 1
JS4374  NAVD 88 (10/28/05)     7.62   (m)          25.0     (f) GPS OBS
JS4374  NAVD 88 (07/10/98)     7.58   (m)          24.9     (f) GPS OBS
JS4374  NAVD 88 (05/14/98)     7.57   (m)          24.8     (f) GPS OBS
JS4374  NGVD 29 (11/03/92)     7.0    (m)          23.      (f) GPS OBS
JS4374
JS4374.Superseded values are not recommended for survey control.
JS4374.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
```

```
JS4374.See file dsdata.txt to determine how the superseded data were derived.
JS4374
JS4374_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SFH1756734346(NAD 83)
JS4374_MARKER: DS = TRIANGULATION STATION DISK
JS4374_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
JS4374_SP_SET: SURROUNDED BY MASS OF CONCRETE
JS4374_STAMPING: MINER 1931 1963
JS4374_MARK LOGO: CGS
JS4374_PROJECTION: RECESSED 20 CENTIMETERS
JS4374_MAGNETIC: N = NO MAGNETIC MATERIAL
JS4374_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
JS4374+STABILITY: SURFACE MOTION
JS4374_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
JS4374+SATELLITE: SATELLITE OBSERVATIONS - April 01, 2011
JS4374
JS4374  HISTORY     - Date     Condition        Report By
JS4374  HISTORY     - 1963     MONUMENTED       CGS
JS4374  HISTORY     - 1932     SEE DESCRIPTION  CGS
JS4374  HISTORY     - 1962     SEE DESCRIPTION  CGS
JS4374  HISTORY     - 1963     SEE DESCRIPTION  CGS
JS4374  HISTORY     - 19911223 GOOD             NOS
JS4374  HISTORY     - 19920110 GOOD
JS4374  HISTORY     - 19970829 GOOD             NGS
JS4374  HISTORY     - 20021122 GOOD             CADWR
JS4374  HISTORY     - 20070329 GOOD             JCLS
JS4374  HISTORY     - 20101110 GOOD             PG+E
JS4374  HISTORY     - 20110401 GOOD             CADWR
JS4374
JS4374                          STATION DESCRIPTION
JS4374
JS4374'DESCRIBED BY COAST AND GEODETIC SURVEY 1932
JS4374'ABOUT 6-1/2 MILES NORTH OF RIO VISTA, 1-1/2 MILES NORTHEAST OF
JS4374'JUNCTION OF MINER AND CACHE SLOUGHS, ON WEST SIDE OF RYER ISLAND,
JS4374'ON EAST LEVEE OF MINER SLOUGH, ONE-HALF MILE NORTH OF ROAD
JS4374'CROSSING RYER ISLAND TO HOWARD LANDING FERRY, 5 METERS (16 FEET)
JS4374'WEST OF CENTER LINE OF LEVEE ROAD, AND 9.5 METERS (31 FEET) SOUTH
JS4374'OF DITCH LINE EXTENDED.  TO REACH FROM WEST END OF RIO VISTA
JS4374'BRIDGE, GO NORTH ALONG RIVER 2.2 MILES TO FERRY, CROSS CACHE SLOUGH
JS4374'BY FERRY TO RYER ISLAND, TURN LEFT ONTO LEVEE ROAD, AND GO
JS4374'5.0 MILES TO STATION SITE.  SURFACE AND UNDERGROUND MARKS
JS4374'ARE STANDARD STATION DISKS IN CONCRETE, NOTES 1A AND 7A.
JS4374'REFERENCE MARKS ARE STANDARD REFERENCE DISKS IN CONCRETE, NOTE
JS4374'11A.  NO. 1 IS ON SOUTH SIDE OF ROAD RUNNING ACROSS ISLAND
JS4374'AND ABOUT ONE-HALF MILE FROM STATION IN AZIMUTH 267 DEG 23 MIN
JS4374'02 SEC.  NO. 2 IS ON LEVEE AND 18.60 METERS (61.0 FEET)
JS4374'FROM STATION IN AZIMUTH 338 DEG 28 MIN.  GABLE OF SMALL PUMP
JS4374'HOUSE IS 10.2 METERS (33 FEET) FROM STATION IN AZIMUTH 45 DEG
JS4374'00 MIN.
JS4374
JS4374                          STATION RECOVERY (1962)
JS4374
JS4374'RECOVERY NOTE BY COAST AND GEODETIC SURVEY 1962 (IRR)
JS4374'THE TOP OF THE SURFACE-STATION MARK CONCRETE POST WAS FOUND BROKEN
JS4374'OFF AND MISSING SO THE POST WAS REMOVED AND THE UNDERGROUND-STATION
JS4374'MARK WAS RECOVERED IN GOOD CONDITION.  THE SURFACE-STATION MARK
JS4374'POST WAS THEN REPLACED AND A DISK WAS CEMENTED IN A DRILL HOLE
JS4374'IN THE TOP OF THE POST DIRECTLY OVER THE UNDERGROUND-STATION
JS4374'MARK.  REFERENCE MARK NUMBER 2 WAS RECOVERED IN GOOD CONDITION BUT
JS4374'REFERENCE MARK NUMBER 1 WAS NOT FOUND AND HAS PROBABLY
JS4374'BEEN DESTROYED BY WORK ON THE IRRIGATION DITCH IT WAS
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```
JS4374'NEAR.  REFERENCE MARK NUMBER 3 WAS SET ON THIS DATE.
JS4374'
JS4374'THE STATION IS LOCATED ABOUT 6-1/2 MILES NORTH OF RIO VISTA,
JS4374'1-1/2 MILES NORTHEAST OF THE JUNCTION OF MINER AND CACHE
JS4374'SLOUGHS, 1/2 MILE NORTH OF THE ROAD CROSSING RYER ISLAND EAST TO
JS4374'HOWARD LANDING FERRY, ON THE WEST SIDE OF RYER ISLAND, AND ON
JS4374'THE EAST LEVEE OF MINER SLOUGH.
JS4374'
JS4374'TO REACH THE STATION FROM THE WEST END OF THE RIO VISTA BRIDGE
JS4374'GO NORTHEAST ALONG THE NORTHWEST SIDE OF THE SACRAMENTO RIVER
JS4374'2.3 MILES TO THE RYER FERRY.  CROSS OVER THE RIVER TO RYER ISLAND
JS4374'AND GO NORTH ALONG THE LEVEE ROAD 5.3 MILES TO A WITNESS POST
JS4374'AND THE STATION ON THE LEFT.
JS4374'
JS4374'THE SURFACE-STATION MARK IS A COAST AND GEODETIC SURVEY TRIANGULATION
JS4374'STATION DISK STAMPED MINER 1931 1962 CEMENTED IN A DRILL HOLE IN
JS4374'A DEPRESSION IN THE TOP OF A 12-INCH SQUARE CONCRETE POST FLUSH
JS4374'WITH THE GROUND.  IT IS 33.1 FEET NORTHEAST OF THE NORTHEAST
JS4374'CORNER OF A SMALL CORRUGATED METAL COVERED PUMP HOUSE; 50 FEET
JS4374'NORTHEAST OF THE INTERSECTION OF A FARM ROAD, AND 15.5 FEET WEST
JS4374'OF THE CENTERLINE OF THE ROAD.
JS4374'
JS4374'REFERENCE MARK NUMBER 2 IS A COAST AND GEODETIC SURVEY REFERENCE
JS4374'MARK DISK STAMPED MINER NO 2 1931 SET IN THE TOP OF AN 8-INCH
JS4374'SQUARE CONCRETE POST THAT PROJECTS 2 INCHES ABOVE THE GROUND.  IT
JS4374'IS 21.2 FEET SOUTH OF A 10-INCH PIPE RUNNING UNDER THE ROAD,
JS4374'13.3 FEET EAST OF THE CENTERLINE OF THE ROAD, AND ABOUT 1 FOOT
JS4374'LOWER THAN THE STATION MARK.
JS4374'
JS4374'REFERENCE MARK NUMBER 3 IS A COAST AND GEODETIC SURVEY REFERENCE
JS4374'MARK DISK STAMPED MINER NO 3 1931 1962 SET IN THE TOP OF A 12-INCH
JS4374'CONCRETE CYLINDER THAT IS FLUSH WITH THE GROUND.  IT IS 41.6
JS4374'FEET NORTH OF THE NORTHEAST CORNER OF THE PUMP HOUSE, 21.5 FEET
JS4374'WEST OF THE CENTERLINE OF THE ROAD, ABOUT THE SAME ELEVATION AS
JS4374'THE STATION, 1.7 FEET NORTH OF A WOODEN WITNESS POST, AND
JS4374'DIRECTLY ON LINE WITH THE STATION MARK AND REFERENCE MARK
JS4374'NUMBER 2.
JS4374
JS4374                          STATION RECOVERY (1963)
JS4374
JS4374'RECOVERY NOTE BY COAST AND GEODETIC SURVEY 1963 (SJD)
JS4374'THE SURFACE STATION MARK WAS FOUND TILTED SHARPLY TO ONE SIDE.  IT
JS4374'WAS REMOVED AND THE UNDERGROUND STATION MARK WAS RECOVERED IN GOOD
JS4374'CONDITION.  A NEW SURFACE STATION MARK WAS SET ON THIS DATE
JS4374'DIRECTLY OVER THE UNDERGROUND STATION MARK.  REFERENCE MARKS
JS4374'NUMBER 2 AND 3 WERE RECOVERED IN GOOD CONDITION.  THE 1962
JS4374'DESCRIPTION IS ADEQUATE WITH THE FOLLOWING ADDITIONS--
JS4374'
JS4374'THE UNDERGROUND STATION MARK IS A COAST AND GEODETIC SURVEY
JS4374'TRIANGULATION STATION DISK STAMPED MINER 1931 SET IN THE TOP OF
JS4374'A BLOCK OF CONCRETE 2.7 FEET BELOW THE SURFACE OF THE GROUND.
JS4374'
JS4374'THE SURFACE STATION MARK IS A COAST AND GEODETIC SURVEY
JS4374'TRIANGULATION STATION DISK STAMPED MINER 1931 1963 SET IN THE
JS4374'TOP OF A 12-INCH CONCRETE CYLINDER 0.4 FEET BELOW THE SURFACE
JS4374'OF THE GROUND.
JS4374
JS4374                          STATION RECOVERY (1991)
JS4374
JS4374'RECOVERY NOTE BY NATIONAL OCEAN SERVICE 1991
```

```
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (1992)
JS4374
JS4374'RECOVERED 1992
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (1997)
JS4374
JS4374'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (JDD)
JS4374'THE STATION WAS RECOVERED AND AN ALTERNATIVE TO REACH FOLLOWS.  TO
JS4374'REACH THE STATION FROM THE COMMUNITY OF RYDE ON GRAND ISLAND GO
JS4374'SOUTHWESTERLY ON STATE HIGHWAY 220 FOR 3.0 MI (4.8 KM) TO A
JS4374'T-INTERSECTION, GRAND ISLAND ROAD.  TURN RIGHT AND GO NORTH ON GRAND
JS4374'ISLAND ROAD FOR ABOUT 0.5 MI (0.8 KM) TO THE HOWARD LANDING FERRY.
JS4374'TAKE THE HOWARD LANDING FERRY TO RYER ISLAND.  CONTINUE WEST ON
JS4374'HIGHWAY 220 FOR 3.05 MI (4.91 KM) TO A T-INTERSECTION, HIGHWAY 84.
JS4374'TURN RIGHT AND GO NORTH ON HIGHWAY 84 FOR 0.5 MI (0.8 KM) TO THE
JS4374'STATION ON THE LEFT.  THE CORRUGATED METAL SHACK INDICATED IN THE
JS4374'ORIGINAL DESCRIPTION IS MOSTLY COLLAPSED.  THE STATION IS 7 FT (2.1 M)
JS4374'EAST OF A WITNESS POST.  IT IS ABOUT 1 FT (0.3 M) LOWER THAN THE ROAD
JS4374'AND ABOUT 0.5 FT (0.2 M) BELOW THE SURFACE.  THE STATION WAS OCCUPIED
JS4374'AS PART OF THE SAN JOAQUIN-SACRAMENTO RIVER DELTA GPS/VERTICAL
JS4374'PROJECT.
JS4374
JS4374                          STATION RECOVERY (2002)
JS4374
JS4374'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
JS4374'RECOVERED AS DESCRIBED. THE STATION WAS OBSERVED AS PART OF THE DWR
JS4374'DELTA 2002 SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
JS4374
JS4374                          STATION RECOVERY (2007)
JS4374
JS4374'RECOVERY NOTE BY JOHN CHANCE LAND SURVEYS INC 2007 (MRY)
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (2010)
JS4374
JS4374'RECOVERY NOTE BY PACIFIC GAS AND ELECTRIC COMPANY 2010 (DPM)
JS4374'RECOVERED IN GOOD CONDITION.
JS4374
JS4374                          STATION RECOVERY (2011)
JS4374
JS4374'RECOVERY NOTE BY CA DEPT OF WATER RES 2011 (GS)
JS4374'RECOVERED AS DESCRIBED.

*** retrieval complete.
Elapsed Time = 00:00:01
```

# The NGS Data Sheet

**See file ds data.txt for more information about the datasheet.**

```
DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4.2
1        National Geodetic Survey,   Retrieval Date = DECEMBER 30, 2011
 JS2070 ***********************************************************************
 JS2070  HT_MOD       -  This is a Height Modernization Survey Station.
 JS2070  DESIGNATION -  SUTTER RESET
 JS2070  PID          -  JS2070
 JS2070  STATE/COUNTY-  CA/SACRAMENTO
 JS2070  USGS QUAD    -  ISLETON (1993)
 JS2070
 JS2070                          *CURRENT SURVEY CONTROL
 JS2070  ___________________________________________________________________
 JS2070* NAD 83(2007)-  38 14 51.69271(N)     121 36 03.38844(W)     ADJUSTED
 JS2070* NAVD 88      -          6.84   (meters)       22.4    (feet)  GPS OBS
 JS2070  ___________________________________________________________________
 JS2070  EPOCH DATE   -         2007.00
 JS2070  X            -  -2,628,088.052 (meters)                        COMP
 JS2070  Y            -  -4,271,738.920 (meters)                        COMP
 JS2070  Z            -   3,927,057.073 (meters)                        COMP
 JS2070  LAPLACE CORR-             5.59  (seconds)                       DEFLEC09
 JS2070  ELLIP HEIGHT-          -24.984 (meters)            (02/10/07) ADJUSTED
 JS2070  GEOID HEIGHT-          -31.85  (meters)                        GEOID09
 JS2070
 JS2070  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 JS2070  Type    PID    Designation                         North   East  Ellip
 JS2070  -------------------------------------------------------------------
 JS2070  NETWORK JS2070 SUTTER RESET                         0.25   0.27   0.88
 JS2070  -------------------------------------------------------------------
 JS2070
 JS2070.The horizontal coordinates were established by GPS observations
 JS2070.and adjusted by the National Geodetic Survey in February 2007.
 JS2070
 JS2070.The datum tag of NAD 8.(2007) is equivalent to NAD 83(NSRS2007).
 JS2070.See National Readjustment for more information.
 JS2070.The horizontal coordinates are valid at the epoch date displayed above.
 JS2070.The epoch date for horizontal control is a decimal equivalence
 JS2070.of Year/Month/Day.
 JS2070
 JS2070.The orthometric height was determined by GPS observations and a
 JS2070.high-resolution geoid model using precise GPS observation and
 JS2070.processing techniques.
 JS2070
 JS2070.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 JS2070
 JS2070.The Laplace correction was computed from DEFLEC09 derived deflections.
 JS2070
 JS2070.The ellipsoidal height was determined by GPS observations
 JS2070.and is referenced to NAD 83.
 JS2070
```

```
JS2070.The geoid height was determined by GEOID09.
JS2070
JS2070;                    North         East     Units Scale Factor Converg.
JS2070;SPC CA 2     -   564,575.179 2,034,932.699   MT  1.00002052   +0 15 05.7
JS2070;SPC CA 2     - 1,852,277.07  6,676,275.03   sFT  1.00002052   +0 15 05.7
JS2070;UTM  10      - 4,234,222.083   622,422.196   MT  0.99978458   +0 51 58.4
JS2070
JS2070!             -  Elev Factor  x  Scale Factor =   Combined Factor
JS2070!SPC CA 2     -   1.00000392  x   1.00002052  =   1.00002444
JS2070!UTM  10      -   1.00000392  x   0.99978458  =   0.99978850
JS2070
JS2070                          SUPERSEDED SURVEY CONTROL
JS2070
JS2070  NAD 83(1998)-  38 14 51.69257(N)    121 36 03.38594(W) AD(2002.86) B
JS2070  ELLIP H (10/28/05)  -24.967  (m)                       GP(2002.86) 4 1
JS2070  NAD 83(1998)-  38 14 51.69295(N)    121 36 03.38659(W) AD(2004.69) A
JS2070  ELLIP H (09/13/05)  -24.978  (m)                       GP(2004.69) 4 1
JS2070  NAD 83(1992)-  38 14 51.69055(N)    121 36 03.38291(W) AD(1997.30) 1
JS2070  ELLIP H (07/10/98)  -24.980  (m)                       GP(1997.30) 4 1
JS2070  NAD 83(1992)-  38 14 51.69019(N)    121 36 03.38336(W) AD(1997.30) 1
JS2070  ELLIP H (05/14/98)  -24.891  (m)                       GP(1997.30) 3 1
JS2070  NAVD 88 (10/28/05)     6.92   (m)           22.7    (f) GPS OBS
JS2070  NAVD 88 (07/10/98)     6.87   (m)           22.5    (f) GPS OBS
JS2070  NAVD 88 (05/14/98)     6.85   (m)           22.5    (f) GPS OBS
JS2070  NGVD 29 (08/19/04)     6.16   (m)           20.2    (f) RESET        3
JS2070
JS2070.Superseded values are not recommended for survey control.
JS2070.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JS2070.See file dsdata.txt to determine how the superseded data were derived.
JS2070
JS2070_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SFH2242234222(NAD 83)
JS2070_MARKER: DS = TRIANGULATION STATION DISK
JS2070_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
JS2070_SP_SET: SET IN TOP OF CONCRETE MONUMENT
JS2070_STAMPING: SUTTER 1931 1970
JS2070_MARK LOGO: CGS
JS2070_PROJECTION: PROJECTING 3 CENTIMETERS
JS2070_MAGNETIC: N = NO MAGNETIC MATERIAL
JS2070_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
JS2070+STABILITY: SURFACE MOTION
JS2070_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
JS2070+SATELLITE: SATELLITE OBSERVATIONS - April 01, 2011
JS2070
JS2070  HISTORY     - Date     Condition        Report By
JS2070  HISTORY     - 1970     MONUMENTED       NGS
JS2070  HISTORY     - 19970829 GOOD             NGS
JS2070  HISTORY     - 20021105 GOOD             CADWR
JS2070  HISTORY     - 20021122 GOOD             CADWR
JS2070  HISTORY     - 20030820 GOOD             CADT
JS2070  HISTORY     - 20041005 GOOD             CADT
JS2070  HISTORY     - 20110401 GOOD             CADWR
JS2070
JS2070                          STATION DESCRIPTION
JS2070
JS2070'DESCRIBED BY NATIONAL GEODETIC SURVEY 1970
JS2070'4 MI NW FROM RYDE.
JS2070'2.75 MILES WEST ALONG A COUNTY PAVED ROAD FROM THE POST OFFICE
```

```
JS2070'AT RYDE, THENCE 1.25 MILES NORTH ALONG A PAVED LEVEE ROAD,
JS2070'0.8 MILE NORTH OF THE EAST END OF THE HOWARD LANDING FERRY
JS2070'(RYER ISLAND FERRY), 119 YARDS NORTH OF THE JUNCTION OF A
JS2070'FARM DRIVEWAY LEADING NORTHEAST, 20.0 FEET WEST OF AND ABOUT
JS2070'2 FEET LOWER THAN THE LEVEE ROAD, 2.0 FEET SOUTHWEST OF A
JS2070'METAL WITNESS POST, AND SET IN THE TOP OF A CONCRETE POST
JS2070'PROJECTING 0.1 FOOT ABOVE THE GROUND.
JS2070
JS2070                          STATION RECOVERY (1997)
JS2070
JS2070'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (JDD)
JS2070'THE STATION WAS RECOVERED AND SOME ADDITIONAL INFORMATION FOLLOWS. THE
JS2070'STATION IS ABOUT 5.5 MI (8.9 KM) NORTH OF ISLETON, 5.5 MI (8.9 KM)
JS2070'SOUTH OF COURTLAND, 5 MI (8.0 KM) WEST OF WALNUT GROVE AND ABOUT 3 MI
JS2070'(4.8 KM) WEST OF THE SMALL COMMUNITY OF RYDE.  TO REACH THE STATION
JS2070'FROM THE INTERSECTION OF STATE HIGHWAYS 220 AND 160 IN RYDE GO
JS2070'WESTERLY ON HIGHWAY 220 FOR ABOUT 3 MI (4.8 KM) TO A T-INTERSECTION,
JS2070'GRAND ISLAND ROAD.  TURN RIGHT AND GO NORTH ON GRAND ISLAND ROAD FOR
JS2070'0.45 MI (0.72 KM) TO THE HOWARD LANDING FERRY. CONTINUE NORTH ON GRAND
JS2070'ISLAND ROAD FOR 0.8 MI (1.3 KM) TO THE STATION ON THE LEFT.  THE
JS2070'STATION IS ABOUT 235 FT (71.6 M) SOUTH OF A GUYED TELEPHONE POLE, 200
JS2070'FT (61.0 M) SOUTH OF THE EXTENDED CENTERLINE OF A GRAVEL DRIVEWAY,
JS2070'20.5 FT (6.2 M) WEST OF THE CENTERLINE OF GRAND ISLAND ROAD, 1.7 FT
JS2070'(0.5 M) EAST OF A CARSONITE WITNESS POST AND ABOUT 2 FT (0.6 M) LOWER
JS2070'THAN THE ROAD. NOTE-REFERENCE MARKS 2 AND 3 WERE RECOVERED.  REFERENCE
JS2070'MARK 2 IS 36.3 FT (11.1 M) SOUTH-SOUTHEAST OF THE STATION.  REFERENCE
JS2070'MARK 3 IS 27.1 FT (8.3 M) SOUTH OF THE STATION.  THE STATION WAS
JS2070'OCCUPIED AS PART OF THE SAN JOAQUIN-SACRAMENTO RIVER DELTA
JS2070'GPS/VERTICAL PROJECT.
JS2070
JS2070                          STATION RECOVERY (2002)
JS2070
JS2070'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
JS2070'RECOVERED AS DESCRIBED. THE STATION WAS OBSERVED AS PART OF THE DWR
JS2070'DELTA 2002 SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
JS2070
JS2070                          STATION RECOVERY (2002)
JS2070
JS2070'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
JS2070'RECOVERED AS DESCRIBED. THE STATION WAS OBSERVED AS PART OF THE DWR
JS2070'DELTA 2002 SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
JS2070
JS2070                          STATION RECOVERY (2003)
JS2070
JS2070'RECOVERY NOTE BY CALTRANS 2003 (RLM)
JS2070'THE STATION, REFERENCE MARK NO. 2, AND REFERENCE MARK NO. 3 WERE
JS2070'RECOVERED AS  DESCRIBED AND FOUND IN GOOD CONDITION. THIS STATION WAS
JS2070'OCCUPIED AS PART OF A CALTRANS  NORTH REGION OFFICE OF SURVEYORS GPS
JS2070'HEIGHT MODERNIZATION PROJECT.
JS2070
JS2070                          STATION RECOVERY (2004)
JS2070
JS2070'RECOVERY NOTE BY CALTRANS 2004 (RLM)
JS2070'THE STATION, REFERENCE MARK NO. 2, AND REFERENCE MARK NO. 3 WERE
JS2070'RECOVERED AS  DESCRIBED AND FOUND IN GOOD CONDITION. THIS STATION WAS
JS2070'OCCUPIED AS PART OF A CALTRANS  NORTH REGION OFFICE OF SURVEYORS GPS
JS2070'HEIGHT MODERNIZATION PROJECT.
```

```
AE9850;SPC CA 2     -   575,326.045 2,032,414.000   MT  0.99999746    +0 14 01.6
AE9850;SPC CA 2     - 1,887,548.87  6,668,011.60   sFT  0.99999746    +0 14 01.6
AE9850;UTM  10      - 4,244,943.717   619,788.718   MT  0.99977672    +0 51 01.9
AE9850
AE9850!             -  Elev Factor  x  Scale Factor =   Combined Factor
AE9850!SPC CA 2     -   1.00000478  x   0.99999746  =   1.00000224
AE9850!UTM  10      -   1.00000478  x   0.99977672  =   0.99978150
AE9850
AE9850                          SUPERSEDED SURVEY CONTROL
AE9850
AE9850  NAD 83(1998)-  38 20 40.70187(N)    121 37 45.16300(W) AD(2002.86) 1
AE9850  ELLIP H (10/28/05)  -30.432  (m)                       GP(2002.86) 4 1
AE9850  NAD 83(1992)-  38 20 40.69998(N)    121 37 45.16006(W) AD(1997.30) 1
AE9850  ELLIP H (07/10/98)  -30.460  (m)                       GP(1997.30) 4 1
AE9850  NAD 83(1992)-  38 20 40.69964(N)    121 37 45.16050(W) AD(1997.30) 1
AE9850  ELLIP H (05/14/98)  -30.370  (m)                       GP(1997.30) 3 1
AE9850  NAVD 88 (10/28/05)    1.25   (m)            4.1     (f) GPS OBS
AE9850  NAVD 88 (07/10/98)    1.21   (m)            4.0     (f) GPS OBS
AE9850  NAVD 88 (05/14/98)    1.20   (m)            3.9     (f) GPS OBS
AE9850
AE9850.Superseded values are not recommended for survey control.
AE9850.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AE9850.See file dsdata.txt to determine how the superseded data were derived.
AE9850
AE9850_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SFH1978844943(NAD 83)
AE9850_MARKER: DD = SURVEY DISK
AE9850_SETTING: 50 = ALUMINUM ALLOY ROD W/O SLEEVE (10 FT.+)
AE9850_STAMPING: RYER 1997
AE9850_MARK LOGO: BOR
AE9850_PROJECTION: RECESSED 6 CENTIMETERS
AE9850_MAGNETIC: N = NO MAGNETIC MATERIAL
AE9850_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AE9850_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AE9850+SATELLITE: SATELLITE OBSERVATIONS - April 01, 2011
AE9850_ROD/PIPE-DEPTH: 3.10 meters
AE9850
AE9850  HISTORY     - Date     Condition        Report By
AE9850  HISTORY     - 1997     MONUMENTED       BOR
AE9850  HISTORY     - 20021122 GOOD             CADWR
AE9850  HISTORY     - 20110401 GOOD             CADWR
AE9850
AE9850                          STATION DESCRIPTION
AE9850
AE9850'DESCRIBED BY US BUREAU OF RECLAMATION 1997 (DWS)
AE9850'THE STATION IS LOCATED ABOUT 18 MI (29.0 KM) SOUTH-SOUTHWEST OF
AE9850'SACRAMENTO, ABOUT 9 MI (14.5 KM) NORTHWEST OF WALNUT GROVE AND ABOUT
AE9850'3.5 MI (5.6 KM) WEST OF COURTLAND.  TO REACH THE STATION FROM THE
AE9850'COMMUNITY OF COURTLAND, GO SOUTH ON HIGHWAY 160 FOR ABOUT 0.5 MI (0.8
AE9850'KM) TO A SIDE ROAD RIGHT, WHERE HIGHWAY 160 CROSSES THE SACRAMENTO
AE9850'RIVER.  TURN RIGHT, CROSSING THE RIVER ON THE HIGHWAY 160 BRIDGE TO A
AE9850'T-INTERSECTION, HIGHWAY 160 TO THE SOUTH AND SOUTH RIVER ROAD TO THE
AE9850'NORTH (RIGHT) .  TURN RIGHT AND GO NORTHERLY ON SOUTH RIVER ROAD FOR
AE9850'ABOUT 1.4 MI (2.3 KM) TO A SIDE ROAD LEFT, COURTLAND ROAD.  TURN LEFT
AE9850'AND GO NORTHWEST AND THEN WEST ON COURTLAND ROAD FOR ABOUT 3.5 MI (5.6
AE9850'KM) TO A SIDE ROAD LEFT, RYER AVENUE AND THE STATION ON THE RIGHT.
AE9850'THE STATION IS ABOUT 56 FT (17.1 M) NORTHWEST OF THE CENTERLINE OF
AE9850'COURTLAND ROAD, ABOUT 35 FT (10.7 M) SOUTH OF A ROW OF TREES AND ABOUT
AE9850'2.8 FT (0.9 M) SOUTH OF A CARSONITE WITNESS POST.  THE STATION WAS
AE9850'OCCUPIED AS PART OF THE SAN JOAQUIN-SACRAMENTO RIVER DELTA
AE9850'GPS/VERTICAL PROJECT.
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AE9850
AE9850                          STATION RECOVERY (2002)
AE9850
AE9850'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
AE9850'RECOVERED AS DESCRIBED. THE STATION WAS OBSERVED AS PART OF THE DWR
AE9850'DELTA 2002 SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
AE9850
AE9850                          STATION RECOVERY (2011)
AE9850
AE9850'RECOVERY NOTE BY CA DEPT OF WATER RES 2011 (GS)
AE9850'RECOVERED AS DESCRIBED.

*** retrieval complete.
Elapsed Time = 00:00:01
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# The NGS Data Sheet

**See file dsdata.txt for more information about the datasheet.**

```
DATABASE = NGSIDB , PROGRAM = datasheet95, VERSION = 7.87.4.2
1        National Geodetic Survey,   Retrieval Date = DECEMBER 30, 2011
 JS2048 ***********************************************************************
 JS2048  HT_MOD       -  This is a Height Modernization Survey Station.
 JS2048  DESIGNATION -  B 474
 JS2048  PID          -  JS2048
 JS2048  STATE/COUNTY-  CA/SOLANO
 JS2048  USGS QUAD    -  RIO VISTA (1993)
 JS2048
 JS2048                         *CURRENT SURVEY CONTROL
 JS2048  ___________________________________________________________________
 JS2048* NAD 83(2007)-  38 12 00.97001(N)     121 42 49.65999(W)     ADJUSTED
 JS2048* NAVD 88      -         7.66   (meters)      25.1    (feet)  GPS OBS
 JS2048  ___________________________________________________________________
 JS2048  EPOCH DATE   -          2007.00
 JS2048  X            -  -2,638,209.154 (meters)                     COMP
 JS2048  Y            -  -4,269,325.205 (meters)                     COMP
 JS2048  Z            -   3,922,922.009 (meters)                     COMP
 JS2048  LAPLACE CORR-            2.03  (seconds)                    DEFLEC09
 JS2048  ELLIP HEIGHT-          -24.506 (meters)         (02/10/07)  ADJUSTED
 JS2048  GEOID HEIGHT-          -32.19  (meters)                     GEOID09
 JS2048
 JS2048  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 JS2048  Type     PID    Designation                     North   East  Ellip
 JS2048  -------------------------------------------------------------------
 JS2048  NETWORK JS2048 B 474                              0.41   0.33   1.00
 JS2048  -------------------------------------------------------------------
 JS2048
 JS2048.The horizontal coordinates were established by GPS observations
 JS2048.and adjusted by the National Geodetic Survey in February 2007.
 JS2048
 JS2048.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
 JS2048.See National Readjustment for more information.
 JS2048.The horizontal coordinates are valid at the epoch date displayed above.
 JS2048.The epoch date for horizontal control is a decimal equivalence
 JS2048.of Year/Month/Day.
 JS2048
 JS2048.The orthometric height was determined by GPS observations and a
 JS2048.high-resolution geoid model using precise GPS observation and
 JS2048.processing techniques.
 JS2048
 JS2048.Photographs are available for this station.
 JS2048
 JS2048.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 JS2048
 JS2048.The Laplace correction was computed from DEFLEC09 derived deflections.
 JS2048
 JS2048.The ellipsoidal height was determined by GPS observations
```

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JS2048.and is referenced to NAD 83.
JS2048
JS2048.The geoid height was determined by GEOID09.
JS2048
JS2048;                     North         East     Units Scale Factor Converg.
JS2048;SPC CA 2       559,273.835 2,025,070.403   MT  1.00003283   +0 10 49.6
JS2048;SPC CA 2     - 1,834,884.24  6,643,918.48   sFT  1.00003283   +0 10 49.6
JS2048;UTM  10      - 4,228,817.504   612,619.868   MT  0.99975620   +0 47 43.8
JS2048
JS2048!             -  Elev Factor  x  Scale Factor =   Combined Factor
JS2048!SPC CA 2     -   1.00000385  x   1.00003283  =   1.00003668
JS2048!UTM  10      -   1.00000385  x   0.99975620  =   0.99976004
JS2048
JS2048                          SUPERSEDED SURVEY CONTROL
JS2048
JS2048  NAD 83(1998)-  38 12 00.97016(N)    121 42 49.65766(W) AD(2002.86) 1
JS2048  ELLIP H (10/28/05)  -24.487  (m)                       GP(2002.86) 4 1
JS2048  NAD 83(1992)-  38 12 00.96850(N)    121 42 49.65506(W) AD(1997.30) 1
JS2048  ELLIP H (07/10/98)  -24.515  (m)                       GP(1997.30) 4 1
JS2048  NAD 83(1992)-  38 12 00.96813(N)    121 42 49.65564(W) AD(1997.30) 1
JS2048  ELLIP H (05/14/98)  -24.430  (m)                       GP(1997.30) 3 1
JS2048  NAVD 88 (10/28/05)     7.74   (m)           25.4    (f) GPS OBS
JS2048  NAVD 88 (07/10/98)     7.67   (m)           25.2    (f) GPS OBS
JS2048  NAVD 88 (05/14/98)     7.65   (m)           25.1    (f) GPS OBS
JS2048  NGVD 29 (??/??/92)     6.972  (m)           22.87   (f) ADJ UNCH    2 0
JS2048
JS2048.Superseded values are not recommended for survey control.
JS2048.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
JS2048.See file dsdata.txt to determine how the superseded data were derived.
JS2048
JS2048_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SFH1261928817(NAD 83)
JS2048_MARKER: DB = BENCH MARK DISK
JS2048_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
JS2048_SP_SET: SET IN TOP OF CONCRETE MONUMENT
JS2048_STAMPING: B 474 1951
JS2048_MARK LOGO: CGS
JS2048_PROJECTION: PROJECTING 15 CENTIMETERS
JS2048_MAGNETIC: N = NO MAGNETIC MATERIAL
JS2048_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
JS2048+STABILITY: SURFACE MOTION
JS2048_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
JS2048+SATELLITE: SATELLITE OBSERVATIONS - April 01, 2011
JS2048
JS2048  HISTORY     - Date     Condition        Report By
JS2048  HISTORY     - 1951     MONUMENTED       CGS
JS2048  HISTORY     - 1966     GOOD             CGS
JS2048  HISTORY     - 1989     GOOD             USPSQD
JS2048  HISTORY     - 19970916 GOOD             NGS
JS2048  HISTORY     - 20020904 GOOD             CADWR
JS2048  HISTORY     - 20041203 GOOD             USPSQD
JS2048  HISTORY     - 20101110 GOOD             PG+E
JS2048  HISTORY     - 20110401 GOOD             CADWR
JS2048
JS2048                          STATION DESCRIPTION
JS2048
JS2048'DESCRIBED BY COAST AND GEODETIC SURVEY 1951
JS2048'4 MI S FROM HASTINGS ISLAND FERRY.
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JS2048'4.0 MILES SOUTH ALONG A PAVED COUNTY ROAD FROM HASTINGS ISLAND
JS2048'FERRY, AND 4.3 MILES NORTHEAST OF RIO VISTA, 101.0 FEET NORTHWEST
JS2048'OF THE NORTHWEST CORNER OF THE NORTHERN ONE OF A GROUP OF FARM
JS2048'HOUSES, 37.0 FEET NORTH OF THE CENTER LINE OF THE NORTH DRIVEWAY
JS2048'LEADING TO THE HOUSES, 22.0 FEET EAST OF THE CENTER LINE OF THE
JS2048'MAIN ROAD, ABOUT 1 FOOT HIGHER THAN THE ROAD, AND SET IN THE
JS2048'TOP OF A CONCRETE POST PROJECTING 0.5 FEET.
JS2048
JS2048                          STATION RECOVERY (1966)
JS2048
JS2048'RECOVERY NOTE BY COAST AND GEODETIC SURVEY 1966
JS2048'RECOVERED IN GOOD CONDITION.
JS2048
JS2048                          STATION RECOVERY (1989)
JS2048
JS2048'RECOVERY NOTE BY US POWER SQUADRON 1989 (TM)
JS2048'RECOVERED IN GOOD CONDITION.
JS2048
JS2048                          STATION RECOVERY (1997)
JS2048
JS2048'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (JDD)
JS2048'THE STATION WAS RECOVERED AND A COMPLETE NEW DESCRIPTION FOLLOWS.  TO
JS2048'REACH THE STATION FROM THE NORTHWEST END OF THE RIO VISTA BRIDGE, IN
JS2048'RIO VISTA, GO NORTHWEST ON HIGHWAY 12 FOR 1.2 MI (1.9 KM) TO THE
JS2048'INTERSECTION OF CHURCH ROAD ON THE RIGHT AND AMERADA ROAD (UNMARKED)
JS2048'ON THE LEFT.  TURN RIGHT ON CHURCH ROAD AND GO NORTHEAST FOR 1.0 MI
JS2048'(1.6 KM) TO A T-INTERSECTION, AIRPORT ROAD.  TURN LEFT ON AIRPORT ROAD
JS2048'AND GO NORTHWEST FOR 1.4 MI (2.3 KM) TO THE END OF AIRPORT ROAD AND
JS2048'THE INTERSECTION WITH LIBERTY ISLAND ROAD.  BEAR RIGHT AND GO NORTH ON
JS2048'LIBERTY ISLAND ROAD FOR 0.4 MI (0.6 KM) AND THE STATION ON THE RIGHT.
JS2048'THE STATION IS 35 FT (10.7 M) NORTH OF THE CENTERLINE OF A GRAVEL
JS2048'DRIVEWAY, 26 FT (7.9 M) SOUTH OF A GRAVEL SIDE ROAD, 24.5 FT (7.5 M)
JS2048'EAST OF THE CENTERLINE OF LIBERTY ISLAND ROAD, 4.2 FT (1.3 M) NORTH OF
JS2048'A POWER POLE AND 3 FT (0.9 M) WEST OF A CARSONITE WITNESS POST.  THE
JS2048'STATION WAS OCCUPIED AS PART OF THE SAN JOAQUIN-SACRAMENTO RIVER DELTA
JS2048'GPS/VERTICAL PROJECT.
JS2048
JS2048                          STATION RECOVERY (2002)
JS2048
JS2048'RECOVERY NOTE BY CA DEPT OF WATER RES 2002 (WLB)
JS2048'RECOVERED AS DESCRIBED WITH THE FOLLOWING ADDITIONAL NOTE. THE
JS2048'DRIVEWAY IS FOR 3362 LIBERTY ISLAND ROAD, AND THE MARK STILL PROJECTS
JS2048'0.5 FT. THE STATION WAS OBSERVED AS PART OF THE DWR DELTA 2002
JS2048'SUBSIDENCE NETWORK HEIGHT  MODERNIZATION SURVEY.
JS2048
JS2048                          STATION RECOVERY (2004)
JS2048
JS2048'RECOVERY NOTE BY US POWER SQUADRON 2004 (DLH)
JS2048'MAIN ROAD IS LIBERTY ISLAND RD.
JS2048
JS2048                          STATION RECOVERY (2010)
JS2048
JS2048'RECOVERY NOTE BY PACIFIC GAS AND ELECTRIC COMPANY 2010 (DPM)
JS2048'RECOVERED IN GOOD CONDITION.
JS2048
JS2048                          STATION RECOVERY (2011)
JS2048
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JS2048'RECOVERY NOTE BY CA DEPT OF WATER RES 2011 (GS)
JS2048'THE STATION WAS RECOVERED AS DESCRIBED WITH THE FOLLOWING ADDITIONAL
JS2048'NOTE.  THE DRIVEWAY IS FOR 3362 LIBERTY ISLAND ROAD, AND THE MARK
JS2048'PROJECTS 0.1 FT ABOVE GROUND.  THE STATION IS ABOUT 120 FT NORTH OF
JS2048'THE EXTENSION OF CLAYTON LANE CENTER LINE.
JS2048'
JS2048'THE STATION WAS OBSERVED AS PART OF THE DWR DELTA 2011 SUBSIDENCE
JS2048'NETWORK HEIGHT MODERNIZATION SURVEY.

*** retrieval complete.
Elapsed Time = 00:00:01
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# Appendix J

# Miner Slough and Sacramento Deep Water Ship Channel Bed Sediment Sample Results

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

# CLASSIFICATION TEST SUMMARY

DIVISION OF ENGINEERING
GEOTECHNICAL & STRUCTURES BRANCH
DAMS & CANALS SECTION

**PROJECT:** Prospect Island Tidal Habitat Restoration **FEATURE:**



| | | | | PERCENT FINER | | | | | | | | | | | | | | | | COMPACTION | | | ASTM D2487 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MECHANICAL ANALYSIS | | | | | | | | | | | HYDROMETER | | | | | Modified DWR | | | |
| | | | | GRAVEL | | | | SAND | | | | | | | SILT & CLAY | | | | | MAXIMUM | OPTIMUM | | CLASSIFICATION |
| | | | | 3.0" | 1.5" | 3/4" | 3/8" | 4 | 8 | 16 | 30 | 50 | 100 | 200 | 5M | 2M | 1M | ATTERBERG | | DRY | MOISTURE | | |
| LAB. | HOLE | F.S. | DEPTH | 75 | 37.5 | 19 | 9.5 | 4.75 | 2.36 | 1.18 | 0.6 | 0.3 | 0.15 | 0.075 | 0.005 | 0.002 | 0.001 | LIMITS | | DENSITY | CONTENT | GROUP | |
| NO. | NO. | NO. | (feet) | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | L.L. | P.I. | (pcf) | % | SYMBOL | GROUP NAME |
| 13-159 | MSDS-4 | | 32.3 | | | | | | | | | | | | | | | | | | | | |
| 13-160 | DWSPI-2RB | | 6.0 | | | 100 | 82 | 76 | 68 | 65 | 64 | 64 | 61 | 53 | 20 | 14 | 12 | | | | | | |
| 13-161 | MSPI-9LB | | 17.9 | | | | | | | 100 | 76 | 3 | 2 | 2 | 0 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-162 | MSPI-1RB | | 18.8 | | | | | | | | | | | | | | | | | | | | |
| 13-163 | MSPI-10CL | | 23.3 | | | | | | | | | | | | | | | | | | | | |
| 13-164 | MSDS-3 | | 26.9 | | | | | | | 100 | 86 | 5 | 3 | 2 | 1 | 0 | 1 | | NP | | | SP | Poorly graded sand |
| 13-165 | MSDS-5 | | 42.7 | | | | 100 | 95 | 92 | 92 | 91 | 91 | 90 | 85 | 64 | 51 | 48 | | | | | | |
| 13-166 | DWSPI-2 | | 9.9 | | | | | | 100 | 99 | 98 | 96 | 95 | 89 | 41 | 29 | 24 | | | | | | |
| 13-167 | MSPI-1LB | | 16.8 | | | | | | | 100 | 98 | 35 | 5 | 2 | 0 | 0 | 1 | | NP | | | SP | Poorly graded sand |
| 13-168 | DWSPI-3LB | | 9.7 | | | | 100 | 99 | 99 | 99 | 97 | 95 | 93 | 87 | 44 | 27 | 20 | | | | | | |
| 13-169 | MSDS-6 | | 38.4 | | | | | | | 100 | 96 | 5 | 3 | 2 | 1 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-170 | MSPI-8CL | | 22.1 | | | | | | | 100 | 76 | 3 | 2 | 1 | 0 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-171 | DWSPI-4RB | | 21.0 | | | | 100 | 95 | 95 | 95 | 94 | 92 | 88 | 70 | 22 | 16 | 15 | | | | | | |
| 13-172 | MSPI-8LB | | 23.5 | | | | | | | | | | | | | | | | | | | | |
| 13-173 | DWSPI-2CL | | 36.2 | | | | 100 | 97 | 97 | 97 | 95 | 83 | 44 | 11 | 4 | 3 | 5 | | | | | | |
| 13-174 | MSPI-6LB | | 15.7 | | | | | | 100 | 99 | 59 | 3 | 2 | 2 | 0 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-175 | MSPI-9RB | | 15.0 | | | | | 100 | 95 | 93 | 91 | 66 | 29 | 9 | 0 | 0 | 0 | | | | | | |
| 13-176 | DWSPI-3CL | | 36.8 | | 100 | 71 | 70 | 68 | 68 | 68 | 67 | 54 | 14 | 7 | 3 | 2 | 1 | | | | | | |
| 13-177 | DWSPI-4CL | | 8.6 | | | | | | | | 100 | 99 | 98 | 87 | 34 | 23 | 18 | | | | | | |
| 13-178 | MSPI-10RB | | 13.8 | | | | | | | 100 | 96 | 13 | 3 | 2 | 1 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-179 | MSPI-8RB | | 15.3 | | | | | | | | 100 | 98 | 79 | 37 | 10 | 7 | 5 | | | | | | |
| 13-180 | MSPI-1 | | 21.1 | | | | | | | 100 | 63 | 5 | 2 | 1 | 1 | 1 | 1 | | NP | | | SP | Poorly graded sand |
| 13-181 | MSPI-6RB | | 16.7 | | | | | | | 100 | 94 | 16 | 2 | 1 | 1 | 0 | 0 | | NP | | | SP | Poorly graded sand |

3/20/2013
INITIAL: JTA
REQUEST NO.: 2013-12

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IM - INSUFFICIENT MATERIAL
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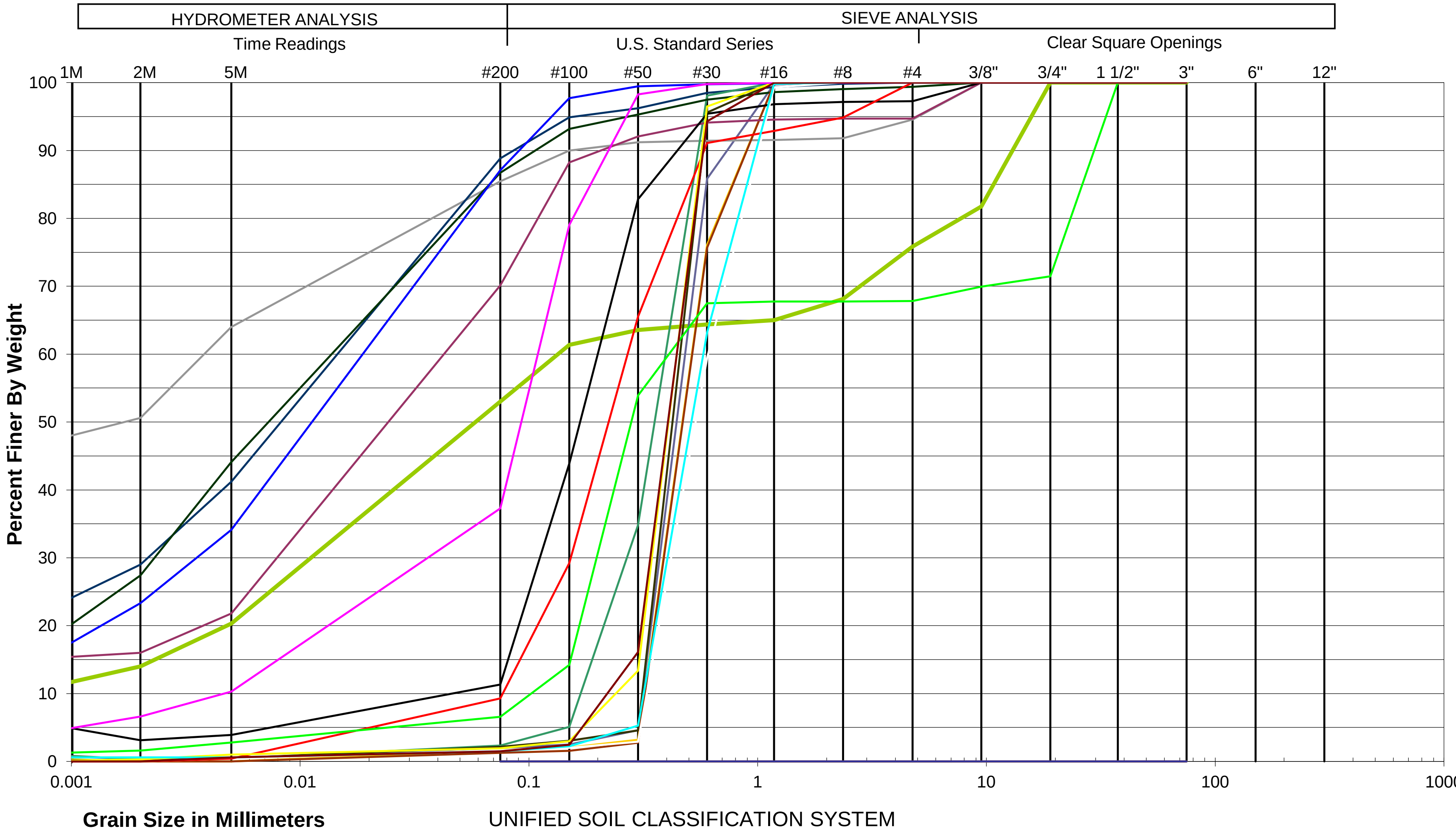
NG - NO GOOD

State of California
The Resources Agency
Department of Water Resources

# Particle Size Analysis Graph

Division of Engineering
Civil Engineering
Dams and Canals Section




**Grain Size in Millimeters**

UNIFIED SOIL CLASSIFICATION SYSTEM

| CLAY OR SILT FINES | SAND | | | GRAVEL | | COBBLES |
|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Coarse | |

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

# CLASSIFICATION TEST SUMMARY

DIVISION OF ENGINEERING
GEOTECHNICAL & STRUCTURES BRANCH
DAMS & CANALS SECTION

**PROJECT:** Prospect Island Tidal Habitat Restoration **FEATURE:**



| LAB. NO. | HOLE NO. | F.S. NO. | DEPTH (feet) | PERCENT FINER — MECHANICAL ANALYSIS — GRAVEL 3.0" 75 mm | 1.5" 37.5 mm | 3/4" 19 mm | 3/8" 9.5 mm | 4 4.75 mm | SAND 8 2.36 mm | 16 1.18 mm | 30 0.6 mm | 50 0.3 mm | 100 0.15 mm | 200 0.075 mm | HYDROMETER — SILT & CLAY 5M 0.005 mm | 2M 0.002 mm | 1M 0.001 mm | ATTERBERG LIMITS L.L. | P.I. | COMPACTION Modified DWR MAXIMUM DRY DENSITY (pcf) | OPTIMUM MOISTURE CONTENT % | GROUP SYMBOL | ASTM D2487 CLASSIFICATION GROUP NAME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13-182 | MSPI-7CL | | 22.4 | | | | | | | 100 | 98 | 21 | 6 | 3 | 1 | 1 | 0 | | NP | | | SP | Poorly graded sand |
| 13-183 | MSPI-9CL | | 17.3 | | | | | | | 100 | 96 | 24 | 4 | 2 | 1 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-184 | MSPI-7LB | | 15.8 | | | | | 100 | 99 | 93 | 63 | 4 | 2 | 2 | 1 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-185 | MSPI-6CL | | 14.2 | | | | | | | 100 | 88 | 3 | 2 | 1 | 1 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-186 | DWSPI-4CL | | 36.0 | | | | | | | | | | | | | | | | | | | | |
| 13-187 | MSPI-7RB | | 13.6 | | | | | | | | | | | | | | | | | | | | |
| 13-188 | MSDS-2 | | 34.9 | | | | 100 | 98 | 97 | 95 | 57 | 3 | 2 | 1 | 1 | 0 | 0 | | NP | | | SP | Poorly graded sand |
| 13-189 | MSDS-1 | | 25.2 | | | | | | | | | | | | | | | | | | | | |
| 13-190 | DWSPI-3RB | | 4.5 | | | | | | | | 100 | 99 | 97 | 95 | 35 | 24 | 17 | | | | | | |

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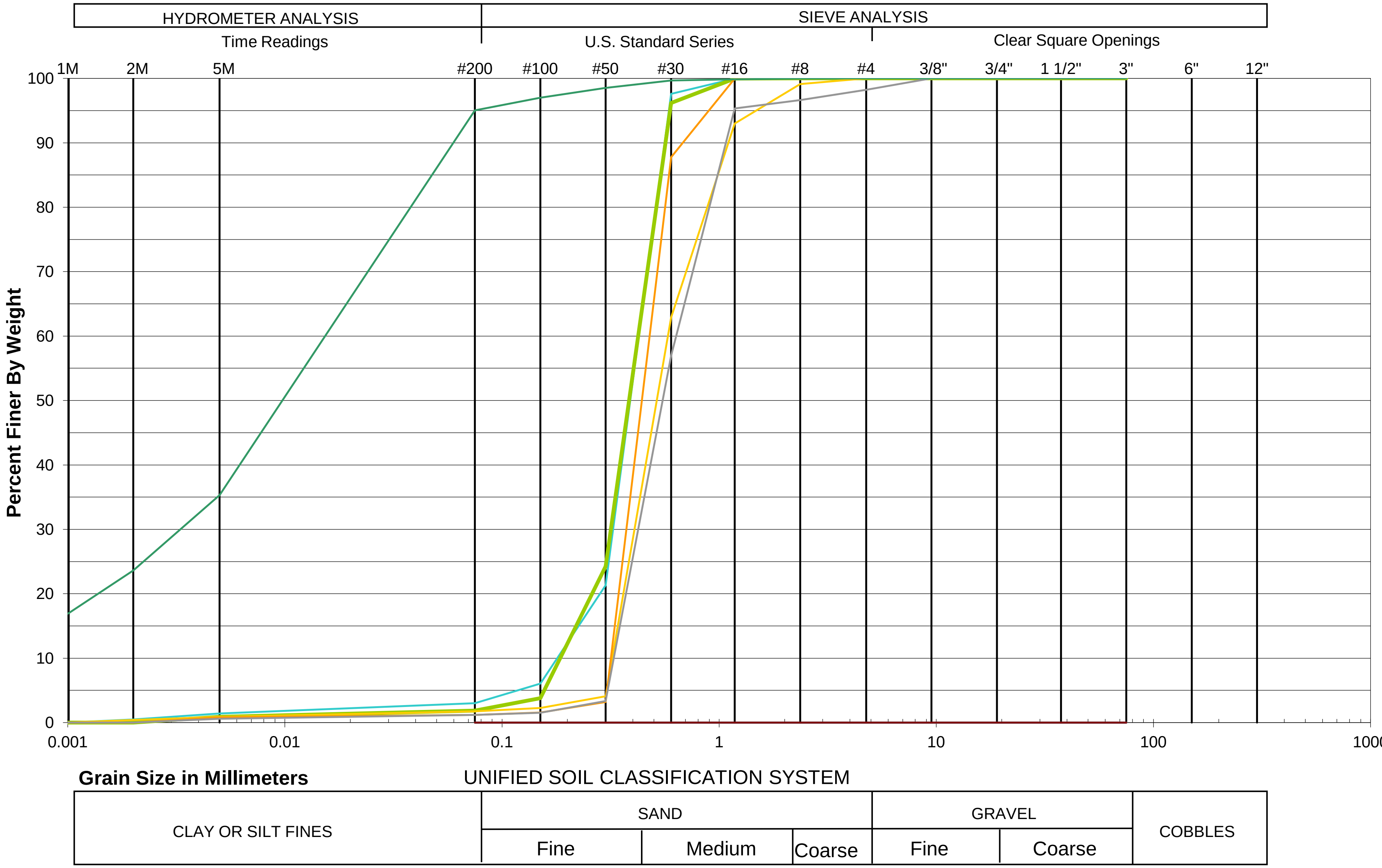


2013-12 SUMMARY GRADATION ANALYSIS WKSHT(STD) 2 of 2.xlsm
Gradation Curve

3/20/2013