



Streamlined Site Characterization & Closure

Subsurface Characterization Using a Heated Trunkline Membrane Interface Probe

Former Verona Research Facility
Germany Road
Verona, NY

PREPARED FOR

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January 4, 2013

PREPARED BY

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TABLE OF CONTENTS

Introduction	1
Objectives	1
Equipment Description.....	1
Summary of Field Investigation	2
QA/QC.....	2
Direct Sensing Log Interpretation	3

Appendix

Appendix A: MIP Logs

Introduction

Lu Engineers (LU) contracted S₂C₂, inc. to conduct an investigation of subsurface contamination at a former Verona Research facility in Verona, NY. The investigation involved delineating the vertical and horizontal extent of volatile organic compounds (VOCs) using Geoprobe®'s Heated Trunkline Membrane Interface Probe (MIP) on the subject property from December 11 to December 12, 2012.

Objectives

The objective of this investigation was to identify and delineate VOC (Chlorobenzene) contamination that had previously been identified in on-site monitoring wells, temporary well points and soil samples.

Equipment Description

S₂C₂ utilized a Geoprobe® 6620DT direct-push unit with a support truck to perform all direct-sensing MIP services. The MIP coupled with an electrical conductivity sensor provides continuous stratigraphic information of the soil as well as semi-quantitative concentrations of volatile organic compounds (VOCs). The MIP can be used in both saturated and unsaturated materials to detect VOCs in the gaseous, sorbed, dissolved or free phases. The "Membrane" acts as an interface between the VOCs in the subsurface and gas phase detectors at the surface. The membrane is semi-permeable and is comprised of a thin film polymer impregnated into a stainless steel screen for support. The membrane is approximately 6.35mm in diameter and may be easily replaced if damaged. The membrane is placed in a heated block attached to the probe. This block is heated to approximately 120°C and is raised at the leading edge to help protect the membrane from damage when being pushed through the geologic matrix. Heating the block helps accelerate diffusion of the VOCs through the membrane. Diffusion occurs due to a concentration gradient between the impacted soil and the clean carrier gas behind the membrane. A constant gas flow of 35-45 mL/min sweeps behind the membrane and carries the diffused VOCs to the gas phase detectors at the surface. Travel time from the membrane interface to the detector(s) is approximately 45-90 seconds (depending on the length of trunkline, flow rate, and ambient air temperature). S₂C₂ used a MP 6510 or equivalent MIP probe, FI 6000 field instrument, MP 6500 MIP controller coupled with a HP GC, and a field laptop with Direct Image Acquisition software. For this project, S₂C₂ used two detectors: a photo-ionization detector (PID) and a halogen-specific detector (XSD). The PID detects total VOCs with the PID more sensitive to aromatic compounds. The XSD is used to detect hydrocarbons that contain chlorine (i.e. PCE, TCE). Detection limits for typical MIP configurations are generally between 1ppm and 250ppb or less. Output from the detectors was displayed on the field laptop in real-time, displaying: conductivity, push-rate, PID response, XSD response, pressure and temperature data. These data were viewed continuously during the logging run.

In addition to the standard MIP setup, S₂C₂ ran a system that uses a heated trunkline. Unlike traditional MIP setups where the MIP probe is the only portion of the system that

is heated, Geoprobe's HTL was used to heat the entire trunkline to approximately 100 degrees C along its entire length. The heated trunkline moves the contaminant through the trunkline quicker than a traditional trunkline and thus reduces the typical slurred baseline drop seen when dealing with high concentrations of contaminants.

Summary of Field Investigation

A total of 15 MiHPT pushes were advanced to delineate the horizontal and vertical extent of VOCs. Initial locations were chosen by LU based upon previous work conducted at the site. Draft logs were sent to an LU representative either immediately or at the end of each day for review. Once localized 'hot spots' were identified, step-outs were selected to refine the delineation. Following the field investigation, an LU representative surveyed the final location northing/easting and estimated elevations from previous site surveys. Based upon the MIP results confirmation samples were collected using the Geoprobe enclosed piston MC soil sampling system. No 3D modeling was requested at this site

QA/QC

S₂C₂ follows a strict QA/QC program following Geoprobe's MIP SOP Technical Bulletin No. MK 3010, revised August 2006. S₂C₂ performs a response test before and after each MIP location. The response test is an important quality control test in that it tests the integrity of the complete system. S₂C₂ performs the response test by preparing a known concentration of the standard, TCE, into 500 ml of water and then immersing the MIP probe into that solution. Chlorobenzene was also used as a standard at this site and the results of the Chlorobenzene std. test were used to determine the trip time for MIP logging. Performing a response test before and after each run measures the integrity of the system and checks for degradation of the membrane. If the post-run results are not similar to pre-run results, then corrective action (replacement of membrane, checking for leaks in the system) may be necessary. Some degradation of the membrane is expected, and responses can be corrected based upon the results of the response test. Without adhering to these QA/QC checks, MIP data from one hole cannot be compared to other locations. MIP QA/QC testing results are provided at the bottom of each log in Appendix A of this report.

To check the EC dipole, an EC dipole tester configured with high and low EC materials on either end is applied across the EC dipole and the isolated steel body of the probe. If the EC response is within +/- 5% of the target value, the EC test is passed. If either the high or low EC test fails, corrective action (typically opening the probe and reconnecting the EC wires) must be taken.

Direct Sensing Log Interpretation

All 15 MIP logs are provided in Appendix A of this report. Each MIP log has four graphs of data. The first graph is a cross-plot with electrical conductivity (mS/m) in blue. In general, electrical conductivity is lower in coarse grained material (i.e., sands and gravels) and higher in fine grained material (i.e., silts and clays). The next graph is a cross-plot with Push Rate in blue. Push Rate can be used with the EC results to help determine soil lithology. The final two graphs on the log are of the PID, and XSD responses in uV.

The MIP detector responses are dependent on a number of factors including: lithologic properties, chemical constituents, and the concentration within the formation. MIP response also varies as a result of membrane degradation. The MIP response provides a gross quantitative response to contamination in the subsurface and can be correlated to known concentrations by comparing confirmation sampling results to the MIP response.

The following QA/QC anomalies were observed during this investigation:

1. A pre-test of MIP-02 was unable to be conducted due to elevated baselines from MIP-01

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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-01**

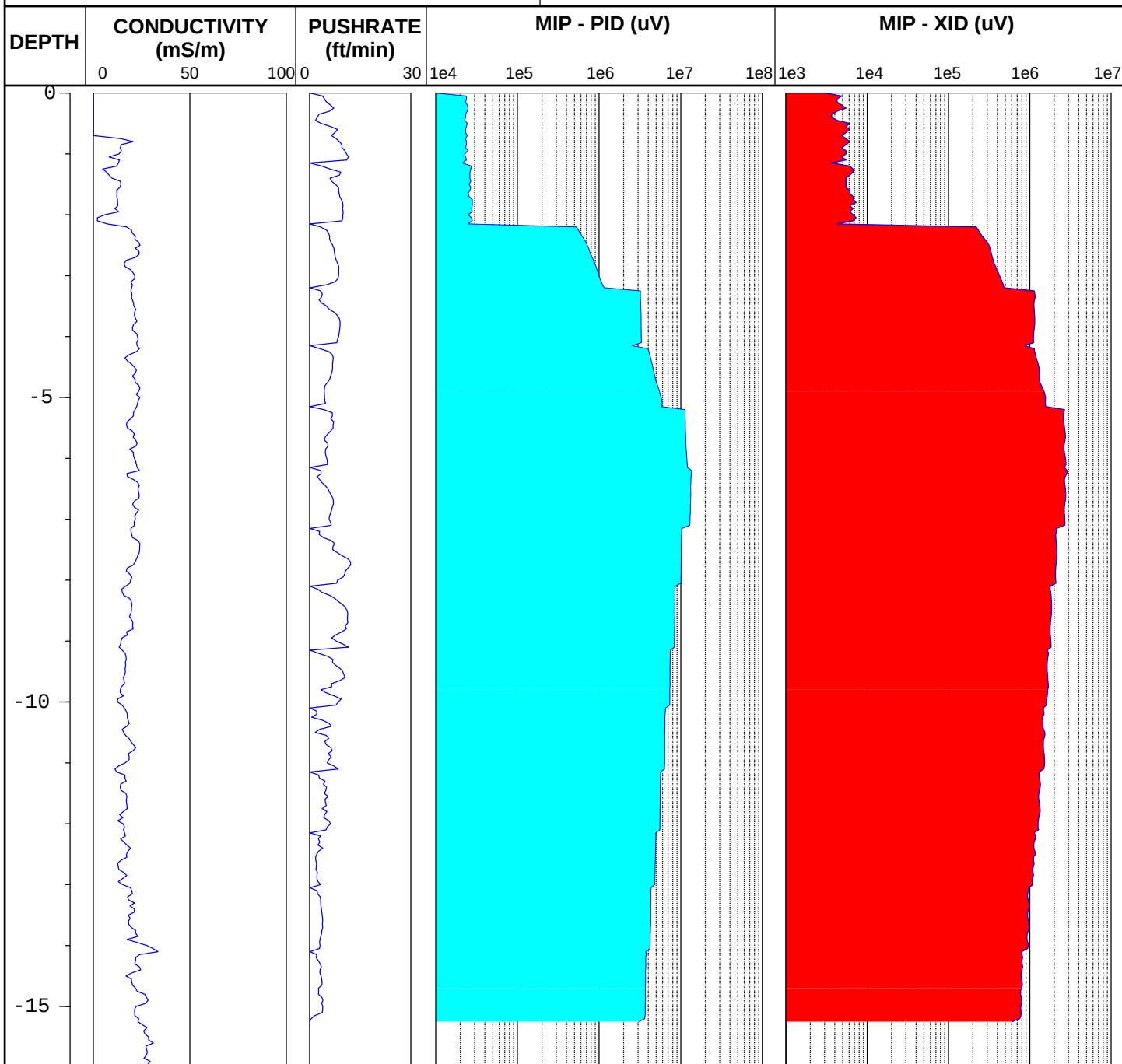
TOTAL DEPTH: **16'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.27e5uV response for 1ppm chlorobenzene.

Post-Test Response: XSD: NA; baseline too high for test. Note higher PID scale.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-02**

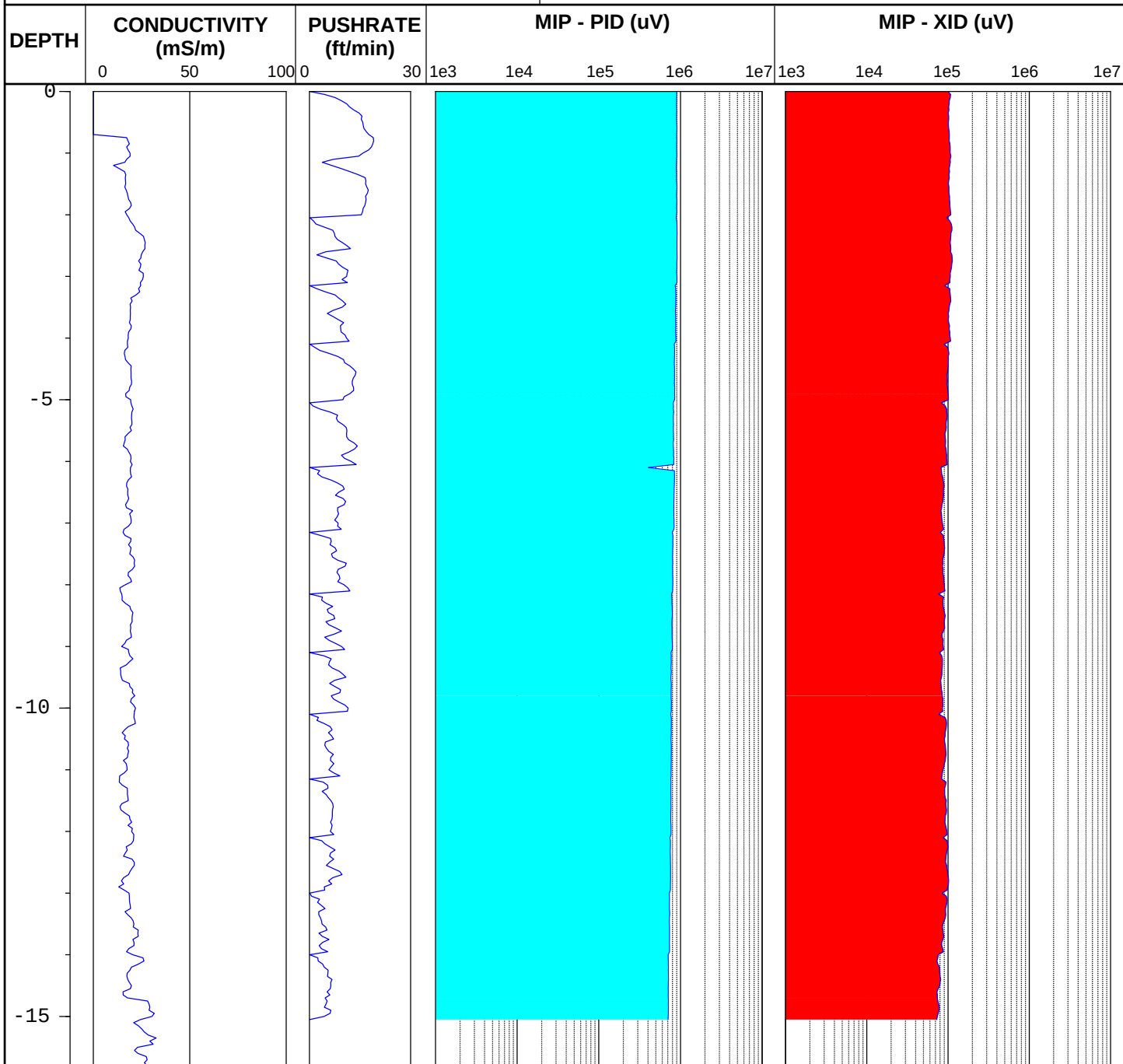
TOTAL DEPTH: **15.8'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: NA; baseline too high for test.

Post-Test Response: XSD: NA; baseline too high for test.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-03**

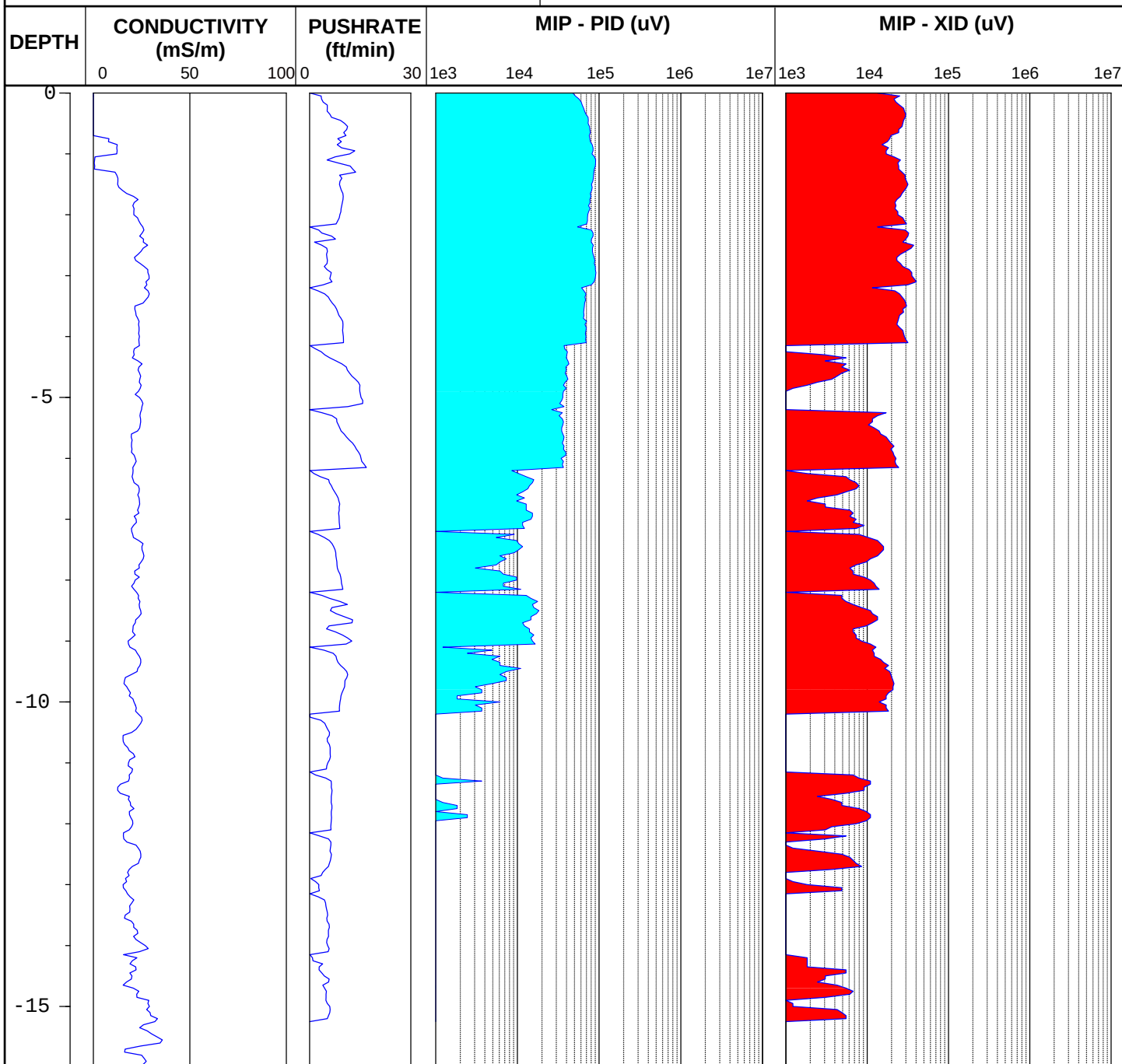
TOTAL DEPTH: **16'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.29e5uV response for 1ppm chlorobenzene; 0.20e5uv response for 1ppm TCE.

Post-Test Response: XSD: 0.53e5uV response for 1ppm TCE.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-04**

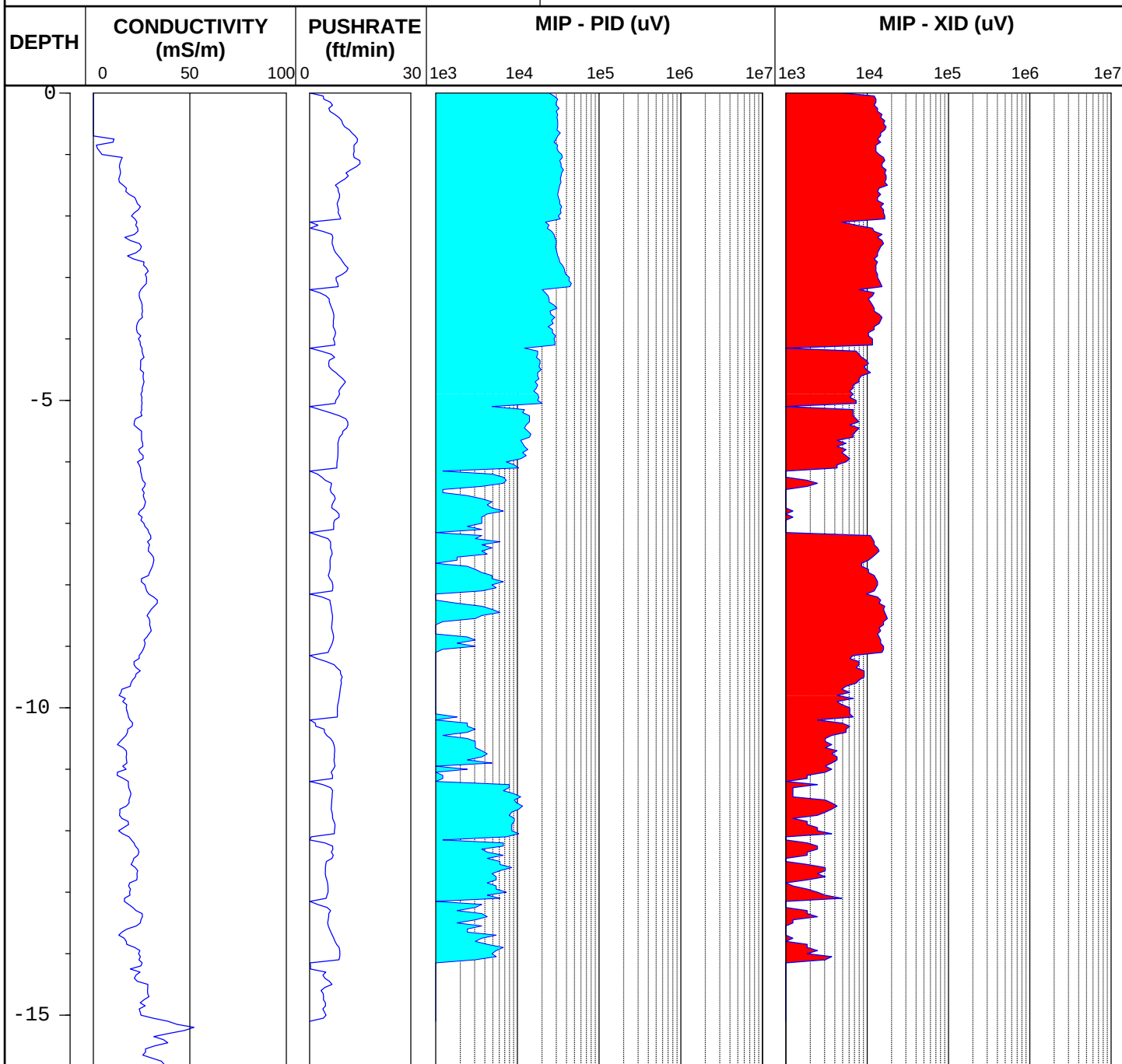
TOTAL DEPTH: **15.85'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.53e5uV response for 1ppm TCE; 0.98e4uV response for 2.5ppm chlorobenzene.

Post-Test Response: XSD: 0.50e5uV response for 1ppm TCE; 1.38e4uV response for 2.5ppm chlorobenzene.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-05**

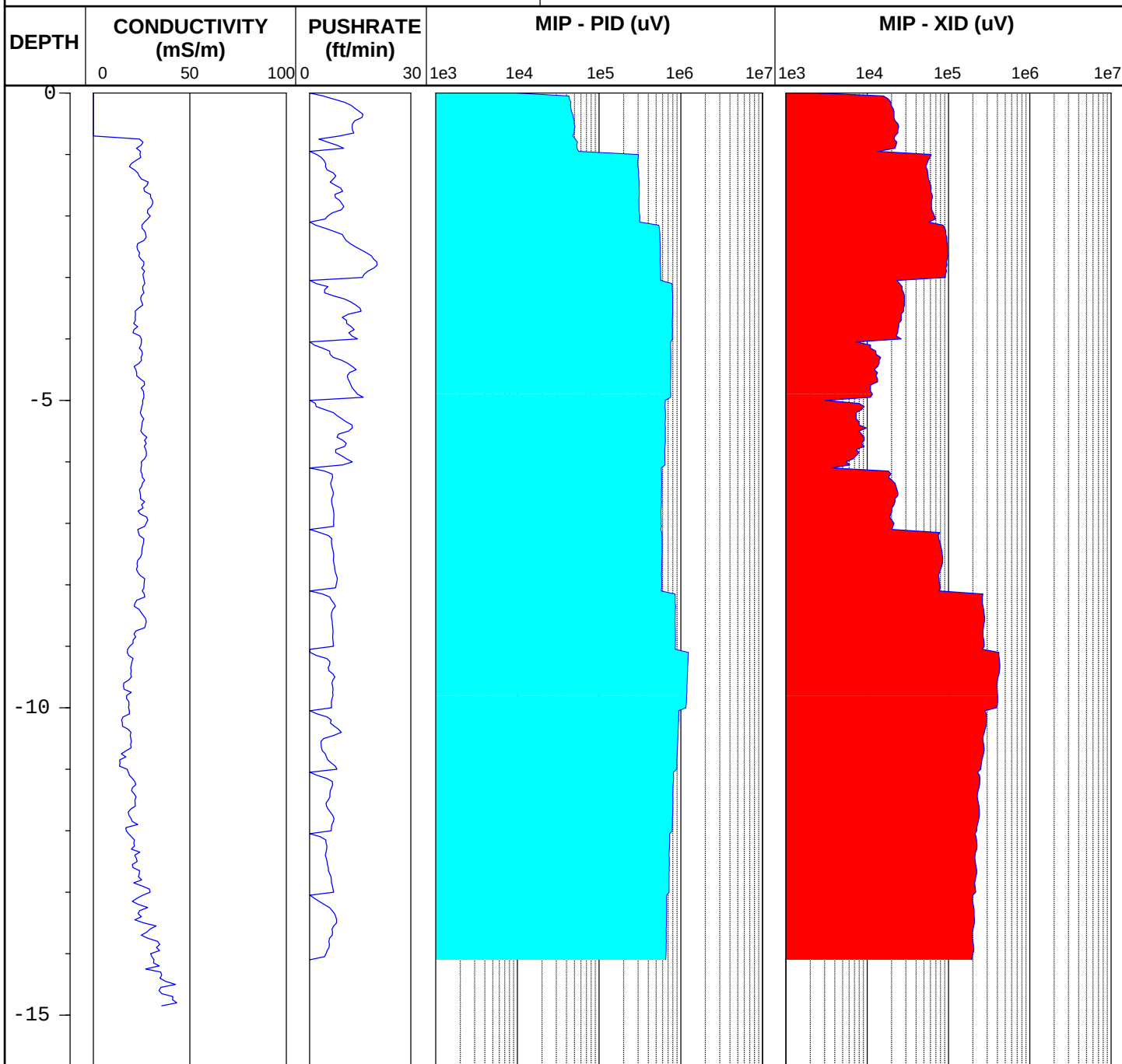
TOTAL DEPTH: **15.85'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.50e5uV response for 1ppm TCE; 1.38e4uV response for 2.5ppm chlorobenzene.

Post-Test Response: XSD: 0.86e5uV response for 1ppm TCE; 0.56e5uV response for 5ppm chlorobenzene.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-06**

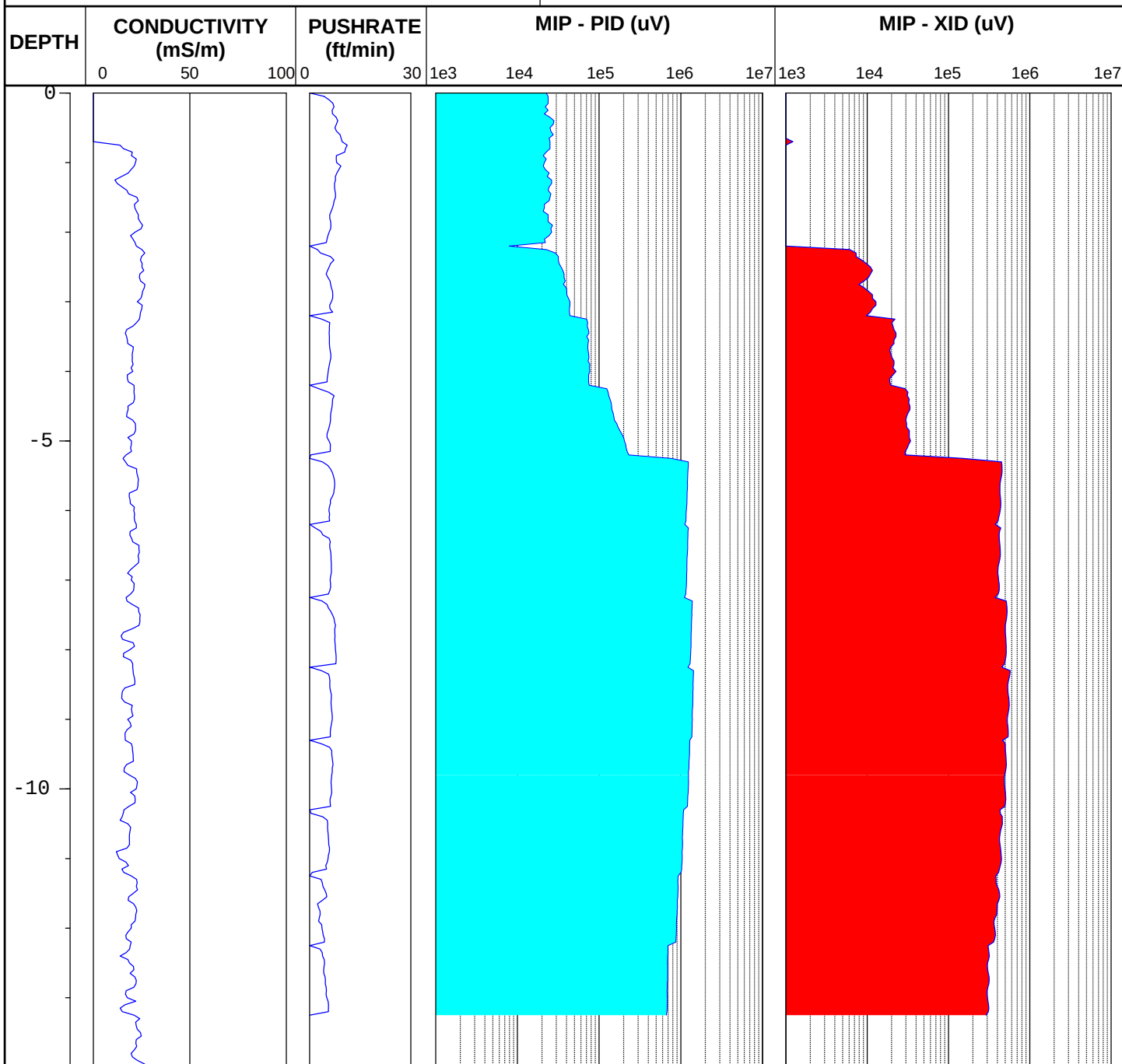
TOTAL DEPTH: **14'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.86e5uV response for 1ppm TCE; 0.56e5uV response for 5ppm chlorobenzene.

Post-Test Response: XSD: 0.75e5uV response for 1ppm TCE; 0.45e5uV response for 5ppm chlorobenzene.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-07**

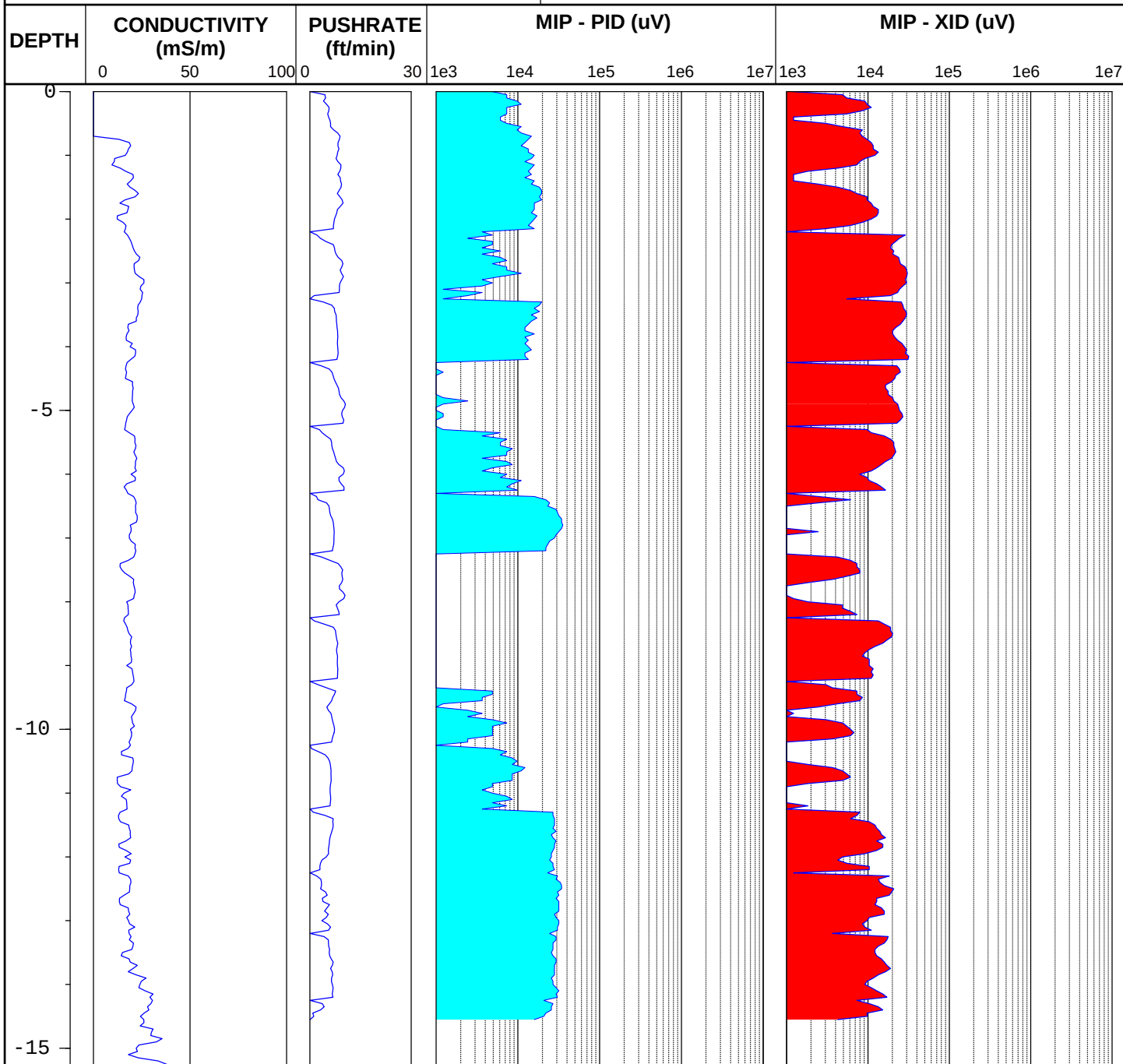
TOTAL DEPTH: **15.3'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.75e5uV response for 1ppm TCE; 0.45e5uV response for 5ppm chlorobenzene.

Post-Test Response: XSD: 0.41e5uV response for 5ppm chlorobenzene.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-08**

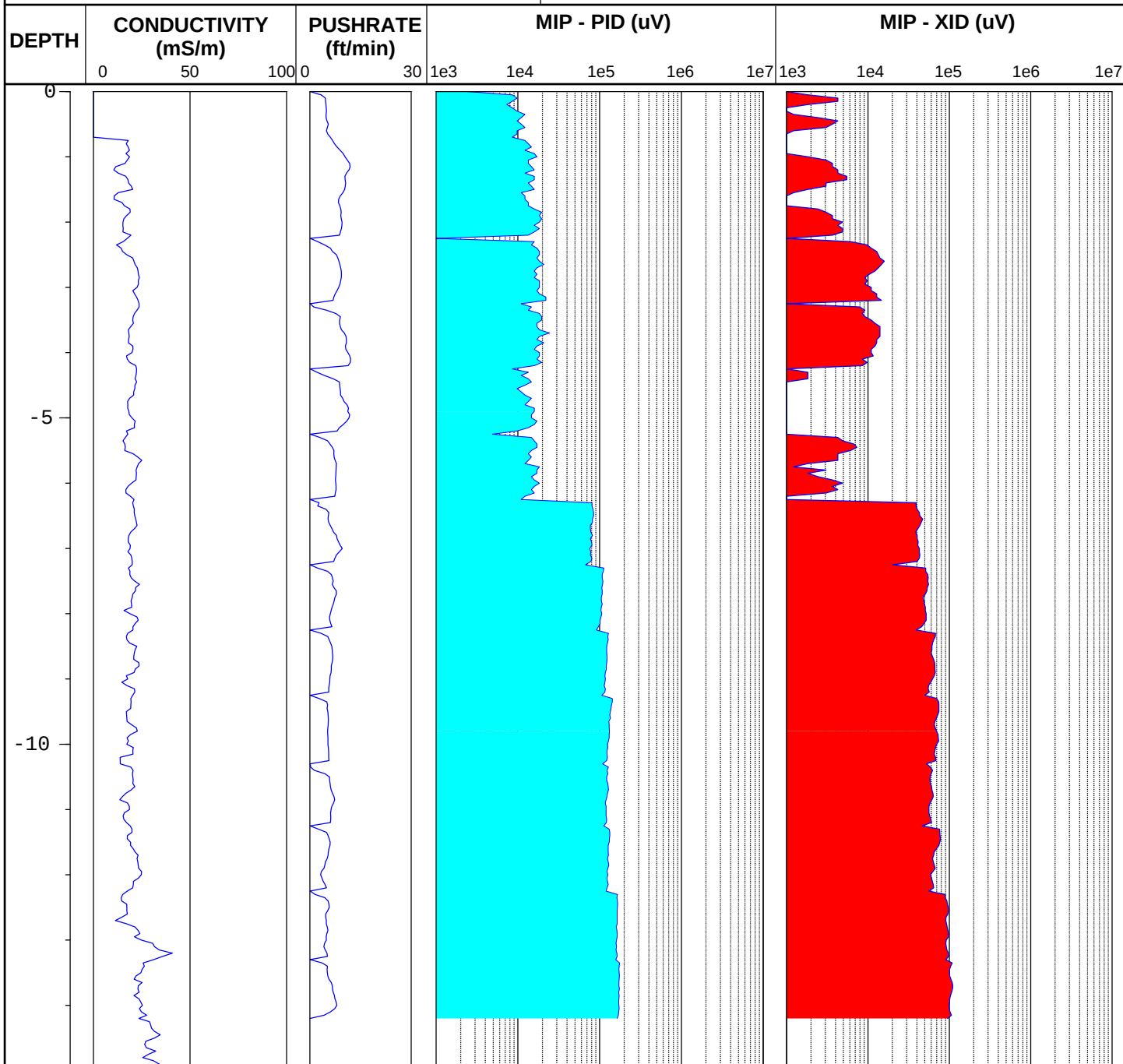
TOTAL DEPTH: **14.95'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.41e5uV response for 5ppm chlorobenzene.

Post-Test Response: XSD: 0.46e5uV response for 5ppm chlorobenzene.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-09**

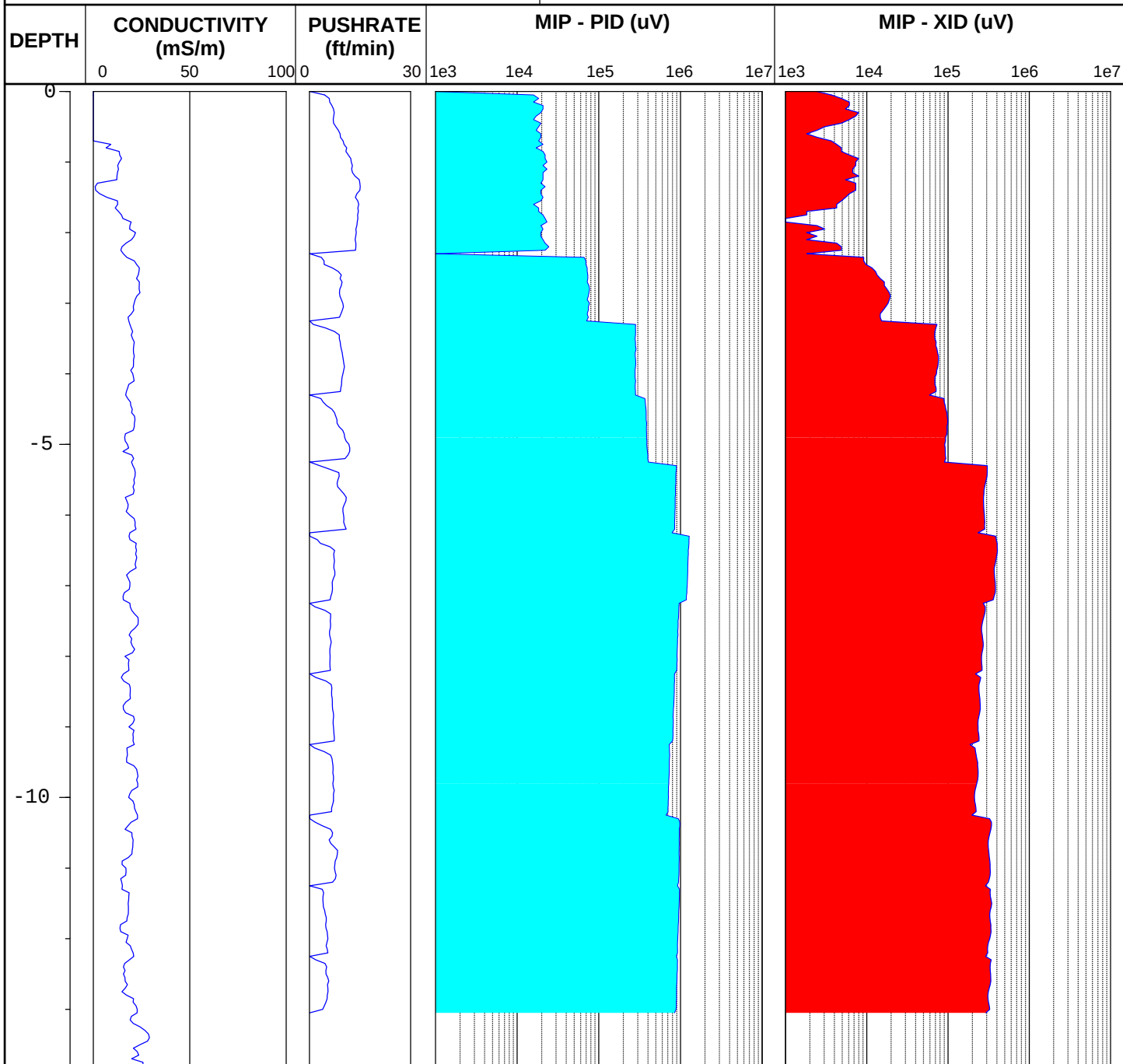
TOTAL DEPTH: **13.8'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/11/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.46e5uV response for 5ppm chlorobenzene.

Post-Test Response: XSD: 0.38e5uV response for 5ppm chlorobenzene.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-10**

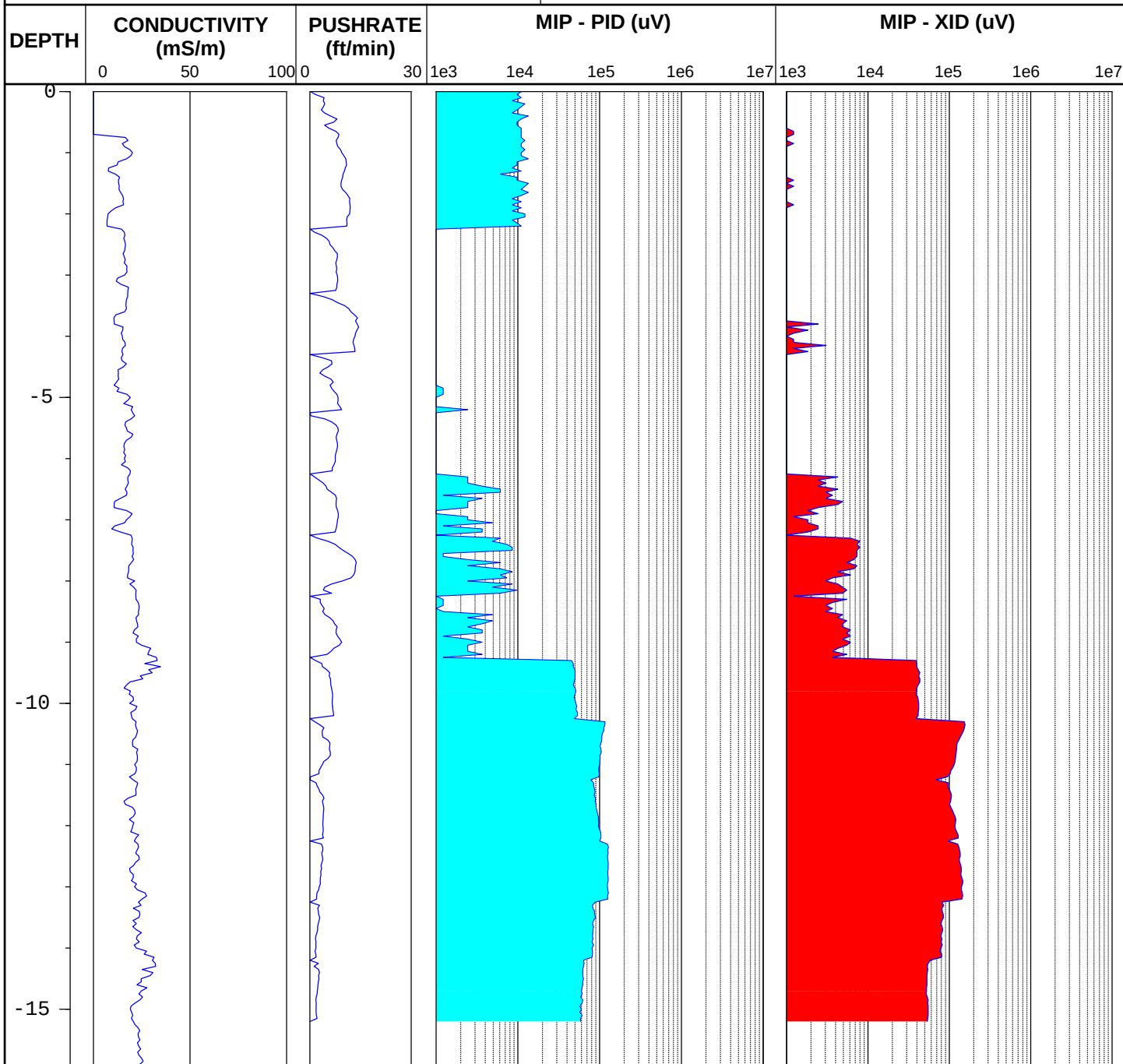
TOTAL DEPTH: **15.95'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/12/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.33e5uV response for 5ppm chlorobenzene; 0.50e5uV response for 1ppm TCE.

Post-Test Response: XSD: 0.28e5uV response for 1ppm TCE.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-11**

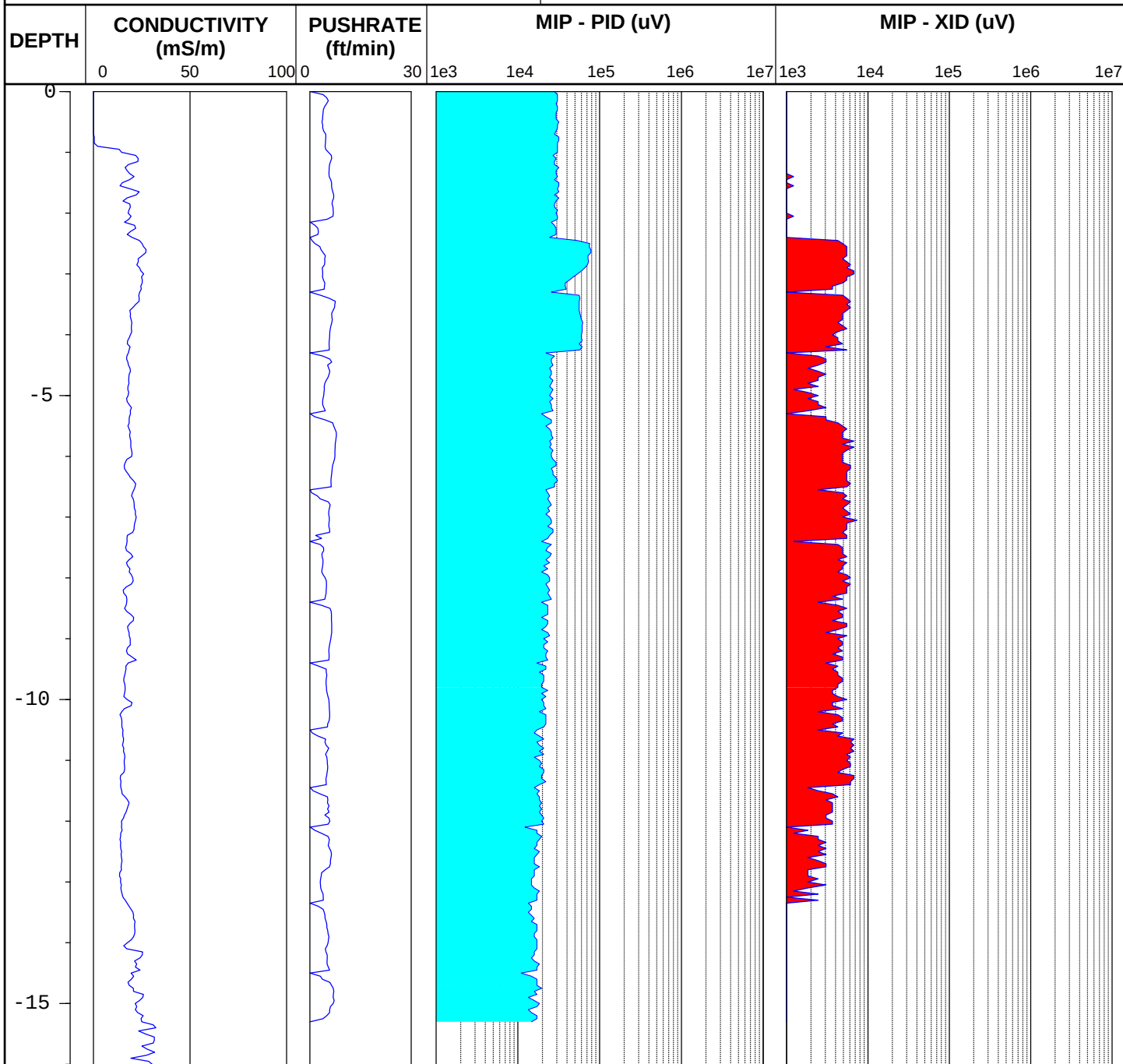
TOTAL DEPTH: **16.05'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/12/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.28e5uV response for 1ppm TCE.

Post-Test Response: XSD: NA



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-12**

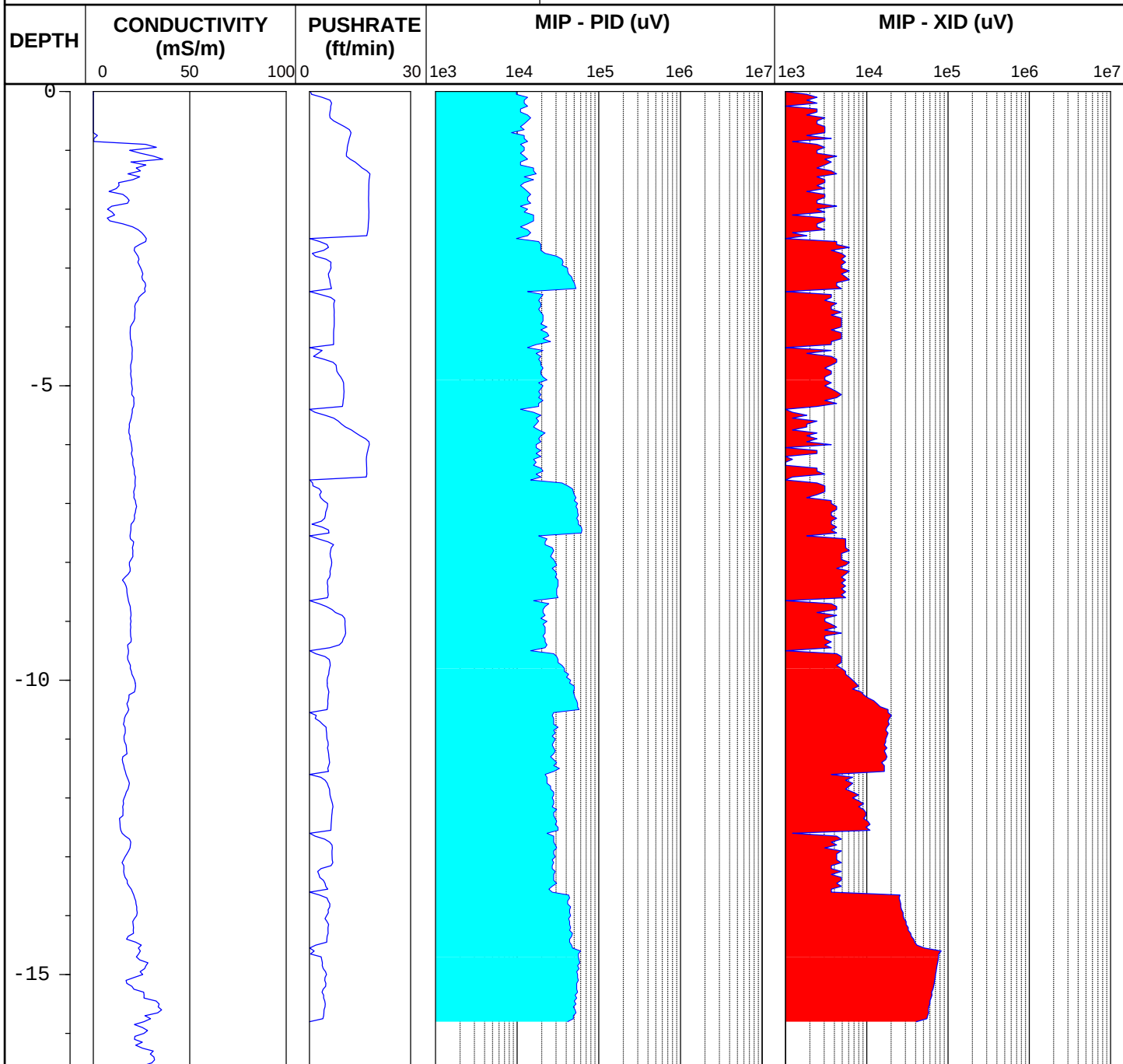
TOTAL DEPTH: **16.55'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/12/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: NA.

Post-Test Response: XSD: 0.28e5uV response for 5ppm chlorobenzene; 0.46e5uV response for 1ppm TCE.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-13**

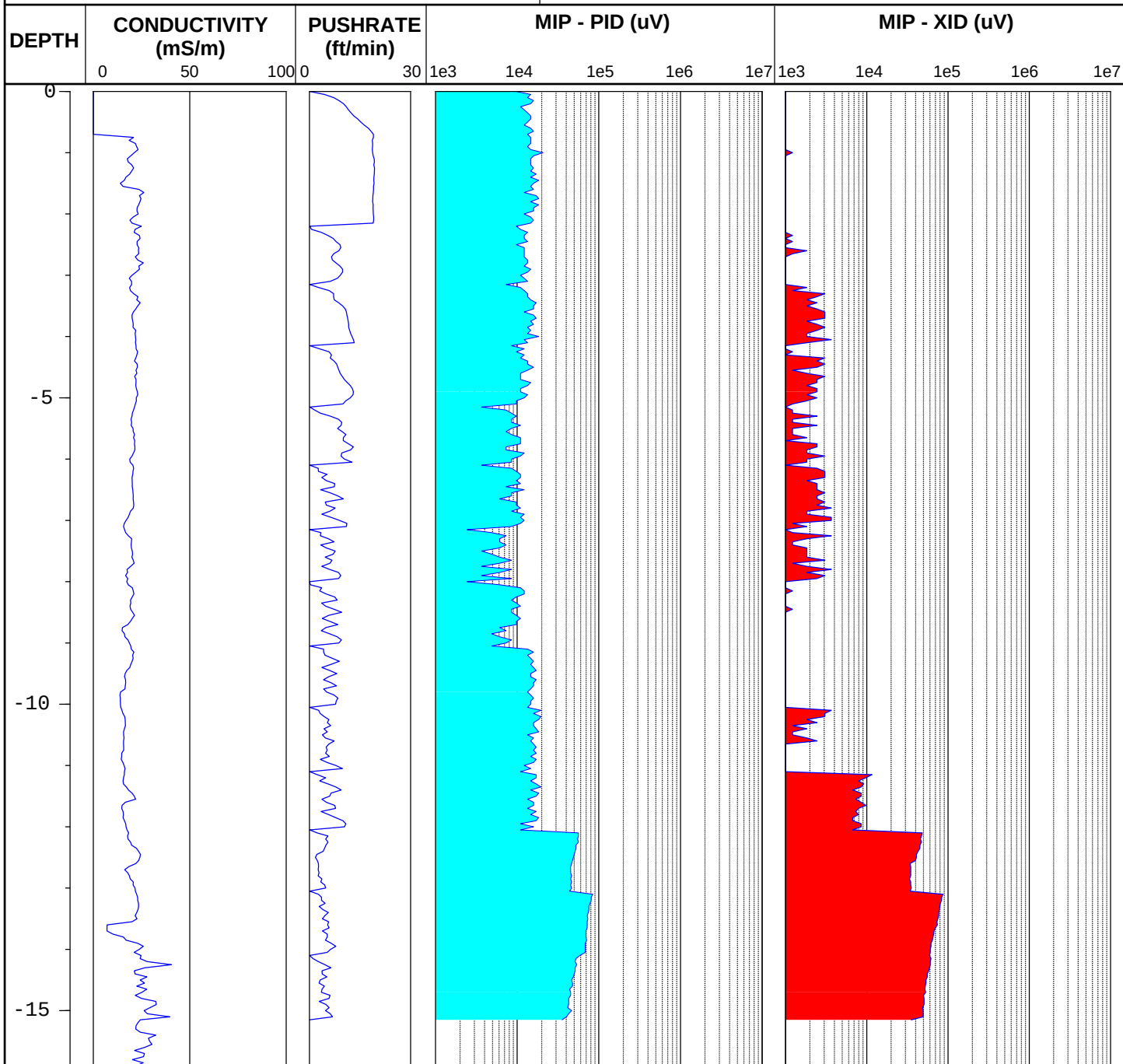
TOTAL DEPTH: **15.9'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/12/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.28e5uV response for 5ppm chlorobenzene; 0.46e5uV response for 1ppm TCE.

Post-Test Response: XSD: 0.55e5uV response for 1ppm TCE.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-14**

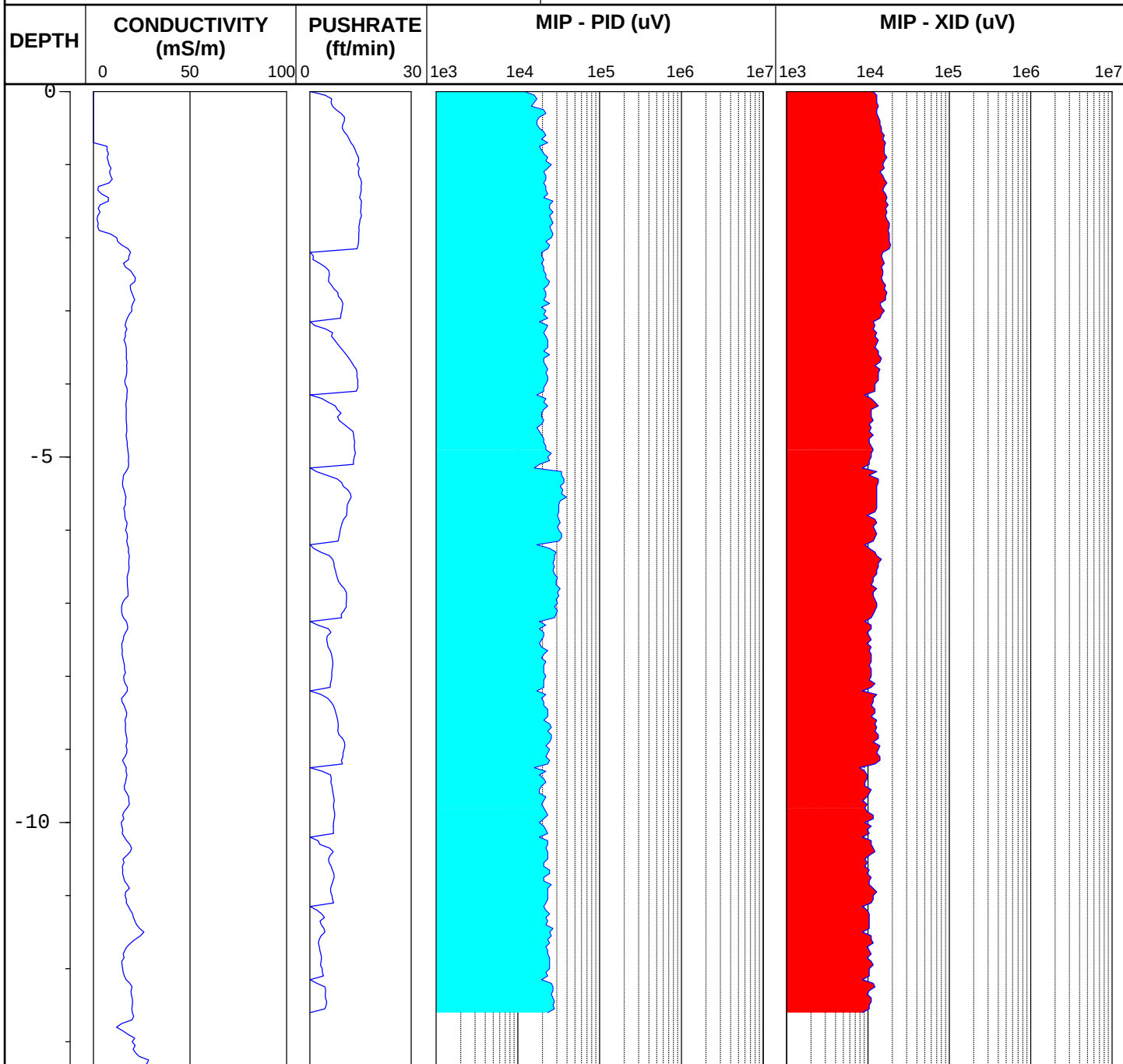
TOTAL DEPTH: **13.35'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/12/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.55e5uV response for 1ppm TCE.

Post-Test Response: XSD: 0.39e5uV response for 1ppm TCE.



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FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-15**

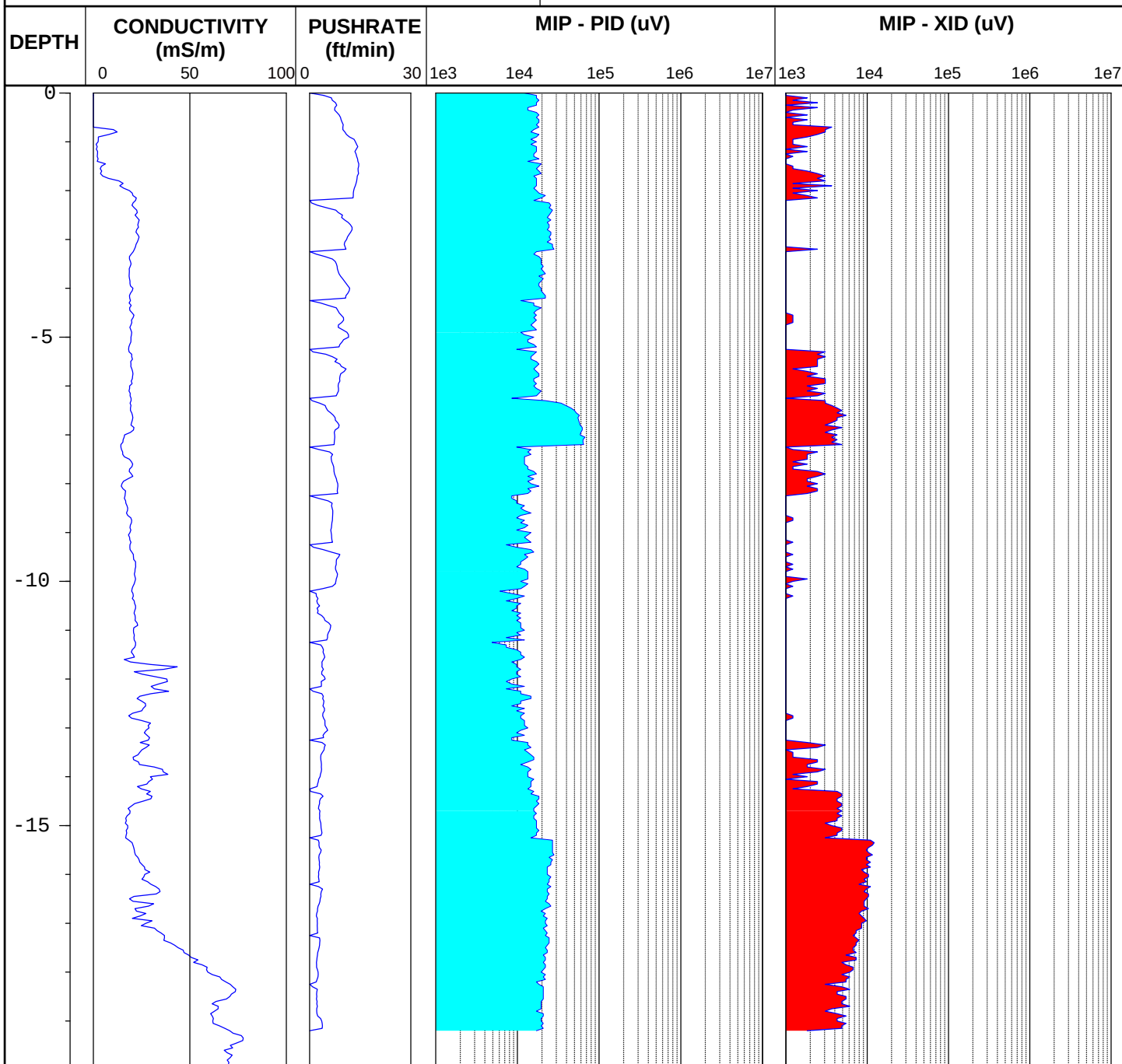
TOTAL DEPTH: **19.95'**

PROJECT INFORMATION

PROJECT: **Verona Research Facility**
SITE LOCATION: **Verona, NY**
JOB NO.: **NA**
LOGGED BY: **FI 6000**
PROJECT MANAGER: **Gregory Andrus**
DATES DRILLED: **12/12/2012**

DRILLING INFORMATION

DRILLER: **Abe Gelb**
RIG TYPE: **Geoprobe 6620DT**
SAMPLING METHOD: **Membrane Interface Probe**
OPERATOR: **Matthew Ruf**
NORTHING:
ELEVATION:
EASTING:



Pre-Test Response: XSD: 0.39e5uV response for 1ppm TCE.

Post-Test Response: XSD: 0.30e5uV response for 5ppm chlorobenzene; 0.35e5uV response for 1ppm TCE.