S2 C2 inc.

Streamlined Site Characterization & Closure

Subsurface Characterization Using an Electrical Conductivity and Membrane Interface Probe (MIP)

PREPARED FOR

PREPARED BY

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Introduction
XXXX contracted S_2C_2, inc. to conduct an investigation of subsurface contamination at a facility located at XXXX, NJ. This investigation involved delineating the vertical and horizontal extent of volatile organic compounds (VOC) using Membrane Interface Probe (MIP) and electrical conductivity (EC) technologies. The MIP investigation was conducted on XXXX.

Objectives
The objective of this investigation was to identify and delineate VOC contamination, specifically benzene, toluene, ethyl benzene, and xylenes (BTEX) as well as chlorinated compounds tetrachloroethene (PCE) and trichloroethene (TCE) and their associated break down components.

Equipment Description
S_2C_2 utilized a Geoprobe direct-push unit with a support truck to perform all direct-sensing MIP/Conductivity services and all confirmation groundwater and soil sampling 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). S_2C_2 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, S_2C_2 used a combination FID/PID/XSD detector. The FID/PID detects total VOC with the PID more sensitive to aromatic compounds. The XSD detects only chlorinated hydrocarbons. 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, speed, FID response, PID response, XSD response, pressure and temperature data. These data were viewed continuously during the logging run.

Summary of Field Investigation
A total of 14 MIP pushes were advanced to delineate the horizontal and vertical extent of VOCs. Figure 1 illustrates the location of all MIP pushes at the site and Appendix A presents logs for all MIP pushes. In addition to the MIP pushes, continuous soil samples

were collected at one location (MIP-08) to provide visual confirmation of the soil lithology. In addition two groundwater grab samples were collected at MIP-03 from 35-38 feet below ground surface (bgs) and at MIP-07 from 16 to 19 feet bgs to confirm estimated concentrations and chemical signature at these two locations. Results of the Category II volatile organic compounds (VOC) results are provided in Appendix B.

Following termination of each borehole, granular bentonite or grout was used to seal all boreholes. Asphalt and/or concrete were used as a surface cap where appropriate. All boring locations were surveyed by a licensed New Jersey surveyor.

QA/QC

S_2C_2 follows a strict QA/QC program following Geoprobe's MIP SOP Technical Bulletin No. MK 3010, revised August 2006. S_2C_2 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. S_2C_2 performs the response test by preparing a known concentration of the standard, tetrachloroethene (PCE) and benzene, into 500 ml of water and then immersing the MIP probe into that solution. After the pre-established trip time, the probe is removed and response is measured. 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. QA/QC testing results are provided in Appendix C.

Direct Sensing Log Interpretation

Each MIP log includes six graphs of data. The first graph is electrical conductivity and is measured in mS/m. 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 second graph is the temperature graph. This graph shows the temperature of the heater block during the push. The graph provides a check on the operation of the heater element and can be used to determine where groundwater is located within the formation. The next graph is the rate of penetration (push rate) of the probe and is measured in ft/min. The push rate can be used in conjunction with the conductivity graph to help identify lithologic contacts. Push rate is also used by the MIP operator to determine refusal; penetrating at a rate of less than 1ft/min is potentially damaging to the probe itself and is therefore called 'MIP refusal'. The final graphs on the log are of the FID, PID and XSD response in uV. The MIP response is 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.

Based on the Category II groundwater grabs samples collected at MIP-03 and MIP-07 and results of groundwater samples collected from site monitoring wells, the following conclusions can be drawn from the existing MIP data:

1. A petroleum hydrocarbon mass primarily comprised of BTEX compounds and associated fuel compounds was detected by the PID and FID detectors in the upper 25 feet of unconsolidated fine sands and silts with the highest level of impacts observed at MIP locations: MIP-05, MIP-06 and MIP-10.

2. A deeper, (25-40 feet bgs) petroleum hydrocarbon mass primarily comprised of Tentatively Identified Compounds (TICs) as shown on the mass spectrometer chromatogram from groundwater grab sample MIP-03 (35-38) was detected by the PID/FID MIP detectors. The magnitude of the PID and FID response from these deeper petroleum hydrocarbon impacts are higher than expected from CVOC impacts alone, and are likely a result of the TIC compounds observed in the results from the MIP-03 groundwater grab sample.

3. A chlorinated VOC mass suspected to be primarily PCE, TCE and associated breakdown products was detected by the XSD detector primarily from 25 feet bgs to 40 feet bgs, located above a known confining layer confirmed by EC responses. The highest level of MIP XSD detector responses were centered at MIP locations: MIP-02, MIP-08, and MIP-09. A known off-site PCE source has been documented upgradient to the east of the site and may explain deeper chlorinated impacts observed in the MIP data. It should also be noted that XSD response above baseline were not observed within the on-site petroleum hydrocarbon mass sources possibly a result of reductive dechlorination occurring in this area.

Model Generation

All data generated as part of this project were uploaded to a project database for 2D and 3D visualization of the results. MIP-PID and XSD responses were modeled using CTech's Environmental Visualization Software (EVS) advanced 3D kriging modeling algorithm and were exported to GIS as shapefiles for chosen response levels. The following model adjustments were made to reflect the current conceptual model for the site:

1. Subsetted detector responses to minimize vertical kriging nearest neighbor interferences.

2. Incorporated a control point CP-01 within the known BTEX source area west of MIP-06 by duplicating the MIP-06 results at the control location. A baseline control point was incorporated at the MW-17 well cluster based on non-detect groundwater results collected in the shallow and deep well pair. MIP response of 1,000 uV was inserted at this location.

Appendix A: MIP Logs

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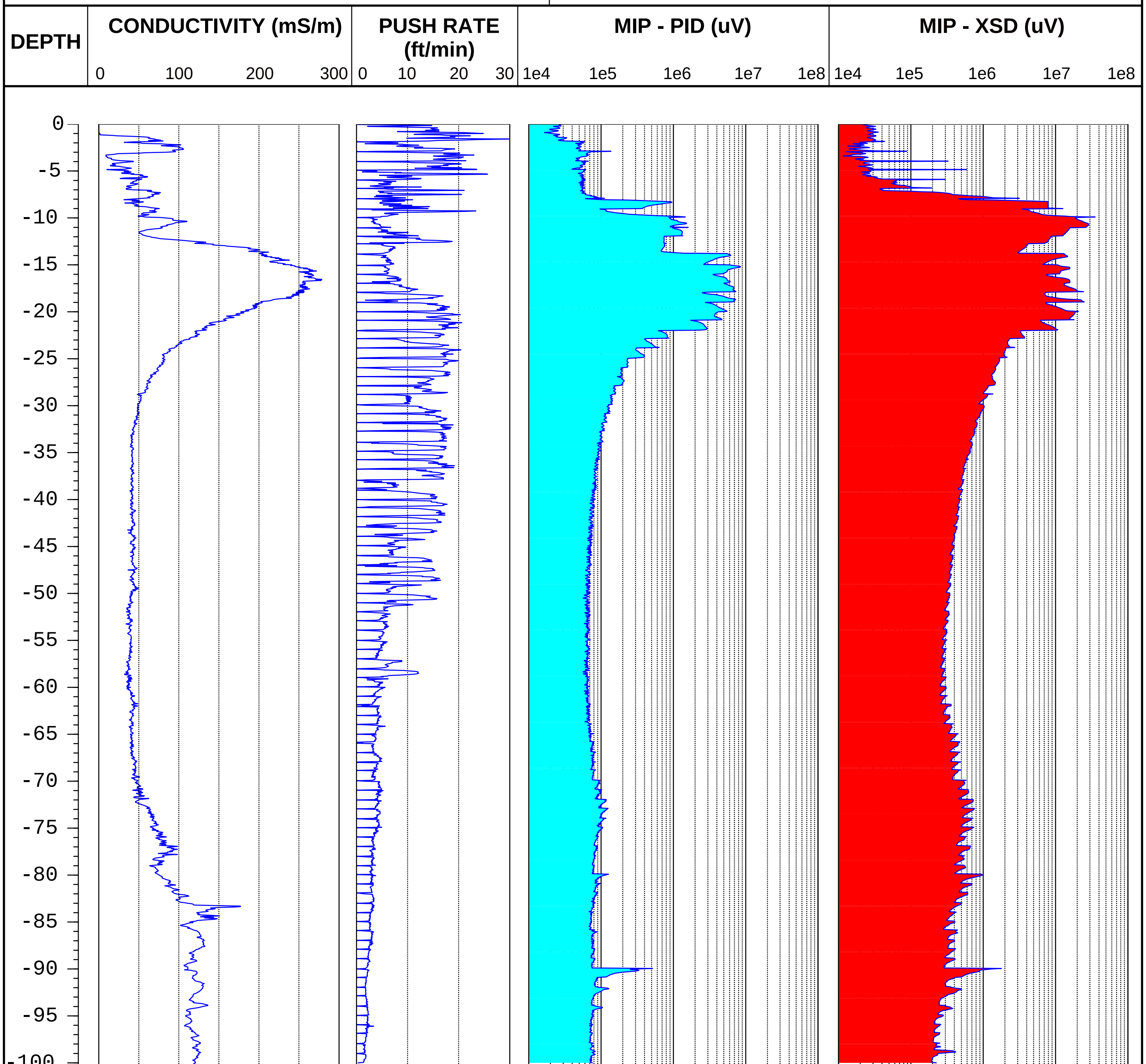
FIELD BOREHOLE LOG

BOREHOLE NO.: **MIP-01**

TOTAL DEPTH: **100.75'**

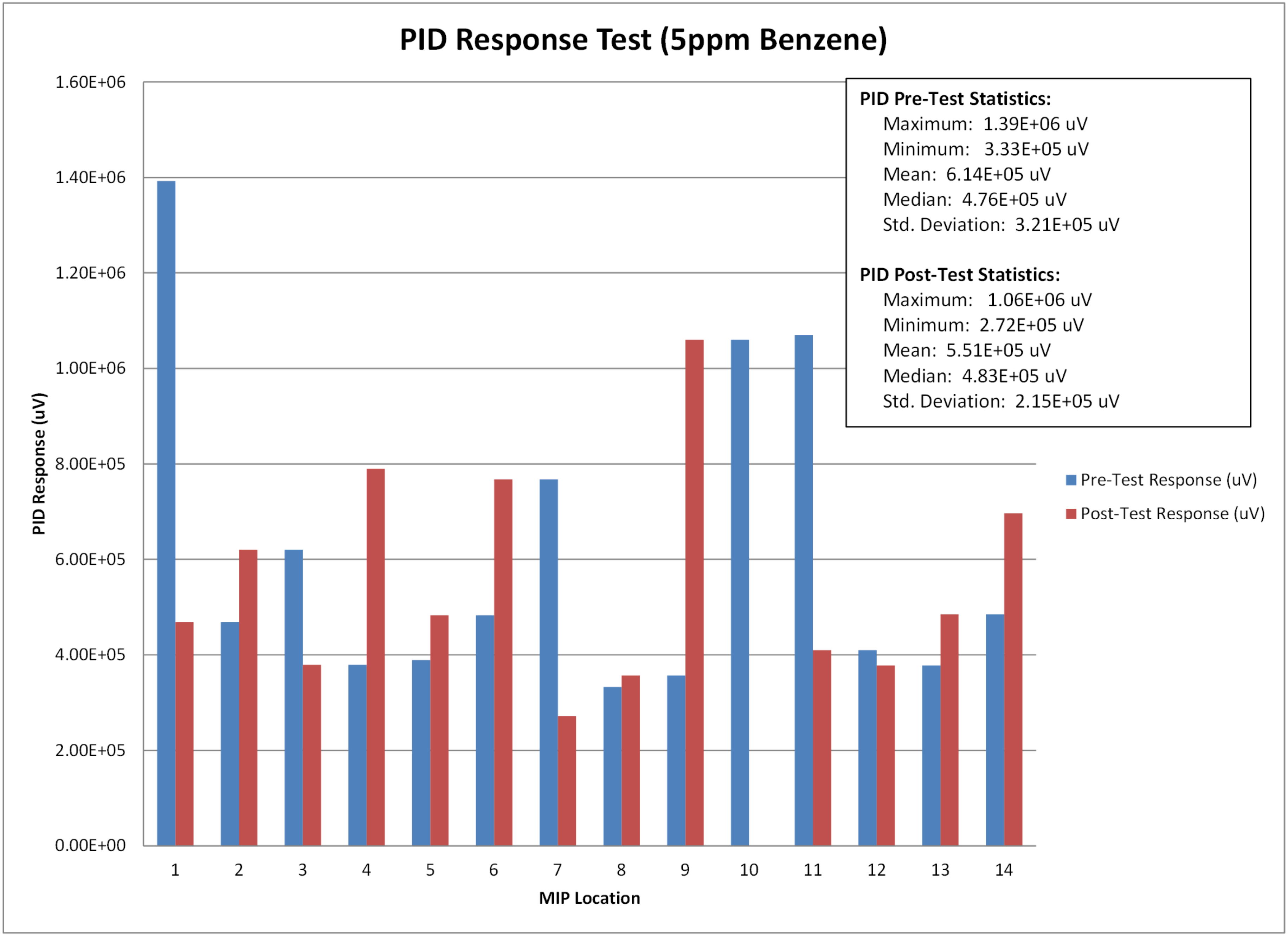
PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:		DRILLER:	S2C2
SITE LOCATION:		RIG TYPE:	Geoprobe 6600
JOB NO.:		METHOD OF DRILLING:	Direct Push
LOGGED BY:	FI 6000	SAMPLING METHOD:	MIP/EC
PROJECT MANAGER:		NORTHING:	ELEVATION:
DATES DRILLED:		EASTING:	

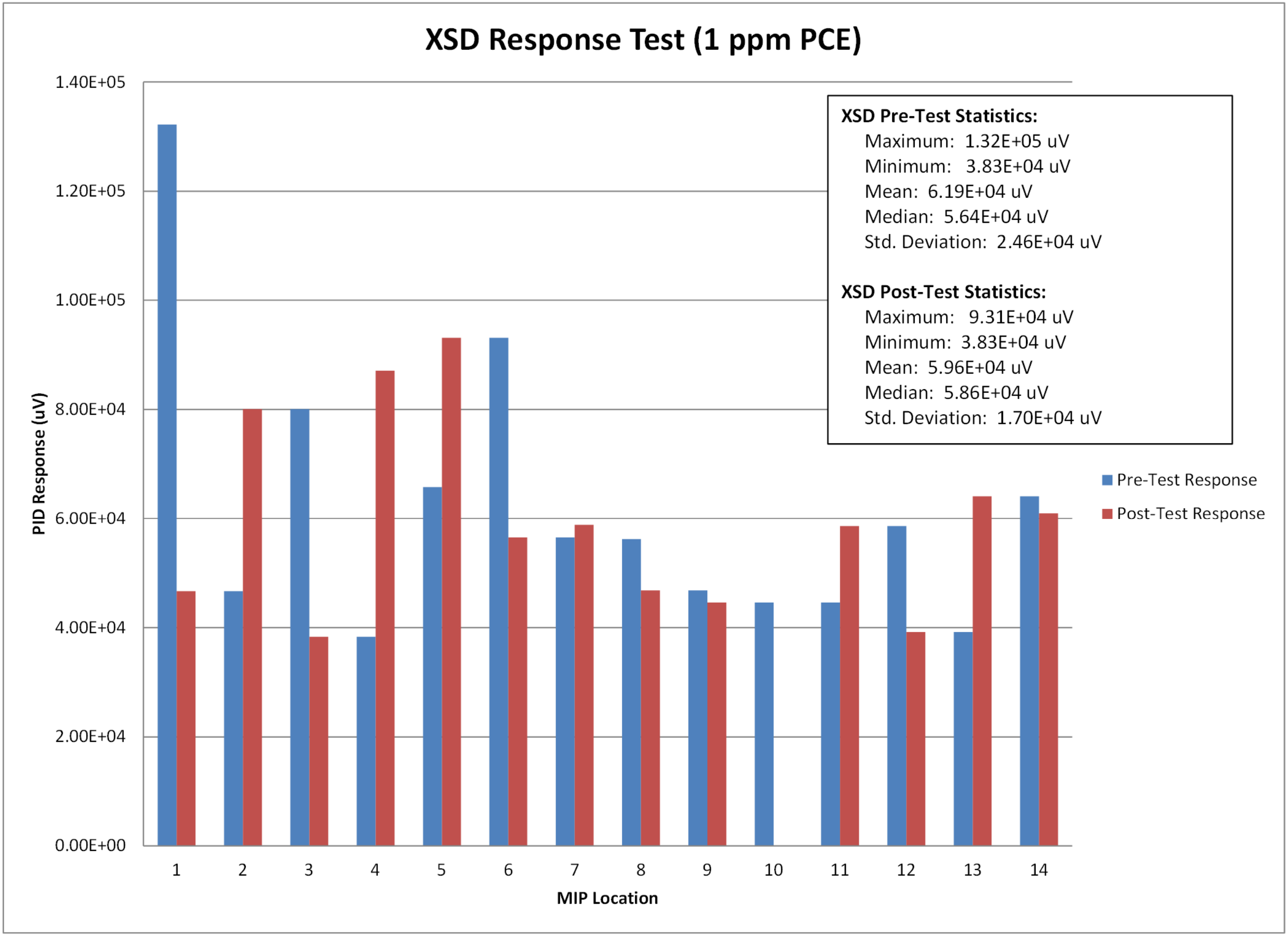


NOTES: Pre-Test Response: XSD: 1.1e5 for 1 ppm TCE.

Post-Test Response: XSD: 2.8e5 for 5 ppm TCE.

Appendix C: MIP Quality Assurance and Quality Control

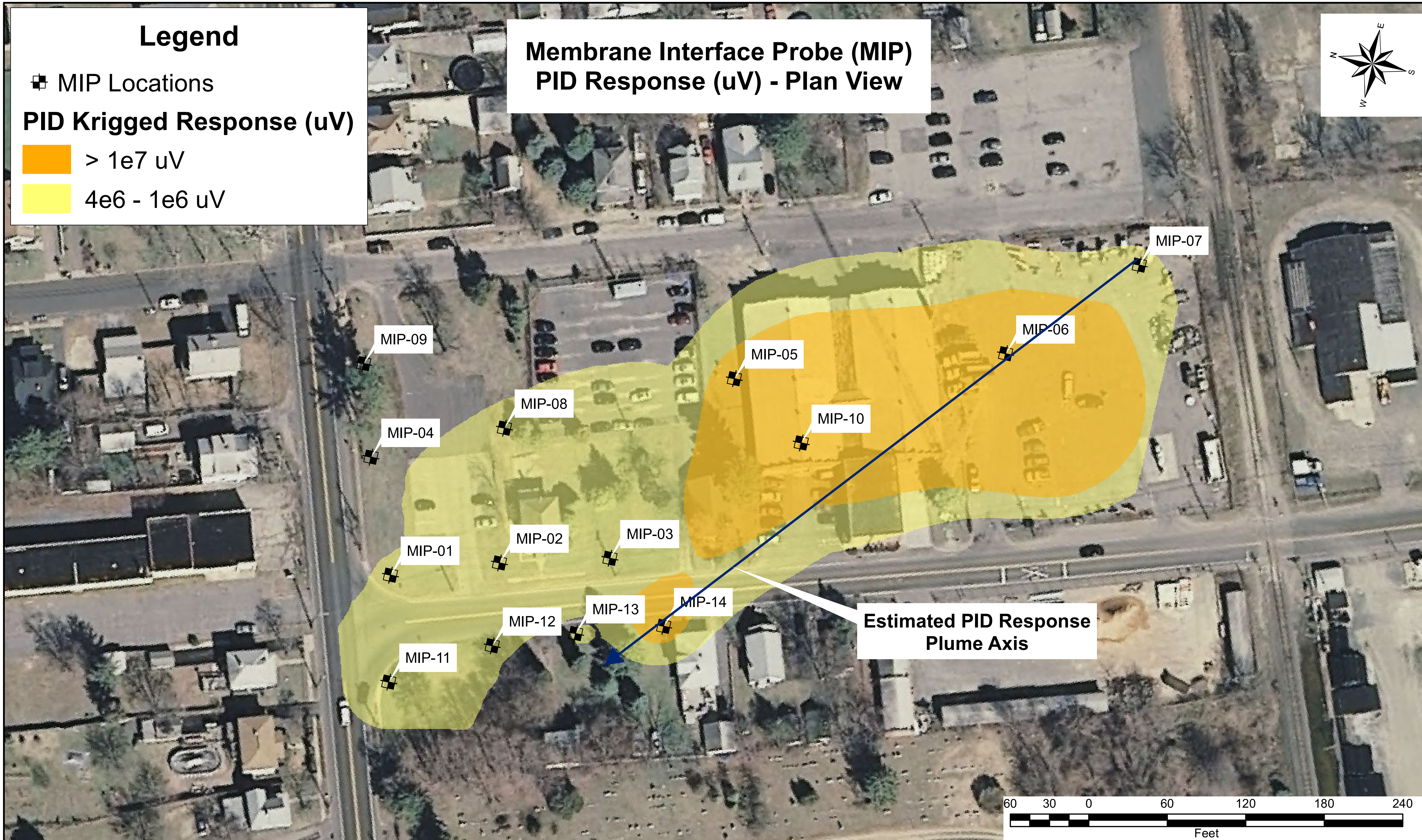

PID Response Test (5ppm Benzene)
PID Pre-Test Statistics:
Maximum: 1.39E+06 uV
Minimum: 3.33E+05 uV
Mean: 6.14E+05 uV
Median: 4.76E+05 uV
Std. Deviation: 3.21E+05 uV
PID Post-Test Statistics:
Maximum: 1.06E+06 uV
Minimum: 2.72E+05 uV
Mean: 5.51E+05 uV
Median: 4.83E+05 uV
Std. Deviation: 2.15E+05 uV
Pre-Test Response (uV)
Post-Test Response (uV)
PID Response (uV)
1.60E+06
1.40E+06
1.20E+06
1.00E+06
8.00E+05
6.00E+05
4.00E+05
2.00E+05
0.00E+00
1 2 3 4 5 6 7 8 9 10 11 12 13 14
MIP Location


XSD Response Test (1 ppm PCE)
PID Response (uV)
1.40E+05
1.20E+05
1.00E+05
8.00E+04
6.00E+04
4.00E+04
2.00E+04
0.00E+00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
MIP Location
XSD Pre-Test Statistics:
Maximum: 1.32E+05 uV
Minimum: 3.83E+04 uV
Mean: 6.19E+04 uV
Median: 5.64E+04 uV
Std. Deviation: 2.46E+04 uV
XSD Post-Test Statistics:
Maximum: 9.31E+04 uV
Minimum: 3.83E+04 uV
Mean: 5.96E+04 uV
Median: 5.86E+04 uV
Std. Deviation: 1.70E+04 uV
Pre-Test Response
Post-Test Response

Figures


Legend
MIP Locations
MIP Model Control Points
Membrane Interface Probe (MIP)
PID Response (uV) - Plan View
MIP-01
MIP-02
MIP-03
MIP-04
MIP-05
MIP-06
MIP-07
MIP-08
MIP-09
MIP-10
MIP-11
MIP-12
MIP-13
MIP-14
CP-1
MW-17
60 30 0 60 120 180 240
Feet
N
E
S
W

Figure 1



Membrane Interface Probe (MIP)
PID Response (uV) - Plan View
Legend
MIP Locations
PID Krigged Response (uV)
> 1e7 uV
4e6 - 1e6 uV
MIP-01
MIP-02
MIP-03
MIP-04
MIP-05
MIP-06
MIP-07
MIP-08
MIP-09
MIP-10
MIP-11
MIP-12
MIP-13
MIP-14
Estimated PID Response
Plume Axis
60 30 0 60 120 180 240
Feet

Figure 2

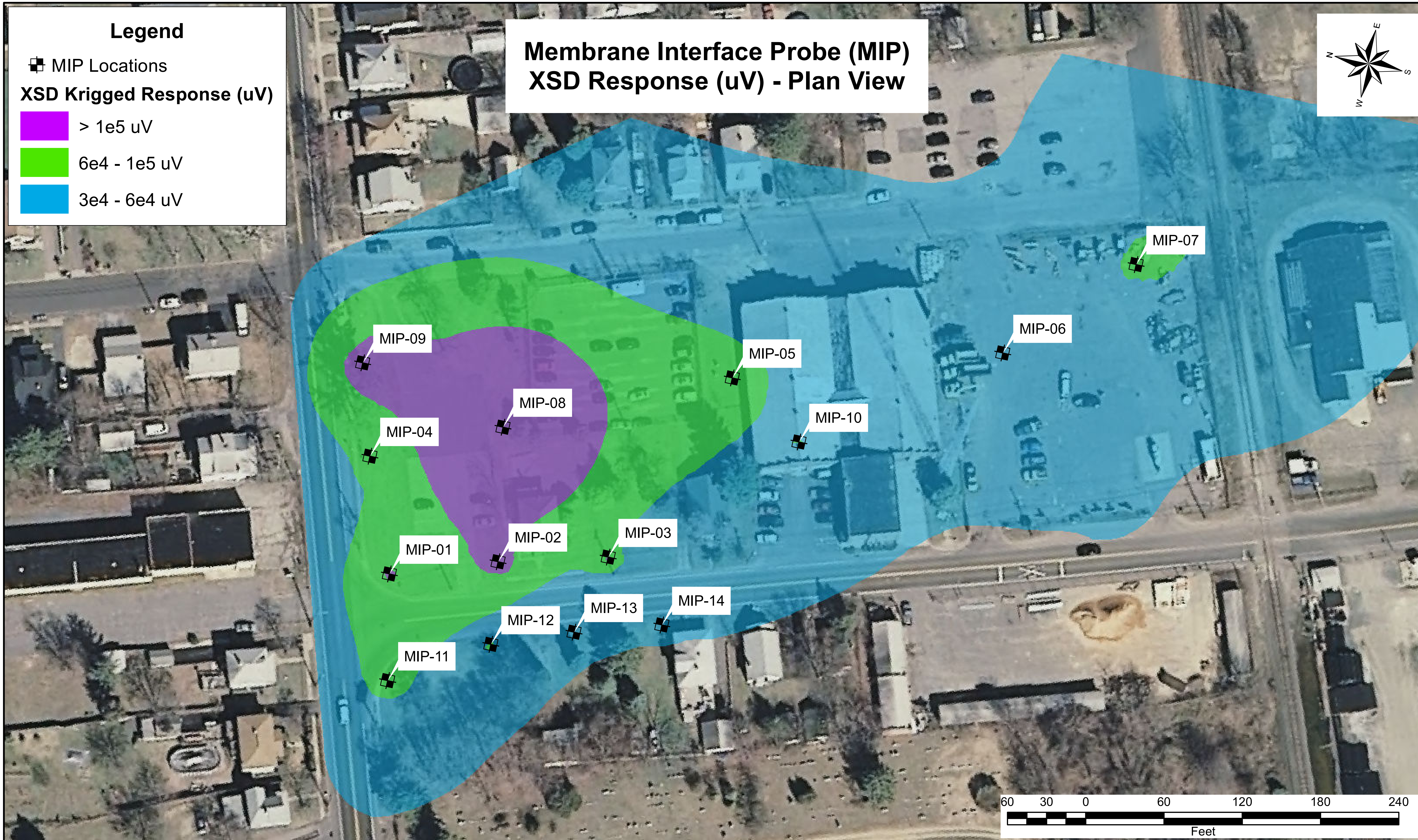
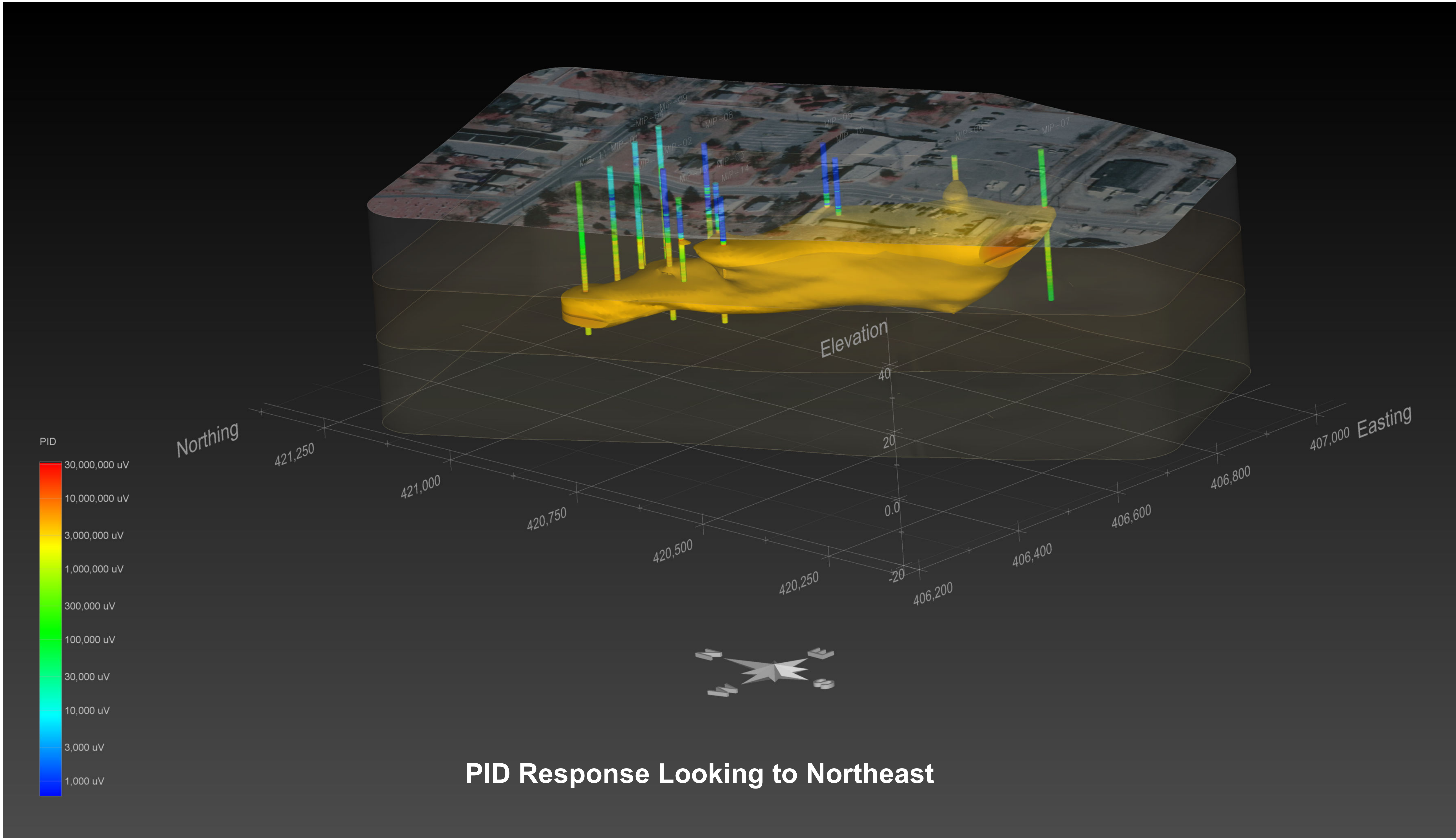
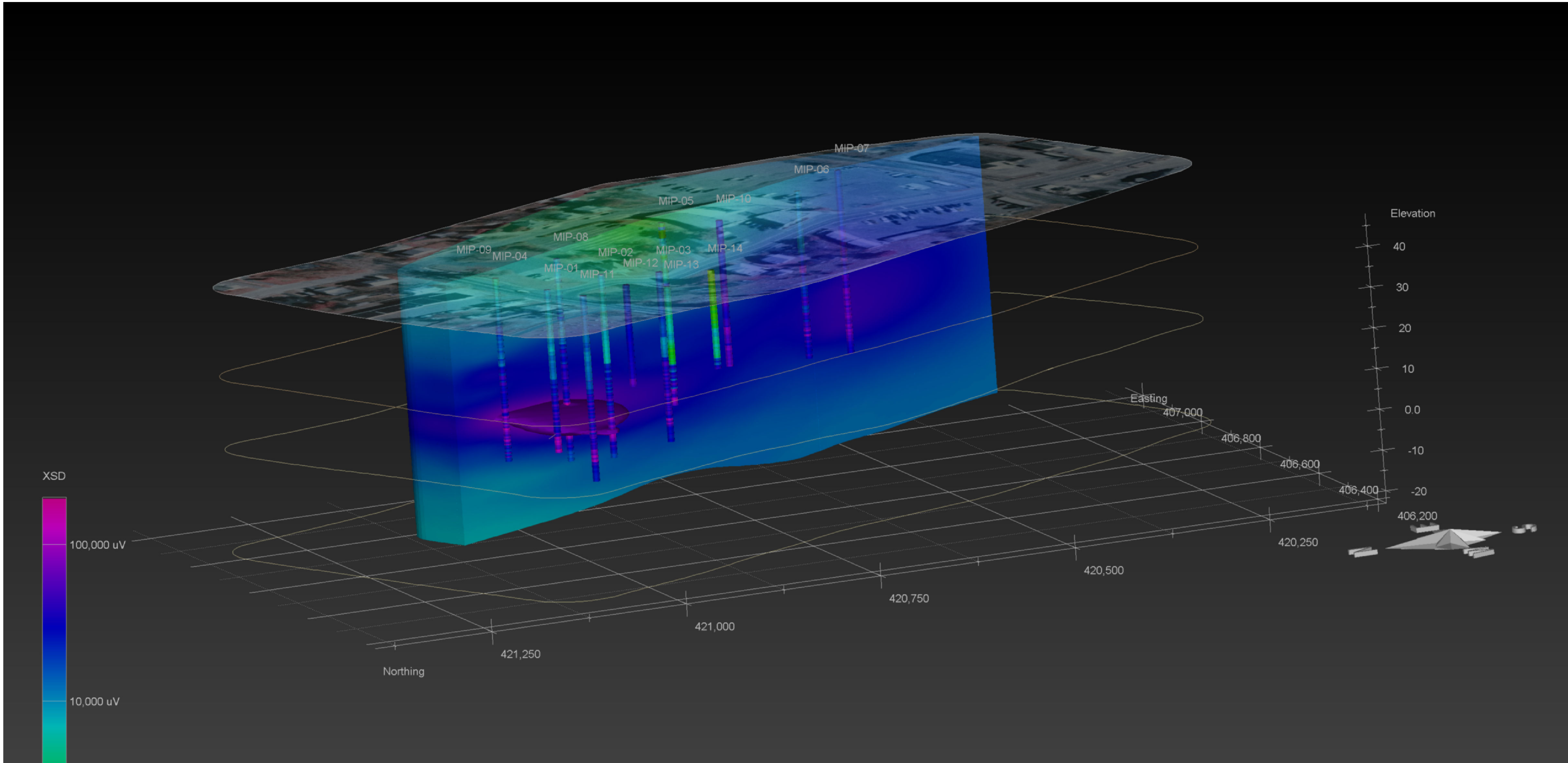

Legend
MIP Locations
XSD Krigged Response (uV)
> 1e5 uV
6e4 - 1e5 uV
3e4 - 6e4 uV
Membrane Interface Probe (MIP)
XSD Response (uV) - Plan View
MIP-01
MIP-02
MIP-03
MIP-04
MIP-05
MIP-06
MIP-07
MIP-08
MIP-09
MIP-10
MIP-11
MIP-12
MIP-13
MIP-14
60 30 0 60 120 180 240
Feet

Figure 3



PID Response Looking to Northeast

FIGURE 4



XSD Response Looking to East
XSD Shell: 1.0e5 uV

FIGURE 5