

**NAS Lemoore
Site 14 Triad Investigation**



**Tetra Tech EM Inc.
June 22, 2005**

Site 14 Setting

- Maintenance hangars and nearby aircraft parking area (Operations Area of NAS Lemoore)
- 22-acre site, 95% surfaced with concrete
- One of the suspected source areas (Building 180) undergoing \$20M remodeling concurrent with Triad investigation



Site 14 History

- Site 14 was a “late bloomer”:
 - Not identified during initial investigations in 1980’s
 - Originally identified in early 1990’s (Basewide RI phase) as Jet Engine Test Cells (sources were USTs and transformer pad)
 - Detections of chlorinated solvents led to investigation of Industrial Wastewater Lines, expanded footprint of site, which was renamed Chlorinated Solvent Plumes

Where Was the Momentum?

- Project was at an impasse because of the inefficiencies of traditional communication model of comment / response
- Progress was slow because of the inefficiencies of a traditional investigation approach, that was based primarily on monitoring well drilling and sampling

Why Triad?

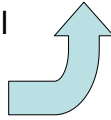
- Both Navy and DTSC were motivated to jump start the process
- Both parties realized a more collaborative approach was necessary to make a “fresh start”
- Tools /methods now available to get the “snapshot” of nature and extent, optimize and focus the monitoring well program

Systematic Planning provided a “fresh start” through collaborative planning, greater transparency, stakeholder involvement

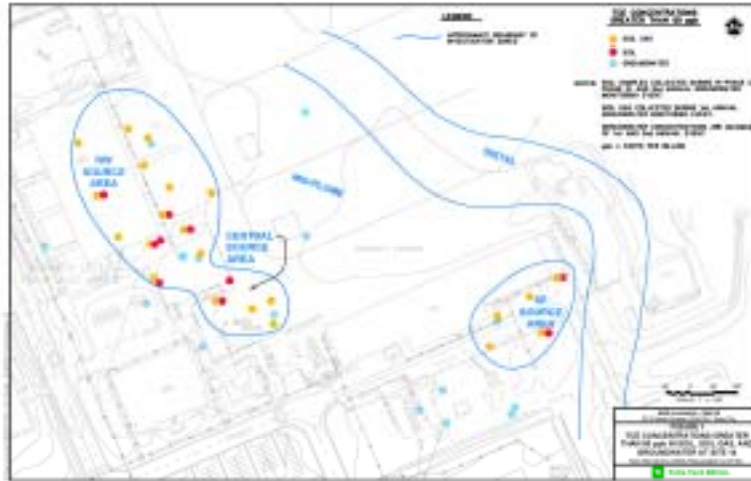
Dynamic Work Planning and Real-time Measurement Technologies provide a means to obtain a “snapshot” of existing conditions / source area / plume extents

Systematic Planning

- **Communication**
 - Quarterly meetings
 - Conference calls: planning, interim results
 - Web casts
 - Regulatory participation in investigation
- **Conceptual Site Model**
 - Collaborative input
 - Decision support tools
- **Managing Uncertainty**
 - Collaborative data sets
 - “Focusing” the investigation (CFESS)



Preliminary Conceptual Site Model for Site 14 Groundwater Plumes

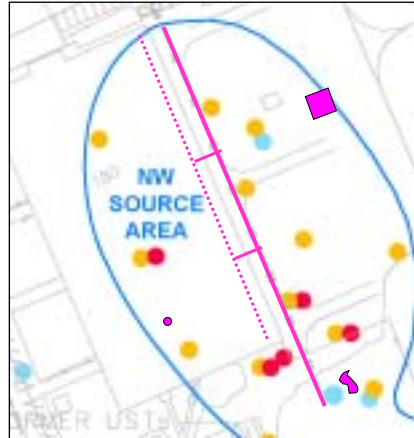


Widespread plume, multiple sources likely

- TCE concentrations in groundwater over 500 parts per billion (ppb) extend across much of the site.
- All soil gas and soil concentrations over 500 ppb are clustered in three potential source areas.

Potential Sources in NW Area

- Product/waste drained or poured on ground. Penetration through joints between concrete blocks. Product / waste poured on dirt area
- Product/waste drained into Building 180 drain, then out storm drain.
- Product/waste drained into drains feeding old IWL lines



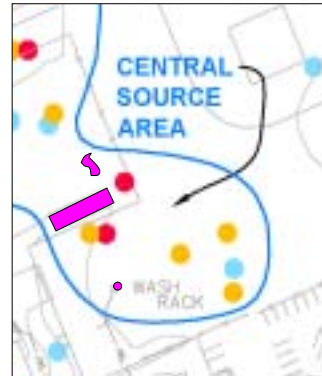
NW Source Area is underlain entirely with concrete.

Storm drain bisects the area, a drain that runs the length of Building 180 connects to storm drain in two places.

Drain lines may have run eastward (within building) to the IWL at one time

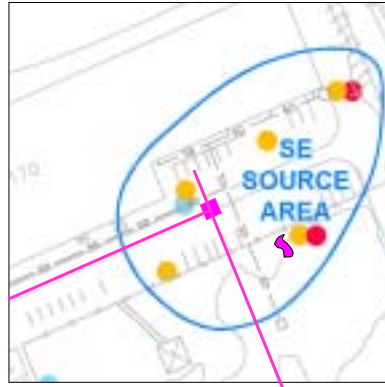
Central Source Area Characteristics

- Northern portion is bare soil (possible spill location)
- Former hazardous waste storage unit (Quonset hut) located in northern portion
- Wash rack catch basin leading to IWL near southern boundary of source area. Surface nearby is concrete.



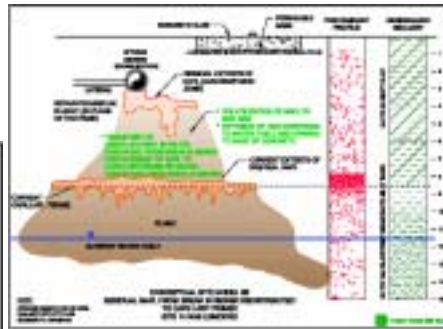
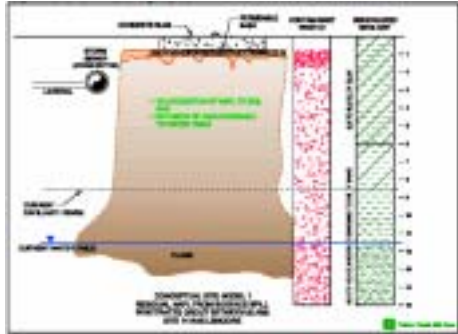
SE Source Area Characteristics

- Bare soil south of parking lot (possible spill location)
- Catch basin in center of parking lot, two storm sewers join below this catch basin



Depicting the CSM: Conceptual Model Alternative (CMA) Diagrams

CMA #1
Surface Spill



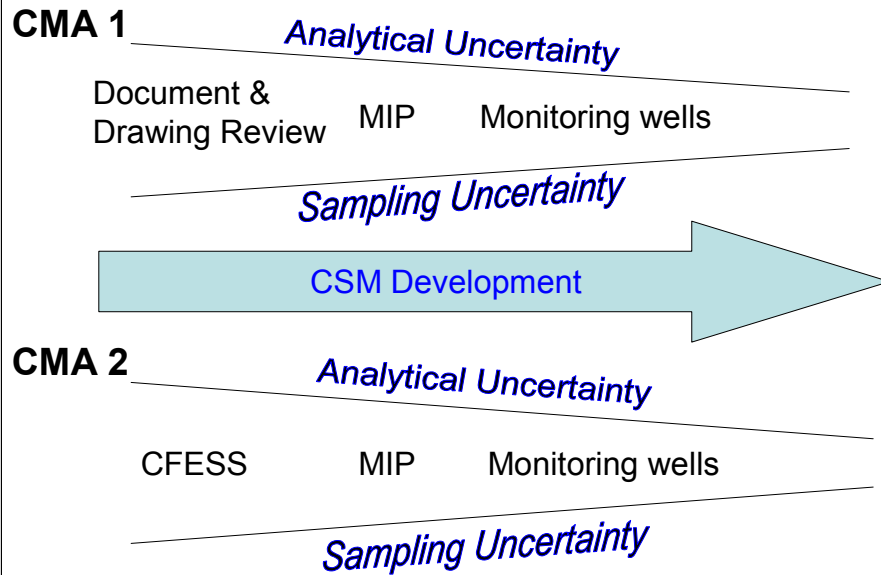
CMA #2B
Discharge through Sewer Joint
(and redistribution to capillary fringe)



Depicting the CSM: Pathway-Release Diagram

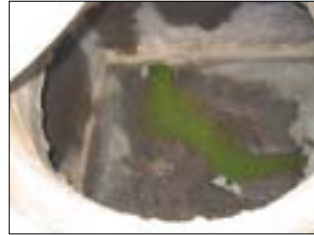


Focusing the Investigation



CFESS: Conduit –Focused Evaluation of Solvent Sources

Investigated potential pathways through: smoke testing, dye testing, video survey and packer-based pressure testing and sampling



CFESS Results



- Smoke testing confirmed connection between sewer and the hangar deck drain (shown above) via the lateral connection (shown at right)

- Pressure testing showed that joints were sealed with rubber gaskets, generally in good shape
- Video showed locations of 4 defects such as the “break-in” lateral connection below

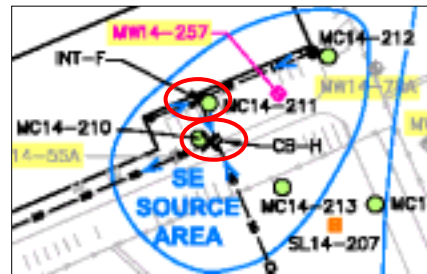


Focusing the Investigation: CFESS Info Provides Basis for MIP locations



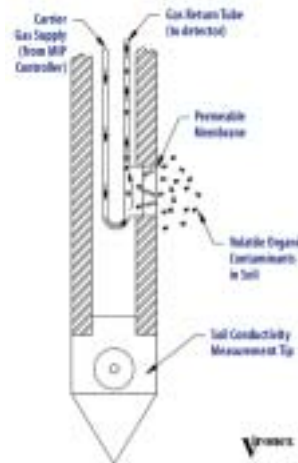
MIP profiles were located adjacent
To all four sewer defects

A fifth location was based on a
floor drain discovered during the
hangar walk-through (bottom left)



Membrane Interface Probe (MIP) Investigation

- Provides nearly-continuous (0.05-foot increments) profile of VOC concentrations with depth in both vadose and saturated zones
- Combined with cone penetrometer test (CPT) sensors to obtain nearly-continuous record of lithology



The Membrane Interface Probe (MIP) is a tool that is used to sample total VOCs in a nearly-continuous manner through the subsurface. It can be combined with CPTs sensors on a single tool, that is pushed through the subsurface using direct push drilling equipment.

VOCs are volatilized by the heated surface of the probe (heated to 80°C to 125°C). The membrane is hydrophobic; VOCs diffuse across the membrane but liquids cannot, therefore, the MIP can be used to sample VOCs both above and below the water table.

After diffusing across the membrane, VOCs partition into a carrier gas that is circulated – at a constant rate – to the surface, where the gas may be analyzed by one or more detectors. An electron capture device (ECD) is used to analyze for chlorinated solvents and a photoionization detector (PID) is used to analyze for fuel constituents. Both readings are plotted on a log, along with a lithologic profile developed from the CPT data, and available immediately after the push. Thus, the data is real-time.

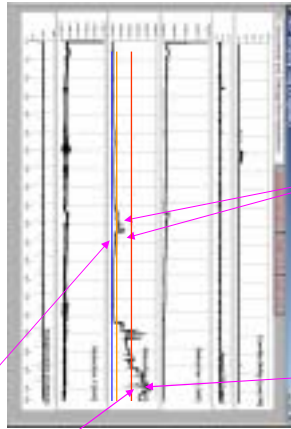
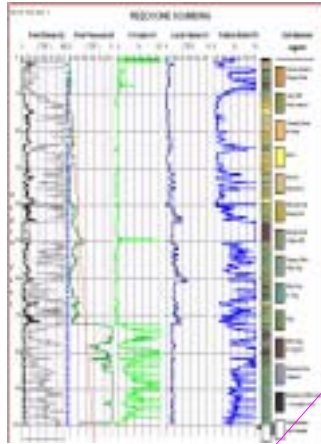
Advantages and Limitations of Analytical Data Types in Collaborative Data Sets

	Advantage	Limitation
MIP Response	<ol style="list-style-type: none"> 1. Continuous profile 2. Rapid data collection 3. Multiple sensors may respond to a wide range of VOCs 4. Can generate lithologic information with CPT log 5. Sensitive to VOCs in all matrices 	<ol style="list-style-type: none"> 1. Not analyte specific 2. Not matrix specific 3. Must be calibrated to a single contaminant 4. Probe subject to damage and could require maintenance 5. Detection limits below 50ug/L unlikely to be attained with certainty
Mobile Lab EPA Method 8260	<ol style="list-style-type: none"> 1. Analyte specific for analytes on list (8260) 2. Able to quantitate data to 5 ug/L 3. Matrix specific above the water table 	<ol style="list-style-type: none"> 1. Only select points can be sampled economically 2. May not identify VOCs on list (8260) 3. Matrix specific above the water table 4. Depth intervals may be uncertain due to lost core

Advantages and Limitations of Lithologic Data Types in Collaborative Data Sets

	Advantage	Limitation
CPT Logs	<ol style="list-style-type: none"> 1. Continuous profile 2. Response is repeatable and consistent between bore holes 3. Can be done at the same time as MIP 4. Can collect hydrologic data with pore pressure sensor 	<ol style="list-style-type: none"> 1. Not a direct observation of geology 2. Some soil types may be misrepresented
Geologic Bore Logs	<ol style="list-style-type: none"> 1. Direct observation of core through sight, touch, and odor 2. Can select direct sampling intervals 3. Can directly observe saturation conditions and some types of contamination (staining) 	<ol style="list-style-type: none"> 1. Depth intervals may be misidentified due to lost core 2. Soil type based on subjective observation of individual geologist

CPT / MIP / Sample Comparison at MC14-203



Discrete Sample Results

TCE	1,1-DCE	Depth
5	5	1.75
17	5	7.75
12	5	11.75
11	5	15.8
210	27	48.8
29	5	53.3
160	24	53.8
5	5	61.3
5	5	71.75
5	5	74.5
5.8	5	91.25
34	5	96.25
51	5.2	103.8
5	5	109.8

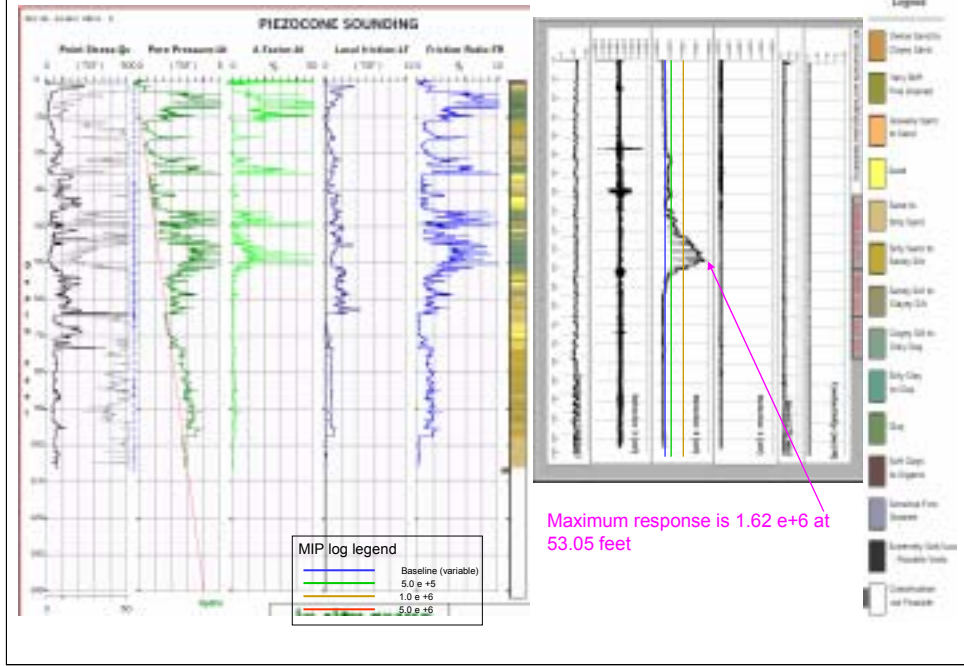
MIP log legend

—	Baseline (variable)
—	5.0 e +5
—	1.0 e +6
—	5.0 e +6

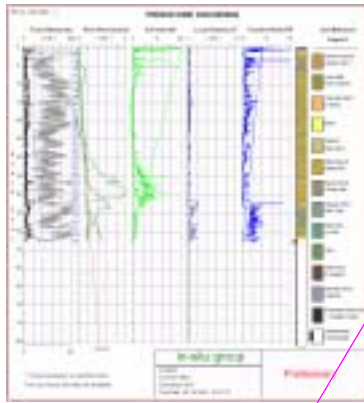
Blue box indicates groundwater sample result, all others are soil.

Max response in 50' zone is 2.6e+6 at 51.3'
 Max response in 100' zone is 7.8e+6 from 94.35' to 95.05'

CPT / MIP / Sample Comparison at MC14-204



CPT / MIP / Sample Comparison at MC14-210



Maximum response is 3.95 e+6 at 24.45 feet

Discrete Sample Results

TCE	1,1-DCE	Depth
1.0	1.0	24.45
1.0	1.0	24.45
1.0	1.0	24.45

Discrete Sample Results from MC14-241

TCE	1,1-DCE	Depth
1.0	1.0	24.45
1.0	1.0	24.45
1.0	1.0	24.45

MIP log legend

Blue line	Baseline (variable)
Green line	5.0 e +5
Red line	1.0 e +6
Orange line	5.0 e +6

Blue box indicates groundwater sample result, all others are soil.

Soil Behavior Legend

- Dark Grey/Black: Organic Clay
- Dark Green: Very Soft Fine Grained
- Orange: Organic Silt to Sand
- Yellow: Sand
- Light Green: Silt to Clay
- Dark Green: Very Soft to Medium Stiff
- Medium Green: Medium Stiff to Clayey Silty
- Dark Green: Clayey Silty to Silty Clay
- Dark Green: Silty Clay to Clay
- Dark Green: Clay
- Dark Grey: Soft Clay to Organic
- Dark Grey: Unconsolidated Fine Grained
- Dark Grey: Extremely Soft/Very Flowable Sands
- Dark Grey: Consolidated and Flowable

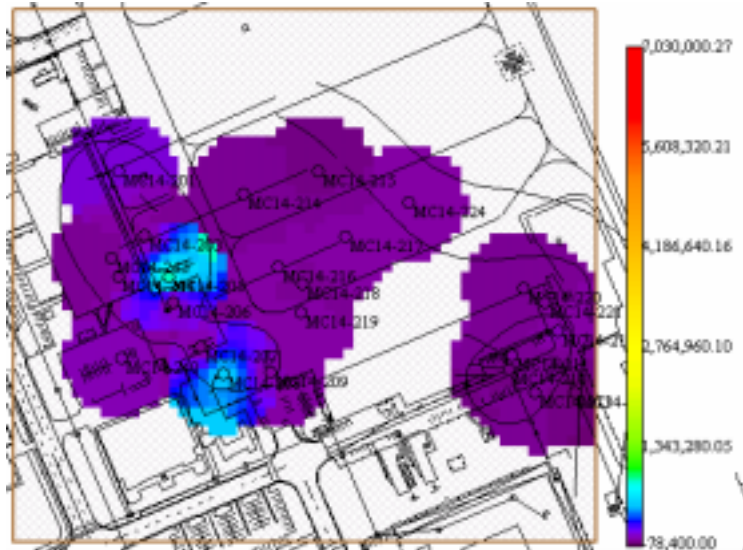
Use of DST for Site 14 Triad Investigation

- SADA was used to provide visualizations before, during and after the field investigation
 - Before: SADA was used to post / plot existing soil, soil gas and groundwater data and share with stakeholders during a web cast
 - During: Real-time data were loaded to SADA during field effort, visualizations were developed and e-mailed to DTSC during later stages of investigation to facilitate collaborative decision-making
 - After: Visualizations developed from revised data set and used to illustrate findings in an appendix to the electronic technical memorandum

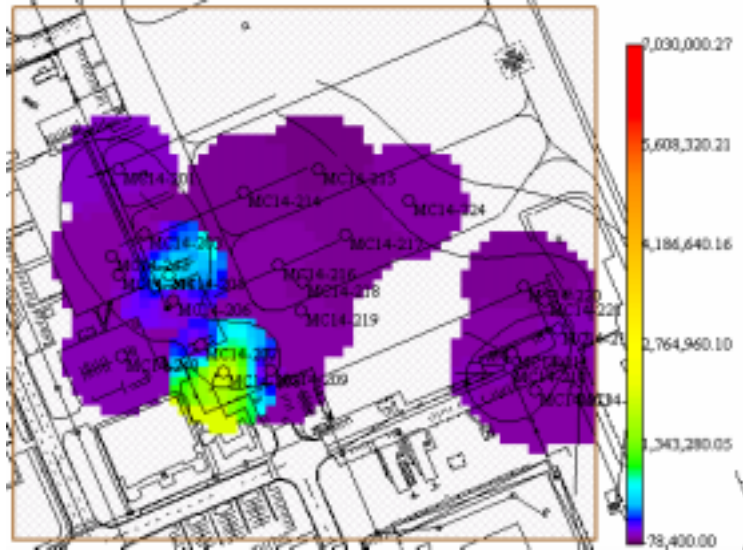
Average MIP Response

- The next sequence of slides represent the average MIP response in each 5-foot interval
- MIP response is recorded on 0.05-foot intervals, thus it averages 100 individual readings
- MIP response is not matrix-specific, may include VOCs on soil, in soil gas and groundwater

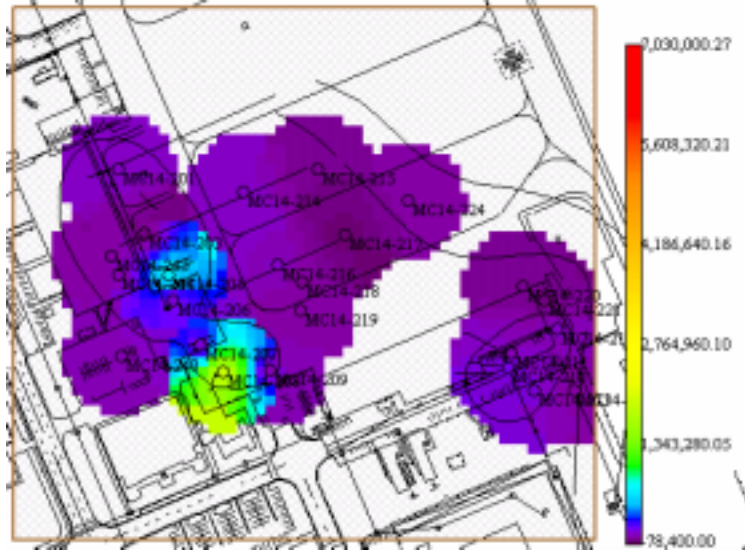
MIP Results: Average Response (uV)
0.0 to 5.0 feet



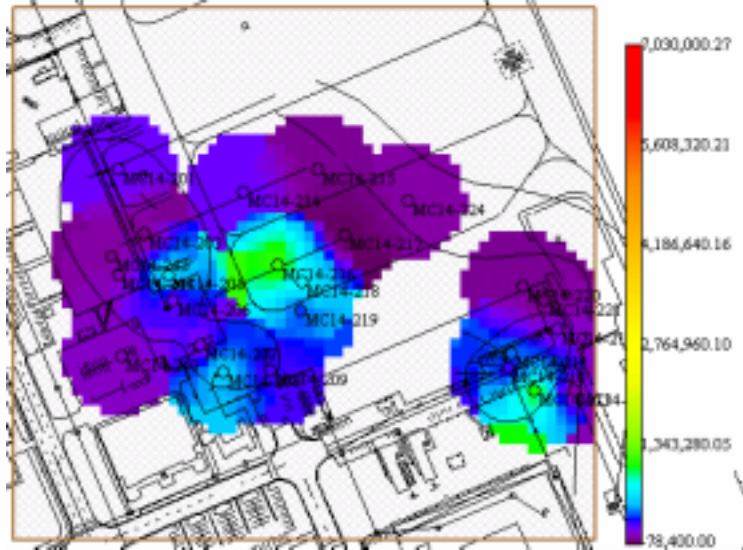
MIP Results: Average Response (uV)
5.0 to 10.0 feet



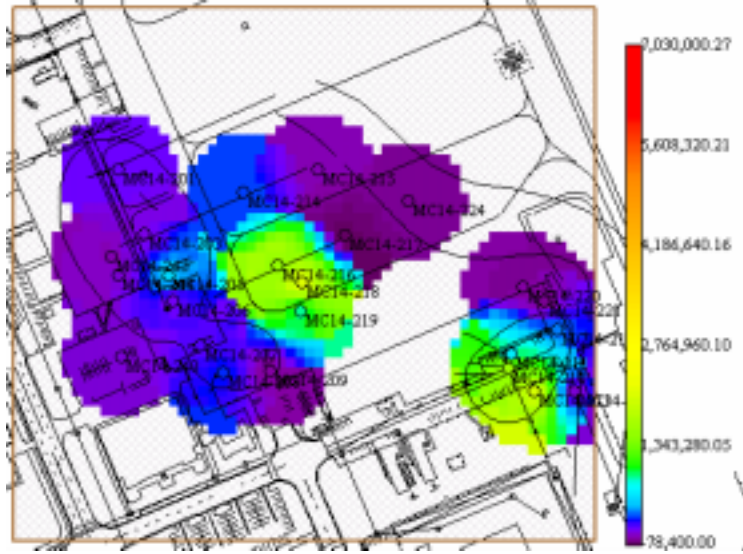
MIP Results: Average Response (uV) 10.0 to 15.0 feet



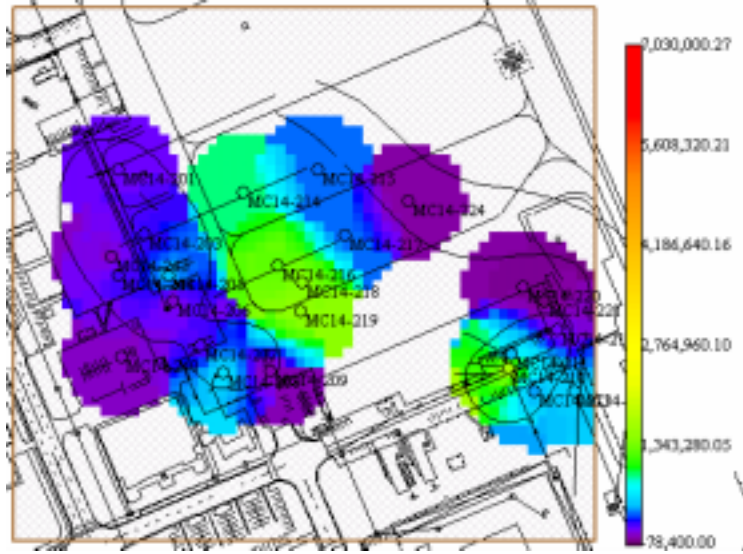
MIP Results: Average Response (uV)
15.0 to 20.0 feet



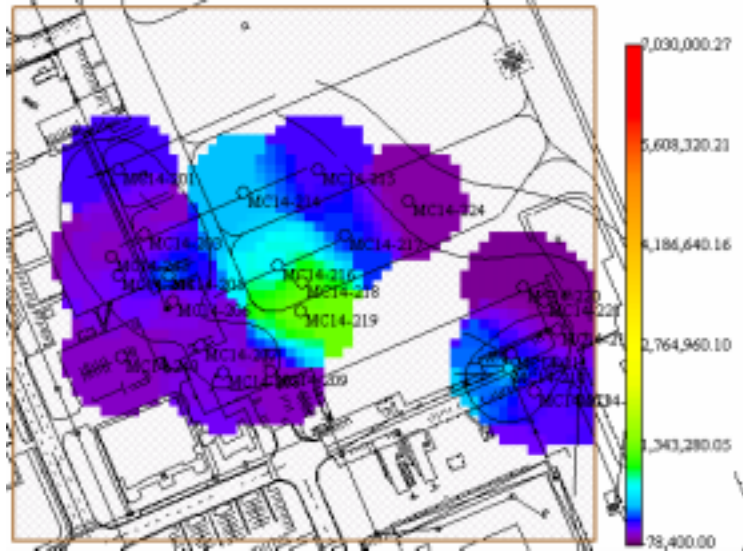
MIP Results: Average Response (uV)
20.0 to 25.0 feet



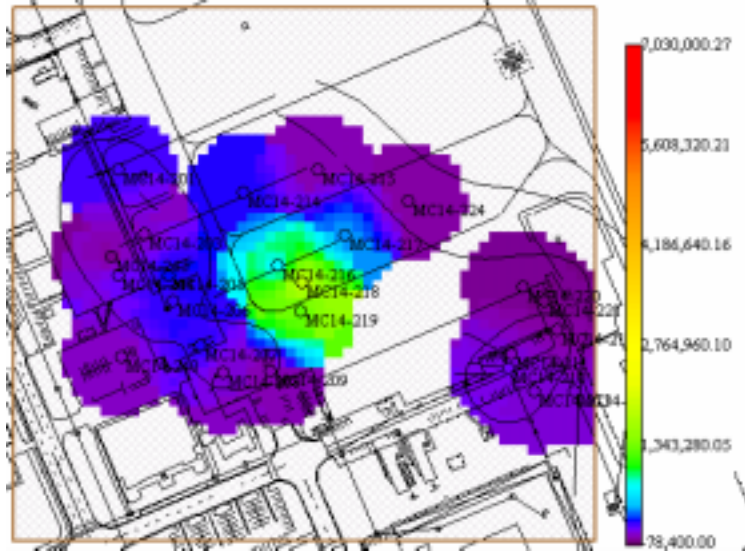
MIP Results: Average Response (uV)
25.0 to 30.0 feet



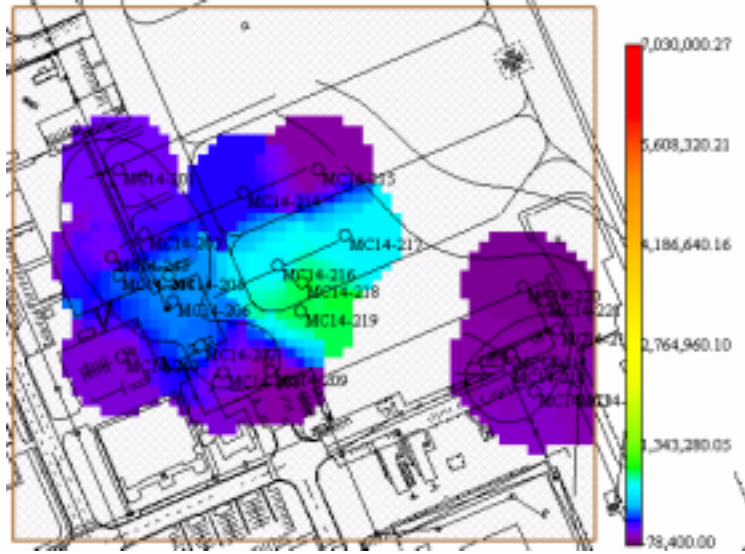
MIP Results: Average Response (uV)
30.0 to 35.0 feet



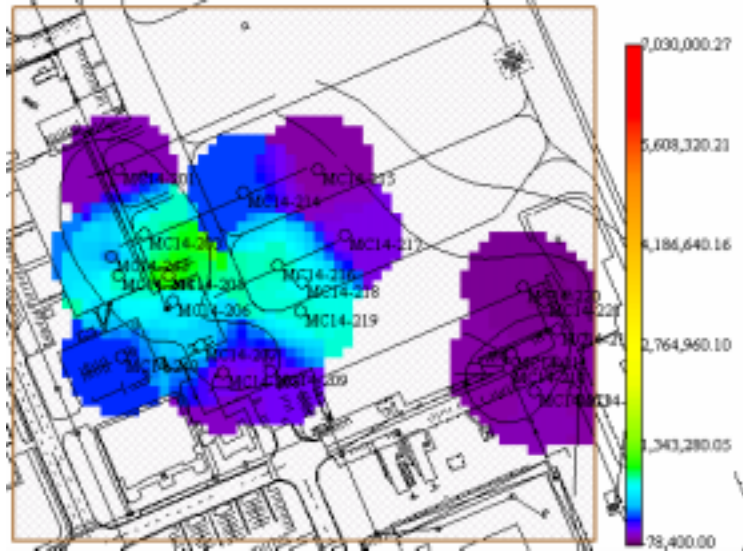
MIP Results: Average Response (uV) 35.0 to 40.0 feet



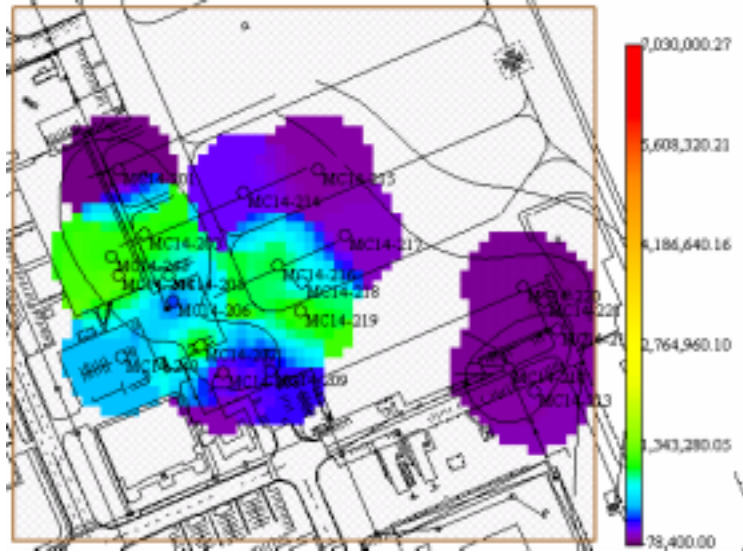
MIP Results: Average Response (uV) 40.0 to 45.0 feet



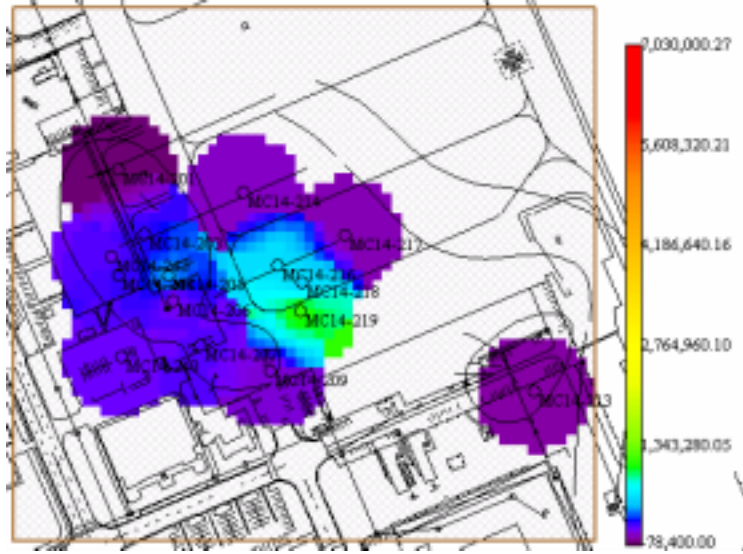
MIP Results: Average Response (uV)
45.0 to 50.0 feet



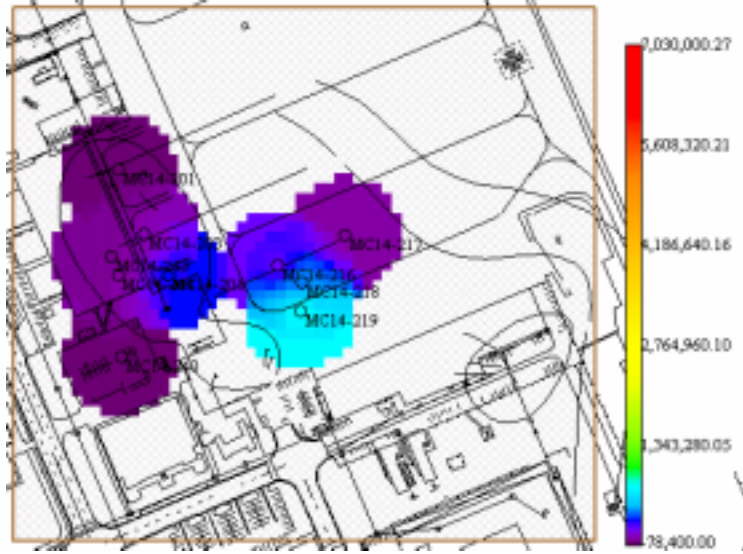
MIP Results: Average Response (uV)
50.0 to 55.0 feet



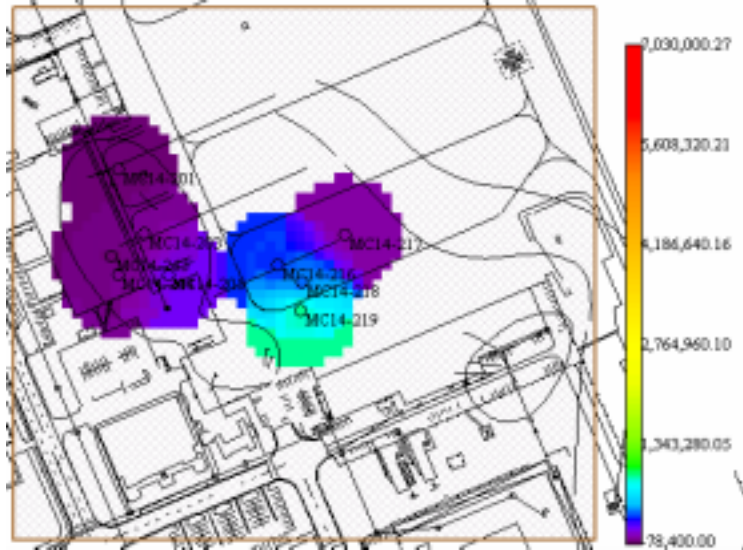
MIP Results: Average Response (uV)
55.0 to 60.0 feet



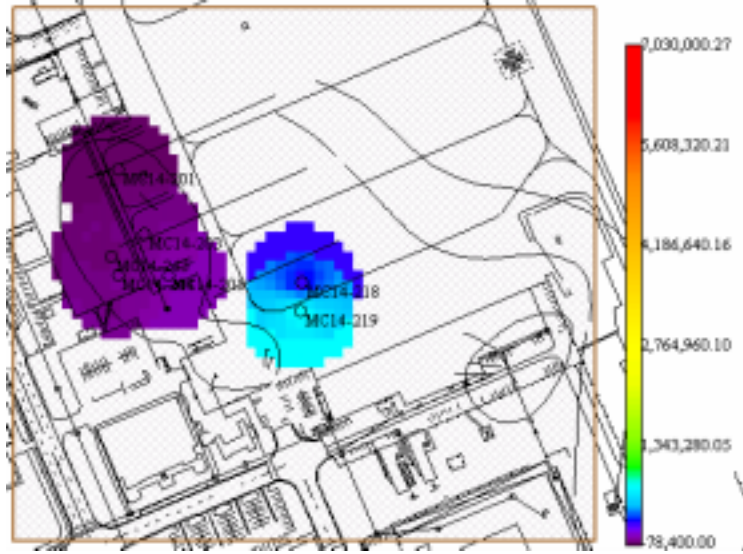
MIP Results: Average Response (uV)
60.0 to 65.0 feet



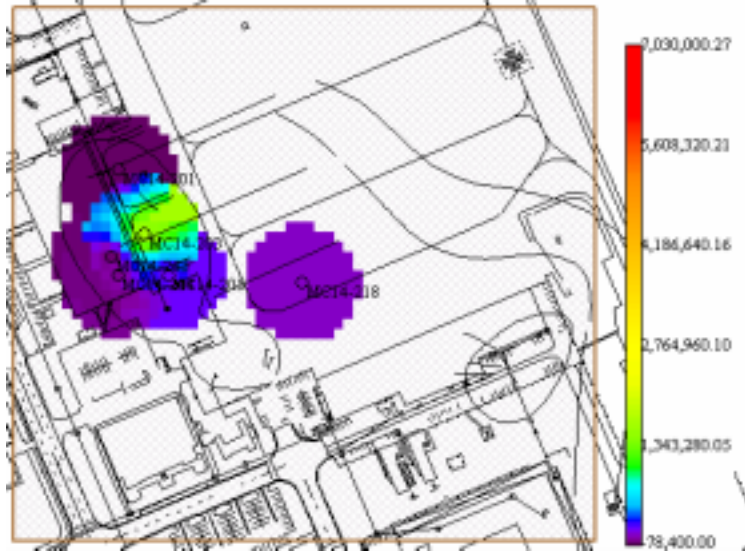
MIP Results: Average Response (uV)
65.0 to 70.0 feet



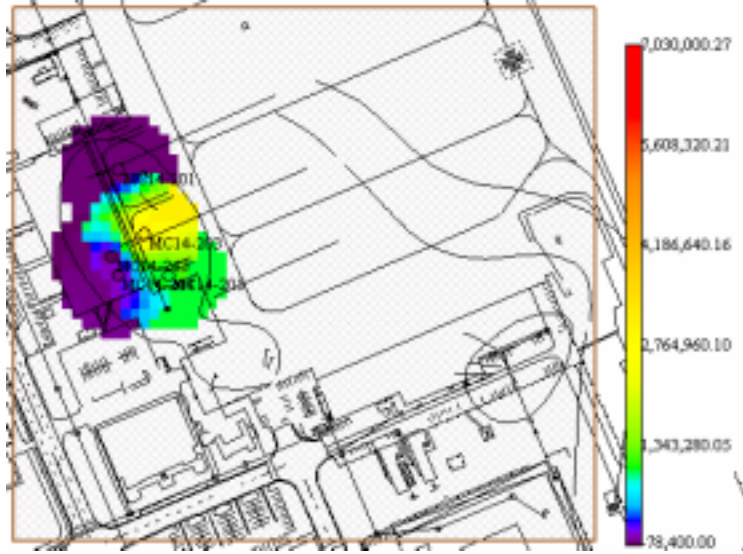
MIP Results: Average Response (uV)
70.0 to 75.0 feet



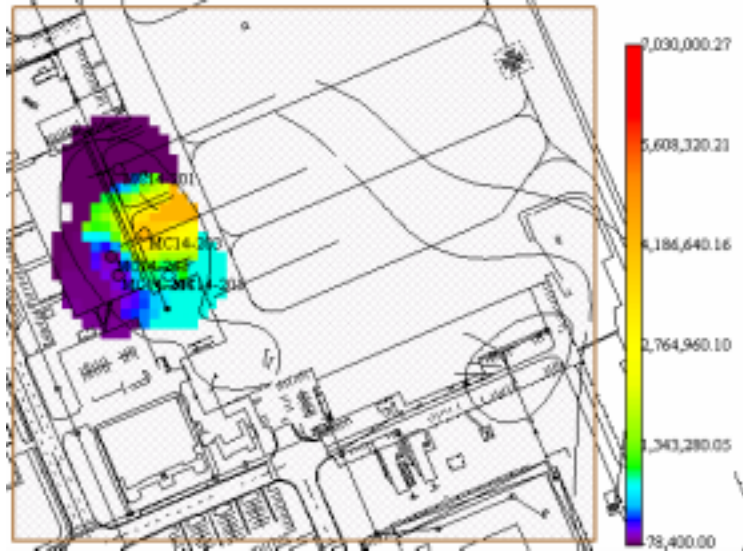
MIP Results: Average Response (uV) 75.0 to 80.0 feet



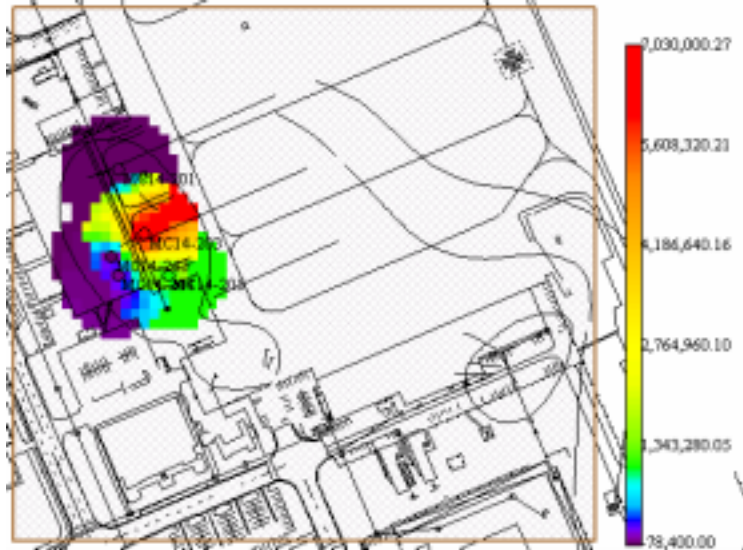
MIP Results: Average Response (uV)
80.0 to 85.0 feet



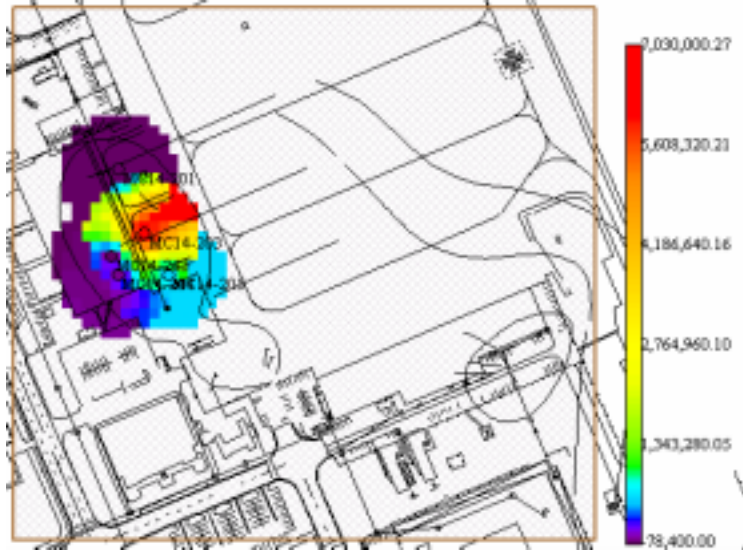
MIP Results: Average Response (uV)
85.0 to 90.0 feet



MIP Results: Average Response (uV)
90.0 to 95.0 feet

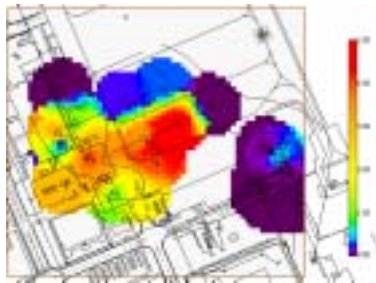


MIP Results: Average Response (uV)
95.0 to 100.0 feet

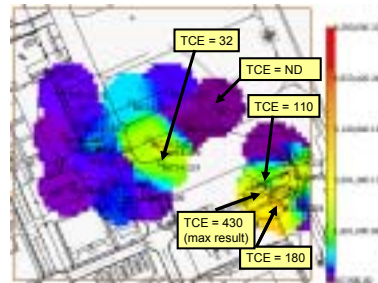


20-Foot Zone:
MIP and Sand Thickness are Directly Related in
One Area and Inversely Related in Other

Sand Thickness (CPT)



Maximum MIP Response

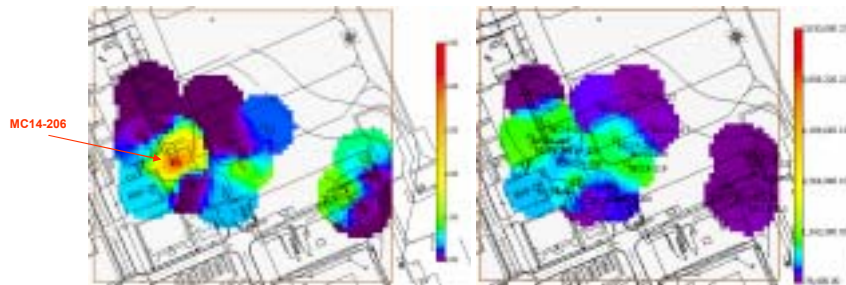


In the north-central portion of site, MIP response and sand thickness are at a maximum in the same area; In the southeastern portion of the site, MIP response is highest where sand is not present.

50-foot zone: Inverse Relationship Between Sand Thickness and MIP Response at MC14-206

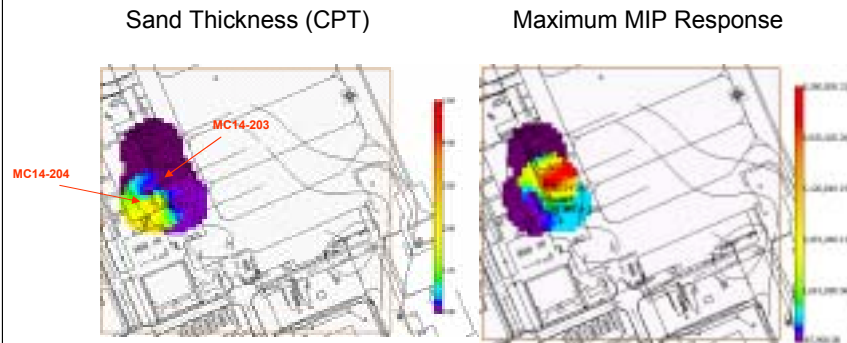
Sand Thickness (CPT)

Maximum MIP Response



Sand thickness is at a maximum at MC14-206, but the MIP response is less than in adjoining areas.

100-foot zone:
Inverse Relationship Between Sand Thickness and
MIP Response at MC14-203 and MC-204



Sand thickness is at a maximum at MC14-204, but the MIP response is low; opposite is true at MC14-203.

Preliminary Observations - General

- Much of the VOC contamination has moved downward and outward in the northern and central source areas
- Overall lateral extents, however, have not expanded
- Much of the contaminant mass is concentrated in fine-grained layers

Preliminary Observations - Specific

- Contamination cuts across significant thickness of fine-grained lithologies in northwestern and central source areas
- Contamination is tightly concentrated in one depth interval (20 to 30 feet bgs) in southeastern source area
- Poor agreement between MIP response and discrete sample results between 75 and 100 feet bgs at MC14-203. TCE at have been detected at a few deep locations, but at much lower concentrations (50 ppb and less) than would be expected by the MIP response
- No VOCs (other than 1,4-dichlorobenzene) present in concentrations above 21 $\mu\text{g}/\text{kg}$ in sludge sample from floor drain. The two MIPs pushed downgradient of this drain do not support the floor drain as a source of VOC contamination.

The CSM Evolves...

- CMA 1 ruled out beneath concrete ramp; may apply to former bare soil area
- CMA 2 confirmed for southeastern and central source areas, still likely for northeastern source area, however...
- VOCs appear to have been largely displaced from shallow portions of source areas (vadose and cap fringe), most of this has likely occurred in the last 5 years

Next Steps

- CSM is being revised and CMAs will be modified based on results of MIP investigation
- Monitoring well and borehole drilling to occur in July / August of 2005
- Fifteen wells will be installed, more than anticipated but within budget (a traditional approach would have required 30+ wells just to do what we accomplished during the MIP phase)
- Dynamic elements will be incorporated in this effort, some decisions will be made on the basis of “quick turn” analyses on borehole samples collected during the first three days

Eyes on the Prize: Ultimate Goals

- Risk assessment will be conducted using fixed-lab soil samples collected during MIP investigation and existing / new monitoring well sample results
- Remaining RI/FS process will be streamlined as a result of using the Triad systematic planning process
- Navy goal is to have remedy in place by the end of FY 2007