

# 3D Solids & Parameter Modeling to Facilitate Triad-Compliant Rapid Site Characterization



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# Problem / Purpose

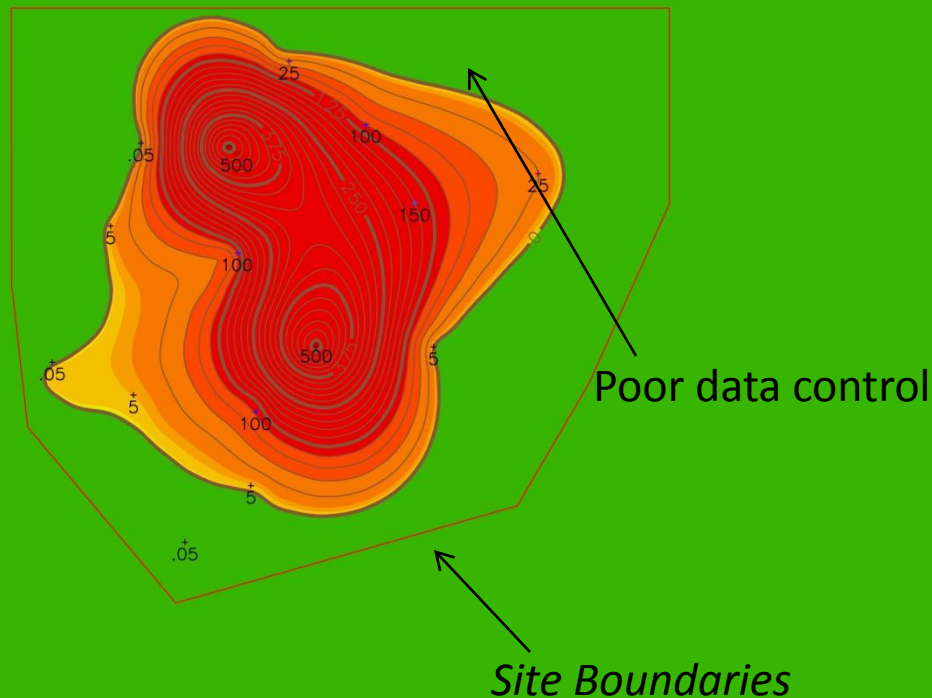


- The cost & duration of standard environmental site characterizations often impede development decisions and environmental restoration.
- Neither the responsible party nor the environment benefit from prolonged and costly characterization studies.
- There is a need to expedite and, at the same time improve, contaminant delineations that form the basis for environmental site characterization.
- 3-D Parameter modeling in conjunction with rapidly collected geotechnical data can dramatically improve contaminant delineations while at the same time dramatically decreasing the duration of the site characterization process.
- This presentation will outline the process and results obtained from an implementation of this process at a brown fields site in Kansas.

# Gridding Problems



*Grid Spacing = 0.5*



Software settings are very significant to output from computer-generated contour maps.

Particularly in regions with sparse data control.

Basic assumption in contouring is that the distribution process is continuous.

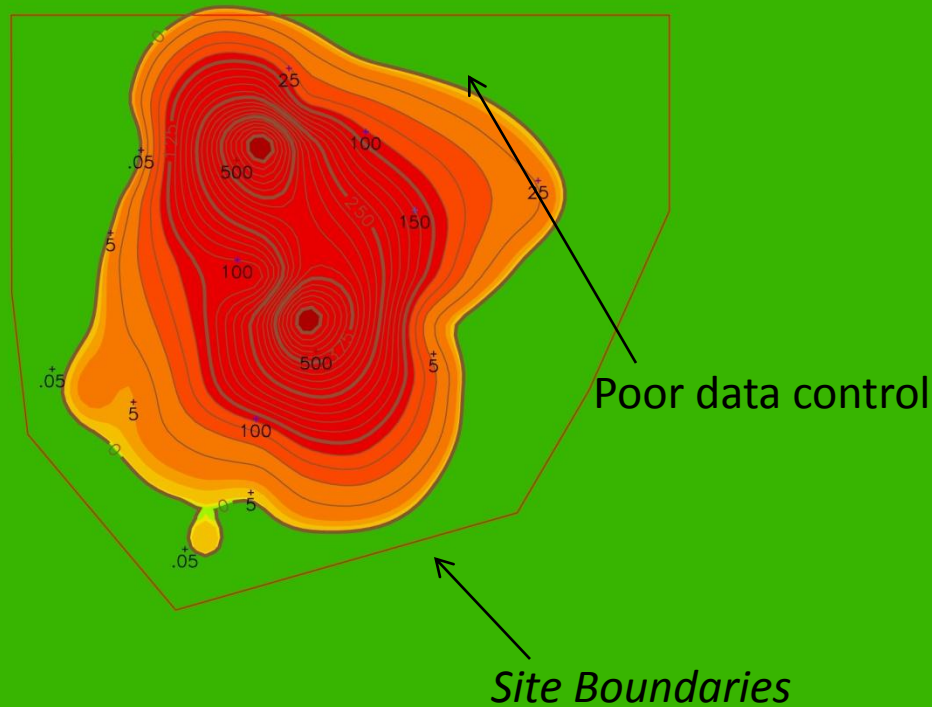
- *geologic heterogeneity?*
- *engineered barriers?*

Data Density = Best Approach

# Gridding Problems



*Grid Spacing = 1.0*



Software settings are very significant to output from computer-generated contour maps.

Particularly in regions with sparse data control.

Basic assumption in contouring is that the distribution process is continuous.

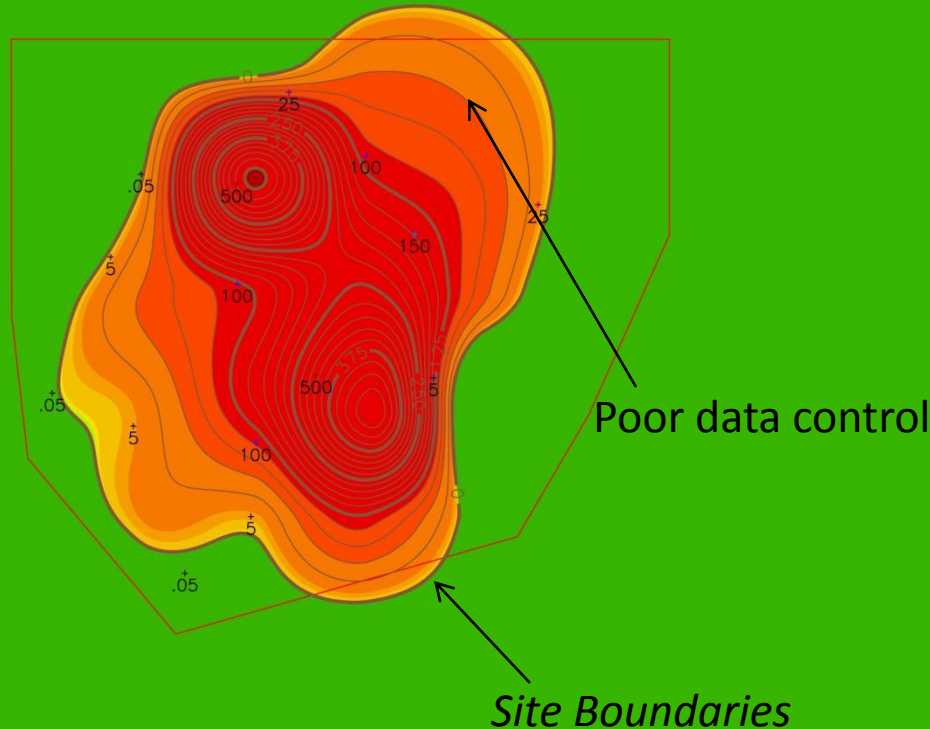
- *geologic heterogeneity?*
- *engineered barriers?*

Data Density = Best Approach

# Gridding Problems



*Grid Spacing = 2.0*



Software settings are very significant to output from computer-generated contour maps.

Particularly in regions with sparse data control.

Basic assumption in contouring is that the distribution process is continuous.

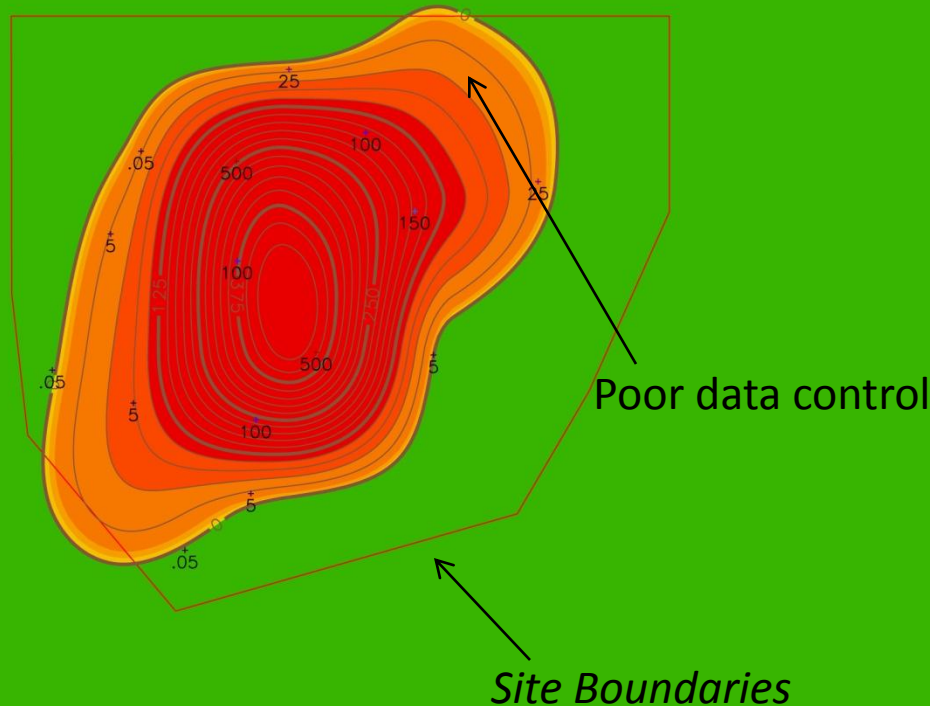
- *geologic heterogeneity?*
- *engineered barriers?*

Data Density = Best Approach

# Gridding Problems



*Grid Spacing = 2.8*



Software settings are very significant to output from computer-generated contour maps.

Particularly in regions with sparse data control.

Basic assumption in contouring is that the distribution process is continuous.

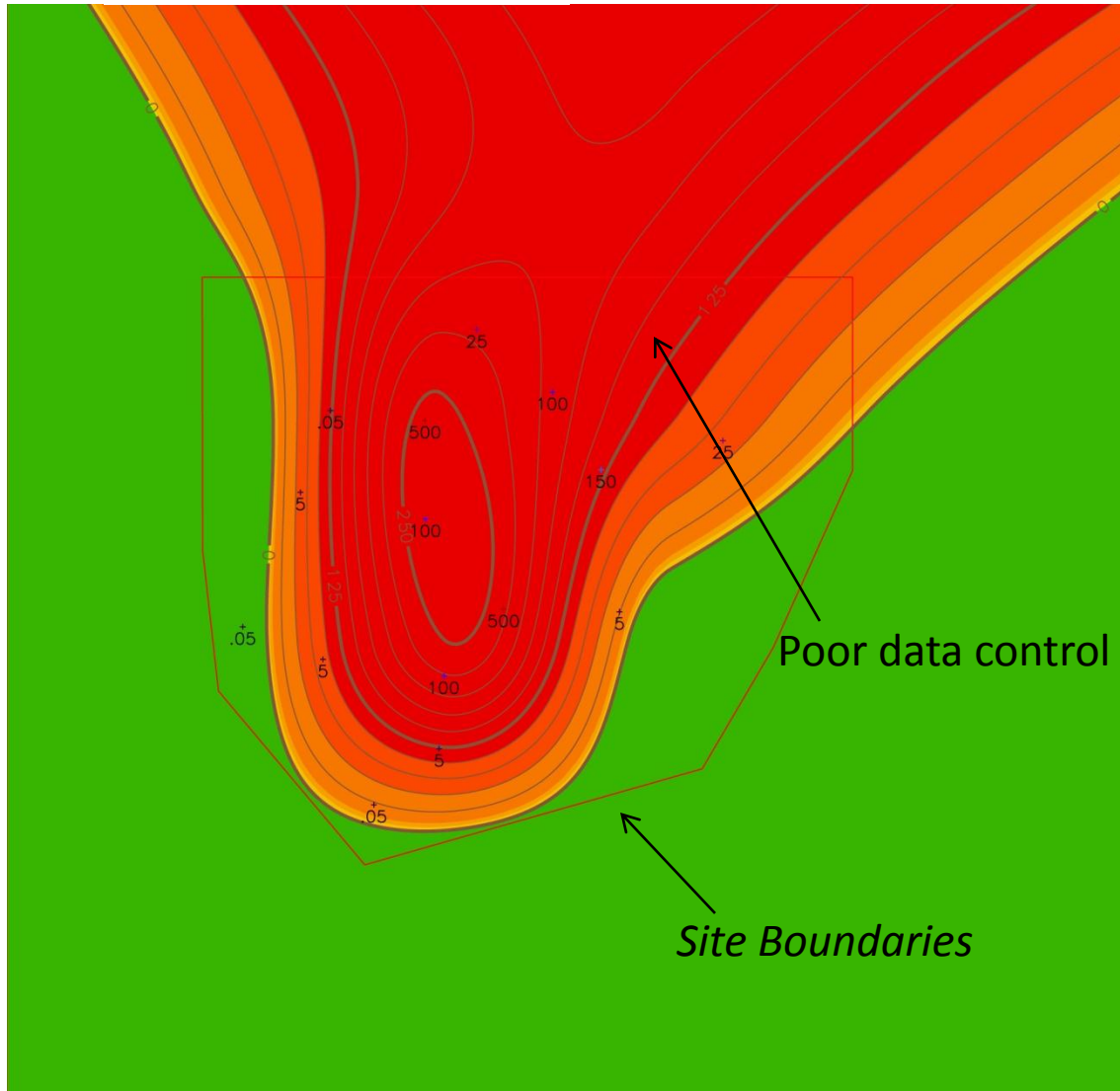
- *geologic heterogeneity?*
- *engineered barriers?*

Data Density = Best Approach

# Gridding Problems



*Grid Spacing = 4.0*



Software settings are very significant to output from computer-generated contour maps.

Particularly in regions with sparse data control.

Basic assumption in contouring is that the distribution process is continuous.

- *geologic heterogeneity?*
- *engineered barriers?*

Data Density = Best Approach

# EPA Triad: Overview



- Triad: 3-pronged approach to site characterization
  - systematic planning
  - dynamic work strategies
  - real-time measurement systems
- Purpose
  - accelerate project schedules
  - reduce overall project costs
  - improve project outcomes

*“Technically defensible methodology for managing decision uncertainty that leverages innovative characterization tools and strategies.”*

<http://www.triadcentral.org/>



# Modeling in a Triad Approach



- Initial analytical data collection
- Initial geotechnical data collection
  - Electrical Resistivity Imaging (ERI)
  - Soil Conductivity / Membrane Interface Probe (SC/MIP)
- Analytical / geotechnical data correlation
- 3D parameter modeling
  - generate initial conceptualization of controls on contaminant distribution
  - use geostatistics to identify regions of uncertainty
  - develop standard model views for analysis
  - develop website for automated output posting
- Geotechnical data collection
  - review modeling analyses
  - focus on regions of uncertainty
  - define hot spots as well as clean areas
- Repeat data collection & modeling as needed...

# SC/MIP Data



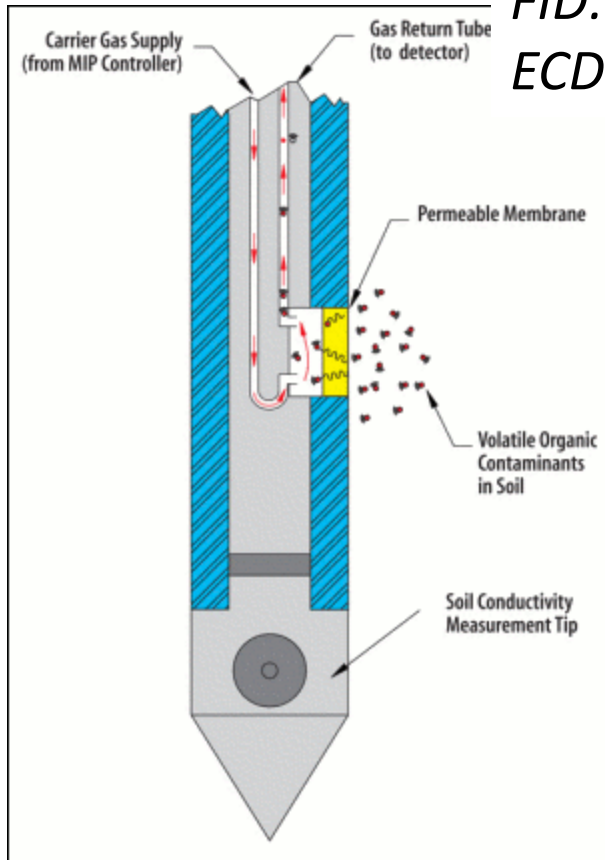
SC: Soil Conductivity

MIP: Membrane Interface Probe

*PID: Photoionization Detector*

*FID: Flame Ionization Detector*

*ECD: Electron Capture Detector*



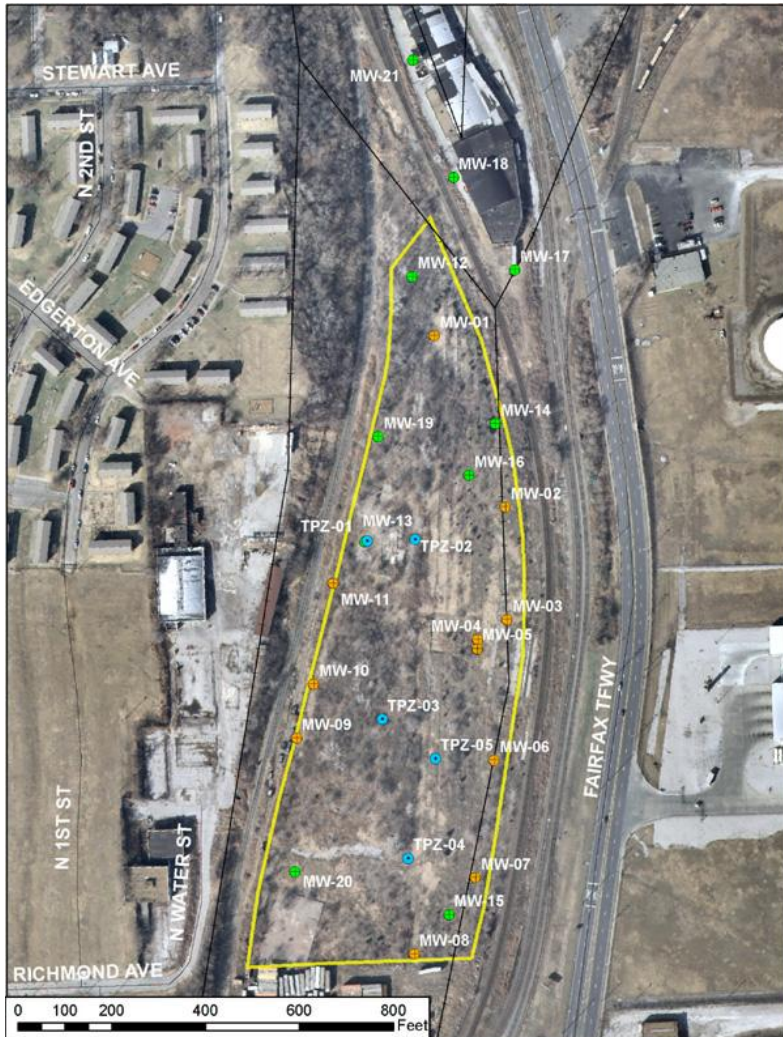
*Tool mounted on GeoProbe*



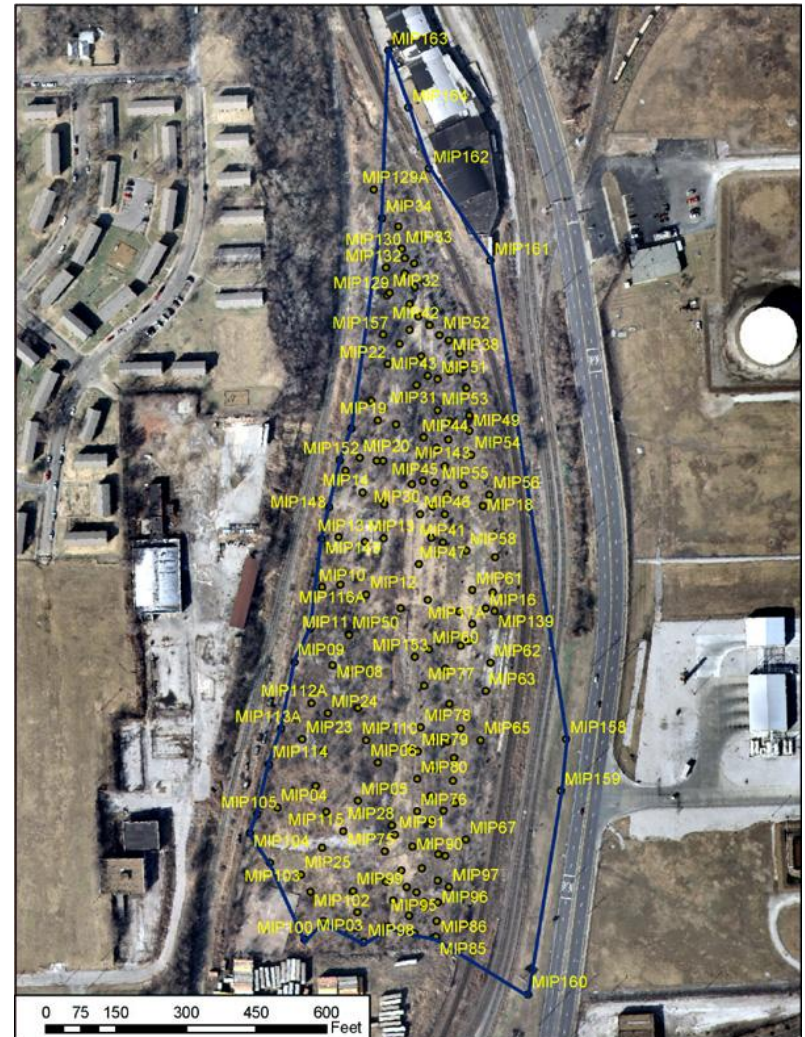
# Brownfield Site Characterization



## Analytical data



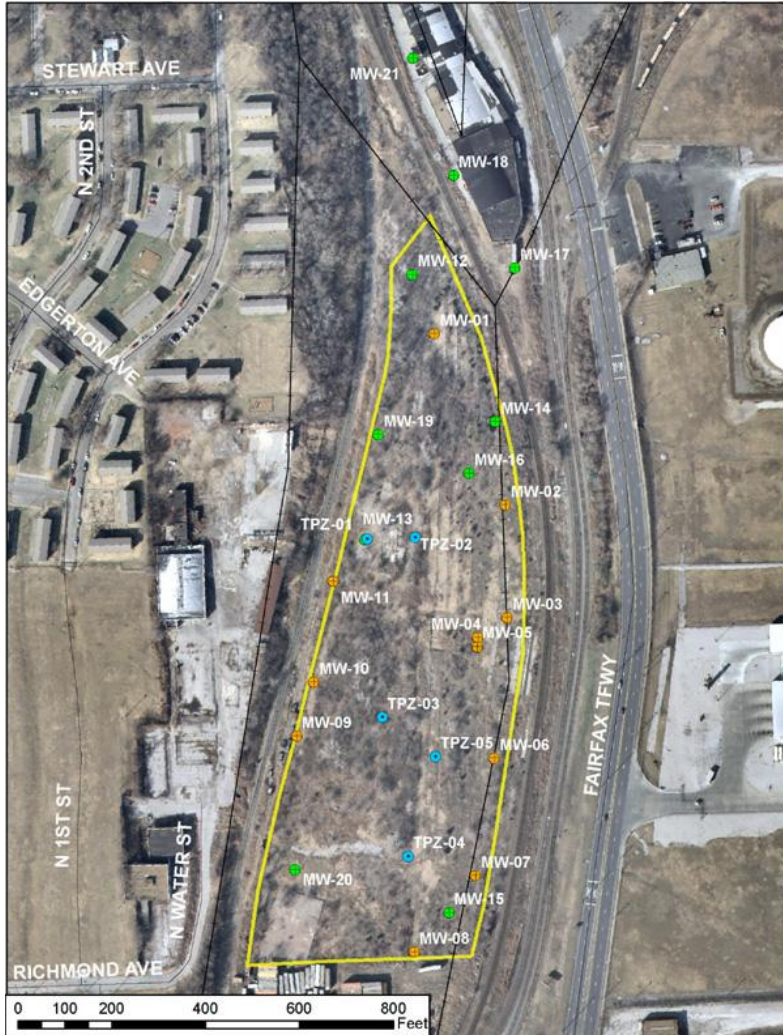
## SC/MIP data



# Brownfield Site Characterization



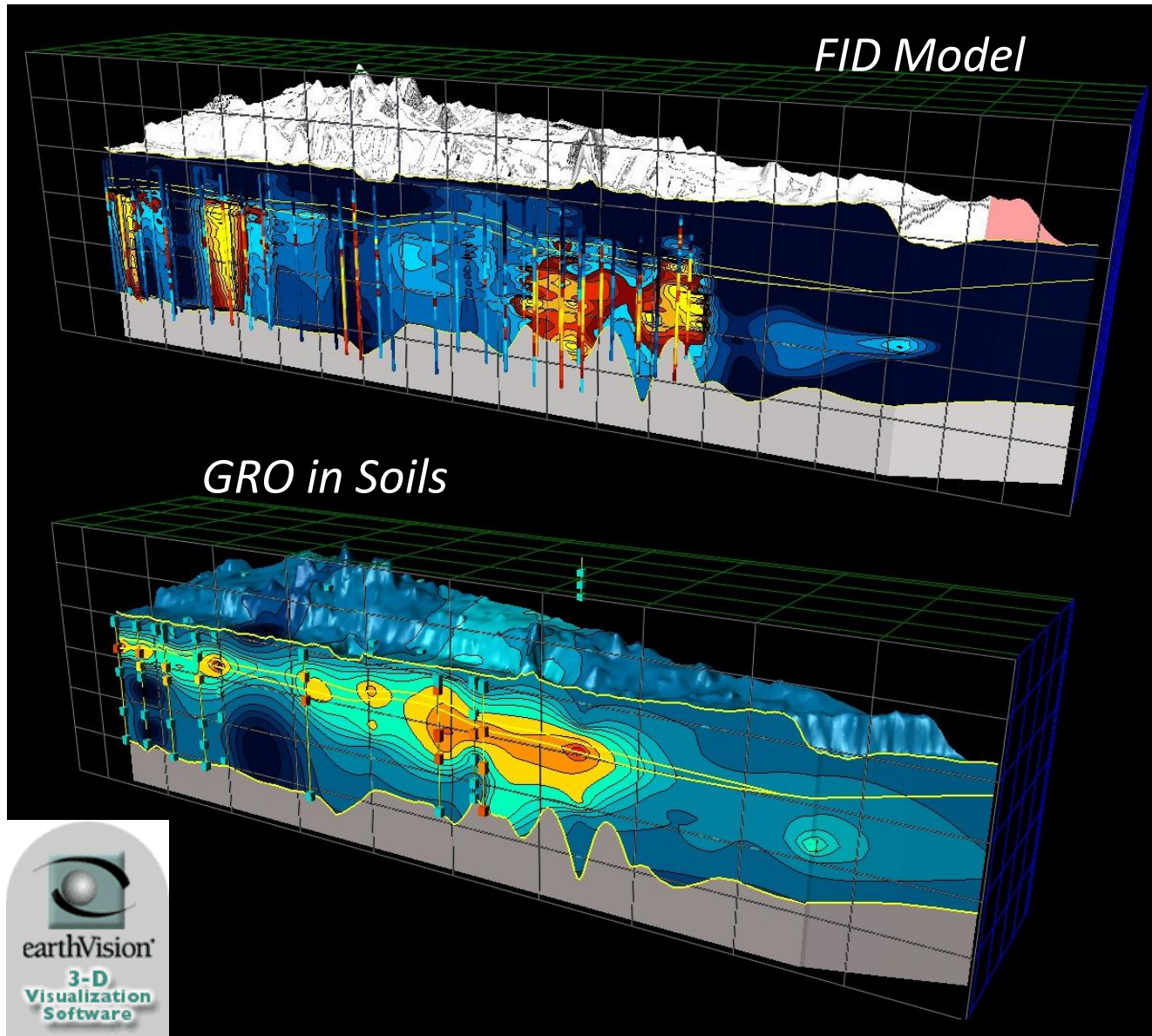
## Analytical data



## ERI: Electrical Resistivity Imaging



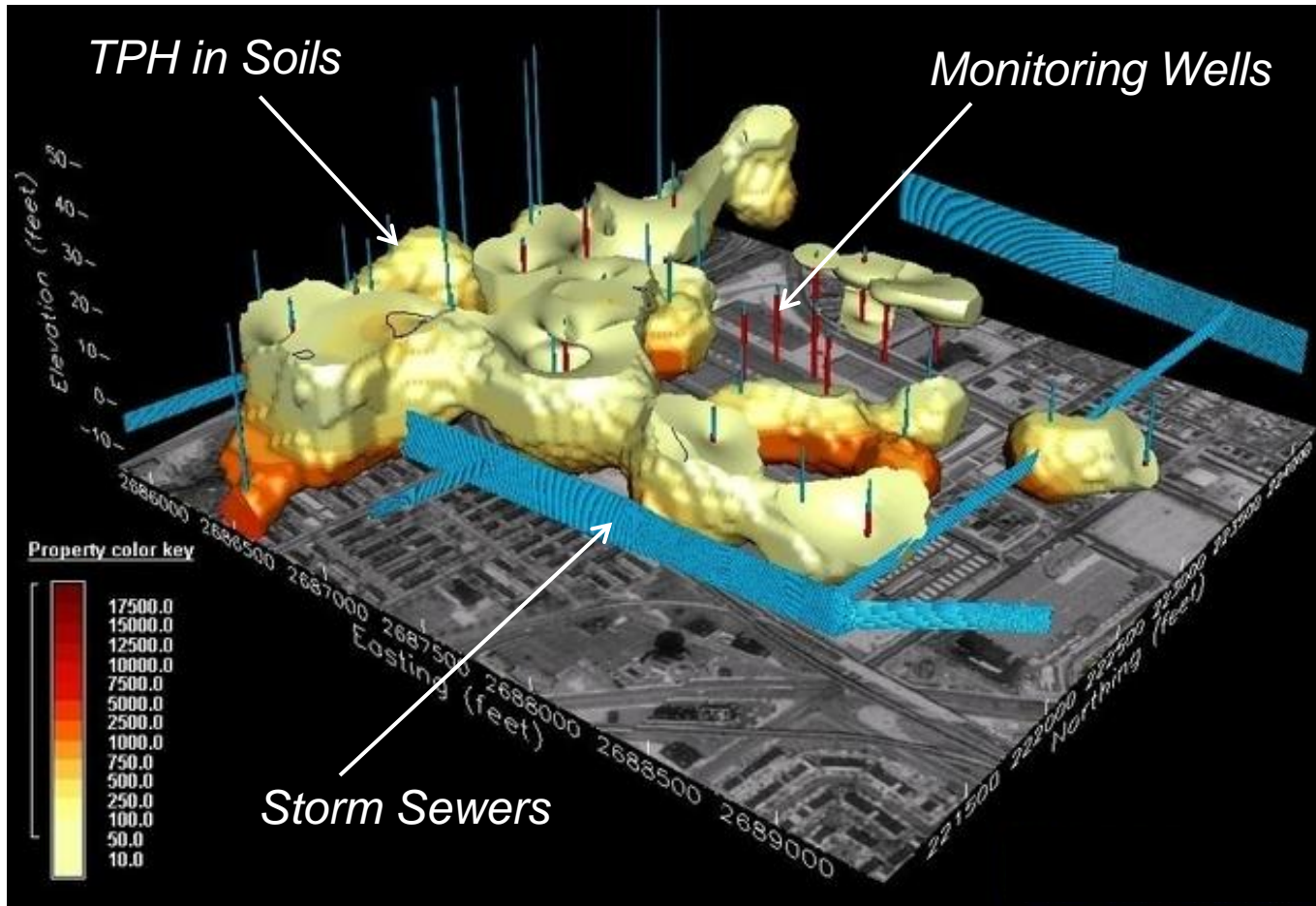
# Analytical / Geotechnical Correlation



# Uncertainty Analysis



Geostatistical uncertainty is based on proximity to data points



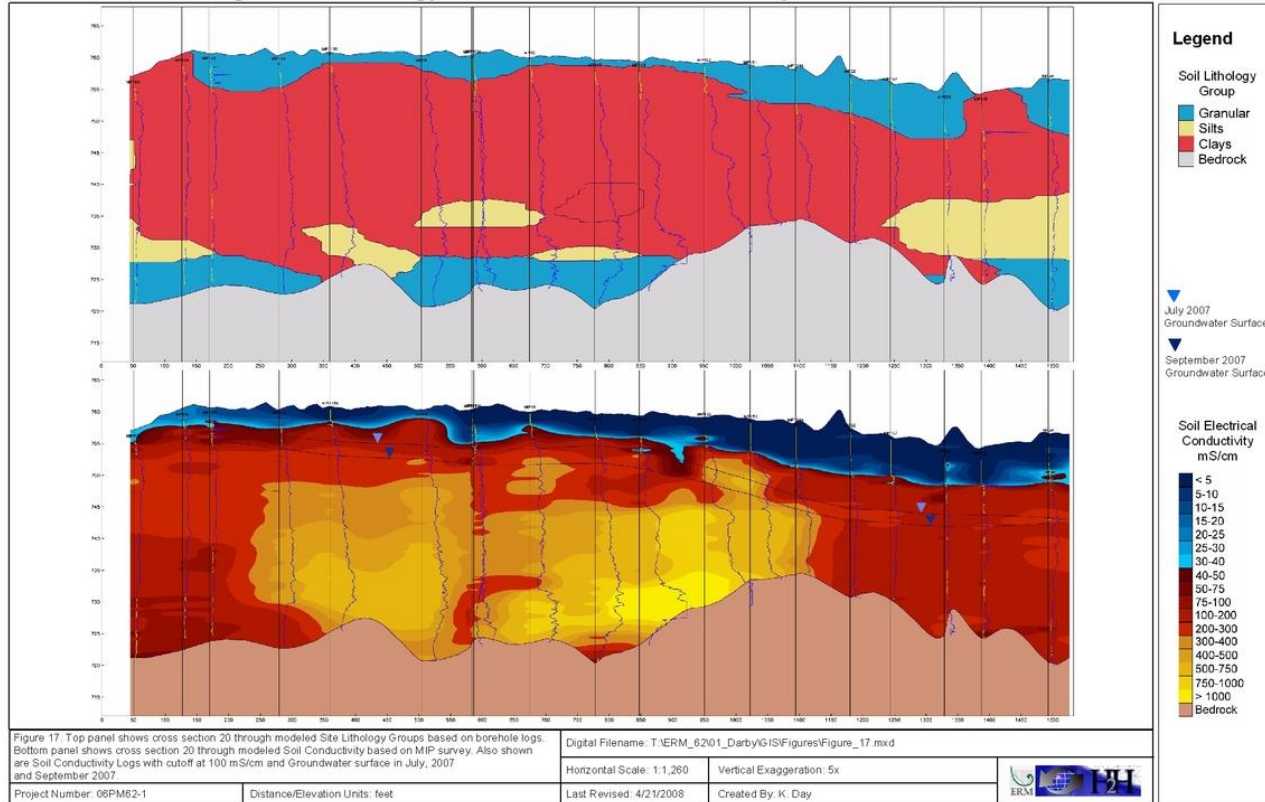
*Model used to identify regions of uncertainty regardless of parameter value*

*LNAPL Contaminated site in Philadelphia*

# Analysis: Scripted Model Output



Figure 17 - Lithology and Soil Electrical Conductivity Traverse 20



# Analysis: Scripted Model Output



Figure 17 - Lithology and Soil Electrical Conductivity Traverse 20

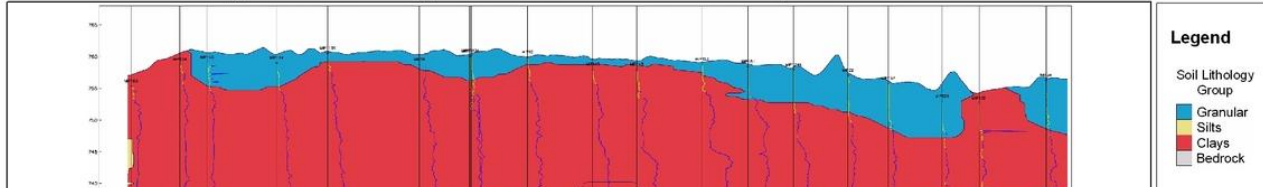


Figure 24 - FID and GRO in Soils - Traverse 1

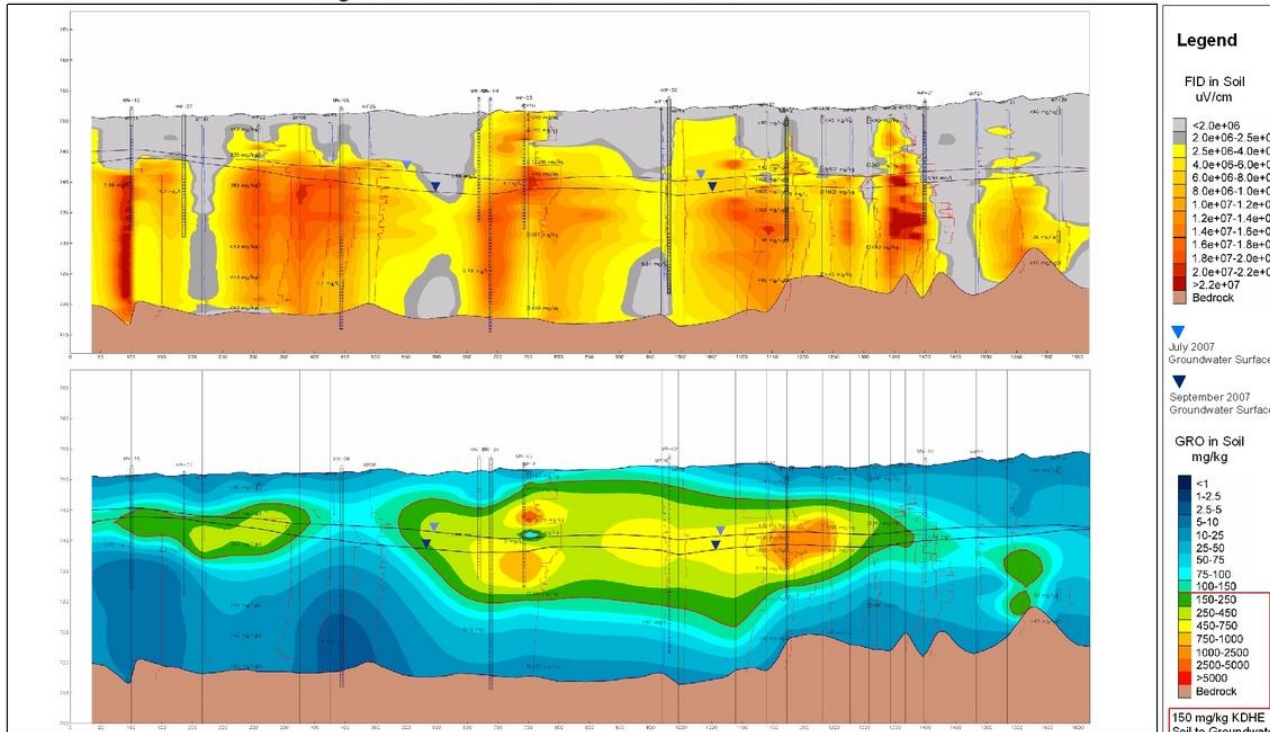


Figure 17. Top panel shows Soil Conductivity and September 2007. Project Number: 06P1

Figure 24. Top panel shows cross section 1 through modeled FID in Soil based on MIP survey results. Bottom panel shows cross section 1 through modeled GRO in Soil based on soil analytical samples. Also shown are Groundwater GRO and Soil GRO results from Analytical Samples and Groundwater surface in July, 2007 and September 2007, and MIP FID Log Trace with cutoff at 250,000 mV.

Digital Filename: T:\ERM\_6201\_DarbyGIS\Figures\Figure\_24.mxd

Horizontal Scale: 1:1,200

Vertical Exaggeration: 15x

Last Revised: 4/28/2008

Created By: K. Day

Project Number: 06PM62-1

Distance/Elevation Units: feet



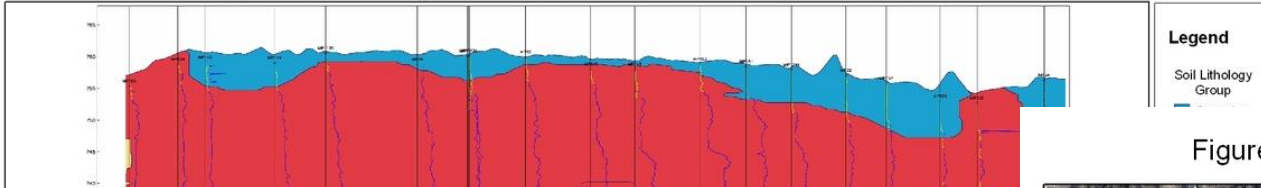
150 mg/kg KOHE Soil to Groundwater Protection Pathway



# Analysis: Scripted Model Output



Figure 17 - Lithology and Soil Electrical Conductivity Traverse 20



**Legend**  
Soil Lithology Group

Figure 24 - FID and GRO in Soils - Traverse 1

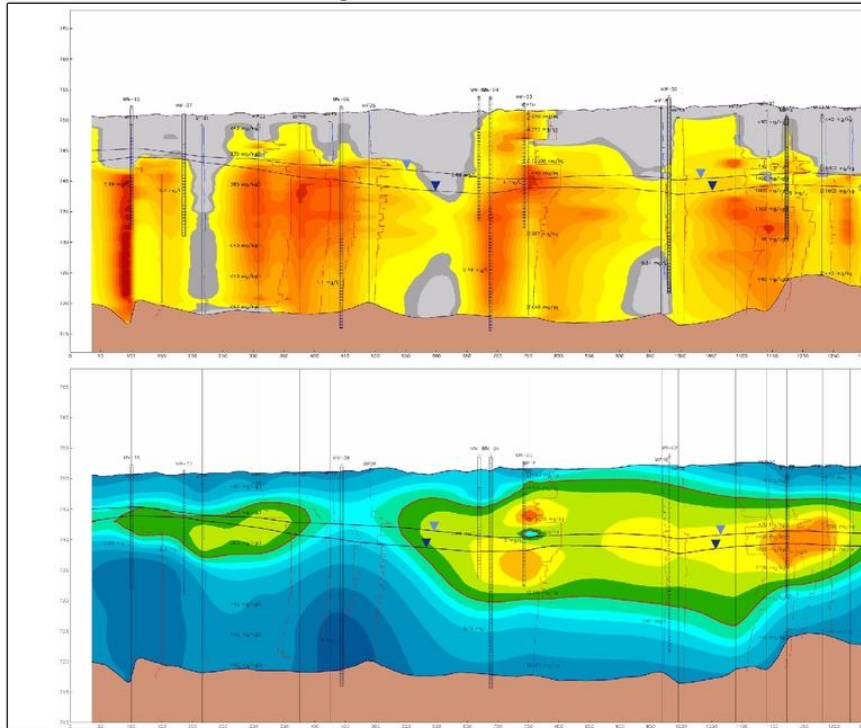
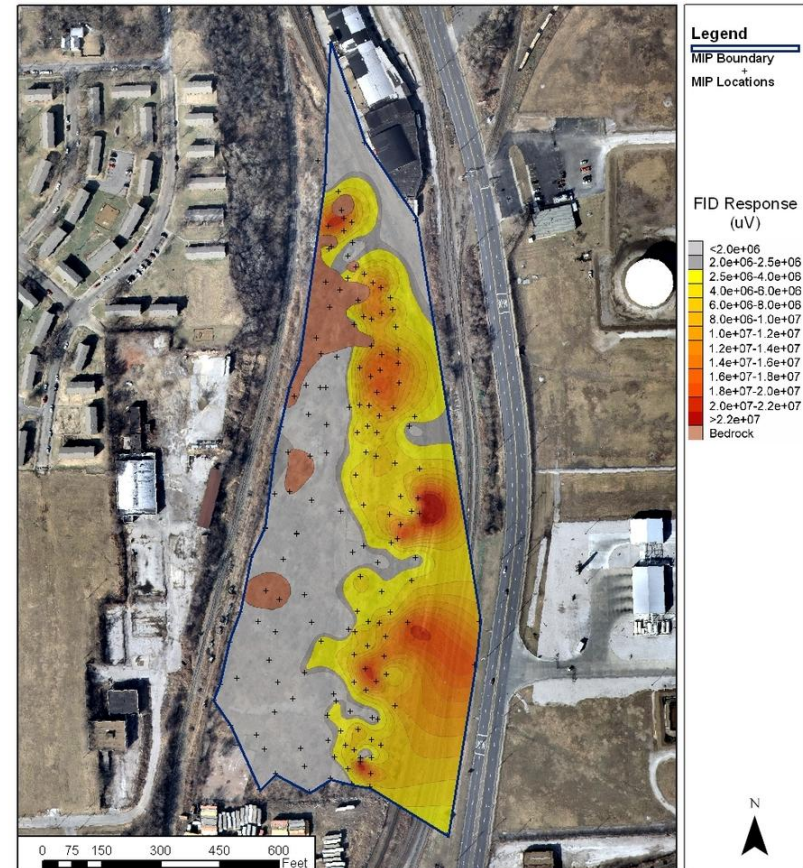


Figure 17. Top panel  
Bottom panel shows  
are Soil Conductivity  
and September 2007.  
Project Number: 06PM

Figure 24. Top panel shows cross section 1 through modeled FID in Soil based on MIP survey results. Bottom panel shows cross section 1 through modeled GRO in Soil based on soil analytical samples. Also shown are Groundwater GRO and Soil GRO results from Analytical Samples and Groundwater surface in July, 2007 and September 2007, and MIP FID Log Trace with cutoff at 250,000 mV

Digital Filename: T:\ERM_62\01_Darby\GIS\Figures\Figure_24	Horizontal Scale: 1:1,200	Vertical Exaggeration: 15x
Project Number: 06PM62-1	Distance/Elevation Units: feet	Last Revised: 4/28/2008
		Created By: K. Day

Figure 23: FID Z-Slice at 727 feet msl



**Legend**  
MIP Boundary  
MIP Locations  
FID Response (uV)  

<2.0e+06
2.0e+06-2.5e+06
2.5e+06-4.0e+06
4.0e+06-6.0e+06
6.0e+06-8.0e+06
8.0e+06-1.0e+07
1.0e+07-1.2e+07
1.2e+07-1.4e+07
1.4e+07-1.6e+07
1.6e+07-1.8e+07
1.8e+07-2.0e+07
2.0e+07-2.2e+07
>2.2e+07
Bedrock

Figure 23: Modeled MIP Flame Ionization Detector (FID) response in Soils at 727 feet msl over 2006 Aerial Photos with MIP survey points.

Digital Filename: T:\ERM_62\01_Darby\GIS\...Figures\Figure_23.mxd	Horizontal Scale: 1:3000	Vertical Scale: n/a
Project Number: 06PM62-1	Created By: K. Day	Last Revised: 4/21/2008




# Web Interface for Data Analysis



H2H Associates: ERM Darby Project Web - Windows Internet Explorer

C:\AYuba\_Files\www\Delta\Darby\Darby\_P3\index.html

DELTA Environmental Consulting Services

Modeling & Visualization  Specialized Geological Modeling Group  
H2H ASSOCIATES, LLC 8(a)/SDB

Darby Site - Kansas City, Kansas

Phase 3 of Darby Site Investigation: February, 2008 - July, 2008

*Click Category headings to expand lists*

**Darby Site Features - Updated with January 2008 Data**

- [MIP Locations and Cross-Section Transect Locations](#) - MIP Locations over 2006 Aerial Imagery, Cross-section transects relative to Sanborn maps

**Darby / KCK / ConocoPhillips Groundwater Plots**

- [Analytical Results](#) - Lab results of Groundwater Samples taken from KCK Site, Darby Site and ConocoPhillips Site for Benzene and GRO. Also shown is a 2006 Aerial Photo of the project area.
- [Product Thickness](#) - Plots showing Darby and Conoco Phillips properties with observed product thickness at monitoring well locations.

**MIP Model preliminary output - Updated with January 3, 2008 Data**

**FID Model**

- [FID Model X \(Easting\) Slices](#) - Cross sectional views step through model from west to east showing distribution of FID in soils. Additionally, 4 modeled zones based on monitoring well data depict ground surface, LNAPL plume, groundwater surface and simulated bedrock surface. Zones are outlined in yellow, while LNAPL zone is filled in pink to provide contrast with color scheme. Data tubes show MIP data used to build model, and are only posted if they are within 50 feet of the model slice. Model domain is the same as that shown in the Z-Slices.

# Web Interface for Data Analysis

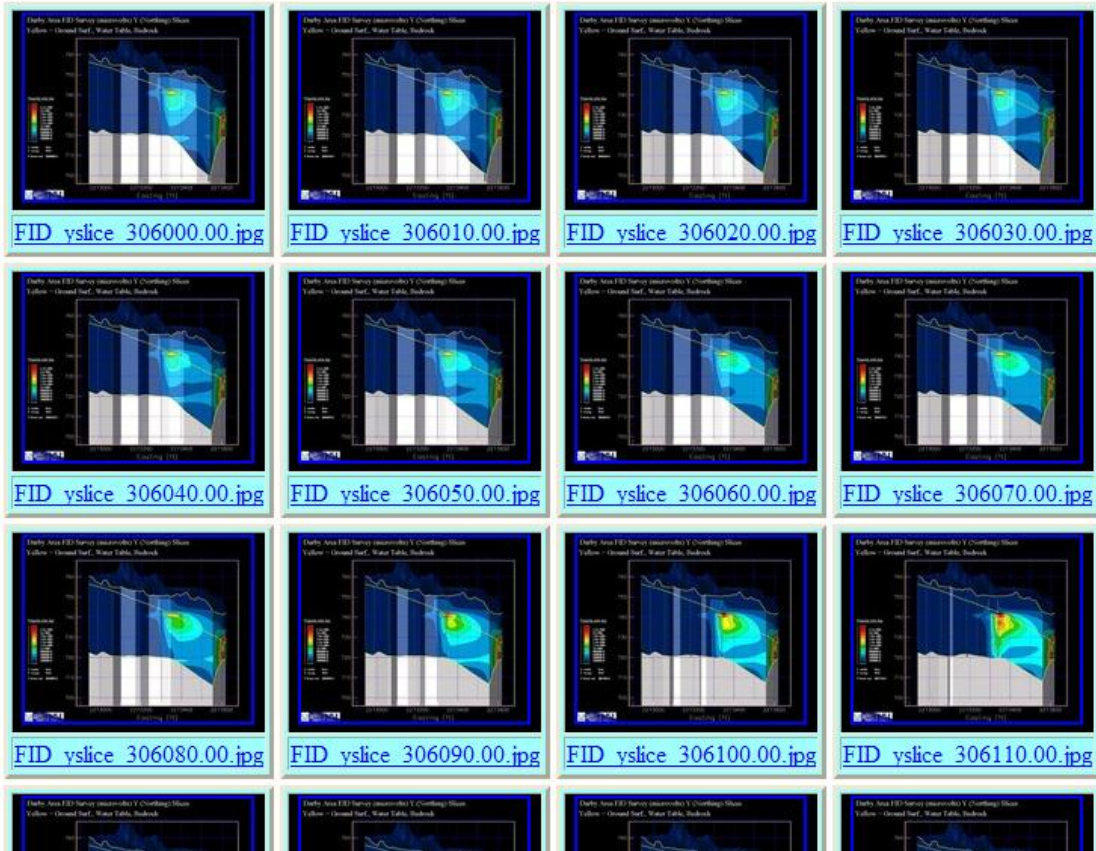


H2H Associates: ERM Darby Project Web - Windows Internet Explorer

Darby Area MIP Survey: Y-Slices of FID in Soils - Windows Internet Explorer

C:\AYuba\_Files\www\Delta\Darby\Darby\_P3\MIP\FID\yslice\index.html

## Darby Area MIP Survey: Y-Slices of FID in Soils



The main content area displays a grid of 16 plots, each representing a different Y-slice of FID in soils. Each plot shows a cross-section of the ground with a color-coded area representing the FID concentration. The plots are arranged in a 4x4 grid. The titles for the plots are:

- FID\_yslice\_306000.00.jpg
- FID\_yslice\_306010.00.jpg
- FID\_yslice\_306020.00.jpg
- FID\_yslice\_306030.00.jpg
- FID\_yslice\_306040.00.jpg
- FID\_yslice\_306050.00.jpg
- FID\_yslice\_306060.00.jpg
- FID\_yslice\_306070.00.jpg
- FID\_yslice\_306080.00.jpg
- FID\_yslice\_306090.00.jpg
- FID\_yslice\_306100.00.jpg
- FID\_yslice\_306110.00.jpg

On the left side of the browser window, there is a sidebar with the following text:

DEL

Mo  
Visu

Darby Sit

- MIP
- Cros

Darby / K

- Anal
- Con
- Prod
- thick

MIP Mod

- FID
- distr
- surfa
- yellow
- data
- is the

# Web Interface for Data Analysis



H2H Associates: ERM Darby Project Web - Windows Internet Explorer

Darby Area MIP Survey: Y-Slices of FID in Soils - Windows Internet Explorer

FID\_yslice\_306130.00.jpg - Windows Internet Explorer

C:\AYuba\_Files\www\Delta\Darby\Darby\_P3\MIP\FID\yslice\pages\FID\_yslice\_306130.00.html

FID\_yslice\_306130.00.jpg

FID\_yslice\_306130.00.jpg    [prev](#) - [index](#) - [next](#)    14 of 161

### Darby Area FID Survey (microvolts) Y (Northing) Slices

Yellow = Ground Surf., Water Table, Bedrock

Property color key

2.2e+006
2e+006
1.8e+006
1.6e+006
1.4e+006
1.2e+006
1e+006
800000.0
600000.0
400000.0
200000.0

760

750

740

730

720

FID\_yslice\_306130.00.jpg

Darby Sit

- [MIP](#)
- Cros

Darby / K

- [Anal](#)
- Con
- [Prod](#)
- thick

MIP Mod

- [FID](#)
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- surfa
- yellow
- data
- is the

# Summary / Conclusions



- The investigation collected approximately 420,000 collaborative measurements over a 6 week period.
- These measurements provided a detailed 3-D understanding of the extent and magnitude of fuel impact in the subsurface environment.
- The cost per measurement was approximately 65 cents.
- Both the Client and the Kansas DHE enthusiastically embraced this method and accepted the results and analyses.
- We believe that this approach saved significant time and money during the site characterization process.

*More info?*

[www.geohydros.com](http://www.geohydros.com)