

**Geophysical Survey Report
Cline Avenue Mystery Oil Removal Site
Gary, Indiana**

Dates of Survey: May-June, 2011



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Introduction

At the request of Mike Beslow (USEPA On-Scene Coordinator – Region 5) several geophysical surveys were conducted at a portion of the Cline Avenue ditch site located northeast of the intersection of Cline Avenue and Gary Avenue in Gary, Indiana (near Longitude -85.4304; Latitude 41.6199). The purpose of the surveys was to locate buried pipelines. These surveys were to assist, if possible, obtaining information as to the possible source of oil seeping out into the Cline Avenue Ditch, which connects to Grand Calumet River and Lake Michigan. Known historical activities in this area included a depository for tank bottom sludge.

Access to the site was provided by Mike Beslow, through the property owner, he also made arrangements to have a utility locate service, along with pipeline locators mark known buried lines in this area. The survey was conducted by J. Ursic from Region 5 USEPA with assistance in the office by Linda Jacobson and Kevin Cunningham who assisted in rectifying aerial photographs.

Geophysical Methods Applied

Three geophysical methods were used at the site:

- EM61-MK2 time domain electromagnetic tool; Survey date: 05/17/2011
- GEM2 frequency domain electromagnetic tool; Survey dates: 05/19/2011, 07/14/2011
- Gradient cesium magnetometer tool; Survey dates: 05/20/2011, 05/22/2011, 06/22/2011
- Ground Penetrating Radar; Survey date: 07/14/2011

The Geonics EM61-MK2 time domain electromagnetic tool was towed by an ATV attached with a square fiberglass tube approximately eight feet behind the vehicle. Traverses were established by a Trimble AgGPS parallel swathing unit which was mounted on the ATV. The AgGPS antenna unit was integrated with OmniSTAR service for real time differential corrections. The datum used by the AgGPS is UTM Zone 17 NAD 83 converted to decimal degrees. The X and Y locations provided by the AgGPS are offset by approximately 10 feet ahead of the EM61-MK2 antenna location since the AgGPS antenna was mounted on the ATV. This instrument is basically a high sensitivity metal detector measuring down to depths of approximately 10 feet.

Frequency domain GEM2 electromagnetic tool was manufactured by Geophex, owned by Aeroquest, and used a Geophex modified Garmin GPS antenna using WAAS signals only. The antenna was mounted on the operator's hard hat. This instrument measures ground conductivity and all types of metal. Depth of investigation varies due to soil conditions, but can function up to depths of 20 feet or more.

A Geometrics® G-858G magnetometer was used for this survey. The magnetometer detects ferrous masses (metal containing iron). This system was used in a gradient configuration, with two sensors, to eliminate disturbances from solar activity and diurnal changes. This instrument

detects ferrous metal only; its sensors limits are dependent on the mass of targets since more mass can be detected at greater depths.

Sensors were mounted on a Geometrics® backpack that incorporated a Global Positioning System (GPS) and antenna to incorporate latitude and longitude values to magnetic data. Magnetometer gradient sensors were mounted approximately six feet off the ground. Orientation of the sensors were set to zero tilt and rotated to 45 degrees, with a separation distance of approximately one Meter.

A ground penetrating radar system, Sensors and Software's Noggin cart, using a 250 MHz antenna was used over an area suspected of having a buried pipeline. The data collected over this area was inconclusive due to the lack of penetration of the GPR signal, since the high water table absorbed the signal at 2.5' to 3' below the ground surface.

Site Conditions

A significant number of interferences to the geophysical survey existed at this site. Natural barriers included vegetation, marshes and a large pond. Interferences that would affect instrument readings were above ground high tension towers/lines and utility lines, random metal scrap and two abandoned standpipes.

Data collected during the month of July were extensively affected by the growth of vegetation, to the point where areas once accessible in May were no longer easily reached (near Longitude -87.43031; Latitude 41.62034).

Field Procedures

An area of primary concern for acquiring geophysical information for this project lays immediately east of the Cline Avenue ditch. Unfortunately, the high tension towers/lines and other utility lines occupying this area could not be surveyed due to interferences from the power lines. Most of the data were collected east of the north-south trending utility line suspended by wooden poles. A ten foot offset east of the utility line was generally the starting point of data collection.

EM61-MK2 Data Collection

The first geophysical tool used was the EM61-MK2 high sensitivity metal detector which was towed by an ATV. This combination of equipment was limited to open areas generally void of vegetation. Guidance and longitude-latitude positioning were provided by the AgGPS unit with parallel swathing intervals set to 20 feet. Figure 1 illustrates the data collection traverses. Note the singular traverse pattern that loops around the eastern part of the site, this is an access road that generally defines the property limits. Various obstacles and vegetation within the large loop prevented surveys in this area.

GEM2 Data Collection

Data collected in May was limited to an area where the EM61-MK2 may have detected a linear object, possibly a buried pipeline. The survey area was 466' by 50' with 10 feet spacing, defined by tape measures and flagging for visual references.

The data collected in July was also conducted to further define past measurements and provide confirmatory data which would define the suspected buried pipeline. However, the limits of the data collection were severely limited to the vegetation which now was approximately five feet tall and dense. Locational data were provided by a WAAS based Garmin GPS antenna.

Gradient Cesium Magnetometer Data Collection

Data collection occurred over two days, the first day was in the western part of the site and day two traversed the roadway which followed the general site limits. Positional data were provided by an AgGPS programmed with 20 foot intervals.

Data Processing

Data were processed using Golden Software's Surfer 9 contouring program using the Kriging Method except where noted on individual figures.

Conclusions

Data will be presented on eight attached illustrations, Figures 1 through 8.

Figure 1

This illustration shows several key features of the site and serves as a base map showing key road intersections. The Cline Avenue Ditch where oil is seeping is highlighted in yellow. A geophysical exclusion area due to high tension towers and lines was not surveyed since it would interfere with the instruments, data collection occurred east of this exclusion area. The red traverse lines show the paths where the EM61-MK2 was towed to collect data. Note that the EM61 antenna was mounted approximately 8 feet behind the GPS antenna. Spacing is approximately 20 feet where maneuvering permitted. The large looping area to the east is a perimeter road with vegetation and debris on its shoulders, except in several areas where there were some small open spaces.

Figure 2

This second base map shows where magnetic data were collected on the site over a two day period. Additional areas were accessible to the magnetic sensors since it was carried on a backpack and was less limited than the large wheeled EM61-MK2 tool. It is important to note that known obstructions or metal scrap noted on the ground surface was walked around by the operator to show the location of the obstruction and its approximate size. Anomalies near these encircled areas are expected and should not be considered a buried target.

Figure 3

This map shows the EM61-MK2 high sensitivity metal detection results that generally has a depth of investigation of about 10-15 feet. This tool will detect all ferrous and non-ferrous metal. The more significant anomalous areas are highlighted with a colored background and numbered. Anomaly 4 appears to be the largest. The larger 20 foot grid spacing was selected to detect long linear features, such as a pipeline, but the individual smaller targets that were encountered could not be defined in detail due to the larger grid spacing. There were no obvious linear anomalies, typical of a pipeline, but a comparison of linear anomalies from other Figures show that parts of a suspected pipeline could have been detected on this figure. Anomalies shown in the large looping area to the east should be evaluated with the magnetic traverses noted in Figure 5 to note the areas marked with an "X" which indicates known surface debris. Note that some data was collected in the exclusion zone under the high tension power lines, but this data should be considered not reliable.

Figure 4

The magnetic gradient map for the western portion of the site illustrates the location of ferrous anomalies. These areas can either be an isolated positive or negative values or combinations of the negative and positive close together. The more significant anomalies were highlighted with a colored background. There appears to be a linear anomaly nearly paralleling longitude -87.4303 that is suggestive of a buried pipeline. The more irregular traverse pattern lines were typically due to walking around vegetation and trees. Areas marked with an "X" indicate known surface debris and anomalies near these marks should be ignored.

Figure 5

This magnetic gradient map shows the eastern section of the site. Once again, areas marked with an "X" indicate known surface debris and anomalies near these marks should be ignored. Generally data could only be collected in a single pass since the area is a single dirt road with debris and vegetation immediately at the edges of the road.

Figure 6

This figure is another magnetic gradient map of an isolated region near the suspected buried pipeline. This area was traversed in a east-west pattern to cross perpendicular to the suspected pipeline using a smaller grid size, approximately 10 feet. There seems to be a linear north-south anomaly pattern, but it was not contiguous through the entire survey area, in the northern section of the site, since the data collection veered off too far to the west. One anomalous area is known in the area and is marked, this anomaly should be ignored. Other isolated anomalies are within this area surveyed and are illustrated by a colored highlighted background.

Figure 7

Figure illustrates the ferrous and non-ferrous metal detection data from the GEM2 frequency domain electromagnetic tool. An open and isolated area was selected near the suspected buried pipeline to collect data. The data was plotted from 13590 Hz frequency which translates to a depth of approximately 6 feet below ground surface. It is possible that the southern end of the pipeline could be curving to the west. Data are presented in the Geophex output mode in parts per million.

Figure 8

This attachment illustrates ground conductivity of an isolated area just east of the power lines as bounded by Longitude and Latitude shown on the drawing. Data were collected by the GEM2 in the Quadrature-Phase mode with output in parts per million, it was not converted to mS/m. Two frequencies were plotted, 35010 Hz & 13590 Hz which is generally collecting data near 3 feet and 6 feet below ground surface respectively. The lower values (darker shades of grey) are most likely areas heavily oiled.

A definitive description of the ferrous anomalies such as scrap metal, automobiles, drums, etc. is almost impossible to determine since no one value is unique to a specific object. However, an idea of metal mass concentrations can be inferred since the magnetic intensity of an anomaly increases as mass of the metal increases.

DISCLAIMERS & WARNINGS:

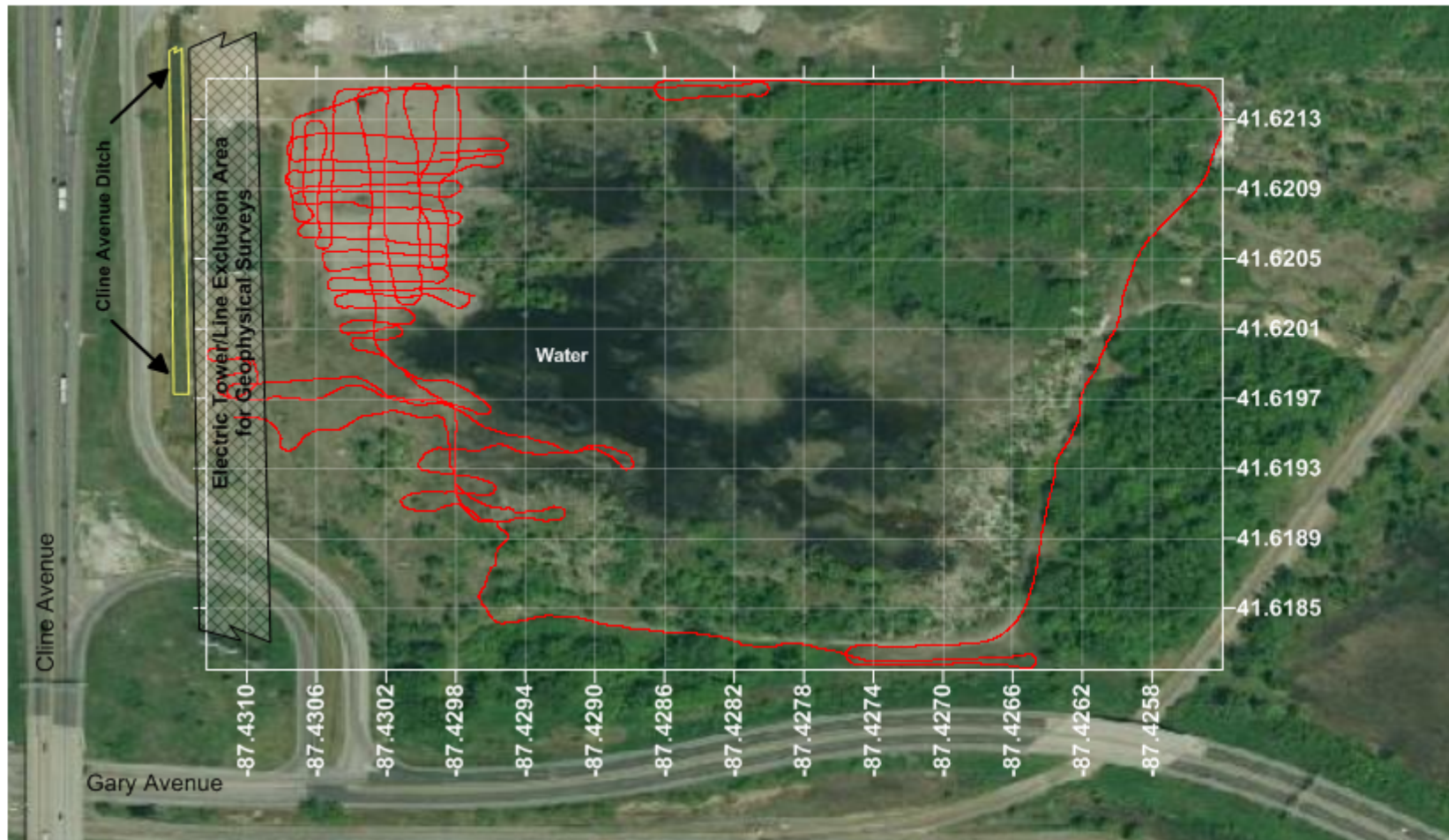
Geophysical instruments used at this site were not configured to locate utility lines, although they could be influenced by such lines under certain conditions. It is critical *not to use this data* for utility line location since methods applied were only directed towards sub-surface targets, other than utility lines.

It is strongly recommended that before any intrusive sampling, test pits, or other excavation methods are applied at the site, that *all* utility services be contacted to verify that none of the anomalies are the result of or near any buried utilities.

If any excavations are attempted near anomalies mentioned in this report, it is recommended that initial ground breaking be conducted outside the anomalous area and slowly moved towards the anomaly. This procedure will reduce the probability of damaging, puncturing, or disturbing the unknown source of the anomaly.

Disclosure of product names in this report is not an implied or direct recommendation of the equipment used for this survey. It is only provided for its scientific value related to a specific method or tool used.

Attachments: Figures 1 - 8



UTM Zone 17 NAD 83
converted to decimal degrees

GPS Omnistar Real Time
Differential Correction Applied

Cline Avenue Ditch Site - EM61-MK2 High Sensitivity Metal Detector Traverses Gary, Indiana

May 17, 2011

Red Lines = Data Collection Traverse Routes

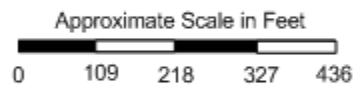
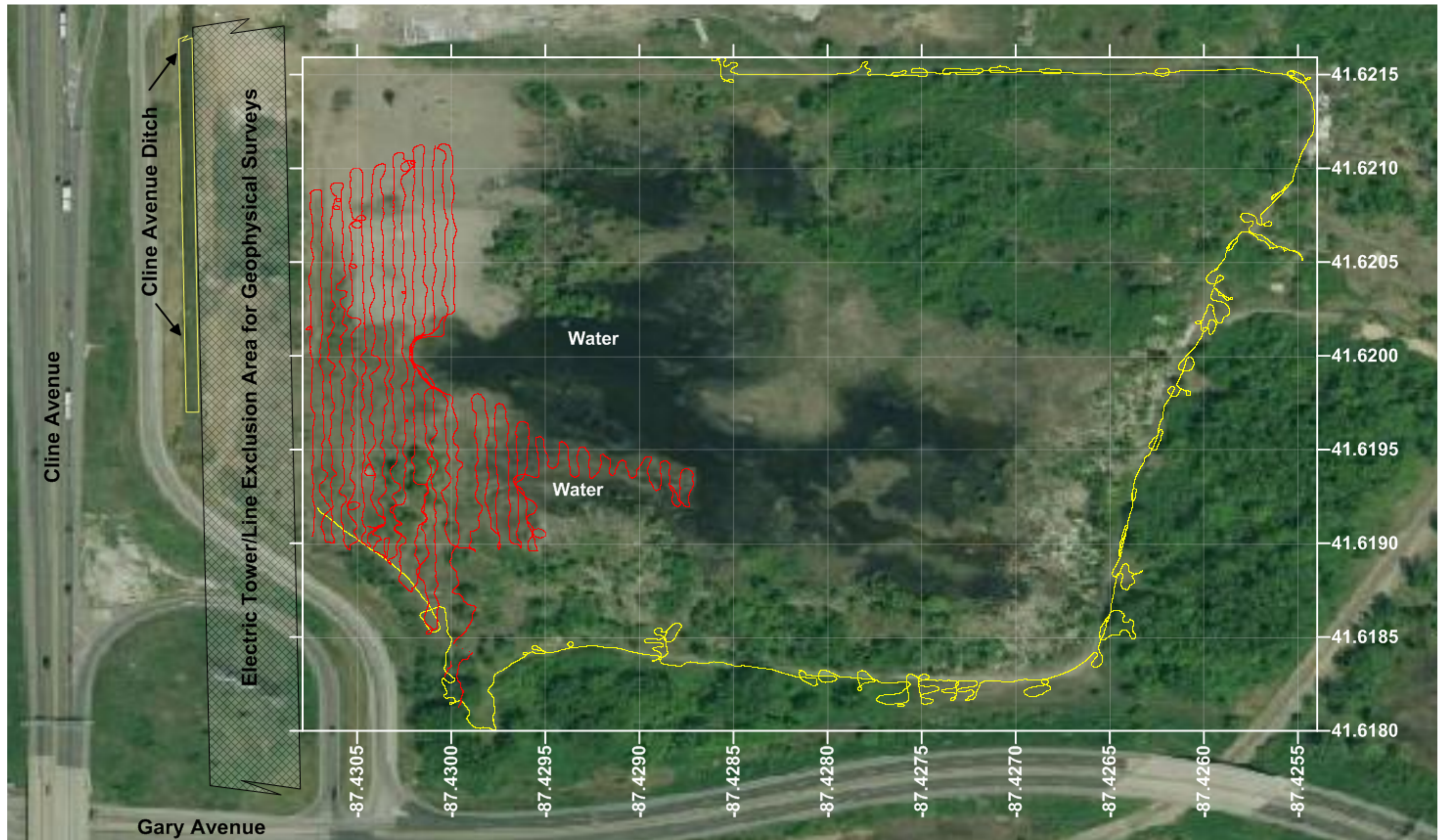


Figure 1



Gradient Cesium Magnetometer Traverse Paths - Cline Avenue Ditch Site - Gary, Indiana

May 20, 2011 = Red Traverse Paths; May 22, 2011 = Yellow Traverse Paths

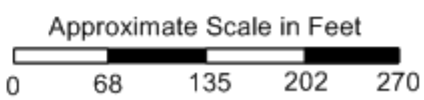
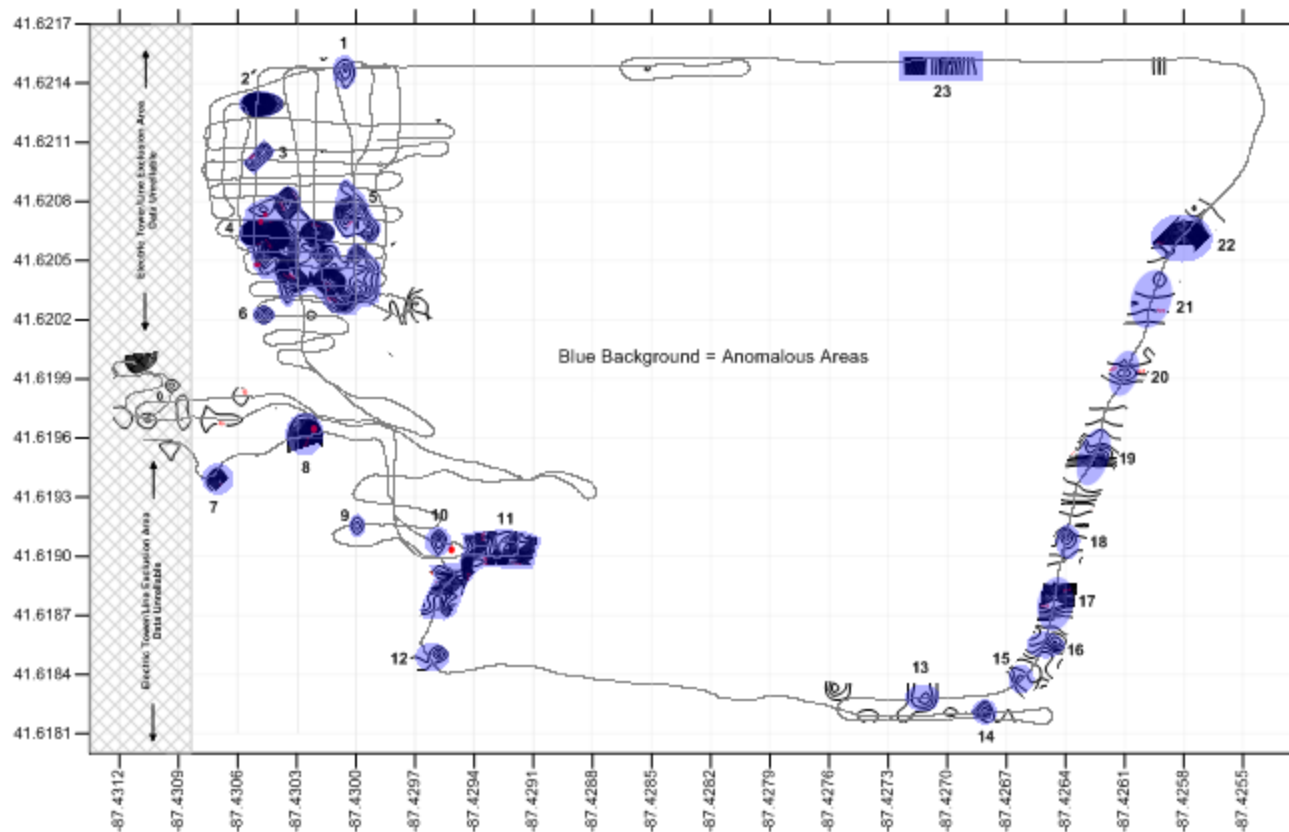


Figure 2

Drawing in Color
Do Not Photocopy in BW





Cline Avenue Ditch Site - EM61/MK2 High Sensitivity Metal Detector Data Gary, Indiana

Date of Survey: May 17, 2011

Contour Interval = 50 mV

Grey Free Flowing Lines = Data Collection
Traverse Routes

= Highlighted Area
Indicating an Anomaly

26 = Identifier for Anomaly Locations

Drawing is in Color; Do Not Photocopy in BW

Figure 3



Cline Avenue Ditch Site Gradient Cesium Magnetometer Data Western Section of Site Gary, Indiana

May 20, 2011

Contour Interval = 50 Gammas Per Meter

Zero Contour Line Not Shown for Clarity

Red Contour Lines = Negative Values
Blue Contour Lines = Positive Values
Grey Lines = Data Collection Traverse Routes

Circular Grey Traverses Indicate Surface Debris

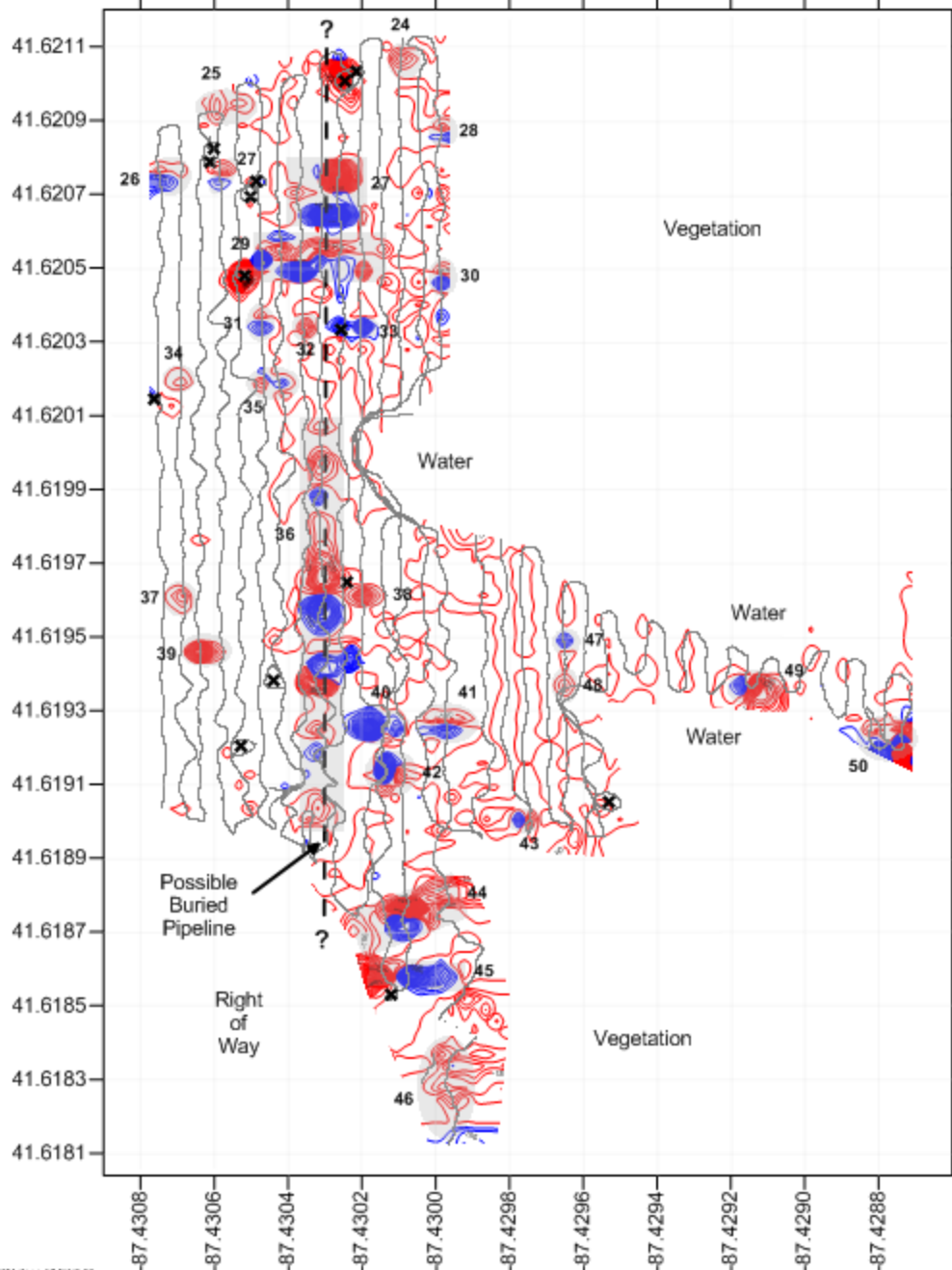
Traverse Routes Approximately 20 Feet Separation

 = Highlighted Area
Indicating an Anomaly

 = Known Above Ground Debris

26 = Identifier for Anomaly Locations

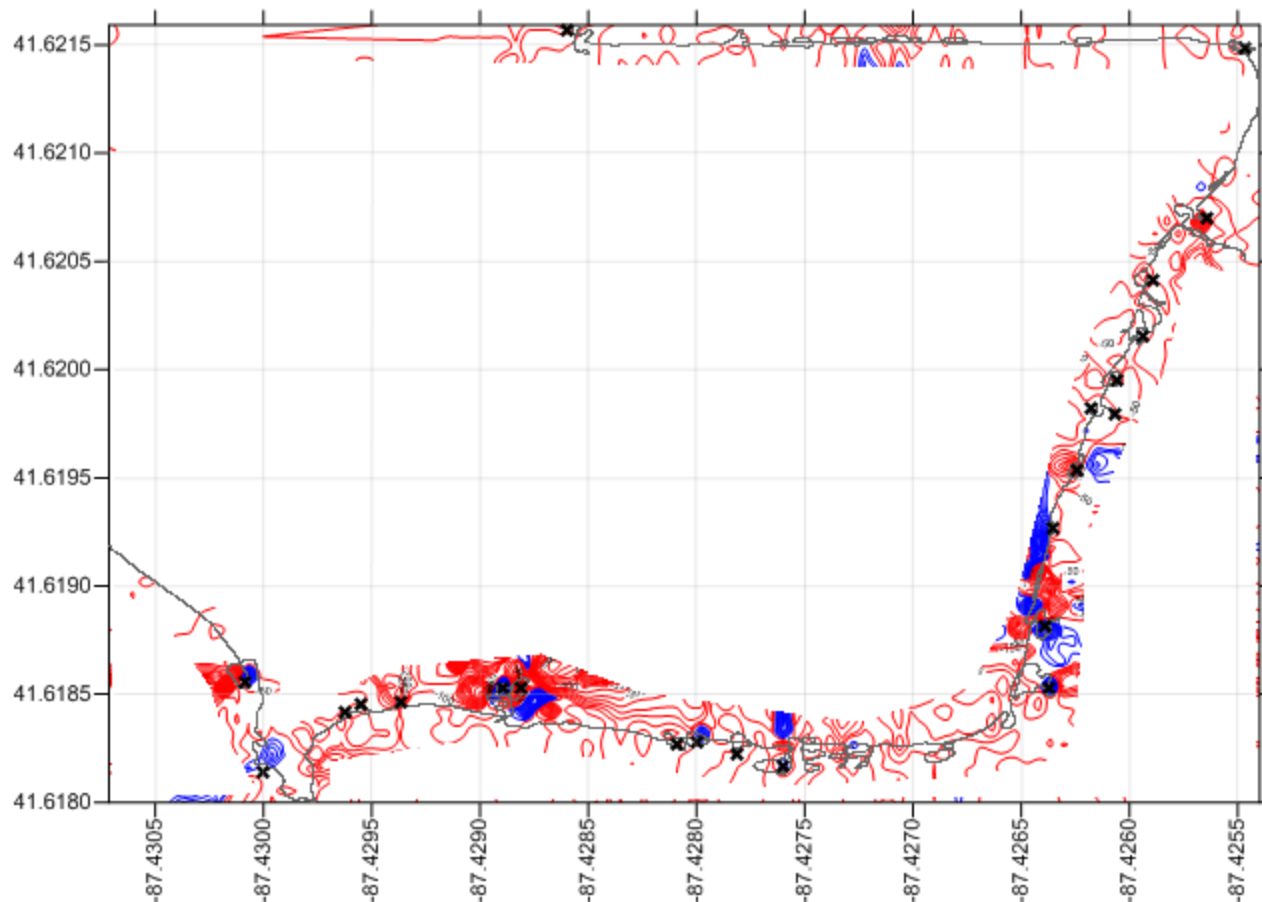
Approximate Scale in Feet



UTM Zone 17 NAD 83
converted to decimal degrees

GPS OneRTK® Real Time
Differential Correction Applied

Figure 4



UTM Zone 17 NAD 83
converted to decimal degrees

GPS Omnistar Real Time
Differential Correction Applied

Cline Avenue Ditch Site - Gradient Cesium Magnetometer Data Eastern Section of Site Gary, Indiana

May 22, 2011

Zero Contour Line Not Shown for Clarity

Red Contour Lines = Negative Values
Blue Contour Lines = Positive Values
Grey Lines = Data Collection Traverse Routes



Contour Interval = 50 Gammas Per Meter
 ✕ = Known Above Ground Debris
 Circular Grey Traverses Indicate Surface Debris



Approximate Scale in Feet

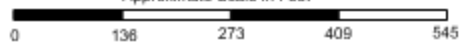
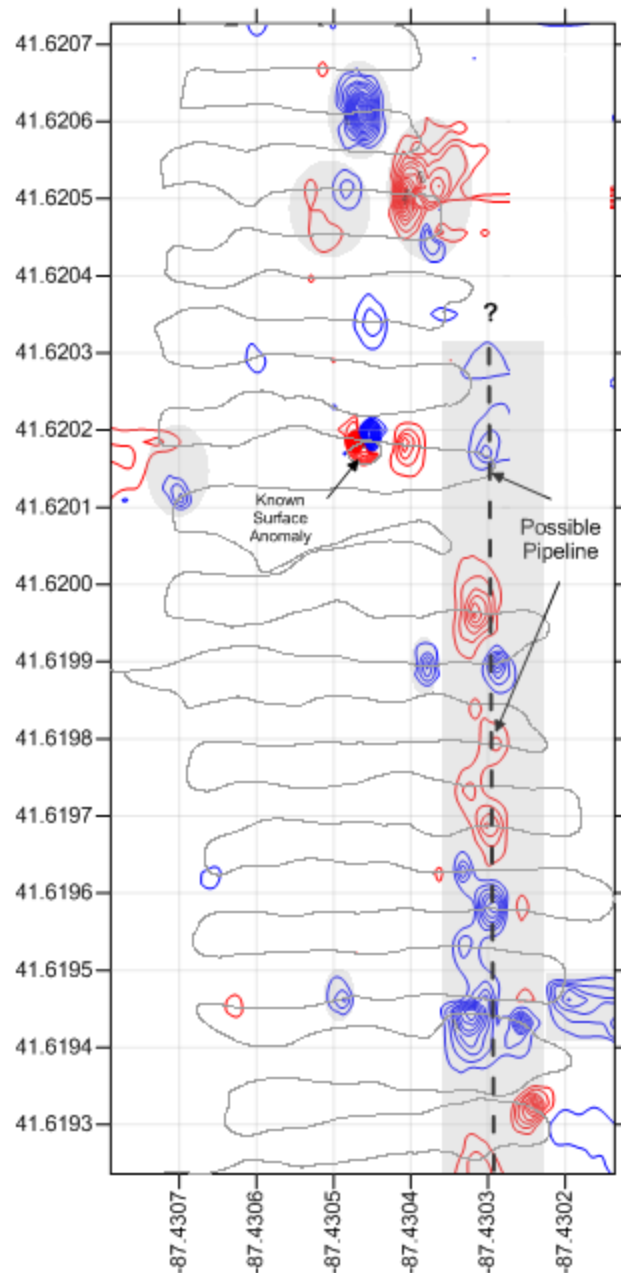


Figure 5



UTM Zone 17 NAD 83
converted to decimal degrees

GPS DinvSTAR Real Time
Differential Correction Applied

Cline Avenue Ditch Site - Gradient Cesium Magnetometer Data Isolated Area Near Suspected & Unknown Pipeline Gary, Indiana

Contour Interval = 100 Gammas Per Meter
Zero Contour Line Not Shown for Clarity

June 22, 2011

Red Contour Lines = Negative Values
Blue Contour Lines = Positive Values
Grey Lines = Data Collection Traverse Routes



 = Highlighted Area
Indicating an Anomaly

Approximate Scale in Feet



Figure 6

Cline Avenue Ditch Spill Gary, Indiana

Electromagnetic Data - Frequency Domain Using Geophex GEM2 Tool In-Phase Data

Data Collected: 07/14/2011

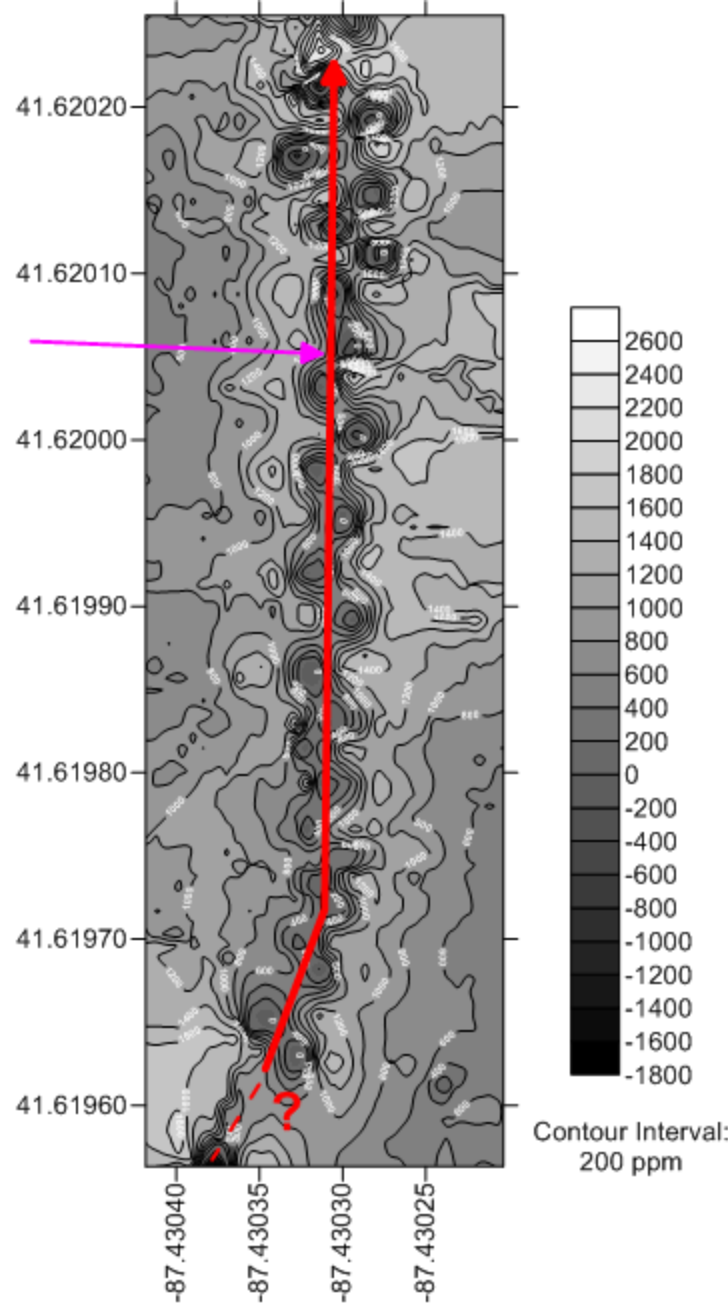
This Drawing is in Color
Do Not Reproduce in B/W

Contour Data Plot:
13590 Hz In-Phase

NOTES:

- 1) Lower values (darker shades) are indicative of linear metallic underground feature.
- 2) Vegetation limited data collection to the North, but anomaly may continue further North than indicated. Anomaly may end or change direction at southern portion of data record.
- 3) GPS data collected with Garmin 18x PC/LVC using WAAS.
Datum: WGS 84
- 4) Data plotted using Golden Software Surfer 9.
Gridding Method: Minimum Curvature.

Probable Pipeline



13590 Hz Data
Approximate Depth: 6 feet



USEPA - Region 5
Chicago, Illinois

Approximate Scale in feet
0 12 24 36

Figure 7

Cline Avenue Ditch Spill Gary, Indiana

Electromagnetic Data - Frequency Domain Using Geophex GEM2 Tool

Data Collected: 05/19/2011

Contour Data Plots:
35010 Hz Quadrature Phase
&
13590 Hz Quadrature Phase

NOTES:

- 1) Data acquired East of power lines since tool is susceptible to interference from electromagnetic fields. Length of N-S traverse approx. 470 feet.
- 2) Direction of ground water flow is unknown. An assumption that it is moving west to the lowest nearby elevation (ditch) could be probable, but not proven to date.
- 3) Lower values (darker shades) are indicative of possible oil contamination.
- 4) GPS data endpoints collected with Trimble AgGPS unit using OmniSTAR differential correction (VBS). UTM 16 NAD 83 converted to decimal degrees. (DD is USEPA Standard for using Lat. Long.)
- 5) Data plotted using Golden Software Surfer 9. Gridding Method: Minimum Curvature.

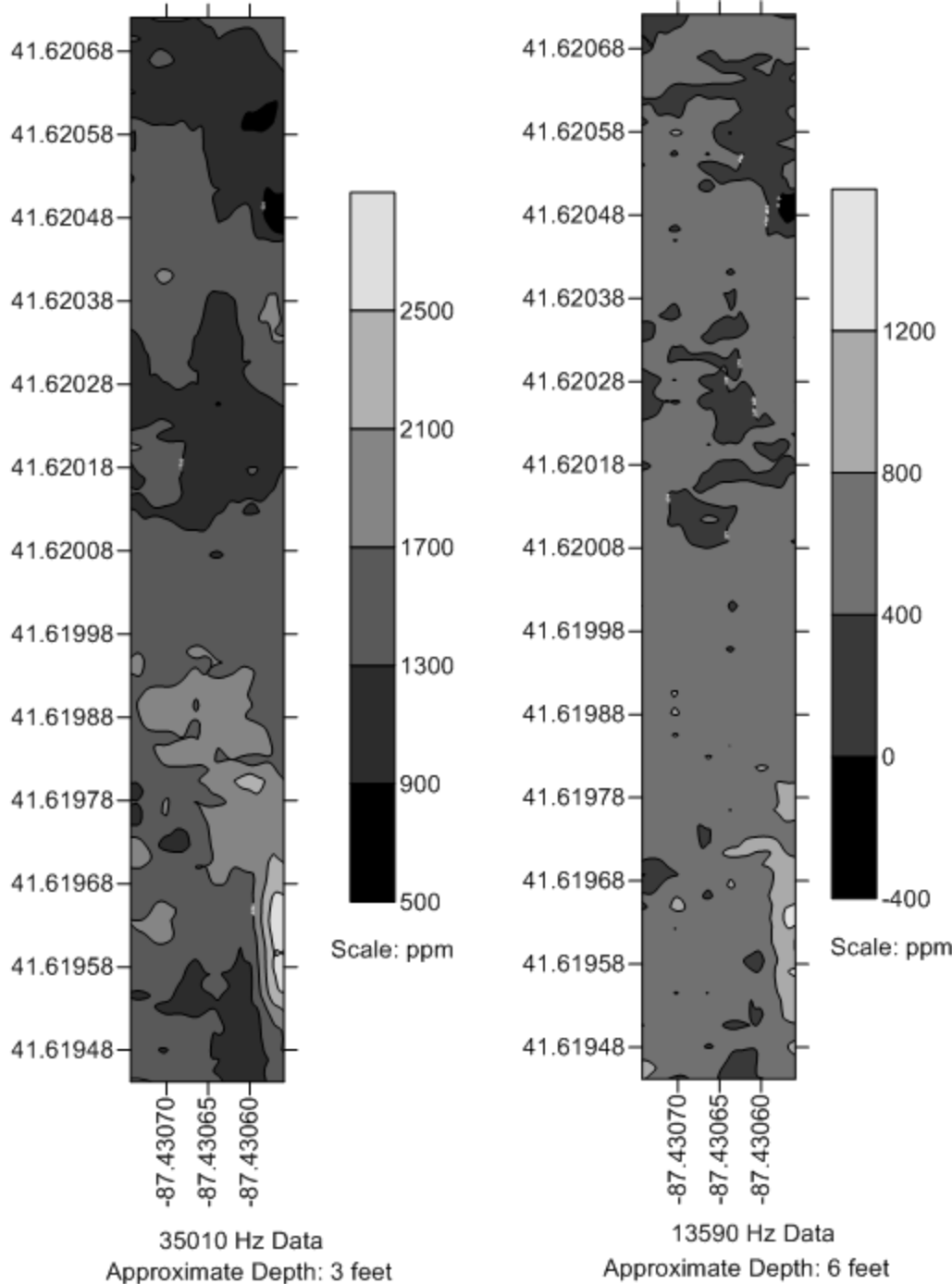


Figure 8



USEPA - Region 5
Chicago, Illinois

