COLLIER GEOPHYSICS
Surface • Marine • Borehole

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A Service-Disabled Veteran-Owned Small Business (SDVOSB)

November 27, 2019

To: Matthew L. Wardlow, P.E.
Environmental Department Manager

CTL|Thompson, Inc.
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Denver, CO 80204
303-825-0777

VIA Email: mwardlow@ctlthompson.com

RE: Geophysical Letter Report | Project #19-231
John P. McHugh Wells 1 & 2 Geophysical Investigation
Adams County, CO

Collier Geophysics, LLC (Collier) conducted a geophysical investigation on behalf of CTL|Thompson, Inc. (CTL), at a project site at 88th St. and Buckley Rd., Adams County, CO (Figures 1 and 2). The objective of the investigation was to determine the presence, if any, of two abandoned oil/gas wells. The investigation was completed with the total-field magnetic (MAG) method.

The survey was conducted on November 13th, 2019, by Collier geophysicist Nicole Pendrigh. The following report presents results from the geophysical investigation and summarizes the site conditions, field methods, data acquisition, and interpretation procedures. For further information regarding the intricacies of the MAG technique, Collier can submit an addendum upon request.

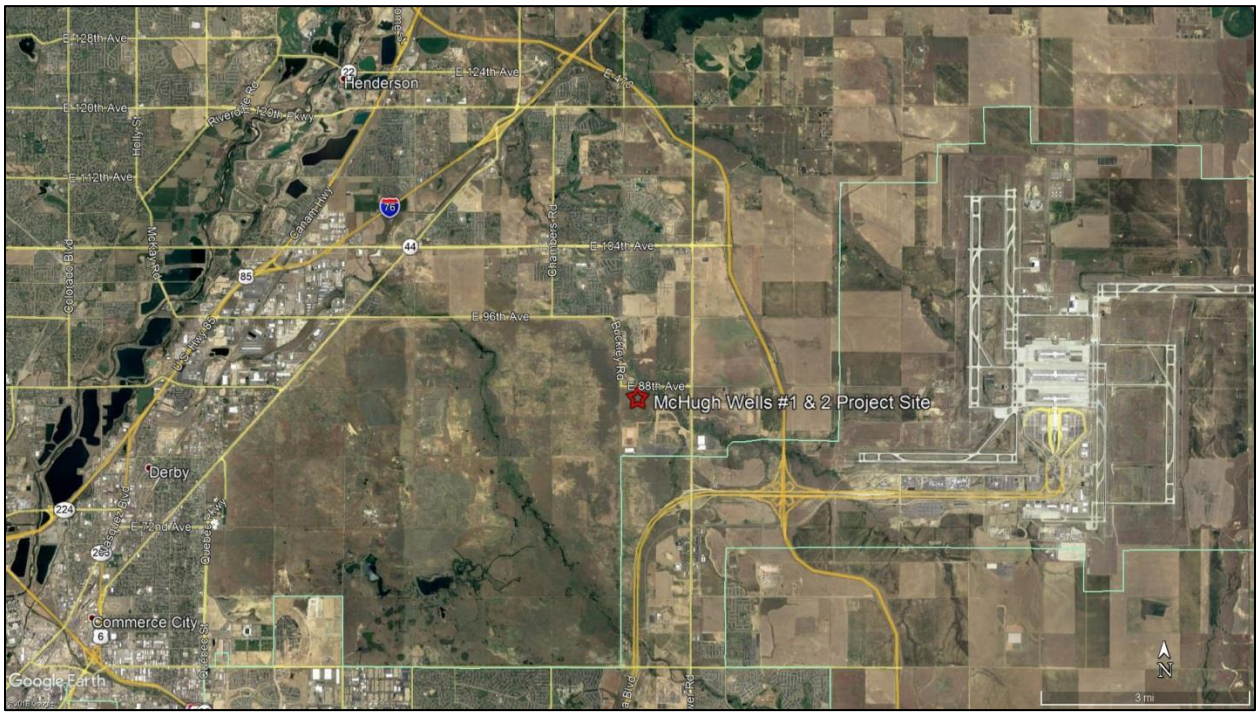


Figure 1. Site location indicated by red star (from Google Earth Images).

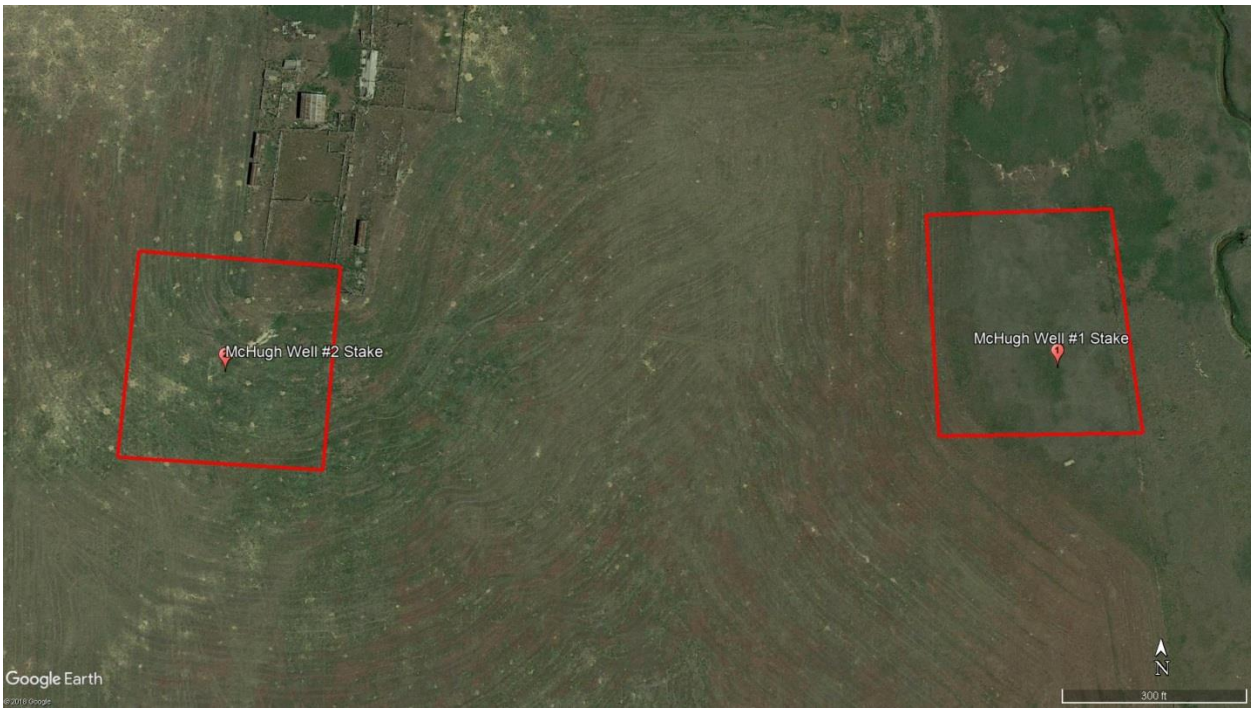


Figure 2. Detailed view of sites. Approximate outline of areas of investigation shown in red (from Google Earth Images). The red pins represent the staked location of the wells as noted in the field.

Site Conditions

The site consisted of two areas of interest approximately 1,300 ft apart. Both areas were located in open fields with minimal vegetation with some tall grasses and weeds. Weather conditions during data acquisition were sunny, warm and slightly breezy. Figure 3 shows site conditions at the time of the survey.

Figure 3. Site conditions at time of survey.

Data Acquisition

Magnetometry data were acquired using a Geometrics G-858 magnetometer system (inset photo right). Data were collected at a sample frequency of 10 Hz. The magnetometer was configured with two sensors, one above the other using a 36 inch separation. Each magnetometer measures the strength of Earth's magnetic field in nanoteslas (nT), called the Total Field Intensity (TFI), simultaneously. The presence of ferrous materials causes distortions in the magnetic field that are detected by the sensors. Magnetometry data were collected along regularly spaced linear transects to generate a grid of continuous data over an area, in the East-West and North-South directions. During this survey a nominal transect spacing of 10 to 20 feet was used. The total area surveyed was approximately 4.5 acres over 2 sites. A Trimble GPS unit capable of sub-meter precision was used to record and merge GPS positions at a rate of 1 Hz into each instrument's data stream during acquisition for accurate, continuous mapping.

Data Processing

Raw MAG data were converted to tabular data files using MagMap2000, version 5.04, by Geometrics, Inc. Data processing, filtering, and gridding were performed using Geosoft Oasis montaj (Geosoft), version 9.3, a processing and data visualization software suite used for analysis of geophysical data sets. GPS data positions were interpolated between each measured GPS position due to higher sample rate of the magnetometer instrument. Geosoft was used to map and grid data using the minimum curvature method and export the results as plan view map images. Data were gridded using the TFI for both the top and bottom sensors, as well as the vertical magnetic gradient between the sensors. Additionally, the Analytic Signal (AS) was calculated and examined for each of the sensors. ASis an amplitude gradient computation which effectively compensates for the positive/negative magnetic dipole effects in order to place magnetic anomalies over their causative bodies. While the various outputs are used to analyze the results, those that represent the objective best (Total Field Magnetic Intensity and Analytic signal of the bottom sensor (Area 1) and top sensor (Area 2)) are presented in the figures.

Results and Discussion

The results of the geophysical surveys for Areas 1 and 2 are presented in Figures 4 and 5, respectively, appended to this report and presented in 11 x 17" landscape format. The results are presented as color-gridded data in a plan view map overlain on aerial imagery. On the Magnetic Total Field grid (left), cool colors (dark blue) represent low anomalous values, yellow represents background values, and hot colors (red) represent higher anomalous values. The analytic signal processing centers the anomalous values over the potential source, and in so doing redistributes the anomalies in the Magnetic Total Field grid so that anomalous data are seen only as high values. Therefore, the color scale of the AS grid (right) is different than TFI, with cool colors representing background values and hot colors representing anomalous high values. Each color scale is presented with the plan view maps.

Both grids on Figures 4 and 5 show one very large anomaly and several smaller anomalies. Some of the smaller anomalies can be explained by metal debris or other sources on the surface, while other small anomalies may be buried metallic debris. The size of the large TFI dipole present in both grids suggests the presence of an abandoned well. The staked location of the wells (as observed by Collier field personnel) is displayed on the grids as a black plus sign. McHugh Well #1 (represented by a bold black x, Figure 4) is approximately 35 ft northeast of the staked location, and McHugh Well #2 (Figure 5) is approximately 15 ft southwest of the staked location. Center point coordinates for McHugh wells 1 and 2 are presented in Table 1, below.

Additionally, steps were taken to determine depth to the likely source of the anomalies. The depths were estimated using VOXI, a modelling software package add-on to Geosoft Oasis Montaj. VOXI allows for 3D inversion and forward modelling using the TFI grid, elevation data, and sensor height to determine depth to source. With no a priori information (depth to source, susceptibility values, etc) the VOXI program generates a best fit model of the source, and depending on modelling parameters, the depth, size, and shape and shape of the model may vary from what is expected (i.e. a vertical well). This may present a non-unique solution for the known source type. Therefore, estimated depths were derived by combining and averaging results from multiple inversions. Average depth estimates are included in Table 1.

Table 1: Center point coordinates and estimated depths. Easting and Northing coordinates are in WGS84 UTM Z13N ft.

Anomaly	Easting (ft)	Northing (ft)	Longitude (WGS84)	Latitude (WGS84)	Estimated Depth (ft)
McHugh Well # 1	1701120.20	14473893.30	-104.783711	39.854608	11
McHugh Well # 2	1699747.52	14473860.50	-104.788603	39.854527	9

Closure

The geophysical methods and field procedures defined in this report were applicable to the project objectives and have been successfully applied by Collier geophysicists to investigations of similar size and nature. However, sometimes field or subsurface conditions are different from those anticipated and the resultant data may not achieve the investigation objectives. Collier warrants that our services were performed within the limits prescribed for this project, with the usual thoroughness and competence of the geophysical profession. Collier conducted this project using the current standards of the geophysical industry and utilized in house quality control standards to produce a precise geophysical survey.

The quality of the geophysical data acquired during this investigation was good. The high quality of the data yields a high degree of confidence in the results obtained and presented in this report. If you have any questions regarding the field procedures, data analyses, or the interpretive results presented herein, please do not hesitate to contact us. We appreciate working with you and look forward to providing you with geophysical services in the future.

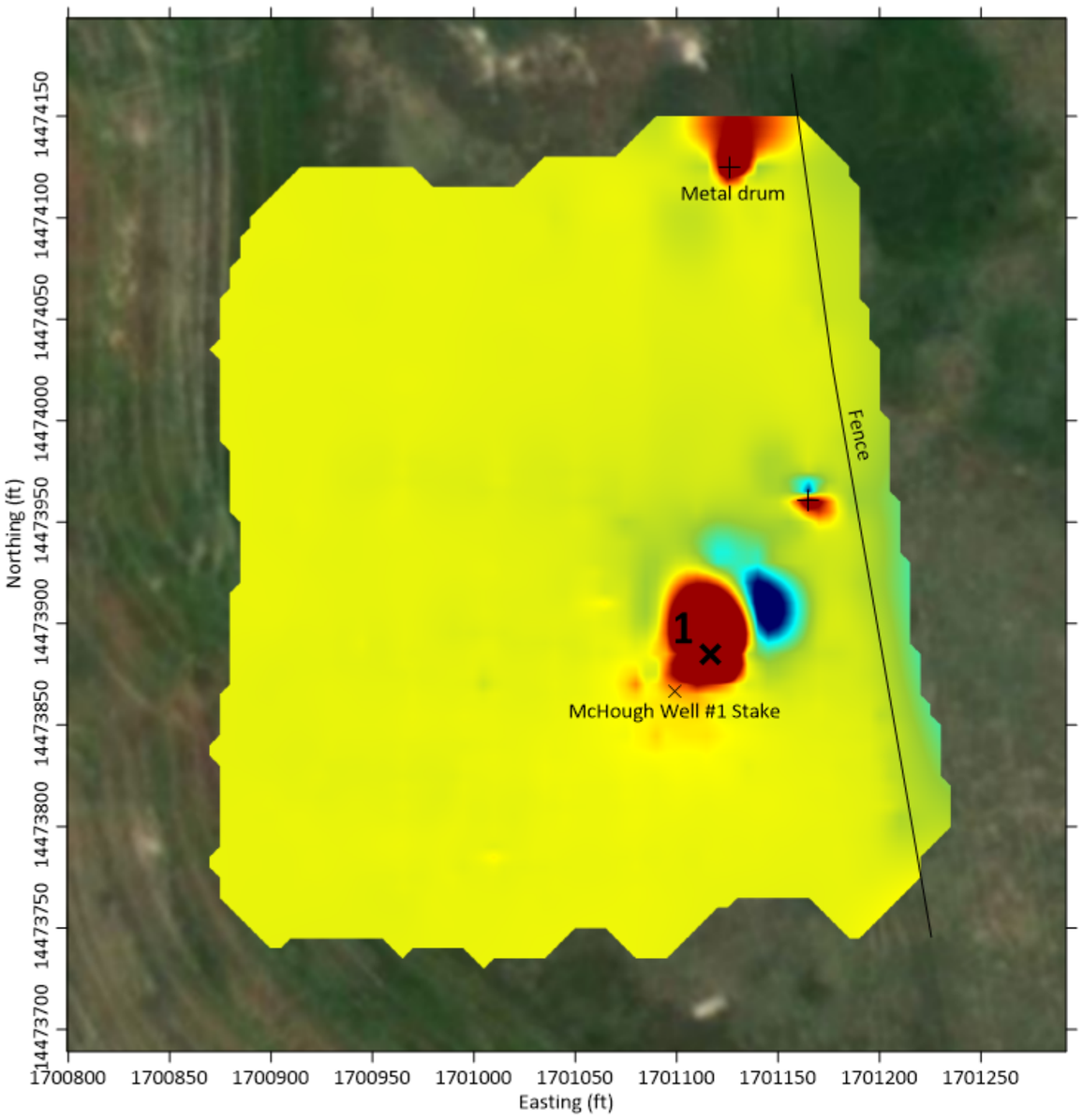
Respectfully,

Nicole Pendrigh
Senior Geophysicist

Trever Ensele
Senior Geophysicist

(1 copy e-mailed PDF format)

Total Field Intensity



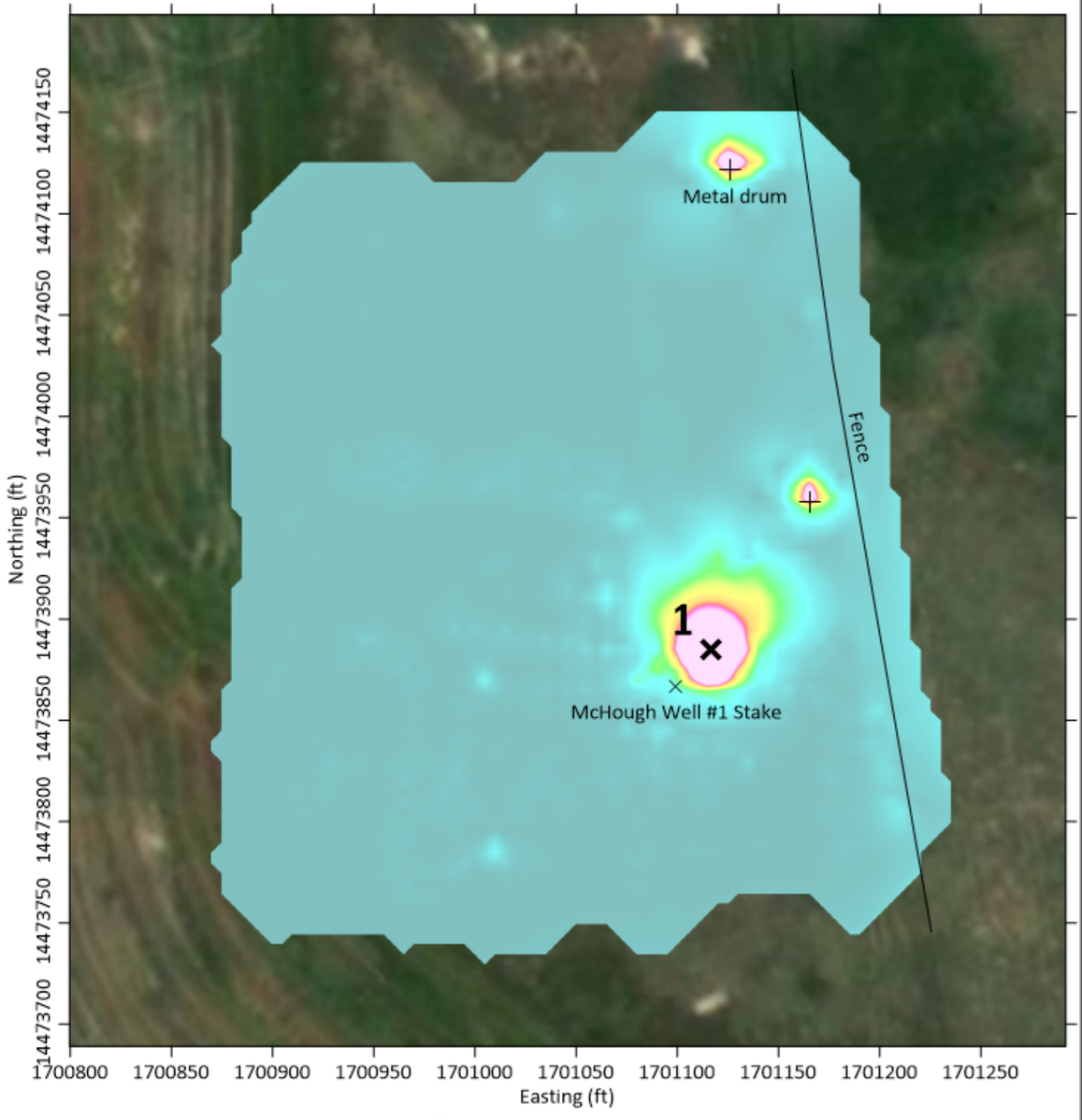
Total Field Intensity (nT)

50500 50750 51000 51250 51500 51750 52000 52250 52500

× Staked well location

+ Surface cultural features and other anomalies

Analytic Signal



Analytic Signal (nT/m)

0 50 100 150 200 250 300 350 400 450 500

✖ Anomaly 1 - Center Point Coordinate:
1701117E, 14473885N
(Geographic: 39.854585°N, 104.783723°W)

*Coordinate Sytem is WGS84 UTM Z13N feet

Magnetometry Survey
McHugh Well 1
Adams County, CO

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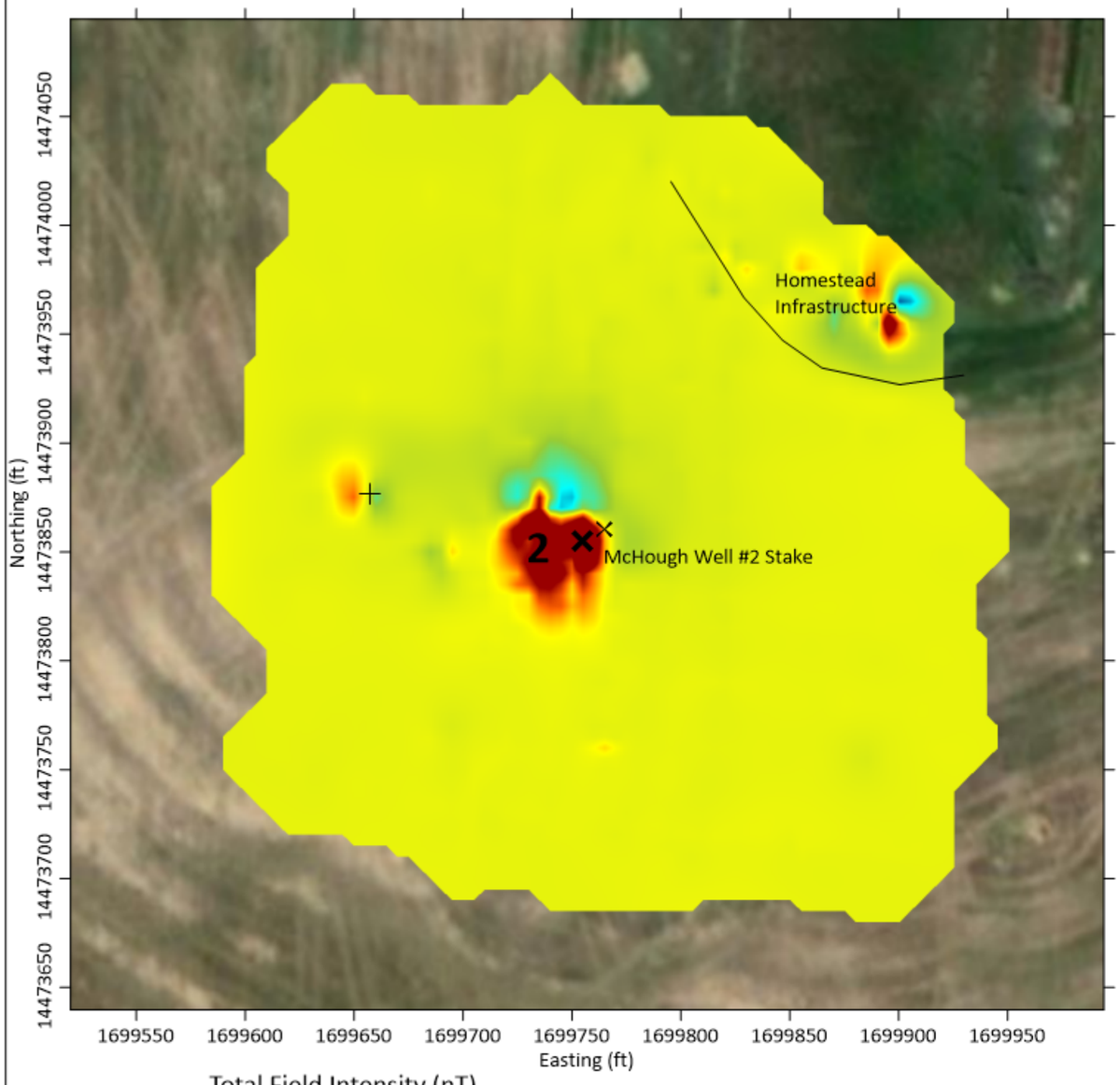
Drafted by: N.Pendrigh	Checked by: J. Sheehan	**Figure 4**

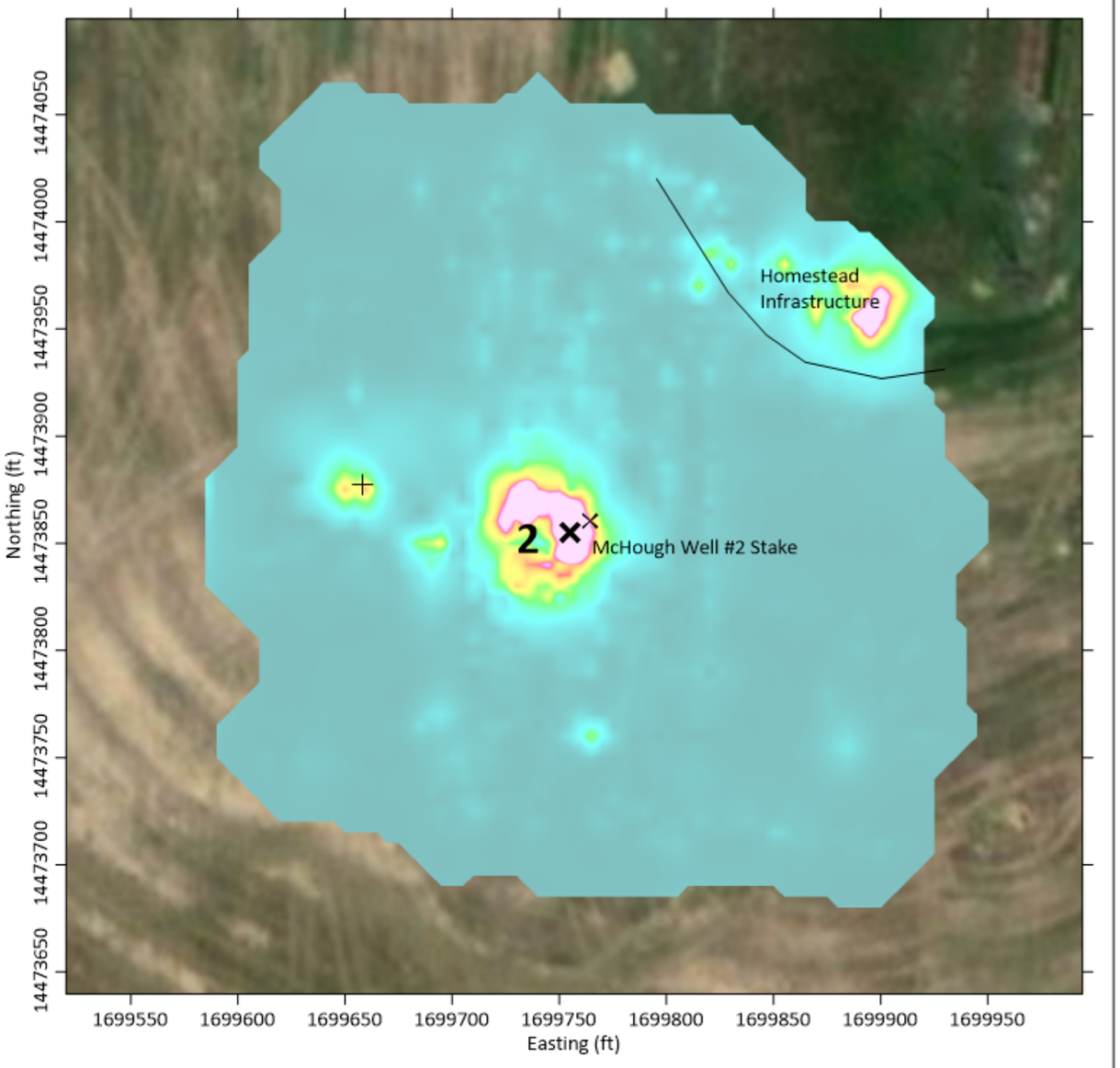
Total Field Intensity



Total Field Intensity (nT)

50500 50750 51000 51250 51500 51750 52000 52250 52500

Analytic Signal



Analytic Signal (nT/m)

0 50 100 150 200

× Staked well location

— + Surface cultural features and other anomalies

✖ Anomaly 2 - Center Point Coordinate:
1699755E, 145473855N
(Geographic: 39.854511°N, 104.788576°W)

*Coordinate Sytem is WGS84 UTM Z13N feet

Magnetometry Survey
McHugh Well 2
Adams County, CO

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