NORTH SENECA
SOLAR PROJECT

APPENDIX 3-C

Magnetometer Survey Report

ORES Permit Application No. 23-00036

Results of UAV Aeromagnetic Survey and Follow-Up Terrestrial Survey
North Seneca Solar Project

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PROJECT AND OVERVIEW OF PROVIDED SERVICES

This document is a report detailing acquisition, processing, and interpretation of results of a UAS aeromagnetic geophysical survey conducted in the planned location of North Seneca Solar Project, near the town of Waterloo, NY. The aeromagnetic survey was conducted by Aletair LLC field crews #1 and #2 in June and July 2023, the total attempted survey site is delineated by the Area of Interest in **Figure 1.** The survey consisted of a UAS total field aeromagnetic survey designed to allow identification of magnetic anomalies associated with metal-cased orphaned oil and gas wells if such features were present. The purpose of this survey was to non-invasively isolate any possible magnetic anomalies without disturbing ground cover. Datasets were collected with some interference from surrounding electromagnetic anomalies associated with electric transmission lines, a gas pipeline, a number of known wells, and existing farm and housing infrastructure, and were processed to allow detailed interpretation. A small section in the northwest of the AOI was not accessible to this UAV survey effort due to rough topography and heavy vegetation resulting in UAV-base station signal loss. Interpretation of the processed datasets revealed presence of disorganized magnetic anomalies likely associated with existing electrical infrastructure, as well as a small number of organized magnetic anomalies likely associated with known infrastructure elements. **The survey revealed evidence of two previously unlocated wells in close proximity to NYS-DEC reported well sites that were further investigated to update and correct current location information with follow-up visual and terrestrial magnetic survey.**

Figure 1

PROJECT AND SCOPE OF SERVICES

This report is to submitted alongside the datasets supporting an application for major renewable energy facilities development reviewed by the Office of Renewable Energy of the State of New York focused on the North Seneca Solar Project. The survey targets assessment of the area of interest (AOI) for possible presence of unmarked orphaned oil and gas wells required for a proposed facility where an oil, gas or mining solution well is known to exist within five hundred (500) feet of proposed areas to be disturbed within a proposed facility boundary (based on records maintained by the NYSDEC) or for any proposed facility located in NYSDEC regions 7, 8, or 9 as specified Section 94-c of the New York State Executive Law

We conducted a UAV-based aeromagnetic survey over the AOI to effectively isolate any magnetic anomalies associated with possible unmarked cased wells. The purpose of this survey was to non-invasively assess the AOI and determine whether any NYSDEC-regulated wells are present within 500 feet of proposed areas to be disturbed, and if so, allow identification of the wells and type prior to development. The survey was conducted using an unpiloted aerial system (UAS) consisting of an unpiloted aerial vehicle (UAV) and integrated micro-fabricated atomic magnetometer (MFAM) array. Acquired datasets were processed and interpreted using proprietary algorithms to effectively denoise the data and highlight any features of interest. Past work demonstrated unparalleled effectiveness of Aletair UAS surveys in wide area assessment of complex terrain areas for presence of unmarked wells, including wells with stripped out upper casing sections, which are virtually undetectable using other means and methods.

STANDARDS & QUALIFICATIONS

Key Aletair personnel have the necessary technical expertise in the deployment of aerial magnetometry systems and are in possession of all necessary equipment and are licensed by the Federal Aviation Administration (FAA) as Remote Pilots under FAA Section 107.

In the past, PIs de Smet and Nikulin (2020a, 2020b, 2020c) have demonstrated successful execution of geophysical and archeological remote sensing research investigations in New York State, including surveys conducted in support of solar energy development projects, including efforts supporting NYC 94C compliance. PIs de Smet and Nikulin (de Smet 2013; de Smet and Everett 2013; de Smet and Eckert 2013; de Smet and Everett 2014; de Smet 2015; de Smet and Eckert 2015; de Smet et al. 2017; de Smet 2019a; de Smet and Nikulin 2020a, 2020b, 2020c, 2020d) have expertise in preparing technical reports documenting the results of archeological remote sensing field surveys including producing documents and reports, compiling data, and producing maps and graphics, using Geographical Information System (GIS), database, and graphics software.

PI de Smet has prior experience with both archaeological and Federal Aviation Administration permitting processes (de Smet 2019b; de Smet and Eckert 2013, 2015), and PI Nikulin is International Mine Action Standards 5.1 certified (Nikulin 2018). Additionally, PI de Smet meets the Federal professional standards as described in *Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines* (48 FR 44716- 44742). Drs. de Smet and Nikulin's full CVs can be made available for review at the client's request.

GEOPHYSICAL METHODS IN WIDE AREA UAS SURVEYS

Vertical metal casing found in conventional oil and gas wells produces a high-intensity magnetic anomaly at the surface and terrestrial magnetics surveys are commonly relied on to locate oil and gas wells and pipelines in areas with limited vegetation (Sapunov et al., 2015). Similarly, piloted aeromagnetic surveys present a viable alternative to terrestrial magnetic well surveys in areas where lack of vegetation and anthropogenic obstacles, as well as gentle topography allow aircraft operation over wide areas and at low altitudes. With the emergence of heavy-lift commercial UAVs, numerous attempts have been made to adapt their use in commercial and humanitarian aeromagnetic surveys, as UAV-based surveys are a considerably less labor-intensive and more cost-efficient solution than either traditional terrestrial surveys or piloted surveys (Sams et al., 2017). In particular, UAV-based aeromagnetic surveys are increasingly being used to detect anthropogenic targets like unexploded ordnance (Mu et al., 2020; Nikulin et al., 2020), mineral exploration (Malehmir et al., 2017; Walter et al., 2020), and pipeline monitoring (Gavazzi et al., 2016).

In contrast to the products and services available on the market, Aletair UAS were developed from the ground up specifically targeting the remote detection of orphaned oil and gas wells over large areas. Because of this, *our technology was able to improve upon the three critical shortcomings of available aeromagnetic surveys by: 1) dynamically determining optimal survey altitude to rapidly and accurately detect wells with an optimal signal-to-noise ratio, 2) avoiding the tree canopy with our digital obstacle model (DOM), and 3) dramatically increasing survey area by integrating a high-endurance UAVs.* Furthermore, our UAS surveys fly GNSS-guided autonomous missions, which are more repeatable and therefore more reproducible than piloted missions, allowing to measure change over time. Our UAS surveys can be conducted in areas too logistically difficult for either terrestrial or helicopter-based surveys, and our surveys are relatively weather-tolerant and can be conducted in the heat of the summer or, as we demonstrated in our field trials, with over a foot of snow on the ground (Figure 3). Finally, mindfully designed and executed UAS surveys are fundamentally safer than piloted missions and, as an unpiloted system poses a reduced threat to the operator, ground personnel, residents, and structures.

Today, our UAS surveys represents a complete geophysical survey, processing, and interpretation service, which may be readily deployed year-round over a variety of environments and weather conditions. Through our research and development efforts, we were able to optimize a hybrid UAS for aeromagnetic surveying, derive the optimal configuration of magnetic sensors, and develop and streamline data processing and visualization algorithms that highlight magnetic anomalies associated with orphaned oil and gas wells, while muting false flag anomalies associated with unrelated infrastructure and metallic debris (Nikulin and de Smet, 2019). Consequently, we developed an automated approach to mapping the location of methane- emitting orphaned oil and gas wells that utilizes proprietary filtering and mapping algorithms (de Smet et al., 2021). Adoption of our UAS as a core element of surveys targeting orphaned oil and gas wells will allow to significantly expand efforts to locate and remediate such wells in terms of geography, timeframe, and survey effectiveness.

COMPLETED WORK:

Based on the agreed survey requirements and scope of work we collected magnetic field data using a UAS with an integrated MFAM laser pumped magnetometer with continuous acquisition at a line (transect) spacing of 25 m and sensor height of 36 m. UAV surveys were conducted North-South over a total AOI measuring 2249 acres (Figure 2), with the exception of a small area in the northwest section of the survey inaccessible to UAV flights due to obstruction by critical infrastructure (high voltage electric lines) and deep vegetation. Raw magnetic data were parsed and de- striped, with correct GPS time markers. A line leveling technique was applied to each of the flight lines for every individual flight, removing the directional interference, or heading erros, in the data. In additional processing and visualization steps, the total field strength was plotted using the Kriging Interpolation to turn the values into rasters and create a properly georeferenced map image of the data in NAD83 projection. From there a low- pass convolution filter removed image background noise and the raster color scale and inversion was adjusted to intensify the magnetic variation in the data, thus clarifying any possible anomalies associated with subsurface well casing.

DELIVERABLES:

1) All raw magnetic data as ASCII text (.txt) files deposited to shared project folder.
2) All processed magnetic data as ASCII text (.txt) files deposited to shared project folder.
3) GIS shapefiles of grid corners and georeferenced rasters (.GeoTIFF) of raw magnetics data in NAD83 deposited to shared project folder
4) Final interpreted maps of survey area in .pdf format deposited to shared project folder
5) Written final survey report with all generated maps and final interpretation.

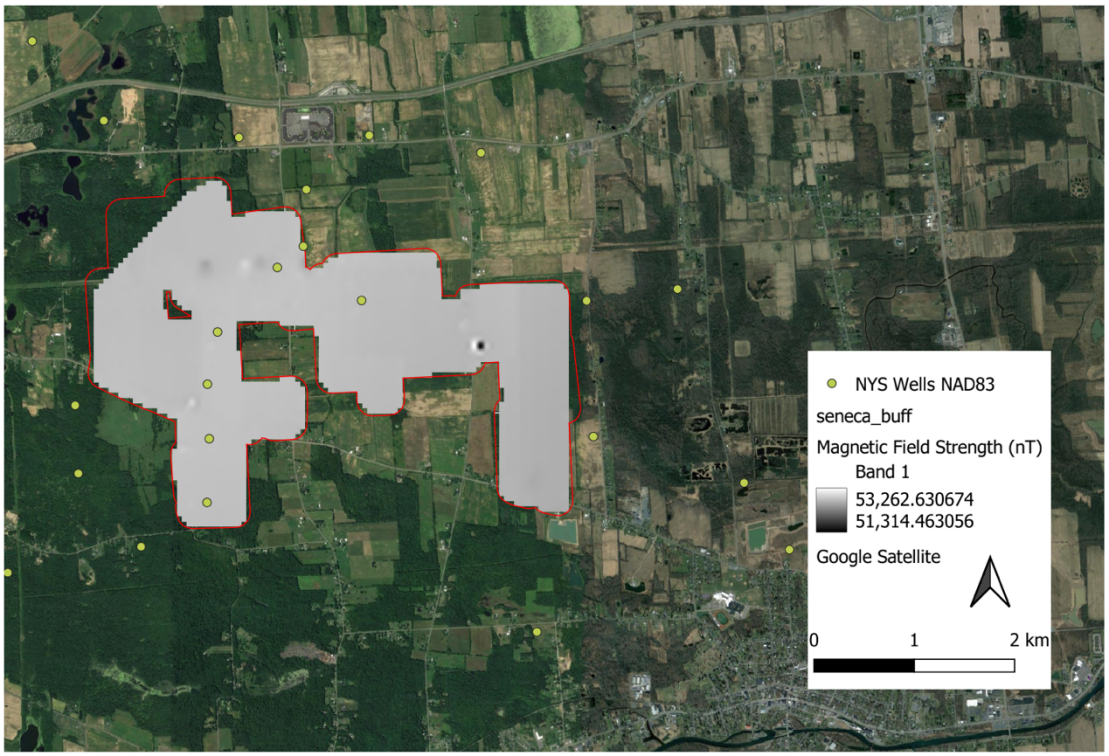


Figure 2: Surveyed areas of AOI. Red rectangle over inaccessible area.

RESULTS AND INTERPRETATION

Final combined and processed dataset covering the extent of the Area of interest is presented in **Figure 3** As it can be easily seen, a number of large organized magnetic anomalies are present, which are associated with known pipeline, agricultural, and housing infrastructure, as well as a number of high-intensity anomalies in the general vicinity of reported well locations likely associated with well casing. Below we highlight and outline the interpreted nature of these anomalies and their likely sources, including those stemming from possible well casing strings in the subsurface. **Importantly, for all figures the zoomed-out figures scale to the largest anomaly present, while zoomed-in figures that follow scale to the largest anomaly in the field of view.**

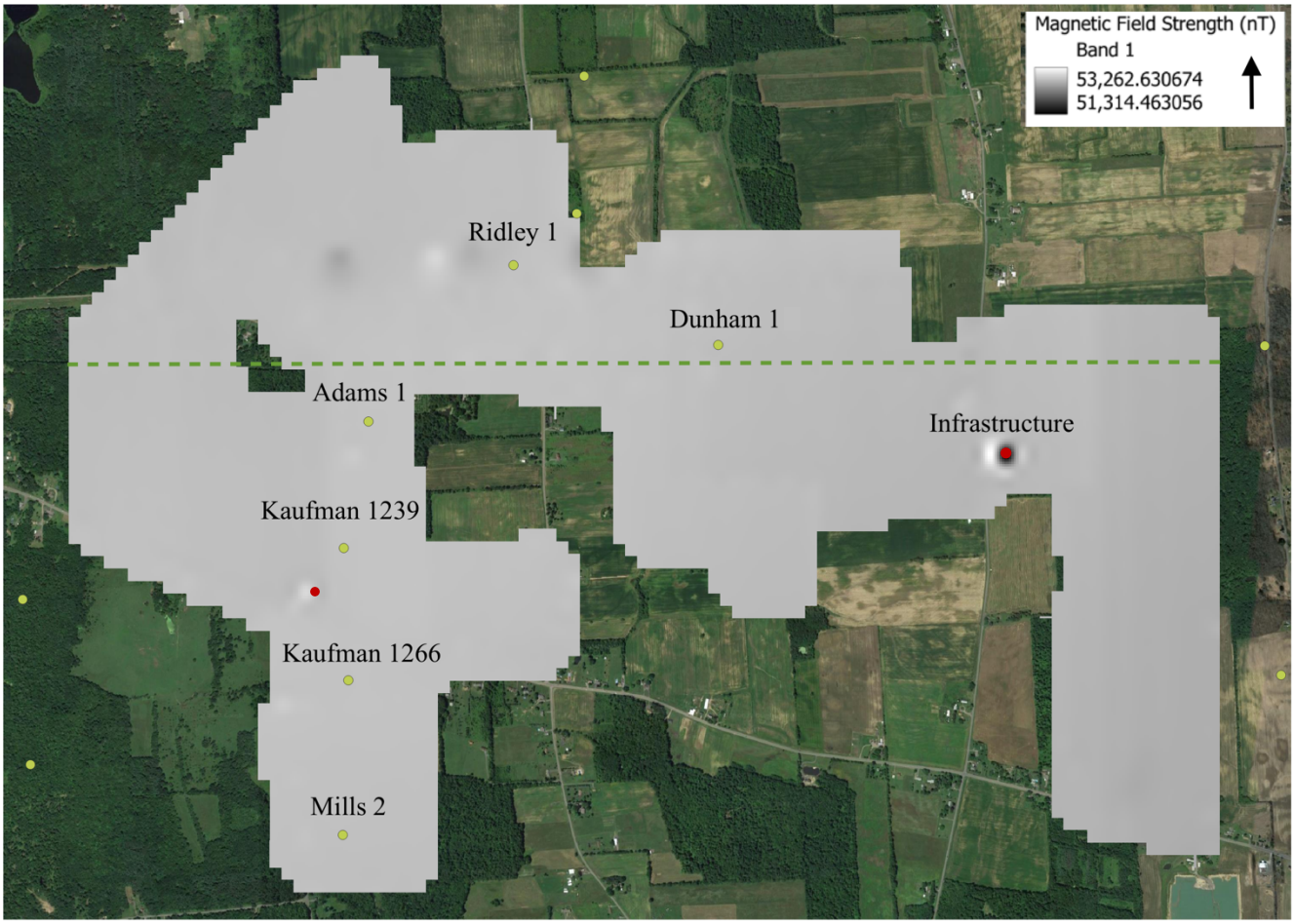
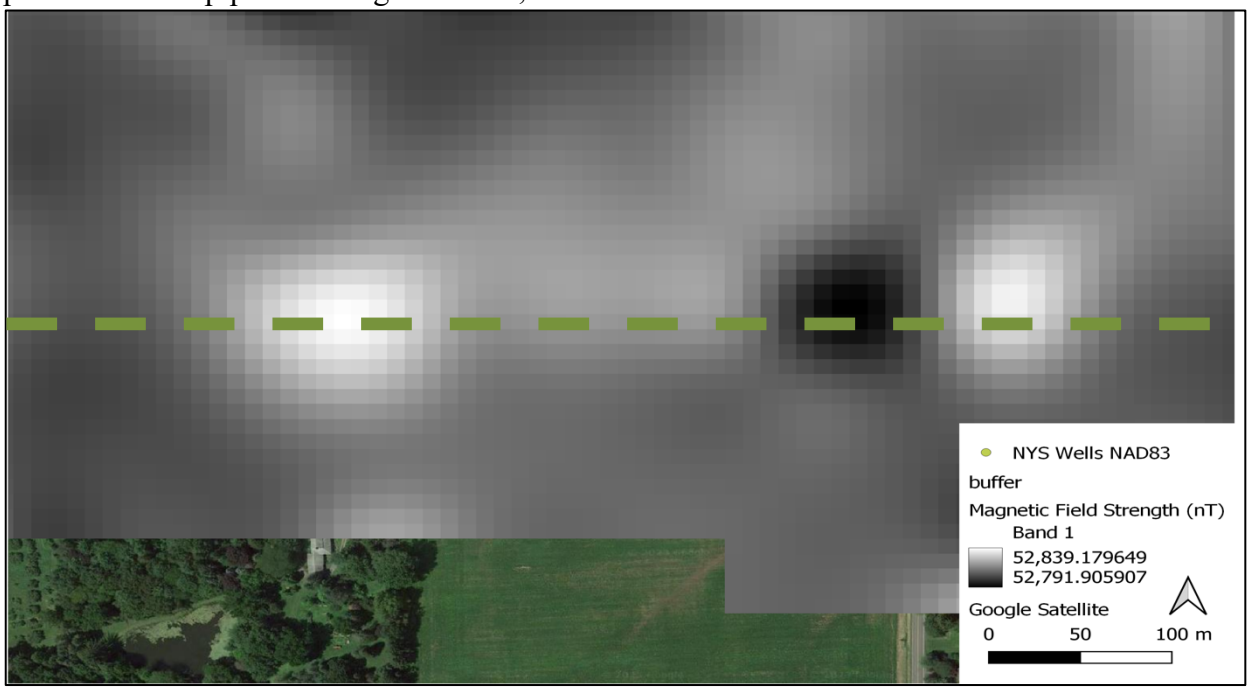


Figure 3 - Figure 2: Magnetic field strength over surveyed areas of AOI with DEC-catalogued well locations (green dots), approximate subsurface pipeline location (green dashed line), and a location of a large agricultural infrastructure facility marked with red dot.

Pipeline Infrastructure

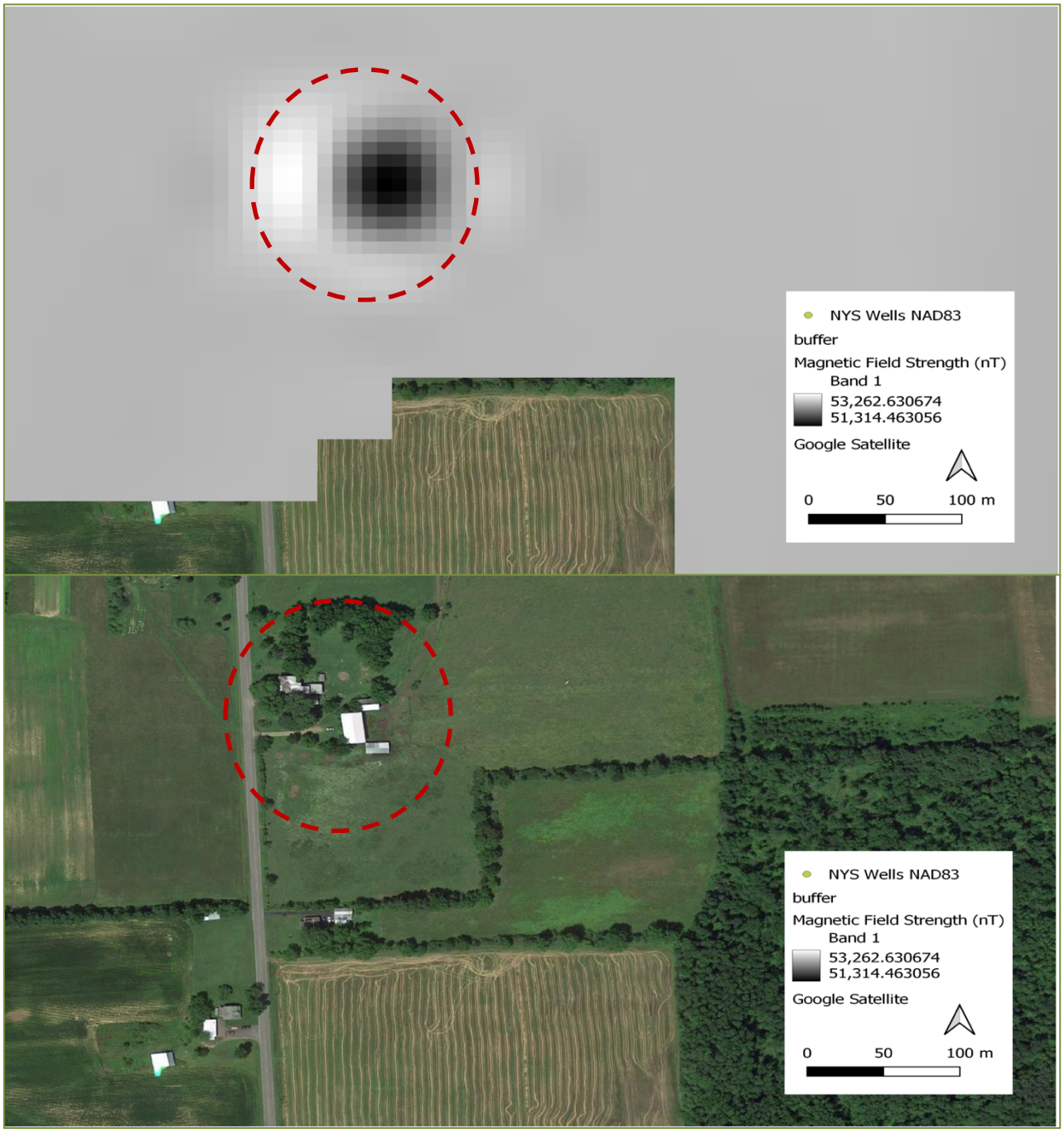
An example of the string of east-west oriented dipoles indicates presence of a subsurface pipeline running east-west across the survey. A subsurface gas pipeline creates a strong magnetic signature, as result of the natural magnetic properties of the steel material used to construct the pipeline, which can additionally be influenced by the magnetic properties of the surrounding soil and any current flowing through the pipeline. As a result, the magnetic field around the pipeline is disturbed due to the presence of the pipeline's magnetic field, which causes a local distortion



Agricultural and Housing Infrastructure

Multiple organized anomalies along local roads largely correlate to agricultural sites and housing units, both those standing close together and those isolated from each other. These anomalies vary in intensity and size, largely correlating to the size of the structure and the amount of metal used in their construction, with possible additional constructive interference from water wells, metal-containing machinery, and other sources of electromagnetic noise common to housing units. An example of one such anomaly is presented below and multiple such features exist in the survey.

(Red dashed circle outlines focus area and carries no geophysical interpretation significance.)



NYS-DEC Reported Wells Summary

Orphaned wells in the subsurface are characterized by large magnetic anomalies is caused by the presence of the ferrous material used in the casing, which creates a local distortion in the Earth's magnetic field if the wells were cased with in metal during their development. Wells drilled as open holes or those that were never cased will not have a demonstrable or detectable magnetic signature. Importantly, many of the wells that pre-date years of the Second World War were stripped of their metal casing during the war in metal scavenging efforts to support the war effort.

The NYS Division of Mineral Resources maintains information on over 40,000 wells. The majority of this information is available through the digital Oil and Gas Searchable Database available through the NYS DEC web server. This database system provides information on well status, well location, well depth, well owners and operators, registered drillers, pluggers, and companies that provide financial security instruments. The searchable database also provides information on well production. Below is a list of DEC – reported wells reported in the AOI, with a brief summary of their reported location and associated magnetic anomalies. In the pages that follow, maps of well sites with magnetic anomaly wells are presented for those wells that were reported as drilled.

Mills 2 – No magnetic anomaly evident in the reported area of its placement, the well may have been drilled as an open hole or a large portion of well casing may have been stripped out as part of historical metal scavenging activities

Kaufman 1266 – Well planned, but not drilled No magnetic anomaly evident in the reported area of its placement.

Kaufman 1239 - Well planned, but not drilled No magnetic anomaly evident in the reported area of its placement.

Ridley 1 - Well location does not directly correlate to an organized magnetic anomaly; however, a large organized magnetic anomaly is present ~250 m to the west of the currently reported location, likely correlating to the true location of the wellsite.

Dunham 1 Well location does not directly correlate to an organized magnetic anomaly; however, a large organized magnetic anomaly is present ~190 m to the northwest of the currently reported location, likely correlating to the true location of the wellsite. **A follow-up field survey effort was able to identify the location of the well in proximity to the magnetic anomaly.**

Adams 1 – Well location does not directly correlate to an organized magnetic anomaly; however, a large organized magnetic anomaly is present ~155 m to the southwest of the reported location. A follow-up visual field survey effort was not able to identify a surface expression of a well in proximity to the magnetic anomaly. **A follow-up terrestrial magnetic survey constrained the location of the high-intensity magnetic anomaly and identified dislodged metal casing in proximity to the subsurface anomaly, giving us high confidence that the anomaly correlates to a subsurface well with previously-exposed surface section of casing removed.**

Mills 2 Well

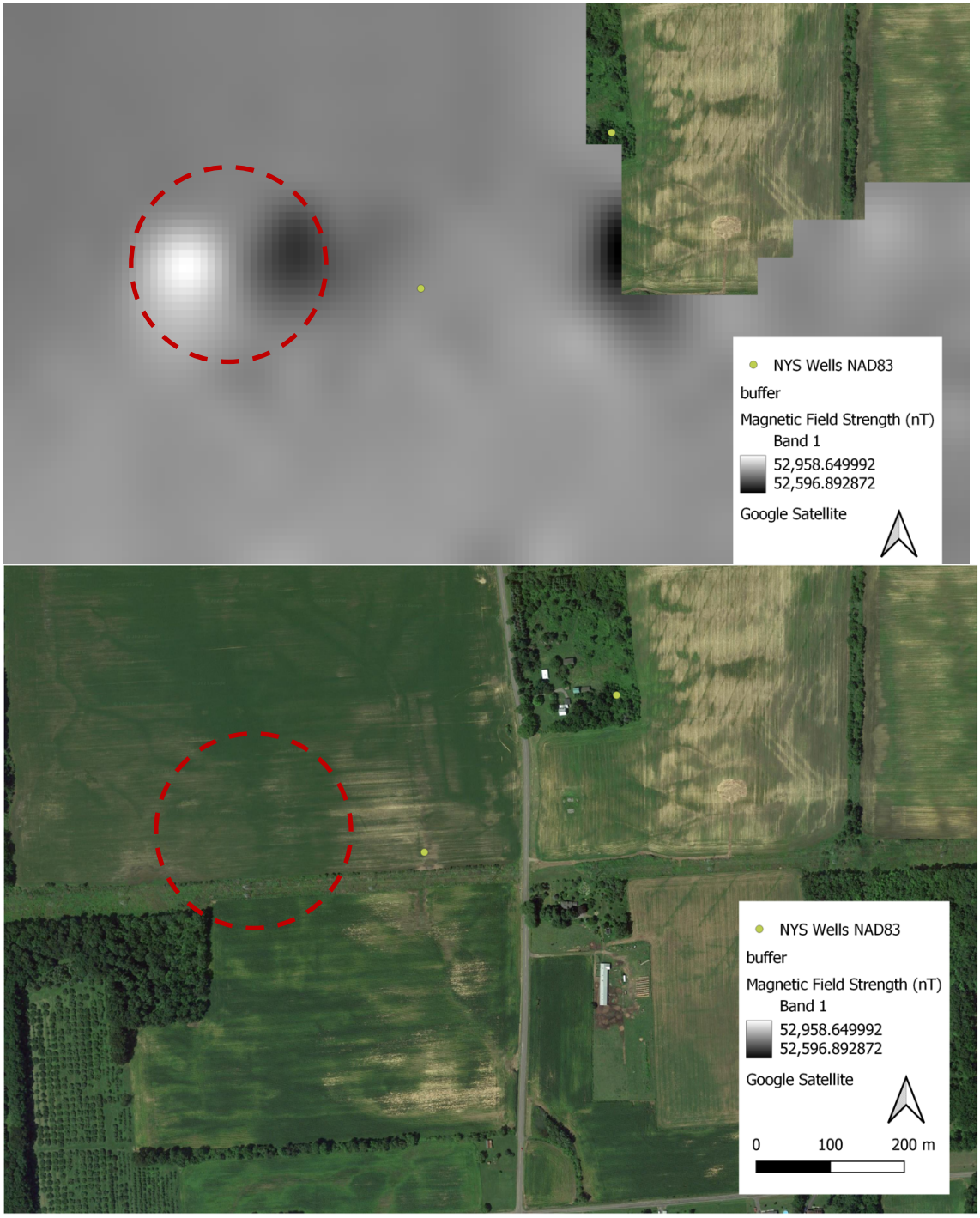
No magnetic anomaly evident in the reported area of its placement, the well may have been drilled as an open hole or the upper section of the well casing may have been stripped. **Surrounding anomalies are spatially correlated to housing development and are likely associated with these units.**

(Red dashed circle outlines focus area and carries no geophysical interpretation significance.)

Ridley 1

Well location does not directly correlate to an organized magnetic anomaly; however, a large organized magnetic anomaly is present ~250 m to the west of the currently reported location, possibly correlating to the true location of the wellsite, however, there is significant electromagnetic interference from high-voltage powerlines and line towers in this section of the survey which present a challenge in interpretation. The location of the anomaly can be constrained to within 12.5 m from highest reported amplitude based on the UAV dataset (lat 42.943460 lon -76.928297).

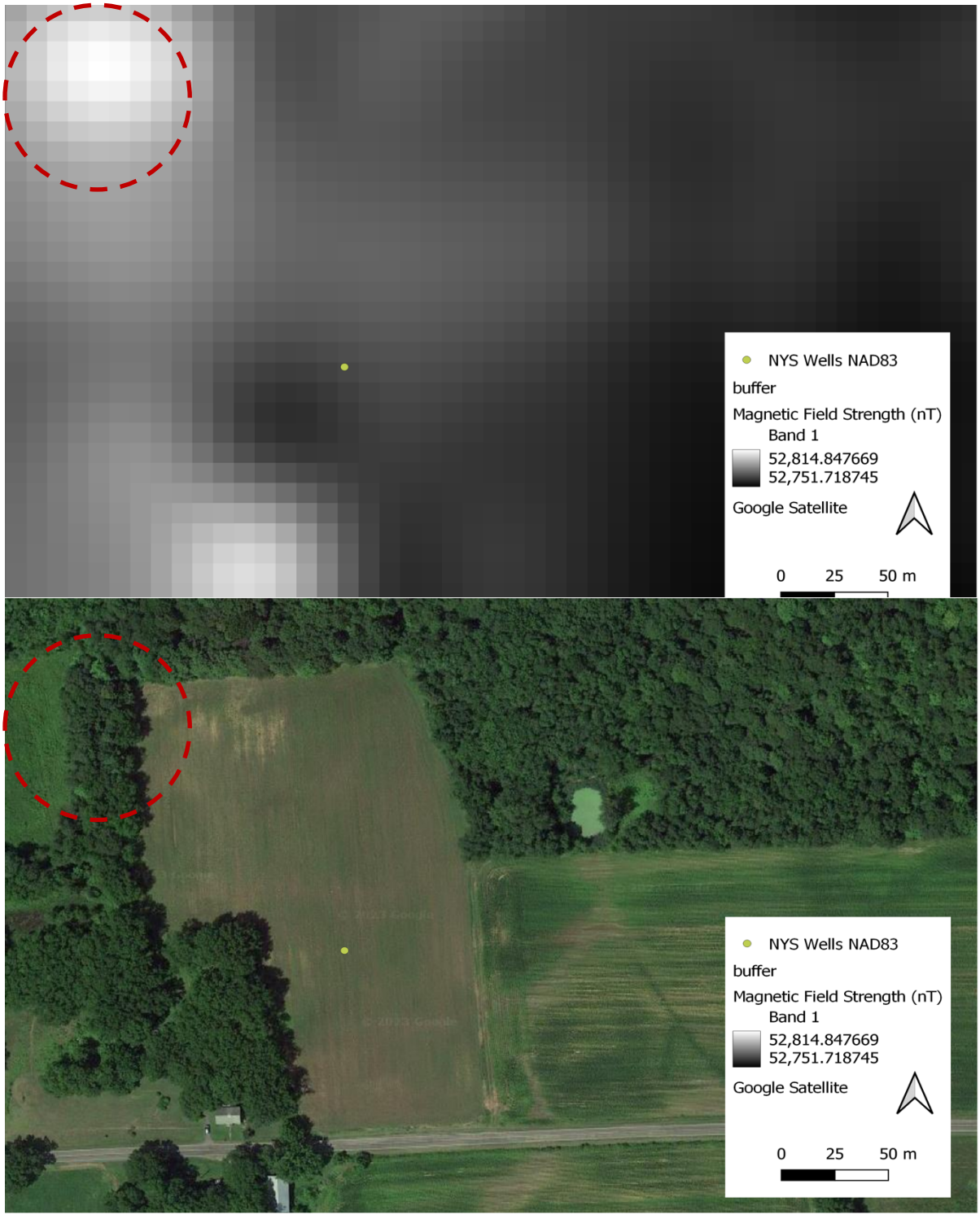
(Red dashed circle outlines focus area and carries no geophysical interpretation significance.)



Dunham 1

Well location does not directly correlate to an organized magnetic anomaly; however, a large organized magnetic anomaly is present ~190 m to the northwest of the currently reported location, likely correlating to the true location of the wellsite. In-field investigation revealed evidence of a wellsite correlating to the magnetic anomaly, rather than the currently-reported location.

(Red dashed circle outlines focus area and carries no geophysical interpretation significance.)



Dunham 1 – UAV magnetic and Initial Field Inspection Results

The high intensity isolated anomaly for Dunham 1 allowed the field team to conduct a quick inspection of the suspected wellsite with landowner permission. The investigation revealed clear evidence of an abandoned wellsite in the general vicinity of the magnetic anomaly, approximately 190m to the northwest of the reported wellsite – concentration of drilling pipe, cables, and other wellsite debris.