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**SANDUSK PROPERTY RESIDENTIAL DEVELOPMENT,  
HAGERSVILLE, ON  
HISTORICAL NATURAL GAS WELL ASSESSMENT  
May 5<sup>th</sup>, 2023**

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### APPENDIX

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## **1. Introduction**

WSP Canada Inc. completed a Phase One Environmental Site Assessment of the Sandusk Property Residential Development site for Empire Communities in 2021. The records review identified four (4) Ontario Oil and Gas Well records and one (1) water well record within the property. No wells were located on the property during the Phase One site reconnaissance.

In October 2022, Mike Dorland Consulting was retained by EC (Sandusk) GP Inc. to complete a historical natural gas well assessment for the Sandusk property. This assessment was requested to address concerns of unidentified historical natural gas wells in the area of residential development and to support the proposed subdivision's compliance with the Oil, Gas & Salt Resources Act and Provincial Policy Statement with regard to construction in an area where petroleum wells are present.

The objectives of the assessment were to: 1) determine if petroleum well files and historical records reported wells drilled on the property, 2) locate and obtain exact coordinates for all on-land wells in the area of residential development, 3) use exact well location coordinates to direct planning so as not to construct buildings over-top of wells and leave room to access the well locations in the future if need be, 4) obtain information needed to apply for petroleum well licences; a petroleum well must be properly licenced before any remediation efforts can begin.

All wells located within the residential development must be evaluated on a case-by-case basis to determine if they have been plugged or need to be re-plugged. Unplugged (or poorly plugged) wells could present hazards to public safety and the environment by providing pathways for oil, gas, and other fluids to migrate between different geologic formations, into aquifers, or to land surface.

## **2. Qualifications of the Assessor**

Mike Dorland, P.Geo., is a Professional Geoscientist with a thorough knowledge of:

- Ontario's subsurface geology.
- The Ontario Oil, Gas & Salt Resources Act, related regulations and standards.
- Well drilling, well construction, and well decommissioning (plugging).

Mike is considered a Qualified Person (QP) by the Ministry of Natural Resources and Forestry (MNRF) Petroleum Operation Section and holds MNRF Class I, Class II, and Class IV Examiner certification (Class I examiner may examine wells with respect to well plugging, isolation of porous zones, cement quality, cement tops, used casing, and well control equipment). Mike is very familiar with Ontario well files and historical well records; and has located many orphan wells in the field using historical maps, aerial photos, a magnetic locator, and high-resolution magnetic surveys. With over 30 years of experience in the oil & natural gas exploration and production industry, Mike brings a wealth of knowledge to the project.

## **3. Policies of concern**

*Oil, Gas and Salt Resources Act (OGSR Act)*

Under the OGSRA Act, the Ministry of Natural Resources and Forestry (MNRF) regulates the drilling and operation of wells and related structures or equipment used for activities such as the exploration and production of oil and natural gas, salt solution mining, the underground storage of hydrocarbons, and compressed air energy storage. These activities are regulated to ensure they are conducted in a safe, efficient, and orderly manner that safeguards the public and the environment.

Section 10.2 (Prohibition on construction, etc.) subsection (1) of the OGSRA Act states that - No person shall erect, locate or construct a building or structure of a type prescribed in the regulations within 75 metres of a well or facility unless the well or facility has been decommissioned in accordance with this Act and the regulations.

Provincial Policy Statement, 2020, issued under section 3 of the Planning Act (PPS)

The PPS provides policy direction on matters of provincial interest related to land use planning and development. As a key part of Ontario's policy-led planning system, the PPS sets the policy foundation for regulating the development and use of land. It also supports the provincial goal to enhance the quality of life for all Ontarians.

Section 3.2 (Human-Made Hazards) subsection (1) states that - Development on, abutting, or adjacent to lands affected by *mine hazards; oil, gas, and salt hazards; or former mineral mining operations, mineral aggregate operations, or petroleum resource operations* may be permitted only if rehabilitation or other measures to address and mitigate known or suspected hazards are under way or have been completed.

#### **4. Records review findings**

The Oil, Gas & Salt Resources Library (OGSRL) is the public access point for the Ministry of Natural Resources and Forestry (MNRF) petroleum well records. The OGSRL has records on many wells in the Hagersville area. A search of Walpole Township revealed the earliest wells drilled in the area in 1905 by Dominion Natural Gas Co. Ltd., exploring for natural gas.

An extensive search of the OGSRL well files and historical records revealed eight (8) wells were drilled for natural gas within the Sandusk property. Figure 1 illustrates the well locations on a georeferenced Dominion Natural Gas Co. Ltd. historical well location map. Figure 2 shows the well locations per the historical map on a Google Earth aerial photo.

Historical well logs for five (5) wells were located in the Province of Ontario, Ontario Department of Mines annual reports (Figure 3). All of these wells are located in Concession 13 Lot 13 on the west side of the Sandusk property in the quarry area/quarry lake (Figures 1 and 2) and were operated by Hagersville Quarries. The well logs report that these wells were completed in 1945, 1946, and 1951.

No well logs or other records were found for the three (3) easternmost on-land located natural gas wells on the Sandusk property. We can infer that these wells were operated by Dominion Natural Gas Co. Ltd., and drilled anywhere from 1905 to 1919 (first year well logs were published in the Ontario Department of Mines annual report was 1919).

## **5. First site reconnaissance**

In October 2022, a site reconnaissance of the Sandusk property was conducted. The reconnaissance included a rapid visual inspection of the entire property, followed by detailed visual and handheld magnetometer inspection in the areas where the wells were located on the historical Dominion gas well map. No wells were located during the site reconnaissance.

Significant visible features of the property included: a former quarry pit located on the west side of the property which is now filled with water, creating a quarry lake; foundations of former industrial buildings north of the quarry lake; agricultural fields on the east side of the property; and remnants of railway spurs in the northeast part of the property.

Various amounts of ground cover (from open grassy to dense bushy and forested areas) are present between the dirt and gravel roads, fields, and around the quarry lake. In addition, throughout the site there are significant amounts of metal debris from past uses of the property, and discarding of materials.

The handheld magnetometer picked-up readings in many locations throughout the detailed investigation areas. It was determined that in this situation, where we have vast amounts of metal debris, areas of dense ground cover, and a large area to investigate, a drone magnetic survey would be better suited for this investigation.

## **6. Drone magnetic survey**

In November 2022, Abitibi Geophysics Inc. was commissioned by EC (Sandusk) GP Inc. to conduct a high-resolution, drone magnetic survey over parts of the Sandusk property to detect and identify historical natural gas wells, water wells, and any other anthropogenic (man-made) metallic objects. The study will facilitate the decommissioning of wells and removal of man-made structures in preparation for residential construction. A copy of the magnetic survey report is provided in Appendix 1.

The interpretation of the magnetic data allowed the identification of several magnetic anomalies over the Sandusk property (Figure 4). In addition, magnetic anomalies whose magnetic responses were very similar to the signature of vertical wells (bullseye magnetic features) were identified and characterized in the report.

## **7. Second site reconnaissance**

In April 2023, a second site reconnaissance of the Sandusk property was conducted. Magnetic anomalies of interest were located in the field using a GPS and a handheld magnetic locator.

Some magnetic anomalies had a metallic expression at the surface, and others did not due to dense

vegetation or because they were buried in the ground.

If there was no surface expression of an anomaly, or if there was any doubt as to whether a metallic object visible at the surface was the source of the anomaly, the area was excavated to determine the source of the magnetic anomaly confidently.

The magnetic survey proved to be very successful. We located the three (3) easternmost on-land gas wells present on the historical Dominion map. We also discovered two (2) water wells. Figure 5 shows the actual locations of the gas wells and water wells as determined by GPS in the field presented on the historical map and a Google Earth image. The UTM Zone 17N coordinates of the wells are noted in Figure 6.

## **8. Moving forward**

Application has been made for petroleum well licences for the three (3) historical gas wells. Once the petroleum well licences are approved, remediation efforts can begin. Each well will be investigated on a case-by-case basis to determine if they are plugged or need to be re-plugged. All work will be completed following the Oil, Gas, and Salt Resources Act, related regulations, and the Operating Standards.

A licenced water well contractor will be used to plug the two (2) water wells following the Wells Regulation. In addition, well records documenting the abandonments will be completed and submitted to the Ministry of the Environment and Climate Change.

## **9. Conclusions**

A historical natural gas well assessment was conducted for the Sandusk Property Residential Development in Hagersville, Ontario. It is understood that this assessment will be used to address concerns about unidentified historical natural gas wells in the area of residential development, and to support the proposed subdivision's compliance with the OGSRA Act and PPS with regard to construction in an area where petroleum wells are present.

The well files and historical records review revealed eight (8) wells were drilled for natural gas within the Sandusk property. Historical well logs were found for all five (5) wells located on the west side of the property in the quarry/quarry lake area; that were drilled in 1945, 1946, and 1951 and operated by Hagersville Quarries. No well logs were found for the three (3) easternmost on-land located wells. So it is inferred that these wells were drilled anywhere from 1905 to 1919 and operated by Dominion Natural Gas Co. Ltd.

No wells were located during the first site reconnaissance using visual inspection and a handheld magnetometer. Thus, it was determined that a drone magnetic survey would be better suited for investigation of the Sandusk property; where we have vast amounts of metal debris, areas of dense ground cover, and a large area to investigate.

The drone magnetic survey of the Sandusk property identified several bullseye magnetic anomalies very similar to the signature of vertical well casings. A second site reconnaissance investigating the magnetic anomalies proved to be very successful. The three (3) easternmost on-land historical gas wells were located, in addition to two (2) water wells.

Locating well logs for all five (5) quarry/quarry lake wells on the west side of the property and physically finding all three (3) on-land wells (without well logs) adds to the confidence that the eight (8) wells documented on the historical Dominion map are all the wells drilled on the property for natural gas.

The drone magnetic survey adds significant confidence that any conduits to the subsurface within the residential development by way of wells have been located.

The physical location of the three (3) on-land wells correlates beautifully with the historical Dominion map adding confidence that all on-land historical gas wells within the residential development area have been located.

The physical coordinates of on-land historical natural gas wells and water wells are being used to direct planning of the residential development so that no buildings are constructed over-top of the well locations, and if the well sites need to be visited in the future there will remain access.

The information needed to apply for petroleum well licences was obtained, and the applications have been submitted.

Yours truly,



Mr. Mike Dorland, P.Geo  
President

## Historical Map and Well Locations

### Legend

- ✕ Well Locations as per Historic Map
- ▭ Property Outline

Projection: UTM Zone 17N  
Datum: NAD 83  
Units: Metres

Prepared: October, 2022

50 0 50 100  
Meters

Scale 1:5,000

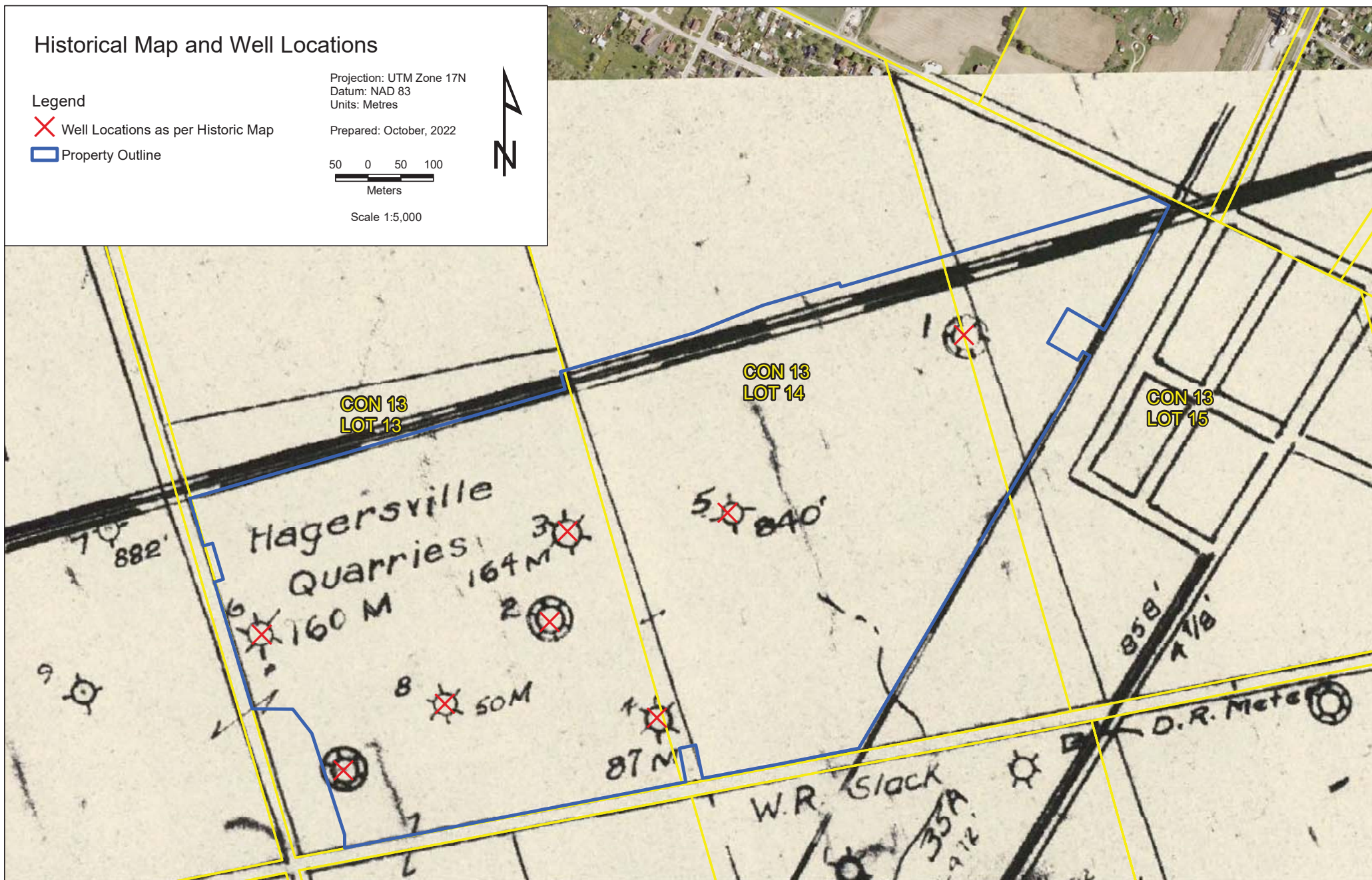


Figure 1

## Historical Map Well Locations

### Legend

- ✗ Well Locations as per Historic Map
- ▭ Property Outline

Projection: UTM Zone 17N  
Datum: NAD 83  
Units: Metres

Prepared: October, 2022

50 0 50 100  
Meters

Scale 1:5,000

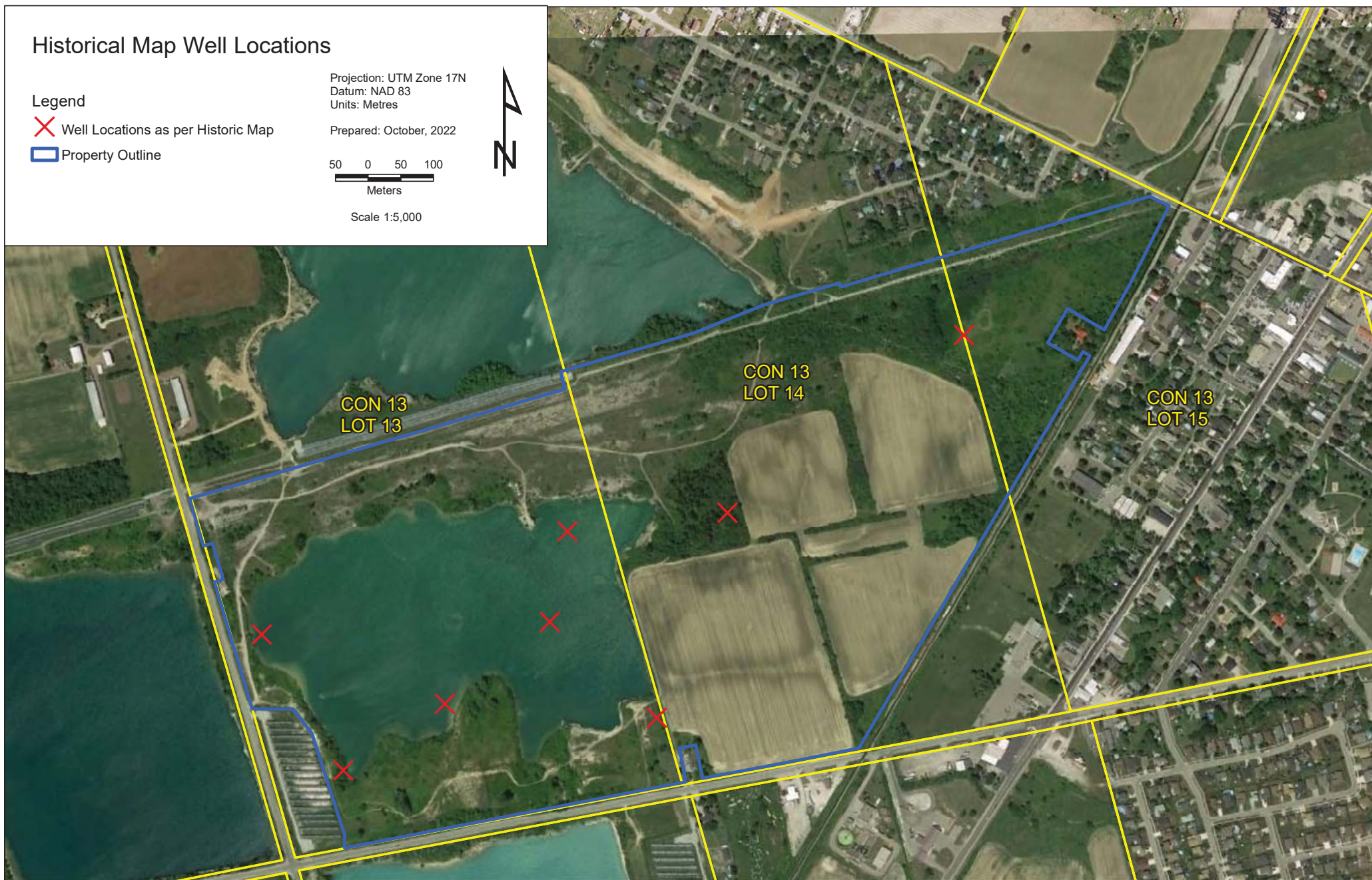


Figure 2

#### HAGERSVILLE QUARRY

Hagersville Quarry No. 1, lot 13, con. XIII,  
Walpole tp.

Completed June 22, 1945.

Producing gas well.

Rock pressure: 350 lbs.

| Formation           | Depth,<br>ft. |
|---------------------|---------------|
| Surface.....        | 2             |
| Lime.....           | 13            |
| Flint.....          | 45            |
| Lime and shale..... | 430           |
| Niagara.....        | 640           |
| Shale.....          | 655           |
| Guelph.....         | 670           |
| Shale.....          | 730           |
| Clinton.....        | 769           |
| Red Medina.....     | 801           |
| Grey shale.....     | 841           |
| White Medina.....   | 848           |
| Red shale.....      | 851           |

Gas at 740 feet.

Fresh water at 90 feet; sulphur water at 240 feet.

#### HAGERSVILLE QUARRY

Hagersville Quarry No. 2, lot 13, con. XIII,  
Walpole tp.

Completed August 15, 1945.

Producing gas well.

Rock pressure: 350 lbs.

| Formation           | Depth,<br>ft. |
|---------------------|---------------|
| Surface.....        | 7             |
| Flint.....          | 45            |
| Lime and shale..... | 422           |
| Niagara.....        | 672           |
| Shale.....          | 719           |
| Clinton.....        | 739           |
| Red Medina.....     | 780           |
| Grey shale.....     | 829           |
| White Medina.....   | 841           |
| Red shale.....      | 856           |

Gas at 722, 730, and 835 feet.

Fresh water at 47 feet; sulphur water at 165 feet.

#### HAGERSVILLE QUARRIES

Hagersville Quarries No. 3, lot 13, con. XIII,  
Walpole tp.

Completed March 28, 1946.

Dry hole.

| Formation           | Depth,<br>ft. |
|---------------------|---------------|
| Surface.....        | 4             |
| Flint.....          | 42            |
| Lime and shale..... | 424           |
| Niagara.....        | 662           |
| Shale.....          | 714           |
| Clinton.....        | 754           |
| Red Medina.....     | 784           |
| Grey shale.....     | 828           |
| White Medina.....   | 838           |
| Red shale.....      | 841           |

Show of gas at 713 and 744 feet.

Fresh water at 92 feet; sulphur water at 158 feet.

#### HAGERSVILLE QUARRIES

Hagersville Quarries No. 4, lot 13, con. XIII,  
Walpole tp.

Completed May 9, 1946.

Producing gas well.

Rock pressure: 345 lbs.

| Formation           | Depth,<br>ft. |
|---------------------|---------------|
| Flint.....          | 20            |
| Lime and shale..... | 396           |
| Niagara.....        | 640           |
| Shale.....          | 698           |
| Clinton.....        | 733           |
| Red Medina.....     | 768           |
| Grey shale.....     | 808           |
| White Medina.....   | 820           |
| Red shale.....      | 824           |

Gas at 700 and 710 feet.

Fresh water at 26 feet; black water at 126 feet.

#### HAGERSVILLE QUARRIES

Hagersville Quarries No. 5, lot 13, con. XIII,  
Walpole tp.

Driller: G. Schweyer.

Completed May 23, 1951.

Producing gas well.

Rock pressure: 175 lb.

| Formation           | Depth,<br>ft. |
|---------------------|---------------|
| Flint.....          | 9             |
| Lime and shale..... | 400           |
| Niagara.....        | 610           |
| Shale.....          | 650           |
| Shale.....          | 687           |
| Clinton.....        | 723           |
| Red Medina.....     | 757           |
| Blue shale.....     | 808           |
| White Medina.....   | 820           |
| Red shale.....      | 825           |

Gas at 702, 705, 717 feet.

Fresh water at 15 and 18 feet.

## Drone Magnetic Survey Targets

Projection: UTM Zone 17N  
Datum: NAD 83  
Units: Metres

Prepared: April, 2023

### Legend

## Property Outline

50 0 50 100

Meters

Scale 1:5,000



Figure 4

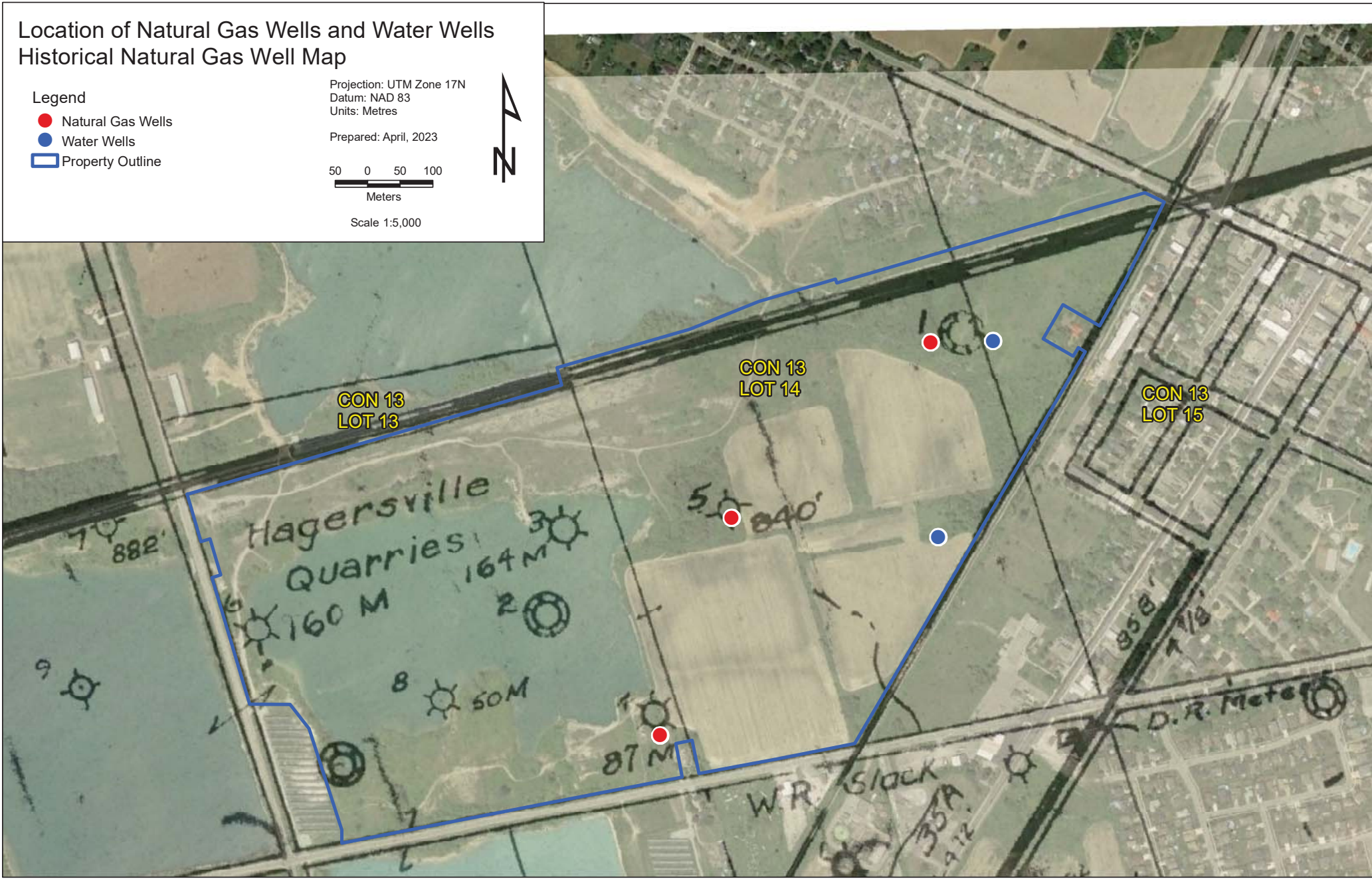


Figure 5



Figure 6

# Drone Magnetic Survey Targets Natural Gas and Water Wells Found

## Legend

- Natural Gas Wells
- Water Wells
- Property Outline

Projection: UTM Zone 17N  
Datum: NAD 83  
Units: Metres

Prepared: April, 2023

50 0 50 100  
Meters

Scale 1:5,000



Figure 7

Appendix 1

**Unmanned Aerial Magnetic Survey, Logistics and Interpretation  
Report, Sandusk Residential Development Project, Hagersville,  
Ontario, Canada, March 2023, Abitibi Geophysics, 22NT077-MU**

UNMANNED AERIAL MAGNETIC SURVEY



LOGISTICS AND INTERPRETATION REPORT

PREPARED FOR  
**EC (Sandusk) GP Inc.**

## **SANDUSK RESIDENTIAL DEVELOPMENT PROJECT**

HAGERSVILLE, ONTARIO, CANADA  
MARCH 2023



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**22NT077-MU**



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# 1. RESEARCH OBJECTIVE

## ❑ **ABSTRACT**

Unplugged (or poorly plugged) petroleum wells and water wells could present hazards to public safety and the environment by providing pathways for oil, gas, and other fluids to migrate between different geologic formations, into aquifers, and / or to land surface. Of primary concern are historic natural gas wells known to have been drilled in the project area.

The first step in the remediation process is to locate these metallic wells, which are often invisible on the surface due to dense vegetation or because they are buried in the ground without leaving any trace or indication. A specialized drone will fly over the project area landscape with equipment that measures magnetic signals (total magnetic field). Signal anomalies will be used to create maps to identify locations for on-site investigation to verify.

Modern unmanned aerial vehicle (UAV) platforms capable of flying at low altitudes, carrying miniaturized magnetometers and highly accurate GPS navigation systems, allow the identification of anthropogenic (man made) targets previously identified only in ground magnetic surveys. The UAV-based magnetic method offers a fast and inexpensive alternative (low-cost solution) to traditional terrestrial surveys that are labor-intensive and sometimes impractical due to lack of access or the presence of hazards on the site.

## ❑ ***GEOPHYSICAL OBJECTIVE***

In November 2022, Abitibi Geophysics Inc. was commissioned by EC (Sandusk) GP Inc., to conduct a high-resolution, drone magnetic survey over parts of the Sandusk site in Hagersville to detect and identify historic natural gas wells, water wells, and any other anthropogenic (man-made) metallic objects. Figure 1 illustrates the presumed location of historic natural gas wells.

With Rosor's UAV-based magnetic survey, Abitibi Geophysics offers a high-end geophysical survey of unmatched resolution with the help of LiDAR data acquired prior to the magnetic survey to maintain a constant and lowest altitude above ground level (AGL) throughout the survey, while continuously avoiding occasional obstacles, like higher trees or structures. The resulting data will have the resolution of a ground survey, but it is collected with the effectiveness of an airborne survey.

The interpretation of the high-resolution drone magnetic data intends to detect well casings and buried metal debris within the Sandusk site construction area to facilitate the decommissioning of wells and removal of man-made structures to make the site suitable for residential construction. A preliminary draft plan of the subdivision is shown in Figure 2.

To achieve the geophysical objective of this project the following steps were carried out:

- Processing of magnetic data to provide a high-quality map of the total magnetic intensity, its reduction-to-pole and the RTP residual anomaly.
- Generating a high-resolution analytic signal map to accurately locate the center of the targets as well as their contours.
- Performing Euler's Deconvolution and 2D magnetic inversions to locate and characterize some bullseye magnetic features that could be related to well casings.

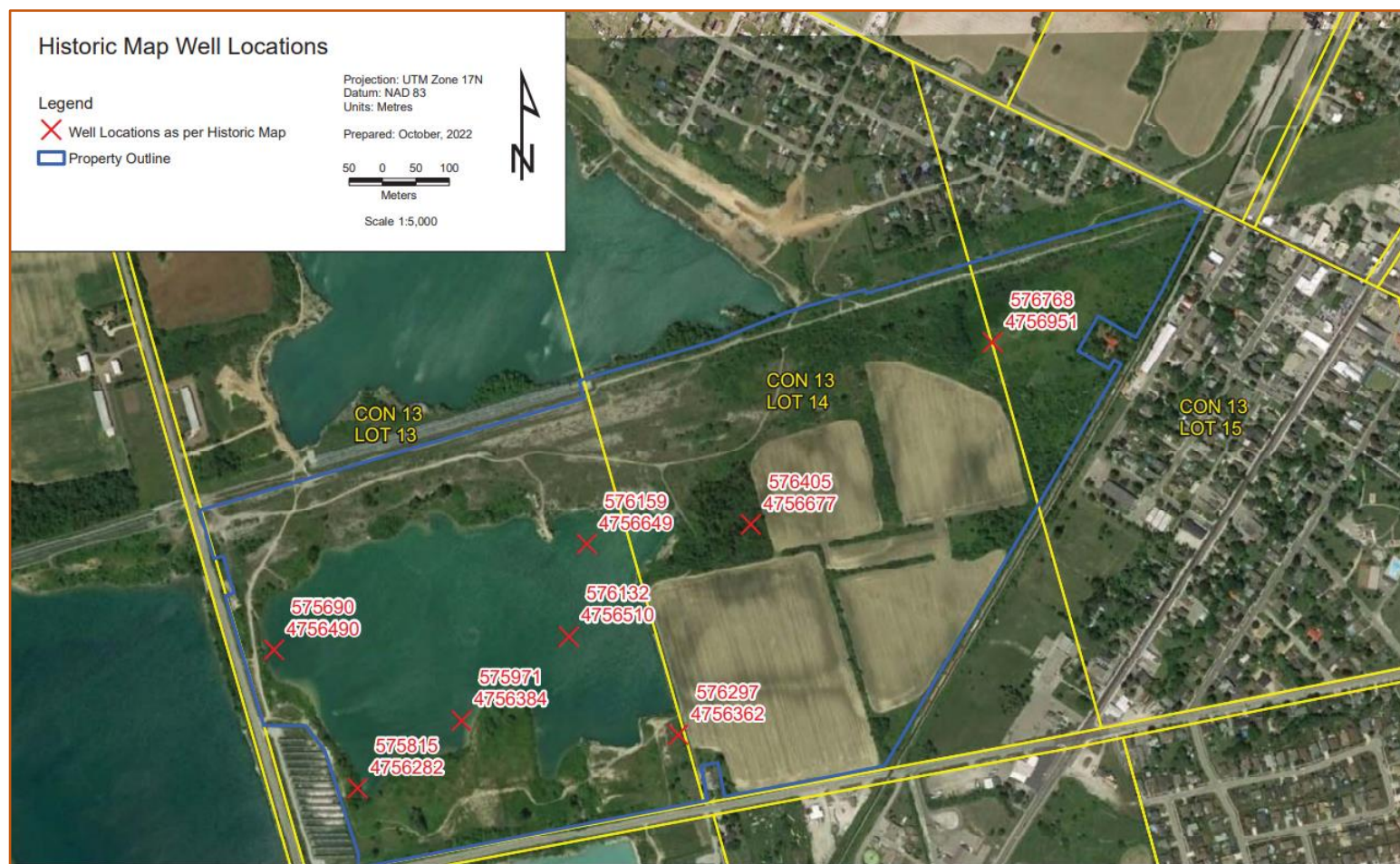


Figure 1. Sandusk Residential Development site including the presumed location of the historic gas wells.

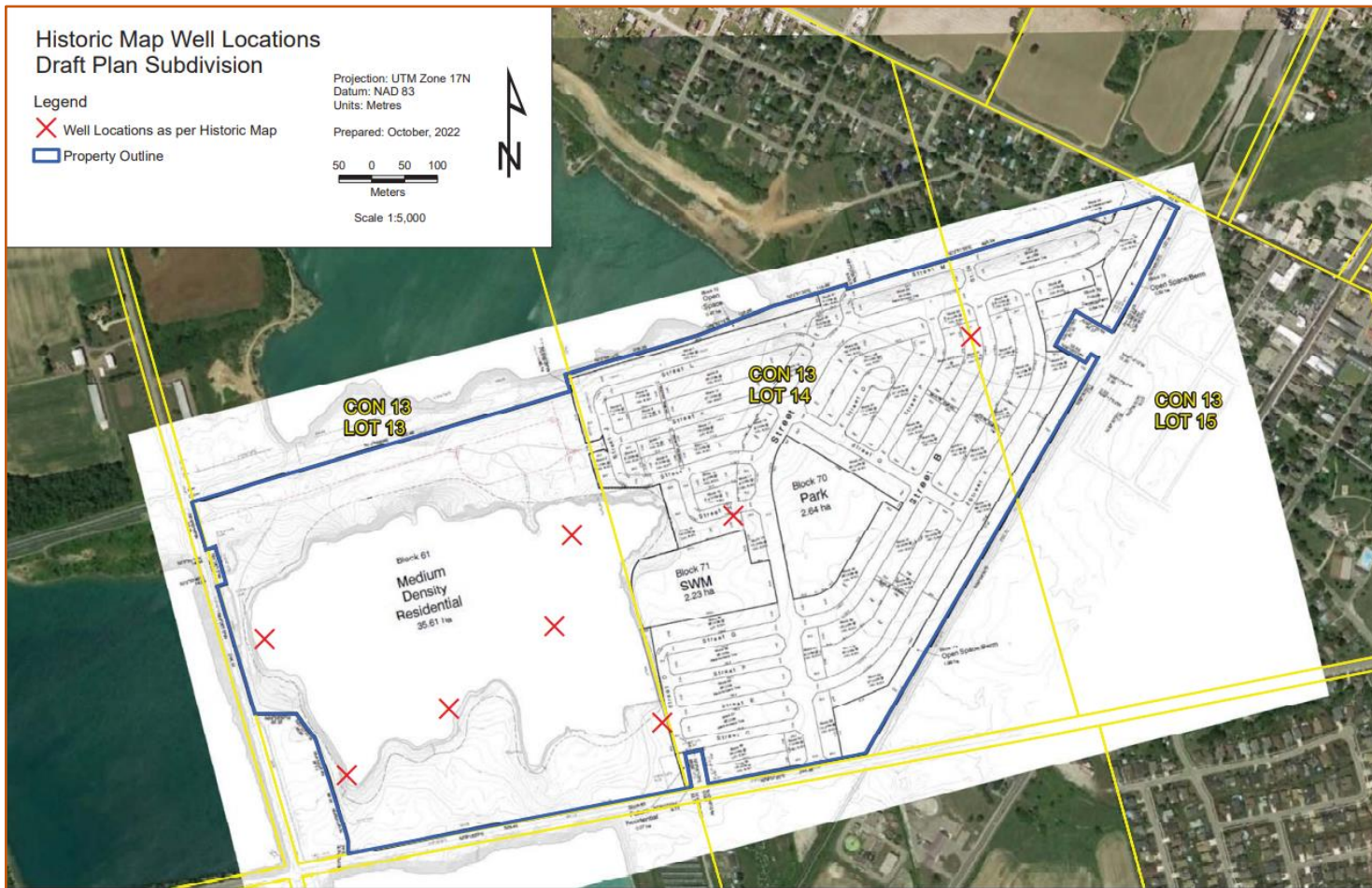


Figure 2. A view of the Sandusk preliminary residential plan including the presumed location of the historic gas wells.



## 2. GEOPHYSICAL INTERPRETATION

### ❑ SURVEY COVERAGE

At the beginning of the project, the drone magnetic survey was deployed to cover the Central grid using regular flight lines spaced 5 m apart and tie lines spaced every 50 m. At the end of the survey, two smaller grids were added, one to the NW and the second to the SW of the Central grid, using the same survey parameters applied to the Central grid. A total of 147 line-kilometers of high-resolution magnetic data was collected in this project.

The drone magnetic data over the Sandusk Residential Development (SRD) Project was collected along 201 lines (L 0E to L 1000E) on the Central grid, along 110 short lines (L 0E to L -545E) on the NW grid and along 93 short lines (L 0E to L -460E) on the SW grid (Figure 3). The flight lines were flown with an azimuth of N166° and a nominal ground clearance of approximately 5 m as shown in Figure 4.

The drone magnetic data were collected in horizontal gradient mode using two *Geodrones Georf-M300* sensors spaced 2.10 m apart. All drone-based magnetometer flights were collected with preprogrammed GPS-guided autonomous missions in which waypoints from the Lidar survey were used to maintain as soon as possible constant altitude above ground level. The mean speed of the DJI drone along the profiles is approximately 5 m/s.



Figure 3. Drone magnetic flight coverage over the Sandusk Residential Development (SRD) Project.

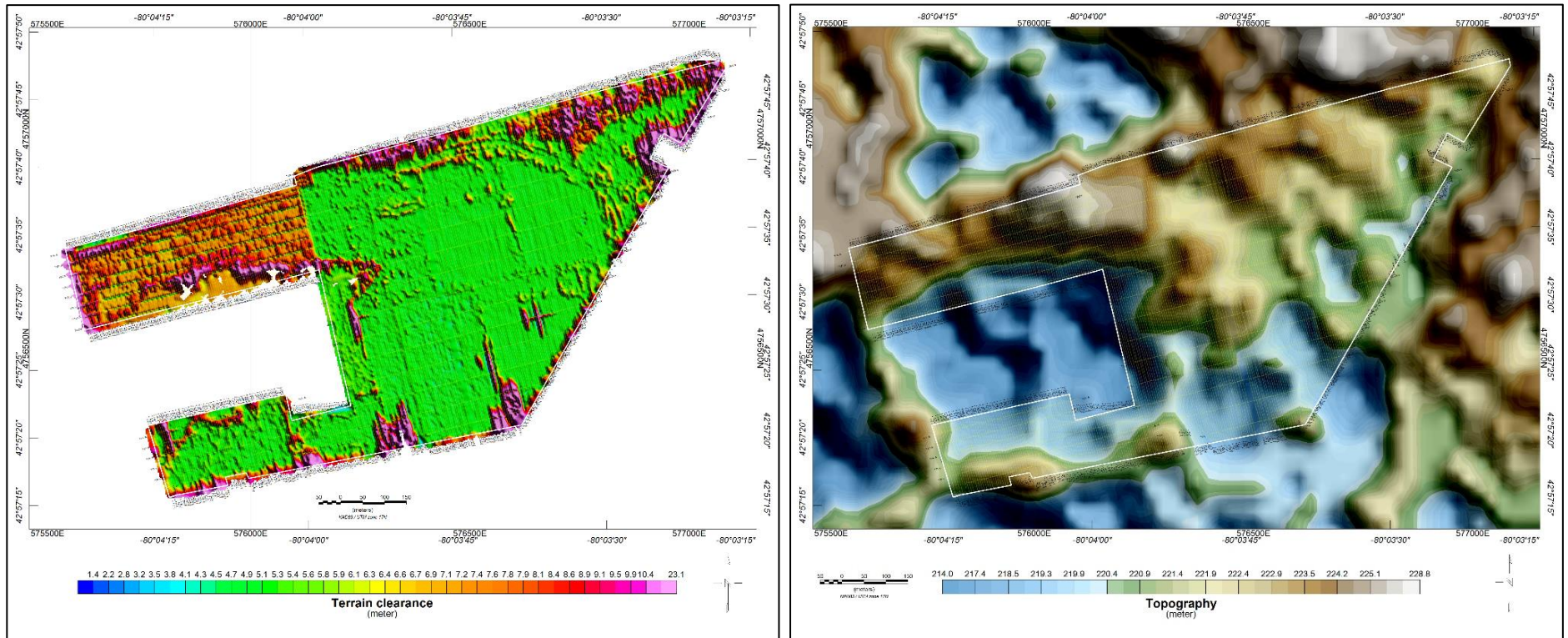


Figure 4. Drone nominal ground clearance versus the topography of the SRD survey grids.



#### ❑ **HISTORIC NATURAL GAS WELL LOCATIONS**

As shown on a historic map, 8 gas wells are present on the property. Three wells are located on the capitalize Central grid, 1 well on the SW grid, and the remainder of the wells appear to be located in the flooded quarry (not surveyed area), specifically between the NW and SW grids (see Figures 1 and 2).

These historic gas wells are not monumented (unmarked) and it is thought that their coordinates are inaccurate; in addition, the areas of these wells have been leveled and currently overgrown with vegetation.

**Table 1. Presumed location of the historic gas wells**

| Gas Well | Grid                | (NAD 83, UTM/ Zone 17) |               |               |
|----------|---------------------|------------------------|---------------|---------------|
|          |                     | Easting (mE)           | Northing (mN) | Elevation (m) |
| 5        | Central             | 576 297                | 47 56 362     | 220.21        |
| 7        |                     | 576 405                | 4 756 677     | 222.90        |
| 8        |                     | 576 768                | 4 756 951     | 222.92        |
| 2        | SW                  | 575 815                | 4 756 282     | 219.99        |
| 1        | (Not surveyed zone) | 575 690                | 4 756 490     | 219.46        |
| 3        |                     | 575 971                | 4 756 384     | 216.95        |
| 4        |                     | 576 132                | 47 56 510     | 215.26        |
| 6        |                     | 576 159                | 47 56 649     | 217.48        |



## ❑ MAGNETIC MODELING OF A VERTICAL WELL

Magnetic forward modelling was done for a 200 m vertically dipping well (pipe) with a diameter of 20 cm buried at a depth of 1 m. The total magnetic intensity (TMI) was calculated at an altitude of 5 m, thus reproducing the altitude of the drone and respecting the IGRF parameters (inclination = 68.73°, declination -9.65°) of the study site. The complexity of the modeling lies in the choice of the magnetic susceptibility of the well since the metallic casing can be very oxidized or may have a significant remanent magnetization that will seriously affect the shape of the magnetic response. In this geophysical simulation, a magnetic susceptibility of 15 SI has been assigned for the pipe target. Note that the magnetic susceptibility of the magnetite ( $\text{Fe}_3\text{O}_4$ ) can range from 8.8 to 25 SI.

Two scenarios were considered during the modeling exercise. In the first scenario, the target was placed so that its center was on the flight line of the drone. In the second scenario, the pipe was placed in the middle of the flight lines, so that the magnetic sensor passes 1.5 m from it. The calculated magnetic responses are shown in Figures 5 and 6. As can be seen, a circular-shaped magnetic signatures (bullseye) were successfully highlighted in both geophysical simulations. It is not important to focus on the amplitude of these anomalies since the true magnetic susceptibility of these pipes is unknown. The amplitude of these anomalies can easily vary from 100 to 10 000 nT and often depends on the type of iron used, its condition (oxidized or not) and its remanent magnetization intensity and inclination. Through forward magnetic modeling, we are confident in our ability to use a drone magnetic survey to target wells at the Sandusk site in Hagersville.

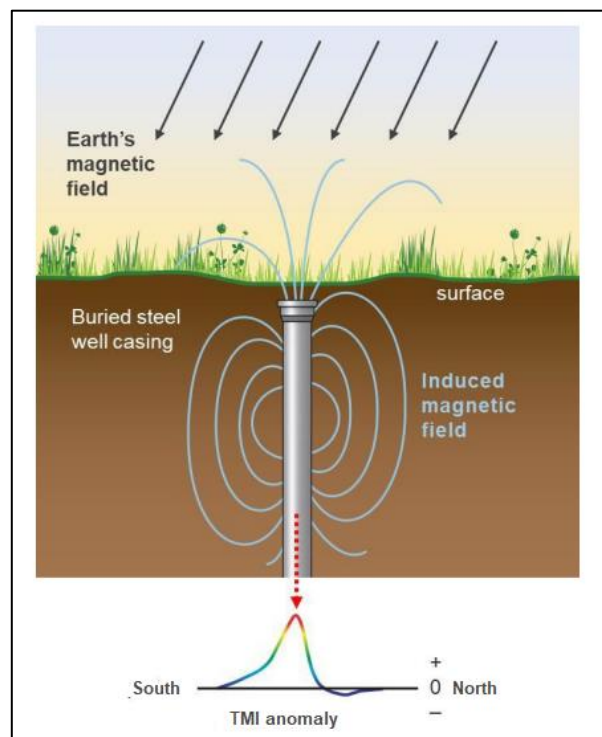


Figure 5. The magnetic shape of a vertical metallic pipe.

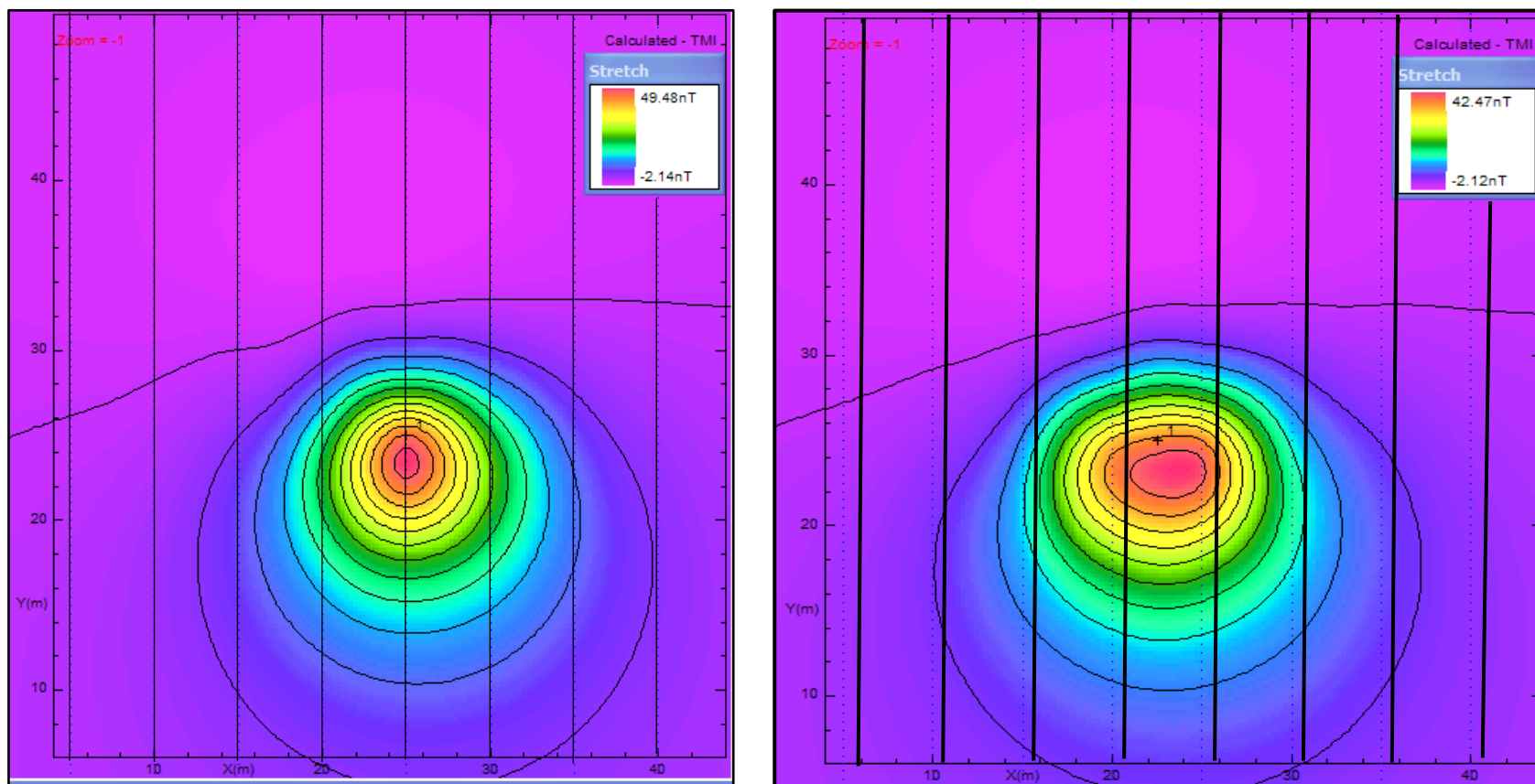


Figure 6. Circular-shaped magnetic anomalies of a crossed (A) and non crossed (B) vertical metallic well at an elevation of 5 m.



## ❑ ANALYSIS OF THE DRONE MAGNETIC DATA

The collected drone magnetic data were subject to a series of corrections, including compensation for the magnetic noise associated with the UAV platform (since the magnetic sensors are closer inboard on a UAV), calibration/compensation maneuvers (roll, pitch, and yaw) to correct for the aircraft in motion, lag correction (residual errors of positioning), correction for temporal (diurnal) variation, levelling, and grid computation. Note that the total magnetic intensity (TMI) in this project is calculated by combining the measurements of the two magnetic sensors installed in horizontal gradient mode.

The resulting total magnetic field map and its reduction to the pole (RTP) are presented in Figure 7. A series of upward continuations of the magnetic field to elevations of 2m, 5m and 10m were performed to remove high frequency noise from the surface and thus leave only the target responses (Figures 8 to 10).

As can be seen, the high-quality magnetic maps resulting from the drone survey successfully mapped several magnetic features within the Sandusk site, the majority of which appear to be cultural (man-made) features. Some of the delineated anomalies appear as punctual (isolated) sources and circular in shape (bullseye) characterized by positive amplitudes, some of which (4 to 5 anomalies) exhibit dipolar signatures; other magnetic features appear in a group, and finally a distinct elongated and arc-shaped magnetic feature following a forest track was also highlighted in the central grid.

On the google earth satellite image, some of the identified magnetic anomalies appear associated with the remains of demolished buildings. As for some "scattered" magnetic anomalies identified in-group, these targets could correspond to buried metallic debris. The arc-shaped magnetic feature observed in the central grid following the track, could be the response of a power line or the response of a horizontal metallic pipe. The origin of this anomaly remains to be verified in the field.

The targets of interest in this study that could correspond to metallic wells would be the small isolated circular anomalies with positive amplitudes or dipolar signatures indicating the presence of remanent magnetization in the metallic casing used.

To better characterize the outlined magnetic features, an enhancement technique consisting of the analytic signal (total gradient amplitude) of the total magnetic field was calculated (Figure 11). This product was chosen because the peaks of the analytic signal are assumed to occur directly above the buried magnetic sources and the contours (edges) of these sources are easily recognized and traceable.



- Picking Targets

An automated grid peak-picking algorithm based on the Blakely (1986) method was used to find the location of individual positive peaks from the analytic signal grid (Figure 12). The apparent depth values for each picked target are calculated by solving Euler's Homogeneity equation for a square window of cells positioned directly over the peak in the analytic signal grid.

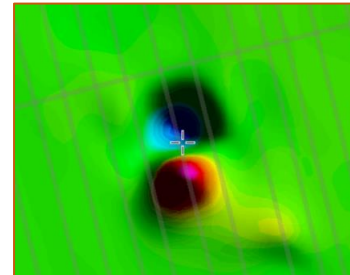
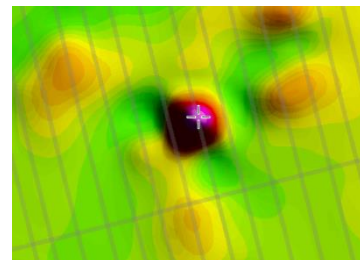
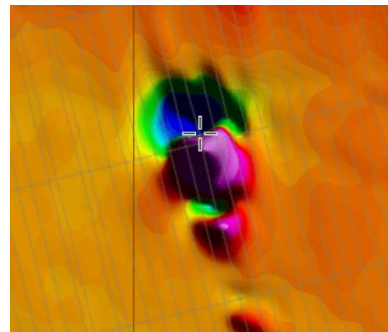
The target size of each anomaly was also estimated from the distance of the anomaly peak to its first inflexion point in eight directions. The mean value of the 8 distances is considered half of the target size.

Advanced AN-EUL method was performed by combining the analytic signal and the 3D Euler deconvolution using a structural index (SI) of 2 to locate the vertical pipe targets and estimate their depth-to-top. The obtained results by this method are given in an excel table (.csv) format accompanying this report.

2D magnetic inversions were also performed to support the AN-EUL results. Potential targets showing identical wells magnetic signatures were listed and discussed in Table 2.

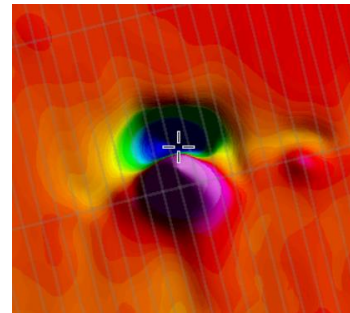
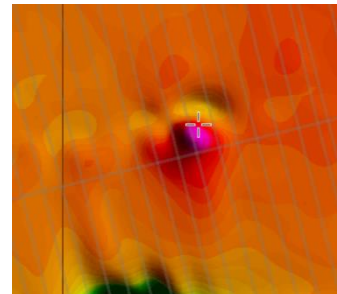
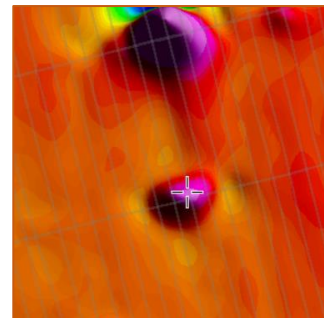


**Table 2. Location of magnetic targets on the Sandusk site**

| Target | (NAD 83, UTM/ Zone 17) |            | Amplitude   | Width | Depth   |         | Comments                                                                                                                                                            | Magnetic response                                                                    |
|--------|------------------------|------------|-------------|-------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|        | X (m)                  | Y (m)      |             |       | Inv     | Euler   |                                                                                                                                                                     |                                                                                      |
| SK_01  | 576273.00              | 4756465.50 | (+23 / -41) | 4.5   | outcrop | outcrop | Dipolar punctual anomaly identified at L 60E on the central grid. Its causative source is almost outcropping and could carry remanence.                             |   |
| SK_02  | 576291.00              | 4756596.00 | +45         | 5.40  | outcrop | outcrop | Moderate punctual positive anomaly located at L 110E on the central grid. Its source is almost outcropping.                                                         |   |
| SK_03  | 576522.00              | 4756587.00 | (+434/-168) | 2 - 5 | outcrop | 0.4     | A strong, punctual dipolar anomaly located at L 330E on the central grid. This target could correspond to well (metallic pipe). Presence of remanent magnetization. |  |

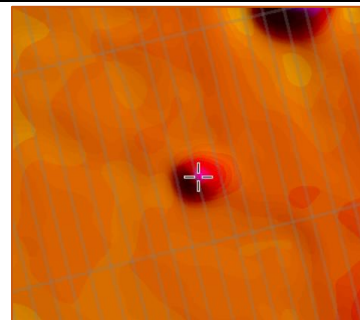
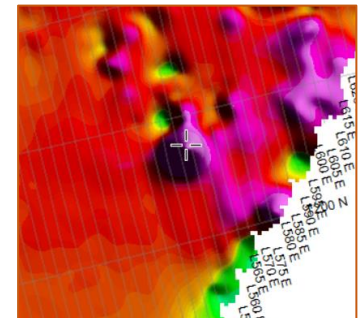
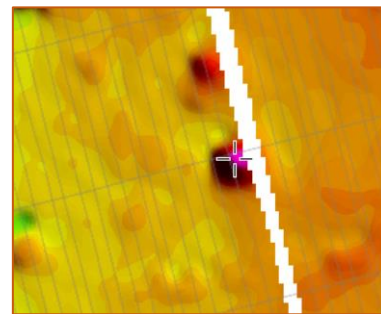


**Table 2. Location of magnetic targets on the Sandusk site (continued)**

| Target | (NAD 83, UTM/ Zone 17) |            | Amplitude    | Width   | Depth   |         | Comments                                                                                                                                                                         | Magnetic response                                                                     |
|--------|------------------------|------------|--------------|---------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|        | X (m)                  | Y (m)      |              |         | Inv     | Euler   |                                                                                                                                                                                  |                                                                                       |
| SK_04  | 576615.00              | 4756668.00 | (+25 2/-110) | 2 - 4.5 | 0.3     | outcrop | A strong, punctual dipolar anomaly located at L 440E on the central grid. The causative source is almost outcropping and could correspond to well casing. Presence of remanence. |    |
| SK_05  | 576532.10              | 4756646.31 | (+16 / -6)   | 4.29    | outcrop | outcrop | A weak punctual magnetic anomaly identified at L 355E in an area overgrown by vegetation. This target is almost outcropping.                                                     |    |
| SK_06  | 576622.50              | 4756617.00 | +25          | 7.15    | outcrop | 1.5     | A moderate magnetic anomaly identified at L 435E, 50m south of the SK_04 target in an area overgrown by vegetation. This target is very close to the surface.                    |  |

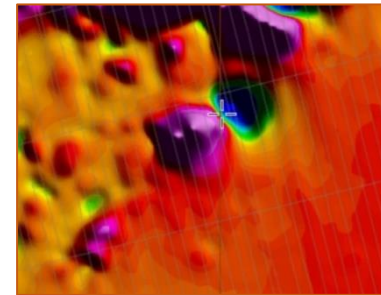
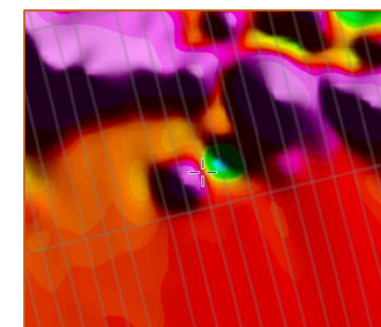
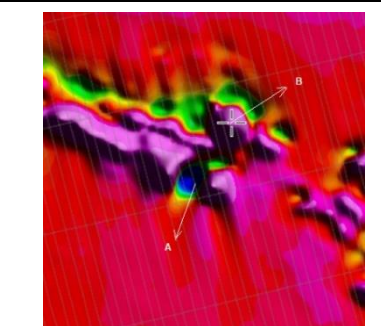


**Table 2. Location of magnetic targets on the Sandusk site (continued)**

| Target | (NAD 83, UTM/ Zone 17) |                          | Amplitude | Width   | Depth   |       | Comments                                                                                                                                                                          | Magnetic response                                                                     |
|--------|------------------------|--------------------------|-----------|---------|---------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|        | X (m)                  | Y (m)                    |           |         | Inv     | Euler |                                                                                                                                                                                   |                                                                                       |
| SK_07  | 576597.00              | 4756572.00               | +12       | 6 - 7   | outcrop | -     | Weak positive magnetic anomaly located at L 400E on the central grid in a cleared field. This magnetic feature could be the response of metallic object on the surface.           |    |
| SK_08  | 576735.00<br>576736.50 | 4756629.00<br>4756629.00 | +210      | 6 - 8.5 | outcrop | 1.0   | Strong positive magnetic anomaly located between L 545E and L 550E in an area overgrown by vegetation.                                                                            |   |
| SK_09  | 576415.50              | 4756662.00               | +22       | 5 - 6.5 | outcrop | 1.5   | Isolated positive magnetic anomaly located at L245E on the central grid in an area overgrown by vegetation. This target is located 18 m SE of the supposed location of gas well 7 |  |

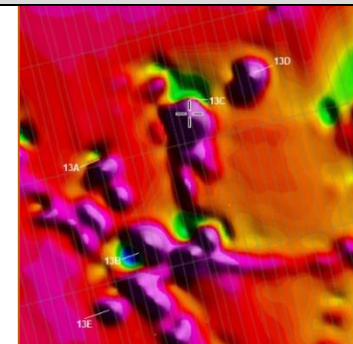
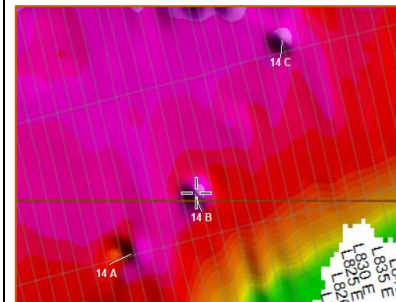
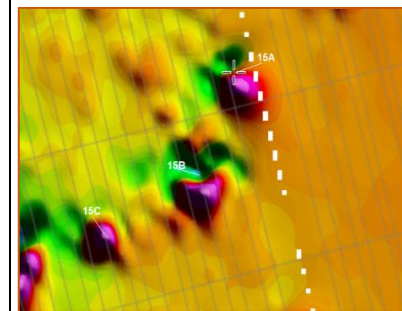


**Table 2. Location of magnetic targets on the Sandusk site (continued)**

| Target           | (NAD 83, UTM/ Zone 17) |                          | Amplitude    | Width        | Depth          |             | Comments                                                                                                                                                                                                                           | Magnetic response                                                                     |
|------------------|------------------------|--------------------------|--------------|--------------|----------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                  | X (m)                  | Y (m)                    |              |              | Inv            | Euler       |                                                                                                                                                                                                                                    |                                                                                       |
| SK_10A<br>SK_10B | 576504.50<br>576489.00 | 4756888.30<br>4756879.50 | -176<br>+145 | 8 - 12<br>15 | outcrop<br>1.0 | 2.7<br>2.6  | According to the analytical signal, this anomaly is not dipolar but consists of 2 sources: one with a positive amplitude and the other negative. Deserve to be verified on the field.                                              |    |
| SK_11A<br>SK_11B | 576587.06<br>576578.00 | 4756924.34<br>4756920.00 | -20<br>+47   | 4 - 6        | outcrop        | 1.2<br>3.0  | SK_11A and SK_11B display the same signature as SK_10 A & B. Located in the central grid in a less dense vegetation area. These targets are close to the surface and deserve to be verified in the field.                          |    |
| SK_12A<br>SK_12B | 576703.50<br>576720.00 | 4756902.00<br>4756929.00 | -262<br>+495 | 7 - 8<br>9.6 | 0.75<br>0.95   | 1.65<br>1.2 | SK_12(A&B) are two magnetic anomalies of high amplitudes located in the central grid next to a forest road and in an area of dense vegetation. These features seem to be man-made sources and deserve to be verified in the field. |  |

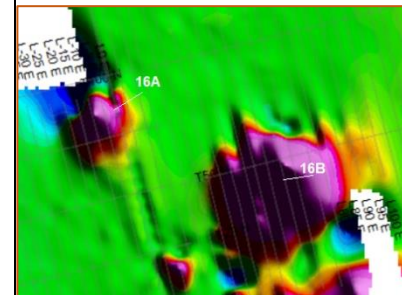
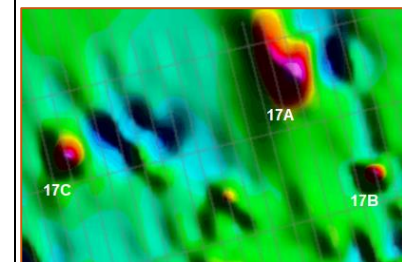
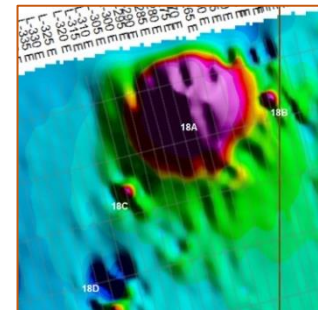


**Table 2. Location of magnetic targets on the Sandusk site (continued)**

| Target                                         | (NAD 83, UTM/ Zone 17)                                        |                                                                    | Amplitude                                             | Width                           | Depth                                   |                                              | Comments                                                                                                                                                                                                                       | Magnetic response                                                                     |
|------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------|---------------------------------|-----------------------------------------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                                | X (m)                                                         | Y (m)                                                              |                                                       |                                 | Inv.                                    | Euler                                        |                                                                                                                                                                                                                                |                                                                                       |
| SK_13A<br>SK_13B<br>SK_13C<br>SK_13D<br>SK_13E | 576781.50<br>576795.00<br>576820.50<br>576847.50<br>576786.00 | 4756909.50<br>4756872.00<br>4756933.50<br>4756951.50<br>4756846.50 | (+45/-20)<br>(-112/+125)<br>(+535/--37)<br>+85<br>+37 | 5.7<br>5.4<br>7.2<br>7.8<br>6.2 | outcrop<br>0.7<br>0.5<br>0.8<br>outcrop | outcrop<br>outcrop<br>0.75<br>1.0<br>outcrop | These targets are of moderate to strong amplitude, mainly with dipolar signature, located south of the supposed gas well 8. All these features should be verified with a metal detector as they are very close to the surface. |    |
| SK_14A<br>SK_14B<br>SK_14C                     | 576859.50<br>576880.50<br>576909.00                           | 4756983.00<br>4757002.50<br>4757050.50                             | +11<br>+24<br>+17                                     | 6.0<br>3 - 4<br>4.5             | outcrop<br>outcrop<br>outcrop           | ?<br>outcrop<br>outcrop                      | SK_14(A, B & C), are isolated weak to moderate magnetic anomalies located in the western part of the central grid in a less dense vegetation area. These targets are almost outcropping and deserve to be verified.            |   |
| SK_15A<br>SK_15B<br>SK_15C                     | 576387.00<br>576379.50<br>576348.00                           | 4756767.00<br>4756734.00<br>4756720.50                             | (+32/-15)<br>(+74/-30)<br>+68                         | 6.4<br>6.0<br>6.34              | outcrop<br>outcrop<br>outcrop           | outcrop<br>-<br>outcrop                      | SK_15(A to C) are moderate magnetic anomalies located in the central grid in an area overgrown by vegetation. These targets are very close to the surface and deserve to be verified by a metal detector.                      |  |



**Table 2. Location of magnetic targets on the Sandusk site (continued)**

| Target                               | (NAD 83, UTM/ Zone 17)                           |                                                      | Amplitude<br>(nT)            | Width                           | Depth                               |                                        | Comments                                                                                                                                                                                                                                                                             | Magnetic response                                                                     |
|--------------------------------------|--------------------------------------------------|------------------------------------------------------|------------------------------|---------------------------------|-------------------------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                      | X (m)                                            | Y (m)                                                |                              |                                 | Inv.                                | Euler                                  |                                                                                                                                                                                                                                                                                      |                                                                                       |
| SK_16A<br>SK_16B                     | 576228.00<br>576309.00                           | 4756348.50<br>4756327.50                             | 140<br>385                   | 7 - 10<br>16 - 22               | outcrop<br>4.5                      | 1.63<br>5.5                            | SK_16A is a high and dipolar magnetic anomaly located at the edge of the lac. Its source could be a metallic object. SK_16B is a large and high magnetic anomaly located near a house and 35 m south of the supposed gas well 5. Source of SK_16B could be lithological or man-made. |    |
| SK_17A<br>SK_17B<br>SK_17C           | 576138.00<br>576159.00<br>576075.00              | 4756329.00<br>4756302.00<br>4756306.50               | 65<br>45<br>60               | 6 - 11<br>1 - 4<br>3 - 6        | 0.31<br>outcrop<br>outcrop          | 2.35<br>outcrop<br>outcrop             | SK_17(A-B-C) are moderate anomalies in amplitude located in the SW grid. These targets seem to be outcropping. SK_17B & 17C deserve to be verified in the field by a metal detector.                                                                                                 |    |
| SK_18A<br>SK_18B<br>SK_18C<br>SK_18D | 575959.50<br>575997.00<br>575934.00<br>575928.00 | 4756339.50<br>4756339.50<br>4756299.00<br>4756255.50 | 300<br>80<br>60<br>(+40/-60) | 17 -30<br>1 - 3<br>2 - 5.5<br>5 | 7<br>outcrop-<br>outcrop<br>outcrop | 0 - 3<br>outcrop<br>outcrop<br>outcrop | SK_18A is a large circular magnetic anomaly located in the SW grid between L-295E and L-255E. Well 3 is supposed to be 40m north. The nature of SK_18A could be lithological. The rest of the targets are punctual anomalies and could be associated with metallic debris.           |  |



### 3. CONCLUSION AND RECOMMENDATIONS

Magnetic sensing is attractive for a variety of applications due to its passive, fast, and non-invasive detection performance, including geological exploration, Unexploded Ordnance (UXO), metal detections and archaeology. The traditional handheld magnetic survey can acquire high-density magnetic data, but it is time-consuming, labor-intensive, and limited by the terrain.

With the advance in the modern Unmanned Aerial Vehicle (UAV), the UAV systems capable of flying at low altitudes, carrying miniaturized magnetometers and highly accurate GPS navigation systems demonstrated significant potential in geological exploration (mapping) and in their ability to successfully detect areas of anthropogenic (man-made) targets previously identified only in ground magnetic surveys. The drone-based magnetic method offers a fast and low-cost alternative, long range and fast magnetic field monitoring, compared with the terrestrial surveys.

In this study, a high-resolution drone magnetic survey was conducted on the Sandusk property in Hagersville, Ontario to detect possible well casings and buried metal objects and debris. The study is to be used to facilitate the decommissioning of wells and removal of man-made structures in preparation for residential construction.

The interpretation of the drone magnetic data allowed the identification of several magnetic anomalies over the Sandusk site. The assumed coordinates for the 4 historic gas wells: **2**, **5**, **7**, and **8** that are within the coverage area do not appear to be accurate as no magnetic anomalies were found exactly at these locations.

Magnetic anomalies whose magnetic responses are very similar to the signature of vertical wells have been identified and characterized using AN-EUL routine and 2D magnetic inversions, and then listed in Table 2. Since most of the detected targets seem to be outcropping or their depth-to-top is very close to the surface, it is recommended that a metal detector be used when excavating these objects as an error of 1 to 3 m in the GPS location may occur.

All other magnetic anomalies not listed in Table 2 should be verified in the field, as it is very difficult for us to speculate (comment) on the nature of these targets or their exact geometry without the knowledge of their real magnetic susceptibility and the possible presence of remanent magnetization (prior information or constraints) when performing a magnetic modeling/inversion.

Among the identified targets, we focus more particularly on magnetic anomalies exhibiting both positive and dipolar signatures. These delineated sources appear to be circular and some of them carry remanent magnetization indicating possible metallic casing.



The author is confident that some of the identified magnetic anomalies in this geophysical study are associated with wells.

Many anomalies have been highlighted; we suggest that they be carefully checked in the field with a metal detector.

Respectfully submitted,  
Abitibi Geophysics Inc.



Catherine Phaneuf, P.Ge.  
PGO #3562  
Project Geophysicist



Madjid Chemam, P.Ge.  
OGQ #1259  
Senior Geophysicist

MC/si

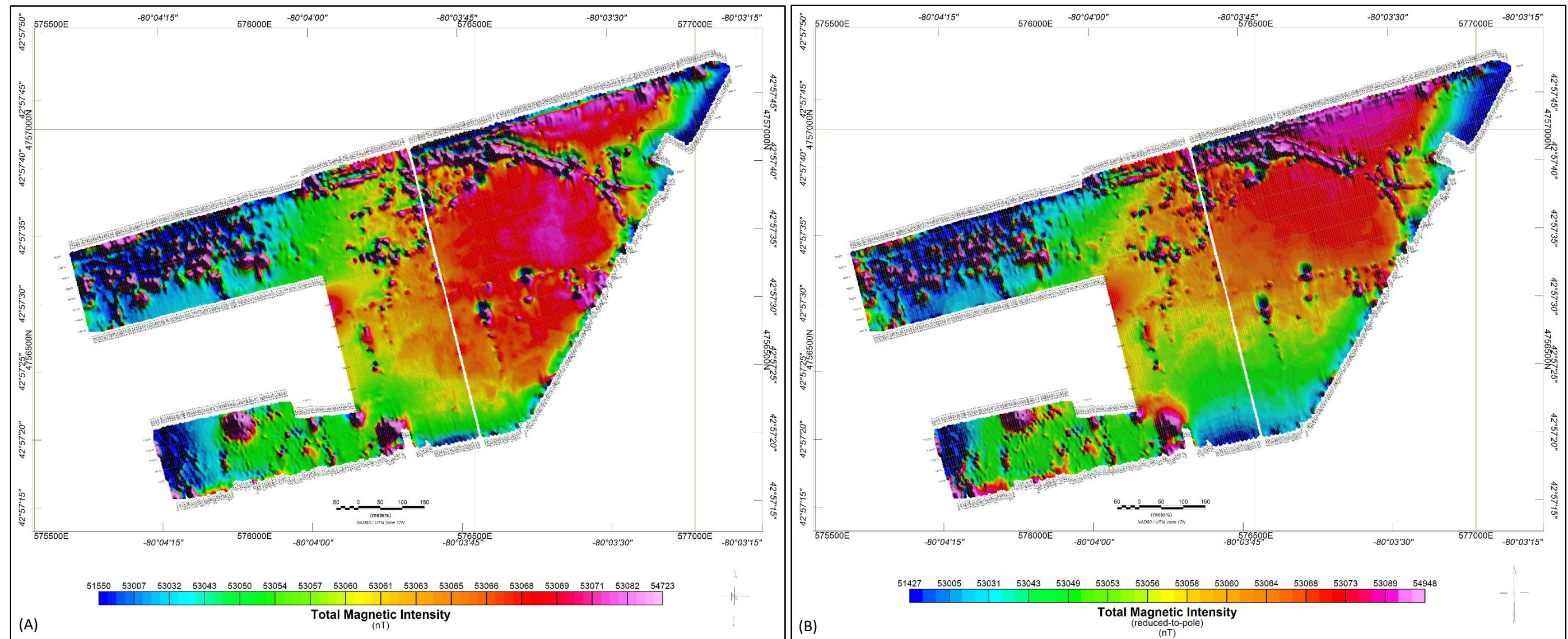


Figure 7. High-resolution total magnetic field (A) and its reduced-to-pole (B), Sandusk Residual Development Project.

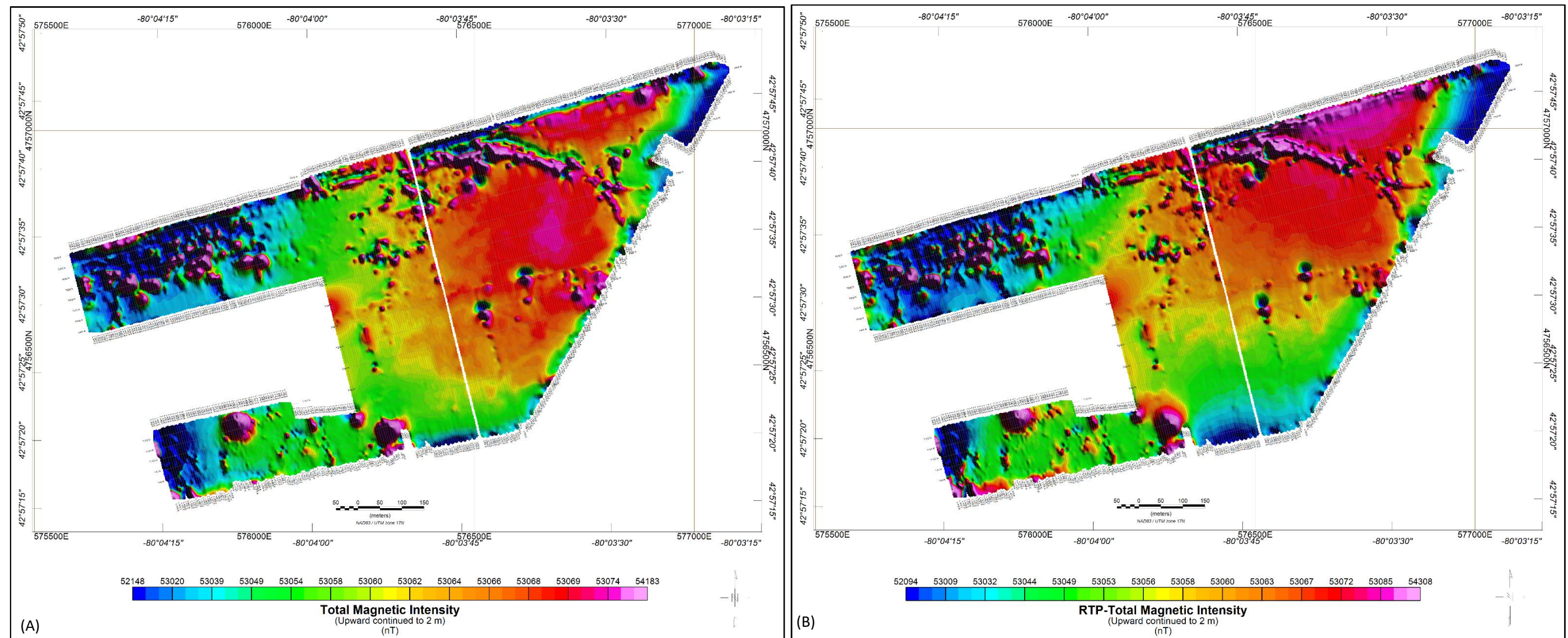


Figure 8. High-resolution total magnetic field upward continued to an elevation of 2 m (A) and its reduced-to-pole (B), Sandusk Residual Development Project.

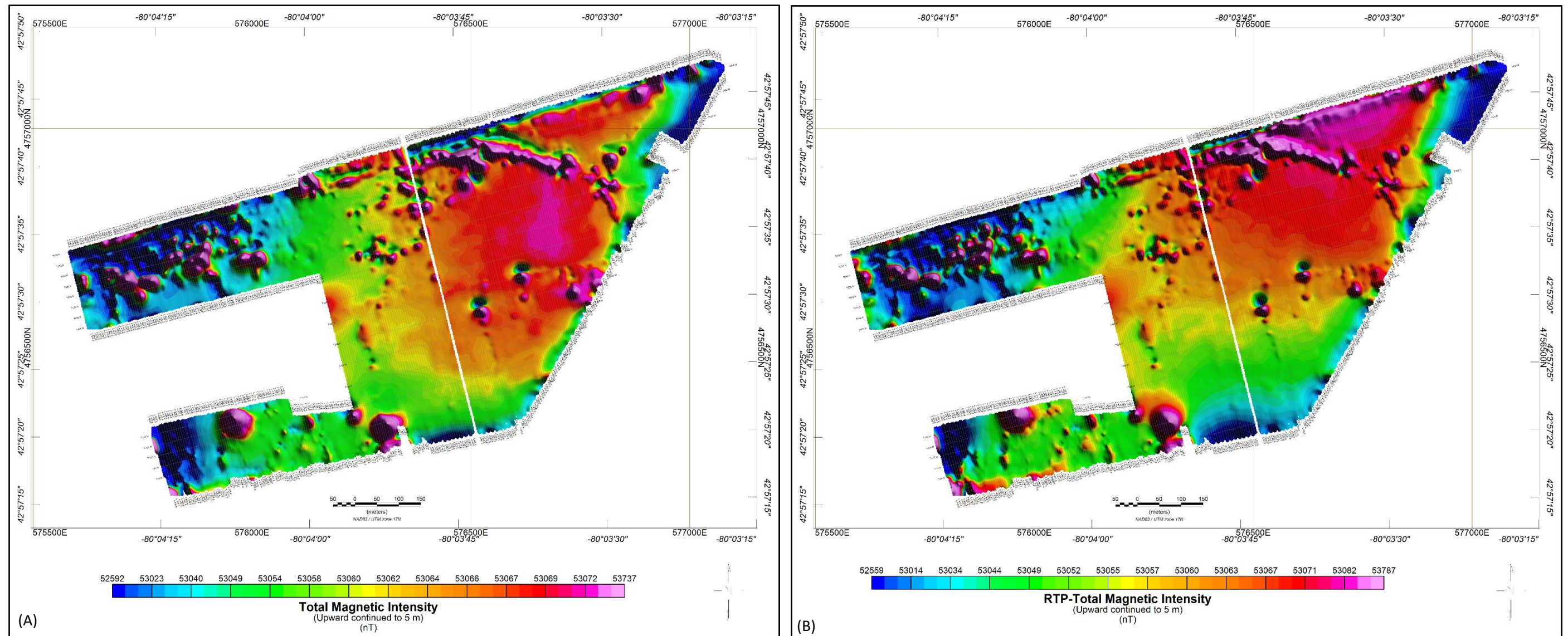


Figure 9. High-resolution total magnetic field upward continued to an elevation of 5 m (A) and its reduced-to-pole (B), Sandusk Residual Development Project.

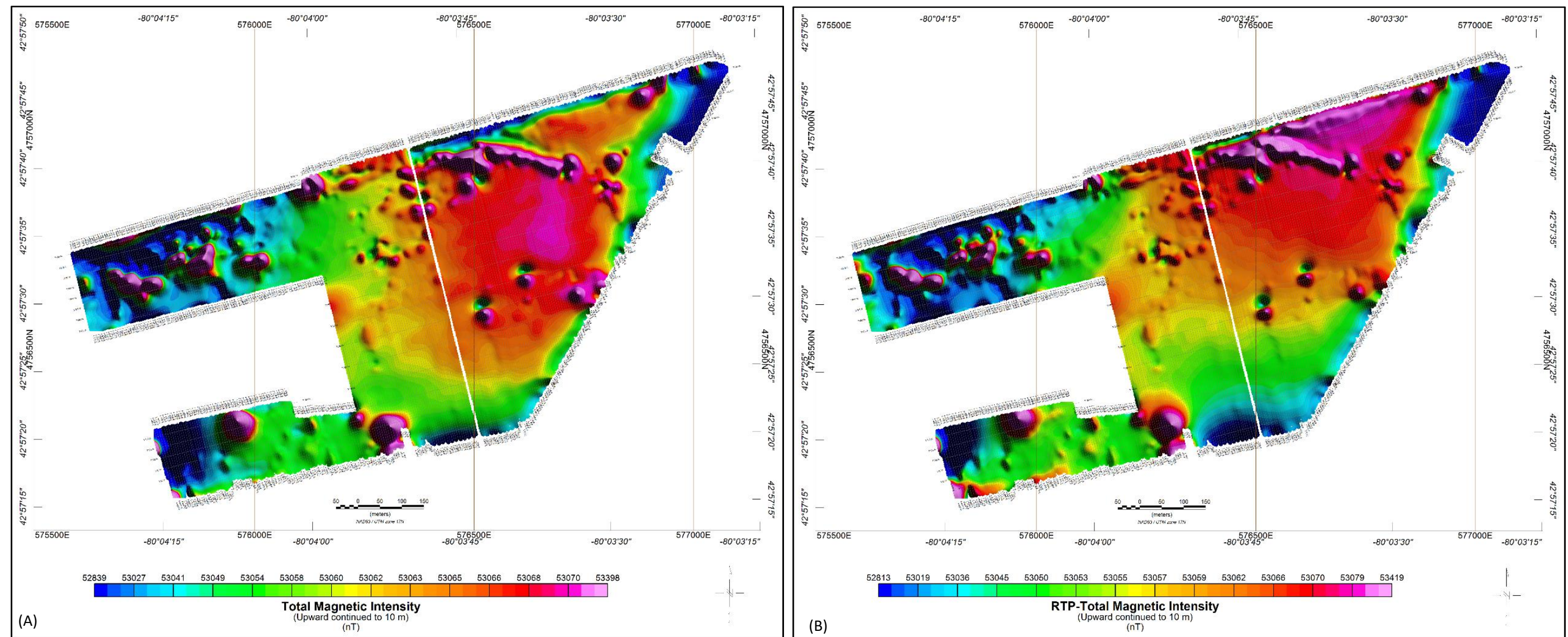


Figure 10. High-resolution total magnetic field upward continued to an elevation of 10 m (A) and its reduced-to-pole (B), Sandusk Residual Development Project.

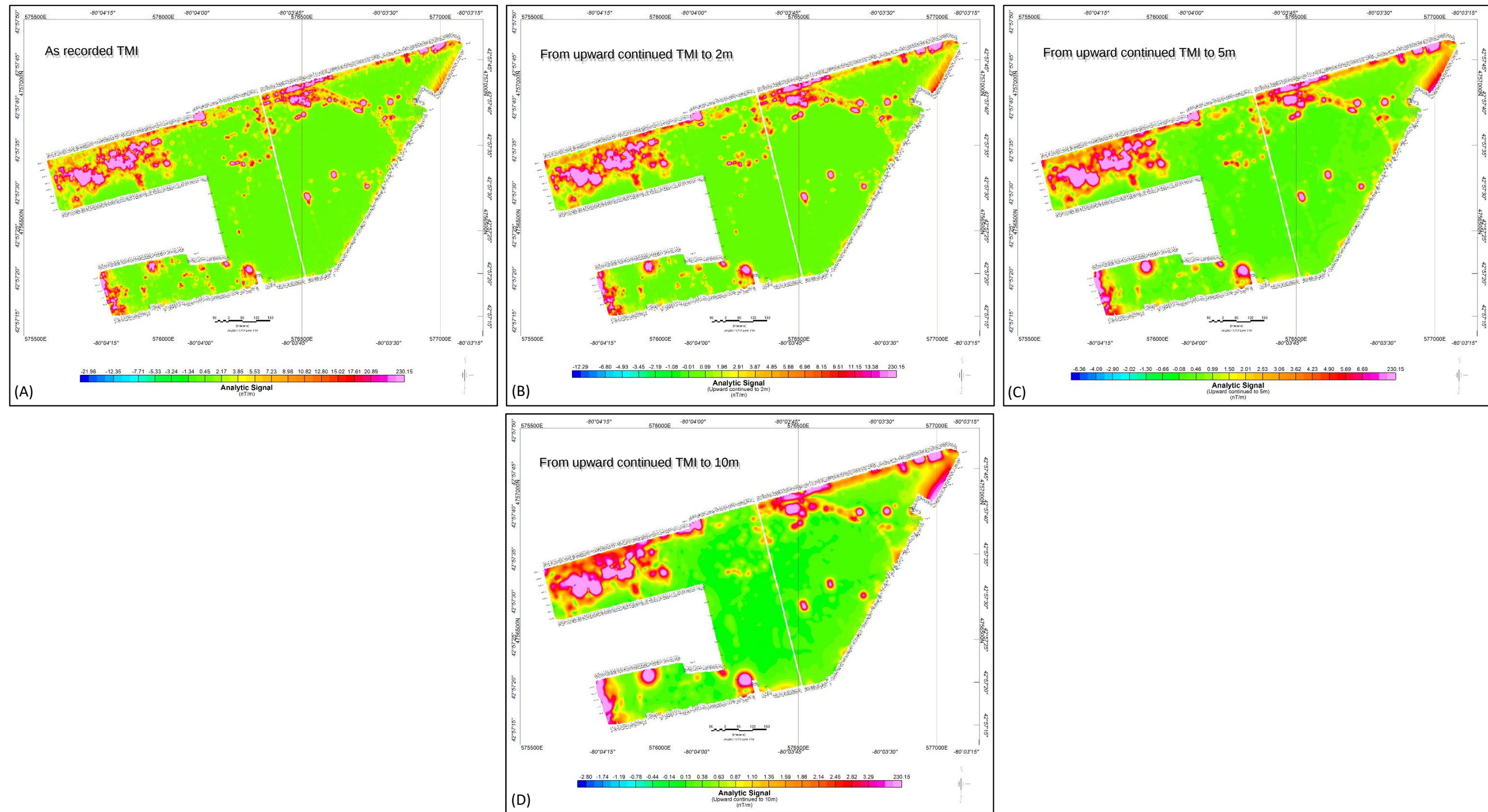


Figure 11. Calculated analytic signal of the total magnetic field at various elevations, Sandusk Residual Development Project.

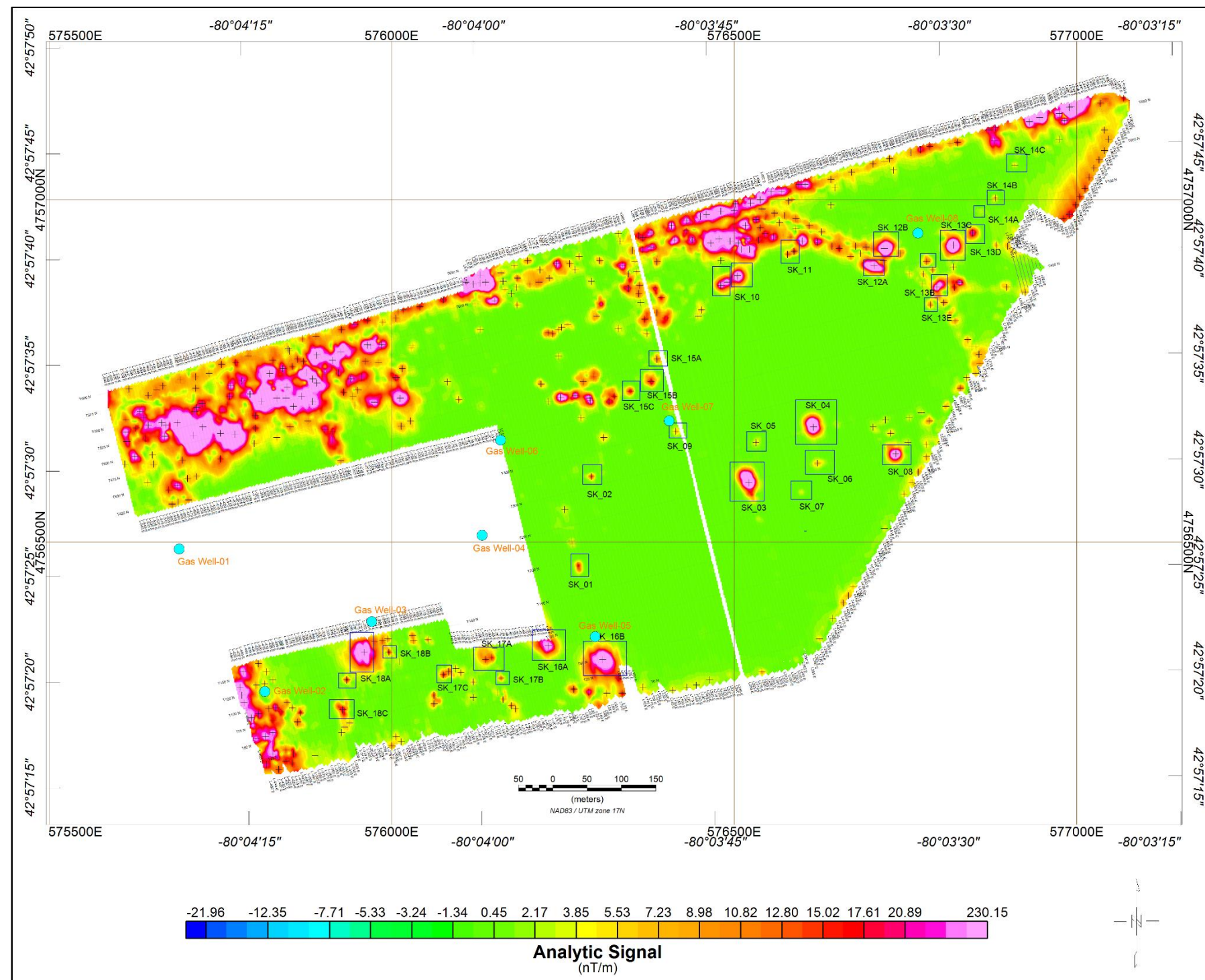


Figure 12. Automatic AN-EUL method combining the analytic signal and the Euler deconvolution method to pick magnetic targets and estimate their depths.



## APPENDIX A – PROJECT OVERVIEW

- ❑ **PROJECT ID** **Sandusk Residential Development**  
(Our reference: **22NT077-MU**)
- ❑ **GENERAL LOCATION** Hagersville, Ontario, Canada
- ❑ **CUSTOMER** **EC (Sandusk) GP Inc.**  
125 Villarboit Crescent  
Vaughn ON, L4K 4K2
- ❑ **REPRESENTATIVE** **Mr. Mike Dorland, P.Geo.**  
Professional Geoscientist  
Consulting Geologist  
[Mikegeo@rogers.com](mailto:Mikegeo@rogers.com)  
**Telephone: (519) 532-3468**  
  
**Mr. John Castro**  
Project Manager, Land Services  
[icastro@empirecommunities.com](mailto:icastro@empirecommunities.com)  
**Telephone: (905) 307-8102, 1182**
- ❑ **SURVEY TYPE** **Drone-MAG Survey**
- ❑ **GEOPHYSICAL OBJECTIVES** To detect and identify wells and other metallic structures.

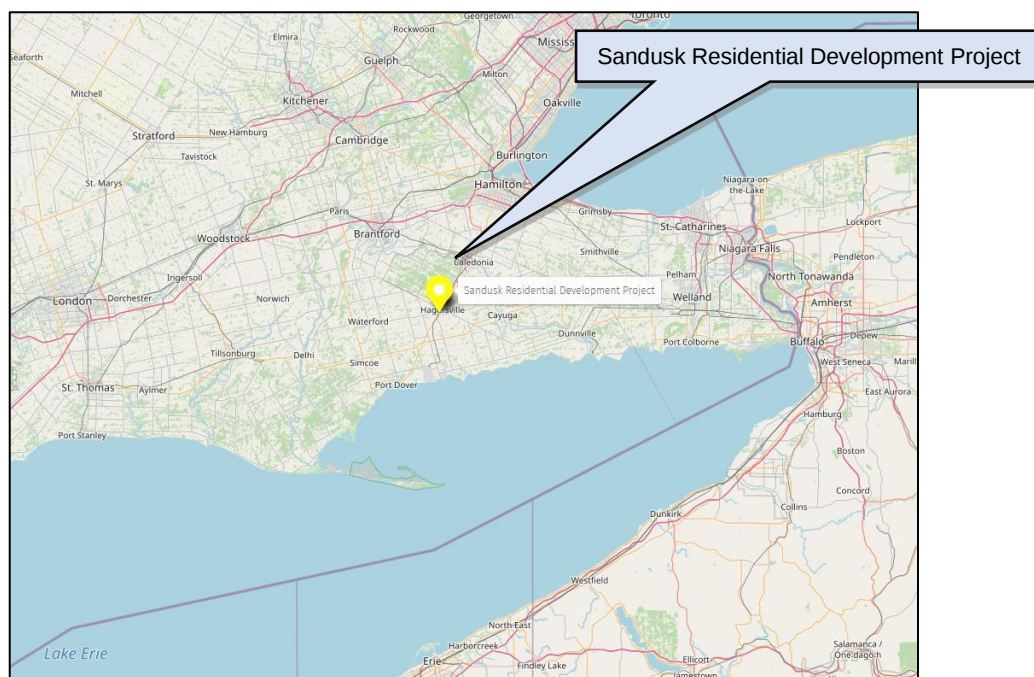


Figure 13. General location of the Sandusk Residential Development Project.



☐ *LOCATION*

**Hagersville, Ontario, Canada**

Centred on 42°57'31" N, and 80°03'51" W  
NAD83 / UTM zone 17N, 576 325 mE, 4 756 658 mN  
NTS sheet: **40I/16H**

☐ *NEAREST SETTLEMENTS*

**Hamilton:** approximately 40 km NE  
**Brantford:** approximately 30 km NW

☐ *ACCESS*

The survey grid is easily accessible via road 9 (concession 12 Walpole) or Sandusk road 18.

☐ *PHYSIOGRAPHY*

The central grid consists of a cleared area that appears as a plowed agricultural zone in the center of the survey area and a vegetated area at the eastern end of the survey grid.

As for the NW grid, this zone is almost devoid of vegetation; remains of building foundations and tracks are observed on this site. As with the SW grid, the ground at this location is covered with poor and sparse vegetation. Remnants of demolished foundations and solar panels are encountered.

The topography of the survey area is relatively flat with elevations ranging from 215 to 228 m above sea level. Note the presence of a flooded former quarry between the NW and SW grids.

☐ *CULTURAL FEATURES*

Several man-made structures are located within the study site. The most prominent include the railway to the east of the study grid, the flooded quarry to the west, two solar panel fields to the north and SW of the site, a few buildings within the survey grid, and various buried metal objects including abandoned gas wells.

☐ *SURVEY GRIDS*

The drone-magnetic survey covered 3 grids:

**Central grid:** this grid consists of 201 lines (L 0E to L 1000E). The survey lines vary from 10 m to 670 m in length. Fourteen tie lines (TL 0N to TL 650N) spaced every 50 m complete this grid.

**NW grid:** this grid consists of 110 lines (L 0E to L -545E). The flight lines vary from 175 m to 200 m in length. Eight tie lines (TL 425N to TL 600N) spaced every 25 m complete this grid.

**SW grid:** this grid consists of 93 lines (L 0E to L -460E). The flight lines on this grid vary from 50 m to 170 m in length. Six tie lines (TL 25N to TL 150N) spaced every 25 m complete this grid.

All the flightlines are regularly spaced at 5 m and oriented N 166°. Refer to Figure 14 for a plan view of the areas covered by the present survey.



☐ COORDINATE SYSTEM

Local datum: NAD83  
Projection type: Universal Transverse Mercator (UTM)  
Zone: 17N

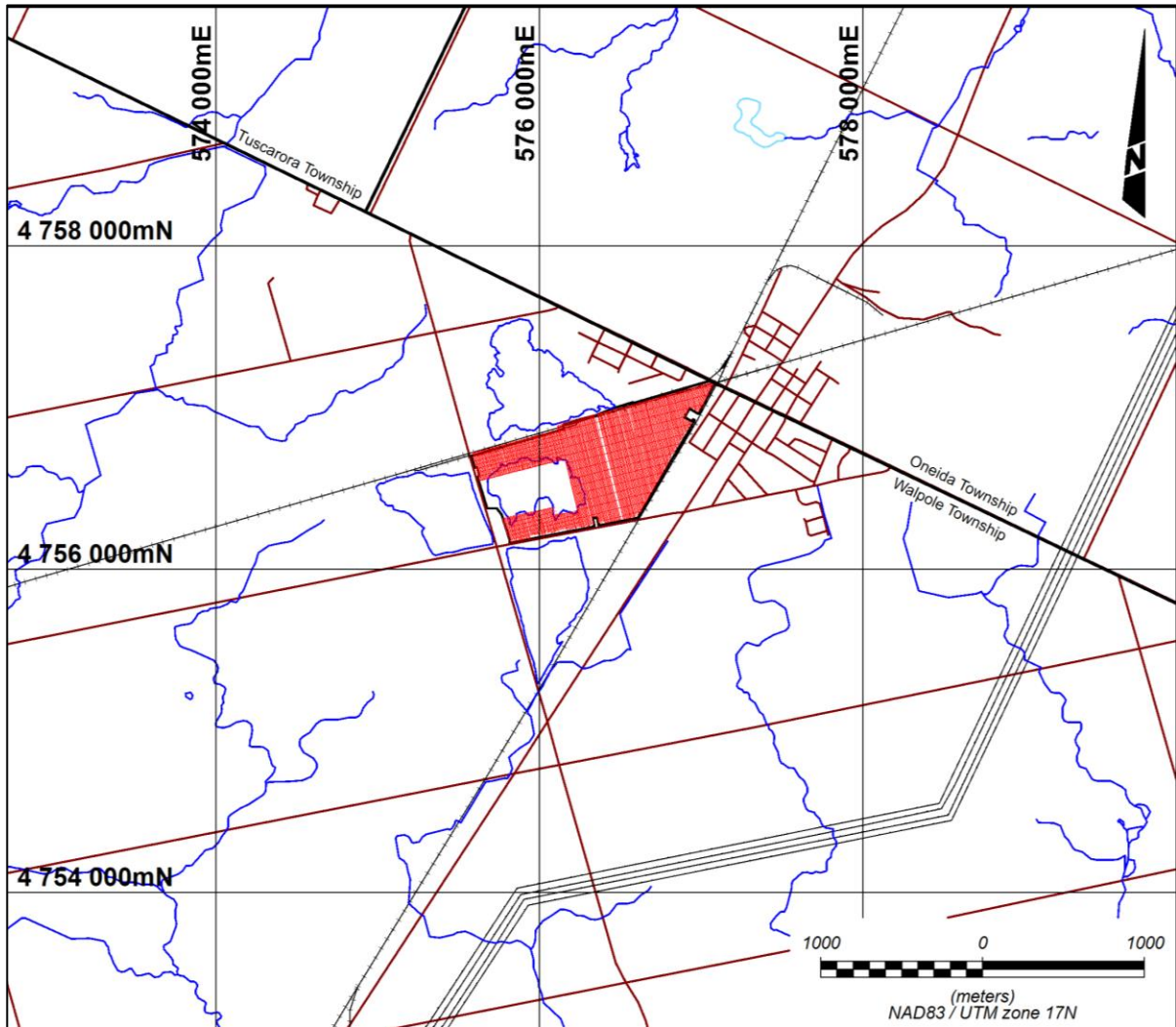


Figure 14. Drone-based magnetometric flight coverage within the Sandusk Residential Development Project.



## APPENDIX B – TECHNICAL SPECIFICATIONS

### ☐ TYPE OF SURVEY

Measurement of the total magnetic intensity in horizontal gradient mode with RTK-GPS readings recorded every 0.1 seconds (10 Hz sample rate) using an unmanned aerial vehicle (UAV). The plotted total magnetic values were corrected for diurnal variations using readings taken every 0.5 seconds by a synchronized local base station.

### ☐ DATA ACQUISITION

Central grid: from December 8<sup>th</sup> to 9<sup>th</sup> 2022

NW & SW grids: January 13, 2023

### ☐ SURVEY COVERAGE

**147.0 km**

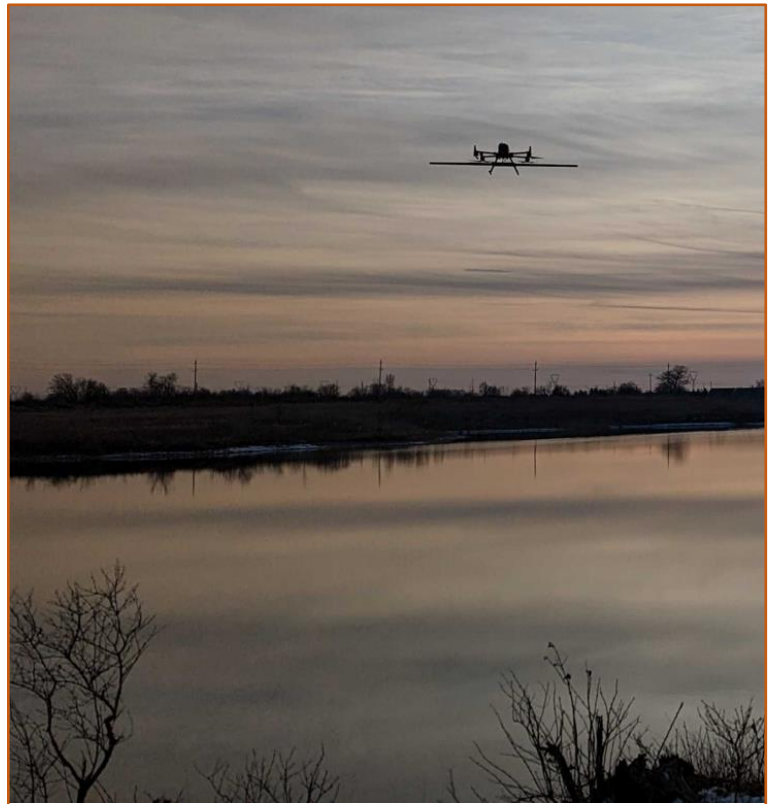


Figure 15. Rosor UAV-Multirotor in horizontal gradient mode operation.



#### ❑ TECHNICAL SPECIFICATIONS

##### **Multirotor DJI MATRICE 300 RTK platform equipped with collision avoidance system in Positioning (P) mode**

- Diagonal Wheelbase 895 mm
- Dimensions 810×670×430 mm
- Weight 6.3 kg with two batteries
- Max Takeoff Weight 9.0 kg
- Operating frequency 2.4000-2.4835 GHz  
5.725-5.850 GHz
- Hovering Accuracy (P-GPS) Vertical:  
±0.1 m (Vision Syst. enabled)  
±0.5 m (GPS enabled)  
±0.1 m (RTK enabled)  
  
Horizontal:  
±0.1 m (Vision Syst. enabled)  
±0.5 m (GPS enabled)  
±0.1 m (RTK enabled)
- Max Pitch Angle 30°
- Max Wind Resistance 15 m/s
- Max Speed 17m/s, no wind
- Max Service Ceiling ASL 5000 m
- Max Flight Time 55 mn
- Operating Temperature -20 à 50 °C.
- Intelligent Battery TB60 (5935 mAh), 52.8 V

#### ❑ ROVER MAGNETOMETER

##### **Air Mag: Geodrones Georf-M300**

- Resolution: 0,0001 nT
- Sensitivity: > 1 pT/√Hz in 0.1-100 Hz band.  
> 2 pT/√Hz in 0.01-0.1 Hz band.
- Dead Zone: single equatorial plane, ± 7°
- Sampling rate: 0.1 sec (10 Hz)
- Gradient tolerance: > 10 000 nT/m
- Operating range: 1 000 – 100 000 nT
- Heading error: below 3 nT (uncompensated)
- Weight: 18 g

#### ❑ BASE STATION MAGNETOMETER

##### **GSM-19W from GEM Systems**

- High Precision Overhauser Magnetometer
- Resolution: 0,01 nT
- Sensitivity: 0.022 nT @ 1 Hz
- Absolute accuracy: ± 0.1 nT
- Sampling rate: 0.5 sec (2 Hz)
- Gradient tolerance: > 10 000 nT/m
- Dynamic range: 20,000 to 120,000 nT
- Sampling rate: 0.5 second
- Reference Field: 53 050 nT
- Location (Long., Lat./ WGS 84): 42.960105 N, 80.065790 W



|                                       |                                                                                                                                                                                                                                                                                                        |                                               |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| ❑ <i>VISION SYSTEM</i>                | Obstacle Sensing Range:                                                                                                                                                                                                                                                                                | Fwd/Backw/L/R 0.7 – 40m<br>Upw/down 0.6 – 30m |
|                                       | Infrared ToF Sensing System                                                                                                                                                                                                                                                                            | 0.1 – 8 m                                     |
| ❑ <i>REMOTE CONTROLLER</i>            | Operating frequency                                                                                                                                                                                                                                                                                    | 2.4000-2.4835 GHz<br>5.725-5.850 GHz          |
|                                       | Max Transmitting Distance                                                                                                                                                                                                                                                                              | 15 km                                         |
| ❑ <i>RTK POSITIONING<br/>ACCURACY</i> | When RTK enabled and fixed:<br>1 cm +1 ppm (Horizontal)<br>1.5 cm + 1ppm (Vertical)                                                                                                                                                                                                                    |                                               |
|                                       | <ul style="list-style-type: none"><li>• Concurrent reception of GPS, GLONASS, Galileo and BeiDou.</li><li>• Multi-band RTK with fast convergence times and reliable performance</li><li>• Centimeter accuracy in a small and energy efficient module</li></ul>                                         |                                               |
| ❑ <i>SURVEY SPECIFICATIONS</i>        | <ul style="list-style-type: none"><li>• Nominal survey speed: 5 m/s or 16 km/h</li><li>• Average terrain clearance: 5 m (AGL)</li><li>• Flight direction: N 166° / N 346°</li><li>• Traverse line interval: 5 m</li><li>• Tie lines: N 76° / N 256°</li><li>• Tie line interval: 50 and 25 m</li></ul> |                                               |
|                                       |                                                                                                                                                                                                                                                                                                        |                                               |
| ❑ <i>PERSONNEL</i>                    | Pyotyr Young<br>Carle Dépatie<br>Carole Picard, Tech.<br>Madjid Chemam, P.Geo.<br>Catherine Phaneuf, P.Geo.                                                                                                                                                                                            |                                               |
|                                       | Field Crew Manager<br>UAV System Operator<br>Plotting<br>Processing and Report<br>Final validation of product<br>Conformity                                                                                                                                                                            |                                               |



#### ❑ DATA QUALITY CONTROLS

##### **Before the survey:**

- ✓ All magnetometers were successfully field-tested and automatically synchronized with GPS time.
- ✓ The pilot uploaded the flight plan to the AutoCopter via a laptop computer and ensured no errors in the GPS waypoints.
- ✓ The pilot estimated the number of lines to survey before switching to the manual mode to return the AutoCopter to the field base operation to change the batteries.

##### **During data acquisition:**

- ✓ The QA/QC geophysicist had to successfully test for any magnetic contamination before each take-off.
- ✓ Clover leaf tests maintained a standard deviation within 1 nT across eight intersections.
- ✓ The QA/QC geophysicist reviewed the quality of the recorded data every time the AutoCopter returned to the base of operations.
- ✓ The QA/QC geophysicist ensured no active geomagnetic activity would be encountered during the survey by visiting the Space Weather Canada website:  
([www.spaceweather.gc.ca/forecast-prevision](http://www.spaceweather.gc.ca/forecast-prevision)).

#### ❑ DATA QUALITY CONTROLS (CONTINUED)

##### **At the Base of Operations:**

- ✓ Field QCs were inspected & validated.
- ✓ The data set was viewed on a line-by-line basis to check for errors (spikes), doubled measures (overlaps), using a profile editor.
- ✓ The short-missed sections in the raw data were filled in by interpolation.
- ✓ A low-pass / B-spline filter was applied to remove the high frequency noise.
- ✓ A diurnal correction was applied.
- ✓ The magnetic data was conventionally levelled using:
  - Statistical levelling: this operation levels the tie lines to the flight lines.
  - Full levelling: this operation levels the flight lines to the ties.
  - Microlevelling: which removes any low-amplitude component of flight line noise still remaining in the UAV survey data after full levelling.