APPENDIX 3-C

Magnetometer Survey 2022

VERSION 1(DRAFT)

Project Report

Somerset Magnetometer Survey

June 15 - June 25, 2022

[JULY 2022]

Prepared for:

AES Clean Energy Development, LLC
2180 South 1300 East, Suite 600
Salt Lake City, Utah 84106
Contact: Jack Donelan

Prepared by:

DUDEK
605 Third Street
Encinitas, California 92024
Contact: Steven Hochart

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Steven Hochart
Mapping & Surveying Practice Director

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
Ac	Acre
AGL	Above ground level
GNSS	Global Navigation Satellite System
IMU	Inertial Measurement Unit
nT	nanoTeslas
nT/m	nanoTeslas per meter
UAS	Unmanned aircraft system

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1 Overview

1.1 Project Description

Dudek was contracted by AES Clean Energy Development to acquire, process, and deliver magnetometer data and derivative products for a project in Northwest New York, with emphasis on identifying potential abandoned oil and gas wells. The project areas cover approximately 1,400 acres (ac), divided into 9 subsections of Somerset, New York.

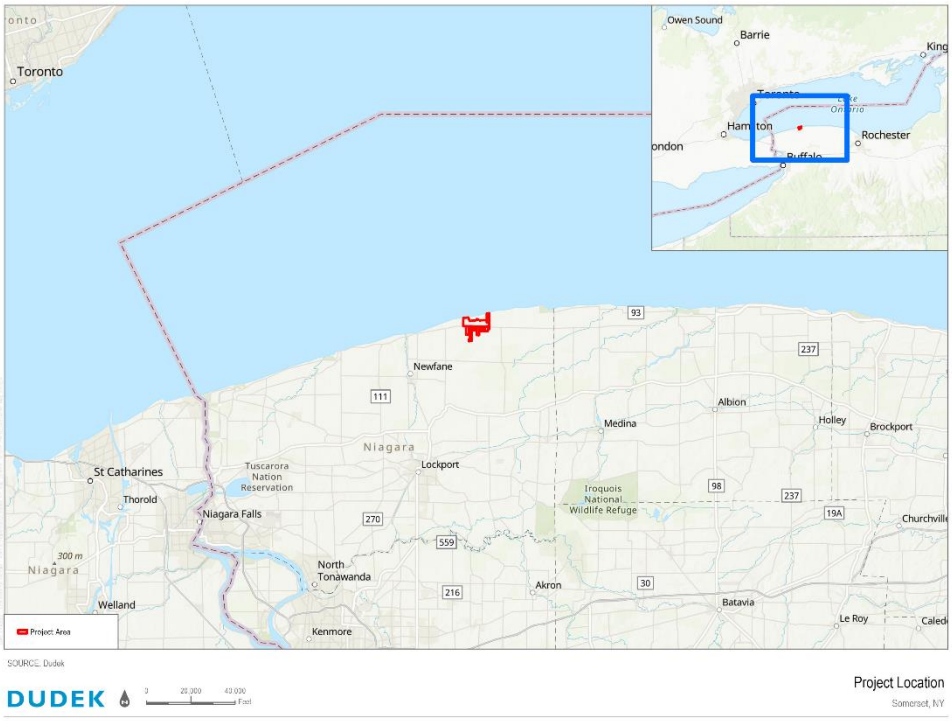

Figure 1- Project Location

Figure 2 - Project Area

2 Magnetic Data Acquisition Methodology

Magnetometer acquisition for the 9 sub-areas at Somerset was performed from June 15 – June 25, 2022 totaling 83 discrete flights. The survey utilized a Geometrics MagArrow Magnetometer suspended from a DJI Matrice 600 Pro drone. Dudek flew at an altitude of 100 ft above ground level (AGL) using terrain following software to maintain consistent altitude. Flight surveys were flown at a speed of 10 mph with 100 ft horizontal distance between flight lines.

Table 1. Flight Parameters

Flight Parameter	Parameter Value
Altitude (ft AGL)	100
Speed (mph)	10
Flight line spacing (ft)	100
Flight number	83

Source: Dudek 2021

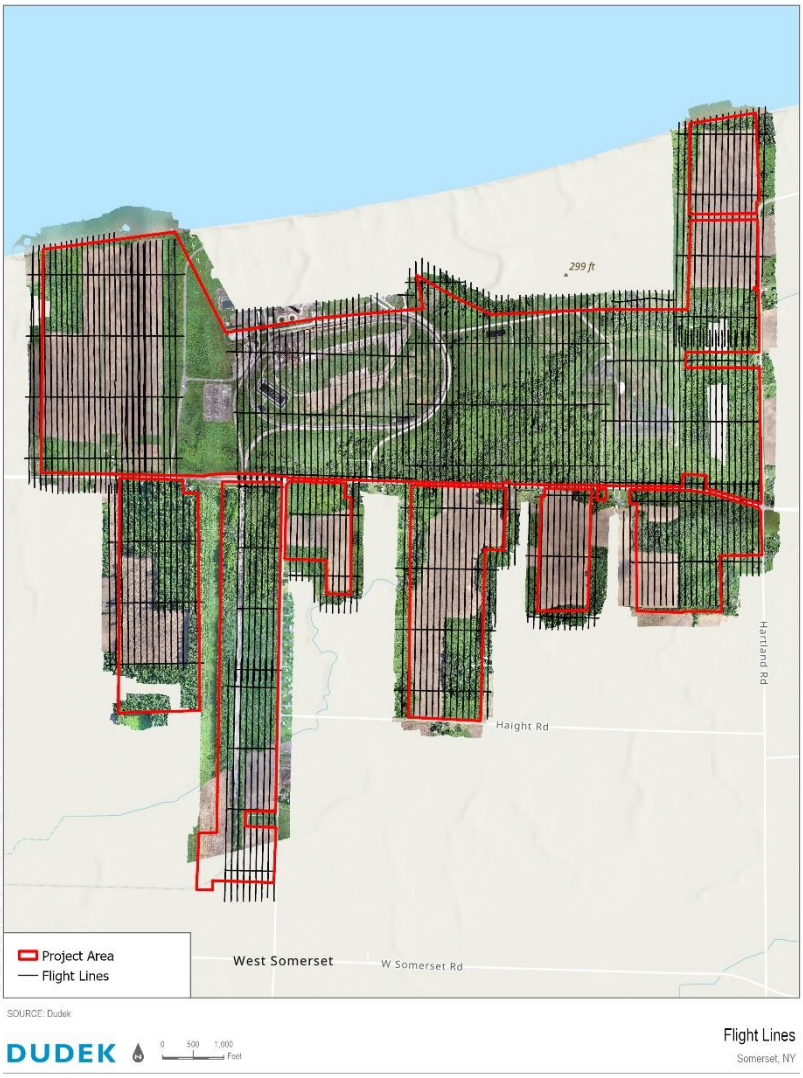

Figure 3 - Flight Lines

2.1 Magnetometer Acquisition Equipment

DJI Matrice 600 Pro

The Matrice 600 Pro (M600 Pro) is a six propped rotary-wing drone built with a modular design for payloads up to 6 kg (13.2 lbs). Unlike the smaller DJI drones, the M600 Pro does not come with any built-in sensors. Instead, this drone is truly for commercial uses and can haul any number of sensors. With all six batteries and no payload the M600 Pro has a max flight time of 32 minutes and with the max 6kg payload it has a flight time of 16 minutes.

Exhibit A. DJI M600 Pro shown with MagArrow payload.

Source: Dudek 2021

The M600 Pro comes with preinstalled arms and antennae that fold down for easy transportation. This allows the field crews to quickly set up, take down, and move take off locations without wasting valuable field time disconnecting and re-connecting various components.

To help ensure safety in the field the M600 Pro comes standard with multiple safety systems. Foremost, the A3 Pro Flight Controller has triple modular redundancy, diagnostic algorithms that compare sensor data from three sets of GNSS units, and analytical redundancies to guarantee the drone flies where programmed to. Additionally, the propulsion system is actively cooled and has a dust proof seal resulting in less maintenance and ensures reliable operation for an extended period. Finally, the battery management system monitors all six batteries during flight to ensure a safe landing in the event of single battery failure.

Geometrics MagArrow Magnetometer

The MagArrow is a lightweight airborne magnetometer developed by Geometrics and designed specifically for use with unmanned aircraft systems (UAS). The scanner is a user-friendly and cost-efficient device used to acquire magnetic data by use of remotely piloted multi-rotor UAS for a variety of applications.

Table 2. MagArrow Specifications

Scanner Attribute	Specification
Operating Principle	Laser pumped cesium vapor (Cs133 non-radioactive) total field scalar magnetometer.
Operating Range	20,000 to 100,000 nT
Gradient Tolerance	10,000nT/m
Sampling Rate	1000 Hz. synchronized to GPS 1PPS

Table 2. MagArrow Specifications

Scanner Attribute	Specification
Bandwidth	400 Hz
GPS	Commercial grade with typical 1 m accuracy
IMU	Bosch BMI160 Accel/Gyro - 200 Hz sample rate. Insentek Compass - 100 Hz Sample rate

Source: Geometrics 2022

Geometrics G-857 base station Magnetometer

A Geometrics G-857 base station magnetometer was set up each day at least 30 min prior to surveying to record the diurnal variations of the Earth's magnetic field. The base station was automatically time synchronized to UTC time using as integrated GPS. The base station collected data at a rate of one reading every 1 seconds.

3 Post-Processing

3.1 MagArrow Data

For each mission, raw data files were batch processed into a single comma-delimited file (CSV) using Geometrics Survey Manager software. The exported CSV files are plotted using Geosoft Oasis Montaj and ESRI ArcGIS Pro and clipped to eliminate any non-flight line data and grouped into individual flight lines for further processing. Using Oasis Montaj software and the G857 base data, data was corrected for diurnal variations throughout the day of acquisition. Finally tie line leveling is performed to combine multiple days of acquisition. With final magnetic values, data is ready for interpolation and analysis.

3.2 Gridding and Analysis

The processed magnetic data values are then interpolated into raster “grids” to visual the magnetometer readings across the entire project site. Using Oasis Montaj generate Total Magnetic Intensity (TMI) maps and Analytic Signal Maps to identify areas of elevated magnetic readings. Total Magnetic Intensity best reflects the real-world magnetic field without major geologic trends. This data is shown in nT (nanotesla) and both negative and positive anomalies are visible.

Analytic Signal is a filter applied TMI data and helps better delineate the boundaries of the anomaly. This is calculated by the square root of the squared sum of the vertical and two horizontal derivatives of the magnetic field resulting in units of nT/meter (nanotesla per meter). From the analytic signal grid, “peaks” are then identified using software. These points indicate spot locations of elevated magnetism. Recently collected orthoimagery as well as field inspection are then used to investigate the sources of those anomalies.

4 Results

4.1 Total Field Intensity

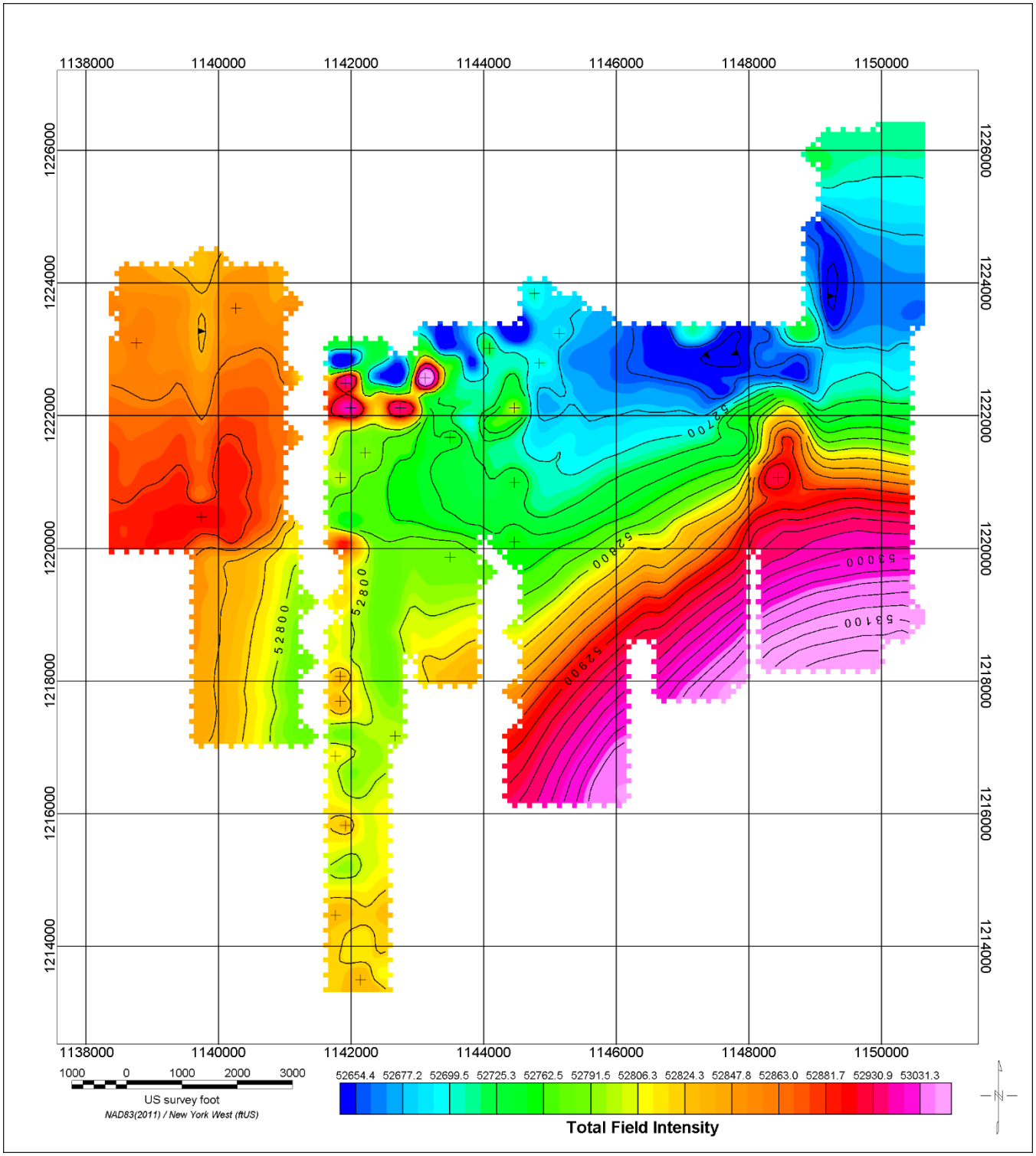

Figure 4 - Field Intensity Map

4.2 Analytic Signal Map

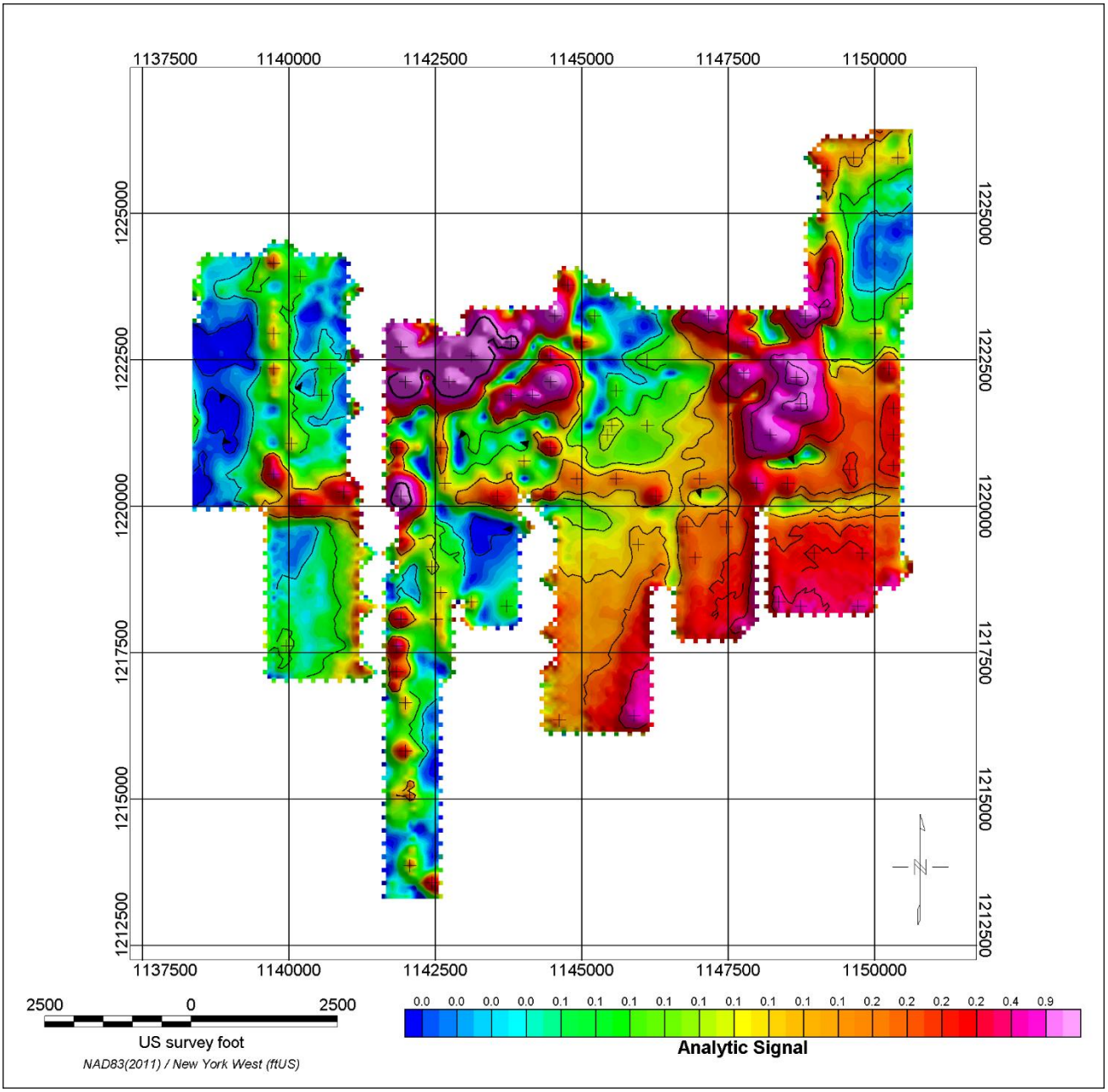

Figure 5 - Analytic Signal Map

4.3 Anomaly Inspection

There were initially **192** anomaly peaks identified in the analytic signal grid data. Using UAV aerial orthoimagery, UAV oblique imagery and ground level field photos Dudek collected in June 2022, Dudek deemed **108** of those **192** points as unnecessary to investigate further due to surface evidence such as telephone poles, overhead electrical utilities, street lights, train infrastructure and general debris. The remaining **84** signals were investigated in person by a Dudek surveyor equipped with NTRIP enabled survey GNSS rover (See Appendix A for surveyed coordinates for each)

Of those **84** points, **66** had no surface evidence of the source of the anomaly (shown in Red on figure 5). The remaining **18** locations that did have surface evidence are shown in blue in figure 5 below. See appendix B for photos for all **84** locations.

Figure 6 - Field Check Results

Table 1 – Features Identified

Point ID	Northing	Easting	Signal Value	Comments
3	1213592	1142393	0.446219	Power pole
4	1216392	1145893	0.363853	Power Pole
5	1213492	1141793	0.355843	Power Pole
6	1213492	1142093	0.345262	Power Pole
15	1220742	1142593	0.280917	Chain-link fence
16	1216892	1145943	0.27732	Power Pole
19	1217492	1144643	0.264936	Sign
22	1216692	1144643	0.259859	Sign
26	1217942	1144643	0.248008	Sign
29	1216442	1144643	0.238337	Sign
30	1218242	1144643	0.233373	Sign
44	1219992	1139743	0.210637	Power pole
45	1220192	1139943	0.208309	Sign
46	1216392	1145393	0.206372	Power pole
47	1220642	1143593	0.202733	Possible Oil or Water Monitoring Well
50	1219992	1140843	0.20011	Sign on Tree
90	1220392	1150243	0.159757	Culvert
91	1220542	1150243	0.159584	Culvert

As indicated above, Point 47is the only anomaly that Dudek located that requires additional follow up. (See figures 6 and 7). Point 47 appears to be vertical metal pipe with a latching cover and a pad lock. Adjacent are two bollard posts. This features is approximately 10 feet south west of a rectangular structure, possibly an old storage container.

Figure 7 - Possible Oil or Water Monitoring Well

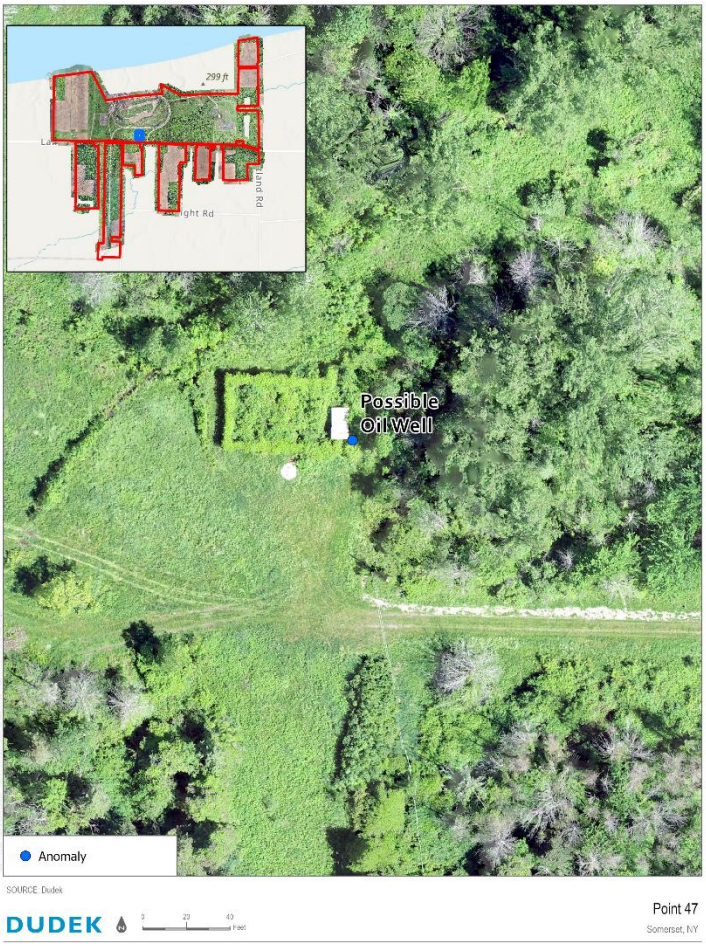

Figure 8 - Possible Water Monitoring or Oil Well

Figure 9- Possible Water Monitoring or Oil Well - Oblique Photo

5 Appendix A – Surveyed Anomalies

Point ID	Easting	Northing	Height	Code
GS0052	1145243	1216650	194.4761	nothing 27
GS0051	1144992	1216641	189.2019	nothing 74
GS0050	1145004	1216986	190.5329	nothing 78
GS0049	1145240	1216979	196.8257	nothing 48
GS0048	1145262	1217695	191.7237	nothing 68
GS0047	1145348	1218054	191.2286	nothing 72
GS0046	1145712	1218058	189.1728	nothing 70
GS0045	1145763	1217887	187.6664	nothing 79
GS0044	1145876	1217675	185.4242	nothing 28
GS0043	1145845	1216875	241.4958	nothing 20
GS0042	1145849	1216744	185.4153	nothing 08
GS0041	1145901	1216641	203.4327	nothing 07
GS0040	1146127	1216256	180.9628	ck pt 2000
GS0039	1139714	1223772	134.7002	nothing 25
GS0038	1139714	1223772	134.903	nothing 36
GS0037	1139703	1223519	146.0749	nothing 52
GS0036	1139699	1223038	151.6877	nothing 24
GS0035	1139702	1222746	163.4944	nothing 21
GS0034	1139688	1222418	172.9345	nothing 23

GS0033	1139667	1221776	184.6339	nothing 33
GS0032	1139665	1221451	188.5671	nothing 32
GS0031	1146730	1222495	188.6479	nothing 11
GS0030	1149787	1218189	231.0446	nothing 53
GS0029	1148199	1218300	181.8347	nothing 38
GS0028	1148550	1218244	180.6403	nothing 69
GS0027	1148802	1218153	183.5368	nothing 49
GS0026	1149122	1218166	194.0904	nothing 54
GS0025	1149436	1218096	198.9426	nothing 65
GS0024	1149561	1218197	206.5026	nothing 57
GS0023	1149771	1218901	211.6986	nothing 88
GS0022	1146968	1218104	158.1815	nothing 87
GS0021	1146970	1218117	178.0502	nothing 87
GS0020	1146951	1218117	170.3679	nothing 81
GS0019	1147262	1218180	159.0412	nothing 51
GS0018	1147445	1218168	177.9425	nothing 75
GS0017	1147457	1218188	190.1416	nothing 64
GS0016	1147311	1218350	183.3252	nothing 80
GS0015	1147251	1218671	176.2855	nothing 100
GS0014	1146875	1218603	176.4076	nothing 94
GS0013	1146831	1219060	187.4612	nothing 86
GS0012	1146644	1219092	183.8418	nothing 82
GS0011	1146427	1219096	182.7364	nothing 84

GS0010	1146488	1219476	180.7257	nothing 92
GS0009	1146427	1219621	182.3674	nothing 95
GS0008	1146413	1219626	184.9443	nothing 67
GS0007	1146416	1219703	176.2335	nothing 60
gs0022	1143587	1220617	171.9972	pipe ? 47
gs0021	1147909	1223150	170.2945	nothing 09
gs0020	1145018	1223317	164.9206	
gs0019	1145089	1223388	154.0118	
gs0018	1144665	1223672	164.9206	nothing 12
gs0017	1144736	1223742	154.0118	nothing 13
gs0016	1147044	1223239	220.8229	nothing 02
gs0015	1144733	1221687	179.4589	nothing 59
gs0014	1144538	1221482	181.7024	nothing 93
gs0013	1144720	1218119	190.6384	sign 30
gs0012	1144711	1217880	190.8025	sign 29
gs0011	1144701	1217322	193.5262	sign 19
gs0010	1144749	1216564	186.9528	sign 22
gs0009	1144713	1216357	173.6021	sign 29
gs0008	1145416	1216306	181.79	pp 46
gs0007	1145865	1216284	182.1827	pp 4
2000	1146123	1216259	174.9614	CP
NYGCS	789429	-432051	305.9	
GS0006	1142079	1213665	201.5511	PP 5
GS0005	1142235	1213667	203.4755	PP 6
GS0004	1142485	1213580	205.719	PP 3
GS0003	1142487	1213587	203.5849	
GS0002	1140162	1220246	186.9202	PP
GS0001	1140116	1220253	186.8953	SIGN