October 22, 2015

ISSUED FOR USE
FILE: E11103085-01
Via Email: NWills@klohn.com

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Attention: Nicole Wills

Subject: Camp Farewell Buried Debris Locate

1.0 INTRODUCTION

Tetra Tech EBA Inc. (Tetra Tech EBA) was retained by IEG Consultants Ltd. (IEG) to conduct a series of geophysical surveys at the Camp Farewell site, approximately 110 km northwest of Inuvik, NT. Initially, a magnetic gradiometer survey was chosen to map out buried ferrous debris on site, including construction debris, fuel drums, and possibly, a buried vehicle. Prior to mobilization, IEG requested additional survey coverage with two apparent terrain conductivity instruments, an EM31 and an EM38.

The three surveys were conducted by Mr. James Mickle, P.Geoph. (AB) of Tetra Tech EBA's Calgary office between August 14 and 19, 2015. The survey area included both the runway and entire lease area, approximately 14 hectares in total.

2.0 THEORY

2.1 Magnetic Gradiometer Theory

The magnetic gradiometer survey at this site was performed using a Geometrics G-858 portable cesium vapour magnetometer, with two sensors separated by a vertical distance of 33 cm. Each sensor measured the total magnetic field strength at its respective location. The total magnetic field strength is a function of the vector sum of the earth's total magnetic field, the diurnal magnetic field variation caused by the sun, and the contributing magnetic field of nearby sources.

The magnetic field contributions for both the earth and the sun are generally the same for each sensor due to their close proximity to each other, and their shared distance from these first two sources. Local magnetic sources such as buried ferrous debris are much closer to the sensors and as a result a difference, or magnetic gradient, will be seen in the total magnetic field value measured at each sensor.

Locations with high magnetic gradients will usually correspond to areas with large quantities of ferrous debris or large ferrous objects. There is no significance between a positive or negative anomaly, other than it provides an indication of the polarity and therefore the direction of the magnetic gradient.

2.2 Electromagnetic Theory

Both the EM31 and EM38 instruments are portable electromagnetic (EM) induction systems that can be used to collect apparent terrain conductivity data over relatively large areas in a short period of time. Apparent terrain conductivity is defined as the bulk electrical conductivity of the subsurface over a measurement half space. It is a

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measure of the combined electrical conductivity of the soil matrix and interstitial pore fluids over a range of depths at the measurement point. The units used to express this measurement are milliSiemens per metre (mS/m).

In general, the electrical conductivity of the subsurface is a function of the amount of groundwater present, the quantity of dissolved solids in the water, and the chemical and physical nature of those solids. Thus, apparent conductivity surveys are often useful in defining the extent of subsurface contamination for soil and/or groundwater quality impact studies, particularly in the case of inorganic contaminants. It should be noted that clay tends to exhibit very high electrical conductivities due to its physical makeup, while permafrost typically exhibits very low electrical conductivities due to the pore fluids being frozen.

The fundamental theory behind measuring apparent terrain conductivities using EM induction methods presumes that the conductivity values are relatively low and evenly distributed. In other words, it is assumed that the subsurface materials being measured are electrical insulators. This is normally a valid assumption, even in the case of brine-saturated soils. Metals, however, are generally excellent conductors. Metallic objects, then, will significantly distort the measured apparent conductivity by providing a preferential current path, thereby violating both the assumption that the subsurface material behaves like an insulator and that the current path is evenly distributed. Under this circumstance, the measured apparent conductivity response will be non-linear and values that appear to be a mixture of strong positive and negative values can occur. These measured values do not represent meaningful apparent terrain conductivity values but can provide a diagnostic indication of buried metal or other sources of EM noise (i.e., impressed EM fields from buried utility cables, overhead power lines, etc.).

The depth of investigation of EM instruments is primarily a function of the intercoil (i.e., transmitter–receiver) spacing. The EM31 has an intercoil spacing of 3.66 m, with peak sensitivity at approximately 1.5 m depth and a maximum effective depth of investigation of approximately 5.5 m when operated in vertical dipole mode. The EM38 has an intercoil spacing of 1.0 m, with peak sensitivity at approximately 0.40 m depth and a maximum effective depth of investigation of approximately 1.5 m when operated in vertical dipole mode. The apparent conductivity value measured by the instrument at each location is a single weighted average response from the coil location down to the maximum effective depth of investigation. It should be noted that the listed depths are depths below instrument, not necessarily the depths below ground, as the instrument is often carried some height above the ground surface.

3.0 DATA COLLECTION AND PROCESSING

The magnetics data was collected August 14 – 17, the EM31 data was collected August 18, and the EM38 data was collected August 19, 2015. The weather during all days of data collection was overcast and misty, with temperatures around 5°C.

For each survey, the respective instrument was mounted on a custom-made non-conductive, non-magnetic cart towed behind a side-by-side. Each instrument was set to collect data at a rate of 10 readings per second. GPS positions were recorded once per second using a Topcon GPS/GLONASS unit mounted on the cart, operating in RTK mode. Positioning information was interpolated and integrated into all the data sets. A photo of the survey setup can be seen in Photo 1.

The magnetics data was collected using approximately 2.5 m line spacings across the entire site where accessible by a side-by-side, while both the EM31 and EM38 data sets had approximately 5 m line spacings. Approximately 80 km of data was collected in total among the three instruments. All geophysical data was contoured and plotted using Golden Software's Surfer 13.

At the time of the surveys, the site was being actively cleaned up, and demolition was taking place on the large fuel tanks on the northern edge of the site. Large piles of steel debris, large steel holding drums and several sea-cans were present in numerous locations on-site during the surveys. In addition to creating obstacles for the survey, these were detected by the various geophysical instruments at various levels of proximity, and thus represent false “targets.” The presence or absence of buried materials in these locations is impossible to distinguish from the signature of the above-ground materials. Most of these obstacles were located in a line, northeast of the remaining shed, and appear as gaps in the survey coverage in Figures 01, 03 and 05. Examples of these obstacles are shown in Photos 2 and 3.

Additionally, several areas of the site were impassable, due to thick overgrowth, deeply incised tundra runoff channels, or relatively deep surface water and, as such, were unable to be safely surveyed. These areas are noted in Figure 01; an example of the overgrowth can be seen in Photo 1.

Anomalies were identified on-site and their locations flagged for subsequent excavation. The status of several of the anomalies is unknown, due to excavation and debris removal being performed while Mr. Mickle was surveying elsewhere on-site.

4.0 RESULTS

Figures 02, 04 and 06 illustrate the results from each geophysical instrument. A total of 29 geophysical anomalies were identified using all 3 data sets, 14 of which can likely be attributed to surficial objects. Table 1 summarizes the known surficial and excavated anomalies, while a subset of the anomalies is illustrated in Photos 4 through 17. The entire set of identified anomalies is displayed on each instrument’s results, to permit cross-comparison of the 3 methods. Figure 07 illustrates the ground surface elevations collected during the EM38 survey.

Table 1: Geophysical Anomalies

Anomaly ID	Source	Photo ID	Excavated
A	AST		
B	Steel strap sticking out of ground, likely rig mat		Y
C	Surface object related to demolition	3	
D	Surface object related to demolition		
E	Surface object related to demolition	2	
F	Surface object related to demolition	2	
G	Surface object related to demolition	2	
H	Surface object related to demolition		
J	Surface object related to demolition		
K	Shed	2	
L	Emergency shelter		
M	Incinerator		
N	Fence (made of steel pipes)		
P	Demolished tank debris, stacked		
Q	Steel straps		Y
R	Rig mats	6	Y
S	Pipe	9	Y
T	Pipe	9	Y
U	Pipe, other debris		Partially
V	<unknown>		Unknown

Table 1: Geophysical Anomalies

Anomaly ID	Source	Photo ID	Excavated
W	Crushed fuel drums	7	Y
X	Pipe	8, 9	Y
Y	Pipe		Y
Z	Small straps, cables	10	Partially
AA	Pipe	11	Y
BB	Fiberglass UST, pipes		Y
CC	Misc waste, cables, tin cans, drums, possible burn pit	12, 13	Partially
DD	Drill head, auger flight, collars, straps	14	Y
EE	Rig mat pieces	4	Y
FF	Drum	5	Y
GG	<unknown>		Unknown
HH	<unknown>		Unknown
JJ	<unknown>		Unknown
KK	<unknown>		Unknown
LL	<unknown>, possibly associated with former pond		N
MM	<unknown>, possibly associated with former pond		N
Rwy1	Auger flights, pipes, misc steel objects	15	Y
Rwy2	Nothing found, excavation likely not broad enough		N
Rwy3	<unknown>		Unknown
Rwy4	<unknown>		Unknown
Rwy5	Clips, drum	16	Y
Rwy6	<unknown>		Unknown
Rwy7	Auger flight	17	Y
Rwy8	<unknown>		Unknown
Rwy9	Auger flight		Y

Anomalies LL and MM were not identified until after demob from the site, so were not flagged for excavation. These anomalies are relatively small, and were not detected by the magnetics survey. They are possibly associated with a dark feature in the airphoto that runs away from a small former storage lagoon. The strong response on the EM instruments (particularly the EM31) and no response from the magnetometer suggests a non-ferrous metal, such as aluminum or copper.

The EM results indicate an overall slight increase in apparent conductivity on the northern half of the site. This also extends to the northwest half of the runway as seen in Figure 04. A single area of elevated apparent conductivity is evident in both EM datasets in the corner of the site west of the former tank farm, near a marsh area. This anomalous area has been outlined in Figures 04 and 06. It is unclear whether the elevated readings are a result of impacted surface or ground water or a partially thawed subsurface in this region. As there was standing water in other locations on site at the time of the surveys and no similar increase in apparent conductivity, it seems unlikely that the increase is attributable solely to the presence of additional water.

5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of IEG Consultants Ltd. (IEG) and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than IEG Consultants Ltd. (IEG), or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Tetra Tech EBA Inc.

REGISTERED PROFESSIONAL GEOPHYSICIST
P.I. FINLAY
NWT/NU
October. 22. 2015

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PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature ____________
Date 22nd October 2015
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

FIGURES

LEGEND

Magnetic Gradiometer Data Collection Tracks

SCALE 1:3,000
NAD83
UTM z8

CLIENT
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TETRA TECH EBA

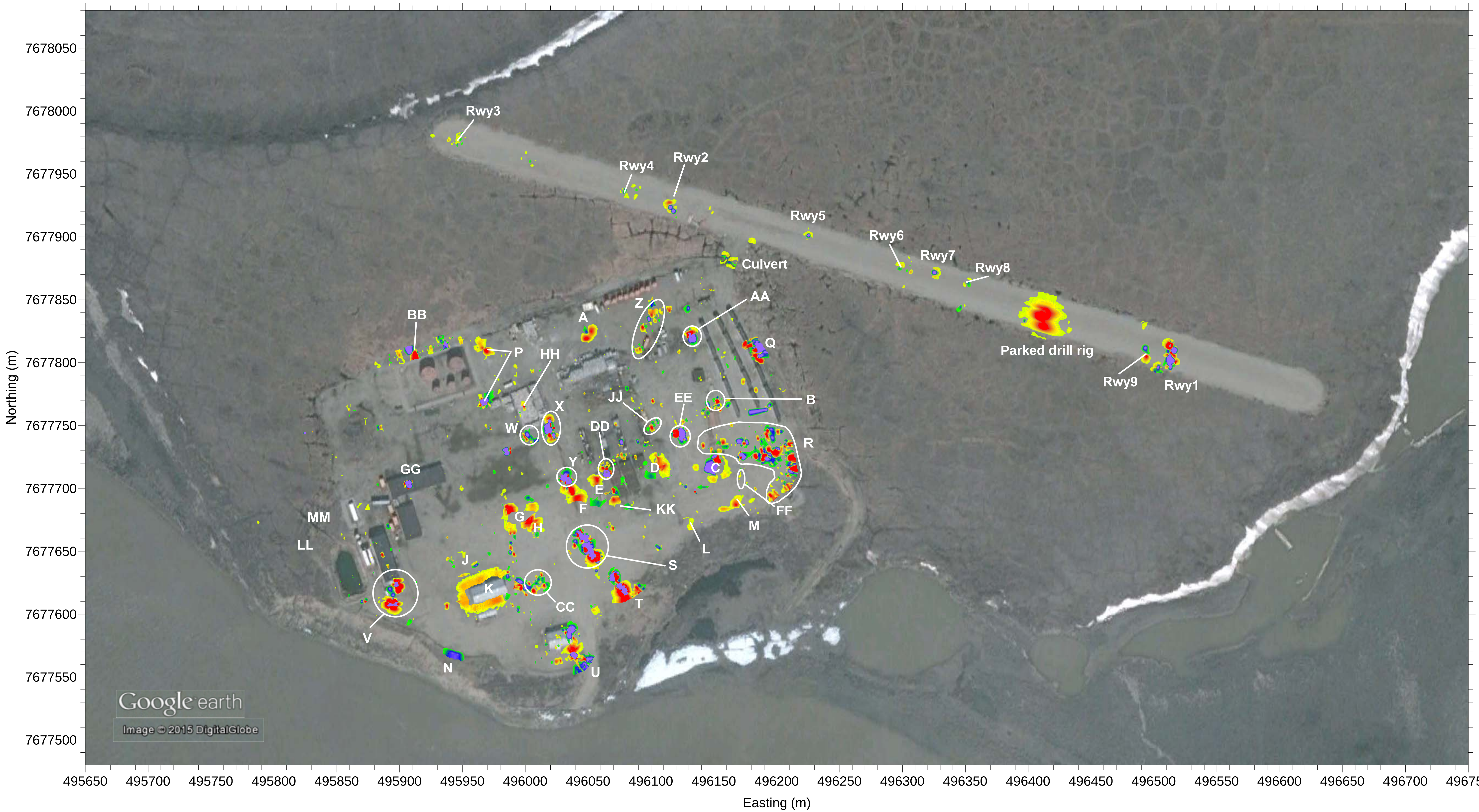
Camp Farewell
Buried Debris Locate

Magnetic Gradiometer
Data Collection Tracks

PROJECT NO.	DWN	CKD	APVD	REV
E11103085-01	CB	RJM	PIF	0

OFFICE	DATE
EBA-EDM	October 16, 2015

Figure 01



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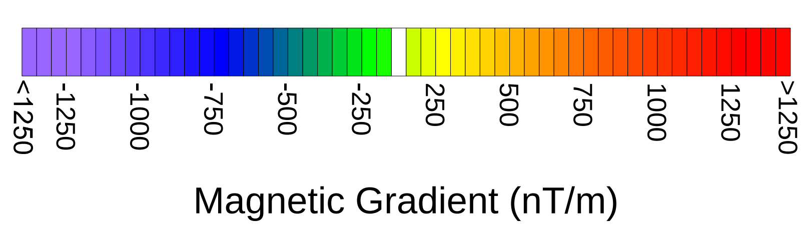

SCALE 1:3,000
NAD83
UTM z8

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Camp Farewell
Buried Debris Locate

Magnetic Gradient Results

PROJECT NO.	DWN	CKD	APVD	REV
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Figure 02

LEGEND

—— EM31 Data Collection Tracks

SCALE 1:3,000
NAD83
UTM z8

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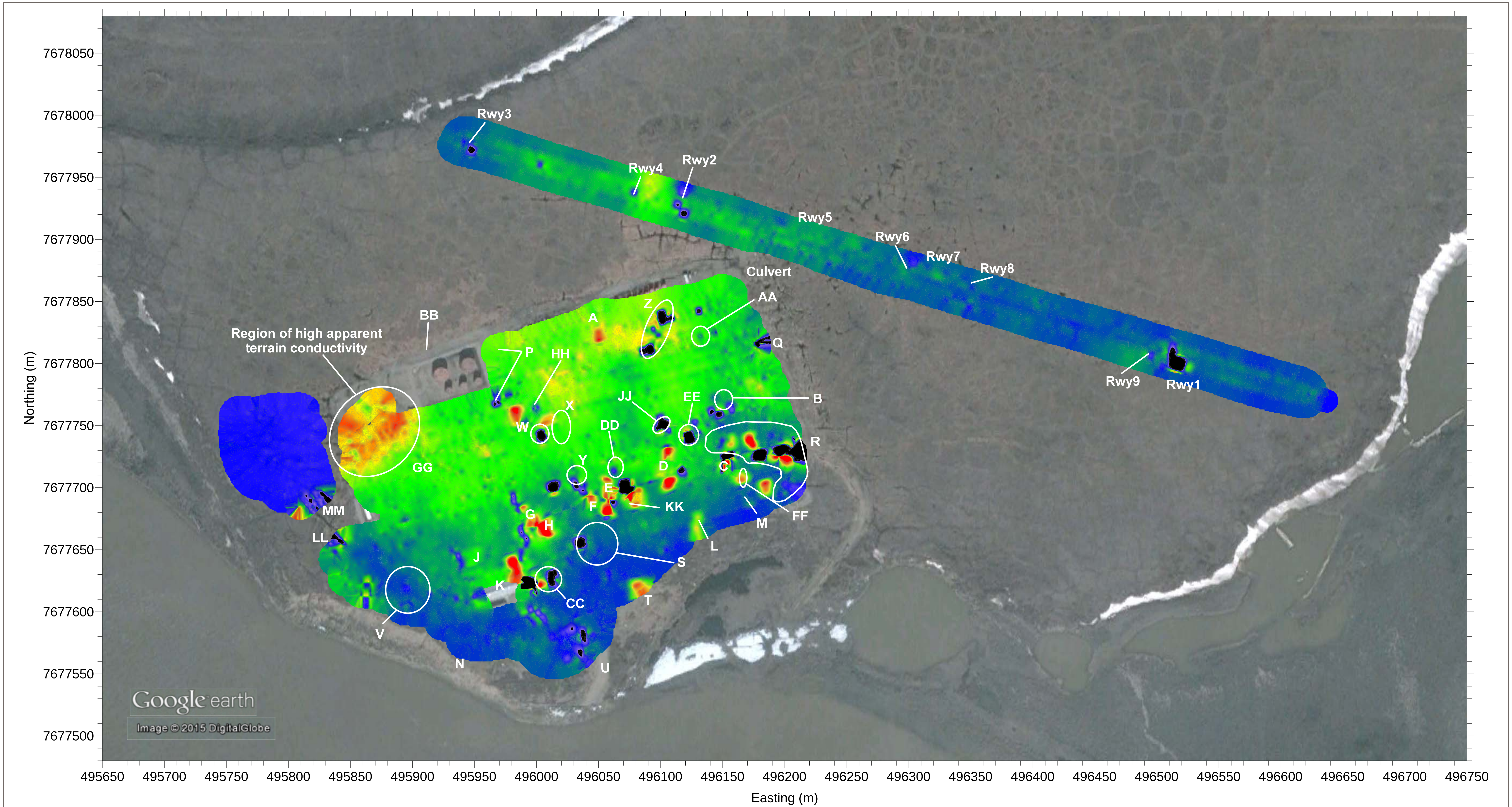
Camp Farewell
Buried Debris Locate

EM31 Data Collection Tracks

PROJECT NO.	DWN	CKD	APVD	REV
E11103085-01	CB	RJM	PIF	0

OFFICE	DATE
EBA-EDM	October 16, 2015

Figure 03



LEGEND

SCALE 1:3,000
NAD83
UTM z8

<0 0 2 4 6 8 10 12 14 16 18 20

Apparent Terrain Conductivity (mS/m)

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Camp Farewell
Buried Debris Locate

EM31 Apparent Terrain Conductivity Results

PROJECT NO.	DWN	CKD	APVD	REV
E11103085-01	CB	RJM	PIF	0

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Figure 04

LEGEND

EM38 Data Collection Tracks

SCALE 1:3,000
NAD83
UTM z8

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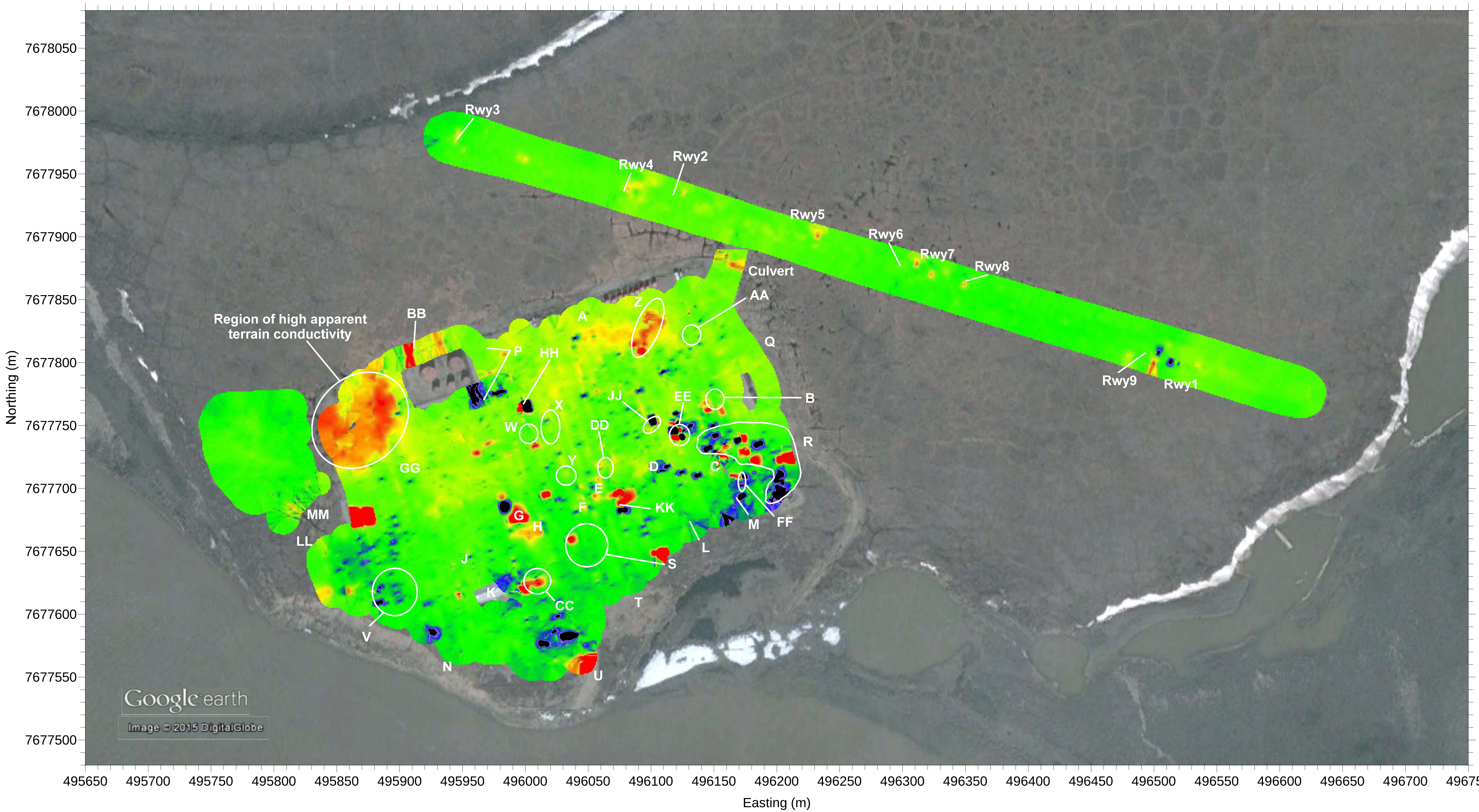
Camp Farewell
Buried Debris Locate

EM38 Data Collection Tracks

PROJECT NO.	DWN	CKD	APVD	REV
E11103085-01	CB	RJM	PIF	0

OFFICE	DATE
EBA-EDM	October 16, 2015

Figure 05



LEGEND

SCALE 1:3,000
NAD83
UTM z8

<0 0 5 10 15 20 25 30 35 40 45 50

Apparent Terrain Conductivity (mS/m)

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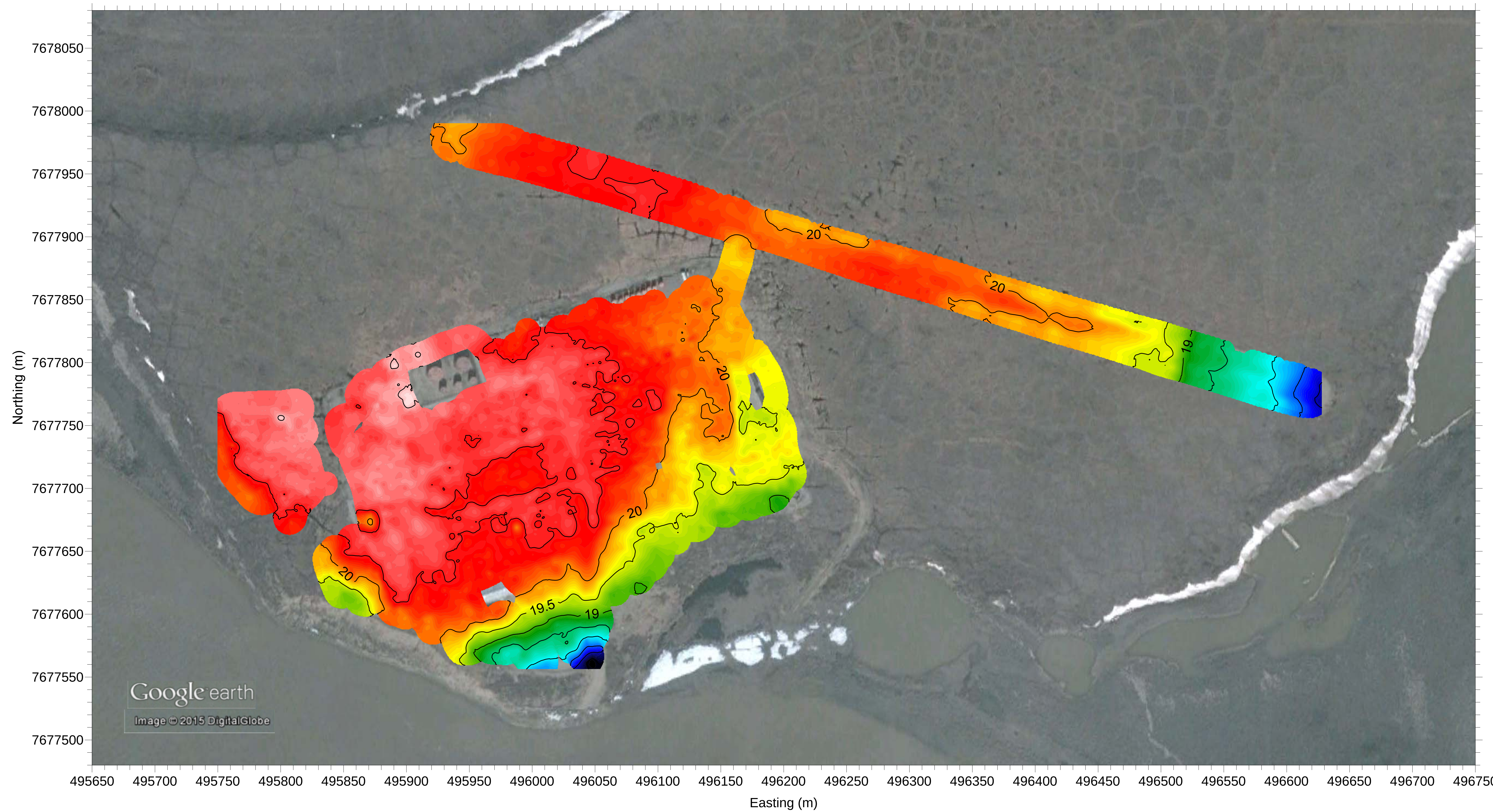
Camp Farewell
Buried Debris Locate

EM38 Apparent Terrain Conductivity Results

PROJECT NO.	DWN	CKD	APVD	REV
E11103085-01	CB	RJM	PIF	0

OFFICE	DATE
EBA-EDM	October 16, 2015

Figure 06



LEGEND

SCALE 1:3,000
NAD83
UTM z8

16.5 17.0 17.5 18.0 18.5 19.0 19.5 20.0 20.5 21.0

CVD28 Elevation (masl)

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Camp Farewell
Buried Debris Locate

Surface Elevation Map

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Figure 07

PHOTOGRAPHS

Photo 1: View of Geophysical Survey setup. All equipment was towed behind the side-by-side, mounted to a non-magnetic and non-conductive wooden cart.

Photo 2: Example of large, highly magnetic objects that were located within the survey area at the time of the survey.

Photo 3: Example of large, highly magnetic objects that were located within the survey area at the time of survey.

Photo 4: Geophysical anomaly EE, post-excavation.

Photo 5: Geophysical anomaly FF, post-excavation.

Photo 6: Geophysical anomaly R, post-excavation.

Photo 7: Geophysical anomaly W, post-excavation.

Photo 8: Geophysical anomaly X, post-excavation.

Photo 9: Geophysical anomaly X, S and T, post-excavation.

Photo 10: Geophysical anomaly Z, post-excavation.

Photo 11: Geophysical anomaly AA, post-excavation.

Photo 12: Geophysical anomaly CC, post-excavation.

Photo 13: Geophysical anomaly CC, post-excavation.

Photo 14: Geophysical anomaly DD, post-excavation.

Photo 15: Geophysical anomaly Rwy1, post-excavation.

Photo 16: Geophysical anomaly Rwy5, post-excavation.

Photo 17: Geophysical anomaly Rwy7, post-excavation.

APPENDIX A
GENERAL CONDITIONS

GENERAL CONDITIONS

GEOPHYSICAL REPORT

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT

This geophysical report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of Tetra Tech EBA’s client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA’s client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report contains figures, maps, drawings and sketches that represent processed geophysical data collected at a specific site. This processed data will have inherent interpretation assumptions and accuracies that are discussed in the report. Consequently, the report can only be considered in its entirety and individual figures, maps, drawings and sketches shall not be distributed without the text of the report unless authorized in writing by Tetra Tech EBA.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA’s instruments of professional service), the Client agrees that only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the project.

Both electronic file and hard copy versions of Tetra Tech EBA’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. Tetra Tech EBA’s instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, Tetra Tech EBA has not been retained to investigate, address, or consider and has not investigated, addressed, or considered any environmental or regulatory issues associated with the development of the site.

4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgemental in nature as to both type and condition. Tetra Tech EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

5.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of testholes and/or soil/rock exposures. Stratigraphy is known only at the locations of the testhole or exposure. Actual geology and stratigraphy between testholes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. Tetra Tech EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

7.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorological conditions; and with development activity. Interpretation of water conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

8.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.