Ground Penetrating Radar Survey of the Jordan Historical Museum

Internment Exploration Study - Thesis Final Report

May 27, 2016

TOWN OF Lincoln

TOWN OF LINCOLN'S JORDAN HISTORICAL MUSEUM

JJT CONSULTING

Niagara College Canada

APPLIED DREAMS.

May 27, 2016
Project ID: 201516-14

Helen Booth (Museum Director)
Jordan Historical Museum
3800 Main Street
Lincoln, Ontario, Canada
L0R 1S0

Dear Ms. Booth,

RE: Jordan Historical Museum – Ground Penetrating Radar Survey

Please accept this letter of formal deliverance for the Jordan Historical Museum – Ground Penetrating Radar Survey Project Final Report.

The objective of this thesis project was to perform a Ground Penetrating Radar (GPR) survey of the lands owned by the Jordan Historical Museum to search for all possible internments and to record subsequent findings. The attached report consists of the final project results. As of **May 27, 2016**, the project is 100% completed, with approximately 903.5 hours expended. The project had a total cost of **$90,228.24**. The cost assumes coverage of labour, rentals and incidentals required for completion of the project. An Electrical Resistance survey was added to the project scope, in turn increasing the required working hours and cost to complete the project goal. After receiving training for the equipment at Western University, the team completed the survey of the museum grounds on May 7, 2016. The data were then processed at Western University. Further analysis, map making, and recording of findings were finalized at Niagara College. A presentation of subsequent findings in the form of a formal report and a presentation is scheduled for **June 1st, 2016**. Despite initial difficulties with the equipment the GPR and Electrical Resistance survey were able to detect possible, interments on the west side of the Fry House.

Should you have any questions or concerns regarding the attached assignment, or if there are any technical issues regarding the document, please feel free to contact me at 647-388-3360 or via email at jess.chan89@gmail.com. We look forward to receiving your comments and advice. Thank you for your time and attention.

Kindest Regards,

Jessica Chan, B.A.
Project Manager/GIS-GM Certificate Candidate
JC/ TV, JJB

CC:	Jonathan Jn Baptiste	Travis Vanos	Ian Smith
	(GIS Analyst)	(GIS Analyst)	(Project Advisor)

Enclosure: Jordan Historical Museum – Ground Penetrating Radar Survey Thesis Report

135 Taylor Rd,
Niagara-on-the-Lake
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Executive Summary

The Jordan Historical Museum currently occupies a parcel of land that once served as a location for a church, a small school, and the historical Fry House, which was built by Jacob Fry in 1815. As historical records indicate, a cemetery has been associated with a former church on the property. While some graves have clear indicators, by means of headstones, the full extent of the cemetery grounds is not known and if any other burials may exist on these grounds. The Jordan Historical Museum, in conjunction with the Town of Lincoln and the Heritage Committee have retained JJT Consulting to conduct Ground Penetrating Radar (GPR), Electrical Resistance, and Total Station surveys of the study grounds to report on the locations of possible internments, and document these possible locations in formal map documents.

This report, serves as the final report on the findings and analysis of the GPR and electrical resistance surveys of the Jordan Historical Museum Grounds. A presentation of the findings and results, open to the public, is to be presented to the client and the Town of Lincoln on June 1st. On June 8th, the presentation will be presented again at the Glendale Campus of Niagara College for public viewing.

The total cost of this project was approximately **$90,229.24.** The budget presented in this report is for ***learning purposes only***; the client is in no way expected to incur these costs. As of May 27, 2016, the project is 100% completed, with approximately 903.5 hours expended. While the initial project budget was estimated to be $46,674.32, JJT expanded upon the original proposal to include an Electrical Resistance survey to supplement the findings of the GPR survey. Sustainable Archaeology and Western University also supplied the Resistivity Meter. While this extra work greatly impacted the original budget estimate in terms of labour commitment, it did not impact the proposed schedule. As a result, the data and the understanding of the possible internments at the study site were greatly increased with this expansion in project scope.

After completion of the survey grounds on May 7th, 2016, the results of the GPR survey were processed at the Western University. These data were analysed and mapped to give a clear understanding of potential internment locations on the museum grounds. After completing the maps, collected data were reviewed and compiled into a report that was submitted to the client for approval. Several areas of interest were found with the GPR. These findings could not always be seen through an electrical resistance survey as the soil content was not altered, and only the GPR wave reflections are highly visible. Evidence exists for a burial area on the premises along the west-side of the Fry house.

The report also includes an explanation of the methodology executed, discussion of results and recommendations for future surveys.

Acknowledgments

The Jordan Historical Museum Ground Penetrating Radar Survey project would not have been successful without the support of:

Helen Booth (Museum & Culture Director), Jordan Historical Museum, Jordan Historical Museum of the Twenty Volunteer Association, Ray Konkle (Volunteer Association Vice-President), and Assad Hoosein (Director) Sport, Recreation & Culture at the Town of Lincoln
Thank you for this amazing opportunity to perform this study on the grounds of the Jordan Historical Museum. Thank you for your financial support, making this project possible.

Ian Smith (Advisor)
Thank you for all your guidance, support, and the amount of time you spent with us. You have taught us so much that cannot be learned in a classroom.

Edward Eastaugh, Sustainable Archaeology, and Western University
Thank you for your endless support and training throughout our surveying period. We could not have done this without your excellent teaching.

Janet Finlay (Thesis Coordinator)
Thank you for matching us to this phenomenal project, the experience and knowledge we received cannot be measured.

Alan Unwin (Associate Dean Environmental and Horticultural Studies), Shannon Collison (Administrative Assistant of the School of Environmental and Horticultural Studies), and Niagara College
Thank you for all of the support including the provision of the surveying equipment and the incredible opportunity to partake in this thesis project.

Niagara College GIS-GM Classmate Volunteers
Thank you to all our fellow classmates who helped us with our GPR data collection - Paresh Parikh, Oreva Oputeh, Alice Lin, Kelly To, Felicitas Hockton, Matt Mort, Brent Matthew, Shannon Millar, and especially Mark Wilkinson who helped us over many days.

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TOWN OF LINCOLN'S JORDAN HISTORICAL MUSEUM

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1.0 Introduction

The Jordan Historical Museum, located in the Town of Lincoln, was established in 1953 and currently occupies a plot of land that once served as a location for a church (Booth, 2013). The grounds house several structures including an administrative building, small school and the "Fry House", which is a European style Mennonite home built by Jacob Fry in 1815.

The project investigated by means of Ground Penetrating Radar (GPR) and Electrical Resistance survey, whether there were any potential unmarked internments and mapped their location locations using Geographic Information Systems (GIS).

1.1 Challenge/Problem Statement

The Jordan Historical Museum has the intention of redeveloping the museum site with the addition of a building expansion/addition known as the Lincoln Heritage Gateway. There has always been some level of uncertainty regarding the extent of the burials at the Museum grounds. No known burial records for the Mennonite church, now occupied by the Fry House exist. That lack of knowledge raised concerns over the possibility of burials extending beyond what is thought to be the boundaries of the Mennonite cemetery.

1.2 Study Area Delineation

The survey area consisted of the museum grounds around an administrative building, the "Fry House", which was moved to its present location atop the former church building, as well as a pre-existing Mennonite cemetery. Although known tombstones and grave markers are present on the cemetery grounds, the Town of Lincoln, Jordan Historical Museum and Heritage Committee members sought to conduct a survey of the premises to identify potentially unmarked burial/internment locations. The Ground Penetrating Radar (GPR) survey was conducted within the area of interest, as seen in Figure 1 below showing the area of interest for this project. Additionally, an Electrical Resistance survey was added to cover the museum grounds with a high potential for interment locations, as seen in Figure 2.

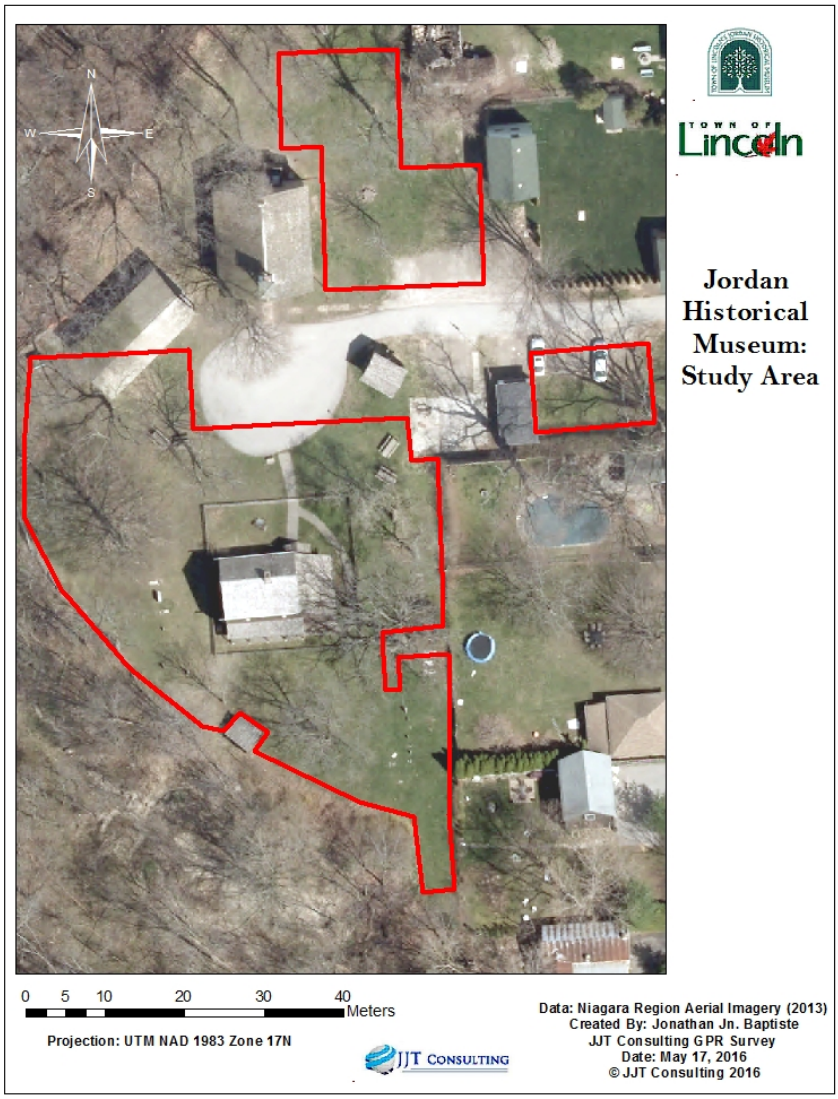

Figure 1 - Map of the Study Area

Figure 2 - Jordan Historical Museum Resistivity Meter Survey Area

1.3 Project Goal & Objectives

The initial project goal was to conduct a Ground Penetrating Radar (GPR) survey with the purpose of detecting possible human burial sites within the Jordan Historical Museum grounds and map points of interest using available Geographic Information Systems (GIS). After equipment procurement was negotiated with Sustainable Archaeology and Western University, it became apparent that the project could be easily expanded to include an Electrical Resistance survey with no impact upon the 'real' project budget (equipment rental), but with a simple increase in time allotment. Given the benefit of using a second non-intrusive sensing technology, it was decided to expand the project scope to include the use of the Resistivity Meter.

1.3.1 Using GPR to detect internments

The use of the GPR enabled the project team to determine potential burial locations in the spring, after the snow melted, as operating in snowy and icy grounds was not feasible.

1.3.2 Mapping potential internment locations with GIS

Potential burial locations were determined through the GPR survey, combined with a Total Station used to capture the accurate locations of these sites. Map layouts were ultimately created using the GPR survey and Total Station results to reveal all potential burial locations.

1.3.3 Using a Resistivity Meter to aid with the GPR survey

Given the uncertainty of internments and their locations due to the age of the cemetery grounds, as noted above, the project scope was expanded to include the use of a Resistivity Meter was in conjunction with the GPR to help verify and detect possible burials.

2.0 Background

2.1 Museum History

The Jordan Historical Museum is located in the town of Lincoln, overlooking the Twenty-Mile Creek Valley. It was established in 1953 and began as a collaborative effort between Jordan Wines, previously called Danforth Wines Ltd., and the residents of Jordan Village, some of whom are descendants of the Pennsylvania German Mennonites. (Booth, 2013)

The Mennonites began arriving in Canada around 1776. They are a religious group established in Germany in the 16th century, when some Christians separated from the Roman Catholic Church because they viewed certain principles differently and had different beliefs. Their main issue was that they believed that infants should not be baptized and that baptism should be a mature, voluntary choice; hence their movement was termed Anabaptists. (Driedger & Epp, 2015)

Jacob Fry moved from Pennsylvania to Canada around 1800, first settling in Grimsby. He later moved to be closer to other Mennonite families who had settled in Vineland, a community within the Town of Lincoln. The Fry House was built in 1815. Jacob Fry and his family lived in this house until 1895 when a new brick home was built for the family a few yards away. (Booth, 2013) Figure 3 below depicts the Fry House in its current location:

Figure 3 - The Fry House in its Current Location (Source: Jonathan Jn. Baptiste)

The museum grounds are believed to contain a Mennonite Cemetery, which was once associated with a Mennonite Church which was destroyed by a fire. The old Fry House was moved from its original location and restored on the grounds where the Mennonite church once sat in the 1950s (Town of Lincoln, 2015).

The grounds of the Jordan Historical Museum are also home to other structures that tell a tale of the Mennonites and their lifestyle. The school house was built in 1895. It was used for 89 years until a more modern school could be constructed. The old school was restored in 1997, and is currently used as part of the museum's tours, which allows visitors to experience what it was like to be in school in the 19th century.

The Administrative Building or Heritage House is used to showcase all aspects of the town's history, including traditional Pennsylvania German folk art. It also houses a research library open to the public. However, in order to access archived material, an appointment needs to be made through the museum staff (Town of Lincoln, 2015), (Ontario Museum Association, 2015).

2.2 Literature Review

A literature review was undertaken to scope this project (Chan, Jn Baptiste, & Vanos, 2015).

The team examined previous studies on the effectiveness of using GPR to locate human burials. Both Schultz and Martin used adult pig burial to symbolize adult human burials as they are roughly the same shape and length (Schultz, 2008-2012), (Martin, 2010). These studies were observed under a controlled environment with the pig bodies buried in a grid system in graves that ranged from 0.5 to 1 meter deep. Schultz determined that a lower GPR antenna frequency (250MHz) was better than a higher frequency (500MHz) for locating results in soils that were wet (Schultz, 2008-2012).

Martin found in his study that pig carcasses buried in denser soils, such as clay, became more difficult to image with GPR after six months (Martin, 2010). Martin also confirmed that the 250MHz antenna frequency was better than the 500MHz frequency for surveying burials. "… the 250-MHz antenna provided better resolution of the burial scenarios than the 500-MHz antenna due to easier discrimination of the forensic targets. Therefore, the use of a 250-MHz antenna would be a viable option to search for clandestine burials containing adult-sized bodies." (Martin, 2010) In addition, the lower frequency detected fewer anomalies than the higher frequency GPR unit.

Other research studied the combination of GPR frequencies with different types of soils, giving insight into different soil types and their effects on study areas (Mohamed Metwaly, 2007). Metwaly found that the density, texture, and moisture content of the soil would yield different results with different radar frequencies (Mohamed Metwaly, 2007). In particular, higher frequencies worked better with soils that had a low clay percentage, and that a lower frequency would be suggested for soils with more clay content.

Using resistivity meters to find graves has also been practiced by many archaeologists as it is a non-intrusive and efficient method of detecting graves. "It can give an idea of whether the soil disturbances are deep or not" (Whittaker, 2015). It should be noted that the soil type and strata will greatly affect the success of the results as it does with GPR surveys; each cemetery can yield different results. For example, in one cemetery, a high resistance indicated graves, while in another, lower resistance provided results for the locations of graves (Bevan, 1991). A study of a mass burial in Saipan found that conductivity meters were better than GPR as locating differences of soil, stones, and tree roots (Doolittle & Kashko, 1990). Weymouth and Jensvold's study of a 1905 Wyuka Cemetery in Lincoln, Nebraska found that soil moisture content can greatly affect results. They noted the importance of using pre-existing grave markers to help differentiate the results of a grave and undisturbed soil (Weymouth & Jensvold, 1996). All literature research indicated that although resistivity meters are useful in aiding the location of burials, a GPR survey typically yields better results.

Archaeological sites that have trees on site are not only affected by the type of tree, but also by the tree roots and the tree coverage. Tree roots affected the soil acidity, texture, and moisture detainment (Crow, 2004). In his study, Crow noted that while tree roots often affect archaeological sites, most roots were removed without documentation and it was unknown how severe the damage may be in some cases.

The study area is dominated by the species of tree known as Black Walnut (*Juglans nigra*). Black walnut trees grow in fertile, lowland soils with high water tables, and Mennonites often settled in areas with black walnut trees. The nuts of the black walnut tree are edible, and the wood is known to be very durable. The roots, nut husks, and leaves secrete a toxin known as juglone, a respiratory inhibitor to other plants; it does not affect humans (Leuty, 2012).

2.3 Sustainable Archaeology

After contacting numerous equipment rental agencies, Sustainable Archaeology was chosen for the rental of both the GPR and resistivity meter instrumentation. Sustainable Archaeology is a collaborative initiative between Western University and McMaster University, funded by the Canadian Foundation for Innovation (CFI) and the Ontario Ministry of Research and Innovation (Ontario Research Fund) (Sustainable Archaeology, 2016). Mr. Edward Eastaugh, the primary contact for Sustainable Archeology, is based at the Western University.

The instruments were rented for 14 calendar days. After the surveys were completed, geoprocessing and digital analysis were performed at the lab at the Western University. Throughout the surveying process, Mr. Edward Eastaugh corresponded with the team regularly and greatly helped with the troubleshooting process (which will be further discussed in 7.0 Challenge Management).

3.0 Geophysical Exploration Methodology

The study consisted of a Ground Penetrating Radar (GPR) survey and an Electrical Resistance survey with the purpose of detecting and mapping possible human burial remains. Instrumentation was procured for 14 calendar days. The data were collected over the course of a 3-day period, see 7.0 Challenge Management. The short time frame reduced the effect of the environment and weather uncertainties on the survey. A single operator conducted the GPR survey, and a single operator conducted the Resistivity Meter survey for data collection consistency.

3.1 Grid Preparation

Using fiberglass tape measures and survey markers, 10 m by 10 m square grids were measured and marked referencing a pre-existing fence to ensure best grid orientation for maximum coverage. Data were collected in an area of 1,800 m^2 with 10 m by 10 m grid squares for electric resistance. GPR data were collected across the entire grounds (2,677 m^2) in the same 10 m by 10 m numbered grids as often as allowed, modified out of necessity for avoiding large obstacles such as the walnut tree seen in Figure 4.

Figure 4 - Large Black Walnut Tree on East Side of Premises (source: Travis Vanos,, May 2016)

3.2 Ground Penetrating Radar

A Ground Penetrating Radar (GPR) survey was completed over the total 2,677 m² of suitable terrain. The GPR unit consisted of a GSSI's SIR-3000 system and a 400 MHz antenna mounted to a three-wheeled survey cart (see Figure 5). The original tow-cart (seen in Figure 7) with single survey wheel proved faulty and was replaced with the functioning push cart configuration (See 7.1 Equipment for a full discussion). Given the content of the soil, a 400 MHz antenna was used, which allowed the best signal penetration. A total of 31 grids were marked, arranged and traversed in either a north to south or east to west direction, depending on the traverse direction that would allow for the fullest or most accurate coverage of the museum grounds.

Figure 5 - Jessica Chan of JJT Consulting using GSSI's SIR-3000 Cart System (source: J Jn. Baptiste, May 2016)

Whenever possible, grids were surveyed in the established 10 m by 10 m grid squares that were also used for the resistivity meter survey. This was completed to facilitate the process of analysing the data and correlating potential burial locations detected with both instruments. However, due to large obstacles

and narrow areas, some additional grids were added to maximize coverage and prevent null data (Figure 6).

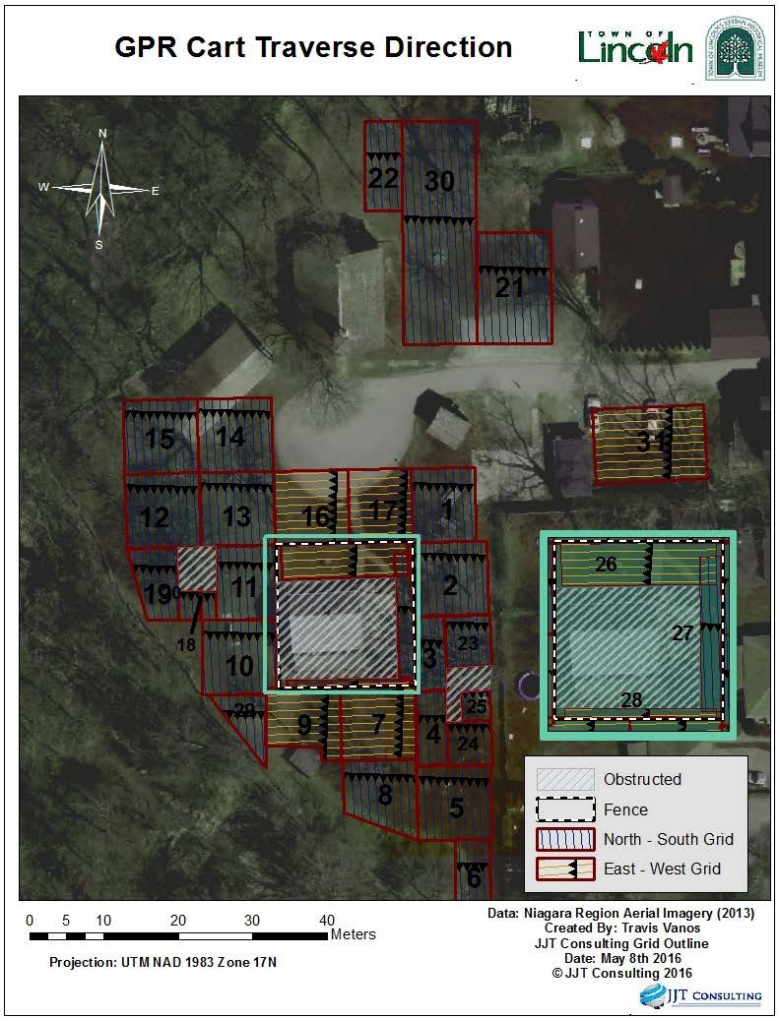

Figure 6 - Traverse Direction of Ground Penetrating RADAR Survey

Data were collected in linear transects at 25 cm intervals resulting in 41 transects per 10 m by 10 m grid (see Figure 7). When possible, grids were walked in a north to south direction to best detect burials that would be east to west facing, typical of Christian burials.

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Figure 7 - Typical 10 m by 10 m Grid with 25cm Transects

The depth of any discovered anomalies were estimated by the amount of time (in nanoseconds, nS) pulses from the GPR antenna took to travel through the medium given the Dielectric Constant of the soil medium. The time length between transmitted pulses is called the "Time Window", T_w, or the total travel time, two-way, the pulse travels to the reflectors and back (Basson & al., Imaging of active fault zone in the Dead Sea Rift: Evrona Fault Zone as a case study, 2002).

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> "When converted to depth, the time window limits the maximum depth (or maximum range) of acquisition in the GPR profile. The transect depth profile, D, can be calculated as half of the time window, T_w, multiplied by the average propagation velocity, v, of the pulse inside the geological media (i.e $D \sim 0.5\, T_w\, v$)." (Basson & al., Imaging of active fault zone in the Dead Sea Rift: Evrona Fault Zone as a case study, 2002; Basson, Mapping of Moisture Content and Structure of Unsaturated Sand Layers with GPR, 1999).

After a thorough literature review was completed to provide the most accurate depth estimation, the area was deemed to have a dielectric constant of 8 to estimate the depth of points of interest (Davis & Annan, 1989).

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3.3 Resistivity Meter

To supplement the results of the GPR survey, an Electrical Resistance survey was added to the project scope, covering 1,800 m^2 of the museum grounds that were deemed to have a high potential for unmarked burials. Similar to GPR, Electric Resistance surveys are a non-destructive, non-intrusive technique for detecting burial shafts (Ellwood, 1990). The resistivity meter was used to detect the disturbances in soil by measuring the changes, in ohms (Ω), in electrical current/flow through the soil medium. Packed soil and grave soil resist electricity differently since they hold dissimilar moisture contents and thus are distinguishable from the surrounding undisturbed earth (Whittaker, 2015). Disturbed soils tend to have a higher moisture content, and therefore a lower resistance (Ohio Valley Archaeology Inc., 2016). Therefore, the resistivity meter was a great asset in correlating possible burial locations found in the GPR survey.

The survey was completed using a Geoscan Research RM 15 electrical resistance meter in twin-probe configuration. The mobile probes were spaced 50 cm apart and the distance from the remote probes was greater than 10 m at all times. A 40 volt (V) supply was used to apply a constant 1 milliamp (mA) current to the mobile probes. Data were collected in linear, north to south transects at 50 cm intervals resulting in an over-all sample density of 4 samples per square meter.

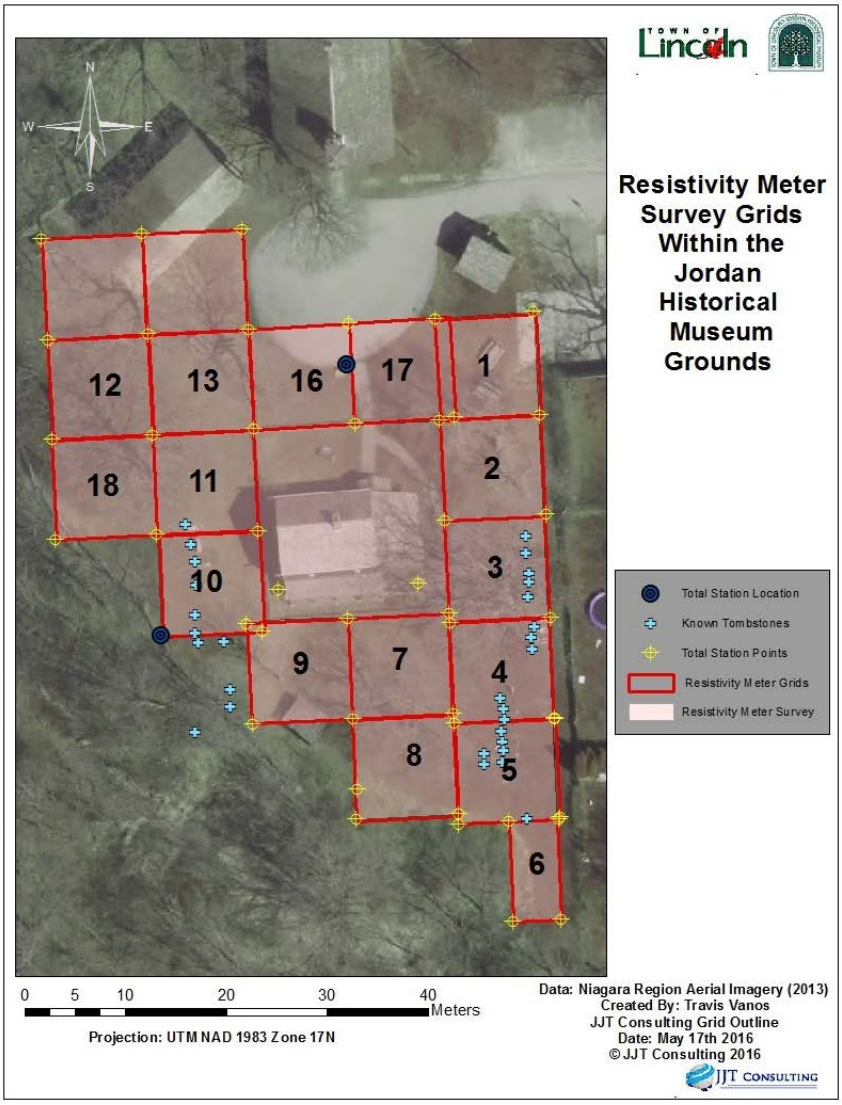

Figure 8 - Total Station Locations in Relation to the Resistivity Meter Grids

3.4 Geo-referencing and Ground Truthing

Using geo-referenced 2013 aerial imagery of the Lincoln/Jordan area (geographically correct to 0.10 metres on the surface of the Earth), a backsight was established for a topographic survey using an electronic Total Station. The Total Station survey (TSS) was conducted for geo-referencing surface features and testing (or "ground truthing") subterranean anomalies detected through GPR and resistivity meter surveys. Several control points were established of large surface features, visible in aerial imagery to ensure positional accuracy with the total station before commencing survey.

After positional accuracy was validated, the co-ordinates of each 10 m by 10 m grid corner was recorded with the total station and imported into ArcGIS as seen in Figure 8, above.

For GPR ground truthing, flat surface tombstones (see Figure 9, below) with coordinates captured using the Total Station were surveyed and then overlaid on the aerial imagery to validate accuracy with the GPR cart

Figure 9 - Known tombstones on the study grounds

. Figure 10 shows the known coordinates of surface tombstones in reference to GPR imagery.

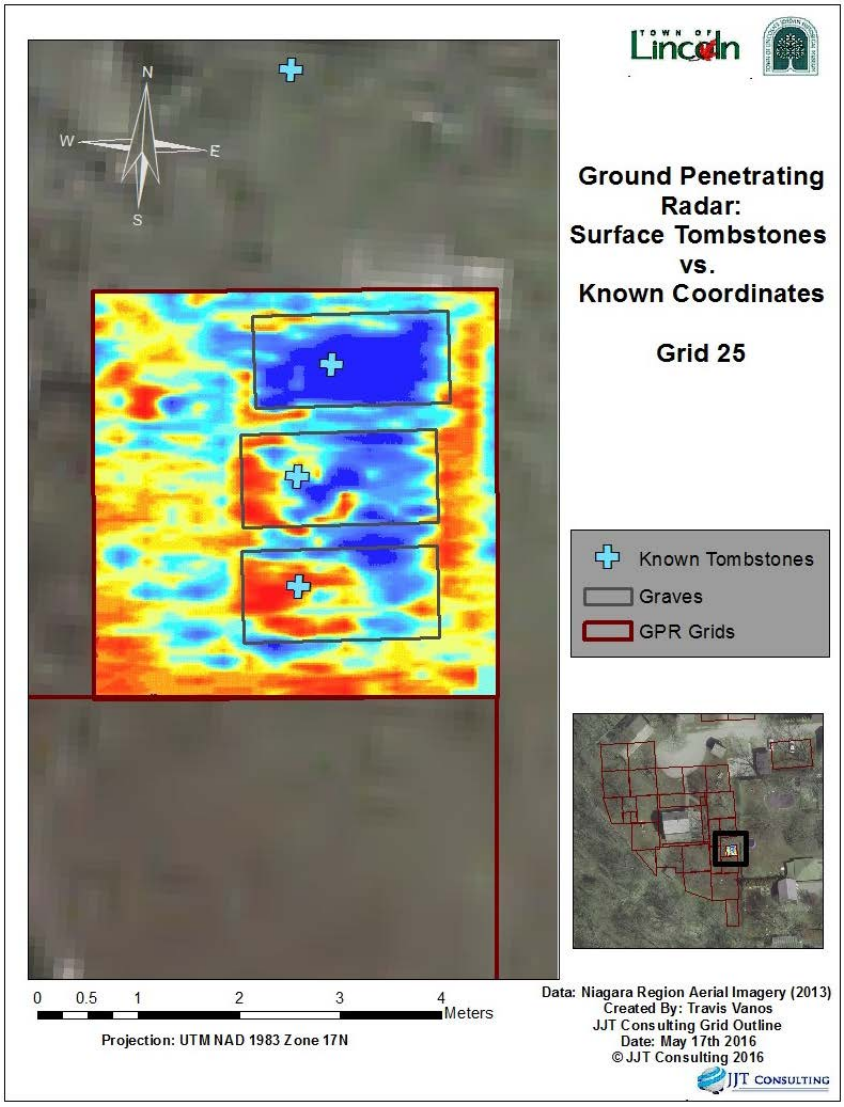

Figure 10 - Surface Tombstones vs. Known Coordinates

3.6 Data Analysis and Required Resources

The GPR survey provided data within individual files that were then processed with GSSI's RADAN 6.0 software for rendering and analysis. The resulting data consisted of a Radargram profile captured for each transect in a two dimensional (2D) JPEG (.jpg) format. An entire grid was then viewed in a single, continuous 2D profile that concatenates transect profiles onto the previous in numerical order, see Figure 11.

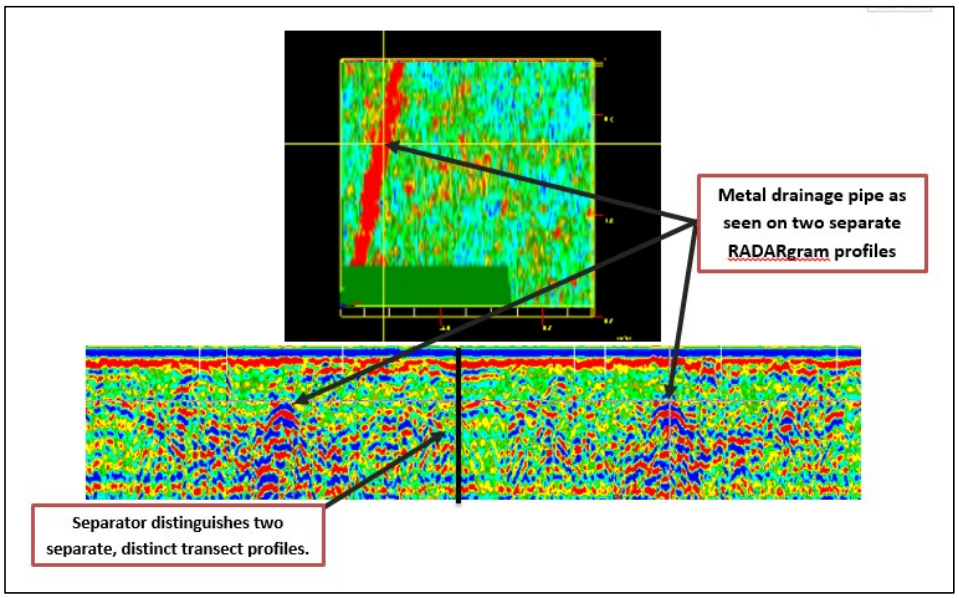

Figure 11 - GPR readings as seen in RADAN 6.0

It was not until all transects in a grid were processed and merged three-dimensionally that patterns and anomalies would be visible and fully understood.

Using a known, highly reflective subterranean feature, one can affirm GPR accuracy and ground truth anomalies. A possible drainage pipe on the premises was used as an identifiable feature that displays the accuracy of the transects as seen in Figure 11, above.

After processing, a 3D rendering of a grid was explored through the X, Y and Z (depth (nS)) data. Exploring the data, anomalies were seen and referenced to the correct transverse (or "slice") that passed the area of interest. Disturbed soil is distinguishable from the surrounding earth as seen in Figure 12.

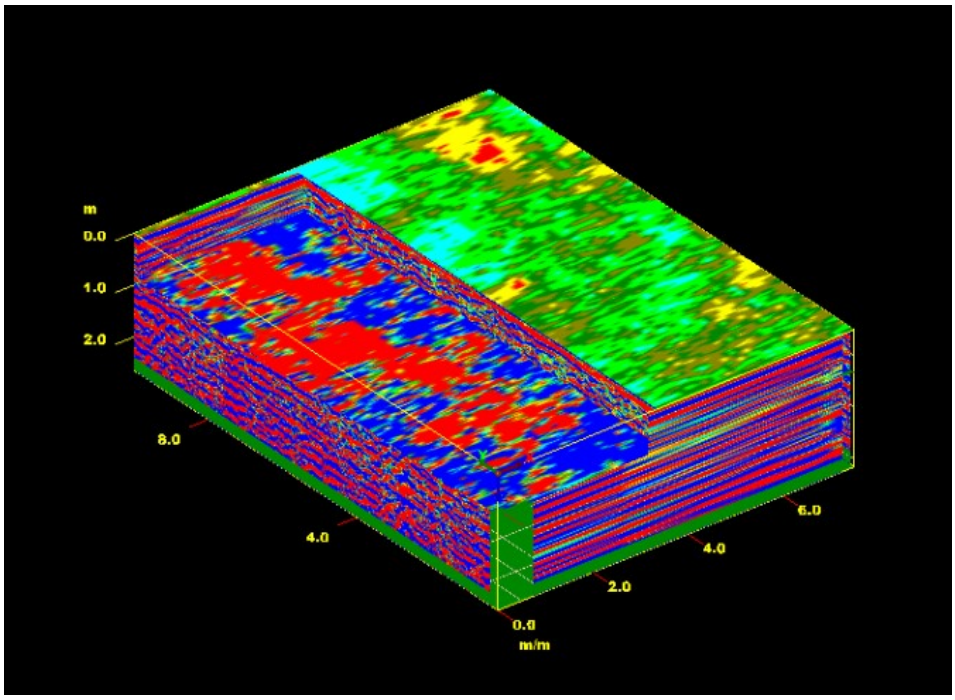

Figure 12 - Disturbed soil at approximately 1m

Disturbed soil could be seen at an approximate depth of 1 m which coincided with the expected burial depth of that era.

3.6 Resistivity Meter Data Analysis

After the resistivity meter survey was concluded, the data could not be analysed until they were extracted using the software provided at Western University. The information was uploaded successfully and each 10 m by 10 m grid was then saved as a greyscale JPEG with a resolution of four samples per 1 m^2. The resulting images were then mosaicked together to for the final result to show the clear pattern of burials on the west side of the museum grounds (see Figure 13, below).

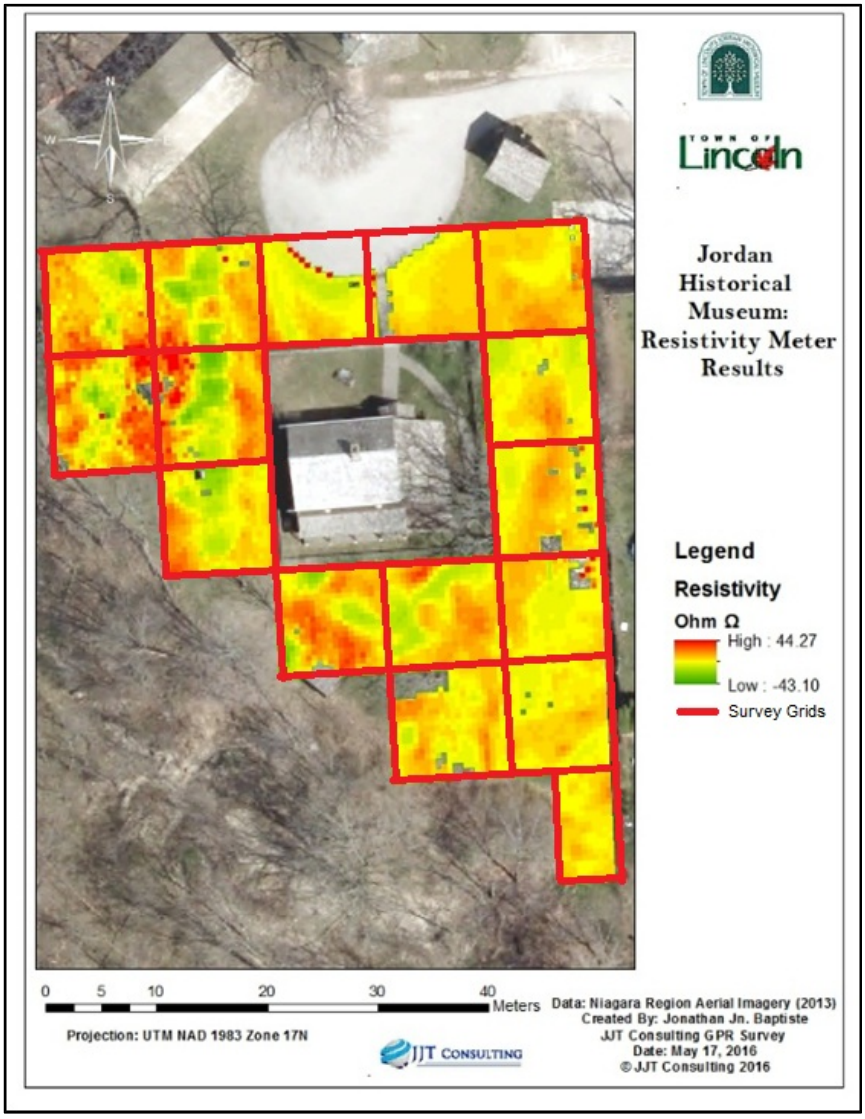

Figure 13 - Mosaicked resistivity meter results

4.0 Results and Analysis

4.1 Post Survey Data Processing

The results of the GPR and Resistivity Meter surveys were georeferenced onto the study area map to help create an understanding of the survey. The GPR results were catalogued at four different slices of time to showcase the museum grounds at different set depths of strata. Table 1 shows the approximate wave penetration time in nanoseconds (nS) and depths (m) at which the GPR data were sampled.

Table 1 - Approximate nanosecond to depth penetration comparison

Approximate Nanoseconds (nS)	Approximate Depth (m)
10	0.5
20	1.0
30	1.5
40	2.0

Figure 14 to Figure 17 represents the GPR results at 10 nanosecond intervals from approximately 10 nanoseconds through to 40 nanoseconds.

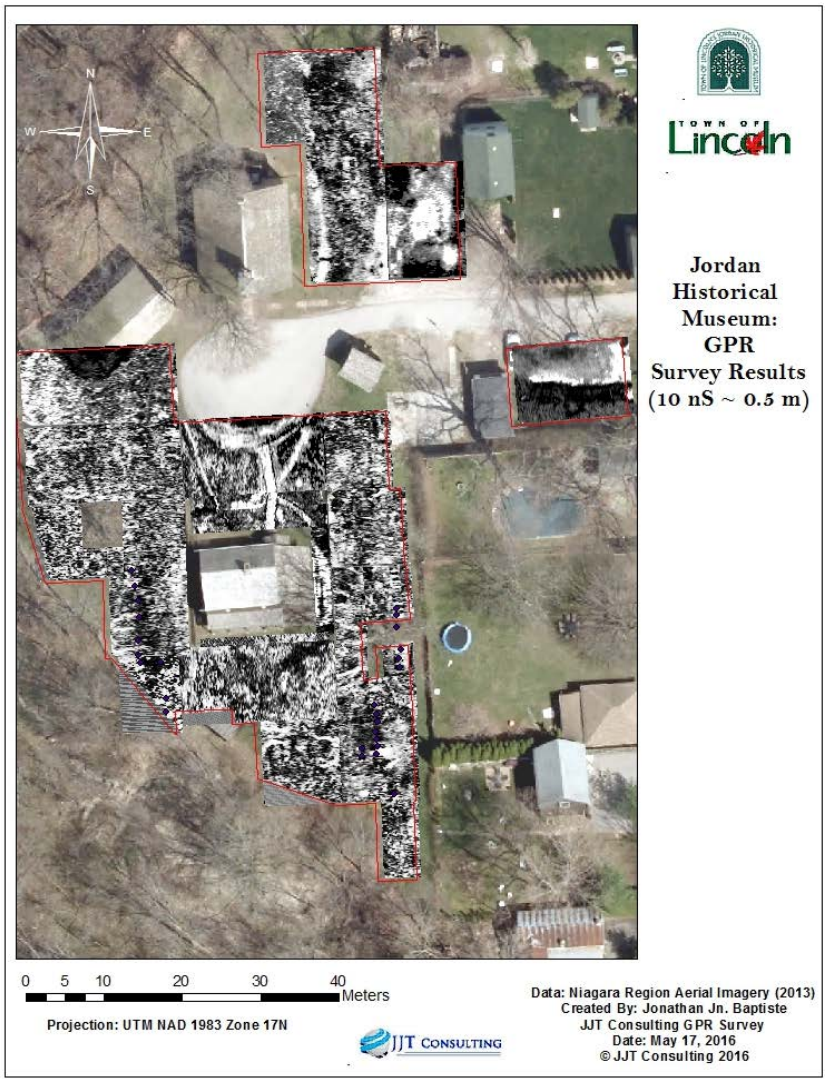

Figure 14 - GPR Survey Results at Approximately 10 Nanoseconds

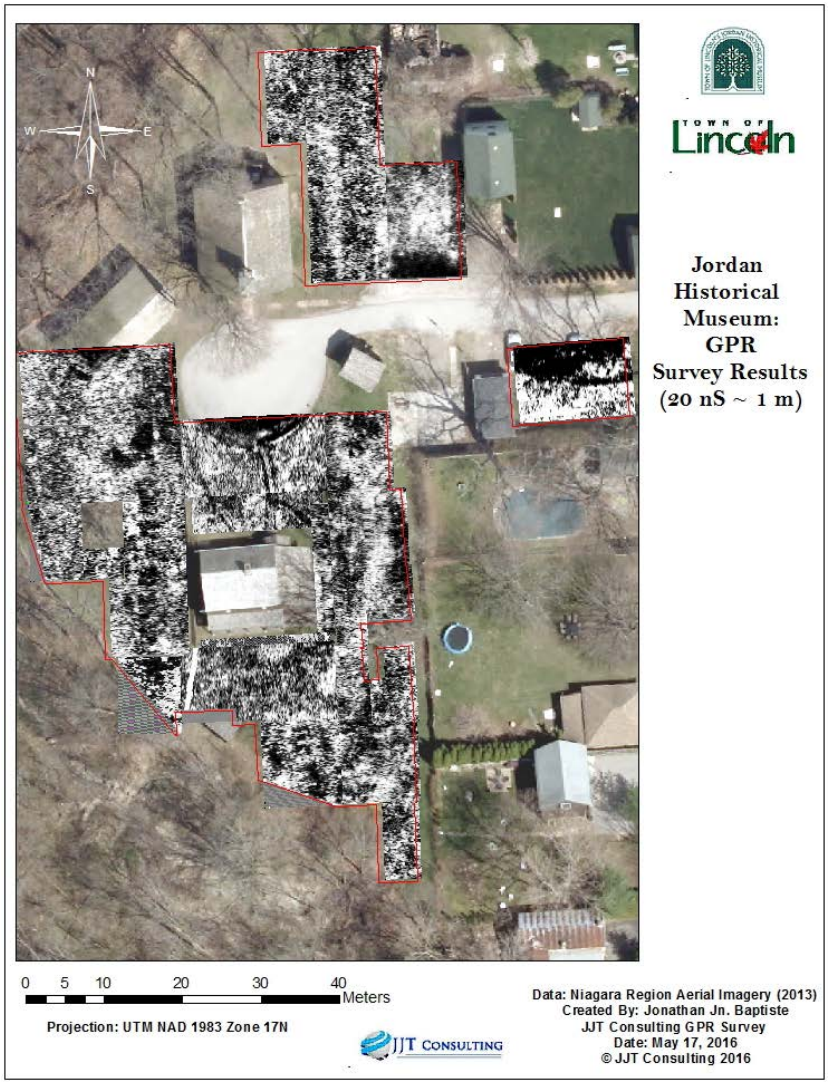

Figure 15 - GPR Survey Results at Approximately 20 Nanoseconds

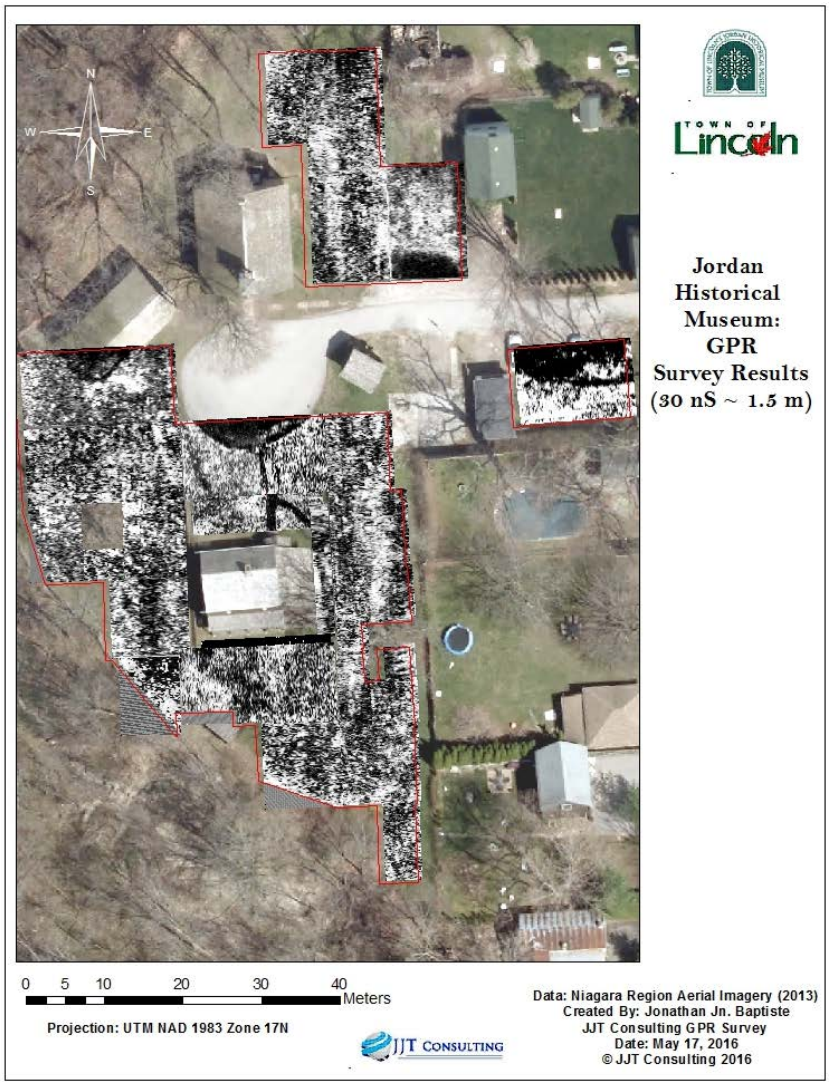

Figure 16 - GPR Survey Results at Approximately 30 Nanoseconds

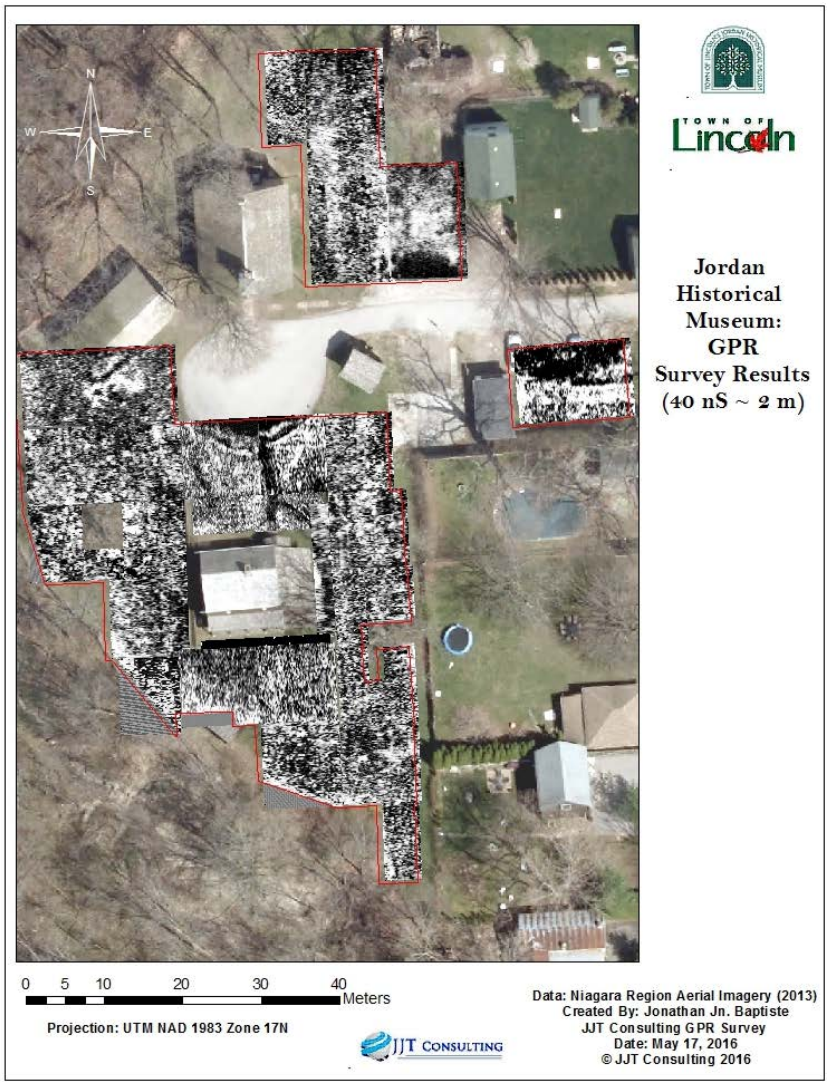

Figure 17 - GPR Survey Results at Approximately 40 Nanoseconds

After this set of maps was created, specific points of interests that were noted during the data processing were investigated further. These points of interest were also mapped according to their grid's geographic coordinates. A more in-depth discussion of these points of interest with corresponding maps can be found in 4.2 Discussion and Summary of Results and Findings.

The results of the Resistivity Meter were relatively straightforward, showcasing the electrical resistance measured in ohms (Ω). Therefore, a single map layer was produced. The map showing the results of the Resistivity Meter survey can be seen below in Figure 18.

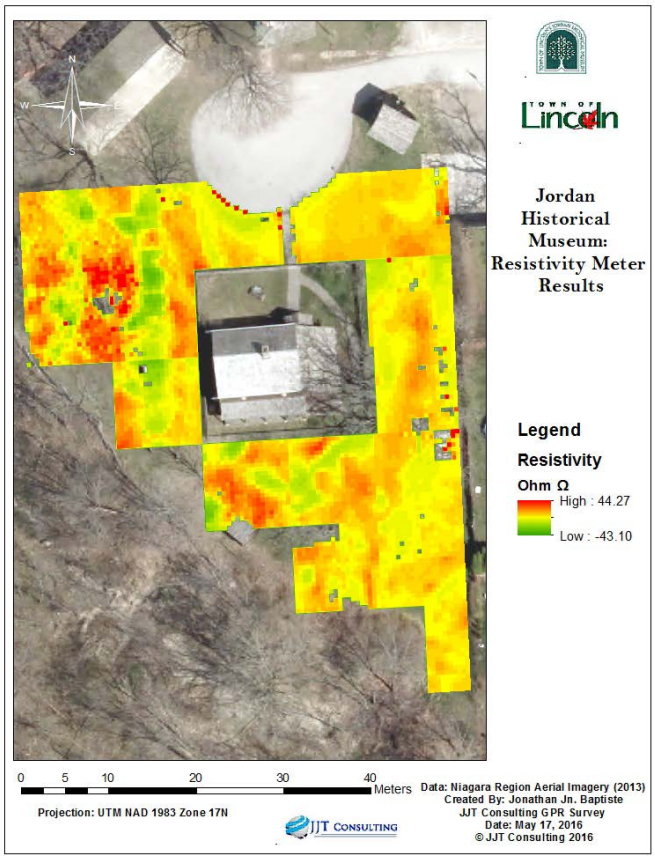

Figure 18 - Resistivity Meter Results

4.2 Discussion and Summary of Results and Findings

Findings are discussed in specific areas within the study site:

Area west of the Fry House outside its surrounding fence: It is known that there are a number of pre-existing tombstones in a relatively regular line (north-south) all facing the east-direction. Using both the GPR and the resistivity meter, a series of underground anomalies were discovered lined up in a similar fashion to the pre-existing graves. These subterranean anomalies appear regularly and extend north towards the cul-de-sac pavement area and south towards the south side of the building. The shapes of these underground anomalies are approximately 1 m by 2 m, which are similar to the known dimensions of regular burials. These anomalies can be seen at approximately 10 to 30 nanoseconds (roughly 0.5 m to 1.5 m in depth), but are clearest at about 20 nanoseconds (~1.0m in depth). This corresponds with the results of Schultz's study of pig burials buried at 0.5 m to 1.0 m depths (Schultz, 2008-2012). Please see Figure 19 for a comparison of the GPR and resistivity meter results of the same area. The possible internment locations based on the GPR imagery can be seen in Figure 20.

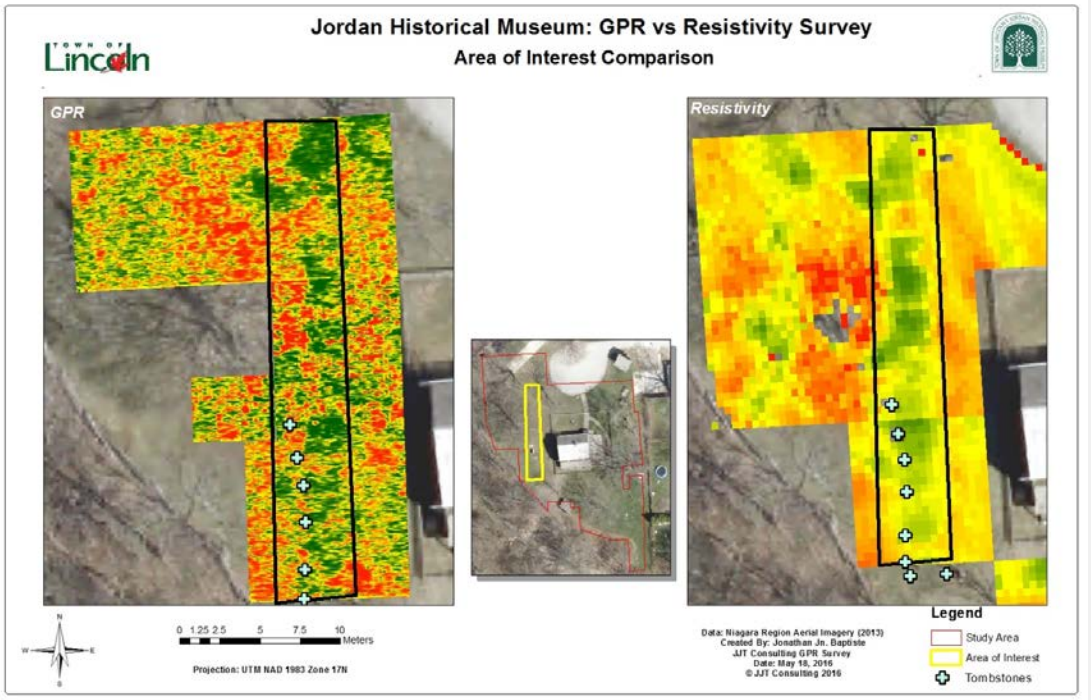

Figure 19 - Comparison of GPR and Resistivity Meter results of the area immediately east of the Fry House

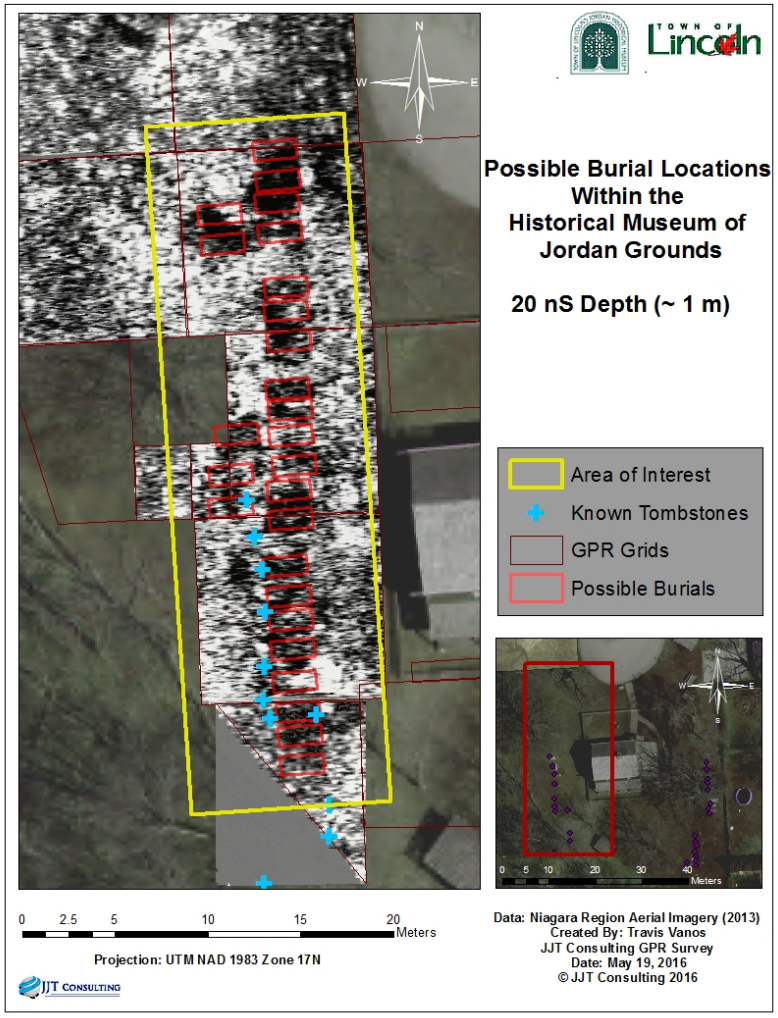

Figure 20 - Possible Burial Locations within the Historical Museum of Jordan Grounds - West side

Additionally, a tombstone was located in the cliff side approximately 10 m south of the previously discussed row of anomalies. It is possible that there may be unmarked interments that continue from the

row of irregularities all the way to the tombstone. Figure 21 shows a picture of the tombstone set into the cliff side.

Figure 21 - Tombstone set into the cliff side

The map in Figure 22 shows the location of the tombstone in the cliff side relative to the anomalies previously discussed in this section.

Figure 22 - Location of the tombstone on the cliff side

Area immediately north of the Dr. Bowman tombstone north of the Fry House: Although the GPR signal was weakened by the pavement of the cul-de-sac, the GPR was able to detect an anomaly at approximately 10 nanoseconds (~0.5m in depth) north of the marker. The size of this subterranean irregularity is about 2 m by 3 m. Although the size of this area is larger than normal burials (they are usually about 1 m by 2 m in size), due to the proximity of this anomaly to the known marker, it is highly likely that this shape is also an internment of its own. It should be noted that the resistivity meter was unable to detect this anomaly and the results showed that the resistivity of this area to be generally the same as the immediate surrounding area. The map in Figure 23 illustrates the area of interest beside the Dr. Bowman marker.

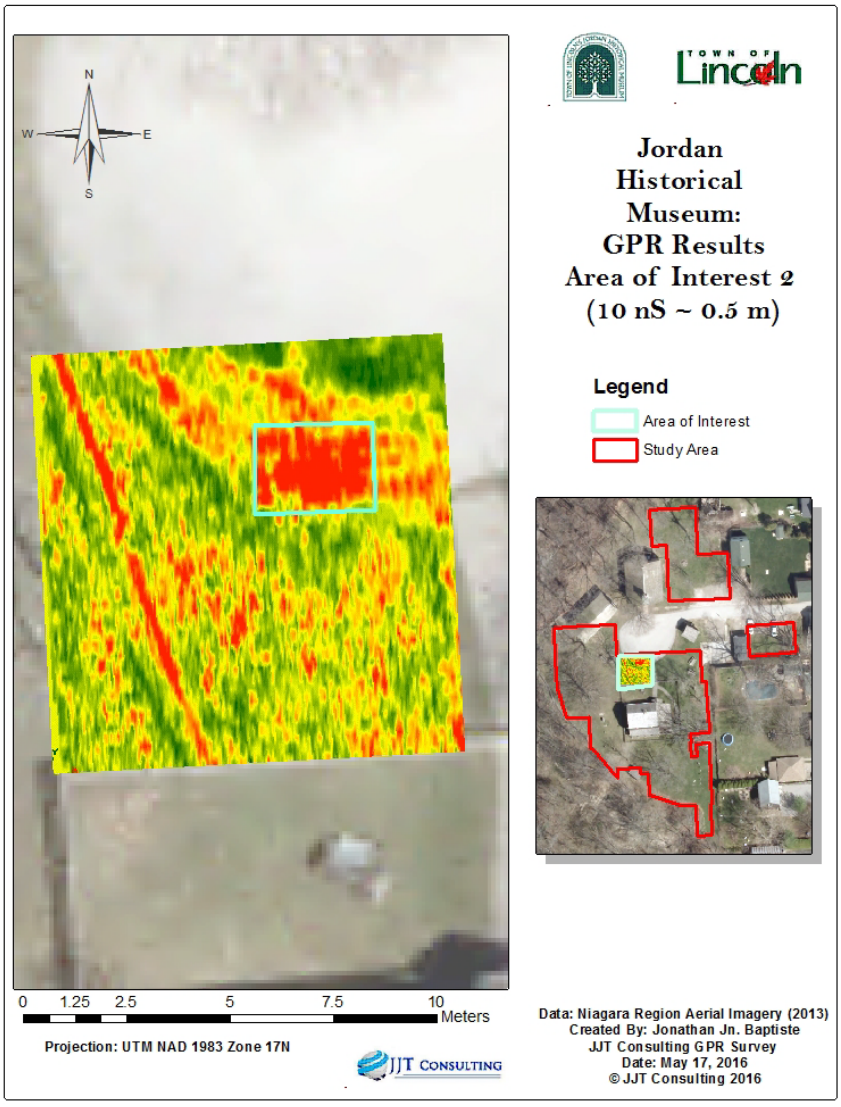

Figure 23 - Possible internment beside Dr. Bowman marker

Area at the most eastern edge of the property immediately east of the black walnut tree: There are a number of known grave markers aligned north-south, generally facing east. Based on the high reflection seen in the GPR results, it is possible that the row of unmarked internments proceeds north and south from the line of known existing tombstones. The high reflection suggests a solid object beneath the Earth's surface. The size and shape of this reflection is about 1 m by 2 m in size, similar to the pre-existing grave markers and the other anomalies found west of the Fry House. Therefore, anomalies such as this are most likely buried grave markers. It should be noted, however, that the resistivity meter was unable to detect any change of electrical resistance in the soils around this area, due to an inability to pass current through the solid tombstone. The resistivity meter can only detect changes in soil, therefore, whenever the meter passed over a tombstone in the ground, a dummy log (or null value) would be logged in lieu of a soil reading. Southwest of the area of interest, where tombstones are visible, the GPR and resistivity meter were both unable to detect any subterranean anomalies. Figure 24 shows the location of these possible internments.

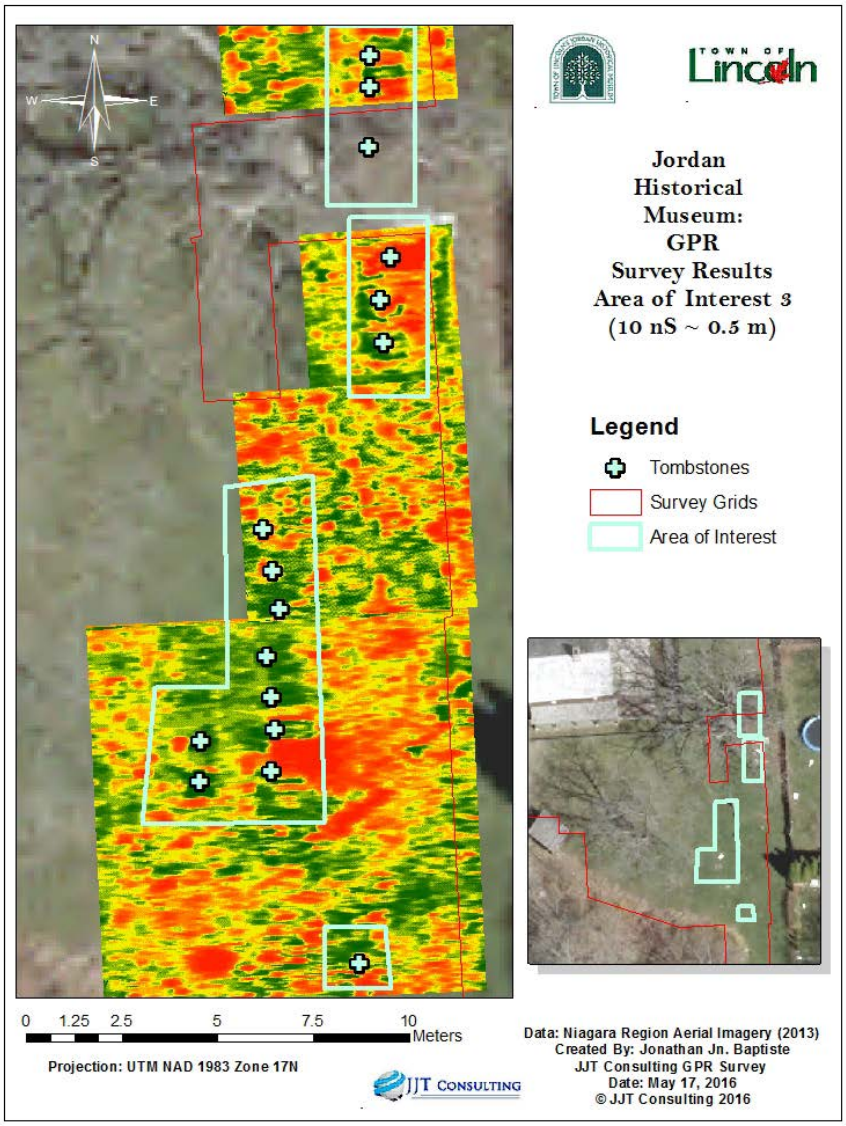

Figure 24 - Possible internments east of the Fry House

Area immediately north of the Fry House, east of the present-day cobblestone path: There is an arced anomaly intersecting the current cobblestone path leading directly to the Fry House from the cul-de-sac pavement seen in the GPR results at approximately 10 nanoseconds (~ 0.5 m in depth). Due to its distinct shape and location, it is highly possible that this curved anomaly is an old path. It is approximately 8 meters in length. The resistivity meter did not detect any differences in electrical resistance of the soil of the area in comparison to its general surround area. The area of interest can be seen in the map found below in Figure 25.

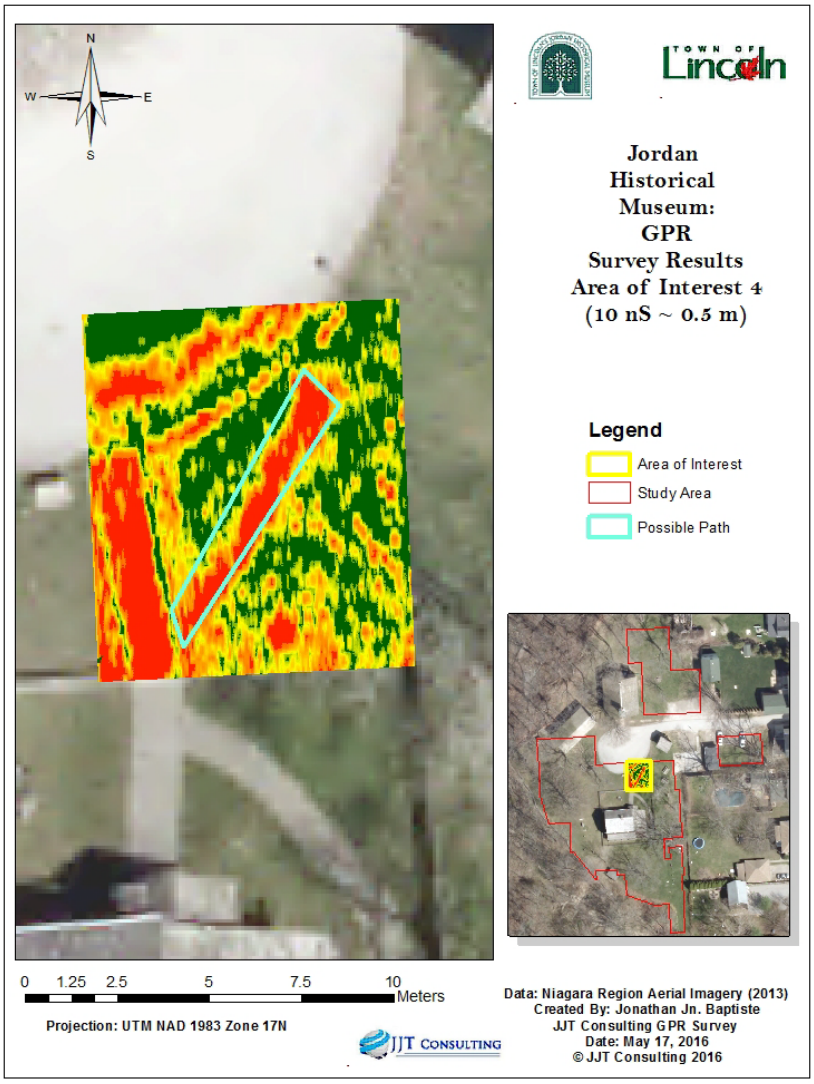

Figure 25 - Area of interest north of the Fry House, east of the cobblestone path

Area within the fence of the Fry House and immediately south of the Fry House outside of the fence: It is known that there was once a Mennonite church where the current Fry House is situated (Town of Lincoln, 2015). JJT Consulting was also informed by Mr. Ray Konkle, Vice-President of the Jordan Historical Museum of the Twenty Volunteer Association, that a possible location of the previous church foundation can be found north of the cobble-stone path as seen in Figure 26 (Konkle, 2016). The GPR was unable to confirm the exact location of the foundation within the fence. However, in the area south of the Fry House immediately outside fence, a triangular anomaly with a base of approximately 13 m (running east-west) and a height of approximately 9 m (north-west) was discovered. Given its size, shape, and the knowledge of the former church foundations, this is most likely part of the church's foundation. Figure 26 shows the triangular anomaly. Foundations and paths were not included in the Electrical Resistivity survey, Electrical Resistivity was used for internment detection solely.

Figure 26 - Possible Foundation of old Mennonite Church

Area east of the schoolhouse: Through the GPR survey, a large relatively rectangular anomaly measuring approximately 6 m by 10 m was found east the schoolhouse. Due to its size and shape, it is possible that this area was a foundation for a barn that once existed on the property. Immediately east of the school house, there is a long arced anomaly marking approximately 15 m in length. According to Ms. Helen Booth, this irregularity is most likely an old path (Booth, Personal Conversation , 2016). Both the rectangular and semi-circular anomalies are best seen at approximately 10 nanoseconds or about 0.5 m in depth. The map shown below in Figure 27 shows the location of this possible foundation beside the schoolhouse.

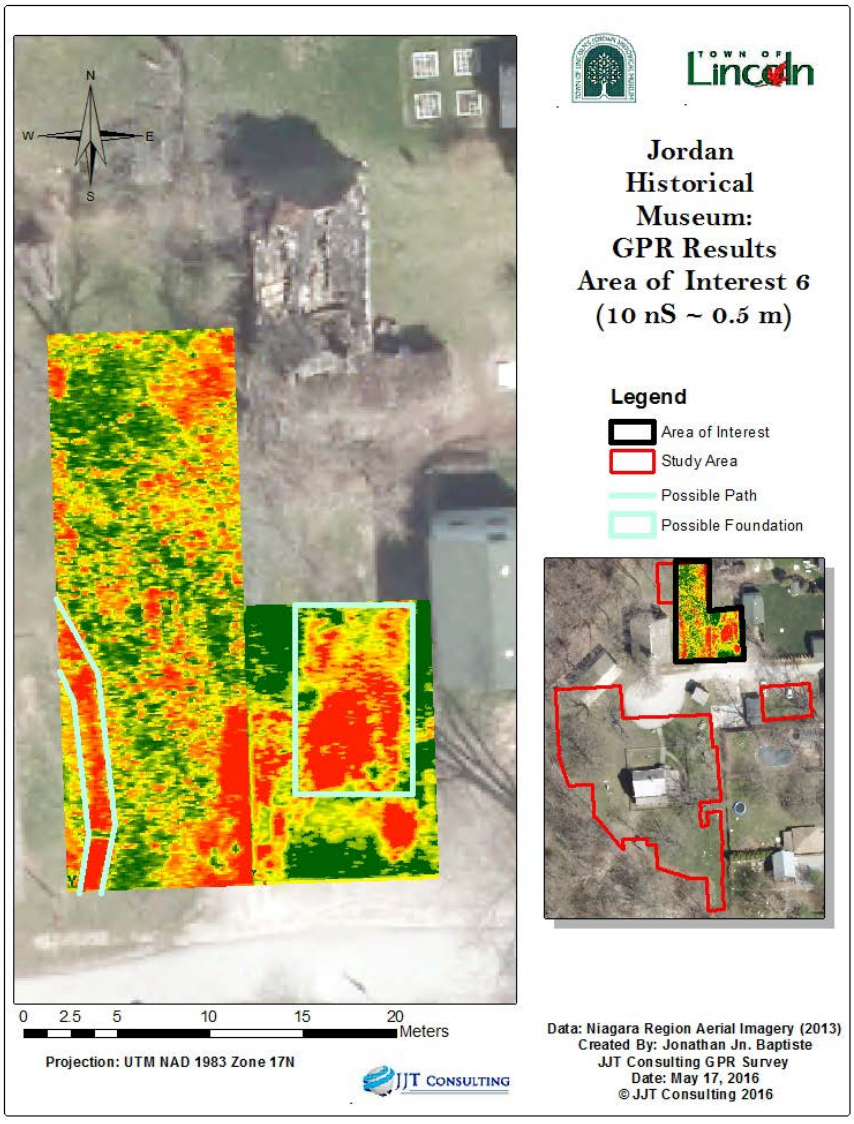

Figure 27 - Possible old path and foundations by the schoolhouse

Several areas of interest were found with the GPR. These findings could not always be seen through an electrical resistance survey as the soil content was not altered, and only the GPR wave reflections are highly visible. Evidence exists for a burial area on the premises along the west-side of the Fry house. A portion of this area contains no grave markings. This burial area can be seen as a uniform, linear pattern that coincides with the known tombstone locations (see Figure 19 and Figure 20). The area thought to contain unmarked burials is primarily concentrated in a **400 m²** area of interest that occupies GPR grids 10, 11, 13, 18 and 29 (refer to Figure 6). Although distinguishable through GPR, the burials could also be identified through electrical resistance as seen in resistivity meter grids 10, 11 and 13 (see Figure 8). The pattern of conductive soils that indicated a potential burial shaft highlighted the same burial pattern and size as the disturbed soil detected through the GPR survey (see Figure 19). A total of 26 anomalies were marked are thought to be contained in the area of interest (see Figure 20). The area extends from the cliff face (Figure 21).

5.0 Recommendations

If excavation were to occur, it would be advisable to perform an archaeological assessment to the screening standards of the Ontario Ministry of Tourism, Culture and Sport (MTCS) for any of the referred areas of interest. Historical building foundations, artifacts, or other internments may be present in the aforementioned areas. The Checklist "Criteria for Evaluating Archaeological Potential" (form 0478E) can be found at the website for Archaeological Assessments at the MTCS's website (Ontario Ministry of Tourism, Culture and Sport, 2015). To avoid potential issues with unearthing potential internments, JJT Consulting ***strongly*** recommends no excavations occur within the **400 m² area of interest** (see Figure 20). Given the data and associated analysis presented in this report, JJT Consulting has reason to believe that previously unknown internments have been discovered using both GPR and electrical resistance surveys. However, additional subterranean exploration could be undertaken. Furthermore, an additional electrical resistance survey, with a smaller sample size and larger grid size in the area of interest may also aid in the definition of burial extents.

If a similar study was to occur, JJT Consulting recommends the use of both resistivity meter and the GPR technologies. The resistivity meter, when used in conjunction with the GPR, can be used to validate the survey results. Although this study used the same grid size for both GPR and resistivity meter, one can determine the grid size for maximum location coverage. A control grid on known soils in a different location is highly recommended. Finally, one should allocate sufficient time to accommodate possible challenges that arise during the surveying period.

6.0 Project Management

6.1 Schedule

Within the project proposal, a schedule was set, outlining the tasks that needed to be completed to achieve the project goal (Chan, Jn Baptiste, & Vanos, 2015). Table 2 below presents the list of all the major tasks, the revised completion date and the status of each task's completion. As of May 27, 2016, the project was 100% complete. After the completion and submission of the report, a presentation of the project will be given once at Council Chambers at the City Hall of Lincoln and again at the Glendale Campus of Niagara College.

Table 2 - Schedule of Major Milestones

Milestone	Original Target End Date	Revised Date	Completed
Meet with client	22-Oct-15		✓
Establish project scope, objectives and benefits	22-Oct-15		✓
Develop Project Overview Statement	22-Oct-15	11-Jan-16	✓
Present Project Proposal	7-Dec-15		✓
Develop Project Proposal Report	11-Dec-15	18-Jan-16	✓
Collect Sources for Literature Review	1-Feb-16	25-Feb-16	✓
Develop Literature Review	8-Feb-16	10-Mar-16	✓
Present Project Progress Status	17-Mar-16		✓
Report on Project Progress	18-Mar-16		✓
Training for Equipment	29-Mar-16	25-Apr-16	✓
Acquire Project Data	18-Mar-16	25-Apr-16	✓
Conduct GPR Survey	3-May-16	25-Apr-16	✓
Geoprocessing and data analysis	27-May-16	7-May-16	✓
Develop map of Jordan Historical Museum grounds	6-Jun-16	10-May-16	✓
Review of project milestones	1-Jun-16	23-May-16	✓
Deliver Final Report to client and present findings	17-Jun-16	27-May-16	✓

Table 3 below, gives a list of completed major project tasks and their descriptions. It corresponds with the Work Breakdown Structure (WBS), found in. The hierarchical structure corresponds with the major project phases and the tasks to complete each phase.

Table 3 - Major Project Tasks

WBS Code	Task Name	Definition
1	Project Initiation	The work to initiate the project.
2	Project Planning	Preliminary Project Proposal/Scope.
3	Project Execution	Identify & Validate data requirements; Research appropriate technical solution; Complete Progress Report; Procure Software/ Instrumentation; Operations Training; GPR Survey/ Data collection; Assessment of measurements: Digitizing and Geoprocessing.
4	Control/Analysis	Project Management (Project Meetings, Bi-weekly Client Status reports, Academic Advisor Meetings, Project Management Plan Updates, Risk assessment/management.
5	Closeout	Audit Procurement; Document Methodology/Lessons Learned; Front of House/Presentation; Gain Formal Acceptance; Archive Files/Documents

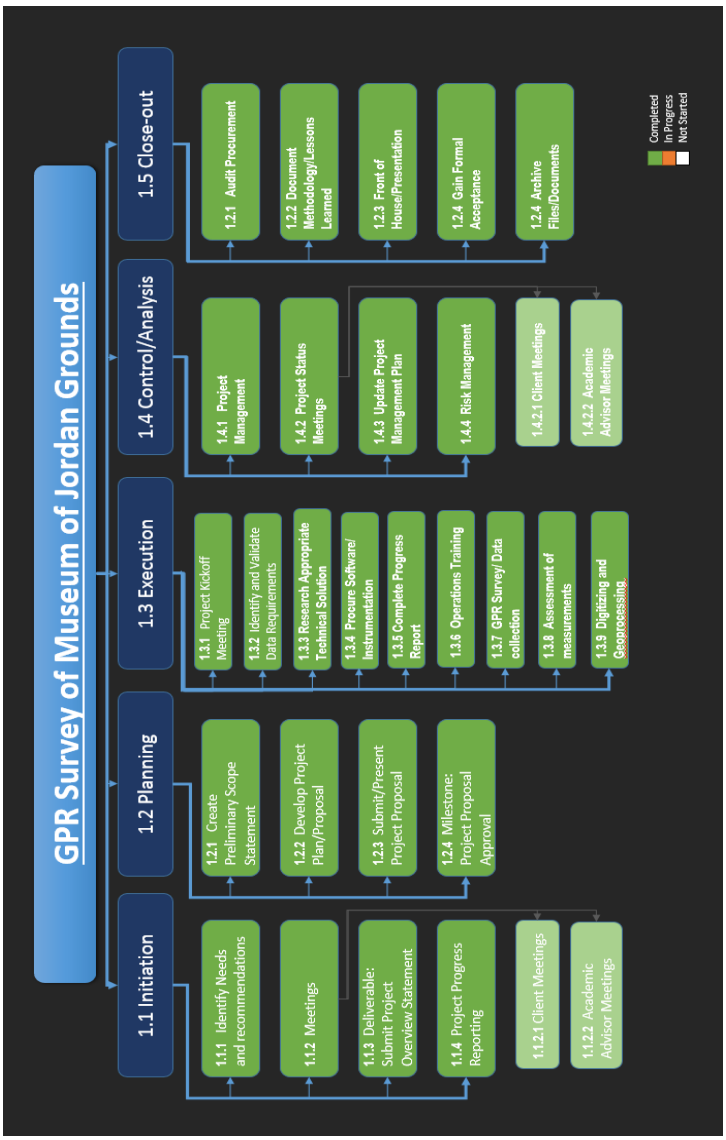

Figure 28 - Work Breakdown Structure of Project

6.3 Final Cost Update for GPR Survey of Museum of Jordan Interments

The project was initiated through the act of identifying the required data. To this end, staff of the Jordan Museum and the Town of Lincoln were interviewed to determine the data needs and conduct a survey of the grounds completing subsequent tasks and milestones the work entails.

The project is in turn completed and a total of **903.5 hours** have been expended.

Table 4 details the total of all labour and costs for the entirety of the project:

Table 4 - Total Cost of Proposed GPR Survey

Project Start Date	Thu 10/15/15	**Project Start Date**	**Thu 10/15/15**
Project Sign-off	Fri 6/10/16	**Project Sign-off**	**Fri 6/10/16**
Proposed Time	338.57 hrs	**Time (person hours)**	**903.5 hrs**
Proposed Cost	**$33,515.43**	**Updated Cost**	**$90,228.24**

6.4 Budget

***Please note: The budget presented in this report is for learning purposes only; the client is in no way expected to incur these costs. The value of this project is being donated to the client by the student consultants, Niagara College and the advisory staff.**

Table 5 outlines the updated total number of hours and cost of labour provided by JJT Consulting.

Table 5 - Total Cost of the Project

JJT Consulting Fees			
Project Member	**Pay/ Hour**	**Total Hours**	**Total**
Jessica Chan	$80.00	290	$23,200.00
Travis Vanos	$80.00	306	$24,448.00
Jonathan Jn Baptise	$80.00	227.5	$18,200.00
Ian Smith	$150.00	80	$12,000.00
		Total Labour	**$77,848.00**
		Instrumentation Costs	**$2,000.00**
		Total (before tax)	**$79,848.00**
		Tax (13%)	**$10,380.24**
		Total Cost	**$90,228.24**

In addition to the labour costs, a "real" value of $2,000 was budgeted for the procurement of the GPR unit used for the duration of the survey. After instrumentation costs and taxes, the total project cost was determined to be $**90,228.24**. A standard rate for all persons of $80/hour, with the exception of Ian Smith, the Academic Advisor, who charged a rate of $150/hour, has been applied for the works of the project.

In total of 903.5 hours were expended on this project, totalling $79,848.00 before applicable taxes and fees. This information is outlined in Table 5 below. The following assumptions have been made during the calculation of the budget:

- The funds for this project are to be paid upfront by the Museum of Jordan and the Township of Lincoln,
- A real cost of $2,000 is allotted to the GPR unit and is included in the Project Instrumentation Costs,
- All prices are in Canadian Dollars,
- All product prices are valid as of January 18, 2016, and
- All data and findings will be transferred to the property of the Museum of Jordan upon completion of the project.

6.5 Earned Value Management (EVM)

The Earned Value Management (EVM) chart, as seen in Figure 29 measures the Earned Value (EV) against the Planned Value (PV) and the Actual Cost (AC).

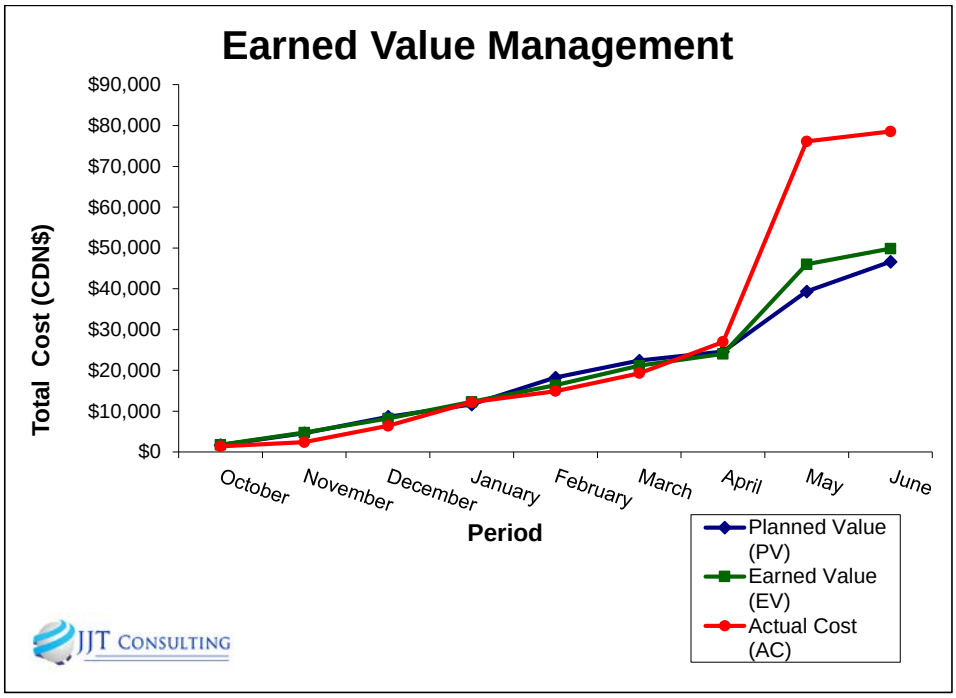

Figure 29 - Earned Value Management Chart

Earned Value (EV) has been closely monitored since February, at which time all previous EV and Actual Cost (AC) from October was also included. The EVM chart was subsequently updated for the duration of the project. Biweekly updates were provided to both the thesis advisor and the client. It should be noted that the Actual Cost far exceeds the original Planned Value as the Project Scope was changed to include the Electrical Resistivity survey. Additional study areas beyond the original agreement were also included. These factors significantly increased the amount of survey time required to complete the survey. However, it should be observed that valuable data were gained from the additions to the survey, within the schedule allotted for the study.

7.0 Challenge Management

7.1 Equipment

Challenge: The team faced some technical issues regarding the odometer on the wheel of the GPR tow cart acquired from Sustainable Archaeology. Aside from the unit being incorrectly calibrated, the odometer was also logging the data inaccurately. The two aforementioned factors caused the resultant data to appear "stripey" (see Figure 30 for a comparison of faulty data versus desired data).

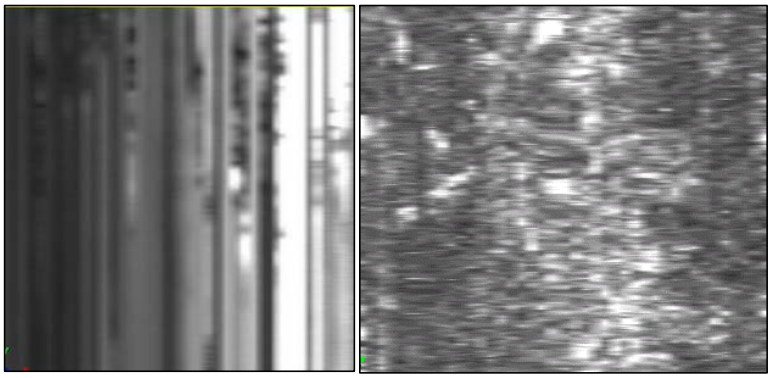

Figure 30 - On the left -"Striped" results of Grid 2 from the original tow cart; on the right – results of Grid 2 using the push cart

Management: After many failed results from test trials and running the machine on a control grid on loamy sand (which will be further discussed in 7.4 Soil Composition below), Mr. Edward Eastaugh from Sustainable Archaeology advised the team to change the equipment. Therefore, the tow cart was returned to Sustainable Archaeology in exchange for the push cart. The push cart was able to log the data correctly and efficiently. Figure 31 shows the two differing GPR platforms used.

Figure 31 - Tow Cart (on the right) and Push Cart (on the left) (Image source: Ian Smith, 2016)

7.2 Software Availability

Challenge: The software used for processing the GPR and resistivity meter data was only available at Western University through Sustainable Archaeology.

Management: The team looked into obtaining open-source software for processing the results at the GIS lab at Niagara College. However, none of the software was capable of amalgamating the data in a format suitable for data analysis. Two separate data processing efforts were carried out; one to process the Resistivity Meter results, and another to process the GPR results. With efficient time management, the team was able to process each set of results during their trips to Sustainable Archaeology.

7.3 Internment Location and Obstructions

Challenge: Given the organic growth of the area, there were numerous obstacles, such as trees, bushes, and natural form of the cliff face at the edge of the property. The positions of the tombstones, the location of the Fry House, and its surrounding fence also affected the manner in which the survey was conducted.

Management: Smaller grids were added around large obstacles to maximize coverage. The 10 m by 10 m grids were divided into smaller grids, boxing in the large obstacle. It was essential to keep the equipment as close to the grounds as possible to avoid incorrect data collection. All corners of the grids were surveyed using the Total Station, input into ArcMap, and overlaid on aerial imagery. Therefore, it was known which areas of the museum grounds were surveyed and which were not.

For smaller obstacles, such as tombstones, the cart was either driven over the obstacle, or steered as close to the obstacle as possible. Despite the differences in traverse distances, the data was corrected

according to the grid and traverse information configured using the processing software at Western University.

7.4 Soil Composition

Challenge: The soil composition of the study area as shown in below in Figure 32, is that of Silty Clay. It was known that soils with higher clay composition (see 2.2 Literature Review) may cause problems in the GPR survey. Clay soils are typically denser and wetter, thereby making it more difficult for RADAR to penetrate.

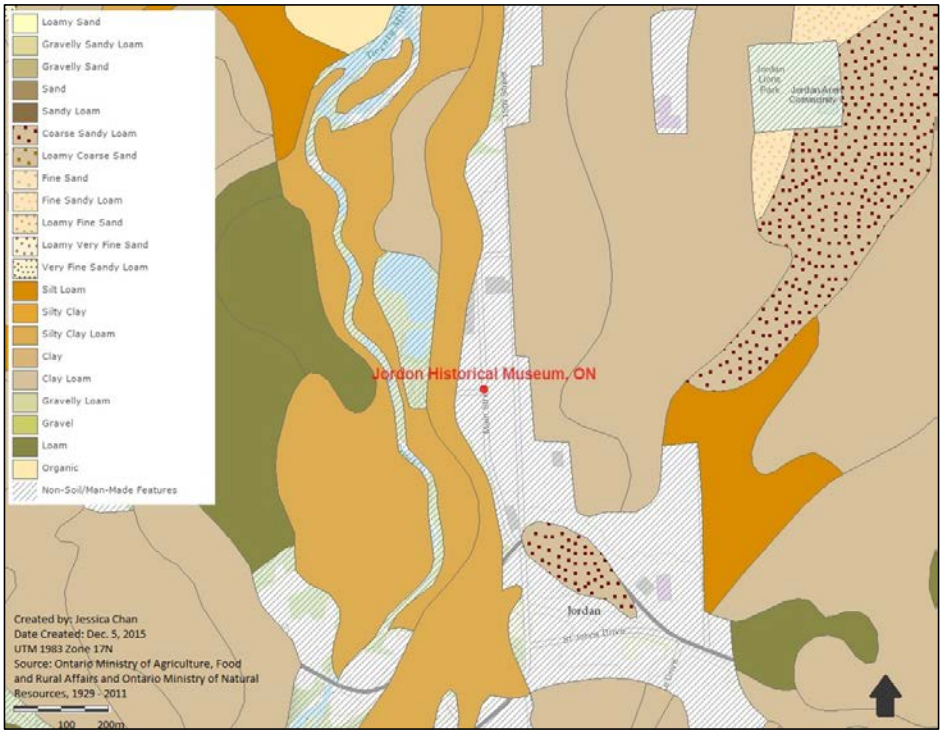

Figure 32 - Map of the Soil Composition in the Area

Management: The team performed extensive research to understand how to mitigate this issue (as seen in 2.2 Literature Review). The team was advised by Sustainable Archaeology that the 400MHz antenna was capable of performing the survey. Although a lower frequency antenna, such as a 250MHz antenna, would provide deeper results, the resolution of the data would be significantly decreased. Alternatively, a higher frequency antenna would not be able to penetrate the data and only reflect the data.

Additionally, the team performed a control test grid on an area known to have loamy sand soil composition where the underground anomalies, such as drainage pipes, were already known. These results were sent to Sustainable Archaeology for processing which allowed the team to understand the differences of known anomalies between the two different types of soils.

8.0 Closure and Discussion

After concluding both Ground Penetrating Radar (GPR) and electrical resistance surveys, compelling evidence exists for an extensive burial area, previously unknown, on the premises along the west-side of the Fry house. Although distinguishable through GPR, an Electrical Resistance survey provided valuable data that correlate with the results produced through the GPR survey. Despite the silty clay soil and high water content of the soil medium, both the 400 MHz GPR antenna and the resistivity meter proved capable of producing tangible results. With a limited timeframe, more accurate results may have been achieved if the survey could have been performed in drier soil. However, the extent of the survey was limited by a deadline for findings. The GPR survey revealed more information about subterranean anomalies than could have been detected through an electrical resistance survey alone. However, an electrical resistance survey, when used in this scenario, validated the findings, required minimal data-processing and minimal image interpretation to determine the area of interest with potential burials. The pattern of conductive soils that indicate potential burial shafts highlights the same burial pattern and size as the disturbed soil detected through the GPR survey (see Figure 18). Both GPR and electrical resistance surveys provided a non-intrusive and efficient alternative to the traditional archaeological excavation.

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Appendix 1

Project Overview Statement

Project Overview Statement (POS)

Executive Summary

Project Name:	Jordan Historical Museum Property, Ground Penetrating RADAR Survey and mapping of Potential Internments
Last Updated Date:	January 18, 2015
Author(s):	Jonathan Jn Baptiste, Travis Vanos, Jessica Chan
Project Manager(s):	Jessica Chan
Project Members:	Jonathan Jn Baptiste, Travis Vanos, Jessica Chan
Client Name:	Helen Booth, museum@lincoln.ca, 905-563-2799 x290
Client Organization:	Jordan Historical Museum, Town of Lincoln

Project Business Case

Business Problem/Issue/Opportunity
The Jordan Historical Museum currently occupies a plot that once served as a location for a church, a small school, and the Fry House. A cemetery was associated with the church on this property. However, it is not clear on the boundaries of this cemetery, where the graves lie, and how many burials are on the site.
Project Business Goal
To undertake a survey of the site by means of ground Penetrating RADAR (GPR) system and GPS of the lands of the Jordan Historical Museum to determine if there are any undiscovered burials and the possible boundaries of the cemetery.

Primary Project Objectives

Primary Project Objectives
The primary project objective is to perform a GPR survey of the land that the Jordan Historical Museum currently occupies in order to determine the boundaries of its pre-existing cemetery. • Complete a Literature Review on the site history , era appropriate to the plot of land which the Jordan Historical Museum occupies • Complete a Literature Review on the use of GPR technology in locating burial sites and human remains • Perform an on-site survey control, tied to UTM NAD 1983 – Zone 17 horizontal co-ordinates and local geodetic vertical control • Perform a GPR survey of the lands of the Jordan Historical Museum, tied to UTM grid and local vertical control • Map the findings in a detailed manner using various GIS software • Report on the locations of possible burials on the property

Project Benefits

Project Benefits
• Benefit 1: Finding unmarked graves • Benefit 2: Marking the boundaries of the cemetery.

Primary Project Deliverables

Milestone 1: Project Proposal and Presentation
• Deliverable 1.1: Create and submit a Project Proposal • Deliverable 1.2: Present Literature Review of the history of the land, as well as the Literature Review for GPR technology used in locating burial sites • Deliverable 1.3: Create and present Project Proposal Presentation
Milestone 2: Progress Report and Presentation
• Deliverable 2.1: Create and submit a Progress Report • Deliverable 2.2: Present collected data • Deliverable 2.3: Create and present Project Proposal Presentation
Milestone 3: Final Report and Presentation

- Deliverable 3.1: Present Literature Review of the history of the land, as well as the Literature Review for GPR technology used in locating burial sites
- Deliverable 3.2: Present collected data, findings, and recommendations to the Jordan Historical Museum
- Deliverable 3.3: Create and submit Final Report
- Deliverable 3.4: Create and present Final Report Presentation

Project Conditions

Project Assumptions and Risks
Assumptions (Accessibility to Resources) • Access to Ground Penetrating RADAR unit • Access to Jordan Historical Museum grounds to perform survey • Access to GIS Lab hardware and software at Niagara College • Access to reliable Transportation to and from the Jordan Historical Museum and Niagara College **Risks and Concerns** • Unable to collect all data required to make informed recommendations – due to pre-existing structures, size of GPR unit, and time constraints • GPR is unable to differentiate between plots and other subterranean anomalies • Density of soil, soil type, and roots may cause difficulties in locating burials • Hardware malfunctions/difficulties – not able to get connections to the satellites
Project Issues and Constraints
• Weather conditions • Procuring the GPR unit – availability based on budget

Project Critical Success Factors (Key Performance Indicators)

Project Critical Success Factors
• Clear and effective communication between all group members, client, and project advisor • Collection and presentation of data • All tasks on critical path completed • Jordan Historical Museum acceptance and write-off on project findings and report

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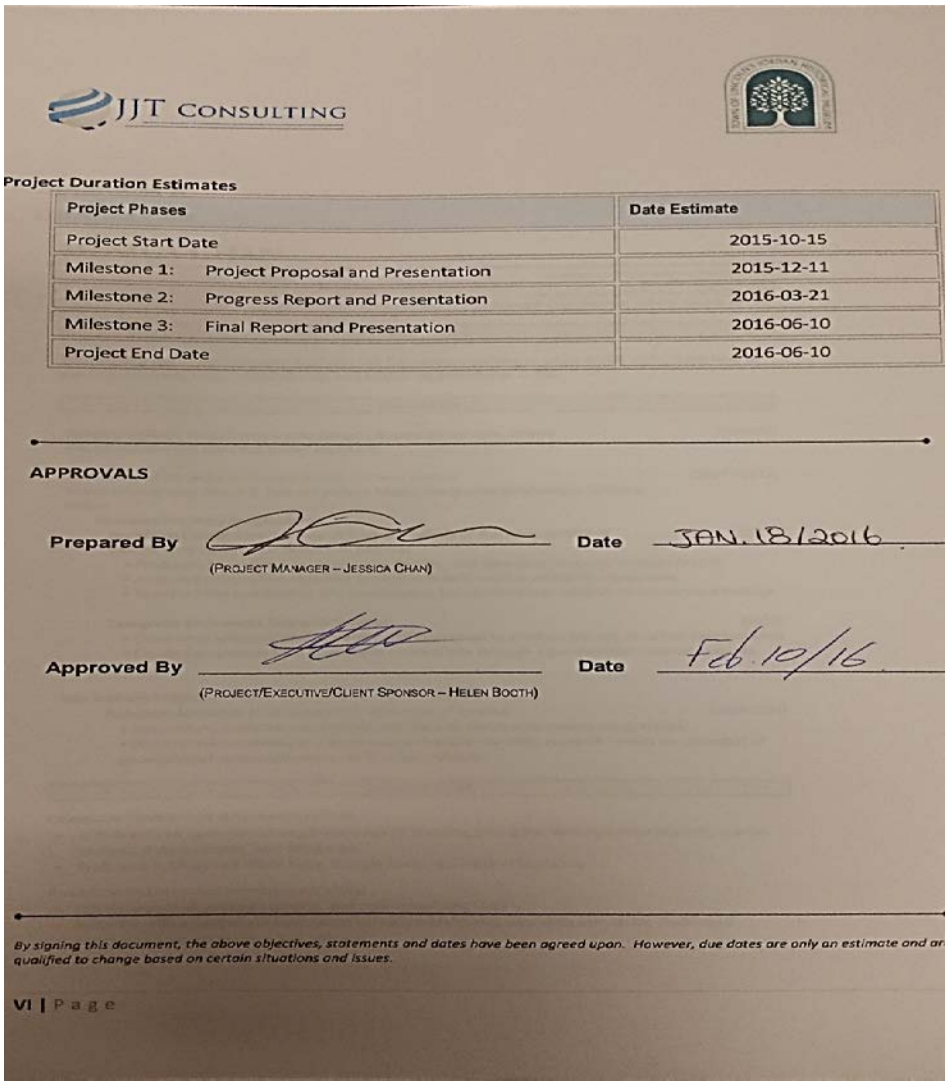
TOWN OF LINCOLN'S JORDAN HISTORICAL MUSEUM



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Project Duration Estimates

Project Phases		Date Estimate
Project Start Date		2015-10-15
Milestone 1:	Project Proposal and Presentation	2015-12-11
Milestone 2:	Progress Report and Presentation	2016-03-21
Milestone 3:	Final Report and Presentation	2016-06-10
Project End Date		2016-06-10

APPROVALS

Prepared By _____ **Date** JAN. 18/2016

(PROJECT MANAGER – JESSICA CHAN)

Approved By _____ **Date** Feb. 10/16

(PROJECT/EXECUTIVE/CLIENT SPONSOR – HELEN BOOTH)

By signing this document, the above objectives, statements and dates have been agreed upon. However, due dates are only an estimate and ar qualified to change based on certain situations and issues.

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Appendix 2

Public Media

May 04, 2016 | Vote 0 0

Jordan Museum digging up history without shovels

Teams up with Niagara College to map a long lost Mennonite cemetery

Jordan Museum dig
Luke Edwards/Staff Photo
Jonathan Jn. Baptiste and Travis Vanos operate the ground penetrating radar device that will map much of the Mennonite cemetery that is buried underneath the Jordan Museum grounds where the Fry house is currently located.

Grimsby Lincoln News
By Luke Edwards

JORDAN — Students at Niagara College are helping to uncover a lost piece of Jordan history, 25 centimetres at a time.

The Jordan Historical Museum has joined forces with a team of GIS – Geospatial Management program student at Niagara College to undertake a Ground Penetrating Radar survey that they hope will uncover details about a Mennonite church and graveyard that once occupied the space that now belongs to the Fry house. The study will help identify likely gravesites in the area.

"It detects changes in the soil and then bounces back up," said Jessica Chan, project manager.

The ground penetrating radar sends electromagnetic waves into the ground. When those waves hit objects – from tree roots to stone, water pipes and graves – they're redirected back to the surface. A machine picks up those waves and with the help of computer software from Western University in London, Ont., maps out the area.

When the area is mapped – the students are systematically going through the study area grid by grid, making 25-centimetre passes with their rented machine – they'll get a picture of what's going on underground. Chan said they'll be looking for objects that are around one metre wide and two metres long.

"We're not going to say that is (a grave) but it should be," she said.

The college has utilized what it calls “applied thesis projects” for years. The projects send postgraduate students out to solve real world problems using what they've learned in class, project manager Ian Smith said. Students in the program have undertaken similar projects in Port Colborne where students examined a pioneer cemetery at Sherkston Shores.

Former Lincoln mayor and member of the Jordan Historical Museum of the Twenty Volunteer Association Ray Konkle approached the college after hearing about the work that was done at Sherkston Shores. The museum and volunteers have long known of a church and cemetery on the site, but museum director Helen Booth said they have very little information.

“There are no records for the church the we have before the Fry house was moved onto it,” she said. “At least we will now know what is here.”

The students will be on site for two weeks, painstakingly going through each grid. The machine used resembles a hand-pushed seeder, and typically requires two people to operate. One person pulls the machine along the ground, keeping it as straight as possible. A second person straps on a device the reads the radar waves that are being redirected off underground objects. Each pass covers 25 centimetres in width. Once a grid is completed the data is uploaded to computers and specialized programs map the underground.

“The most important part is to try not to disturb the ground,” Chan said.

Once complete the students will report back to the Town's sports, recreation and culture committee with its findings. The committee and museum are in the midst of planning for museum renovation and expansion. Booth said the study will help guide their decision making when it comes to the museum master plan.

“We want to know where they were so at least we know to be respectful,” she said.

In addition to the ground penetrating radar, the students will also conduct resistivity meter testing, which uses electrical flows to map objects underground.

“I've been really impressed by the students. We're very excited and eager to have this information,” Booth said.

Luke Edwards is a reporter for the Grimsby Lincoln News and editor for **Niagara Farmers' Monthly**. His column appears alternate weeks in The News' Tuesday edition. You can follow him on **Twitter** and **Facebook.**

editorial

Was this the most "active" weekend ever?

MIKE WILLISCRAFT

This past weekend really snuck up on me.

Usually, those super busy weekends in the summer are well known, major events, spin-off barbecue fundraisers and events at all times of the day and night.

Last weekend: fashion show, Kinsmen 50th dinner, McNally House Walk for Hospice, Jordan Lions Swap Meet and Car Show, Wayzgoose, West Lincoln Home Show, United Mennonite Home craft sale, Grimsby Tennis Club's opening and even more...

It amazes me how much stuff goes on around here and I have been doing this for a very long time.

This weekend, when one considers the variety of events, may have been the best weekend I've seen in 20-plus years working the West Niagara beat.

When you can check off everyone from gear heads to fashionistas and heritage printers to do-it-yourselfers there was definitely something for everyone.

The whole thing got kind of kicked off with a super unique happening when efforts started to x-ray the entire yard of Jordan Museum.

About 10 days is what it will take to cover most of the yard there. The technicians said they would run out of time before they run out of real estate.

The notion behind the work to get an idea of where they may be unmarked graves on the site, so if any work is ever done they would know where to avoid. Over the decades, if not centuries, grave markers have disappeared in some cases.

Haines while a demonstration was being set up, he related a typically funny story... I thought it was anyways.

He said stories have been commonly told by people who attended the schoolhouse there back in the day that at recess the boys would venture over the precipice and down into the valley where, as "legend" has it, some graves eroded to over time.

They would find "bones", take them in hand and chase the schoolgirls around the yard with them.

Sounds like a scene from Little House on the Prairie...

That whole scene, the x-raying of the yard I mean, was truly unique, covering the whole area in 10-inch-wide passes is a big task but, once completed, will let know museum officials know what they have been wondering for years.

Going from the past to the future, the future looks bright for the West Lincoln Chamber of Commerce's Home and Trade Show. I popped in there Saturday and it was busy with nearly vendor having someone at

Attendance came in at just over 1,000 for the two-day event, by far the best turnout in many years. That is good news for the Chamber and the community to see people coming out like that.

My favourite part of the weekend was Saturday night's Grimsby Kinsmen Club's 50th anniversary dinner up at the old St. Mary's Hall, now called the Mountain Ridge Community Centre.

That building has seen countless celebrations in its day, none better than one.

The hall was decorated with all kinds of Kin memorabilia all around and scrap books covered about a dozen tables at the back. It was the history of a half-century of Grimsby brought to life.

It was a really great night!

Sunday, I was looking forward to checking out some cool rides at Jordan Lions annual car show. Cool and wet weather really dampened that event unfortunately, but those Lions are a resilient bunch. They have to be if they can hang around as long as they have, just like the Kinsmen.

Both these groups could use more active members to help make all the things happen which they facilitate in our community. This is true of virtually every service club.

There are a lot of great causes which need time and attention out there so if you have looking to get involved, invest in your community and, most of all, have some fun, these are the guys to call. Jordan Lions, Glen Corfield, 905-321-2645.