NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

MUNICIPALITY OF CENTRAL HURON, ONTARIO

APM-REP-06144-0127

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Municipality of Central Huron

Revision: 0 (Final)

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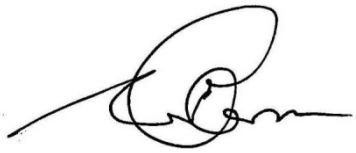
Approved by:	 Kenneth Raven	

EXECUTIVE SUMMARY

In July 2014, the Municipality of Central Huron (herein "the Municipality") expressed interest in continuing to learn more about the Nuclear Waste Management Organization nine-step site selection process (NWMO, 2010), and requested that a preliminary assessment be conducted to assess potential suitability of the Municipality for safely hosting a deep geological repository (Step 3). This request followed successful completion of an initial screening conducted during Step 2 of the site selection process.

The preliminary assessment is a multidisciplinary study integrating both technical and community well-being studies, including geoscientific suitability, engineering, transportation, environment and safety, as well as social, economic and cultural considerations. The findings of the overall preliminary assessments are reported in an integrated report (NWMO, 2015). The objective of the geoscientific desktop preliminary assessment is to determine whether the Municipality contains general areas that have the potential to meet NWMO's geoscientific site evaluation factors.

This report presents the findings of an interpretation study looking at historical borehole geophysical well log data and historical 2D seismic data. The assessment focused on the Municipality and its immediate periphery, referred to as the Central Huron area. This study was completed as part of the Phase 1 Geoscientific Desktop Preliminary Assessment for the Municipality of Central Huron (Geofirma Engineering Ltd., 2015).

The main information sources relied on in this study include:

- the petroleum wells subsurface database from the Ministry of Natural Resources Oil, Gas and Salt Resources Library (OGSRL) current as of December 2014;
- historical 2D seismic data purchased from a seismic data brokerage company;
- the OGS bedrock depth (drift thickness) data (Gao et al., 2006);
- ground surface elevation data defined by a topographic model created from Shuttle Radar Topographic Mission (SRTM) data provided by National Aeronautical and Space Administration (NASA, 2006);
- Additional information sources included several files on drainage features, watersheds, lake depths, aggregate pits, and roads obtained from Land Information Ontario (LIO, 2014); and,
- Additional stratigraphic information was provided by the site characterization activities undertaken at the Bruce nuclear site (NWMO, 2011; Intera Engineering Ltd., 2011).

The study addresses the following four main objectives:

- Assessing key bedrock formation top elevations across the Central Huron area based on the reinterpretation of available borehole geophysical data.
- Interpreting available 2D seismic data and evaluating their usefulness for the purpose of identifying geological structures in the Precambrian basement and Paleozoic bedrock within the Central Huron area.
- Providing a better understanding of the three-dimensional geometry (depth, thickness and extent) of key Paleozoic sedimentary packages and the top of the Precambrian basement, based on the borehole geophysical data assessment and the interpretation of 2D seismic data.

- Interpreting potential geological structures such as: pinnacle reefs, faults, salt dissolution features, and karst, within the Central Huron area.

To meet the study objectives outlined above, the scope of work involved the completion of two complimentary desktop studies, including a borehole geophysics data interpretation and a 2D seismic data interpretation, based on available data for the Central Huron area.

A total of 335 boreholes from the OGSRL exist within the Central Huron area and its surrounding region, 111 of which contain useful gamma and neutron borehole geophysical logs. These borehole geophysical logs were studied to select formations which could be easily and consistently identified based on the geophysical signals. Eight formation tops were identified and termed "key formation tops". A dataset of these eight key formation tops for each of the 111 boreholes was created. These key formation tops included:

- Bass Islands Formation;
- Salina Group G-Unit;
- Salina Group F-Unit;
- Cabot Head Formation;
- Queenston Formation;
- Cobourg Formation - Collingwood Member;
- Coboconk Formation; and,
- Precambrian.

The updated formation top dataset discussed above was used to create geological cross-sections to assist with the interpretation of regional geology and 2D seismic data. A total of approximately 9.9 km of historical 2D seismic data, originally acquired as part of a single line during 1977, was purchased, re-processed and interpreted as part of this study. The quality of this historical data was sufficient for use in this study but considered to be of lower quality compared to current 2D seismic standards.

Key formation tops reinterpreted from borehole geophysical data remained mostly unchanged from the OGSRL (MNR) picks. The reinterpreted key formation top that changed most frequently compared to the MNR pick was the Cobourg Formation, mostly due to differences with the way this formation top was historically picked in the past.

The cross-sections constructed using the updated formation top dataset highlight the relatively uniform apparent dip and relatively uniform thicknesses of the Upper Ordovician shale and limestone packages beneath the Municipality of Central Huron. The interpretation of the 2D seismic data also generally supports this interpretation of lateral continuity and uniformity of the thickness of the Ordovician formation packages. It was not possible to interpret any faults or reefal structures in the Paleozoic sequence within the Municipality based on the borehole data, constructed geological cross-sections, or the 2D seismic data.

The results of the study provide a foundation for developing an integrated interpretation of the subsurface geological and stratigraphic framework in the Central Huron area.

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1 INTRODUCTION

In July 2014, the Municipality of Central Huron expressed interest in continuing to learn more about the Nuclear Waste Management Organization nine-step site selection process (NWMO, 2010), and requested that a preliminary assessment be conducted to assess potential suitability of the Municipality for safely hosting a deep geological repository (Step 3). This request followed the successful completion of initial screening of the Municipality of Central Huron conducted during Step 2 of the site selection process by AECOM Canada Ltd. (2013).

This report presents the results of borehole geophysical data and two dimensional (2D) seismic data interpretation for the Municipality of Central Huron. The assessment focused on the Municipality of Central Huron and its immediate periphery, referred to as the Central Huron area (Figure 1). This study was completed as part of the Phase 1 Geoscientific Desktop Preliminary Assessment study for the Municipality of Central Huron (Geofirma Engineering Ltd., 2015).

1.1 Central Huron Area

The geoscientific desktop preliminary assessment (Geofirma Engineering Ltd., 2015) focused on the area within the boundaries of the Municipality of Central Huron. Areas beyond the municipal boundaries were not considered. For the purpose of the assessment, geoscientific information was collected and interpreted for the Municipality and surrounding areas, referred to in this report as the Central Huron area (Figure 1).

1.2 Study Objectives

The objective of the geoscientific desktop preliminary assessment (Geofirma Engineering Ltd., 2015) is to determine whether the Municipality of Central Huron contains general areas that have the potential to satisfy NWMO's geoscientific site evaluation factors based on available geoscientific information. To help fulfill this goal, the borehole geophysical and 2D seismic data interpretation objectives include:

- Assessing key bedrock formation top elevations across the Central Huron area based on the reinterpretation of available borehole geophysical data. This assessment will provide an updated borehole dataset that will be used for:
  a) construction of strike-parallel and perpendicular cross-sections through the Municipality;
  b) constraining the 2D seismic data interpretation; and
  c) gravity stripping procedures as part of the geophysical data interpretation study (PGW, 2015).
- Interpreting available 2D seismic data and evaluating their usefulness for the purpose of identifying geological structures in the Precambrian basement and Paleozoic bedrock within the Central Huron area.
- Providing a better understanding of the three dimensional geometry (depth, thickness and extent) of key Paleozoic sedimentary packages and the top of the Precambrian basement, based on the borehole geophysical data assessment and the interpretation of 2D seismic data.
- Interpreting potential geological structures such as: pinnacle reefs, faults, salt dissolution features, and karst, within the Central Huron area.

1.3 Qualifications of the Team

The team responsible for the borehole geophysics and 2D seismic data review, processing and interpretation investigation component of the Phase 1 Geoscientific Desktop Preliminary Assessment consisted of qualified experts from Geofirma Engineering Ltd. and Seismic Solutions Inc.

The following is a brief description of the qualifications and roles of key project team members.

Sean Sterling, M.Sc., P.Eng, P.Geo. is a senior hydrogeologist/geoscientist with Geofirma Engineering Ltd. and is a registered professional engineer and geoscientist in Ontario. He has 20 years of specialized experience and expertise in characterization and investigation of fractured bedrock sites. He managed all field work and data collection activities for the Deep Geological Repository (DGR) project at the Bruce nuclear site from 2005 through 2012, including the acquisition and interpretation of approximately 20 km of 2D surface seismic data and the acquisition and interpretation of borehole geophysical data from eight deep boreholes (DGR-1 to DGR-8). He was responsible for picking bedrock formation tops in the DGR wells and obtained interpretative assistance from provincial sedimentary geologists Terry Carter and Derek Armstrong. For the current study Mr. Sterling was responsible for the interpretation of borehole geophysical data, project management and report preparation.

David Schieck, M.Sc., P.Geoph. is the president of Seismic Solutions Inc. and a professional geophysicist in Alberta and professional geoscientist in Ontario. In 1988 Mr. Schieck founded and managed a full-service seismic company operating in Ontario (Geophysical Applications) where he acquired, processed and interpreted 2D seismic data collected north of Goderich for numerous oil and gas exploration companies. He has also designed, acquired, processed and interpreted 3D seismic data for more than 35 projects within southwestern Ontario ranging from 4 km^2 to 35 km^2 for gas storage and exploration development. For a number of these projects he was the lead contractor responsible for the management of surveying, seismic data acquisition, processing and final interpretation. He was recently involved in the peer review and final reporting of the 20 linear km of 2D seismic data acquired at the Bruce nuclear site as part of the DGR site characterization work at the Bruce nuclear site completed by Geofirma for NWMO in 2010. For the current study Mr. Schieck was responsible for data review, selection, purchase, processing, interpretation and reporting on historical 2D seismic data.

Kenneth Raven, M.Sc., P.Eng. P.Geo. is President of Geofirma Engineering Ltd. He has over 35 years of experience in site characterization for the purpose of radioactive waste management for a variety of clients including Atomic Energy of Canada Ltd., Ontario Hydro, Ontario Power Generation and NWMO. He recently served as principal geoscientist and project manager for the DGR site characterization program at the Bruce nuclear site from 2005 to 2012. He currently manages Geofirma geoscience consulting services to NWMO under the Adaptive Phased Management Program including the Phase 1 geoscientific preliminary assessment for sedimentary sites, southwestern Ontario. Mr. Raven completed review of this report.

1.4 Report Organization

This report is organized into nine sections and four appendices.

- Section 1 of this report includes an introduction, lists the study objectives and scope of work for the borehole geophysical well log and 2D seismic data interpretation, and describes the qualifications of the geophysical interpretation team.

- Section 2 provides an overview of the geological setting and of the bedrock and Quaternary geology in the Central Huron area.

- Section 3 summarizes the data sources available and data limitations for both the borehole geophysical well log interpretation as well as the 2D seismic interpretation.

- Section 4 documents the methodology used for the borehole geophysical well log and 2D seismic data interpretation studies.

- Section 5 documents the findings of the two studies. This includes a description of the results from borehole geophysical well log interpretation, a discussion of the resulting geologic cross-sections and their important relevant features, and seismic reinterpretation for the 2D seismic line studied including any geologically important features (e.g., faults, salt layers, reef structure, seismic character, etc.) that were identified.

- Section 6 provides a discussion of the integrated results from both studies.

- Section 7 provides a summary of the report findings.

- Section 8 lists the report references, and Section 9 includes a report signoff page.

- Appendix A includes a summary of all OGSRL boreholes used in this study. Appendix B includes a summary of 2D seismic collection and processing parameters. Appendix C includes a summary of formation tops picked as part of this study based on analysis of borehole geophysical logs. Appendix D includes a compilation of processed 2D seismic data figures used during interpretation of the 2D seismic data.

2 SUMMARY OF PHYSICAL GEOGRAPHY AND GEOLOGY

2.1 Physical Geography

A detailed discussion of the physical geography of the Central Huron area including physiography, topography, surface water/wetlands and built-up areas is provided in a separate Terrain and Remote Sensing Study Report (JDMA, 2015) and the following is a summary of that information.

The Central Huron area contains a set of landforms and landform complexes that resulted from the advance and retreat of the glaciers during the Late Wisconsinan glaciation. These landforms provide evidence of the glacial and postglacial events that were largely responsible for producing the detailed topography of the area. The physiography of the Central Huron area is classified into a set of six physiographic units based on the presence of distinct landforms such as valleys, drumlin fields, escarpments and till plains (JDMA, 2015). Five of these physiographic units extend into the Municipality. The dominant physiographic units within the Municipality in terms of extent are the Horseshoe moraines (64.1% of Municipality), the Stratford till plain (20.6% of Municipality) and the Huron slope (14.1% of Municipality). The Huron fringe and Teeswater drumlin field are very minor physiographic units in the Municipality representing 1.2% and 0.01% respectively of the Municipality. These physiographic units are in part reflected in the surficial geology of the area.

The large-scale topography in the Central Huron area is controlled by bedrock topography, whereas the detailed topography is almost entirely controlled by surficial landforms. The elevation gradient in the Central Huron area from east to west (Lake Huron) is from 366 to 176 m, with this elevation drop occurring over an approximate 35 km lateral distance. The elevation minimum is defined by the surface of Lake Huron, with a chart datum of 176 m. The highest points in the Central Huron area with elevations of 366 m, are located along the Mitchell Moraine at the east edge of the Central Huron area. Steep slopes are rare in the Central Huron area and associated with drumlins, river valleys, spillway margins, kames and till ridges, and raised shore bluffs.

Apart from Lake Huron, the Central Huron area contains no large lakes. The largest lake in the area with an extent of 1.3 km^2 is associated with the Hullett Marsh, located in the southeast part of the Municipality (Figure 1). Water bodies and wetlands cover 0.8 % and 5.6 % of the land within the Central Huron area, respectively.

Built-up areas are found in the villages and towns of the Municipality. The largest of these built-up areas are associated with settlements of Clinton, Holmesville, Londesborough and Kinburn (Figure 1).

2.2 Bedrock Geology

The bedrock geology of southern Ontario and the Central Huron area is described in detail in Geofirma Engineering Ltd. (2015) and the following is a summary of that information.

2.2.1 Geological Setting

The bedrock geology of southern Ontario consists of a thick Paleozoic sequence of sedimentary rocks ranging in age from Cambrian to Mississippian deposited between approximately 540 and 323 million years ago (Johnson et al., 1992). This sedimentary sequence rests unconformably on the Precambrian crystalline basement rocks of the Grenville Province, which is the southeastern-most

subdivision of the Canadian Shield. The Grenville Province comprises 2,690 to 990 million year old metamorphic rocks deformed during orogenic events 1,210 million to 970 million years ago (Percival and Easton, 2007; White et al., 2000). The Grenville Province is considered to have been relatively tectonically stable for the past 970 million years (Williams et al., 1992).

Southern Ontario is underlain by two paleo-depositional centres referred to as the Michigan Basin and the Appalachian Basin. The Appalachian Basin is an elongate foreland basin that parallels the Appalachian orogen and comprises primarily siliciclastic sediments. The Michigan Basin is a broadly circular carbonate-dominated, evaporite-bearing intracratonic basin. These basins are separated by the northeast-trending Algonquin and Findlay arches. These arches, along with the east-southeast-trending Chatham Sag structural depression, define a regional basement high beneath southern Ontario that extends further southwestward into the northeastern United States.

The Paleozoic succession underlying the Central Huron area was deposited within the Michigan Basin. The Paleozoic rocks have a maximum thickness of about 4,800 m at the centre of the Michigan basin; at the northeast corner of the Central Huron area the thickness is about 900 m (OGSRL, 2014). The Paleozoic strata dip gently (3.5 to 12 m/km) to the west or southwest throughout the Ontario portion of the Michigan Basin (Armstrong and Carter, 2010).

Figure 2 shows the bedrock geological map for southern Ontario, and Figure 3 shows a vertically exaggerated representative regional cross-section constructed approximately east-west about 60 km north of the Central Huron area. The location of the cross-section is shown on Figure 2. The geological cross-section (Figure 3) shows the west-southwesterly dip of the Paleozoic sedimentary formations from the Niagara Escarpment in the east to below Lake Huron in the west. The large vertical exaggeration of 50 times used in Figure 3 results in apparent moderate formation dips when, in reality, the sedimentary formations along the cross-section and within the Central Huron area are flat lying with dips of 1º or less. These moderate west-southwesterly dips result in outcrop or subcrop exposure of increasingly older sedimentary formations from west to east across southern Ontario, as shown on Figure 2.

2.2.2 Geological and Tectonic History

The structural and tectonic history of southern Ontario includes both Precambrian and Phanerozoic events. These events are described below and summarized in Table 1.

As mentioned above, the Paleozoic sedimentary sequence of southern Ontario lies unconformably on the Precambrian crystalline basement of the Grenville Province of the Canadian Shield. The Grenville Province is a complex orogenic belt that truncates several older geologic provinces. Basement rocks in southern Ontario have been affected by approximately 1,210 to 970 million year old orogenic events, referred to generally as the Grenville Orogeny. The Grenville Orogeny is generally interpreted to have involved northwest-directed thrusting and imbrication of the entire crust, presumably as a result of collision with another continental landmass originally located somewhere to the southeast. Older tectonic events including the approximately 2,700 million year old Kenoran Orogeny and the approximately 2,000-1,700 million year old Trans-Hudson/Penokean Orogeny, built the proto-North American craton upon which Grenville deformation was imprinted (Easton, 1992). Post-Grenville extension associated with rifting prior to the initial opening of the Iapetus Ocean began approximately 970 million years ago (Thomas, 2006).

Table 1 Timetable of Major Tectonic Events in Southern Ontario

Million Years Before Present	*Tectonic Activity*	*Reference*
1,210 – 1,180	Regional metamorphism in Central Metasedimentary Belt Boundary Zone (proto-Grenville)	Easton (1992), Lumbers et al. (1990), Hanmer and McEachern (1992)
1,109 – 1,087	Magmatism and formation of Midcontinent Rift	Van Schmus (1992)
1,030 – 970	Main phase of Grenville Orogeny	Carr et al. (2000), White et al. (2000)
970 – 530	Rifting and opening of the Iapetus Ocean	Thomas (2006)
530 – 320	Subsidence of Michigan Basin and uplift of Frontenac and Algonquin Arches (episodic)	Howell and van der Pluijm (1999), Sanford et al. (1985), Kesler and Carrigan (2002)
470 – 440	Taconic Orogeny • E-W to NW-SE compression, uplift in foreland (Frontenac and Algonquin Arches)	Quinlan and Beaumont (1984), Sloss (1982), McWilliams et al. (2007)
410 – 320	Caledonian/Acadian Orogeny • E-W to NW-SE compression, uplift (Frontenac and Algonquin Arches)	Gross et al. (1992), Marshak and Tabor (1989), Sutter et al. (1985), Kesler and Carrigan (2002)
300 – 250	Alleghenian Orogeny • E-W to NW-SE compression	Gross et al. (1992), Engelder and Geiser (1980)
200 – 50	• Opening of the Atlantic Ocean • St. Lawrence rift system created • Reactivation of Ottawa-Bonnechère Graben • NE-SW extension • Uplift	Kumarapeli (1976, 1985)
Pre-50 – Present	• NE-SW compression (from ridge push) • Post-glacial uplift	Barnett (1992)

The deposition of the sedimentary rocks within the Michigan and Appalachian basins was largely dependent on two tectonic influences (Johnston et al., 1992). These were the orogenic activity at the eastern margin of North America, which provided clastic input to both the Appalachian and Michigan basins, and the resultant tectonic forces that controlled the positioning of the basins and arches separating the basins. The Algonquin Arch acted as a major structural control on depositional patterns, rising and falling with respect to the Michigan and Appalachian basins in response to epirogenic movements and horizontal tectonic forces during the course of several distinct Paleozoic orogenic episodes (Howell and van der Pluijm, 1999).

Coincident with sediment deposition, the bedrock of southern Ontario was subject to a complex history of Paleozoic tectonism that included the Taconic (Ordovician), Caledonian/Acadian (Devonian) and Alleghenian (Carboniferous) orogenies (Howell and van der Pluijm, 1999). Subsequent events include the Mesozoic initiation of far field stresses associated with the opening of the Atlantic Ocean

(Jurassic), compression from global-scale plate reorganization and ridge push (late Cretaceous-Eocene), and finally post-glacial uplift (Quaternary).

2.2.3 Precambrian Geology

The geology of the Precambrian crystalline basement of the Grenville Province in southern Ontario has been well characterized by surface mapping north of the Paleozoic/Precambrian basement boundary, regional geophysical data (aeromagnetics and gravity), regional seismic reflection surveys and geochemical, geochronological and petrographic analyses of rock samples recovered from boreholes (O'Hara and Hinze, 1980; Green et al., 1988; Carr et al., 2000; Carter and Easton, 1990; Easton and Carter, 1995; Carter et al., 1996).

The Precambrian basement in southern Ontario has been grouped into two lithologic belts – the Central Gneiss Belt, located between the Grenville Front Tectonic Zone and the Central Metasedimentary Belt Boundary Zone, and the Central Metasedimentary Belt located southeast of the Central Metasedimentary Belt Boundary Zone. The Grenville Front Tectonic Zone and the Central Metasedimentary Belt Boundary Zone are major subparallel shear zones several kilometres or more in width that are generally assumed to be related to the approximately 1 billion year old Grenville Orogeny (Easton, 1992). These shear zones are characterized by strongly deformed rocks with northeast-trending, moderately to shallowly southeast-dipping tectonic layering and southeast plunging mineral lineations (Easton and Carter, 1995). Similar subparallel zones of intense deformation on a smaller scale form boundaries between lithotectonic terranes within both the Central Gneiss Belt and Central Metasedimentary Belt (Easton and Carter, 1995).

Major tectonic zones in southern Ontario are defined by extrapolation of the exposed basement structural boundaries beneath the Paleozoic cover. This process is aided by field mapping, borehole stratigraphic correlation, interpretation of seismic, aeromagnetic and gravity surveys (e.g., Boyce and Morris, 2002; Wallach et al., 1998), and by geochemical, geochronological and petrographic analyses of samples recovered from drill cuttings and core (Carter and Easton, 1990; Carter et al., 1996).

Based on aeromagnetic data and borehole samples, the Precambrian basement below the sedimentary rock cover has been subdivided into several lithotectonic domains and boundary zones similar in scale and form to those found where the Precambrian bedrock of the Grenville Province is exposed (Carter and Easton, 1990). Much of southern Ontario, including the Central Huron area, is underlain by Precambrian crystalline basement of the Central Gneiss Belt and consists mainly of quartzofeldspathic gneissic rocks that have generally been metamorphosed to upper amphibolite facies, and locally to granulite facies. Most of these gneisses are believed to be plutonic in origin, with subordinate amounts of metasedimentary gneiss.

The Huron Domain is a lithotectonic domain within the Central Gneiss Belt, and underlies the Central Huron area. The Huron Domain acted as a single crustal block during the Paleozoic. It is defined by Carter and Easton (1990), Easton and Carter (1995) and Carter et al. (1996) based on lithologic data from boreholes and published aeromagnetic maps. Geofirma Engineering Ltd. (2015) provides additional information and mapping outlining the Huron Domain and tectonic boundary zones.

2.2.4 Paleozoic Stratigraphy

Table 2 illustrates the Paleozoic bedrock stratigraphy for the Central Huron area as presented by Geofirma Engineering Ltd. (2015). The Paleozoic stratigraphic nomenclature has evolved over time and a recent compilation by Armstrong and Carter (2010) provides the current standard for usage. Two key stratigraphic designations have recently been revised. Firstly, strata traditionally referred to as Middle Ordovician, i.e., Black River and Trenton groups (from Armstrong and Carter, 2006), are now considered part of the Upper Ordovician. Secondly, the formal term Middle Silurian (from Armstrong and Carter, 2006) has been abandoned so all strata have been re-assigned to either the Lower or Upper Silurian.

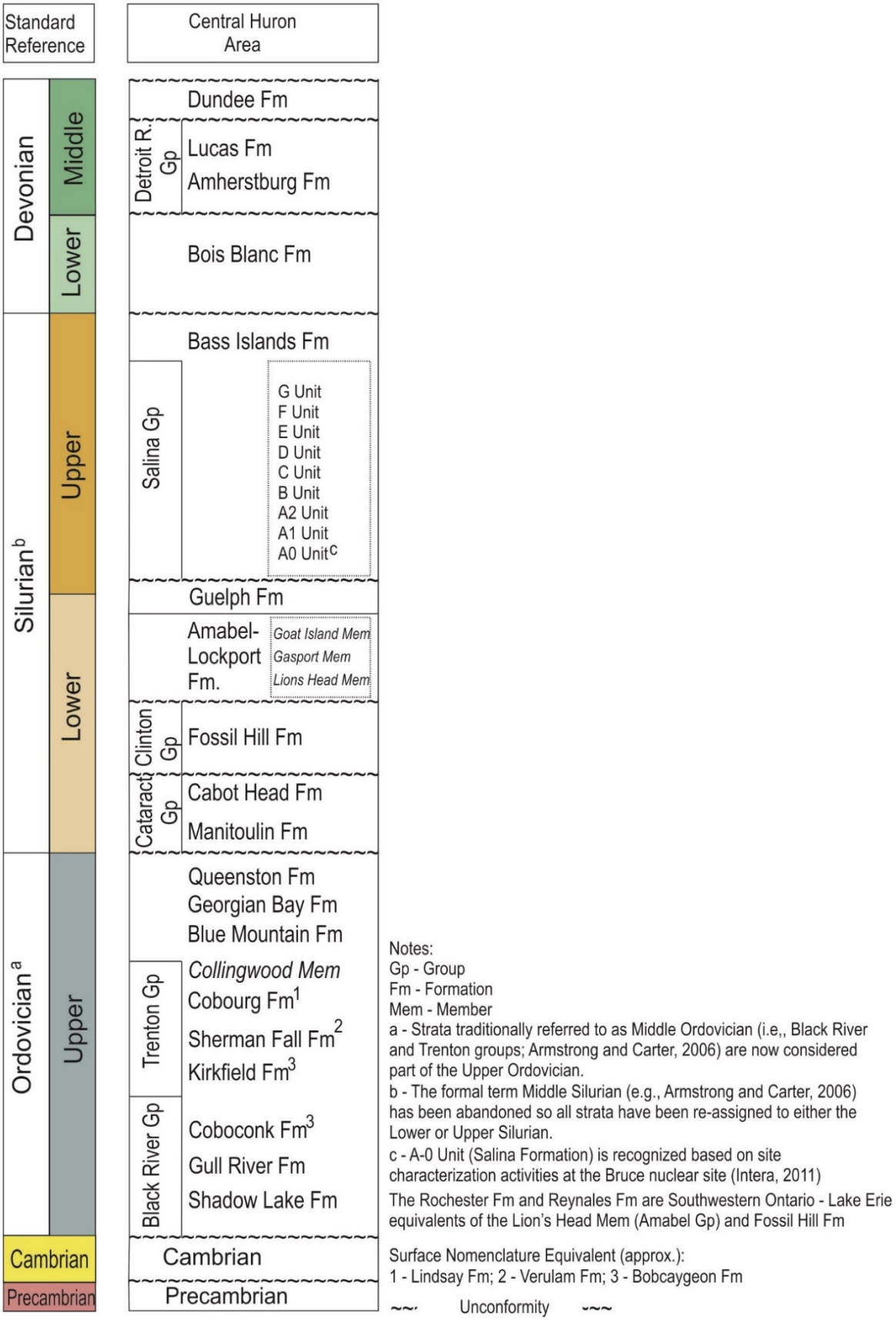
In addition, the stratigraphic nomenclature in Table 2 and Figure 3 adopts the subsurface nomenclature of Armstrong and Carter (2010), while geological mapping as shown in Figures 2 and 4 uses an outcrop nomenclature. This distinction primarily applies to the Trenton and Black River groups, where the Bobcaygeon Formation (outcrop) is equivalent to the Coboconk and Kirkfield formations (subsurface), and the Verulam and Lindsay formations (outcrop) are approximately equivalent to the Sherman Fall and Cobourg formations (subsurface), respectively.

The Paleozoic stratigraphy in the Central Huron area includes shale, carbonate and evaporite units formed predominantly from marine sediments that were deposited when this portion of eastern North America was located at tropical latitudes and intermittently covered by shallow seas (Johnson et al., 1992; Armstrong and Carter, 2010).

2.2.4.1 Cambrian

The Cambrian bedrock geology in southern Ontario is dominated by white to grey quartzose sandstone with regional lithological variations that include fine to medium crystalline dolostone, sandy dolostone, and argillaceous dolostone to fine to coarse quartzose sandstone (Hamblin, 1999). Cambrian sedimentary rocks unconformably overlie the Precambrian basement. These sedimentary rocks are generally characterized as a succession of clastic and carbonate rocks resulting from transgressive Cambrian seas that flooded across the broad platform of the Algonquin Arch and into the subsiding Michigan and Appalachian basins (Hamblin, 1999). The Cambrian units are largely absent over the Algonquin Arch as the result of a pre-Ordovician regional-scale unconformity (Bailey Geological Services Ltd. and Cochrane, 1984a). The Cambrian unit is interpreted to pinch out eastwards about 5 to 10 km east of Lake Huron (Bailey Geological Services Ltd. and Cochrane, 1984a), and thus is expected to be absent beneath most of the eastern and central parts of the Central Huron area. There are no surface exposures of the Cambrian unit in southern Ontario.

Table 2 Stratigraphy of the Central Huron Area (after Armstrong and Carter, 2010)



2.2.4.2 Upper Ordovician

Unconformably overlying the Cambrian unit is a thick sequence of Upper Ordovician sedimentary units with a distinctly bimodal composition consisting of a carbonate-rich lower unit and a shale-rich upper unit. The lower unit was deposited during a major marine transgression (Coniglio et al., 1990) prior to the westward inundation of the carbonate platform by the upper shale-dominated sediments (Hamblin, 1999). The Upper Ordovician carbonates subcrop in the northeastern part of southern Ontario around Lake Ontario and Lake Simcoe, and the Upper Ordovician shales subcrop east of the Niagara Escarpment between Owen Sound and Niagara Falls (Figure 2).

The lower carbonate unit of the Upper Ordovician succession is a thick sequence of predominantly limestone formations (carbonate and argillaceous carbonate sedimentary rocks), which include, from bottom to top: the Shadow Lake, Gull River and Coboconk formations of the Black River Group; and the Kirkfield, Sherman Fall, and Cobourg (including the Collingwood Member) formations of the Trenton Group (Table 2). These rocks range in character from coarse-grained bioclastic carbonates to carbonate mudstone with interbedded calcareous and non-calcareous shales. The Shadow Lake Formation, at the base of the Black River Group, is characterized by poorly sorted, red and green sandy shales, argillaceous and arkosic sandstones, minor sandy argillaceous dolostones and rare basal arkosic conglomerate. The lower part of the overlying Gull River Formation consists mainly of light grey to dark brown limestones and the upper part of the formation is very fine grained with thin shale beds and partings. The Coboconk Formation, at the top of the Black River Group, is composed of light grey-tan to brown-grey, medium to very thick bedded, fine to medium grained bioclastic limestones (Armstrong and Carter, 2010).

The Kirkfield Formation, at the base of the Trenton Group, is characterized by fossiliferous limestones with shaley partings and locally significant thin shale interbeds. The overlying Sherman Fall Formation ranges in lithology from dark grey argillaceous limestones interbedded with calcareous shales, found lower in the formation, to grey to tan bioclastic, fossiliferous limestones that characterize the upper portions of the formation. The overlying Cobourg Formation is described regionally as a grey, fine-grained limestone to argillaceous limestone with coarse-grained fossiliferous beds and a nodular texture. The Cobourg Formation is also subdivided to include an upper Collingwood Member that consists of dark grey to black, calcareous shales with increased organic content and distinctive fossiliferous limestone interbeds (Hamblin, 2003; Armstrong and Carter, 2010).

The upper unit of the Upper Ordovician succession is characterized by a thick sequence of predominantly shale sedimentary rocks, which comprise from base to top: the Blue Mountain, Georgian Bay and Queenston formations. The Blue Mountain Formation is characterized by uniform soft and laminated grey non-calcareous shale with minor siltstone and minor impure carbonate (Johnson et al., 1992; Hamblin, 1999). In the lower part of the Blue Mountain Formation there is downward gradation from grey to greenish-grey shales to a very dark grey to black shale (Armstrong and Carter, 2010). This lower part of the Blue Mountain Formation was historically named the Rouge River Member (Russell and Telford, 1983). The overlying Georgian Bay Formation is composed of blue-grey shale with intermittent centimetre-scale siltstone and limestone interbeds. The Queenston Formation is characterized by maroon, with lesser green, shale and siltstone with varying amounts of carbonate. The top of the Queenston Formation is marked by a regional erosional unconformity (Table 2; Armstrong and Carter, 2010).

2.2.4.3 Lower Silurian

The Lower Silurian units, including the Cataract and Clinton groups and the Amabel-Lockport and Guelph formations, unconformably overlie the Upper Ordovician shales (Table 2). A major marine transgression at the top of the Clinton Group marks the transition to deposition of the extensive carbonate-dominated Amabel and Guelph formations. These Lower Silurian units form the cap-rock of the Niagara Escarpment in outcrop. The Lower to Upper Silurian boundary occurs within the Guelph Formation (Table 2; Brunton and Dodge, 2008).

The Cataract Group unconformably overlies the Upper Ordovician Queenston Formation and includes a lower unit of grey argillaceous dolostone and minor grey-green shale, and an upper clastic unit which consists of grey to green to maroon noncalcareous shales with minor sandstone and carbonate interbeds. The Clinton Group is composed of thin- to medium-bedded, very fine- to coarse-grained fossiliferous dolostone.

The Amabel-Lockport Formation includes a lower unit of light grey to grey-brown, finely crystalline, thin- to medium-bedded, sparingly fossiliferous dolostone with minor chert nodules. It also includes an upper unit of blue-grey, fine- to coarse-grained, thick bedded to massive dolostone, which locally contains minor dolomitic limestone.

The Guelph Formation lithology varies from reefal to inter-reefal dolostones and dolo-mudstones (Armstrong and Goodman, 1990). Reefal facies represent pinnacle, patch and barrier reefs and their distribution defines the key aspects of the paleogeography during deposition. The widespread inter-reefal dolostones are typically sucrosic, dark brown to black dolo-mudstones with pebble-size fragments lithologically similar to the underlying Goat Island unit (Armstrong and Carter, 2006). Within the Central Huron area, the Guelph Formation is characterized by facies deposited between the basinward pinnacle reef belt found along the eastern shore of Lake Huron, the patch reefs found in the eastern parts of the Central Huron area, and the basin margin reef complex typically located east of the Central Huron area (Johnson et al., 1992).

2.2.4.4 Upper Silurian

The Upper Silurian units include the evaporite and evaporite-related sedimentary rocks of the Salina Group, and overlying dolostones and minor evaporites of the Bass Islands Formation (Table 2). The Upper Silurian units subcrop in a northwest trending belt that extends from south of Niagara Falls to west of Owen Sound (Figure 2). The Salina Group is characterized by repeated, cyclical deposition of carbonate, evaporite and argillaceous sedimentary rocks, comprising Units A through G. Parts of the Silurian salt beds (i.e., A2, B, D, E and F Unit salts) are present in the Central Huron area, thinning and pinching out eastward from Lake Huron (Sanford, 1993; 1977). Underground mining of salt at the Goderich Mine is from the Salina A2 Unit salt at a depth of about 550 m (Hewitt, 1962). In areas where salt has been removed by dissolution, collapse structures are present within the overlying uppermost Silurian and Devonian strata.

A change to less-restricted depositional conditions was responsible for deposition of the Bass Islands Formation, which is a microcrystalline, commonly bituminous, dolostone containing evaporite mineral clasts. The contact with the overlying Devonian carbonates marks a major unconformity characterized by subaerial exposure (Uyeno et al., 1982).

2.2.4.5 Lower and Middle Devonian

The Lower and Middle Devonian units unconformably overlie the Upper Silurian Bass Islands Formation and are dominated by carbonate sedimentary rocks of the Bois Blanc Formation, the Detroit River Group consisting of the Amherstburg and Lucas formations, and the Dundee Formation (Table 2). The Bois Blanc Formation consists of cherty, fossiliferous limestones and argillaceous dolostones that unconformably overlie Silurian strata. The Amherstburg Formation is a bituminous bioclastic fossiliferous limestone and dolostone (Table 2). The Lucas Formation is a fine-crystalline, fossiliferous dolostone and limestone and subcrops in the northeast and north-central parts of the Central Huron area, mostly outside of the Municipality. The Dundee Formation, which is the dominant subcropping bedrock formation within the Municipality of Central Huron (Figure 4), comprises sparsely fossiliferous limestones and minor dolostones that unconformably overly the Detroit River Group.

2.2.5 Faulting of the Paleozoic Strata

Figure 2 shows basement-seated faults that displace the Paleozoic strata in southern Ontario. These faults were compiled from several sources by the Ontario Geological Survey (Armstrong and Carter, 2010) and given relative ages based on the youngest geological unit that is offset: i) Shadow Lake/Precambrian, ii) Trenton Group and iii) Rochester Formation (Silurian-aged; equivalent to Lions Head Member of the Amabel-Lockport Formation in Table 2). These faults are interpreted based on vertical displacements of key unit-top surfaces in the Paleozoic strata, based on earlier compilation and assessment work completed by Brigham (1971) and Bailey Geological Services Ltd. and Cochrane (1984a; 1984b). Vertical displacement of unit top surfaces was identified based primarily on hand contouring and interpretation of formation top data in the Petroleum Wells Subsurface Database (OGSRL, 2014). Where these data are numerous, such as in the southwestern corner of southern Ontario, the faults are identified with a high degree of confidence, and are often named (e.g., Dawn Fault and Electric Fault). In areas where oil and gas exploration wells are widely spaced, faults are identified with a low degree of confidence. As shown in Figure 4, there are no OGS mapped faults within the Central Huron area. As described in Section 5.3, the interpretation of historic 2D seismic Line A000300528 in the Municipality did not identify any faults.

2.3 Quaternary Geology

Information on Quaternary geology in the Central Huron area is described in detail in the Terrain and Remote Sensing Study Report (JDMA, 2015) and a summary of that information is provided here.

Quaternary glaciations have played a major role in shaping and creating the landscape of southern Ontario (Barnett, 1992). Glacial landforms and associated sediments within the Central Huron area were formed and deposited by the Huron and Georgian Bay lobes of the Laurentide Ice Sheet during the Late Wisconsinan 23,000 to 10,000 years ago. Exposures of older deposits are rare as they are mostly buried beneath the Late Wisconsinan sediments and can only be seen in such places as riverbank exposures, lake bluffs or man-made exposures in quarries and pits (Barnett, 1992). The surficial deposits of the Central Huron area have been mapped at the scale of 1:50,000 by Cooper and Fitzgerald (1977), Cooper et al., (1977) and Cowan et al. (1986).

Overburden thickness in the Central Huron area ranges from zero up to about 91 m with an average thickness of 28 m (Gao et al., 2006). Within the Municipality the overburden thickness ranges from

zero to 80 m with an average of 31 m. The thickest overburden in the area is associated areas of high relief and elevation, and with till moraines and kame moraines, particularly the Wyoming Moraine and the northeast extension of the Wawanosh Moraine (Figure 5). The thinnest drift occurs along the Maitland and South Maitland rivers where bedrock is exposed locally in the channels. Overburden thickness generally increases from east to west across the Municipality.

Figure 5 shows the surficial Quaternary geology of the Central Huron area. Table 3 provides a summary in percentages of the areal extent of the different surficial deposits mapped within the Central Huron area and within the Municipality.

Table 3 Extent of Surficial Deposits Based on Primary Genesis of Deposit

Area	*Primary genesis (expressed as % area)*						
	Fluvial	*Glacial Morainal*	*Glacio-fluvial*	*Glacio-lacustrine*	*Lacustrine*	*Organic*	*Bedrock*
Municipality of Central Huron	2.0	45.8	34.2	17.8	0.0	0.1	0.1
Central Huron Area	2.4	53.4	26.3	17.0	0.1	0.7	0.1

Glacial morainal deposits occur extensively throughout the Central Huron area covering 53.4% of the area and consisting of, in decreasing order of abundance, the Rannoch Till, the St. Joseph Till and the Elma Till. Glaciofluvial deposits consisting primarily of sand or sand and gravel are exposed over 26.3% of the Central Huron area. These glaciofluvial deposits are associated with kames, eskers and outwash plains. Glaciolacustrine deposits are exposed over 17.0% of the Central Huron area, with about 79% of these deposits mapped as fine-grained sediments consisting of silts and clays and the remaining 21% as sand or sand and gravel. Other surficial deposits including fluvial, lacustrine, organic and bedrock are all relatively minor occurrences in the Central Huron area.

The eastern part of the Municipality is characterized by thin drift, low relief, high elevation and low permeability surficial deposits principally comprised of Rannoch Till of the Stratford till plain. The central part of the Municipality is dominated by a very hummocky and irregular area of topography underlain largely by glaciofluvial deposits associated with the Wawanosh Moraine. Ice-contact deposits of sand and gravel are abundant in this area. The ice-contact deposits in the Wawanosh Moraine overlie Elma Till and locally underlie Rannoch Till. The Wyoming Moraine represents a north-south trending band of hummocky topography about 5 to 6 km wide located in the western part of the Municipality. A network of meltwater channels extends between the Wawanosh and Wyoming moraines and in the valleys of the Maitland and Bayfield rivers (Figure 5). The westernmost part of the Municipality along Lake Huron is characterized by a bevelled till plain with shallow deposits of permeable sand overlying several metres of silt and clay.

2.4 Land Use

Land use within the Central Huron area consists mostly of agricultural lands, wetlands, forested areas, and developed/built-up areas with residential, commercial and industrial land uses. Wetlands and forested areas represent 5.6 % and 15.6 % respectively of the Central Huron area.

3 DATA SOURCES AND LIMITATIONS

Two main tasks were undertaken during this study including an assessment of borehole geophysical data and 2D seismic data interpretation. The data sources used for each of these tasks and the respective limitations to each data source are described below.

3.1 Source Data for Borehole Geophysics Study

Borehole data used for the borehole geophysics component of this assessment were obtained from the Oil, Gas and Salt Resources Library database (OGSRL, 2014). This database includes six boreholes drilled and tested as part of the site characterization work completed at the Bruce nuclear site about 50 km north of the Central Huron area (Intera Engineering Ltd., 2011) and two boreholes drilled as part of the shaft investigation (Sterling, 2011). The OGSRL contains a database with information on depths to the top of each bedrock formation intersected, as well as borehole geophysical data and core data when these are available. The amount of core available for the Central Huron area is limited to four wells, with only one well within the Municipality. All boreholes in the OGSRL database have data pertaining to the bedrock formation tops provided in the Ministry of Natural Resources (MNR) Form 7 submission, and several of the boreholes also have updated formation tops provided by an MNR geologist.

Borehole data as of December 2014 was obtained from the OGSRL database for the Central Huron area and its surrounding region (OGSRL, 2014). This was done to provide a regional context to the assessment, which is needed for subsequent tasks such as creating cross-sections through the Municipality. In total, data from 335 boreholes were obtained from the OGSRL database for the Central Huron area and its surrounding region. Two of these boreholes (T012177 and T012326) were drilled after the geoscientific desktop preliminary assessment for the Municipalities of Arran-Elderslie, Brockton and South Bruce, Township of Huron-Kinloss and Town of Saugeen Shores (Geofirma Engineering Ltd., 2015) was completed. Both of these additional boreholes are located in Goderich, Ontario and outside of the Municipality of Central Huron.

Quality assurance checks (Section 4.1.1) identified 75 of the 335 total number of OGSRL boreholes as not being of sufficient quality for use in this assessment, leaving 260 remaining boreholes with reliable data. A variety of borehole geophysical logs are available for boreholes in the Central Huron area and surrounding region, including gamma ray, neutron, sonic, and density. The most useful of these geophysical logs for the purpose of this study were: gamma ray (GR) and neutron logs (NL) for interpretation of formation tops; and sonic logs for correlation and interpretation of 2D seismic data. Of the 260 quality-checked boreholes (Section 4.1.1) available, 111 have useable gamma ray and/or neutron log data for the purpose of this study. A total of 48 boreholes documented in the OGSRL are located with the Municipality of Central Huron, however only 43 were considered to be of sufficient quality for use in this assessment as discussed in Section 4.1.1. Twenty boreholes have borehole geophysical data available.

Figure 4 shows the location of the OGSRL boreholes in the Central Huron area. Appendix A lists the characteristics of the boreholes obtained for the Central Huron area and its surrounding region, including: MNR license number, well name, operator name, purpose, UTM coordinates, total depth, deepest formation intersected, date of drilling, and an indication of additional data available such as geophysical logs on record, and rock core in archive.

For the construction of the geological cross-sections, the following additional data sources were also used: the Ontario Ministry of Northern Development and Mines (MNDM) Miscellaneous Release Data 207 titled *Bedrock Topography and Overburden Thickness Mapping, Southern Ontario* (Gao et al., 2006); and the ground surface elevation data defined by a topographic model created from Shuttle Radar Topographic Mission (SRTM) data provided by National Aeronautical and Space Administration (NASA, 2006). Gao et al (2006) compiled data from approximately 253,000 data points (including outcrop mapping, oil and gas well records, geotechnical drill records and 180,000 domestic water wells records) to establish the depth to the top of the bedrock surface. The ground surface elevation data used in this study (SRTM) has a resolution of 90 m, and was smoothed to produce a dataset with a resolution of 500 m to match other formation top surfaces. This dataset is considered to be sufficient for the purpose for which it was used in this study.

3.2 Source Data for 2D Seismic Study

Figure 4 shows all of the known 2D seismic data that were potentially available for purchase within the Central Huron area. In addition, Figure 4 also indicates the portions of 2D seismic data that were acquired for this assessment.

Sigma Explorations Inc., a seismic data brokerage company based in Calgary, was retained to provide a list of available seismic lines within the Central Huron area. Portions of the available lines were reviewed for quality, location and data acquisition parameters. Based on this assessment, data from one seismic line (A000300528) was purchased within the Municipality of Central Huron. This line was selected for use in this study based mostly on its length (it was one of the longest lines available) and its location in the central portion of the Municipality, and in proximity to known pinnacle reefs. Line A000300528 is 9.9 km long and is oriented north-south (Figure 4). It was collected by Shell Canada in 1977, which also currently owns the rights to the data. Table 4 summarizes the acquisition parameters of the seismic data associated with this seismic line.

The entire 9.9 km of data associated with Line A000300528 was purchased for this assessment as defined in Table 4 by the beginning of line (BOL) and end of line (EOL) station numbers, where the station number represents the position of the receivers along the seismic array. Source (Sx) and receiver spacing (Rx) were both set to increments of 20 m along the survey line. Source spacing is defined as the incremental spacing between shot points, while receiver spacing is the incremental spacing between receivers. The subsurface lateral sampling of the final processed wiggle trace is approximately half of the receiver interval spacing, therefore a 20 m receiver spacing interval results in a 10 m common midpoint (CMP) sampling. The number of traces (NTR) used by the acquisition system is equal to the number of receivers recorded for each source station. A fold of 24 is essentially the number of times the same common reflection point (CRP) is sampled in the subsurface. The CRP represents the same reflection point on a seismic horizon that is generally located half way between the source point and seismic receiver point. The fold is calculated simply as the receiver spacing multiplied by the number of channels divided by two times the source spacing.

Field filters were used during acquisition to minimize unwanted noise that would saturate the amplifiers in the instruments; modern instruments have broader dynamic range and do not require field filters. These data were acquired using 0.2 kg of dynamite as the energy source (charge) at source stations separated incrementally by 20 m spacing. At each source station the energy source

was positioned at a depth of 6 m below ground surface (mBGS). More specific detail regarding the recording and processing parameters used for Line A000300528 is included in Appendix B.

Table 4 Summary of 2D Seismic Data Acquired for Study

Line	***A000300528***
Beginning of Line (BOL)	400
End of Line (EOL)	895
Source Spacing (Sx)	20 m
Receiver Spacing (Rx)	20 m
Length (L)	9.9 km
Owner at Acquisition	Shell Canada
Current Data Owner	Shell Canada
Date Acquired	1977
Instrument	DFS IV
Charge	0.2 kg
Depth	6 m
Number of Traces (NTR)	48
Fold	24
Far offset	520 m
Field filter	0-128 Hz and 60 Hz Notch

3.3 Data Limitations

The main limitation associated with the borehole geophysical data is their sparse spatial distribution in the Central Huron area and its surrounding region. It is common for any two boreholes within the Central Huron area to be 3 to 5 km apart on average (Figure 4). Furthermore, very few boreholes extend through the entire sequence of Paleozoic bedrock; therefore vertical control is limited on some of the deeper bedrock formations (e.g. Ordovician and Cambrian formations). In addition, the number of boreholes within the Central Huron area and surrounding region that contain usable geophysical data for determining formation contacts is approximately 33 % (111 out of 336), as discussed in Section 3.1. Formation tops at boreholes without useable geophysics data were taken as the values listed in the OGSRL database.

Another limitation associated with the borehole geophysical data is that their quality is variable, owing to the historical nature of the collected data. Some geophysical logs were acquired in the 1970's, and as a result formation contacts are in some cases difficult to distinguish as sharp signal contrasts, especially in comparison to more recently acquired borehole geophysical data (e.g., Intera Engineering Ltd., 2011). This is primarily due to the logging parameters used, particularly logging speed. It is common for contractors in the oil and gas industry to use logging speeds of 18 m per minute (m/min) or greater, while the high resolution datasets for the Bruce DGR boreholes were completed using logging speeds of approximately 3 m/min. In order to mitigate against this limitation a workflow was devised in which the geophysical interpretation was limited to those formations tops whose geophysical character or transitional pattern was most discernible and distinct (Section 4.1.2).

Limitations of the 2D seismic data are primarily attributed to data quality issues, which can be attributed to near surface conditions and/or data collection methods including limitations in equipment technology when these data were collected in 1977. The data for Line A000300528 were acquired with 48 channel seismographs and 20 m station spacing which compared to modern standards is below optimal. For comparison, data typical of modern seismic acquisition is usually collected with 480 channel seismographs using 10 m station spacing. Finally, the overburden heterogeneity and thickness within the Municipality had a detrimental effect on data quality. This limitation would still be valid today using modern equipment and collection methods and is a well known limitation of seismic methods for areas within southwestern Ontario north of Lambton County.

Station spacing is essentially representative of the lateral sampling interval. For example, 30 m station spacing results in a common reflection point (CRP) spacing of 15 m, compared to a seismic survey with 20 m station spacing which results in a CRP of 10 m. For comparison, modern parameters typically include spacings of 10 m resulting in a CRP of 5 m, essentially 200 % greater than the 10 m CRP acquired on Lines A000300528. In simple terms a 30 m wide geologic feature would have only three sample traces at 10 m spacing whereas with 5 m spacing it would have 5 samples or subsurface traces. A feature such as a reef within the Silurian would typically be 200 - 300 m across and be more difficult to see with a 10 m sampling interval of the older acquisition parameters. Modern systems also enable higher frequency recording, hence better vertical resolution; higher fold or subsurface fold multiplicity thus gives much higher confidence in the final results; and finally broader dynamic range available with modern 24 bit systems provides the ability to separate meaningful signal from background noise.

The Central Huron area is known to be a difficult area to collect high quality seismic data due to the thickness and heterogeneity of the overburden material. Seismic signals emanated from the source pulse are attenuated through the overburden and reflected and refracted at the overburden-bedrock interface; reflected and transmitted through acoustic boundaries within the bedrock and then returned back up through the overburden to the recording receivers. Although refraction statistical models attempt to remove the effects of the overburden layer by calculating its characteristics and replacing with a standardized layer, the seismic signal-to-noise ratio is reduced dramatically by the often thick and irregular overburden layer typical of the Central Huron area. Modern recording systems with broader dynamic signal recording range have enabled seismic methods to improve the signal-to-noise ratio typical of this area.

An additional limitation of the historical 2D seismic data acquired for this study is that most of the line does not lie close to high quality borehole data that can provide geological constraints to the seismic

data interpretation. Three sonic logs are located at a distance of 0.7 to 3.2 km off section. Although this information is helpful in the interpretation, the distance from the section makes it difficult to calibrate the interpreted seismic horizons to the tops of formations known from geological logs.

4 METHODOLOGY

4.1 Workflow for Borehole Geophysical Data Interpretation

The borehole geophysical data interpretation included four distinct tasks: acquisition and quality check of borehole geophysical data; selection of key formation tops to consider for the reinterpretation of geophysical data; generation of an updated dataset of key formation tops; and creation of geological cross-sections through the Municipality of Central Huron. The following sections describe each of these tasks in detail.

Reinterpretation of key formation tops was based on geophysical data only, given the limited amount of core available for the Central Huron area. Only four wells in the Central Huron area have core data, with only one of them within the Municipality.

4.1.1 Quality Check of OGSRL Borehole Data

As discussed in Section 3.1, a total of 335 boreholes had geological data available from the OGSRL database for the Central Huron area and its surrounding region, 260 of which were considered to be of sufficient quality for use in this assessment. The rationale for discarding the data from the remaining 75 boreholes included a variety of reasons, such as:

- The borehole did not intersect any of the key formation tops;
- The OGSRL borehole data did not have a ground surface elevation;
- The total vertical depth associated with the borehole was not reliable; and,
- The geophysical logs were unreliable due to depth issues or poor quality data.

4.1.2 Selection of Key Formation Tops

The selection of key formation tops for reinterpretation in the borehole geophysical data assessment took into consideration the following: historical formation tops from the OGSRL database to assess stratigraphic variations throughout the Central Huron area and its surrounding region; formation tops interpreted by Armstrong and Carter (2010); and formation tops interpreted from geophysical data in eight boreholes drilled at the Bruce nuclear site (Intera Engineering Ltd., 2011; Sterling, 2011). As a result, eight key formations tops were defined (Table 5) based on:

- Ability to interpret the formation top using borehole geophysical data and to consistently identify these same formation tops in boreholes throughout the Central Huron area and its surrounding region;
- Geological significance of the Paleozoic formation packages defined by these key formation tops for the overall objective of the geoscientific desktop preliminary assessment; and,
- Grouping of Paleozoic formations to provide a reasonable dataset for use in gravity stripping as discussed in the geophysics interpretation report (PGW, 2015).

As shown in Table 5, a rationale for identifying the key formation tops was established to ensure that they were interpreted consistently at every borehole. Table 5 also lists the stratigraphic packages defined by the key formation tops that formed the basis for creating the cross-sections through the Municipality of Central Huron (Section 4.1.4). The rationale for identifying the top depth of each key

formation was selected to remain consistent with the approach taken by Armstrong and Carter (2010), and Intera Engineering Ltd. (2011) at the Bruce nuclear site, which involved discussions with geologists of the Ministry of Natural Resources (MNR) and the Ontario Geological Survey (OGS).

This rationale is premised on selecting an easily identifiable inflection point of the appropriate geophysical curves for each individual key formation top. Differences between the historical formation top depths in the OGSRL and the depths identified during the reinterpretation of geophysical logs may be the result of geophysical logging acquisition parameters (e.g. cable stretch, tool speed, frequency of data collection) that result in depth offsets, but no attempt to reconcile such potential depth differences was attempted during this work.

When the reinterpretation of a key formation top overlapped or created a conflict with the historic under/overlying formation top pick, the conflicting formation top was also reinterpreted (although the confidence of such reinterpretation was lower). As discussed in Section 5.1.1, conflicts arose with the Cobourg (Lower Member) and Gull River formation tops as a consequence of the reinterpretation of the overlying Cobourg (Collingwood Member) and the Coboconk formations. Such conflicts had no impact on the resulting cross-sections included herein, as the Cobourg (Lower Member) and Gull River formations were not defined as key formation tops for this study.

Table 5 Summary of Key Formation Tops and Rationale for Identification Based on Geophysical Logs

Formation Top	*Rationale*	*Confidence*	*Stratigraphic Package*
Bass Islands	increase in neutron log associated with higher permeability "aquifer"	Low to Medium	Silurian
Salina (G-Unit)	last gamma spike (large) ~9m above F-shale and start of drop in NL (last NL trough before higher GR plateau of F-shale); upper gamma peak if double	Medium to High	
Salina (F-Unit)	Sharp increase in gamma ray above Cabot Head	High	
Cabot Head	sharp gamma increase above Queenston and sharp decrease in NL	High	
Queenston	top of gamma plateau and sharp decrease in NL	High	Upper Ordovician Shales
Cobourg (Collingwood)	base of sharp, significant gamma plateau	High	Upper Ordovician Limestones
Coboconk	base of gamma plateau (Kirkfield) and approximately 6m above largest gamma peak in Coboconk	Medium	
Precambrian	Increase and spiky gamma ray	Low to Medium based on limited log data	n/a

Table 5 lists the general level of confidence (low, medium, high) to consistently pick the same key formation top throughout all boreholes in the Central Huron area and its surrounding region. Figure 6 shows examples of gamma ray and neutron logs for the eight key formation tops, demonstrating the rationale. It is worth noting that, while wells shown on Figure 6 lie outside of the Central Huron area, they are representative of the log responses in wells within the area. Generally, the highest level of

confidence was assigned to those key formation tops with obvious and consistent changes in gamma ray or neutron logs, such as the Salina Group F-Unit, the Cabot Head Formation, Queenston Formation, and the Collingwood Member of the Cobourg Formation (Figure 6). The Salina G unit could also be picked with a high degree of confidence in some cases; however, this formation top was not always as clearly distinguishable in all borehole logs. In wells where the Bass Islands Formation and Precambrian basement are intersected, their tops were distinguishable in the borehole geophysical logs; however, their gamma ray or neutron log signatures were less consistent between boreholes and were therefore attributed a lower confidence.

It is worth noting that even though the Central Huron area lies within the Guelph Formation pinnacle reef belt (Section 2.2.4.3), the top of this formation was deemed not to be a clear, high confidence pick on borehole geophysical data and so it was not reinterpreted as part of this study. The same can be said with regard to salt beds within the Salina Group, which were not clearly discernible from borehole geophysical data.

4.1.3 Updated Database for Key Formation Tops

An updated database for the key formation tops listed in Table 5 was compiled for the boreholes used as part of this assessment. This updated database includes:

- Key formation top depths reinterpreted as part of this study using borehole geophysical logs; and
- Historical key formation top depths from the OGSRL database for those wells where no geophysical data was available for reinterpretation. In these cases the MNR picks from the OGSRL database, as opposed to the Form 7 picks, were used when available as they include quality control checks completed by the MNR.

Generally, the steps followed to create this database included:

a) Tabulate top depths for key formations in all boreholes within the Central Huron area and its surrounding region as listed in the OGSRL database (Section 3.1);

b) Reinterpret key formation top depths in boreholes with useable gamma ray or neutron geophysical log data;

c) Update the OGSRL top depths of key formations with the reinterpreted formation top depths; and,

d) Remove borehole entries flagged to contain unreliable data as discussed in Section 4.1.1. (Quality Checks).

The one exception to step (c) above involved the reinterpreted top depths for the Cobourg Formation - Collingwood Member. The rationale used as part of this study, which is consistent with that used by Intera Engineering Ltd. (2011), identified the large, sharp decrease in gamma signal which corresponds to the top of the Cobourg Formation being called the Cobourg Formation – Collingwood Member. Most historical OGSRL formation top entries do not follow this rationale and instead identify this same large, sharp gamma decrease as simply the top of the Cobourg Formation while sometimes identifying the Collingwood “Formation” above the Cobourg and associating it with the top of the Rouge River Member of the Blue Mountain Formation. This discrepancy is addressed by interpreting the historical Cobourg Formation top depths in the OGSRL database to correlate with the newly picked Cobourg Formation – Collingwood Member top depths identified from boreholes with useful

geophysics logs as part of this study. Therefore, the updated database for key formation tops more consistently identifies the Cobourg Formation - Collingwood Member.

The depth of the key formation tops included in the updated database are expressed in units of metres below ground surface (mBGS). The updated key formation tops dataset was used to create the geological cross-sections shown and discussed later in this report (Section 4.1.4), as well as for gravity stripping (PGW, 2015).

4.1.4 Creation of Cross-Sections

Two stratigraphic cross-sections were created to illustrate the depths and thicknesses of the Paleozoic stratigraphic packages defined by the key formation tops (Table 5) within the Central Huron area (Figures 8 and 9). It was necessary to use borehole data from outside of the Central Huron area to complete some of the cross-sections due to a lack of data within this area. For this reason Figure 7, which shows the location of the cross-sections, encompasses a slightly larger area than the Central Huron area. A 25X vertical exaggeration was employed in the construction of the cross-sections shown in Figures 8 and 9.

The orientation and location of each cross-section was selected to maximize subsurface coverage both parallel and perpendicular to the regional northwesterly strike of formations across the Central Huron area. In creating the cross-sections, effort was made to use the highest confidence data available, including boreholes with available geophysical data and those referenced by Armstrong and Carter (2010), as control points. However, due to the limited availability of geophysical data, and to the generally low density of deep boreholes across the area, additional boreholes without accompanying geophysical data were also used in constructing the cross-sections. In these latter cases, data on the depth to the key formation tops were obtained from the OGSRL database (OGSRL, 2014) aside from the top of Cobourg Formation - Collingwood Member, as discussed in Section 4.1.3. Solid and dashed lines are utilized to indicate where confidence was higher (solid) versus lower (dashed) in extending key formation top surfaces across the cross-sections (Figures 8 and 9). Solid lines were used when there were borehole data to define both ends of the straight line; conversely, dashed lines were used when the formation top surface was only defined at one end and the data needed to be extrapolated to define the other end. The cross-sections created also present gamma ray log data where they exist, location of known reefs, the Cambrian unit where present, as well as the ground surface and top of bedrock surfaces.

4.2 Workflow for 2D Seismic Data Interpretation

4.2.1 2D Seismic Data Processing

Standard 2D seismic data processing has been applied, including elevation statistics, refraction statics, amplitude balancing, pre-stack noise reduction, deconvolution, move out correction, residual statistics, post-stack spectral whitening and post stack time migration. This workflow is consistent with typical data processing routinely used for oil and gas exploration in this area. Appendix B presents the details of the recording and processing parameters for the 2D seismic line used as part of this assessment.

These 2D seismic data were provided as shot gathers in digital form, including survey information and observer notes detailing the location of each shot gather and corresponding channels. The data

processing steps used as part of the 2D seismic interpretation included:

- *Elevation and Refraction Statistics:* The shot gathers were analyzed for the first seismic-signal arrival time using a refraction program to estimate the thickness of the drift layer or shallow low velocity layer. The variable velocity and thicknesses of the weathered bedrock (or overburden layer) were calculated for each source and receiver point. A time was calculated to replace the time delays resulting from these variations with a replacement elevation (400m) and velocity (3700 m/s) to correct for the calculated time delays for each source and receiver point. This replacement elevation is approximately the highest elevation within the area of interest and this replacement velocity is the highest rock velocity calculated with the refraction analysis. This is known as a weathering static correction. In addition, the effects of variable elevations were similarly corrected to provide a floating surface in time enabling accurate comparison of the subsequent seismic section to reflect true stratigraphy in time.
- *Amplitude Balancing:* A spherical divergence correction was applied to the amplitudes as well as a low frequency envelope to attempt to scale the data to highlight the reflection events
- *Pre-Stack Noise Reduction:* A signal velocity filter is used to remove the effects of the ground roll, a low frequency filter of 4-20 Hz and a low velocity filter of 300-2000 m/s was used.
- *Deconvolution:* A deconvolution filter was used along with spectral whitening to enhance the high frequency reflections events that correspond to velocity/density stratigraphy within the geology. A spiking deconvolution process with 3 % pre-whitening and a 40 ms operator length was used.

After the above data processing was completed, these 2D seismic data were stacked into common reflection point cross-sections. During this stacking process, the following data processing steps were followed:

- *Residual Statics:* Not all of the time delays can be captured with the refraction statics so a process of analyzing common shot gathers and common receiver gathers is used to assess additional time delays that occur for all recorded traces that are common to a source or receiver point.
- *Move Out Correction:* Hyperbolic reflection events depicted in the shot gathers were corrected for velocity and stacked into sections using a normal move out method. A number of iterative steps of residual static correction and velocity analysis were completed prior to arriving at the final reflection sections.
- *Post-stack Spectral Whitening:* The frequency spectrum was balanced to optimize the sections for geologic interpretation. This process is also known as post-stack noise reduction.
- *Post-stack Time Migration:* These final reflection sections were then processed using migration methods which correct the dips relative to lateral location and helps to filter random noise. 100 % of the stacking velocity, max dip of 25 degrees and frequency range of 10-115 Hz were the parameters set for the FX migration algorithm. The final plot was filtered with a bandpass filter of 10/20-70/80Hz which is relatively limited to attempt to highlight the reflection events.

Appendix D includes the processed 2D seismic data that were used in this study. The final processed 2D seismic section for Line A000300528 is shown in Figure 13. The top of this figure shows the ground elevation as well as the results of the refraction interpretation of the overburden thickness and velocities. These results were used to correct for near surface time delays within the processing of the final time sections below.

This final processed data set was then loaded into Winpics 5.9.0 workstation geo-referenced to the well, culture and land database in NAD83 UTM zone 17N, metres.

4.2.2 Creation of Synthetic Seismograms

Seismic reflection data are initially only available in the time domain. In order that the geology encountered in a borehole can be tied to the seismic data, a 1D synthetic seismogram is generated. This is important in identifying the origin of seismic reflections seen on the seismic data. Density and velocity data are routinely measured down the borehole using wireline logging tools. These logs provide data with a sampling interval much smaller than the vertical resolution of the seismic data. Sonic logs, also referred to as acoustic impedance logs, are measures of the signal velocity versus distance between source and receiver (travel time) within the bedrock formations encountered in a borehole. These acoustic impedance logs were combined with the velocity data to generate a reflection coefficient series in time. This series is convolved with a seismic wavelet to produce the synthetic seismogram. The input seismic wavelet is chosen to match as closely as possible to that produced during the original seismic acquisition, paying particular attention to phase and frequency content. The spectral band width of the data processing was identified by analyzing the processed sections using a Fourier transform around the window of interest and determined to be 0 phase 20-70 Hz.

Three sonic logs in digital LAS format were obtained from the OGSR library (OGSRL, 2014). These were chosen as they were the closest sonic logs to the seismic line. Borehole T005166 is a abandoned gas well within the 133 m thick Tipperary Pool reef and is located approximately 745 m west of the` southern end of the seismic line near station 497. Borehole T005326 is a dry borehole located approximately 3.2 km to the east of station 757, about one third of the way down from the north end of the seismic line. Borehole T010054 is an abandoned borehole located approximately 2.5 km west of the north end of the line. All of the sonic logs within these wells were limited to the Silurian section starting with the Salina Group G Unit shale and ending within the Cabot Head Formation. Without any of the sonic logs penetrating deeper into the Ordovician formations, interpretation of these deeper seismic horizons is based on previous experience within Southern Ontario (Geofirma Engineering Ltd., 2014). Sonic and pseudo-density logs were used to generate an acoustic impedance reflectivity sequence and their corresponding reflection coefficients. Pseudo-density was calculated following the empirical formula as outlined by Gardner et al. (1974) which multiplies signal velocity (in units of m/s) to the power of 1.4 by an empirical constant value of 0.31. These reflection coefficients were convolved using an Ormsby wavelet with 10/20-70/80 Hz corners (wavelet #1) and a Klauder wavelet sweep length 10-70 Hz with 0.5 s tapers (wavelet #2) to generate a synthetic seismogram that can be tied to the seismic sections. The details of the exact wavelets are shown at the bottom of Figures 10, 11 and 12 as wavelets in time with their amplitude spectrum details. The depths to bedrock formations are known within these boreholes, therefore the seismic section depicted in time can be correlated to a synthetic seismogram that was created by converting formation depths in a borehole log to travel time.

Figures 10, 11 and 12 depict the resulting synthetic seismograms, sonic velocity, pseudo-density, and acoustic impedance with the known geologic tops from OGSRL boreholes T005166, T005326 and T010054, respectively, to show the resulting seismic markers on the seismic sections.

These synthetic seismograms were created to assist with the interpretation of seismic markers. Although these synthetic seismograms generated from the OGSRL sonic logs are off of the seismic section, they are tied to the processed lines in a general way in order to assist with identifying the reflection markers on the 2D seismic sections. Details of the horizons picked are discussed below as part of the interpretation of each seismic line and are largely based on seismic markers identified on the synthetic seismograms.

4.2.3 Interpretation of Synthetic Seismograms

Final digital files of the processed 2D seismic lines were compared to ground surface elevations and geological information from existing borehole data for interpretation. Figures 10 through 12 depict key markers used in the geologic borehole study, where present on the log, as well as key seismic markers known to have good reflectivity. Key markers identified, using the synthetic seismograms, are the Salina Group G-Unit, B-Unit, A2-Carbonate Unit, and A1-Carbonate Unit (lower-upper Silurian), the Fossil Hill Formation (base of Lion's Head, lower Silurian), and the Cabot Head/Queenston Formation (base of Silurian). Without any of the sonic logs penetrating deeper into the Ordovician formations it is not possible to make any absolute ties to the Cobourg, Coboconk or Precambrian seismic horizons. Table 6 summarizes the observable seismic markers with a brief description of their quality and their appearance in the seismograms as either a peak or a trough.

Table 6 Summary of 2D Seismic Markers

Seismic Marker	*Peak/Trough (normal polarity plots)*	*Quality*	*Geologic Time*
Bass Islands/G-unit	Trough	Low reflection coefficient	Top Silurian
B-unit	Trough	Good when thick enough and/or present	Upper Silurian
A2-Carb	Peak	Excellent marker, strong reflection coefficient	Upper Silurian
A1-Carb	Peak	Excellent Carbonate seismic marker as a package with the A2 carbonate/salt above	Upper Silurian
Fossil Hill	Peak	Good marker	Lower Silurian
Cabot Head/Queenston	Trough	Good marker	Base Silurian
Cobourg*	Peak	Excellent reflector	Upper Ordovician
Coboconk*	Trough	Very weak reflector	Upper Ordovician
Shadow Lake/Precambrian*	Trough	Very weak reflector	Precambrian

* Summary of seismic markers is based on inferences from Geofirma Engineering Ltd., 2014

The Cabot Head, Manitoulin, and Queenston formations are all difficult to distinguish from each other, and although the true seismic reflector is likely the hard carbonate Manitoulin Formation, this seismic marker is termed the Cabot Head/Queenston reflector for the purpose of this report to remain consistent with the key formation tops identified using borehole geophysical logs. Although sonic log

information on the Ordovician formations was not available near the seismic line, some inferences can be made from synthetic seismograms generated from other sonic logs in the region (Geofirma Engineering Ltd., 2014).

Vertical resolvability of the individual geologic packages is very limited by the frequency of the recorded data and thickness of each package. Using a dominant frequency of 40 Hz based on the amplitude spectrum depicted in Section 4.2.2, the minimum resolvable layer is roughly 22 m. This minimum resolvable layer thickness is approximated as a quarter of the wavelength, assuming an average velocity of 3500 m/s, and a dominant source pulse frequency of 40 Hz (0.025 seconds). As an example, within borehole T005166 the Goat Island Formation is identified to be approximately 12 m thick, thereby making it difficult to interpret. The portion of the seismic wavelet identified in the borehole data related to the top of the Goat Island Formation corresponds to the cross-over between positive and negative peaks. Below the Goat Island pick a strong seismic reflection is due to the hard carbonate Rochester Formation (high velocity) and immediately below is the shaley Cabot Head formation (lower velocity). Neither the Cabot head or the Goat Island formations are good seismic markers and so are grouped together as the strong peak of the Rochester The seismic markers picked as part of this study and summarized in Table 6 are the common peak/trough events typically identified on seismic sections within southwestern Ontario.

5 RESULTS

5.1 Reinterpretation of Borehole Geophysical Data

Appendix C lists the top depths of key formations identified in Table 5 reinterpreted based on the review of borehole geophysical data from 111 boreholes that contained useable gamma ray and/or neutron logs within the Central Huron area and its surrounding region. Appendix C summarizes: the borehole geophysical data acquired; depths of logging; reinterpreted key formation top picks based on gamma and/or neutron logs; the MNR key formation top pick; the difference in depth if the reinterpreted top was different from the MNR top; and a note as to which geophysical logs were used to identify the top depth of the key formation.

Table 7 summarizes the number of picks and percentage of picks changed for each key formation top, as well as the total dataset. In total, there were 502 picks recorded in the OGSRL database for the eight key formation tops in boreholes where geophysical data existed in the Central Huron area and surrounding region. Of these 502 key formation top picks, 349 were not changed, 86 were changed less than 5 m, 26 were changed between 5-10 m, and 41 were changed greater 10 m. This represents approximately 69 % formation picks unchanged, 17 % with changes less than 5 m, 5 % with changes between 5-10 m, and 8 % with changes greater than 10 m.

Table 7 Summary of Changes to Key Formation Top Depths Based on Borehole Geophysical Well Logs in the Central Huron Area and Surrounding Region

Formation	*Total # with OGSRL picks*	*Unchanged from OGSRL*		*Changed +/- 0 to 5m*		*Changed +/- 5 to 10m*		*Changed > +/- 10m*	
		#	*%*	*#*	*%*	*#*	*%*	*#*	*%*
Bass Islands	95	73	77	11	12	6	6	5	5
Salina (G-Unit)	94	62	66	16	17	10	11	6	6
Salina (F-Unit)	82	64	78	11	13	5	6	2	2
Cabot Head	87	60	69	22	26	3	4	2	2
Queenston	44	30	69	13	30	0	0	1	2
Cobourg (Collingwood)	33	10	30	2	6	0	0	21	64
Coboconk	36	25	69	5	14	2	6	4	11
Precambrian	31	25	81	6	19	0	0	0	0
Total	502	349	69	86	17	26	5	41	8

As shown on Table 7, most of the key formation tops reinterpreted from borehole geophysical data were unchanged from the OGSRL (MNR) picks. The high percentage of unchanged tops for the Salina F-Unit, Salina G-Unit, Cabot Head, Queenston and Coboconk formations is due to the fact that these tops can be picked from geophysical data with a medium to high level of confidence as they show distinct log signatures (Table 7; Section 4.1.2). The high percentage of unchanged tops for the Bass Islands Formation and the Precambrian basement is related to the fact that these contacts were harder to identify on borehole geophysical data (i.e. data were not clear or the change in the signal at

the formation top was not obvious) and therefore the Geofirma pick simply defaulted back to the MNR pick. There were also several instances where the geophysical logs did not extend to the bottom of the borehole and the MNR had formation top pick entries above or below the geophysical logs signals. In both of these cases, a confident reinterpretation of formation tops was not possible and therefore the default formation top pick reverted to the MNR pick.

The reinterpreted key formation top that changed most frequently compared to the MNR pick was the Cobourg Formation (Collingwood Member). Typical corrections to the MNR top for the Collingwood Member of the Cobourg Formation involved lowering the pick to the large drop in gamma signal at the bottom of the elevated gamma plateau associated with the Upper Ordovician shales (Figure 6). This correction is the result of historically picking the top of the Collingwood Member within the Blue Mountain Formation (Table 2; Section 4.1.3). In this assessment the Cobourg Formation (Collingwood Member) top was reinterpreted based on Armstrong and Carter (2006) and methods employed during site characterization work performed at the Bruce nuclear site (Sterling and Melaney, 2011; Sterling, 2011).

5.2 Geological Cross-Sections

In order to visualize the results of the borehole geophysical data interpretation, and to better understand the subsurface geometry of the Paleozoic formations beneath the Municipality of Central Huron and the surrounding area, two geological cross-sections have been constructed (Figures 7 through 9). Figure 7 shows the location of the two geological cross-sections as well as the locations of oil and gas pools, known pinnacle reefs, the processed seismic line, and the interpreted extent of Cambrian sandstone. Figure 8 shows cross-section A-A', and Figure 9 shows cross-section B-B'.

There are several qualitative comments that can be made based upon visual inspection of the constructed cross-sections, and in relation to the general distribution of the Paleozoic formation packages that were defined during the borehole geophysics assessment (Table 5). The Upper Ordovician shale and limestone packages exhibit relatively uniform thicknesses, about 200 m each (ranging from approximately 216 to 240 m), regardless of the orientation of the cross-section, thus highlighting the lateral uniformity of both packages beneath the Central Huron area. The Silurian formation package shows some variability in total thickness (Figures 8 and 9), ranging from approximately 331 to 448 m. There are several factors to consider in assessing this variability, including:

- The understanding that the top of the Bass Islands Formation is a regional unconformity (Armstrong and Carter, 2010);
- Salt dissolution throughout the Salina Group (not shown), which would have induced collapse of the overlying formations resulting in localized reduced thickness of the entire Silurian formation package; and
- The existence of several types of reef facies (e.g., pinnacle, barrier) in the Guelph Formation (not shown on the cross-sections) across the Central Huron area.

There is an increased degree of uncertainty in the subsurface distribution of the key formation packages with increased distance away from control boreholes with available geophysical data. Given the larger number of boreholes drilled through the Devonian and Silurian formation packages in the

Central Huron area, there is a higher degree of confidence on the lateral and vertical distribution of these formations along the cross-section lines. Conversely, there is a limited number of boreholes with geophysical data penetrating the entire Paleozoic succession and without a depth pick for a key formation top based on the OGSRL borehole log; therefore, the interpretation of the subsurface distribution of the Upper Ordovician package and the Precambrian basement along the cross sections was done with a lower degree of confidence. As mentioned above, this is acknowledged by the use of solid and dashed lines in the constructed cross-sections (Figures 8 and 9).

The inflections in the dips of key formation tops between boreholes observed in the cross-sections are an artefact of the irregular distribution of the boreholes used to construct the sections, rather than actual variability in the dip of the layering. This is because none of the cross-section lines are uniformly parallel or perpendicular to the strike of the layering. The dip inflections are also magnified by the 25X vertical exaggeration employed in the construction of the cross-sections. In reality, the Paleozoic formations are reported to dip uniformly to the southwest at between 0.23° and 1°, which is equivalent to 4 to 17 m/km (Watts et al., 2009) in the Central Huron area and its surrounding region. Similarly, regional dips within southwestern Ontario are reported by Armstrong and Carter (2010) to be approximately 3 to 6 m/km southwestwards along the crest of the Algonquin Arch and 3.5 to 12 m/km down the flanks of the Algonquin Arch westwards into the Michigan Basin.

There are no interpreted subsurface faults in the Central Huron area (Figure 4) and it was not possible to interpret any basement-seated fault structures in the Paleozoic sequence based on the constructed cross-sections and the lower quality 2D seismic dataset.

Section A-A’ (Figure 8) is approximately 71 km long, intersecting 12 boreholes, and is roughly oriented to show a strike-perpendicular section through the Paleozoic sequence. All of the boreholes along the cross-section were drilled through the Silurian formation package, with seven of them including borehole geophysical data. Only four of the 12 boreholes along the line extend to the bottom of the Paleozoic sequence, and only one of these deeper wells contains borehole geophysical data (borehole T004767). The key formation top picks from the boreholes that intersect the entire Paleozoic sequence highlight the relatively uniform thicknesses of the Upper Ordovician shale and limestone formation packages (e.g. approximately 200 m thick each), and provide justification for projecting these formation packages beneath the entire section. However, a relatively large portion of the cross-section (to the northeast) lacks borehole data for these formation and the extrapolation is done with a lower degree of confidence than with the shallower Silurian formation package. Two of the boreholes on cross-section A-A’ (T005885 and F011978) intersect known pinnacle reefs within the lower half of the Silurian formation package, as indicated in Figure 8. However, the top of the Guelph Formation was not reinterpreted as part of this assessment (see Section 4.1.2), and thus it was not possible to distinguish different reefal facies in the Guelph Formation along the cross-section. It should be noted that the Cambrian sandstone reported in the OGSRL borehole log for borehole F011970, located at the intersection of cross-section A-A' and B-B' and east of the pinch out line shown in Figure 7, is actually interpreted as the Shadow Lake Formation based on the small thickness reported and to be consistent with the interpreted distribution based on Bailey and Cochrane (1984a). Therefore, borehole F011970 does not show any interpreted Cambrian sandstone in Figures 8 and 9.

Section B-B’ (Figure 9) is approximately 44 km long, it intersects eight boreholes and is roughly oriented to show a strike-parallel section through the Paleozoic sequence. Section B-B’ is also crossed by the northernmost edge of Seismic Line A000300528, interpreted as part of this

assessment (Section 5.3). Similarly to cross-section A-A', formation tops of the Silurian formation package were interpolated between wells with a higher degree of confidence than tops of the Upper Ordovician packages. All of the wells along the cross-section intersect the Silurian formation package, four of which contain geophysical data. Instead, only four boreholes (with no geophysical data) extend through the Upper Ordovician package, with a relatively large portion (approximately 28 km) in the eastern half of the cross-section without borehole data below the Upper Silurian formation package. Only one of the deeper boreholes in this cross-section (well F011974) is interpreted to indicate the presence of Cambrian sandstone. As meniontedabove, Cambrian sandstone reported in the OGSRL borehole log for borehole F011970 is interpreted as the Shadow Lake Formation based on the small thickness reported and to be consistent with the interpreted distribution based on Bailey and Cochrane (1984a).

5.3 Interpretation of 2D Seismic Data on Line A000300528

This section provides an interpretation of the 2D seismic line A000300528, including limitations derived from interpreting the data. Figure 13 shows the interpreted 2D seismic located in the central-west portion of the Municipality of Central Huron in a north-south orientation. On Figure 13, the y-axis represents the two-way travel time of seismic signal expressed in units of milliseconds (ms), while the x-axis represents the horizontal shot positions along the seismic line. No seismic data is available between shot positions at approximately 530 and 535, and at approximately shot position 480. These intervals are shown as a white zones through the seismic section.

The boreholes with sonic logs that are in close proximity to the seismic line do not extend through the entire geologic section, limiting their use when interpreting the seismic data below the Silurian units. Interpretation of the deeper seismic horizons is based on previous experience from the interpretation of other similar projects within Southern Ontario (Geofirma Engineering Ltd., 2014). The synthetic seismograms, shown in Figures 10 through 12, provide information on the depth to the formation tops within these boreholes. Some of these formation tops are interpreted as horizons on the seismic section (Figure 13).

In general, the lower quality of the seismic data, and minimal amounts of corresponding deep borehole data make interpretation of seismic horizons difficult. In some cases, seismic horizons have been interpreted with lower confidence, and are traced as dashed lines along the seismic section where the data is less reliable. In places along the seismic line, the lower confidence horizons are interpreted as the lateral continuations between segments of higher confidence horizons. The higher confidence interpreted horizons are traced as solid lines. Locally, the lower quality of the seismic data may partially be due to a thickening of overburden or changes in overburden type (e.g. gravel does not transmit a seismic signal as well as sand or clay), which degrades the seismic signal-to-noise ratio, ultimately resulting in a poorer quality signal and a decrease in confidence in any interpreted horizons. The 2D seismic data quality along this line is also very poor due to the limited number of channels, and the sparse station spacing. Between shot positions 580 to 600 the data shows a anomalous zone of convex upward reflections. This zone is considered to be an artifact in the data as a result near surface absorption of the seismic energy, and may not represent reflections from formation tops.

Despite the limitations in the quality of the seismic data, some general observations can be made about the overall sequence of seismic horizons that have been interpreted. In general, the interpreted

seismic horizons appear to reflect approximately horizontal formation tops, and show evidence of uniform thickness of the Ordovician and Silurian stratagraphic packages along the entire length of the seismic line. Salts of the Salina Group are known to exist beneath the Municipality of Central Huron; the interpretation of 2D seismic data identified the top of the Salina B salt horizon, which extends continuously throughout the seismic section (Figure 13).

Based on the location of the seismic line relative to the location of a known pinnacle reef structure in borehole T005166, it is possible that the seismic line crosses the edge of the reef structure or may image sideswip energy from the steep flank of this relatively high reef. Given the poor quality and limited lateral resolution of the seismic data the reef structure is not interpreted. In addition, due to the low quatily 2D seismic data no faults were evident along the section.

6 DISCUSSION OF RESULTS FOR THE MUNICIPALITY OF CENTRAL HURON

This section summarizes the results of the borehole geophysical data and the 2D seismic data interpretation for the Municipality of Central Huron. Table 8 lists the OGSRL wells available within the Municipality of Central Huron, including the date drilled, an indication if there were borehole geophysical data available, their total depth (TD), and the depth of the key formation tops. Table 9 lists the thicknesses of the stratigraphic packages defined by top depth for key formation tops in the wells within the Municipality of Central Huron, as summarized in Table 8.

There are a total of 48 boreholes recorded in the OGSRL database within the Municipality of Central Huron; however only 43 were considered to be of sufficient quality for use in this assessment as discussed in Section 4.1.1. These boreholes provide reasonable coverage throughout the Municipality, although a cluster of boreholes is found associated with the Tipperary and Tipperary South pools in the southwestern portion of the Municipality (Figure 7). Only five of the boreholes within the Municipality were drilled into the Ordovician formations (i.e., F011970, F011974, F011982, T006341, T006364), three of which were drilled through the entire Paleozoic sequence into the Precambrian bedrock (F011970, F011974, T006364). The remaining boreholes were all drilled to shallower depths, with most of them ranging from approximately 500 to 660 mBGS in depth and completed within the Silurian formations package (e.g., Guelph Formation or Cabot Head Formation). Twenty of the boreholes in the Municipality of Central Huron have geophysical data available, which were used to reinterpret key formation tops as part of this assessment. One of the wells in the Municipality of Central Huron (T006364) was used as a reference well by Armstrong and Carter (2010). There are numerous 2D seismic lines available within the Municipality of Central Huron (see Section 3.2), including seismic Line A000300528 that was reinterpreted as part of this study.

In the Municipality of Central Huron the top of the bedrock surface underlying the overburden comprises primarily the Devonian Dundee Formation, with only very small isolated portions interpreted (without well control within the Municipality of Central Huron) as comprising the Lucas Formation (Figure 7). Table 8 lists the depth at which the different key formation tops are found in the Municipality, where the wells are drilled. The total thickness of the Paleozoic sequence in the three deep wells ranges from approximately 1,026 m (F011970) to 1,073 m (T006364). Thickness of the Silurian formation package varies from approximately 330 to 412 m (Table 9). The top of the Upper Ordovician shale package within the Municipality is found at depths ranging from about 526 to 669 mBGS, with an average thickness of about 220 m (Table 9). Based on three wells within the Municipality, the depth to the top of the Upper Ordovician limestone package ranges from about 828 to 886 mBGS (Table 8); the thickness of the Ordovician limestone package ranges from approximately 229 to 241 m. There is no well control on the depth of the key formation tops below the top of the Ordovician shales in the northern and eastern extents within the Municipality of Central Huron (Table 8, Figure 4).

Cross-sections A-A’ (Figure 8) and B-B’ (Figure 9) show cross-sections through the Paleozoic stratigraphic sequence beneath the Municipality of Central Huron. Section A-A' is constructed roughly strike-perpendicular and Section B-B' is constructed roughly strike-parallel (Figure 7). As discussed in Section 5.2, the relatively uniform apparent dip and the relatively uniform thicknesses of the Upper Ordovician shale and limestone packages are evident beneath the Municipality of Central Huron, based on borehole data and illustrated with cross-sections shown on Figures 8 and 9.

Table 8 Summary of Bedrock Formation Top Depths within the Municipality of Central Huron (in mBGS)

		OGSRL Well ID	F011928	F011941	F011953	F011965	F011970	F011973	F011974	F011975	F011976	F011977
		Date Drilled	1953	1953	1953	1958	1939	1955	1955	1953	1953	1953
		Total Depth (mBGS)	642.5	628.5	547.4	618.2	1075.7	563.3	1128.4	566.6	563.3	561.8
Standard		**Geological Unit**										
Devonian	Middle	Dundee Formation	64.9	64.3	25	26.2	35.98	24.4	51.2	28.39	29.3	28.35
		Lucas Formation	85	80.2	45.1	38.4	64.93	46.3	68	55.79	63.7	60.35
		Amherstburg Formation										
	Lower	Bois Blanc Formation			147.5	132.6			174.7			
Silurian	Upper	Bass Islands*	289	261.5	207.3	215.2	212.76	221	261.5	226.49	225	220.98
		Salina G Unit*	360.6	334.1	251.8	***264.8***	269.1	262.1	296.6	276.79	275.9	276.76
		Salina F Unit*	366.1	352.1	259.7	273.7		273.7	304.2		281.3	
		Salina E Unit	415.5	426.1	296.6	337.4		305.4	356.9	318.79	308.5	315.16
		Salina D Unit				361.2			386.2			
		Salina C Unit	431	452.9	330.1	370.4		336.8	393.5	344.99	342.9	343.81
		Salina B Unit		484.9	354.2	398.1	371.3	377	420	384.69	369.1	368.2
		Salina A2 Unit	456.6	494.1	427.6	474.6	445.9	439.8	493.2	435.89	433.4	435.25
		Salina A1 Unit	477.9	549.6	471.8	538.6	494.7	488.6	555.7	492.59	484	487.37
		Guelph Formation	512.7	593.5	510.5	579.4	535.8	531.3	598.3	534.59	528.8	530.05
	Lower	Goat Island Formation										
		Gasport Formation										
		Rochester Formation	630.3	613.9	535.5	603.8		553.2	623.9	557.19	552.6	553.52
		Reynales / Fossil Hill Formation	633.4	617.2	538.6	606.9		556.3	627.3	561.09	555.7	555.95
		Cabot Head Formation*	638.6	627.3	543.5	610.5	566.3	561.1	630.3	564.79	563	560.83
		Manitoulin Formation							659.6			
Ordovician	Upper	Queenston Formation*					602.9		669.4			
		Georgian Bay / Blue Mtn Formation					682.2		747.4			
		Collingwood Member*					828.5		885.8			
		Cobourg Formation										
		Sherman Fall Formation										
		Kirkfield Formation										
		Coboconk Formation*										
		Gull River Formation										
		Shadow Lake Formation[1]					**1060.1**					
Cambrian		Cambrian Sandstone							1115			
Precambrian		Precambrian*					1062.2		1123.8			

1. The bold value indicating Shadow Lake Formation in borehole F011970 was reported in OGSRL log as Cambrian but changed as part of this study (see Section 5.2)

Table 8 Summary of Bedrock Formation Top Depths within the Municipality of Central Huron (in mBGS) (Continued)

		OGSRL Well ID	F011978	F011981	F011982	F011986	F011987	F011989	T000085	T001092	T002731A	T002842
		Date Drilled	*1956*	*1950*	*1941*	*1953*	*1958*	*1956*	*1959*	1961	1969	1969
		Total Depth (mBGS)	*517.6*	*503.8*	*551.4*	*549.0*	*611.1*	*569.7*	*590.1*	523.4	625.8	615.7
Standard Reference		**Geological Unit**										
Devonian	Middle	Dundee Formation	11.6	14	14.6	25.3	21	30.2	28.1	18	64.9	64.9
		Lucas Formation	28.4	16.2	16.2	34.1	30.8	51.2	45.1	25	79.6	96.9
		Amherstburg Formation									151.5	171
	Lower	Bois Blanc Formation		118.3	119.8		146.3		170.7	147	210	233.5
Silurian	Upper	Bass Islands*	190.2	183.5	176.2	205.7	210.3	221.3	226.8	189.6	***281.6***	***277.8***
		Salina G Unit*	***232.4***	217.6	223.4	255.4	***262.4***	***264.4***	272.8	242.7	***356.6***	***340.1***
		Salina F Unit*	***239.4***	224			***271.4***	***272.4***	281.6		363.3	***349.3***
		Salina E Unit	287.4	259.4	261.5	289.3	321	317.9	330.4		393.5	391.1
		Salina D Unit					346.9		353.9			413.3
		Salina C Unit	309.1	293.2	295.1	324.9	352.7	340.2	362.4	326.2	430.7	425.8
		Salina B Unit	329.2	322.8	327.1	348.1	386.8	362.7	390.2	340.5	438	433.7
		Salina A2 Unit	350.8	378.9	378.9	419.7	458.7	439.2	458.1	401.8	462.7	460.3
		Salina A1 Unit	369.1	419.1	416.4	469.4	524.6	492	506.3	442.3	478.6	476.4
		Guelph Formation	391.1	460.3	458.4	510.9	568.2	532.8	554.1	495	484	500.8
	Lower	Goat Island Formation										
		Gasport Formation									551.7	
		Rochester Formation	495.6	487.4	485.6	538.6	588	558.1	574.6	521.6	619.4	612.7
		Reynales / Fossil Hill Formation	499.6	489.5	488.3	540.7	591	559.9	577.3			
		Cabot Head Formation*	505.7	494.7	496.2	548.3	***605.9***	566.3	584			
		Manitoulin Formation			516							
Ordovician	Upper	Queenston Formation*			526.4							
		Georgian Bay / Blue Mtn Formation										
		Collingwood Member*										
		Cobourg Formation										
		Sherman Fall Formation										
		Kirkfield Formation										
		Coboconk Formation*										
		Gull River Formation										
		Shadow Lake Formation										
Cambrian		Cambrian Sandstone										
Precambrian		Precambrian*										

Table 8 Summary of Bedrock Formation Top Depths within the Municipality of Central Huron (in mBGS) (Continued)

		OGSRL Well ID	T003607	T003632A	T003785	T005166	T005326	T006251	T006341	T006346	T006364	T007179
		Date Drilled	1973	1973	1975	1979	1980	1983	1983	1983	1983	1987
		Total Depth (mBGS)	539.5	535.3	623.9	642.8	599.8	622.6	630.8	646.0	1132.0	596.5
Standard Reference		**Geological Unit**										
Devonian	Middle	Dundee Formation	13.7	25	63.1	68.8	24.8	39.8	22.8	66.7	57.8	47.9
		Lucas Formation	33.2	45.7	***72.1***	85.8	39.8	58.8	40.8	88.2	87	58.5
		Amherstburg Formation	102.4	120.4	156.1	167.8	118.8	111.8	111.5	168.3	162	137.2
	Lower	Bois Blanc Formation	153.3	193	210.9	199.8	195.3	156.8	143.3	200.4	206	174.2
Silurian	Upper	Bass Islands*	***199.8***	***211.8***	***256.1***	282.8	222	226.8	220.3	286.2	255	234
		Salina G Unit*	257.3	260.3	360.6	338.3	***266.3***	275.8	271.5	***336***	348.5	283.7
		Salina F Unit*	265.8	***268.8***	367.3	345.8	***278.8***	283.8	279	***344***	355	291.3
		Salina E Unit	301.2	303.6	413.3	377.1	312.4	343.8	312.4	391.6	409.7	335.2
		Salina D Unit	334.1	330.1			347.4	368.8	364.5			358.3
		Salina C Unit	341.7	338	459.3	413.4	362.3	383.8	375.3	428.1	446.8	373
		Salina B Unit	360	355.7	468.2	423.1	380.2	400.8	394.5	436.6	453	390.3
		Salina A2 Unit	437.7	431	510.9	460.7	463.2	487.3	478.5	451.3	477	485.5
		Salina A1 Unit	488.6	483.7	550.5	487.2	518.8	549.8	542.5	477.2	514.1	532.5
		Guelph Formation	527	520.9	595.3	506.5	556.8	591.8	580.3	495.6	524.4	571.3
	Lower	Goat Island Formation	531.3	525.2	606	620.3		598.8	589.7	614	589.3	578.6
		Gasport Formation			616.6	629.3		609.8	600.6	623	598.7	587.8
		Rochester Formation			623.3	632		613.8	605.5	627.2	613	592.5
		Reynales / Fossil Hill Formation						620.8	608.7	630.5	629.3	
		Cabot Head Formation*				639.3	587.8	620.8	611.8	***632***	636.2	
		Manitoulin Formation							614.7		657.7	
Ordovician	Upper	Queenston Formation*							617.4		666.6	
		Georgian Bay / Blue Mtn Formation									760.7	
		Collingwood Member*									***883.5***	
		Cobourg Formation									***899***	
		Sherman Fall Formation									939	
		Kirkfield Formation									984	
		Coboconk Formation*									1027.3	
		Gull River Formation									1051.6	
		Shadow Lake Formation									1117.4	
Cambrian		Cambrian Sandstone										
Precambrian		Precambrian*									***1124***	

Table 8 Summary of Bedrock Formation Top Depths within the Municipality of Central Huron (in mBGS) (Continued)

		OGSRL Well ID	T008843	T010054	T010686	T011649	T011650	T011651	T011714	T011715	T011716	T011956
		Date Drilled	1999	2001	2004	2007	2007	2007	2008	2008	2008	2009
		Total Depth (mBGS)	621.7	661.4	638.7	559.4	558.4	559.4	576.4	574.4	573.4	599.4
Standard Reference		**Geological Unit**										
Devonian	Middle	Dundee Formation	58.5	55.4	77	74.4	74.4	74.4	73.7	73.7	73.7	74.4
		Lucas Formation	74.2	72.4	87.9	84.4	84.4	84.4	84.6	84.6	84.6	84.4
		Amherstburg Formation	131.7		164.7	161.4	161.4	161.4	161.6	161.6	161.6	161.4
	Lower	Bois Blanc Formation	188		221.4	216.4	216.4	216.4	216.1	216.1	216.1	216.4
Silurian	Upper	Bass Islands*	255.2	***240.4***	290.5	287.4	287.4	287.4	287.2	287.2	287.2	287.4
		Salina G Unit*	303	299.4	364.2	361.4	361.4	361.4	361	361	361	361.4
		Salina F Unit*	310.9	308.4	371.7	369.4	369.4	369.4	368.8	368.8	368.8	369.4
		Salina E Unit	344	357.9		402.4	402.4	402.4	404.5	404.5	404.5	402.4
		Salina D Unit	379.4	381.9					433.8	433.8	433.8	
		Salina C Unit	392.1	393.4	439.1	432.4	432.4	432.4	435.8	435.8	435.8	432.4
		Salina B Unit	411.8	421.9	445.7	463.4	463.4	463.4				
		Salina A2 Unit	494.5	503.9	460.2				464.4	464.4	464.4	463.4
		Salina A1 Unit	554.6	560.4	481.2							
		Guelph Formation	594.3	602.9	491.7	488.4	488.4	488.4	492.4	492.4	492.4	488.4
	Lower	Goat Island Formation	600.2		620							
		Gasport Formation	607.2									
		Rochester Formation	611.7	635.9								
		Reynales / Fossil Hill Formation	614.7	647.4								
		Cabot Head Formation*	619.7									
		Manitoulin Formation										
Ordovician	Upper	Queenston Formation*										
		Georgian Bay / Blue Mtn Formation										
		Collingwood Member*										
		Cobourg Formation										
		Sherman Fall Formation										
		Kirkfield Formation										
		Coboconk Formation*										
		Gull River Formation										
		Shadow Lake Formation										
Cambrian		Cambrian Sandstone										
Precambrian		Precambrian*										

Table 8 Summary of Bedrock Formation Top Depths within the Municipality of Central Huron (in mBGS) (Continued)

		OGSRL Well ID	T011957	T011959	T011960
		Date Drilled	2010	2010	2009
		Total Depth (mBGS)	587.1	587.7	567
Standard Reference		**Geological Unit**			
Devonian	Middle	Dundee Formation	61.1	70.7	73.3
		Lucas Formation	84.6	87.7	84.3
		Amherstburg Formation			
	Lower	Bois Blanc Formation	202.1	211.2	213.3
Silurian	Upper	Bass Islands*	284.1	309.2	292.3
		Salina G Unit*	340.3	360.2	357.3
		Salina F Unit*	348.2	368.7	367.3
		Salina E Unit	395.6	394.7	402.3
		Salina D Unit			
		Salina C Unit	418.6	437.2	430.3
		Salina B Unit	427.3	445.2	
		Salina A2 Unit	450.6	466.2	459.3
		Salina A1 Unit			
		Guelph Formation	479.1	481.7	485.3
	Lower	Goat Island Formation			
		Gasport Formation			
		Rochester Formation			
		Reynales / Fossil Hill Formation			
		Cabot Head Formation*			
		Manitoulin Formation			
Ordovician	Upper	Queenston Formation*			
		Georgian Bay / Blue Mtn Formation			
		Collingwood Member*			
		Cobourg Formation			
		Sherman Fall Formation			
		Kirkfield Formation			
		Coboconk Formation*			
		Gull River Formation			
		Shadow Lake Formation			
Cambrian		Cambrian Sandstone			
Precambrian		Precambrian*			

Notes:

* and shading indicate Key Formations
bold and italicized indicates entry that has been updated as part of this study based on borehole geophysical data repick as per Appendix C
underlined indicates updated entry based on replacing depth to Collingwood Member with depth to Cobourg Formation as discussed in Section 4.1.3

In addition, the 2D seismic data shown in Figure 13 also generally supports the interpretation of lateral continuity and uniformity of the thickness of the Ordovician and Silurian formation packages, however, these data are recognized to be of poor quality as discussed in Section 3.3 and Section 5.3.

A number of boreholes in the Municipality of Central Huron were drilled through three known pinnacle reefs (Figure 7) of the Silurian Guelph Formation. As discussed in Section 2.2.4.3, the Municipality of Central Huron is situated in the pinnacle reef belt found along the eastern shore of Lake Huron. It is not possible to identify these known pinnacle reefs from the cross-sections (Figures 8 and 9), as the top of Guelph Formation was not able to be reinterpreted as part of this assessment and thus is not included in the construction of the cross-sections. It is possible that the interpreted 2D seismic line crosses the edge of the Tipperary Pool reef structure (Figure 7); however, given the poor quality and limited lateral resolution of the seismic data the reef structure was not interpreted (Section 5.3). Salt beds of the Salina Group known to exist beneath the Municipality were not discernible from borehole geophysical data, and have not been interpreted in the cross-sections (Figures 8, 9). The interpretation of 2D seismic data, however, identified the top of the Salina B salt horizon and interpreted it continuously throughout the seismic section (Figure 13). It was not possible to interpret any fault structures in the Paleozoic sequence within the Municipality based on the borehole data, constructed geological cross-sections, or the 2D seismic data.

Table 9 Summary of Bedrock Formation Group Thicknesses within the Municipality of Central Huron (in m) from OGSRL Data

Bedrock Group	*Statistic*	*Central Huron*
Overburden	Min	11.6
	Max	77.0
	Avg	44.9
	N	48
Paleozoic	Min	1026.2
	Max	1072.6
	Avg	1055.0
	N	3
Devonian	Min	161.6
	Max	238.5
	Avg	199.2
	N	43
Silurian	Min	331.0
	Max	411.6
	Avg	378.0
	N	5
Ordovician Shale	Min	216.4
	Max	225.6
	Avg	219.6
	N	3
Ordovician Limestone	Min	229.2
	Max	240.5
	Avg	233.8
	N	3

Notes:
thicknesses calculated using data from Table 8
NA = not applicable
N = number of boreholes in the Municipality with thickness data (i.e. OGSRL contains depth information for both top and bottom of formation groups)

7 SUMMARY

This report presents the findings of an interpretation study looking at historical borehole geophysical well log data and historical 2D seismic data for the Municipality of Central Huron. The assessment focused on the Municipality of Central Huron and the surrounding area, referred to as the "Central Huron area". This study was completed as part of the desktop geoscientific preliminary assessment of the Municipality of Central Huron (Geofirma Engineering Ltd., 2015).

The main data sources used in this study include the OGSRL borehole database (OGSRL, 2014) for bedrock formation top depths, overburden thickness mapping from the MNDM Miscellaneous Release Data 207 (Gao et al., 2006); the ground surface elevation data provided by National Aeronautical and Space Administration (NASA, 2006); the stratigraphic information from site characterization activities at the Bruce nuclear site (NWMO, 2011; Intera Engineering Ltd., 2011), and existing 2D seismic data inventories from the OGSRL (OGSRL, 2014) and from Sigma Exploration Inc. (2015), a seismic data broker.

A total of 335 boreholes from the OGSRL exist within the Central Huron area and its surrounding region, 111 of which contain useful gamma and neutron borehole geophysical logs. These borehole geophysical logs were used to reinterpret the depths to the top of key formations which could be easily and consistently identified based on the geophysical signals. These reinterpreted picks were merged with the existing OGSRL data for these 335 boreholes to produce an updated database for the Central Huron area and surrounding region. The updated formation top dataset was used to create geological cross-sections through the Municipality to assist with the assessment of subsurface geology and the interpretation of 2D seismic data. In addition, the updated borehole database was used for the interpretation of airborne geophysical data (PGW, 2015) that looked at gravity stripping to interpret gravity data.

There are abundant historical 2D seismic data within the Municipality of Central Huron. A total of approximately 10 km of historical 2D seismic data, originally acquired as part of a single seismic line during 1977, was purchased, re-processed and interpreted as part of this study. These seismic data are completely located within the Municipality of Central Huron. The quality of this historical data was sufficient for use in this study, but considered to be of lower quality compared to current 2D seismic standards. These data were useful for understanding general subsurface geometry and for comparison to borehole data, and provided some insight into the applicability of seismic techniques to image geology between boreholes. The re-processing and interpretation of the historical 2D seismic data allowed for the identification of several key formation tops also identified as part of the borehole geophysical study.

In the Municipality of Central Huron the top of the bedrock surface underlying the overburden primarily comprises the Devonian Dundee Formation. The Municipality contains 46 boreholes with reliable data recorded in the OGSRL database, only five of which extend into the Queenston Formation and only three of which extend through the entire Paleozoic bedrock sequence and into Precambrian bedrock. The total thickness of the Paleozoic sequence in the three borehole records that intersects the Precambrian basement ranges from approximately 1,026 to 1,073 mBGS. Twenty boreholes have borehole geophysical data available, for which key formation tops were reinterpreted. The density of borehole data is higher in the southwestern portion of the Municipality, associated with the Tipperary

and Tipperary South pools.

The Ordovician shale and limestone packages exhibit relatively uniform thicknesses in the Central Huron area, approximately 200 m each, as illustrated by the constructed cross sections (Figures 8 and 9). In contrast, the Silurian formations package shows some variability in total thickness. This may be attributed to several factors, including: the top of the Bass Islands Formation is a regional unconformity; salt dissolution throughout the Salina Group resulting in collapse of overlying formations; and the known existence of reef facies in the Guelph Formation across the Municipality of Central Huron. The Paleozoic strata are reported to dip at approximately 3.5 to 12 m/km to the west or southwest throughout the Ontario portion of the Michigan Basin (Armstrong and Carter, 2010) which is consistent with dips shown on the two geologic cross-sections that were constructed using the updated database (Figures 8 and 9).

The entire 9.9 km length of the acquired seismic line (A000300582) exists within the Municipality of Central Huron. In general, seismic data along this line is of relatively low quality, partially due to the thickness and type of overburden deposits, which attenuates the surface seismic energy, ultimately resulting in a poorer quality signal and a decrease in confidence in any of the interpreted horizons. The 2D seismic data quality along this line is also poor due to the limited number of channels, the limits of seismic equipment available in 1977 and the sparse station spacing. Despite its low quality, the interpreted 2D seismic data generally supports the interpretation of lateral continuity and uniformity of thickness of the Ordovician and Silurian formation packages. No faults were interpreted on the 2D seismic line.

The boreholes in the Municipality of Central Huron were drilled through three known pinnacle reefs of the Guelph Formation, within the Silurian formation package. However, it is not possible to identify these known pinnacle reefs or any additional potential reefs from the cross-sections constructed, as the top of the Guelph Formation was not reinterpreted as part of this assessment and thus the reefs do not express themselves in constructed cross-sections. Commonly reefs can be identified within seismic sections, and the interpreted seimic line within the Municipality likely crosses the edge of the Tipperary Pool reef structure. However, given the poor quality and limited lateral resolution of the seismic data the reef structure was not interpreted. Salt beds of the Salina Group known to exist beneath the Municipality were not discernible from borehole geophysical data, but the interpretation of 2D seismic data identified the top of the Salina B salt horizon extending throughout the seismic section.

8 REFERENCES

AECOM Canada Ltd., 2013. Initial Screening for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel, The Corporation of the Municipality of Central Huron. Report Prepared for the Nuclear Waste Management Organization (NWMO). AECOM Report 60247068-6, Markham, Canada.

Armstrong, D.K. and T.R. Carter, 2010. The Subsurface Paleozoic Stratigraphy of Southern Ontario, Ontario Geological Survey, Special Volume 7.

Armstrong, D.K. and T.R. Carter, 2006. An Updated Guide to the Subsurface Paleozoic Stratigraphy of Southern Ontario, Ontario Geological Survey, Open File Report 6191.

Armstrong, D.K. and W.R. Goodman, 1990. Stratigraphy and Depositional Environments of Niagaran Carbonates, Bruce Peninsula, Ontario. Field Trip No. 4 Guidebook. American Association of Petroleum Geologists, 1990 Eastern Section Meeting, hosted by the Ontario Petroleum Institute. London, Ontario.

Bailey Geological Services Ltd. and R.O. Cochrane, 1984a. Evaluation of the Conventional and Potential Oil and Gas Reserves of the Cambrian of Ontario, Ontario Geological Survey, Open File Report 5499.

Bailey Geological Services Ltd. and R.O. Cochrane, 1984b. Evaluation of the Conventional and Potential Oil and Gas Reserves of the Ordovician of Ontario, Ontario Geological Survey, Open File Report 5498.

Barnett, P. J., 1992. Quaternary Geology of Ontario, *In:* Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 2, pp. 1011-1090.

Boyce, J.I. and W.A. Morris, 2002. Basement-Controlled Faulting of Paleozoic Strata in Southern Ontario, Canada: New Evidence from Geophysical Lineament Mapping, Tectonophysics, Vol. 353, pp. 151-171.

Brigham, R.J., 1971. Structural Geology of Southwestern Ontario and Southeastern Michigan, Ontario Department of Mines and Northern Affairs, Petroleum Resources Section, Paper 71-2.

Brunton, F.R. and J.E.P. Dodge, 2008. Karst of Southern Ontario and Manitoulin Island, Ontario Geological Survey, Groundwater Resources Study 5.

Carr, S.D., R.M. Easton, R.A. Jamieson and N.G. Culshaw, 2000. Geologic Transect Across the Grenville Orogen of Ontario and New York, Canadian Journal of Earth Sciences, Vol. 37, No. 2-3, pp. 193–216.

Carter, T.R. and R. M. Easton, 1990. Extension of Grenville Basement Beneath Southwestern Ontario: Lithology and Tectonic Subdivisions, *In:* Carter, T.R. (Ed), Subsurface Geology of Southwestern Ontario, a Core Workshop, American Association of Petroleum Geologists, 1990 Eastern Sectional Meeting, Ontario Petroleum Institute, London, Ontario, pp. 9-28.

Carter, T.R., R.A. Trevail and R.M. Easton, 1996. Basement Controls on Some Hydrocarbon Traps in Southern Ontario. *In:* van der Pluijm, B.A., and P.A. Catacosinos, (Eds.), Basement and Basins of Eastern North America: Geological Society of America Special Paper 308, pp. 95-107.

Coniglio, M. R., M.J. Melchin and M.E Brookfield, 1990. Stratigraphy, Sedimentology and Biostratigraphy of Ordovician Rocks of the Peterborough-Lake Simcoe Area of Southern Ontario, American Association of Petroleum Geologists, 1990 Eastern Section Meeting, hosted by the Ontario Petroleum Institute, Field Trip Guidebook No. 3, London, Ontario.

Cooper, A.J. and W.D. Fitzgerald, 1977. Quaternary Geology of the Goderich Area, Southern Ontario. Ontario Geological Survey, Preliminary Map P1232, scale 1:50,000.

Cooper, A.J., W.D. Fitzgerald and J. Clue, 1977. Quaternary Geology of the Seaforth Area, Southern Ontario. Ontario geological Survey, Preliminary Map P1233, scale 1:50,000.

Cowan, W.R., A.J. Cooper and J.J. Pinch, 1986. Quaternary Geology of the Wingham-Lucknow Area, Southern Ontario. Ontario Geological Survey, Preliminary Map P2957.

Easton, R. M., 1992. The Grenville Province and the Proterozoic History of Southern Ontario, *In:* Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 2, pp. 715-906.

Easton, R.M. and T.R. Carter, 1995. Geology of the Precambrian Basement Beneath the Paleozoic of Southwestern Ontario, *In:* Ojakangas, R.W., A.B. Dickas and J.C. Green (Eds.), Basement Tectonics 10, Kluwer Academic Publishers, The Netherlands, pp. 221-264.

Engelder, T. and P. Geiser, 1980. On the Use of Regional Joint Sets as Trajectories of Paleostress Fields During the Development of the Appalachian Plateau, New York, Journal of Geophysical Research, Vol. 85, No. B11, pp. 6319-6341.

Gao, C., J.Shirota, R.I. Kelly, F.R. Brunton and S. van Haaften, 2006. Bedrock Topography and Overburden Thickness Mapping, Southern Ontario, Ontario Geological Survey, Miscellaneous Release-Data 207.

Gardner, G.H.F., Gardner, L.W. and Gregory, A.R., 1974. Formation Velocity and Density – the Diagnostic Basics for Stratigraphic Traps, Geophysics, Vol. 39, pp. 770-780.

Geofirma Engineering Ltd., 2015. Phase 1 Geoscientific Desktop Preliminary Assessment of Potential Suitability for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel, Municipality of Central Huron. Prepared for the Nuclear Waste Management Organization (NWMO). NWMO Report APM-REP-06144-0126, Toronto, Canada.

Geofirma Engineering Ltd., 2014. Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data, Municipalities of Arran-Elderslie, Brockton and South Bruce, Township of Huron-Kinloss and Town of Saugeen Shores. Prepared.for the Nuclear Waste Management Organization (NWMO). NWMO Report APM-REP-06144-0110, Toronto, Canada.

Green, A.G., B. Milkereit, A. Davidson, C. Spencer, D.R. Hutchinson, W.F. Cannon, M.W. Lee, W.F. Agena, J.C. Behrendt and W.J. Hinze, 1988. Crustal Structure of the Grenville Front and Adjacent Terranes, Geology, Vol.16, pp. 788-792.

Gross, M.R., T. Engelder and S.R. Poulson, 1992. Veins in the Lockport Dolostone: Evidence for an Acadian Fluid Circulation System, Geology, Vol. 20, pp. 971-974.

Hamblin, A., 2003. Detailed Outcrop and Core Measured Sections of the Upper Ordovician/Lower Silurian Succession of Southern Ontario, Geological Survey of Canada, Open File 1525.

Hamblin, A., 1999. Upper Ordovician Strata of Southwestern Ontario: Synthesis of Literature and Concepts, Geological Survey of Canada, Open File 3729.

Hanmer, S. and S.J. McEachern, 1992. Kinematical and Rheological Evolution of a Crustal-Scale Ductile Thrust Zone, Central Metasedimentary Belt, Grenville Orogen, Ontario. Canadian Journal of Earth Sciences, Vol. 29, pp.1779-1790.

Hewitt, D.F., 1962. Salt in Ontario, Industrial Mineral Report No. 6, Ontario Department of Mines, Toronto.

Howell, P.D., and B.A. van der Pluijm, 1999. Structural Sequences and Styles of Subsidence in the Michigan Basin, Geological Society of America Bulletin, Vol. 111, pp. 974-991.

Intera Engineering Ltd., 2011. Descriptive Geosphere Site Model. Prepared for the Nuclear Waste Management Organization (NWMO). NWMO Report DGR-TR-2011-24 R000, Toronto, Canada.

JDMA, J.D. Mollard and Associates Ltd., 2015. Phase 1 Geoscientific Desktop Preliminary Assessment, Terrain and Remote Sensing Study, Municipality of Central Huron. Prepared for the Nuclear Waste Management Organization (NWMO). NWMO Report APM-REP-06144-0128, Toronto, Canada.

Johnson, M.D., D.K. Armstrong, B.V. Sanford, P.G. Telford and M.A. Rutka, 1992. Paleozoic and Mesozoic Geology of Ontario, *In:* Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 2, pp. 907-1008.

Kesler, S.E. and C.W. Carrigan, 2002. Discussion on "Mississippi Valley-Type Lead-Zinc Deposits Through Geological Time: Implications from Recent Age-Dating Research" by D.L. Leach, D. Bradley, M.T. Lewchuk, D.T.A. Symons, G. de Marsily, and J. Brannon (2001). Mineralium Deposita Vol. 36, pp. 711-740.

Kumarapeli, P.S., 1976. The St. Lawrence Rift System, Related Metallogeny, and Plate Tectonic Models of Appalachian Evolution, pp. 301-320. *In:* D.F. Strong (Ed.), Metallogeny and Plate Tectonics. Geological Association of Canada, Special Paper 14.

Kumarapeli, P.S., 1985. Vestiges of lapetan Rifting in the Craton West of the Northern Appalachians, Geoscience Canada, Vol. 12, No. 2.

LIO, Land Information Ontario, 2014. Land Information Ontario. Ontario Ministry of Natural Resources, http://www.mnr.gov.on.ca/en/Business/LIO/index.html.

Lumbers, S.B., L.M. Heaman, V.M. Vertolli and T.W. Wu, 1990. Nature and Timing of Middle Proterozoic Magmatism in the Central Metasedimentary Belt, Grenville Province, Ontario. Special Paper- Geological Association of Canada, Vol. 38, pp. 243-276.

Marshak, S. and J.R. Tabor, 1989. Structure of the Kingston Orocline in the Appalachian Fold-Thrust Belt, New York, Geological Society of America Bulletin. Vol. 101, pp. 683-701.

McWilliams, C.K., R.P. Wintsch and M.J. Kunk, 2007. Scales of Equilibrium and Disequilibrium During Cleavage Formation in Chlorite and Biotite-Grade Phyllites, SE Vermont, Journal of Metamorphic Geology, Vol. 25, pp. 895-913.

NASA, National Aeronautics and Space Administration, 2006. Shuttle Radar Topography Mission (SRTM) digital topographic data, version 2. http://www2.jpl.nasa.gov/srtm/ [data accessed, 2013].

NWMO, Nuclear Waste Management Organization, 2015. Preliminary Assessment for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel, Municipality of Central Huron, Ontario – Findings from Step 3, Phase One Studies. NWMO Report APM-REP-06144-0124,Toronto, Canada.

NWMO, Nuclear Waste Management Organization, 2011. Geosynthesis. NWMO Report DGR-TR-2011-11 R000, Toronto, Canada.

NWMO, Nuclear Waste Management Organization, 2010. Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel, Nuclear Waste Management Organization. (Available at www.nwmo.ca).

OGS, Ontario Geological Survey, 2011. Regional Structure and Isopach Maps of Potential Hydrocarbon-Bearing Strata for Southern Ontario, Ontario Geological Survey, Miscellaneous Release – Data 276.

OGS, Ontario Geological Survey, 2010. Surficial Geology of Southern Ontario, Miscellaneous Release-Data 128-REV.

OGS, Ontario Geological Survey, 2007. Paleozoic Geology of Southern Ontario, Ontario Geological Survey, Miscellaneous Release Data 219.

OGSRL, Ontario Oil Gas Salt Resources Library, 2014. Subsurface Geology and Petroleum Well Data, http://www.ogsrlibrary.com/ (accessed December, 2014).

O'Hara, N.W. and W.J. Hinze, 1980. Regional Basement Geology of Lake Huron, Geological Society of America Bulletin, Part I, Vol., 91, pp. 348-358.

Percival, J.A., and R.M. Easton, 2007. Geology of the Canadian Shield in Ontario: an Update. Ontario Power Generation, Report No. 06819-REP-01200-10158-R00, OGS Open File Report 6196, GSC Open File Report 5511.

PGW, Paterson, Grant & Watson Limited, 2015. Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Geophysical Data, Municipality of Central Huron. Prepared for the Nuclear Waste Management Organization (NWMO). NWMO Report APM-REP-06144-0129, Toronto, Canada.

Quinlan, G. and C. Beaumont, 1984. Appalachian Thrusting, Lithospheric Flexure and the Paleozoic Stratigraphy of the Eastern Interior of North America, Canadian Journal of Earth Sciences, Vol. 21, pp. 973-996.

Russell, D.J. and P.G. Telford, 1983. Revisions to the Stratigraphy of the Upper Ordovician Collingwood Beds in Ontario – A Potential Oil Shale, Canadian Journal of Earth Sciences, Vol. 20, pp. 1780-1790.

Sanford, B.V., 1993. St. Lawrence Platform - Economic Geology, *In:* Sedimentary Cover of the Craton in Canada, Stott, D.F and J.D. Aiken (Eds.), Geological Survey of Canada, Geology of Canada No. 5, pp. 787-798.

Sanford, B.V., 1977. Distribution, Thickness and Three-Dimensional Geometry of Salt Deposits, Southwestern Ontario, Geological Survey of Canada Open File 401, 11 sheets, doi:10.4095/129206.

Sanford, B.V., F.J. Thompson, F.J. and G.H. McFall, 1985. Plate Tectonics – A Possible Controlling Mechanism in the Development of Hydrocarbon Traps in Southwestern Ontario, Bulletin of Canadian Petroleum Geology, Vol. 33, No.1, pp. 52-71.

Sigma Explorations Inc., 2015. 2D Seismic Data acquired in February.

Sloss, L.L., 1982. The Michigan Basin: Selected Structural Basins of the Midcontinent, USA. UMR Journal Vol. 3, pp. 25-29.

Sterling, S., 2011. Technical Report: Bedrock Formations in DGR-7 and DGR-8, TR-11-06, Revision 0, December 6, Intera Engineering Ltd., Ottawa, 21 pp., www.nwmo.ca/dgrsitecharacterizationreports

Sterling, S. and M. Melaney, 2011. Technical Report: Bedrock Formations in DGR-1 to DGR-6, TR-09-11, Revision 0, April 7, Intera Engineering Ltd., Ottawa, 25 pp., www.nwmo.ca/dgrsitecharacterizationreports.

Sutter, J.F., N.M. Ratcliffe and S.B. Mukasa, 1985. $^{40}Ar/^{39}Ar$ and K-Ar Data Bearing on the Metamorphic and Tectonic History of Western New England, Geological Society of America Bulletin, Vol. 96, pp. 123-136.

Thomas, W.A., 2006. Tectonic Inheritance at a Continental Margin, Geological Societey of America Today, Vol. 16, No. 2, pp.4-11.

Uyeno, T.T., P.G. Telford and B.V. Sanford, 1982. Devonian Conodonts and Stratigraphy of Southwestern Ontario. Geological Survey of Canada, Bulletin 332.

Van Schmus, W.R., 1992. Tectonic Setting of the Midcontinent Rift System, Tectonophysics, Vol. 213, pp. 1-15.

Wallach, J.L., A.A. Mohajer and R.L. Thomas, 1998. Linear Zones, Seismicity, and the Possibility of a Major Earthquake in the Intraplate Western Lake Ontario Area of Eastern North America, Canadian Journal of Earth Sciences, Vol. 35, No. 7, pp. 762-786.

Watts, M., D. Schieck and M. Coniglio, 2009. 2D Seismic Survey of the Bruce Site, Technical Report TR-07-15 prepared for the Nuclear Waste Management Organization, Revision 0, Intera Engineering Ltd., Ottawa, Canada, 105 pp., www.nwmo.ca/dgrsitecharacterizationreports..

White, D.J., D.A. Forsyth, I. Asudeh, S.D. Carr, H. Wu, R.M. Easton, and R.F. Mereu, 2000. A Seismic-Based Cross-Section of the Grenville Orogen in Southern Ontario, and Western Quebec, Canadian Journal of Earth Sciences, Vol. 37, pp. 183-192.

Williams, H.R., G.M. Stott, P.C. Thurston, R.H. Sutcliff, G. Bennett, R.M. Easton and D.K. Armstrong, 1992. Tectonic Evolution of Ontario; Summary and Synthesis, *In:* Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 2, pp. 1255-1334.

9 REPORT SIGNATURE PAGE

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APPENDIX A

Summary of OGSRL Wells in the Central Huron Area and Surrounding Region

COUNT	LICENSE NUMBER	NAME	OPERATOR	UTM NAD83 EASTING	UTM NAD83 NORTHING	PURPOSE	WELL MODE	GROUND ELEVATION (m)	TVD	TOTAL DEPTH FORMATION	POOL	TD_DATE	Geophysics	Armstrong/Carter Reference	Used in BR Surface	Rock Core Available	OilGasPool	PinReef
1	F011876	Bluewater Oil & Gas - Martin No. 1	Prenalta Minerals Inc.	447190	4814135	Oil and Gas	Abandoned Well	248.1	606.25	Cabot Head	N/A	Jul-57			√			
2	F011877	Imperial 497 - McKinley No. 1	Imperial Oil Ltd	448134	4814180	Oil and Gas	Abandoned Well	273.71	623.01	Cabot Head	N/A	Jan-55			√			
3	F011878	Imperial 516 - W. Aikenhead No. 1	Imperial Oil Ltd	457744	4814798	Oil and Gas	Abandoned Well	268.83	527	Cabot Head	N/A	May-55			√			
4	F011880	Pan Western Oils No. 2 - L. Barker No. 1	Pan Western Oils Ltd	481094	4815330	Oil and Gas	Abandoned Well	345.64	958.6	Precambrian	N/A	Sep-54			√			
5	F011881	Pan - Western	Pan Western Oils Ltd	481548	4816847	Oil and Gas	Abandoned Well	345.03	439.52	Cabot Head	N/A	Dec-55			√			
6	F011882	Pan - Western Logan 25-2 Panwestern #6	Pan Western Oils Ltd	480174	4816956	Oil and Gas	Abandoned Well	344.12	449.28	Cabot Head	N/A	Nov-55	√		√			
7	F011886	Pan - Western	Pan Western Oils Ltd	479989	4818246	Oil and Gas	Abandoned Well	343.51	523.65	Queenston	N/A	Nov-54			√			
8	F011888	Pan-Western Oil No. 1 - J. Shea No. 1	Unknown	477415	4818522	Oil and Gas	Abandoned Well	338.63	496.82	Queenston	N/A	Jul-54			√			
9	F011890	Pan-Western Oils No. 7 - J. Delaney No. 1	Unknown	478077	4819180	Oil and Gas	Abandoned Well	338.63	454.76	Cabot Head	N/A	Dec-55			√			
10	F011891	Imperial 672 et al - Mustard No. 1	Imperial Oil Ltd	453906	4819543	Oil and Gas	Abandoned Well	258.17	578.82	Cabot Head	N/A	Sep-58			√			
11	F011893	Imperial Oil No. 451 - Imperial - Sun - G. Wilson No. 1	Imperial Oil Ltd	453927	4820690	Oil and Gas	Abandoned Well	245.67	1065.58	Precambrian	N/A	Aug-54			√			
12	F011894	Pan-Western Oils - Nolan No. 1	Pan Western Oils Ltd	471523	4821046	Oil and Gas	Abandoned Well	317.6	482.8	Cabot Head	N/A	Sep-55	√		√			
13	F011895	Pan - Western	Pan Western Oils Ltd	491261	4821075	Oil and Gas	Abandoned Well	360.27	411.48	Cabot Head	N/A	Aug-55			√			
14	F011904	Imperial 523 - Weston No. 1	Imperial Oil Ltd	445417	4823418	Oil and Gas	Abandoned Well	221.6	611.12	Cabot Head	N/A	Aug-55			√			
15	F011909	Imperial 471 - G. Turner No. 1	Imperial Oil Ltd	460308	4824404	Oil and Gas	Abandoned Well	288.65	551.69	Cabot Head	N/A	Oct-54			√			
16	F011928	Imperial 397 - I. McCullagh No. 1	Imperial Oil Ltd	449486	4826945	Oil and Gas	Abandoned Well	280.72	643.13	Cabot Head	N/A	Aug-53			√			
17	F011941	Imperial 368 - Huron Lorne Murch	Imperial Oil Ltd	449938	4827429	Oil and Gas	Abandoned Well	276.15	629.11	Cabot Head	N/A	Mar-53			√			
18	F011951	B. Gibbings	Unknown	458580	4822533	Solution Mining	Unknown	280.35	391.67	N/A	N/A	N/A			note 1			
19	F011953	Imperial 400 - A. Gloor No. 1	Imperial Oil Ltd	459781	4828116	Oil and Gas	Abandoned Well	284.99	548.03	Cabot Head	N/A	Sep-53			√			
20	F011962	Bluewater Oil & Gas - D. Murray No. 1	Prenalta Minerals Inc.	478539	4828801	Oil and Gas	Abandoned Well	338.94	438.3	Rochester	N/A	Jun-56			√			
21	F011965	Imperial 658 - J. Wain No. 1	Imperial Oil Ltd	443873	4829976	Oil and Gas	Abandoned Well	205.13	619.35	Cabot Head	N/A	Jun-58	√		√			
22	F011968	Forest & Daley - J. Mann	Unknown	461193	4830801	Oil and Gas	Unknown	297.48	60.35	Dundee	N/A	Sep-38			note 1			
23	F011969	Nationwide Minerals No. 2 - L. Quipp No. 1	Nationwide Minerals Ltd.	495901	4830644	Oil and Gas	Abandoned Well	357.84	883.92	Precambrian	N/A	May-54			√			
24	F011970	Huron & Bruce Oil Co.	Unknown	457824	4830925	Oil and Gas	Unknown	299.62	1076.25	Precambrian	N/A	May-39			√			
25	F011973	Imperial 511 - J.E. Murch No. 1	Imperial Oil Ltd	457284	4833589	Oil and Gas	Abandoned Well	284.07	563.88	Cabot Head	N/A	Apr-55			√			
26	F011974	Imperial (533)	Imperial Oil Ltd	446767	4833840	Oil and Gas	Abandoned Well	254.51	1128.98	Precambrian	N/A	Nov-55			√			
27	F011975	Imperial 380 - Farquhar No. 1	Imperial Oil Ltd	457688	4834080	Oil and Gas	Abandoned Well	292.3	567.23	Cabot Head	N/A	May-53			√			
28	F011976	Imperial 396 - Farquhar No. 2	Imperial Oil Ltd	458300	4834132	Oil and Gas	Abandoned Well	295.96	563.88	Cabot Head	N/A	Aug-53			√			
29	F011977	Imperial 409 - Wm. Blacker No. 1	Imperial Oil Ltd	457695	4834694	Oil and Gas	Abandoned Well	288.04	562.36	Cabot Head	N/A	Oct-53			√			
30	F011978	Imperial 573 - J.L. Taylor No. 1	Imperial Oil Ltd	469037	4835202	Oil and Gas	Abandoned Well	323.09	518.16	Cabot Head	N/A	Sep-56	√		√			√
31	F011981	Silver Creek Oil No. 1 - B. Allen No. 2	Unknown	469781	4836310	Oil and Gas	Abandoned Well	324.31	504.44	Cabot Head	N/A	Feb-50			√			
32	F011982	Huron Dome Oil Co. - H.S. Allen No. 1	Unknown	470317	4837011	Oil and Gas	Abandoned Well	327.36	551.99	Queenston	N/A	Aug-41			√			
33	F011983	Bluewater Oil & Gas - G. Knight No. 1	Prenalta Minerals Inc.	482654	4831106	Oil and Gas	Abandoned Well	349.91	430.99	Cabot Head	N/A	Sep-57			√			
34	F011984	Imperial 464 - E. Spuran No. 1	Imperial Oil Ltd	490433	4837045	Oil and Gas	Abandoned Well	359.36	451.41	Queenston	N/A	Aug-54			√			
35	F011985	Imperial 583 - P. Fischer No. 1	Imperial Oil Ltd	451442	4837291	Oil and Gas	Abandoned Well	284.68	610.21	Rochester	N/A	Nov-56	√		√			
36	F011986	Imperial 369 - E. Jamieson No. 1	Imperial Oil Ltd	460163	4838578	Oil and Gas	Abandoned Well	294.44	549.55	Cabot Head	N/A	Mar-53			√			
37	F011987	Imperial 679 - G. Ginn No. 1	Imperial Oil Ltd	449252	4839547	Oil and Gas	Abandoned Well	244.45	611.73	Cabot Head	N/A	Oct-58	√		√			
38	F011988	Imperial 378 - H. Hill No. 1	Imperial Oil Ltd	452698	4841323	Oil and Gas	Abandoned Well	288.65	624.84	Cabot Head	N/A	May-53			√			
39	F011989	Imperial 557 - J. Yungblut No. 1	Imperial Oil Ltd	457162	4841796	Oil and Gas	Abandoned Well	293.52	570.28	Cabot Head	N/A	Jun-56	√		√			
40	F011993	Dominion Rock Salt Co.	Dominion Rock Salt Co.	441627	4842978	Stratigraphic	Abandoned Well	206.04	569.37	A-2 Salt	N/A	Apr-57			note 1			
41	F011995	Sifto Salt (1960) Ltd.	Sifto Canada Inc.	444463	4843044	Solution Mining	Abandoned Well	218.2	485.55	B Salt	N/A	Nov-60			note 1			
42	F011997	Dominion Rock Salt Co.	Dominion Rock Salt Co.	441539	4843226	Stratigraphic	Abandoned Well	178	537.06	A-2 Salt	N/A	Sep-56			note 1			
43	F011998	Dominion Rock Salt Co.	Dominion Rock Salt Co.	441607	4843225	Stratigraphic	Abandoned Well	178.49	256.64	Drift	N/A	Jul-56			note 1			
44	F011999	Dominion Rock Salt Co.	Dominion Rock Salt Co.	440984	4843601	Stratigraphic	Abandoned Well	179.59	543.46	A-2 Salt	N/A	Sep-56			√			
45	F012000	Dominion Rock Salt Co. - D.D.H. No. 6	Dominion Rock Salt Co.	441566	4843658	Stratigraphic	Abandoned Well	181.51	540.41	A-1 Carbonate	N/A	Jun-56			note 1			
46	F012001	Dominion Rock Salt Co.	Dominion Rock Salt Co.	440717	4843850	Stratigraphic	Abandoned Well	179.16	548.94	A-2 Salt	N/A	Sep-56			√			
47	F012002	Dominion Rock Salt Co.	Dominion Rock Salt Co.	441233	4843938	Stratigraphic	Abandoned Well	178.77	542.85	A-2 Salt	N/A	Jun-56			√			
48	F012003	Dominion Rock Salt Co.	Dominion Rock Salt Co.	441680	4843996	Stratigraphic	Abandoned Well	177.7	344.73	E Unit	N/A	Jun-57			√			
49	F012004	Dominion Rock Salt Co.	Dominion Rock Salt Co.	442240	4844053	Stratigraphic	Abandoned Well	180.75	586.74	Guelph	N/A	Jan-57			√			

COUNT	LICENSE NUMBER	NAME	OPERATOR	UTM NAD83 EASTING	UTM NAD83 NORTHING	PURPOSE	WELL MODE	GROUND ELEVATION (m)	TVD	TOTAL DEPTH FORMATION	POOL	TD_DATE	Geophysics	Armstrong/Carter Reference	Used in BR Surface	Rock Core Available	OilGasPool	PinReef
50	F012005	Dominion Rock Salt Co.	Dominion Rock Salt Co.	442240	4844084	Stratigraphic	Abandoned Well	178.16	585.06	Guelph	N/A	May-55			√			
51	F012006	Dominion Rock Salt Co.	Dominion Rock Salt Co.	441659	4844089	Stratigraphic	Abandoned Well	178.16	233.78	G Unit	N/A	Oct-55			√			
52	F012008	Imperial 390 - K. Webster No. 1	Imperial Oil Ltd	466347	4844141	Oil and Gas	Abandoned Well	344.12	542.54	Cabot Head	N/A	Jul-53			√			
53	F012009	Dominion Rock Salt Co.	Dominion Rock Salt Co.	440967	4844218	Stratigraphic	Abandoned Well	179.1	545.9	A-2 Salt	N/A	Nov-56			√			
54	F012010	Imperial 412 - R. McCabe No. 1	Imperial Oil Ltd	448188	4844164	Oil and Gas	Abandoned Well	252.37	618.74	Cabot Head	N/A	Oct-53			√			
55	F012011	Imperial 445 - H. Walter No. 1	Imperial Oil Ltd	448755	4844857	Oil and Gas	Abandoned Well	267.31	633.98	Cabot Head	N/A	Jun-54			√			
56	F012013	Imperial 562 - E.A. Toll No. 1	Imperial Oil Ltd	464073	4847133	Oil and Gas	Abandoned Well	323.1	533.4	Cabot Head	N/A	Jul-56			√			
57	F012014	Bluewater Oil & Gas - W. Marks No. 1	Prenalta Minerals Inc.	476524	4847389	Oil and Gas	Abandoned Well	336.8	441.35	Cabot Head	N/A	Aug-57			√			
58	F012015	Imperial 643 - Buchanan No. 1	Imperial Oil Ltd	498939	4829467	Oil and Gas	Abandoned Well	360.27	346.25	Cabot Head	N/A	Nov-57	√		√			
59	F012016	Imperial 389 - Procter No. 1	Imperial Oil Ltd	472541	4849662	Oil and Gas	Abandoned Well	337.41	469.7	Cabot Head	N/A	Jun-53			√			
60	F012017	Imperial 385 - B. Ruddock No. 1	Imperial Oil Ltd	452831	4851698	Oil and Gas	Abandoned Well	265.8	590.4	Cabot Head	N/A	Jun-53			√			
61	F012018	Imperial Oil No. 563 - W.W. Hill No. 1	Imperial Oil Ltd	444530	4852040	Oil and Gas	Abandoned Well	218.54	1111	Cambrian	N/A	Sep-56	√		√			
62	F012021	Felmont Oil Corporation No. 11 - Campbell No. 1	Unknown	481723	4850624	Oil and Gas	Abandoned Well	336.8	435.86	Queenston	N/A	Sep-55	√		√			
63	F012022	Imperial 594 - Horn No. 1	Imperial Oil Ltd	497118	4830456	Oil and Gas	Abandoned Well	358.44	348.08	Cabot Head	N/A	Jan-57	√		√			
64	F012025	Imperial Oil No. 600 - Black No. 1	Imperial Oil Ltd	448372	4854801	Oil and Gas	Abandoned Well	238.96	1083.87	Precambrian	N/A	May-57	√		√			
65	F012026	Imperial 526 - G. Feagan No. 1	Imperial Oil Ltd	446305	4854953	Oil and Gas	Abandoned Well	226.47	622.1	Cabot Head	N/A	Aug-55			√			
66	F012027	Felmont Oil Corp. - R. Thompson No. 1	Felmont Oil Corporation	462480	4855139	Oil and Gas	Abandoned Well	328.88	551.69	Cabot Head	N/A	Nov-55	√		√			
67	F012040	Imperial Oil No. 469 - J.L. Currie No. 1	Imperial Oil Ltd	471212	4857171	Oil and Gas	Abandoned Well	323.1	975.06	Precambrian	N/A	Nov-54			√			
68	F012042	Felmont Oil Corporation - G. Webster No. 1	Felmont Oil Corporation	462578	4857930	Oil and Gas	Abandoned Well	319.43	542.54	Cabot Head	N/A	Feb-56			√			
69	F012047	Felmont MacTavish No. 1	Felmont Oil Corporation	456657	4858617	Oil and Gas	Abandoned Well	297.18	577.6	Cabot Head	Dungannon Pool	Aug-58	√		√		√	
70	F012048	Felmont Oil No. 13 - M. Berger No. 1	Felmont Oil Corporation	449791	4859452	Oil and Gas	Abandoned Well	245.67	601.98	Cabot Head	N/A	Oct-55	√		√			
71	F012059	Bluewater - G. Walden No. 1	Prenalta Minerals Inc.	457070	4867346	Oil and Gas	Abandoned Well	291.08	556.87	Cabot Head	N/A	Sep-57			√			
72	F012061	Lake St Clair Gasfields	Lake St. Clair Gasfields Ltd.	458057	4870139	Natural Gas	Abandoned Well	295.96	1021.38	Precambrian	N/A	Mar-56			√			
73	F012062	Dominion Gas - McKenzie No. 1	Domestic Natural Gas Co.	476382	4870517	Natural Gas	Abandoned Well	316.7	870.2	Precambrian	N/A	Apr-42			√			
74	F012063	Felmont Oil	Felmont Oil Corporation	453515	4871111	Natural Gas	Abandoned Well	260.3	568.76	Cabot Head	N/A	Jan-59	√		√			
75	F012066	Felmont Oil	Felmont Oil Corporation	450276	4874071	Natural Gas	Abandoned Well	235.61	566.93	Cabot Head	N/A	Apr-56	√		√			√
76	F012068	Dominion Gas - Armstrong No. 1	Unknown	480626	4874752	Natural Gas	Abandoned Well	318.2	323.09	Guelph	N/A	Nov-41			√			
77	F012077	Dominion Gas - Smyth No.1	Dominion Natural Gas Co.	474716	4878798	Natural Gas	Abandoned Well	282.9	726.6	Cobourg	N/A	Sep-41			√			
78	F012078	Imperial Oil	Imperial Oil Ltd	457447	4881565	Oil and Gas	Abandoned Well	264.87	507.49	Guelph	N/A	Nov-55	√		√	√		√
79	F012088	Imperial 161 S.T. No. 5	Imperial Oil Ltd	489695	4887137	Stratigraphic	Abandoned Well	294.4	75.59	C Unit	N/A	Jun-48			√			
80	F012089	Imperial (166) S.T. No. 6	Imperial Oil Ltd	491066	4887416	Stratigraphic	Abandoned Well	285.3	26.82	G Unit	N/A	Jun-48			√			
81	F012090	Imperial 167 S.T. No. 7	Imperial Oil Ltd	487527	4887709	Stratigraphic	Unknown	289.99	64.01	N/A	N/A	Jul-48			note 1			
82	F012093	Imperial (172) S.T. No. 8	Imperial Oil Ltd	486917	4890231	Stratigraphic	Abandoned Well	274	35.05	G Unit	N/A	Jul-48			√			
83	F012102	Union Gas Co. -Kincardine No.1 -J.J. Sem	Union Gas Limited	451704	4901991	Natural Gas	Abandoned Well	184.1	890.9	Cambrian	N/A	Sep-41			√			√
84	F012117	D. Carmichael No. 1 - H. R. Matches No. 1	Carmichael, D. H.	486555	4936704	Natural Gas	Abandoned Well	212.18	525.5	Precambrian	N/A	Jul-58			√			
85	F012119	Imperial Oil Co. - M.S. Rourke No.1	Imperial Oil Ltd	488651	4938416	Natural Gas	Unknown	216.7	511.5	Trenton Group	N/A	May-01			√			
86	F012120	NottABWa Oil & Gas Co.- Hillis No.1	Nottawa Oil & Gas Co. Ltd.	488015	4940108	Natural Gas	Abandoned Well	226.2	449.9	Trenton Group	N/A	Oct-35			√			
87	F012121	NottABWa Gas & Oil Company - P. Doubt No. 1	Nottawa Oil & Gas Co. Ltd.	487193	4940162	Natural Gas	Abandoned Well	212.8	526.7	Precambrian	N/A	Nov-35			√			
88	F012122	NottABWa Oil & Gas Co.- P. Doubt No.2	Nottawa Oil & Gas Co. Ltd.	487263	4940998	Natural Gas	Abandoned Well	212.8	452	Trenton Group	N/A	Feb-36			√			
89	F012123	NottABWa Oil & Gas Co. - L. Kinch No. 1	Nottawa Oil & Gas Co. Ltd.	489404	4941596	Natural Gas	Unknown	218.8	439.52	Guelph	N/A	Jan-35			note 1			
90	F012124	NottABWa Oil & Gas Co. No.8 - R. Kinch No. 1	Nottawa Oil & Gas Co. Ltd.	487159	4941859	Natural Gas	Abandoned Well	207.85	436.5	Trenton Group	N/A	Aug-35			√			
91	F012125	NottABWa Oil & Gas Co. - Cupsky No.1	Nottawa Oil & Gas Co. Ltd.	489272	4941935	Natural Gas	Unknown	218.5	453.2	Trenton Group	Hepworth Pool	Jun-35			√		√	
92	F012126	NottABWa Oil & Gas Co. - C.W. Sinclair No 1	Nottawa Oil & Gas Co. Ltd.	488556	4941983	Natural Gas	Unknown	215.2	438.9	Trenton Group	Hepworth Pool	Nov-35			√		√	
93	F012127	NottABWa Oil & Gas Co.- T. Ruth No. 1	Nottawa Oil & Gas Co. Ltd.	487490	4942059	Natural Gas	Unknown	210.9	455.7	Trenton Group	N/A	Nov-36			√			
94	F012128	Mckillop No. 2 -Hughes No.2	McKillop, W.	485637	4942112	N/A	Unknown	200.92	457.2	Cobourg	N/A	Mar-19			√			
95	F012129	NottABWa Oil & Gas Co.-Binns No.1	Nottawa Oil & Gas Co. Ltd.	489343	4942154	Natural Gas	Unknown	217.9	525.8	Trenton Group	Hepworth Pool	Nov-35			√		√	
96	F012130	NottABWa Oil & Gas Co.- B. Kocker Estate No. 3	Nottawa Oil & Gas Co. Ltd.	487391	4943556	Natural Gas	Unknown	210	457.2	Black River Group	Hepworth Pool	Jul-36			√		√	
97	F012131	Mckillop No. 1 - H. Anderson	McKillop, W.	485468	4942464	Natural Gas	Unknown	192.3	460.2	Trenton Group	N/A	Apr-19			√			
98	F012132	Grey & Bruce Oil & Gas Company No. 7 - W. S. Driffle	Grey and Bruce Oil & Gas Co.	489146	4942656	Natural Gas	Unknown	215.5	430.99	N/A	N/A	Dec-00			note 1			

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99	F012133	Grey-Bruce Oil & Gas Co. - W. Driffle No. 2	Grey and Bruce Oil & Gas Co.	488982	4942768	Natural Gas	Unknown	215.2	429.5	Trenton Group	Hepworth Pool	Jan-01			√		√	
100	F012134	Grey & Bruce Oil and Gas Company No. 2 - W. Driffle No. 1	Grey and Bruce Oil & Gas Co.	489314	4942528	Natural Gas	Unknown	215.8	502.92	Precambrian	N/A	Dec-05			√			
101	F012135	Grey-Bruce Oil & Gas Co. - Hepworth No. 3	Grey and Bruce Oil & Gas Co.	488930	4942849	Natural Gas	Unknown	214	458.7	Trenton Group	Hepworth Pool	Dec-01			√		√	
102	F012136	Northern Gas - Kemp No. 1	Northern Gas & Gasoline C.	488408	4943116	Natural Gas	Unknown	214	442	Trenton Group	Hepworth Pool	Sep-19			√		√	
103	F012138	Grey-Bruce Oil & Gas Co. - Hepworth No. 4	Grey and Bruce Oil & Gas Co.	489314	4943512	Natural Gas	Unknown	219.5	433.1	Trenton Group	Hepworth Pool	Dec-01			note 5		√	
104	F012139	Imperial Oil Co. -A. Schnurr No. 1	Imperial Oil Ltd	486945	4944066	Natural Gas	Abandoned Well	212.8	448.4	Trenton Group	N/A	Jan-02			√			
105	F012141	Imperial Oil No.536 - Taylor et al No. 1	Imperial Oil Ltd	484603	4950304	Natural Gas	Abandoned Well	208.5	501.4	Precambrian	N/A	Oct-55	√		√			
106	F012142	Wiarton Local Co. - G. Farrow No. 1	Wiarton Local Company	488214	4952580	Natural Gas	Unknown	198.7	396.2	Trenton Group	N/A	Dec-01			√			
107	F012144	NottABWa Oil & Gas Co.-J.Goetz No. 1	Nottawa Oil & Gas Co. Ltd.	489058	4941714	Natural Gas	Abandoned Well	217.3	442	Trenton Group	N/A	Aug-35			√			
108	F013429	Unknown	Unknown	477017	4816701	Solution Mining	Unknown	0	425.5	N/A	N/A	N/A			note 2			
109	F013430	Unknown	Unknown	502431	4850628	Location	Abandoned Well	0	0	N/A	N/A	Jan-15			note 5			
110	F013547	Northern Gas & Gasoline - Doubt Farm	Northern Gas & Gasoline Co.	488833	4942880	N/A	Unknown	213.97	428.24	N/A	N/A	N/A			note 1			
111	F013549	W. McKillop No. 2 - J. Hughes	McKillop, W.	483927	4942048	Natural Gas	Unknown	195.36	457.2	Cobourg	N/A	Mar-19			√			
112	F013552	Kincardine Salt	Unknown	448548	4891083	Natural Gas	Unknown	180.97	342.9	N/A	N/A	Jul-29			√			
113	F014090	OGS 86-6	ON Geological Survey	491669	4948301	Stratigraphic	Abandoned Well	0	6	Eramosa	N/A	Jan-86			note 5	√		
114	F014091	OGS 86-10	ON Geological Survey	479271	4936988	Stratigraphic	Abandoned Well	0	6.5	Eramosa	N/A	Jan-86			note 2			
115	F014092	OGS 86-1	ON Geological Survey	496600	4937299	Stratigraphic	Abandoned Well	0	3	Eramosa	N/A	Jan-86			note 2	√		
116	F014095	G. Bowles	ON Geological Survey	530395	4897466	Stratigraphic	Unknown	473.77	46.94	Guelph	N/A	Jan-31			note 1			
117	F014194	Golder Assoc. BH 2 Proj. 783224	Golder Associates	503190	4950731	Stratigraphic	Abandoned Well	236	5.9	Gasport	N/A	N/A			note 1	√		
118	F014195	Golder Assoc. ORIH 783224	Golder Associates	503234	4950731	Stratigraphic	Abandoned Well	236	6.1	Gasport	N/A	N/A			note 1	√		
119	F014196	Sutherland Quarry	Gamsby and Mannerow Ltd	500601	4942498	Stratigraphic	Unknown	248	21.7	Cabot Head	N/A	Jun-86			√	√		
120	F014197	Golder Assoc. BH1 773163 St. Vincent	Golder Associates	532458	4937549	Stratigraphic	Abandoned Well	218	7.6	Gasport	N/A	N/A			note 1	√		
121	F014198	Golder Assoc BH1 Proj. 773300	Golder Associates	501136	4886813	Stratigraphic	Abandoned Well	0	14.1	Gasport	N/A	N/A			note 2	√		
122	F014199	Seeley & Arnill TW-1	Seeley & Arnill Aggregates	529606	4925230	Stratigraphic	Unknown	426	50.9	Cabot Head	N/A	Mar-90			√	√		
123	H000007	NottABWa Oil & Gas Co. - W. Binns	Nottawa Oil & Gas Co. Ltd.	488838	4941736	Natural Gas	Unknown	217.9	527.3	Black River Group	N/A	Oct-34			note 1			
124	H000009	Oliphant Well	Unknown	478698	4952518	N/A	Unknown	184.7	335.3	Cobourg	N/A	Dec-08			note 5			
125	H000022	Canadian Oil Fields - Lever	Canadian Oil Fields Limited	534866	4904382	Oil and Gas	Unknown	425.2	570.9	Cambrian	N/A	Jan-17			√			
126	H000029	Arnora Sulphur Mining Corporation No.2 - J. O'Neill No. 1	Arnora Sulphur Mining Corp	522830	4897482	Oil and Gas	Abandoned Well	390.14	598.02	Precambrian	N/A	Jan-56			√			
127	H000030	West Kale - Harrison Well	Unknown	489715	4942058	Oil and Gas	Unknown	218.85	452.6	Trenton Group	N/A	N/A			√			
128	H000031	NottABWa Oil & Gas Co. - A.Barfoot No. 1	Nottawa Oil & Gas Co. Ltd.	493662	4937961	Oil and Gas	Unknown	221.75	492.9	Cambrian	N/A	Mar-35			√			
129	H000032	Imperial Oil No. 527 - W. Radbourne No. 1	Imperial Oil Ltd	492711	4941352	Oil and Gas	Abandoned Well	240.18	497.43	Precambrian	N/A	Aug-55	√		√			
130	H000033	Ben Allen Cement Co. - Chambers & Dewus - McMillan No. 1	Chambers & Dewus	501617	4940342	Oil and Gas	Unknown	239.57	472.44	Shadow Lake	N/A	Mar-58	√		√			
131	H000034	NottABWa Oil & Gas Co. - A. Cunningham No. 1	Nottawa Oil & Gas Co. Ltd.	489832	4942819	Oil and Gas	Abandoned Well	217.93	463.91	Trenton Group	N/A	Jun-35			√			
132	H000035	Thomas Smith No. 1	Imperial Oil Ltd	489249	4947328	Oil and Gas	Abandoned Well	219.8	457.2	Trenton Group	N/A	May-02			note 5			
133	H000036	NottABWa Oil & Gas Co. - D. Carson No. 1	Nottawa Oil & Gas Co. Ltd.	491274	4940382	Oil and Gas	Abandoned Well	228.79	454.2	Trenton Group	N/A	Mar-36			note 5			
134	H000038	Arnora Sulphur Mining Corporation No.1 - A.B. Whyte No. 1	Arnora Sulphur Mining Corporation	534100	4891959	Oil and Gas	Abandoned Well	475.49	701.95	Precambrian	N/A	Oct-55	√		√			
135	H000039	T. Catbush	Unknown	503895	4938239	Oil and Gas	Unknown	181.66	382.2	Trenton Group	N/A	N/A			√			
136	H000040	Morrison Well	Unknown	503988	4938212	Oil and Gas	Unknown	170.99	0	Precambrian	N/A	N/A			note 3			
137	H000041	Wm L. Forrest - F. McNeil No. 2	Forrest, W. L.	503962	4945893	Oil and Gas	Abandoned Well	222.5	416.4	Precambrian	N/A	Oct-39			√			
138	H000042	Wm L. Forrest - E. Hind No. 1	Forrest, W. L.	505163	4945894	Oil and Gas	Unknown	218.54	402.34	Precambrian	N/A	Jul-39			√			
139	H000043	Annan Petroleum No. 1 - D. Morris No. 1	Annan Petroleum	505423	4945958	Oil and Gas	Unknown	217.3	368.2	Black River Group	N/A	Jan-48	√		√			
140	H000044	Annan Petroleum No. 4 - F. Cavell No. 1	Annan Petroleum	504458	4947117	Oil and Gas	Unknown	228.3	362.71	Trenton Group	N/A	Aug-48			note 5			
141	H000045	Goodfellow Well	Unknown	504103	4948008	Oil and Gas	Unknown	224.03	367	Kirkfield	N/A	Jan-24			note 5			
142	H000046	Doran Oil & Gas Company No. 3	Ben Doran Oil & Gas Company	529597	4943399	Oil and Gas	Unknown	181.4	260.3	Trenton Group	N/A	Jun-19			note 5			
143	H000047	Doran Oil & Gas Company No. 4 - B. Doran	Ben Doran Oil & Gas Company	528228	4943962	Oil and Gas	Unknown	227.47	297.48	Trenton Group	N/A	Jul-21			note 5			
144	H000048	Doran Oil & Gas Company No. 1 -B. Doran	Ben Doran Oil & Gas Company	529083	4944315	Oil and Gas	Abandoned Well	197.5	260.9	Trenton Group	N/A	Jan-18			note 5			
145	H000049	Penn-Ryan Oil & Gas Limited - G.H. Brown	Penn - Ryan Oil & Gas Co. Ltd.	526500	4944301	Oil and Gas	Unknown	347	417.6	Precambrian	N/A	Jan-30			note 5			
146	H000050	Pennsylvania Oil & Gas Company - G. Brown No. 1	Pennsylvania Oil & Gas	525884	4945714	Oil and Gas	Unknown	326.1	317	Cobourg	N/A	Jan-30			note 1			

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147	H000051	Annan Petroleum No. 2 - S. Reilly No. 1	Annan Petroleum	514003	4944104	N/A	Unknown	224.72	353.6	Black River Group	N/A	May-48			√			
148	H000052	Annan Petroleum No. 3 - J. B. Duggan No.	Annan Petroleum	517854	4945971	Oil and Gas	Unknown	268.53	353.9	Black River Group	N/A	Jul-48			√			
149	H000139	Mitchell Oil Producing Syndicate - J. Challenger No. 1	Mitchell Oil Producing Syndicate	483227	4815056	Oil and Gas	Abandoned Well	351.43	971.7	Precambrian	N/A	Jun-26			√			
150	H000167	Ohio Oil Co. - G. Ernst No. 1	Ohio Oil Company	523867	4834692	Natural Gas	Abandoned Well	396.94	784.25	Precambrian	N/A	Aug-00			√			
151	N000050	NottABWa Oil and Gas Co. No. 6 - Goetz	Nottawa Oil & Gas Co. Ltd.	488835	4941754	Natural Gas	Unknown	217.32	435.86	N/A	N/A	Jan-35			note 1			
152	N000053	Grey & Bruce Oil & Gas	Grey and Bruce Oil & Gas Co.	489200	4942460	Natural Gas	Unknown	217	432.82	Trenton Group	Hepworth Pool	Dec-00			note 1		√	
153	N000055	Northern Gas - Corbett No. 1	Northern Gas & Gasoline Co.	488374	4942708	N/A	Unknown	215.33	441.96	Cobourg	Hepworth Pool	Dec-19			√		√	
154	N000252	Walsh Well	Unknown	503458	4936873	Oil and Gas	Unknown	195.99	438.91	Precambrian	N/A	N/A			√			
155	N000265	J. McWilliams	Unknown	502595	4938142	Oil and Gas	Unknown	213.78	387.1	Trenton Group	N/A	N/A			note 5			
156	N000266	S.S. Spencer	Unknown	489881	4938149	Oil and Gas	Unknown	226.16	499.87	Precambrian	N/A	N/A			note 1			
157	N000267		Unknown	490709	4938524	N/A	Abandoned Well	221.89	243.84	N/A	N/A	N/A			note 1			
158	N000269	NottABWa Gas Company No. 2	Nottawa Oil & Gas Co. Ltd.	490217	4940223	Oil and Gas	Unknown	224.33	437.08	Trenton Group	N/A	Jan-35			note 1			
159	N000270	Shallow Lake Well	Unknown	492609	4940091	N/A	Unknown	225.55	471.83	N/A	N/A	N/A			note 1			
160	N000271	NottABWa Oil & Gas Company - A. Cunningham No. 3 (?)	Nottawa Oil & Gas Co. Ltd.	489918	4942835	Oil and Gas	Unknown	218.54	438.3	N/A	N/A	Jan-35			note 1			
161	N000273	OGS CLGD No. 17	ON Geological Survey	533204	4939143	Stratigraphic	Abandoned Well	181.72	54.96	Cobourg	N/A	Mar-82			√	√		
162	N000274	Robert Cherry	Unknown	532168	4939361	Oil and Gas	Unknown	183.15	0	N/A	N/A	N/A			note 1			
163	N000275	Doran Oil & Gas Company No. 2 - H. McCarkney	Ben Doran Oil & Gas Company	529374	4943876	Oil and Gas	Unknown	192.6	249.94	Trenton Group	N/A	Jan-19			note 5			
164	N000276	R.B. Harkness	Unknown	521380	4945676	Oil and Gas	Unknown	304	42.06	Georgian Bay-Blue Mountain	N/A	N/A			note 1			
165	N000277	Desborough Well	Unknown	500033	4916285	Oil and Gas	Unknown	274.32	298.7	Georgian Bay-Blue Mountain	N/A	Jan-07			note 1			
166	N000278	Ormiston Well	Unknown	509098	4935774	Oil and Gas	Unknown	216.71	426.72	Black River Group	N/A	Jan-24			note 5			
167	N000554	Goderich Salt Co. - No. 5 Brine Well	Goderich Salt Co.	443941	4843133	Solution Mining	Abandoned Well	227	353.57	B Salt	N/A	Jan-35			note 5			
168	N000556	F.C. Rogers	Unknown	464074	4841823	Oil and Gas	No Well Found	329.2	370.33	Guelph	N/A	N/A			note 1			
169	N000559	Seaforth Chemicals & Salt No. 2	Seaforth Chemicals & Salt Ltd.	467426	4822225	Solution Mining	No Well Found	309.37	350.52	B Salt	N/A	Apr-48			√			
170	N002664	Brussels - Henry No. 1	Brussels Oil Co. Ltd.	491272	4827672	Oil and Gas	Unknown	0	213.36	N/A	N/A	Jan-14			note 2			
171	N002809	Brimblecombe and Manderson No. 1	Brimblecombe & Manderson	511481	4862737	Natural Gas	Suspended Well	383.2	277.37	Queenston	N/A	Mar-31			√			
172	N004151	Pounder & Harmon	Unknown	458889	4828664	N/A	Abandoned Well	0	0	N/A	N/A	N/A			note 5			
173	T000084	Canadian Hemisphere Petroleum No. 3 - Young No. 1	Canadian Hemisphere Petroleum Ltd.	451200	4846690	Oil and Gas	Abandoned Well	259.38	589.48	Cabot Head	N/A	Apr-59			√			
174	T000085	Canadian Hemisphere Petroleum - Wilson No. 1	Canadian Hemisphere Petroleum Ltd.	453206	4831213	Oil and Gas	Abandoned Well	267.61	590.7	Cabot Head	N/A	Apr-59			√			
175	T000382	British American - R. Dolmage No. 1	Unknown	469936	4830429	Oil and Gas	Abandoned Well	325.53	507.8	Cabot Head	N/A	Nov-59			√			
176	T000856	United Reef No. 3 - S. Wilson No. 1	United Reef Petroleums Limited	460053	4818532	Oil and Gas	Abandoned Well	280.11	548.94	Rochester	N/A	Sep-61			√			
177	T000857	United Reef Petroleum No. 4 - John Kerr No. 1	Brady Oil & Gas Limited	474075	4825241	Oil and Gas	Abandoned Well	324.92	481.28	Rochester	N/A	Sep-61			√			
178	T001092	United Reef No. 1 - G. H. Leiper No. 1	Panhandle Drilling Company	466193	4835747	Oil and Gas	Abandoned Well	314.6	525.78	Rochester	N/A	Jul-61			√			
179	T001182	Imperial 801 - Turner No. 2	Imperial Oil Ltd	459939	4824141	Oil and Gas	Abandoned Well	286.21	544.68	Rochester	N/A	Feb-62			√			
180	T001720	B.P. Exploration Triad	B.P. Exploration Canada Ltd.	473227	4910800	Natural Gas	Abandoned and Junked (Lost)	239.88	315.47	Manitoulin	N/A	Jul-64			√			√
181	T001720A	BP Triad	B.P. Exploration Canada Ltd.	473240	4910793	Natural Gas	Abandoned Well	239.88	722.38	Precambrian	N/A	Aug-64	√		√	√		√
182	T001877	Silver City Petroleums	Silver City Petroleums Ltd.	508633	4912734	Oil and Gas	Abandoned Well	322.63	558.4	Precambrian	N/A	Sep-64			√			
183	T001892	Home C.D.R.	Home Oil Company Limited	466526	4913077	Natural Gas	Abandoned Well	235.31	770.5	Precambrian	N/A	Mar-65	√		√			√
184	T001925	BP Triad	B.P. Resources Canada Limited	460322	4894759	Natural Gas	Abandoned Well	274.93	912.9	Precambrian	N/A	Apr-65	√		√	√		
185	T001942	BP Home	B.P. Resources Canada Limited	455764	4900536	Natural Gas	Abandoned Well	233.17	897.9	Precambrian	N/A	Feb-66	√		√			
186	T002053	GIBRALTAR SEVEN SEVENTY SEVEN	839040 Ontario Inc.	456481	4823061	Natural Gas	Abandoned Well	269.14	554.13	Irondequoit	N/A	Apr-66			√			
187	T002229	Creesing No.1	Creesing Explorations Syndicate	524520	4876199	Oil and Gas	Abandoned Well	432.8	667.51	Precambrian	Egremont Pool	Sep-66			√		√	
188	T002235	ALTAIR ET AL	Northern Cross Energy Limited	456310	4858496	Natural Gas	Active Well	285.3	560.83	Goat Island	Dungannon Pool	Jan-67			√		√	√
189	T002238	Texaco No.4 Home C.D.R.	Texaco Exploration Co.	459943	4909022	Natural Gas	Abandoned Well	234.7	850.4	Precambrian	N/A	Jan-67	√		√			
190	T002250	Altair et al	Altair Oil & Gas Company	455946	4858492	Oil and Gas	Abandoned Well	289.56	1053.08	Precambrian	N/A	Jun-67	√		√			

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191	T002284	Creesing No.2	McDougall, Ross (William)	524656	4875701	Private Gas Well	Active Well	438.61	672.08	Precambrian	Egremont Pool	Oct-66	√		√		√	
192	T002347	Kenartha No.1	Kenartha Oil and Gas Company Ltd.	525183	4860023	Oil and Gas	Abandoned Well	427.3	718.72	Precambrian	N/A	Jul-67			√			
193	T002380	MESA PETROLEUMS	Northern Cross Energy Limited	456157	4858315	Natural Gas	Abandoned Well	290.47	577.6	Cabot Head	Dungannon Pool	Oct-67	√		√		√	
194	T002433	Kenartha No.2	Kenartha Oil and Gas Co.	529044	4856068	Natural Gas	Active Well	442	726.95	Precambrian	Arthur Pool	Jan-68			√		√	
195	T002470	MESA ET AL TEESWATER	Mesa Petroleums Limited	464082	4861103	Oil and Gas	Abandoned Well	314.55	526.69	Cabot Head	N/A	May-68	√		√			
196	T002478	Kenartha No.3	Kenartha Oil and Gas Co.	527739	4855270	Natural Gas	Active Well	435.9	731.82	Precambrian	Arthur Pool	May-68	√		√		√	
197	T002556	MESA ET AL BELMORE NO.1	Northern Cross Energy Ltd.	462409	4857947	Natural Gas	Active Well	320.04	543.5	Reynales/Fossil Hill	West Wawanosh 26-X Pool	Oct-68	√		note 5		√	√
198	T002613	Monray No.1	Monray Enterprises Inc.	523662	4872322	Oil and Gas	Abandoned Well	422.45	677.57	Precambrian	N/A	Oct-68	√	√	√			
199	T002627	Monray No.2	Monray Enterprises Inc.	525962	4875340	Oil and Gas	Abandoned Well	449.58	679.7	Precambrian	Egremont Pool	Nov-68	√		√		√	
200	T002636	Texaco No.6 Bruce 8-E-IV	Texaco Exploration Co.	456347	4905796	Natural Gas	Abandoned Well	228.9	881.5	Cambrian	N/A	Jan-69	√		√			
201	T002663	PINETREE MID-NORTHERN NO.1	Pinetree Capital Corp.	444274	4876779	Natural Gas	Abandoned Well	210.31	608.69	Cabot Head	N/A	Apr-69	√		√			
202	T002713	Buxton Bozlan No.1	Buxton Oil & Gas Limited	530430	4855695	Natural Gas	Abandoned Well	435.9	716.28	Precambrian	N/A	Jul-69	√	√	√			
203	T002730	PINETREE ET AL NO.1	Pinetree Capital Corp.	467411	4883088	Natural Gas	Abandoned Well	277.1	429.46	Cabot Head	N/A	May-69	√		√			
204	T002731	ZURICH ET AL GODERICH NO.1	Talisman Energy Inc.	449436	4827242	Natural Gas	Abandoned and Junked (Lost)	277.98	77.11	Dundee	N/A	May-69			note 1			
205	T002731A	Zurich et al Goderich No.1A	Clearwood Resources Inc.	449438	4827137	Natural Gas	Abandoned Well	277.37	626.67	Rochester	Tipperary Pool	Aug-69	√		√		√	
206	T002754	Buxton No.2	Buxton Oil & Gas Limited	526987	4853659	Natural Gas	Abandoned Well	434.9	743.41	Precambrian	N/A	Jul-69	√		√			
207	T002783	MID-NORTHERN NO.1	Mid-Northern Explorations Ltd.	481403	4843921	Oil and Gas	Abandoned Well	345.03	420.01	Cabot Head	N/A	Aug-69	√		√			
208	T002842	Zurich et al Goderich No.2	Tipperary Gas Corp.	449607	4827352	Natural Gas	Active Well	280.11	616.92	Rochester	Tipperary Pool	Nov-69	√		√		√	
209	T003126	Kenartha No.4	Kenartha Oil and Gas Co.	528369	4855816	Natural Gas	Abandoned Well	442.57	800.4	Precambrian	N/A	Feb-71	√		√			
210	T003298	Kenartha No.5	Kenartha Oil and Gas Co.	528470	4855205	Natural Gas	Abandoned Well	434.9	730.91	Precambrian	N/A	Oct-71			√			
211	T003350	Barr MacKinnon No. 1	Barr, O.P.	464779	4906776	Natural Gas	Abandoned Well	249	393.8	Cabot Head	N/A	Mar-72			√			√
212	T003387	Barr Cormack No. 1	Barr, O.P.	470293	4908301	Natural Gas	Abandoned Well	247.5	335.89	Cabot Head	N/A	May-72	√		note 4			√
213	T003535	FITZGERALD	Milton Resources Limited	444999	4883101	Natural Gas Storage Well	Abandoned Well	203	583.69	Cabot Head	N/A	Mar-73	√		√			√
214	T003553	FITZGERALD	Milton Resources Limited	461680	4877090	Natural Gas	Abandoned Well	295.05	511.45	Cabot Head	N/A	Aug-73	√		√			
215	T003563	DOMTAR GODERICH S.T.#1	Domtar Chemicals Ltd.(Sifto Salt Div.)	444609	4842965	Stratigraphic	Abandoned Well	228.6	498.35	B Anhydrite	N/A	Apr-73			√	√		
216	T003588	FITZGERALD	Milton Resources Limited	458401	4893571	Natural Gas	Abandoned Well	268.83	481.89	Cabot Head	N/A	May-73	√		√			
217	T003607	POUNDER & HARMON	Pounder, Harmon & Hill Inc.	456630	4835278	Oil and Gas	Abandoned Well	278.6	540.72	Goat Island	N/A	Jul-73	√		√			
218	T003625	THIMAC YOUNG CATHERINE NO.1	J.B. McClusky Ltd.	490215	4827080	Oil and Gas	Abandoned Well	358.44	401.73	N/A	N/A	Aug-73	√		√			
219	T003632	POUNDER & HARMON	Pounder, Harmon & Hill Inc.	458882	4828485	Oil and Gas	Abandoned and Junked (Lost)	288.04	92.05	Lucas	N/A	Jul-73			note 1			
220	T003632A	Pounder & Harmon	Pounder, Harmon & Hill Inc.	458884	4828488	Oil and Gas	Abandoned Well	288.04	536.45	Goat Island	N/A	Sep-73	√		√			
221	T003656	JACKLIN	Baier, John E., Jacklin Farms Limited	440913	4877017	Oil and Gas	Abandoned Well	189.59	643.13	Cabot Head	N/A	Oct-73	√		√			
222	T003661	THIMAC	J.B. McClusky Ltd.	486101	4842408	Oil and Gas	Abandoned Well	349	390.14	Rochester	N/A	Sep-73	√		√			
223	T003684	THIMAC	J.B. McClusky Ltd.	448246	4871846	Oil and Gas	Abandoned Well	241.1	612.34	Cabot Head	N/A	Mar-74	√		√			
224	T003785	MOFFAT LAKE GODERICH #3	Clearwood Resources Inc.	449583	4827632	Oil and Gas	Abandoned Well	279.2	624.84	Gasport	Tipperary Pool	Mar-75	√		√		√	
225	T003895	Domtar No.9 Brine Well	Sifto Canada Inc.	444461	4842834	Solution Mining	Active Well	228.6	495.3	B Salt	N/A	Apr-97	√		√			
226	T004315	Kenartha No.6	Kenartha Oil and Gas Co.	528883	4856669	Oil and Gas	Abandoned Well	440.7	773.58	Precambrian	N/A	Dec-77	√		√			
227	T004413	Fitzgerald	Milton Resources Limited	459111	4817532	Oil and Gas	Abandoned Well	275.23	528.52	Goat Island	N/A	Jul-77	√		√			
228	T004433	Kenartha No.7	Kenartha Oil and Gas Co.	529087	4855430	Natural Gas	Abandoned Well	433.7	762	Precambrian	N/A	Aug-77			√			
229	T004545	Kenartha No.8	Kenartha Oil and Gas Co.	527690	4855837	Natural Gas	Abandoned Well	438.3	730	Precambrian	N/A	Dec-77			√			
230	T004604	Shell	Shell Canada Products Limited	461636	4865951	Oil and Gas	Abandoned Well	307.24	528.52	Gasport	N/A	Feb-78	√		√			
231	T004730	Pacific Elma 2-13-XI	Petro-Canada Inc.	496270	4833007	Oil and Gas	Abandoned Well	357.84	873.25	Precambrian	N/A	Aug-78	√		√			
232	T004767	Pacific	Petro-Canada Inc.	485863	4856905	Oil and Gas	Abandoned Well	342.3	865.94	Precambrian	N/A	Nov-78	√	√	√			
233	T004848	Kenartha	Kenartha Oil and Gas Co.	528475	4855545	Natural Gas	Abandoned Well	435.9	739.14	Precambrian	N/A	Oct-78	√		√			
234	T004849	FITZGERALD	Northern Cross Energy Ltd.	446265	4866188	Natural Gas	Active Well	222	567.54	Goat Island	Ashfield 5-IX WD Pool	Feb-79	√		√		√	√

COUNT	LICENSE NUMBER	NAME	OPERATOR	UTM NAD83 EASTING	UTM NAD83 NORTHING	PURPOSE	WELL MODE	GROUND ELEVATION (m)	TVD	TOTAL DEPTH FORMATION	POOL	TD_DATE	Geophysics	Armstrong/Carter Reference	Used in BR Surface	Rock Core Available	OilGasPool	PinReef
235	T004851	Total et al	Rigel Oil & Gas Ltd.	455710	4862980	Oil and Gas	Abandoned Well	272.8	1037.23	Precambrian	N/A	Dec-78	√		√			
236	T004853	BURT	Burt, Ross	442104	4855920	Oil and Gas	Abandoned Well	201.8	573	A-2 Carbonate	N/A	Aug-79			√			
237	T004854	Pacific	Petro-Canada Inc.	466865	4888669	Natural Gas	Abandoned Well	289.3	894	Precambrian	N/A	Feb-79	√	√	√			
238	T004855	Fitzgerald	Milton Resources Limited	458926	4817079	Oil and Gas	Abandoned Well	272.8	544.4	Cabot Head	N/A	Feb-79	√		√			
239	T004864	SHELL	Northern Cross Energy Limited	444283	4857305	Natural Gas	Active Well	213.7	639	Cabot Head	Ashfield 7-1-III ED Pool	Mar-79	√		√		√	√
240	T004869	Kenartha	Kenartha Oil and Gas Co.	527186	4859433	Oil and Gas	Abandoned Well	431.8	726.6	Precambrian	N/A	Apr-79			√			
241	T004881	Pacific	Petro-Canada Inc.	473530	4869343	Natural Gas	Abandoned Well	294.1	882.7	Precambrian	N/A	May-79	√	√	√			
242	T004910	Amoco A-1	BP Canada Energy Co.	463644	4889056	Natural Gas	Abandoned Well	282.2	909	Precambrian	N/A	Jul-79	√		√	√		√
243	T004918	SHELL	Northern Cross Energy Limited	444455	4857109	Natural Gas	Active Well	213.3	626.4	Cabot Head	Ashfield 7-1-III ED Pool	May-79	√		√		√	
244	T004985	Petromark et al	Petromark Minerals Limited	503007	4825710	Oil and Gas	Abandoned Well	363.6	875.1	Precambrian	N/A	Jul-79	√	√	√			
245	T005051	SHELL	Shell Canada Products Limited	459873	4851356	Oil and Gas	Abandoned Well	305.9	594	Cabot Head	N/A	Aug-79	√		√			
246	T005124	AMOCO	BP Canada Energy Co.	466979	4825797	Oil and Gas	Abandoned Well	311.7	525	Cabot Head	N/A	Aug-79	√		√			
247	T005130	Shell	Shell Canada Products Limited	451474	4818493	Oil and Gas	Abandoned Well	250.6	604	Queenston	N/A	Sep-79	√		√			
248	T005131	FITZGERALD	Milton Resources Limited	448788	4859000	Oil and Gas	Abandoned Well	236.2	573.4	Goat Island	N/A	Nov-79	√		√			
249	T005166	Shell	Clearwood Resources Inc.	448978	4826279	Natural Gas	Abandoned Well	272.8	644	Cabot Head	Tipperary South Pool	Nov-79	√		√		√	
250	T005177	Kenartha Arthur 4-24-VII	Kenartha Oil and Gas Co.	528341	4855921	Natural Gas	Active Well	438.3	883.9	Precambrian	Arthur Pool	Jan-80	√		√		√	
251	T005182	FITZGERALD	Pounder, Harmon & Hill Inc.	456649	4825121	Oil and Gas	Abandoned Well	271.9	545	Goat Island	N/A	Feb-80	√		√			
252	T005326	SHELL	Shell Canada Products Limited	452933	4831468	Oil and Gas	Abandoned Well	264.5	601	Cabot Head	N/A	Jun-80	√		√			
253	T005397	DOMTAR TEST HOLE #3	Domtar Chemicals Ltd.(Sifto Salt Div.)	442310	4844361	Stratigraphic	Unknown	180	259	G Unit	N/A	Aug-80			√	√		
254	T005404	SHELL	Shell Canada Products Limited	452248	4841009	Oil and Gas	Abandoned Well	292.5	625.5	Cabot Head	N/A	Sep-80	√		√			
255	T005478	DOMTAR FREEZE HOLE NO.'S 1 TO 34 INC.	Domtar Chemicals Ltd.(Sifto Salt Div.)	442310	4844361	Stratigraphic	Unknown	180	95	Amherstburg	N/A	Dec-80			√	√		
256	T005554	HURON 1	Talisman Energy Inc.	449183	4815723	Oil and Gas	Abandoned Well	257.5	592	Cabot Head	N/A	Jan-82	√		√			
257	T005555A	Huron 2	Stanley Reef Resources Limited	446264	4816101	N/A	Abandoned and Junked (Lost)	237.7	9	Drift	N/A	Mar-82			note 1			
258	T005652	Pamperth	Burt, Ross	506804	4849490	Oil and Gas	Abandoned Well	391.3	809.3	Precambrian	N/A	Dec-81			√			
259	T005778	Aurelian No. 1	Aurelian Small Business Developers Ltd.	497562	4937527	N/A	Abandoned Well	251.1	478.5	Shadow Lake	N/A	Apr-82			√			
260	T005779	DOMTAR & CHEM.DDH #2	Domtar Chemicals Ltd.(Sifto Salt Div.)	441659	4844120	Stratigraphic	Abandoned Well	177.7	91.3	Guelph	N/A	Oct-81			note 1			
261	T005884	HURON 2 STANLEY 4-12-XII	Talisman Energy Inc.	446255	4816092	Oil and Gas	Abandoned Well	237.7	603.8	Cabot Head	N/A	Jun-82			√			
262	T005885	Huron 3	Tribute Resources Inc.	447664	4814373	Natural Gas	Abandoned Well	270	615	Cabot Head	Stanley 4-7-XI Pool	Aug-82	√		√		√	
263	T006251	MILTON RESOURCE	Milton Resources Limited	443500	4832167	Oil and Gas	Abandoned Well	211.5	623.8	Cabot Head	N/A	Jul-83	√		√			
264	T006307	HURON #4	Tribute Resources Inc.	447698	4814467	Natural Gas	Suspended Well	262.49	576	Guelph	Stanley 4-7-XI Pool	Aug-83	√		√		√	√
265	T006322	HURON #5	PPC Oil & Gas Corp.	449053	4815783	Oil and Gas	Abandoned Well	255.04	604	Cabot Head	N/A	Aug-83	√		√			
266	T006341	TIPPERARY #6	PPC Oil & Gas Corp.	444686	4829334	Oil and Gas	Abandoned Well	214.55	632.8	Queenston	N/A	Sep-83	√		√			
267	T006346	Tipperary S #2	Tipperary Gas Corp.	448905	4826391	Natural Gas	Active Well	269.5	610	Cabot Head	Tipperary South Pool	Sep-83	√		√		√	
268	T006364	Tipperary No.4	Tipperary Resources Limited	449452	4827488	Oil and Gas	Abandoned Well	278.55	1134	Precambrian	N/A	Oct-83	√	√	√			
269	T006737	Forbes No. 1	J.E.English General Drilling & Well Servicing Ltd.	492812	4940700	N/A	Abandoned Well	240	451.5	Gull River	N/A	Aug-85			√			
270	T007104	Florentine et al 1	PPC Oil & Gas Corp.	447155	4819475	Oil and Gas	Abandoned Well	250	613.5	Cabot Head	N/A	Mar-87	√		√			
271	T007136	Florentine et al 2	Paladin Petroleum Corporation	448453	4818959	Natural Gas	Abandoned Well	270.3	614.2	Grimsby	N/A	Jun-87			√			
272	T007179	Owenbrook et al 1	Paladin Petroleum Corporation	450367	4824196	Oil and Gas	Abandoned Well	252.5	598	Cabot Head	N/A	Oct-87	√		√			
273	T007307	Orford Res et al 1	Talisman Energy Inc.	448924	4813785	Oil and Gas	Abandoned Well	256.8	1114.7	Precambrian	N/A	Aug-88	√		√			
274	T007412	Orford Res et al #2	Clearwood Resources Inc.	451441	4818271	Natural Gas	Abandoned Well	250.4	572	Cabot Head	N/A	Nov-88	√		√			
275	T007544	BP 1	B.P. Resources Canada Limited	446248	4868249	Oil and Gas	Abandoned Well	219.9	1100	Precambrian	N/A	Jan-90	√	√	√			
276	T007586	OGS 90-2	Grey Sauble Conservation Authority	487360	4932814	Observation Well	Abandoned Well	226.9	106.4	Cabot Head	N/A	Mar-90	√		√	√		

COUNT	LICENSE NUMBER	NAME	OPERATOR	UTM NAD83 EASTING	UTM NAD83 NORTHING	PURPOSE	WELL MODE	GROUND ELEVATION (m)	TVD	TOTAL DEPTH FORMATION	POOL	TD_DATE	Geophysics	Armstrong/Carter Reference	Used in BR Surface	Rock Core Available	OilGasPool	PinReef
277	T007587	OGS 90-3	Grey Sauble Conservation Authority	483154	4946326	Observation Well	Abandoned Well	205.8	91.1	Cabot Head	N/A	Mar-90	√		√	√		
278	T007588	OGS 90-2A	ON Geological Survey	487702	4934816	Observation Well	Unknown	0	0	N/A	N/A	N/A			note 5			
279	008004+B49	Sifto #10 Brine Well	Sifto Canada Inc.	444482	4842709	Solution Mining	Active Well	233.1	498.6	B Salt	N/A	Jul-93	√		note 1			
280	T008250	Paragon Bayfield #1	Clearwood Resources Inc.	445367	4822581	Oil and Gas	Abandoned Well	217.9	612	Cabot Head	N/A	Apr-95	√		√			
281	T008657	Clearwood et al #12	Clearbeach Resources Inc.	460213	4824266	Natural Gas	Active Well	286.6	539	Goat Island	Tuckersmith 30-III-SHR Pool	Oct-98	√		√		√	√
282	T008752	Bluewater Imperial Porter #1	Tribute Resources Inc.	447063	4822226	Natural Gas	Potential	242.01	592.23	Guelph	Bayfield Pool	Oct-56			note 1	√	√	
283	T008753	Bluewater Imperial Grainger #1	Tribute Resources Inc.	447186	4821949	Natural Gas	Potential	246.89	580.95	Guelph	Bayfield Pool	Feb-57			√		√	
284	T008843	Tribute et al #16	Clearwood Resources Inc.	448233	4825295	Natural Gas	Abandoned Well	253.42	623	Cabot Head	N/A	May-99	√		√			
285	T008915	Domtar-Sifto Salt No. 8	Sifto Canada Inc.	444578	4842945	Solution Mining	Abandoned Well	220.61	453.54	B Salt	N/A	Oct-64			√			
286	T009126	Sifto #11	Sifto Canada Inc.	444083	4843330	Solution Mining	Active Well	193.3	470	A-2 Carbonate	N/A	Feb-00	√		√			
287	T009355	Brine Well No. 6	Sifto Canada Inc.	444348	4843144	Solution Mining	Abandoned Well	217	477.6	B Salt	N/A	Dec-60	√		√			
288	T010054	Lyleton Sturdy	Lyleton Corporation	447294	4834524	Natural Gas	Abandoned Well	256	665	Rochester	N/A	Jul-01	√		√			
289	T010686	Tribute et al #22	Tipperary Gas Corp.	449348	4826823	Natural Gas	Plugged back and whipstocked	279.7	640	Gasport	Tipperary Pool	Aug-04	√		√	√	√	
290	T011156	ONTZINC	HudBay Minerals Inc.	504962	4868851	Stratigraphic	Abandoned Well	365.1	55.2	Queenston	N/A	Dec-04			√			
291	T011523	Goderich Salt Co. - No. 2 Brine Well	Sifto Canada Inc.	443892	4843077	Solution Mining	Abandoned Well	223.6	370.03	B Salt	N/A	Apr-19			√			
292	T011524	Goderich Salt Co. - No. 3 Brine Well	Sifto Canada Inc.	443799	4843165	Solution Mining	Abandoned Well	224.3	353.87	B Salt	N/A	Sep-32			√			
293	T011525	Goderich Salt Co. - No. 4 Brine Well	Sifto Canada Inc.	443889	4843173	Solution Mining	Abandoned Well	223.8	374.9	B Salt	N/A	Sep-34			√			
294	T011560	NCE Fordyce North	Northern Cross Energy Limited	464022	4861410	Natural Gas	Active Well	320.7	541	Cabot Head	West Wawanosh 1-25-XII Pool	Sep-07	√		√		√	
295	T011565	NCE St. Augustine	Northern Cross Energy Limited	458012	4856413	Natural Gas	Abandoned Well	303.6	581.8	Rochester	N/A	Oct-07			note 5			
296	T011582	DGR-1	Ontario Power Generation Inc.	454240	4907755	Stratigraphic	Active Well	185.7	465.1	Queenston	N/A	Apr-07	√		√	√		
297	T011583	DGR-2	Ontario Power Generation Inc.	454208	4907720	Stratigraphic	Active Well	185.8	864.2	Precambrian	N/A	Aug-07	√		√	√		
298	T011634	Tribute et al #24	Clearwood Resources Inc.	446406	4819213	Natural Gas	Abandoned Well	242.1	78	Rochester	N/A	Nov-07			note 1			
299	T011634A	Tribute et al #24A	Clearbeach Resources Inc.	446410	4819213	Natural Gas	Abandoned Well	242.1	600	Gasport	N/A	Apr-08			√			
300	T011649	Tribute et al #23 (Horiz.#1-Lat.#2)	Tipperary Gas Corp.	449296	4826627	Natural Gas Storage Well	Active Well	280	564	Guelph	Tipperary South Pool	Dec-07			note 1			
301	T011650	Tribute et al #23 (Horiz.#1-Lat.#1)	Tipperary Gas Corp.	449294	4826309	Natural Gas Storage Well	Active Well	280	563	Guelph	Tipperary South Pool	Dec-07			note 1			
302	T011651	Tribute et al #23 (Horiz.#1)	Tipperary Gas Corp.	449293	4826254	Natural Gas Storage Well	Active Well	280	564	Guelph	Tipperary South Pool	Dec-07	√		√			
303	T011714	Tribute et al #22 (Horiz.#1-Lat.#2)	Tipperary Gas Corp.	449350	4827209	Natural Gas Storage Well	Active Well	279.7	581	Guelph	Tipperary Pool	Jan-08			note 1			
304	T011715	Tribute et al #22 (Horiz.#1-Lat.#1)	Tipperary Gas Corp.	449352	4827356	Natural Gas Storage Well	Active Well	279.7	579	Guelph	Tipperary Pool	Jan-08			note 1			
305	T011716	Tribute et al #22 (Horiz.#1)	Tipperary Gas Corp.	449353	4827476	Natural Gas Storage Well	Active Well	279.7	578	Guelph	Tipperary Pool	Jan-08			note 1			
306	T011737	Sifto #12	Sifto Canada Inc.	444017	4843415	Solution Mining	Active Well	193.3	473	A-2 Carbonate	N/A	Mar-08			√			
307	T011742	NCE FitzGerald	Northern Cross Energy Limited	446282	4866019	Natural Gas	Active Well	221.9	566	Goat Island	N/A	Nov-07	√		√			
308	T011771	HudBay #1	HudBay Minerals Inc.	504948	4868849	Stratigraphic	Abandoned Well	365.2	269.8	Queenston	N/A	Aug-08			√	√		
309	T011772	HudBay #2	HudBay Minerals Inc.	506018	4867745	Stratigraphic	Abandoned Well	374.6	280	Queenston	N/A	May-08			√			
310	T011773	HudBay #3	HudBay Minerals Inc.	508297	4869336	Stratigraphic	Abandoned Well	376.6	261	Queenston	N/A	Mar-08			√	√		
311	T011811	DGR-3	Ontario Power Generation Inc.	453080	4907740	Stratigraphic	Active Well	187.35	871.3	Cambrian	N/A	Jul-08	√		√	√		
312	T011812	DGR-4	Ontario Power Generation Inc.	453378	4908744	Stratigraphic	Active Well	181.6	859.2	Cambrian	N/A	Oct-08	√		√	√		
313	T011820	Tribute et al #25	Tribute Resources Inc.	447762	4814257	Natural Gas	Potential	263.4	583	Guelph	Stanley 4-7-XI Pool	Oct-08			√	√	√	
314	T011861	Seaforth Salt No. 1	D. L. Smith Packaging Ltd.	467709	4822094	Solution Mining	Abandoned Well	307.3	338.33	B Salt	N/A	Mar-43			√			
315	T011910	Tribute et al #30	Tribute Resources Inc.	447044	4822147	Stratigraphic	Abandoned Well	244.3	66	Rochester	Bayfield Pool	Apr-09			note 1		√	√
316	T011926	DGR-5 (Dev.#1)	Ontario Power Generation Inc.	454220	4907482	Stratigraphic	Active Well	185.65	754.9	Kirkfield	N/A	Oct-09	√		√	√		
317	T011942	DGR-6 (Dev.#1)	Ontario Power Generation Inc.	453953	4908371	Stratigraphic	Active Well	183.5	789	Gull River	N/A	Feb-10	√		√	√		

COUNT	LICENSE NUMBER	NAME	OPERATOR	UTM NAD83 EASTING	UTM NAD83 NORTHING	PURPOSE	WELL MODE	GROUND ELEVATION (m)	TVD	TOTAL DEPTH FORMATION	POOL	TD_DATE	Geophysics	Armstrong/Carter Reference	Used in BR Surface	Rock Core Available	OilGasPool	PinReef
318	T011956	Tribute et al #23 (Horiz.#1-Lat.#3)	Tipperary Gas Corp.	449292	4826094	Natural Gas Storage Well	Active Well	279.9	604	Guelph	Tipperary South Pool	Nov-09			note 1			
319	T011957	Huron Tipperary South 10	Tipperary Gas Corp.	448931	4826339	Observation Well	Active Well	271.8	589	Guelph	N/A	Feb-10			√			√
320	T011959	Huron Tipperary North 7	Tipperary Gas Corp.	449429	4827275	Natural Gas Storage Well	Active Well	278.8	589	Guelph	N/A	Feb-10			√			√
321	T011960	Huron Tipperary South 9 (Horiz.#1)	Tipperary Gas Corp.	449262	4826060	Natural Gas Storage Well	Active Well	279.6	567	Guelph	Tipperary South Pool	Dec-09			note 1			√
322	T012044	NottABWa Oil & Gas Company - B. Kocker Estate No. 2	Kocher, William Joseph	488122	4943244	Natural Gas	Abandoned Well	211.2	457.2	Coboconk	Hepworth Pool	Jun-36			√		√	
323	T012045	Northern Gas & Gasoline Co.- Kemp No.2	Atchison, Julie Lynne	488506	4942909	Natural Gas	Abandoned Well	212.9	438.9	Trenton Group	Hepworth Pool	Sep-19			√		√	
324	T012046	T. Thompkins Well	Chalinor, Terence	486704	4944719	Natural Gas	Abandoned Well	207.75	472.4	Gull River	N/A	Jan-00			√			
325	T012047	Rankin No. 1	Rankin, Dorothy	489454	4942094	Natural Gas	Abandoned Well	217.95	0	N/A	N/A	N/A			√			
326	T012065	NottABWa Oil & Gas Co.- B. Kocker Estate	Kocher, William Joseph	488137	4942752	Natural Gas	Abandoned Well	213.9	457.2	Trenton Group	N/A	Jan-36			√			
327	T012067	John Schnurr #1	Schnurr, Scott	488932	4942146	Natural Gas	Abandoned Well	218	0	Coboconk	N/A	Jan-00			√			
328	T012096	OGS-SG11-01	ON Geological Survey	529257	4867501	Stratigraphic	Suspended Well	458.8	131.4	Guelph	N/A	Mar-11			note 1			
329	T012100	OGS-SG11-02	ON Geological Survey	529255	4867491	Stratigraphic	Suspended Well	458.7	496.5	Cobourg	N/A	Oct-11			√			
330	T012102	DGR-8	Ontario Power Generation Inc.	453397	4908235	Stratigraphic	Abandoned Well	186.25	727.1	Kirkfield	N/A	Sep-11	√		√	√		
331	T012103	DGR-7	Ontario Power Generation Inc.	453473	4908216	Stratigraphic	Abandoned Well	186.2	190	F Unit	N/A	May-11	√		√	√		
332	T012177	VWP-1	Sifto Canada Inc.	441542	4843926	Stratigraphic	Abandoned Well	178.17	260	F Unit	N/A	Sep-13			note 6			
333	T012178	VWP-3	Sifto Canada Inc.	441531	4843994	Stratigraphic	Not Drilled	0	0	N/A	N/A	N/A			note 2			
334	T012179	VWP-2	Sifto Canada Inc.	441538	4844074	Stratigraphic	Not Drilled	0	0	N/A	N/A	N/A			note 2			
335	T012326	Sifto # 13	Sifto Canada Inc.	443930	4843476	Solution Mining	Active Well	190.1	473	A2 Carbonate	N/A	Jul-14			note 6			

Notes:

1 OGSRL borehole log does not have an entry for any of the key formation tops
2 Borehole did not have a ground surface elevation
3 Total vertical depth data not reliable
4 Unreliable geophysical logs

Notes:

5 deleted from 3DGFM model
6 borehole was drilled after BR surfaces created but BH data is consistent with BR surface interpretation
TVD Total Vertical Depth

APPENDIX B

Summary of 2D Seismic Data Collection Parameters

Client: Nuclear Waste Management
Area: Ontario
Processed by: Seiscraft Processing Inc.
Date Processed: May 2013

RECORDING INFORMATION

LINE: A00030528 SP RANGE: 402 - 892	
SHOT FOR	Shell Canada Limited
SHOT BY	Shell Party 3
RECORDING DATE	October 1977
GROUP INT	20 m
SHOT INT	20 m
NUMBER OF TRACES	48
FOLD	24
SPREAD	500----------60 SP 60----------520 m
SOURCE TYPE	Dynamite
NUMBER OF HOLES	One at 6 m
GEOPHONE TYPE	Mark IV 14hz
PATTERN	4 x 3 over 20m
INSTRUMENT TYPE	DFS V
FILTER	O-124 hz Notch In
SAMPLE RATE	2 ms
REC LENGTH	1 sec

PROCESSING PARAMETERS

REFORMATTED FROM SEGA FORMAT	Processing data length: 1.0 sec
TIME POWER SCALING:	Exponent: 1.5 to 1.0 sec
ENVELOPE SCALING	Lowpass Envelope Filter: 4-8 hz
FK FILTER	Velocity Reject: +/- 300-2000 m/s
MINIMUM PHASE SPIKING DECONVOLUTION	Operator Length: 40 ms
	Pre-Whitening: 3.0 %
	Design Gate: 0.6 - 0.6 sec @ 60 m 0.2 - 0.65 sec @ 390 m
TIME VARIANT SPECTRAL WHITENING	Bandwidth 15-20-95-110 hz
ENVELOPE SCALING	Lowpass Envelope Filter: 4-8 hz
TRACE EQUALIZATION	Design Gate: 0.6 - 0.6 sec @ 60 m 0.2 - 0.65 sec @ 390 m
REFRACTION STATICS	Datum: 400 m; Replacement Velocity: 3700 m/sec
	Processing Datum: 340 m Datum at 0 ms Wx Velocity: 1700 m/sec
	Farrell & Euwema Method – 1 Layer Solution
ENVELOPE SCALING	Lowpass Envelope Filter: 2-4
AUTOMATIC RESIDUAL STATICS	Correlation Window: 0.05 - 0.5
VELOCITY ANALYSIS	Interactive Semblance/Common Offset Stacks/ CDP Stacks
NMO	Velocities Referenced to Datum
STACK MUTE	0.010 sec @ 110 m 0.100 sec @ 330 m 0.150 sec @ 390 m
CDP TRIM STATICS	Correlation Window: 0.0 - 0.6 sec
ENVELOPE SCALING	Lowpass Envelope Filter: 1-2 hz
TRACE EQUALIZATION	Window: 0.1 - 0.6 SEC
F/X TIME MIGRATION	Time Section Output
	100% Stacking Velocity
	Velocity Model: Smoothed Interval Velocities
	Max Dep: 25 Degrees
	Bandwith: 15 - 110 hz
TRACE EQUALIZATION	Window: 0.05 - 0.6 sec

APPENDIX C

Summary of Key Formation Top Picks Using Borehole Geophysics

Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	Pan - Western Logan 25-2 Panwestern #6, Logan - 29 - II			
BH ID	F011882			
Northing (UTM NAD83)	4816955.53			
Easting (UTM NAD83)	480173.6611			
BH Depth (TVD)	449.28			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	0.61			
BH Log	GR			
Date Acquired	1955			
Top Depth	15			
Bottom Depth	457			
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	dif	181.66	0	GR
Salina (G-unit)	212	np	NA	GR
Salina (F-unit)	nc	223.42	0	GR
Cabot Head	446.5	444.7	1.8	GR
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Pan-Western Oils - Nolan No. 1, McKillop 3 - 17 - I			
BH ID	F011894			
Northing (UTM NAD83)	4821046.498			
Easting (UTM NAD83)	471522.9858			
BH Depth (TVD)	482.8			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	0.76			
BH Log	GR			
Date Acquired	1955			
Top Depth	0			
Bottom Depth	488			
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nc	168.6	0	GR
Salina (G-unit)	205	214	-9	GR
Salina (F-unit)	213	np	NA	GR
Cabot Head	484	482.5	1.5	GR
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial 658 - J. Wain No. 1, Goderich - 31 - II			
BH ID	F011965			
Northing (UTM NAD83)	4829976.14			
Easting (UTM NAD83)	443873.4719			
BH Depth (TVD)	619.35			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	1.22			
BH Log	GR			
Date Acquired	1958			
Top Depth	0			
Bottom Depth	610			
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	dif	216.4	0	GR
Salina (G-unit)	266	269.1	-3.1	GR
Salina (F-unit)	nc	317.3	0	GR
Cabot Head	nl	611.7	0	
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial 573 - J.L. Taylor No. 1, Hullett - 5 - XII			
BH ID	F011978			
Northing (UTM NAD83)	4835202.397			
Easting (UTM NAD83)	469036.6501			
BH Depth (TVD)	518.16			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	0.61			
BH Log	GR	NL		
Date Acquired	1956	1956		
Top Depth	0	0		
Bottom Depth	518	518		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nc	190.8	0	NL
Salina (G-unit)	233	236.2	-3.2	GRNL
Salina (F-unit)	240	np	NA	GRNL
Cabot Head	nc	506.3	0	GR
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial 583 - P. Fischer No. 1, Colborne - 25 - MC			
BH ID	F011985			
Northing (UTM NAD83)	4837290.676			
Easting (UTM NAD83)	451442.0289			
BH Depth (TVD)	610.21			
BH TD Formation	Rochester			
Kelly Bushing Height (m)	0.62			
BH Log	GR	NL		
Date Acquired	1956	1956		
Top Depth	0	0		
Bottom Depth	610	610		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nc	245.4	0	NL
Salina (G-unit)	nc	293.8	0	GR
Salina (F-unit)	nc	301.8	0	GR
Cabot Head	nl	np	NA	
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial 679 - G. Ginn No. 1, Goderich - 12 - MC			
BH ID	F011987			
Northing (UTM NAD83)	4839546.799			
Easting (UTM NAD83)	449251.5553			
BH Depth (TVD)	611.73			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	1.22			
BH Log	GR	NL		
Date Acquired	1958	1958		
Top Depth	0	0		
Bottom Depth	610	610		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nc	210.9	0	NL
Salina (G-unit)	263	264.6	-1.6	GR
Salina (F-unit)	272	268.8	3.2	GR
Cabot Head	606.5	605	1.5	GR
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial 557 - J. Yungblut No. 1, Hullett - 38 - XI			
BH ID	F011989			
Northing (UTM NAD83)	4841796.154			
Easting (UTM NAD83)	457162.2277			
BH Depth (TVD)	570.28			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	0.61			
BH Log	GR	NL		
Date Acquired	1956	1956		
Top Depth	0	0		
Bottom Depth	564	564		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nc	221.9	0	NL
Salina (G-unit)	265	272.8	-7.8	GR
Salina (F-unit)	273	np	NA	GR
Cabot Head	nl	566.9	0	
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial 643 - Buchanan No. 1, Elma - 23 - XIII			
BH ID	F012015			
Northing (UTM NAD83)	4829467.181			
Easting (UTM NAD83)	498939.4434			
BH Depth (TVD)	346.25			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	0.61			
BH Log	GR	NL		
Date Acquired	1957	1957		
Top Depth	0	0		
Bottom Depth	350	350		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nc	83.82	0	NL
Salina (G-unit)	111.5	120.09	-8.59	GR
Salina (F-unit)	120.5	np	NA	GR
Cabot Head	nc	340.46	0	GR
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial Oil No. 563 - W.W. Hill No. 1, Colborne - 12 - LRE			
BH ID	F012018			
Northing (UTM NAD83)	4852039.709			
Easting (UTM NAD83)	444529.8767			
BH Depth (TVD)	1111			
BH TD Formation	Cambrian			
Kelly Bushing Height (m)	0.61			
BH Log	GR	NL		
Date Acquired	1956	1956		
Top Depth	0	0		
Bottom Depth	975	975		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	dif	220.4	0	GR
Salina (G-unit)	269	277.7	-8.7	GR
Salina (F-unit)	277	np	NA	GR
Cabot Head	630	630.9	-0.9	GR
Queenston	660	659	1	GR
Cobourg (Collingwood)	870	815.9	54.1	GR
Cobourg (Lower)	884	872	12	GR
Coboconk	nl	1010.1	0	GR
Gull River (if conflict)	nl	1017.7	0	
Precambrian	nl	np	NA	

Well Name	Felmont Oil Corporation No. 11 - Campbell No. 1, Morris - 26 - II			
BH ID	F012021			
Northing (UTM NAD83)	4850624.362			
Easting (UTM NAD83)	481723.0814			
BH Depth (TVD)	435.86			
BH TD Formation	Queenston			
Kelly Bushing Height (m)	0			
BH Log	GR			
Date Acquired	1955			
Top Depth	0			
Bottom Depth	442			
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	dif	141.7	0	GR
Salina (G-unit)	nc	173.7	0	GR
Salina (F-unit)	182	np	NA	GR
Cabot Head	nc	403.9	0	GR
Queenston	nc	431.3	0	GR
Cobourg (Collingwood)	nl	np	NA	GR
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial 594 - Horn No. 1, Elma - 18 - XIII			
BH ID	F012022			
Northing (UTM NAD83)	4830455.784			
Easting (UTM NAD83)	497118.1254			
BH Depth (TVD)	348.08			
BH TD Formation	Cabot Head			
Kelly Bushing Height (m)	0.6			
BH Log	GR	NL		
Date Acquired	1957	1957		
Top Depth	0	18.5		
Bottom Depth	350	350		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nc	98.45	0	NL
Salina (G-unit)	120	126.49	-6.49	GR
Salina (F-unit)	129	np	NA	GR
Cabot Head	dif	344.42	0	GR
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

Well Name	Imperial Oil No. 600 - Black No. 1, Ashfield 8 - 8 - IIIED			
BH ID	F012025			
Northing (UTM NAD83)	4854800.977			
Easting (UTM NAD83)	448371.5272			
BH Depth (TVD)	1083.87			
BH TD Formation	Precambrian			
Kelly Bushing Height (m)	0.61			
BH Log	GR	NL		
Date Acquired	1957	1957		
Top Depth	0	0		
Bottom Depth	1066	1066		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	226	217	9	NL
Salina (G-unit)	276	268.2	7.8	GR
Salina (F-unit)	285	np	NA	GR
Cabot Head	635	616	19	GR
Queenston	657	635.5	21.5	GR
Cobourg (Collingwood)	878	808	70	GR
Cobourg (Lower)	892.5	850.4	42.1	GR
Coboconk	1015	983.6	31.4	GR
Gull River (if conflict)	1021	1074.4	-53.4	GR
Precambrian	nl	np	0	

Legend				Log Legend			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

Prepared by: SNS
Reviewed by: VMS
Date:4/24/2015
10-214-11.40_BHGeophys2DSeismicRpt_Appendices_R0.xlsx

Geofirma Engineering Ltd

Well Name	Felmont Oil Corp. - R. Thompson No. 1, East Wawanosh 5 - 28 - VIII				Felmont MacTavish No. 1, West Wawanosh 5 - 17 - VIII				Felmont Oil No. 13 - M. Berger No. 1, Ashfield 3 - 7 - VIED				Felmont Oil, Huron - 10 - I				Felmont Oil, Huron - 31 - I				Imperial Oil, Huron - 9 - XI			
BH ID	F012027				F012047				F012048				F012063				F012066				F012078			
Northing (UTM NAD83)	4855138.54				4858616.974				4859452.065				4871110.618				4874071.473				4881565.156			
Easting (UTM NAD83)	462479.5761				456656.5422				449791.2403				453514.7523				450275.9702				457446.8353			
BH Depth (TVD)	551.69				577.6				601.98				568.76				566.93				507.49			
BH TD Formation	Cabot Head				Cabot Head				Cabot Head				Cabot Head				Cabot Head				Guelph			
Kelly Bushing Height (m)	0.61				0.61				0.61				0.61				0.61				0.61			
BH Log	GR	NL			GR	NL			GR				GR	NL			GR	NL			GR	NL		
Date Acquired	1955	1955			1958	1958			1955				1959	1959			1956	1956			1955	1955		
Top Depth	0	0			0	0			0				0	0			0				0	0		
Bottom Depth	549	549			579	579			579				579	579			579				518	518		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	dif	213.4	0	NL	192	188.06	3.94	NL	dif	217.9	0	GR	199	196.6	2.4	NL	dif	182.88	0	GR	nc	162.76	0	NL
Salina (G-unit)	257	263	-6	GR	273	232.87	40.13	GR	nc	265.2	0	GR	242.5	252.37	-9.87	GR	223	233.48	-10.48	GR	202	201.17	0.83	GR
Salina (F-unit)	264	np	NA	GR	281	np	NA	GR	nc	274.3	0	GR	251	np	NA	GR	231	237.74	-6.74	GR	nc	208.79	0	GR
Cabot Head	nl	547.1	0	GR	nl	574.24	0	GR	nl	598.9	0	GR	nl	561.44	0	GR	nl	562.36	0	GR	nl	np	NA	GR
Queenston	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	

Well Name	Imperial Oil No.536 - Taylor et al No. 1, Amabel - 52 - II				Imperial Oil No. 527 - W. Radbourne No. 1, Keppel 2 - 22 - IIS				Ben Allen Cement Co. - Chambers & Dewus - McMillan No. 1, Keppel 5 - 30 - VIII				Arnora Sulphur Mining Corporation No.1 - A.B. Whyte No. 1, Proton 1 - 10 - XIX				Annan Petroleum No. 1 - D. Morris No. 1, Sarawak 2 - 29 - III				BP Triad, (A), Saugeen - 29 - II			
BH ID	F012141				H000032				H000033				H000038				H000043				T001720A			
Northing (UTM NAD83)	4950304.141				4941351.636				4940341.934				4891958.835				4945957.915				4910793.318			
Easting (UTM NAD83)	484603.2864				492711.0118				501617.0691				534100.1972				505422.6767				473240.2468			
BH Depth (TVD)	501.4				497.43				472.44				701.95				368.2				722.38			
BH TD Formation	Precambrian				Precambrian				Shadow Lake				Precambrian				Black River Group				Precambrian			
Kelly Bushing Height (m)	0.6				0.61				0.1				0				0				3.62			
BH Log	GR	NL			GR	NL			GR	NL			GR				GR				GR	NL		
Date Acquired	1955	1955			1955	1955			1958	1958			1955				1948				1964	1964		
Top Depth	55	55			91	91			0	0			0				0				0	0		
Bottom Depth	503	503			472	472			472	472			701				371				732	732		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Salina (G-unit)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		dif	64.92	0	
Salina (F-unit)	nl	np	NA		nl	np	NA	GR	nl	np	NA		nl	np	NA		nl	np	NA		dif	np	NA	
Cabot Head	67	74.7	-7.7	GR	dif	57.9	0		9.9	10.4	-0.5	GR	nc	149.4	0		nl	np	NA		287	284.07	2.93	GR
Queenston	nc	114.3	0	GR	dif	102.1	0		54	54.9	-0.9	GR	nc	176.2	0	GR	nl	6.1	0	GR	314	310.9	3.1	GR
Cobourg (Collingwood)	319	288	31	NL	321	300.2	20.8	GRNL	274.5	np	NA	GR	449	431.9	17.1	GR	209	205.7	3.3	GR	525	np	NA	GR
Cobourg (Lower)	333	317	16	GR	334	317	17		282	274.3	7.7		469	451.1	17.9		217.5	210.3	7.2		538.5	522.7	15.8	
Coboconk	nc	426.4	0	GR	429.5	431	-1.5		nc	388.6	0	GRNL	597	592.84	4.16	GR	362	np	NA	GR	nc	643.7	0	GR
Gull River (if conflict)	dif	447.8	0	GR	nc	435.3	0		nl	np	NA		dif	616.6	0		nl	np	NA		nc	649.22	0	GR
Precambrian	dif	497.7	0	GR	nl	496.2	NA		nc	460.25	0	NL	nc	651.1	0	GR	nl	np	NA		717	719.94	-2.94	

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

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Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	Home C.D.R., Saugeen - 12 - I				BP Triad, Kincardine - 17 - VIII				BP Home, Kincardine - 57 - C				Texaco No.4 Home C.D.R., Bruce - 1 - VIII				Altair et al, West Wawanosh 8 - 16 - VIII				Creesing No.2, Egremont 3 - 8 - IX			
BH ID	T001892				T001925				T001942				T002238				T002250				T002284			
Northing (UTM NAD83)	4913076.684				4894758.957				4900536.342				4909022.351				4858492.069				4875701.348			
Easting (UTM NAD83)	466525.877				460321.9592				455764.4025				459943.1843				455946.0204				524655.9084			
BH Depth (TVD)	770.5				912.9				897.9				850.4				1053.08				672.08			
BH TD Formation	Precambrian				Precambrian				Precambrian				Precambrian				Precambrian				Precambrian			
Kelly Bushing Height (m)	0.89				3.37				1.23				1.5				0.91				0.91			
BH Log	GR	NL			GR	NL			GR	NL			GR	NL			GR	NL			GR	NL		
Date Acquired	1965	1965			1965	1965			1966	1966			1967	1967			1967	1967			1966	1966		
Top Depth	0	0			0	0			0	0			0	0			0	0			30			
Bottom Depth	762	762			914	914			899	899			853	853			1036	1036			670			
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nc	45.42	0	NL	182.5	185.93	-3.43	NL	166	167.64	-1.64	NL	123	110.6	12.4	NL	dif	206.3	0		nl	np	NA	
Salina (G-unit)	72	80.47	-8.47	GRNL	219	231.65	-12.65	GR	206	207.87	-1.87	GR	151	150.3	0.7	GR	nc	311.5	0		nl	np	NA	
Salina (F-unit)	82	np	NA	GRNL	227	np	NA	GR	217	219.46	-2.46	GR	160.5	160	0.5	GR	nc	319.4	0		nl	np	NA	
Cabot Head	331	326.14	4.86	GR	nc	466.34	0	GR	449	453.24	-4.24	NL	409.5	406.3	3.2	NL	573	569.1	3.9	GR	nc	174.7	0	GR
Queenston	360	358.44	1.56	GR	nc	493.78	0	GR	474	478.54	-4.54	NL	438	435.3	2.7	NL	605	602.9	2.1	GR	nc	200.3	0	GR
Cobourg (Collingwood)	571	np	NA	GR	702	np	NA	GR	683	664.46	18.54	GRNL	643	616.3	26.7	GRNL	817	795.5	21.5	GR	467	419.1	47.9	GR
Cobourg (Lower)	583.5	573	10.5		715.5	701.04	14.46		695.5	687	8.5		659	642.8	16.2		834	819	15		481	467.3	13.7	GR
Coboconk	nc	689.5	0	GR	824	np	NA	GR	805	806.8	-1.8	NL	nc	758	0	GRNL	nc	956.5	0	GR	nc	613.6	0	GR
Gull River (if conflict)	nl	np	NA		835	np	NA	GR	nc	831.8	0		nc	769	0		nc	975.4	0	GR	nc	630.9	0	
Precambrian	nl	769.01	0		nc	909.52	0	GR	894	897.3	-3.3	NL	nc	833.6	0	GRNL	nl	1042.7	0		nc	670.3	0	GR

Well Name	MESA PETROLEUMS, West Wawanosh 7 - 17 - VIII				MESA ET AL TEESWATER, West Wawanosh 2 - 26 - XII				Kenartha No.3, Arthur 8 - 25 - VII				MESA ET AL BELMORE NO.1, West Wawanosh 8 - 26 - X				Monray No.1, Egremont 5 - 4 - VI				Monray No.2, Egremont 1 - 11 - VIII			
BH ID	T002380				T002470				T002478				T002556*				T002613				T002627			
Northing (UTM NAD83)	4858314.811				4861102.66				4855269.966				4857947.097				4872321.501				4875339.757			
Easting (UTM NAD83)	456156.8628				464081.5429				527739.2694				462409.2597				523661.5377				525961.6589			
BH Depth (TVD)	577.6				526.69				731.82				543.5				677.57				679.7			
BH TD Formation	Cabot Head				Cabot Head				Precambrian				Reynales/Fossil Hill				Precambrian				Precambrian			
Kelly Bushing Height (m)	1.53				0.61				1.2				0.56				1.22				0.91			
BH Log	GR	NL			GR	NL			GR	NL			GR	NL			GR	NL			GR	NL		
Date Acquired	1967	1967			1968	1968			1968	1968			1968	1968			1968	1968			1968	1968		
Top Depth	0	0			0	0			655	655			304	304			0	0			30	30		
Bottom Depth	576	576			533	533			719	719			542	542			671	671			670	670		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nc	195.1	0	GR	dif	214.6	0	GR	nl	np	NA		nl	189	0		nl	np	NA		nl	np	NA	
Salina (G-unit)	nc	314.6	0	GR	nc	252.4	0	GR	nl	np	NA		nl	249.6	0		nl	np	NA		nl	np	NA	
Salina (F-unit)	nc	319.4	0	GR	nc	259.7	0	GR	nl	np	NA		nl	257.3	0		nl	np	NA		nl	np	NA	
Cabot Head	571.5	574.5	-3	GR	nc	519.1	0	GR	nl	201.8	0		nl	np	NA		nc	179.8	0	GR	nc	176.8	0	GR
Queenston	nl	np	NA		nl	np	NA		nl	222.5	0		nl	np	NA		nc	204.2	0	GR	nc	206.3	0	GR
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	499.9	0		nl	np	NA		nc	472.4	0	GR	473.5	459.6	13.9	GR
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	517.6	0		nl	np	NA		nc	484.6	0		484.5	472.4	12.1	GR
Coboconk	nl	np	NA		nl	np	NA		672	661.4	10.6	GR	nl	np	NA		nc	624.5	0	GR	619.5	620.88	-1.38	GR
Gull River (if conflict)	nl	np	NA		nl	np	NA		692.5	673.6	18.9		nl	np	NA		nc	637.6	0		nc	635.51	0	
Precambrian	nl	np	NA		nl	np	NA		nl	728.8	0		nl	np	NA		nl	672.4	0		nl	677.3	0	GR

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

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Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	Texaco No.6 Bruce 8-E-IV, Bruce - E - IV				PINETREE MID-NORTHERN NO.1, Huron - 63 - I				Buxton Bozlan No.1, Arthur 8 - 25 - V				PINETREE ET AL NO.1, Greenock - 3 - IN				Zurich et al Goderich No.1A, Goderich - 38 - IX				Buxton No.2, Maryborough 1 - 12 - XVI			
BH ID	T002636				T002663				T002713				T002730				T002731A				T002754			
Northing (UTM NAD83)	4905796.314				4876779.029				4855695.156				4883088.07				4827136.723				4853659.456			
Easting (UTM NAD83)	456347.2124				444273.8091				530430.0595				467410.7814				449437.6831				526986.6648			
BH Depth (TVD)	881.5				608.69				716.28				429.46				626.67				743.41			
BH TD Formation	Cambrian				Cabot Head				Precambrian				Cabot Head				Rochester				Precambrian			
Kelly Bushing Height (m)	0.9				0.92				0.9				0.9				0.93				1			
BH Log	GR	NL			GR	NL			GR	NL			GR	NL			GR	NL			GR	NL		
Date Acquired	1969	1969			1969	1969			1969	1969			1969	1969			1969	1969			1969	1969		
Top Depth	0	0			0	0			0	0			0	0			0	0			0	0		
Bottom Depth	884	884			609.5	609.5			716	716			430	430			625	625			740	740		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nc	148.1	0	NL	nc	215.19	0	NL	nl	np	NA		dif	161.2	0	GRNL	282.5	278	4.5	NL	nl	np	NA	
Salina (G-unit)	nc	190.2	0	GR	nc	268.53	0	GRNL	nl	np	NA		190	190.8	-0.8	GR	357.5	356.6	0.9	GRNL	nl	np	NA	
Salina (F-unit)	nc	199	0	GR	nc	277.98	0	GRNL	nl	np	NA		198	199.3	-1.3	GRNL	nc	364.2	0	GRNL	nl	np	NA	
Cabot Head	nc	436.8	0	GR	601	np	NA	GR	nc	185.9	0		428	427.3	0.7	GR	nl	np	NA		nc	208.5	0	GR
Queenston	nc	472.4	0	GR	nl	np	NA		nc	211.5	0		nl	np	NA		nl	np	NA		nc	230.7	0	GR
Cobourg (Collingwood)	679	646.8	32.2	GR	nl	np	NA		505	506	-1	GR	nl	np	NA		nl	np	NA		526	502.3	23.7	GR
Cobourg (Lower)	691.7	679.4	12.3		nl	np	NA		nc	518.2	0	GR	nl	np	NA		nl	np	NA		544.5	526.1	18.4	GR
Coboconk	nc	792.5	0	GR	nl	np	NA		nc	659.9	0	GR	nl	np	NA		nl	np	NA		nc	679.1	0	GR
Gull River (if conflict)	nc	804.7	0	GR	nl	np	NA		nc	670.6	0	GR	nl	np	NA		nl	np	NA		nl	691.9	0	
Precambrian	nl	np	NA	GR	nl	np	NA		709	707.1	1.9	GR	nl	np	NA		nl	np	NA		nc	732.7	0	GRNL

Well Name	MID-NORTHERN NO.1, Grey 1 - 3 - IX				Zurich et al Goderich No.2, Goderich 1 - 38 - IX				Kenartha No.4, Arthur 4 - 24 - VII				Barr Cormack No. 1, Bruce - 22 - XIII				FITZGERALD, Huron 1 - 33 - LR				FITZGERALD, Kinloss 3 - 6 - IX			
BH ID	T002783				T002842				T003126				T003387*				T003535				T003553			
Northing (UTM NAD83)	4843921.249				4827352.491				4855815.617				4908300.657				4883101.264				4877090.105			
Easting (UTM NAD83)	481402.7195				449607.161				528368.8181				470293.1905				444998.6962				461679.6592			
BH Depth (TVD)	420.01				616.92				800.4				335.89				583.69				511.45			
BH TD Formation	Cabot Head				Rochester				Precambrian				Cabot Head				Cabot Head				Cabot Head			
Kelly Bushing Height (m)	1.22				1.22				0.63				0.6				1.22				1.22			
BH Log	GR	NL			GR	NL			GR	NL			GR*	NL*			GR	NL			GR	NL		
Date Acquired	1969	1969			1969	1969			1971	1971			1972	1972			1973	1973			1973	1973		
Top Depth	0	0			0	0			0	0			0	0			0	0			0	0		
Bottom Depth	609	609			728	728			728	728			609	609			579	579			518	518		
Formation Tops	**Geofirma Formation Top (mBKB)**	**MNR Formation Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Formation Top (mBKB)**	**MNR Formation Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Formation Top (mBKB)**	**MNR Formation Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Formation Top (mBKB)**	**MNR Formation Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Formation Top (mBKB)**	**MNR Formation Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Formation Top (mBKB)**	**MNR Formation Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	160	159.4	0.6	NL	279	271.3	7.7	NL	nl	np	NA		dif	34.1	0	NL	nc	184.4	0	NL	dif	210.01	0	NL
Salina (G-unit)	nc	195.7	0	GR	341.3	342	-0.7	GRNL	nl	np	NA		62	np	NA	GRNL	233.5	235	-1.5	GRNL	nc	249.02	0	GR
Salina (F-unit)	nc	203.6	0	GR	350.5	351.7	-1.2	GRNL	nl	np	NA		nc	68.9	0	GRNL	242.25	243.84	-1.59	GRNL	nc	256.64	0	GR
Cabot Head	416	415.7	0.3	GR	nl	np	NA		nc	197.5	0	GR	597	327.7	269.3	GR	578	579.12	-1.12	GR	nc	507.49	0	GR
Queenston	nl	np	NA		nl	np	NA		nc	223.4	0	GR	nl	np	NA		nl	np	NA		nl	np	NA	GR
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		518	494.7	23.3	GR	nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		537	518.2	18.8	GR	nl	np	NA		nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		670	665.4	4.6	GRNL	nl	np	NA		nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		685	670.9	14.1	GRNL	nl	np	NA		nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nc	720.2	0	GRNL	nl	np	NA		nl	np	NA		nl	np	NA	

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

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Reviewed by: VMS
Date:4/24/2015
10-214-11.40_BHGeophys2DSeismicRpt_Appendices_R0.xlsx

Geofirma Engineering Ltd

Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	FITZGERALD, Kincardine 1 - 14 - VIN				POUNDER & HARMON, Hullett 1 - 31 - V				THIMAC YOUNG CATHERINE NO.1, Logan 4 - 21 - XVI				Pounder & Harmon, Hullett 3 - 18 - I				JACKLIN, Ashfield - 44 - FCNPA				THIMAC, Grey 1 - 15 - VIII			
BH ID	T003588				T003607				T003625				T003632A				T003656				T003661*			
Northing (UTM NAD83)	4893570.605				4835277.5				4827079.871				4828488.322				4877016.8				4842407.615			
Easting (UTM NAD83)	458401.2511				456629.9708				490214.9977				458883.8912				440912.8255				486100.8313			
BH Depth (TVD)	481.89				540.72				401.73				536.45				643.13				390.14			
BH TD Formation	Cabot Head				Goat Island				0				Goat Island				Cabot Head				Rochester			
Kelly Bushing Height (m)	1.22				1.21				0.61				1.22				1.21				0.61			
BH Log	GR	NL			GR	NL			GR	NL			GR	NL			GR	NL			GR	NL		
Date Acquired	1973	1973			1973	1973			1973	1973			1973	1973			1973	1973			1973	1973		
Top Depth	0	0			0	0			0	0			0	0			0	0			0	0		
Bottom Depth	487	487			533	533			411	411			532	532			640	640			396	396		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	201	190.2	10.8	NL	201	207.6	-6.6	NL	136	134.72	1.28	NL	213	212.14	0.86	NL	192	231.6	-39.6	NL	101	151.5	-50.5	NL
Salina (G-unit)	234.5	234.7	-0.2	GRNL	nc	258.5	0	GR	160	np	NA	GR	nc	261.52	0	GRNL	nc	290.5	0	GRNL	nc	171.3	0	GR
Salina (F-unit)	243.5	237.44	6.06	GRNL	nc	267	0	GR	169.5	177.7	-8.2	GR	270	267	3	GRNL	nc	299.6	0	GRNL	nc	179.2	0	GR
Cabot Head	nc	476.1	0	GR	nl	np	NA		394	401.42	-7.42	GR	nl	np	NA		nc	638.9	0	GR	nl	np	NA	
Queenston	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	

Well Name	THIMAC, Ashfield 2 - 6 - XIIIWD				MOFFAT LAKE GODERICH #3, Goderich 3 - 37 - IX				Domtar No.9 Brine Well, Goderich 6 - 2 - MC				Kenartha No.6, Arthur 8 - 23 - VI				Fitzgerald, Tuckersmith 2 - 26 - I				Shell, West Wawanosh 1 - 18 - XIV			
BH ID	T003684				T003785				T003895				T004315				T004413				T004604			
Northing (UTM NAD83)	4871845.721				4827632.346				4842833.871				4856669.347				4817531.812				4865950.959			
Easting (UTM NAD83)	448245.8633				449582.6949				444461.248				528883.0756				459110.9214				461635.638			
BH Depth (TVD)	612.34				624.84				495.3				773.58				528.52				528.52			
BH TD Formation	Cabot Head				Gasport				B Salt				Precambrian				Goat Island				Gasport			
Kelly Bushing Height (m)	0.61				0.6				3.7				0.7				1.53				1.52			
BH Log	GR	NL			GR	NL			GR	NL			GR	NL			GR	NL			GR			
Date Acquired	1974	1974			1975	1975			1997	1997			1977	1977			1977	1977			1978			
Top Depth	0	0			0	0			0	0			506	506			0	0			45			
Bottom Depth	609	609			624	624			493	493			768	768			527	527			530			
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nc	224.9	0	NL	257	270.4	-13.4	NL	dif	225.25	0	NL	nl	np	NA		nc	204.8	0	NL	dif	192.6	0	GR
Salina (G-unit)	nc	270.1	0	GRNL	nc	361.5	0	GRNL	nc	282.85	0	GRNL	nl	np	NA		nc	248.1	0	GRNL	nc	238.7	0	GR
Salina (F-unit)	nc	278.3	0	GRNL	nc	368.2	0	GRNL	nc	291.39	0	GRNL	nl	np	NA		nc	256.6	0	GRNL	nc	246	0	GR
Cabot Head	nc	605.3	0	GR	nl	np	NA		nl	np	NA		nl	196.6	0		nl	np	NA		nl	np	NA	
Queenston	nl	np	NA		nl	np	NA		nl	np	NA		nl	224.6	0		nl	np	NA		nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		515.5	496.8	18.7	GR	nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		534	515.7	18.3	GR	nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		668	659.6	8.4	GRNL	nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		682	666.3	15.7	GRNL	nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nc	721.2	0	GRNL	nl	np	NA		nl	np	NA	

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

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Well Name	Pacific Elma 2-13-XI, Elma 2 - 13 - XI				Pacific, Turnberry 1 - 1 - II			
BH ID	T004730				T004767			
Northing (UTM NAD83)	4833006.684				4856904.889			
Easting (UTM NAD83)	496269.7068				485863.2041			
BH Depth (TVD)	873.25				865.94			
BH TD Formation	Precambrian				Precambrian			
Kelly Bushing Height (m)	1.21				1.2			
BH Log	GR				GR			
Date Acquired	1978				1978			
Top Depth	403				50			
Bottom Depth	891				865			
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nl	93.88	0		dif	115.5	0	GR
Salina (G-unit)	nl	113.39	0		146	146	0	GR
Salina (F-unit)	nl	np	NA		157	157.3	-0.3	GR
Cabot Head	nl	349	0		372	372.5	-0.5	GR
Queenston	nc	371.25	0		399	398.7	0.3	GR
Cobourg (Collingwood)	681	615.09	65.91	GR	640	607.8	32.2	GR
Cobourg (Lower)	700.5	642.2	58.3	GR	657	639.8	17.2	
Coboconk	835	791.3	43.7	GR	787	787	0	GR
Gull River (if conflict)	851	796.75	54.25	GR	nc	805.5	0	
Precambrian	nl	868.07	0	GR	859	860	-1	GR

Well Name	Kenartha, Arthur 3 - 25 - VII				FITZGERALD, Ashfield 4 - 5 - IX			
BH ID	T004848				T004849			
Northing (UTM NAD83)	4855544.573				4866187.845			
Easting (UTM NAD83)	528474.9082				446265.2406			
BH Depth (TVD)	739.14				567.54			
BH TD Formation	Precambrian				Goat Island			
Kelly Bushing Height (m)	1.2				1.1			
BH Log	RHOB				GR	NL		
Date Acquired	1978				1979	1979		
Top Depth	512				0	0		
Bottom Depth	739				563	563		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nl	np	NA		222	214	8	NL
Salina (G-unit)	nl	np	NA		nc	260.6	0	GRNL
Salina (F-unit)	nl	np	NA		nc	269.4	0	GRNL
Cabot Head	nl	194.2	0		nl	np	NA	
Queenston	nl	221.3	0		nl	np	NA	
Cobourg (Collingwood)	518	499.9	18.1	RHOB	nl	np	NA	
Cobourg (Lower)	536	517.6	18.4	RHOB	nl	np	NA	
Coboconk	671	665.1	5.9	RHOB	nl	np	NA	
Gull River (if conflict)	692	670.9	21.1	RHOB	nl	np	NA	
Precambrian	nc	726.9	0		nl	np	NA	

Well Name	Total et al, Ashfield 1 - 12 - IXED				Pacific, Greenock 1 - 32 - VIII			
BH ID	T004851				T004854			
Northing (UTM NAD83)	4862979.699				4888669.131			
Easting (UTM NAD83)	455710.4304				466865.2542			
BH Depth (TVD)	1037.23				894			
BH TD Formation	Precambrian				Precambrian			
Kelly Bushing Height (m)	1.22				1.2			
BH Log	GR				GR	NL		
Date Acquired	1978				1979	1979		
Top Depth	300				0	0		
Bottom Depth	1025				894	894		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	nl	214.3	0		nc	151.8	0	NL
Salina (G-unit)	nl	255.1	0		nc	190.8	0	GR
Salina (F-unit)	nl	263	0		nc	198.1	0	GR
Cabot Head	560	560.8	-0.8	GR	nc	436.5	0	GR
Queenston	595	595.6	-0.6	GR	nc	463.3	0	GR
Cobourg (Collingwood)	811	776.3	34.7	GR	680	633.4	46.6	GR
Cobourg (Lower)	826	810.5	15.5		694	679.4	14.6	
Coboconk	nc	944.6	0	GR	nc	808.3	0	GR
Gull River (if conflict)	nc	969.9	0		nc	832.1	0	
Precambrian	nl	1034.8	0		nl	889.7	0	

Well Name	Fitzgerald, Tuckersmith 3 - 25 - I				SHELL, Ashfield 7 - 1 - IIIED			
BH ID	T004855				T004864			
Northing (UTM NAD83)	4817079.432				4857305.018			
Easting (UTM NAD83)	458926.2813				444283.3788			
BH Depth (TVD)	544.4				639			
BH TD Formation	Cabot Head				Cabot Head			
Kelly Bushing Height (m)	1.2				1.2			
BH Log	GR	NL			GR	NPHI	DPHI	DT
Date Acquired	1979	1979			1979	1979	1979	1979
Top Depth	0	0			25	300	300	25
Bottom Depth	548	548			639	639	640	635
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	204	199.3	4.7	NL	dif	209.1	0	GR
Salina (G-unit)	243	243.2	-0.2	GRNL	nc	259.7	0	GR
Salina (F-unit)	252	252.4	-0.4	GRNL	nc	267.9	0	GR
Cabot Head	nc	539.5	0		dif	618.7	0	NPHI
Queenston	nl	np	NA		nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA	

Well Name	Pacific, Culross 4 - 25 - V				Amoco A-1, Kincardine 2 - 31 - V			
BH ID	T004881				T004910			
Northing (UTM NAD83)	4869343.455				4889056.394			
Easting (UTM NAD83)	473529.9803				463644.0134			
BH Depth (TVD)	882.7				909			
BH TD Formation	Precambrian				Precambrian			
Kelly Bushing Height (m)	1.2				4.8			
BH Log	GR	NL			GR	NL		
Date Acquired	1979	1979			1979	1979		
Top Depth	0	0			140	150		
Bottom Depth	884	894			900	920		
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	132	137.2	-5.2	NL	nl	136	0	
Salina (G-unit)	nc	173.7	0	GR	nc	169.5	0	GRNL
Salina (F-unit)	nc	182.6	0	GR	nc	177.8	0	GRNL
Cabot Head	nc	407.9	0	GR	456.5	460	-3.5	GRNL
Queenston	nc	435.3	0	GR	487.5	487.3	0.2	GRNL
Cobourg (Collingwood)	659.3	632.2	27.1	GR	696.7	573.4	123.3	
Cobourg (Lower)	674.6	659.3	15.3		711.1	696.7	14.4	
Coboconk	nc	797.1	0	GR	nc	830	0	
Gull River (if conflict)	nc	817.5	0		nl	859.6	0	
Precambrian	nc	875.7	0	GRNL	nl	903.7	0	

Well Name	SHELL, Ashfield 8 - 1 - IIIED				Petromark et al, Elma 2 - 36 - XIV			
BH ID	T004918				T004985*			
Northing (UTM NAD83)	4857109.385				4825710.271			
Easting (UTM NAD83)	444455.3857				503006.9414			
BH Depth (TVD)	626.4				875.1			
BH TD Formation	Cabot Head				Precambrian			
Kelly Bushing Height (m)	1.1				1.2			
BH Log	GR				no logs			
Date Acquired	1979				1979			
Top Depth	15							
Bottom Depth	624							
Formation Tops	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick	Geofirma Form. Top (mBKB)	MNR Form. Top (mBKB)	Δ Elevation (m)	Log Used to Make Pick
Bass Island	dif	204	0	GR	nl	77.1	0	
Salina (G-unit)	256	257.4	-1.4	GR	nl	80.8	0	
Salina (F-unit)	nc	265.5	0		nl	83.8	0	
Cabot Head	nc	612.3	0		nl	328.6	0	
Queenston	nl	np	NA		nl	351.1	0	
Cobourg (Collingwood)	nl	np	NA		nl	572.6	0	
Cobourg (Lower)	nl	np	NA		nl	638.3	0	
Coboconk	nl	np	NA		nl	797.4	0	
Gull River (if conflict)	nl	np	NA		nl	813.5	0	
Precambrian	nl	np	NA		nl	868.7	0	

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	SHELL, East Wawanosh 7 - 28 - V				AMOCO, McKillop 4 - 33 - III				Shell, Stanley 3 - 16 - VII				FITZGERALD, Ashfield 2 - 6 - VED				Shell, Goderich 4 - 40 - IX				Kenartha Arthur 4-24-VII, Arthur 4 - 24 - VII			
BH ID	T005051				T005124				T005130				T005131				T005166				T005177			
Northing (UTM NAD83)	4851355.797				4825796.655				4818492.556				4859000.012				4826279.437				4855921.196			
Easting (UTM NAD83)	459873.3191				466979.2949				451474.0848				448788.0246				448978.2021				528340.8859			
BH Depth (TVD)	594				525				604				573.4				644				883.9			
BH TD Formation	Cabot Head				Cabot Head				Queenston				Goat Island				Cabot Head				Precambrian			
Kelly Bushing Height (m)	1.2				3.8				1.4				1.2				1.2				1.5			
BH Log	GR	NL			GR	NPHI	DT	GR#2	GR	NL			GR	NL			GR#3	NPHI	DT	DPHI	GR	NL		
Date Acquired	1979	1979			1979	1979	1979	1979	1979	1979			1979	1979			1979	1979	1979	1979	1980	1980		
Top Depth	0	0			200	180	200	180	810	810			0	0			30	110	335	345	652	652		
Bottom Depth	565	565			500	600	500	600	975	975			575	575			650	649	650	650	817	817		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	212	217.9	-5.9	NL	nl	184.5	0		nc	207	0	GR	dif	211.5	0	NL	dif	284	0	GR&NPHI	nl	np	NA	
Salina (G-unit)	256	261.6	-5.6	GRNL	nc	226	0	GR	nc	250.6	0	GR	260	260.4	-0.4	GRNL	nc	339.5	0	GR&NPHI	nl	np	NA	
Salina (F-unit)	263	272.6	-9.6	GRNL	nc	234.5	0	GR	nc	258	0	GR	nc	268	0	GRNL	nc	347	0	GR&NPHI	nl	np	NA	
Cabot Head	556	555.2	0.8	GRNL	nl	512.5	0	GR	nc	564.4	0	GR	nl	np	NA		nc	640.5	0	GR	nl	195	0	
Queenston	nl	np	NA		nl	np	NA		nl	599.8	0	GR	nl	np	NA		nl	np	NA		nl	225.1	0	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	494.7	0	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	511.1	0	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		672	635.9	36.1	GR
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		691	670.9	20.1	GR
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		722	719.8	2.2	GR

Well Name	FITZGERALD, Stanley 3 - 30 - I				SHELL, Goderich 1 - 9 - HRC				SHELL, Colborne 1 - 8 - I				HURON 1, Stanley 1 - 10 - X				Huron 3, Stanley 4 - 7 - XI				MILTON RESOURCE, Goderich 1 - 26 - II			
BH ID	T005182				T005326				T005404				T005554				T005885				T006251			
Northing (UTM NAD83)	4825121.127				4831467.573				4841008.735				4815723.477				4814372.664				4832166.722			
Easting (UTM NAD83)	456649.4076				452932.5494				452247.7537				449183.2605				447663.7489				443499.7137			
BH Depth (TVD)	545				601				625.5				592				615				623.8			
BH TD Formation	Goat Island				Cabot Head				Cabot Head				Cabot Head				Cabot Head				Cabot Head			
Kelly Bushing Height (m)	1.2				1.2				1.2				0.3				0.5				1.2			
BH Log	GR	NL			GR	DT			GR				GR	NL			GR	NPHI			GR	NL		
Date Acquired	1980	1980			1980	1980			1980				1982	1982			1982	1982			1983	1983		
Top Depth	0	0			10	275			0				0	0			80	80			0	0		
Bottom Depth	545	550			600	600			625				594	594			614	614			625	625		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	dif	201.9	0	NL	dif	223.2	0	GR	dif	245.4	0	GR	nc	214	0	NL	nc	239.9	0	NPHI	nc	228	0	NL
Salina (G-unit)	nc	252.3	0	GRNL	267.5	272.3	-4.8	GR	nc	292	0	GR	nc	264.6	0	GRNL	nc	284.2	0	GR&NPHI	nc	277	0	GRNL
Salina (F-unit)	nc	261	0	GRNL	280	280.6	-0.6	GR	nc	301.2	0	GR	nc	273.1	0	GRNL	nc	292.4	0	GR&NPHI	nc	285	0	GRNL
Cabot Head	nl	np	NA		nc	589	0	GR	nc	617	0	GR	nc	589.8	0	GR	nl	612.3	0		nc	622	0	NL
Queenston	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

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Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	HURON #4, Stanley 3 - 7 - XI				HURON #5, Stanley 2 - 10 - X				TIPPERARY #6, Goderich 1 - 33 - III				Tipperary S #2, Goderich 4 - 40 - IX				Tipperary No.4, Goderich 2 - 37 - IX				Florentine et al 1, Stanley 3 - 20 - XI			
BH ID	T006307				T006322				T006341				T006346				T006364				T007104			
Northing (UTM NAD83)	4814467.418				4815783.076				4829333.824				4826391.06				4827488.33				4819475.245			
Easting (UTM NAD83)	447698.2279				449053.439				444686.2898				448905.0477				449451.5449				447155.2354			
BH Depth (TVD)	576				604				632.8				610				1134				613.5			
BH TD Formation	Guelph				Cabot Head				Queenston				Cabot Head				Precambrian				Cabot Head			
Kelly Bushing Height (m)	2.01				1.96				1.95				2				2.05				1.5			
BH Log	GR	NPHI			GR	NPHI			GR	NPHI			GR	NPHI	DPHI		GR	NPHI	RHOB		GR	NPHI		
Date Acquired	1983	1983			1983	1983			1983	1983			1983	1983	1983		1983	1983	1983		1987	1987		
Top Depth	15	50			20	20			20	20			0	0	334		32	30	360		25	25		
Bottom Depth	565	570			567	575			620	620			641	650	650		1130	1134	1135		615	615		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	dif	247	0	GR&NPHI	nc	215.2	0	GR&NPHI	dif	222.3	0	GR&NPHI	dif	288.2	0	GR&NPHI	nc	257	0	GR	dif	221.6	0	GR
Salina (G-unit)	nc	284	0	GR&NPHI	284	268.3	15.7	GR&NPHI	nc	273.5	0	GR&NPHI	338	350.4	-12.4	GR	nc	350.5	0	GR	nc	271.9	0	GR
Salina (F-unit)	nc	292.1	0	GR&NPHI	292	276.4	15.6	GR&NPHI	nc	281	0	GR&NPHI	346	358.6	-12.6	GR	nc	357	0	GR	nc	279.5	0	GR
Cabot Head	nl	np	NA		nl	594.8	0		nl	613.8	0		634	635.6	-1.6	GR	nc	638.2	0	GR	605.5	603.5	2	NPHI
Queenston	nl	np	NA		nl	np	NA		nl	619.4	0		nl	np	NA		nc	668.6	0	GR	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		885.5	np	NA	GR	nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		901	885.5	15.5	GR	nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nc	1029.3	0	GR	nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		dif	1053.6	0	GR	nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		1126	1123.8	2.2	GR	nl	np	NA	

Well Name	Owenbrook et al 1, Goderich 1 - 21 - BAC				Orford Res et al 1, Stanley 3 - 5 - X				Orford Res et al #2, Stanley 3 - 15 - VII				BP 1, Ashfield 2 - 6 - XWD				OGS 90-2, Amabel - 7 - A				OGS 90-3, Amabel - 16 - XIV			
BH ID	T007179				T007307				T007412				T007544				T007586				T007587			
Northing (UTM NAD83)	4824195.758				4813784.836				4818270.665				4868248.575				4932813.621				4946326.428			
Easting (UTM NAD83)	450366.6979				448923.7323				451441.0505				446247.5951				487360.3989				483154.3356			
BH Depth (TVD)	598				1114.7				572				1100				106.4				91.1			
BH TD Formation	Cabot Head				Precambrian				Cabot Head				Precambrian				Cabot Head				Cabot Head			
Kelly Bushing Height (m)	1.5				1.4				2.5				3.6				0				0			
BH Log	GR	NPHI			GR	GR#1	GR#2	NPHI	GR	NPHI			GR	GR#1	GR#2	NL	GR				GR			
Date Acquired	1987	1987			1988	1988	1988	1988	1988	1988			1990	1990	1990	1990	1990				1990			
Top Depth	15	15			25	0	285	267	0	0			575	350	275	275	0				0			
Bottom Depth	600	600			1100	285	1100	1100	570	570			1100	1095	1090	1090	104				91			
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nc	235.5	0	GR&NPHI	dif	218.5	0	DT	dif	211	0	GR&NPHI	nl	198	0		nl	np	NA		nl	np	NA	
Salina (G-unit)	nc	285.2	0	GR&NPHI	nc	270.9	0	GR&DT	nc	251.6	0	GR&NPHI	278.5	268.1	10.4	NL	nl	np	NA		nl	np	NA	
Salina (F-unit)	nc	292.8	0	GR&NPHI	nc	278.6	0	GR&DT	nc	260.2	0	GR&NPHI	283	276.4	6.6	GRNL	nl	np	NA		nl	np	NA	
Cabot Head	nl	np	NA		598	598	0	GR&DT	567.5	568.4	-0.9	GR	nc	596	0	GR	100	105.2	-5.2	GR	nc	89.1	0	GR
Queenston	nl	np	NA		nc	636	0	GR&DT	nl	np	NA		nc	634.1	0	GR	nl	np	NA		nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		861.1	np	NA	GR&DT	nl	np	NA		841.4	np	NA	GR	nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		879	861.1	17.9	GR&DT	nl	np	NA		855	841.4	13.6	GR	nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nc	1009.8	0	GR&DT	nl	np	NA		nc	960.5	0	GR	nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	1035	0		nl	np	NA		nl	991.8	0		nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	1104	0		nl	np	NA		dif	1066	0	GR	nl	np	NA		nl	np	NA	

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

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Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	Sifto #10 Brine Well, Goderich 6 - 2 - MC				Paragon Bayfield #1, Stanley 1 - 10 - RE				Clearwood et al #12, Tuckersmith 2 - 30 - IIISHR				Tribute et al #16, Goderich 2 - 66 - VIII				Sifto #11, Goderich 5 - 13 - A				Brine Well No. 6, Goderich - 1 - MC			
BH ID	T008004*				T008250				T008657				T008843				T009126				T009355			
Northing (UTM NAD83)	4842709.42				4822580.896				4824266.412				4825294.773				4843329.594				4843143.655			
Easting (UTM NAD83)	444482.2927				445366.5836				460213.32				448232.7801				444083.4693				444347.6169			
BH Depth (TVD)	498.6				612				539				623				470				477.6			
BH TD Formation	B Salt				Cabot Head				Goat Island				Cabot Head				A-2 Carbonate				B Salt			
Kelly Bushing Height (m)	3.2				1.3				1.35				1.3				3.2				0.3			
BH Log	no logs?				GR	DT			GR	DT			GR	NPHI	ZNPHI		GR	NL	DT#2	DT#3	GR			
Date Acquired	1993				1995	1995			1998	1998			1999	1999	1999		2000	2000	2000	2000	1960			
Top Depth					325	325			0	16			0	0	335		0	0	60	385	35			
Bottom Depth					610	610			525	530			625	625	625		470	470	385	465	195			
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nl	np	NA		nl	227	0		dif	178.2	0	GR&DT	dif	256.5	0		dif	183	0	NL	nl	210.31	0	
Salina (G-unit)	nl	np	NA		nl	271.4	0		nc	270	0	GR	nc	304.3	0		246	248.9	-2.9	GRNL	nl	268.53	0	
Salina (F-unit)	nl	np	NA		nl	279.7	0		nc	278	0	GR	nc	312.2	0		255	257.2	-2.2	GRNL	nl	276.15	0	
Cabot Head	nl	np	NA		603.5 (dif)	604.8	-1.3	DT	nl	np	NA		dif	621	0	GR	nl	np	NA		nl	np	NA	
Queenston	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	

Well Name	Lyleton Sturdy, Goderich 3 - 20 - VII				Tribute et al #22, Goderich 2 - 39 - IX				NCE Fordyce North, West Wawanosh 1 - 25 - XIIWD				DGR-1, Bruce 4 - 20 - LR				DGR-2, Bruce 4 - 20 - LR				Tribute et al #23 (Horiz.#1), Goderich 2 - 39 - IX			
BH ID	T010054				T010686				T011560				T011582				T011583				T011651			
Northing (UTM NAD83)	4834523.749				4826822.838				4861410.397				4907754.913				4907719.803				4826253.755			
Easting (UTM NAD83)	447293.854				449347.573				464022.2215				454239.7915				454208.4902				449293.2441			
BH Depth (TVD)	665				640				541				465.1				864.2				564			
BH TD Formation	Rochester				Gasport				Cabot Head				Queenston				Precambrian				Guelph			
Kelly Bushing Height (m)	3.6				1.3				3.3				2.21				2.14				4.6			
BH Log	GR	GR#1	NPHI	DT	GR	GR#1	NPHI	PE	GR	DT			GR	NL			GR				GR			
Date Acquired	2001	2001	2001	2001	2004	2004	2004	2004	2007	2007			2007	2007			2007				2007			
Top Depth	0	295	0	300	0	360	0	368	10	250			177	0			0				5			
Bottom Depth	650	650	655	655	655	640	640	640	540	540			462.5	463			836				345			
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	244	np	NA	GR	nc	291.8	0	GR	dif	198.4	0	GR	128.3	126.2	2.1	NL	nc	124	0	NL	dif	292	0	GR
Salina (G-unit)	nc	303	0		nc	365.5	0	GR	nc	246	0	GR	nc	180.2	0	NL	nc	169.3	0	GR	nl	366	0	GR
Salina (F-unit)	nc	312	0		nc	373	0	GR	nc	253.8	0	GR	nc	185.2	0	GRNL	nc	178.6	0	GR	nl	374	0	GR
Cabot Head	nl	np	NA		nl	np	NA		nc	531	0	DT	nc	413.2	0	GR	nc	411	0	GR	nl	np	NA	
Queenston	nl	np	NA		nl	np	NA		nl	np	NA		447.6	449.9	-2.3	GR	nc	447.7	0	GR	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nc	651.6	0	GR	nl	np	NA	
Cobourg (Lower)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nc	659.5	0	GR	nl	np	NA	
Coboconk	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nc	762	0	GR	nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nc	785	0	GR	nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	860.7	0	GR	nl	np	NA	
			0				0				0				2				0				0	

Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

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Appendix C. Summary of Key Formation Top Picks Using Borehole Geophysics

Well Name	NCE FitzGerald, Ashfield 5 - 5 - IXWD				DGR-3, Bruce 8 - 18 - LR				DGR-4, Bruce 9 - 23 - LR				DGR-5 (Dev.#1), Bruce 4 - 20 - LR				DGR-6 (Dev.#1), Bruce 6 - 22 - LR				DGR-8, Bruce 8 - 20 - LR			
BH ID	T011742				T011811				T011812				T011926				T011942				T012102			
Northing (UTM NAD83)	4866018.938				4907739.802				4908743.902				4907481.642				4908371.35				4908235.175			
Easting (UTM NAD83)	446281.9276				453080.4944				453378.3014				454219.9807				453953.3784				453397.2654			
BH Depth (TVD)	566				871.3				859.2				754.9				789				727.1			
BH TD Formation	Goat Island				Cambrian				Cambrian				Kirkfield				Gull River				Kirkfield			
Kelly Bushing Height (m)	3.3				2.15				2.2				2.75				3.5				3.32			
BH Log	GR	NPHI			GR	NL			GR	GR#2	NL	NL(U)	GR	NL			GR				GR (U)	GR	NL	NL#4
Date Acquired	2007	2007			2008	2008			2008	2008	2008	2008	2009	2009			2010				2011	2011	2011	2011
Top Depth	5	5			0	1			0	165	166	0	0	0			0				0	205	0	198
Bottom Depth	535	535			847	849			187	838	839	189	806	806			896				192	732	192	726
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	dif	190.5	0	GR	144.5	143.3	1.2	NL	nl	128.2	0	NL	nc	134.8	0	NL	nc	145.3	0	GR	nc	138.9	0	NL
Salina (G-unit)	nc	261.2	0	GR	nc	187.3	0	GR	nc	170.1	0	GRNL	nc	184	0	GRNL	nc	193	0	GR	nc	182.8	0	GRNL
Salina (F-unit)	nc	270.2	0	GR	nc	196.5	0	GR	nc	177.4	0	GRNL	nc	192.5	0	GRNL	nc	203	0	GR	nc	190.3	0	GRNL
Cabot Head	nl	np	NA		nc	422.8	0	GR	nc	411.5	0	GR	nc	447.8	0	GR	nc	467.9	0	GR	nc	420.5	0	GR
Queenston	nl	np	NA		nc	457	0	GR	nc	446.3	0	GR	483	486.6	-3.6	GR	nc	507.9	0	GR	453	454.9	-1.9	GR
Cobourg (Collingwood)	nl	np	NA		nc	664.3	0	GR	nc	653.1	0	GR	nc	699.9	0	GR	nc	738.3	0	GR	nc	661.3	0	GR
Cobourg (Lower)	nl	np	NA		676	673	3	GR	nc	661.5	0	GR	nc	708.7	0		nc	746.1	0	GR	nc	669.2	0	
Coboconk	nl	np	NA		nc	775.6	0	GR	nc	763	0	GR	nl	np	NA		nc	870.5	0	GR	nl	np	NA	
Gull River (if conflict)	nl	np	NA		nl	799.3	0	GR	nl	786.8	0	GR	nl	np	NA		nc	897.2	0		nl	np	NA	
Precambrian	nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA		nl	np	NA	

Well Name	DGR-7, Bruce - -			
BH ID	T012103			
Northing (UTM NAD83)	4908215.659			
Easting (UTM NAD83)	453473.1433			
BH Depth (TVD)	190			
BH TD Formation	F Unit			
Kelly Bushing Height (m)	3.2			
BH Log	GR	NL		
Date Acquired	2011	2011		
Top Depth	8	1		
Bottom Depth	188	190		
Formation Tops	**Geofirma Form. Top (mBKB)**	**MNR Form. Top (mBKB)**	**Δ Elevation (m)**	**Log Used to Make Pick**
Bass Island	nc	138.3	0	NL
Salina (G-unit)	nc	182	0	GRNL
Salina (F-unit)	nc	190.7	0	NL
Cabot Head	nl	np	NA	
Queenston	nl	np	NA	
Cobourg (Collingwood)	nl	np	NA	
Cobourg (Lower)	nl	np	NA	
Coboconk	nl	np	NA	
Gull River (if conflict)	nl	np	NA	
Precambrian	nl	np	NA	

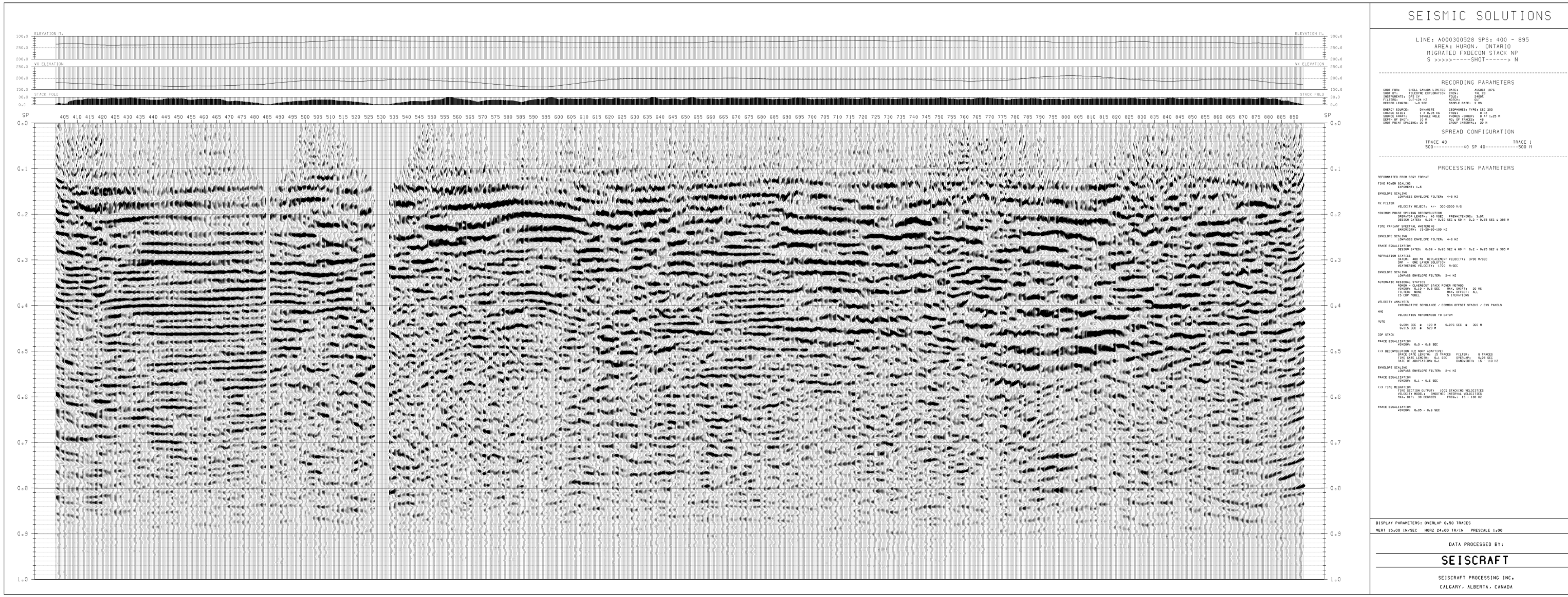
Legend				**Log Legend**			
nc	no change	Fm	Formation	GR	Gamma Ray	NPHI	Neutron Porosity
nl	not logged BH geophysical data does not cover this formation	mBKB	metres below Kelly Bushing	NL	Neutron Log	DPHI	Density Porosity
np	not present (not picked in MNR interpretation and not evident in geophysics)	Δ Elevation	change in elevation of Fm top from MNR pick to Geofirma pick	RHOB	Bulk Density	DT	Interval Transit Time
dif	difficult, not easy to pick based on geophysical logs	*	Issues with geophysical logs?	PE	Photo-Electric Factor		

Prepared by: SNS
Reviewed by: VMS
Date:4/24/2015
10-214-11.40_BHGeophys2DSeismicRpt_Appendices_R0.xlsx

Geofirma Engineering Ltd

APPENDIX D

Summary of 2D Seismic Processed Data



Processed 2D Seismic Data (Line A000300528)

PROJECT No: 10-214-11.40

Phase I Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

Prepared by: ADG
Reviewed by: KGR/SNS
Date: 04/22/2015

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"P:\Projects\2010\10-214 NWMO APM Site Screening\10-214-11 Central Huron\40 2D Seismic and BH Geophys\Figures\Working Files\10-214-11-40_CentralHuron_AppendixD.cdr"

FIGURES

450000

475000

4850000

4825000

Maitland River

Middle Maitland River

South Maitland River

Bannockburn River

Bayfield River

Hullet Marsh Complex

Lake Huron

MUNICIPALITY OF CENTRAL HURON

Londesborough

Holmesville

Clinton

Kinburn

1

15

21

18

8

31

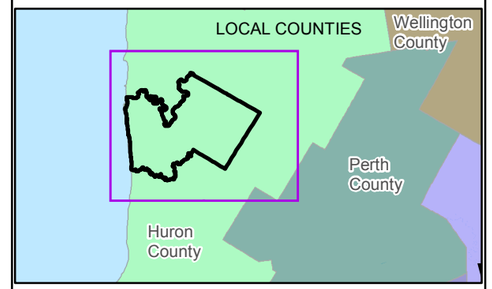
13

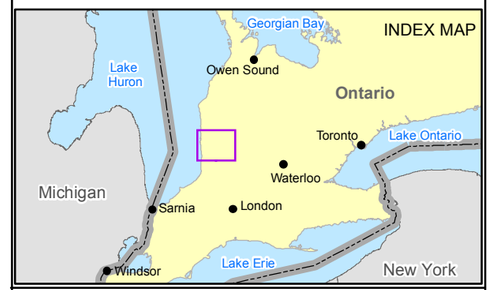
4

7

LEGEND

- Municipality of Central Huron
- Highway/Major Road
- Utility Line
- Waterbody
- Watercourse





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0 1.25 2.5 5 7.5 10

Kilometres

COORDINATE SYSTEM: UTM NAD83 Zone 17N
SOURCE:
Basemap Layers: LIO, MNR, ESRI
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Ontario Ministry of Natural Resources, ©Queens Printer 2011

PROJECT No. 10-214-11.40

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

TITLE

The Central Huron Area

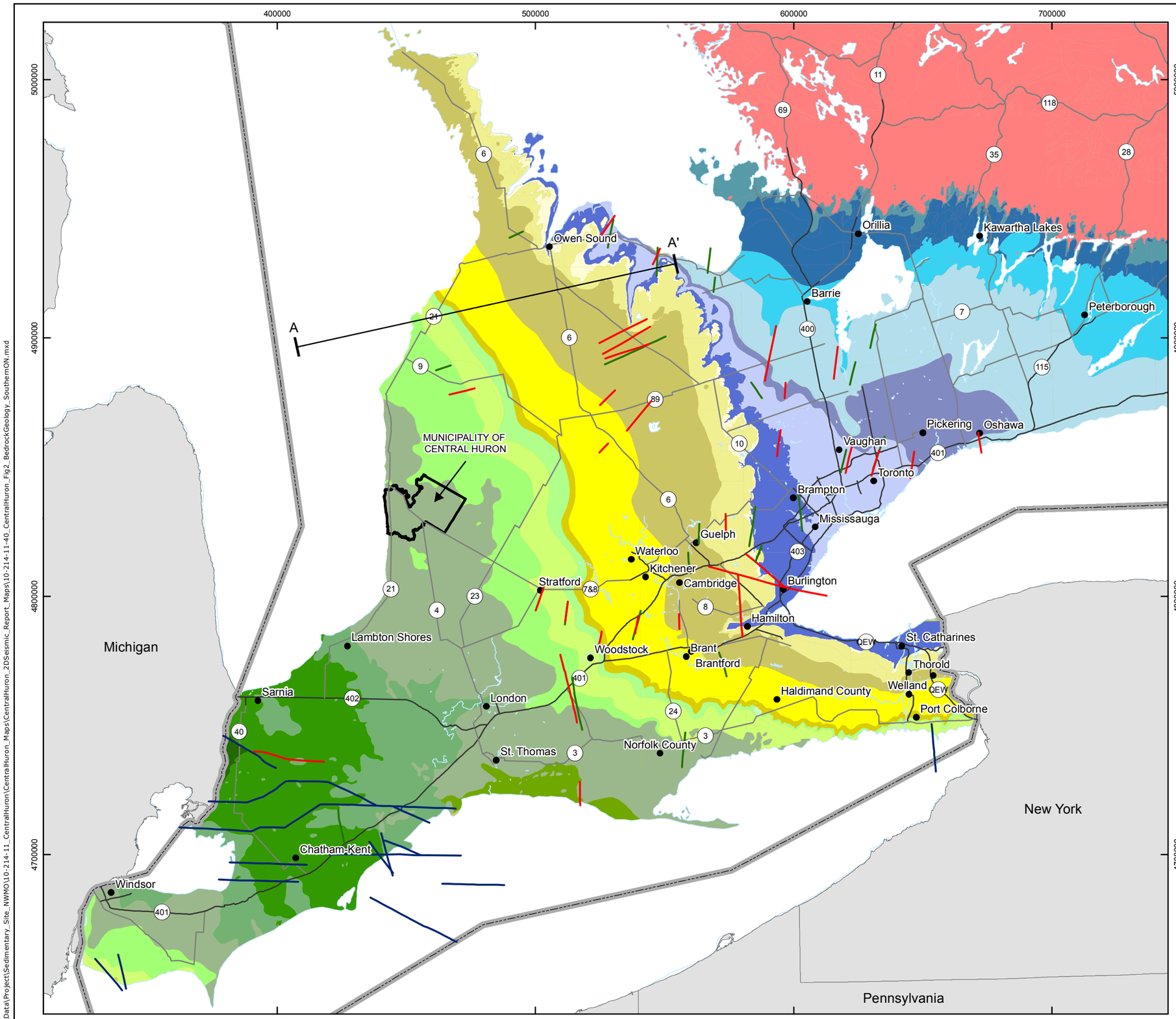
FIGURE 1

DESIGN: ADG
CAD/GIS: VMS/ADG
CHECK: KGR/SNS
REV: 0

DATE: 9/3/2015

Geofirma Engineering Ltd

G:\Data\Project\Sedimentary_Site_NWMO\10-214-11_CentralHuron\CentralHuron_Maps\CentralHuron_2DSeismic_Report_Maps\10-214-11-40_CentralHuron_Fig1_StudyArea.mxd



LEGEND

- Municipality of Central Huron
- Expressway
- Highway
- Canada - USA Boundary
- Waterbody
- Regional Cross-Section (Figure 3)

Mapped Subsurface Faults

- Rochester (Silurian)
- Trenton (Ordovician)
- Shadow Lake/Precambrian

Bedrock Geology

Upper Devonian
- Port Lambton Gp
- Kettle Point Fm

Middle Devonian
- Hamilton Gp
- Marcellus Fm
- Dundee Fm
- Lucas Fm
- Amherstburg Fm
- Onondaga Fm

Lower Devonian
- Bois Blanc Fm
- Oriskany Fm

Upper Silurian
- Bass Islands Fm
- Bertie Fm
- Salina Gp
- Guelph Fm

Lower Silurian
- Amabel Fm
- Lockport Fm
- Clinton-Cataract Gp

Upper Ordovician
- Queenston Fm
- Georgian Bay Fm
- Blue Mountain Fm
- Lindsay (Cobourg) Fm
- Verulam (Sherman Fall) Fm
- Bobcaygeon (Coboconk & Kirkfield) Fm
- Gull River Fm
- Shadow Lake Fm

Precambrian
- Precambrian

(Cobourg) = Subsurface Nomenclature
Gp = Group
Fm = Formation

SCALE 1:1,500,000

0 15 30 60 90 120

Kilometres

COORDINATE SYSTEM: UTM NAD83 Zone 17N
SOURCE:
Basemap Layers: LIO, MNR, ESRI
Geology: MRD219 Paleozoic Geology of Southern Ontario, OGS, 2007
Fault Mapping: MRD 276 Regional structure and isopach maps of potential hydrocarbon-bearing strata for southern Ontario, OGS, 2011
Regional Cross Section: NWMO, 2011

NORTH

PROJECT No. 10-214-11.40

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

TITLE

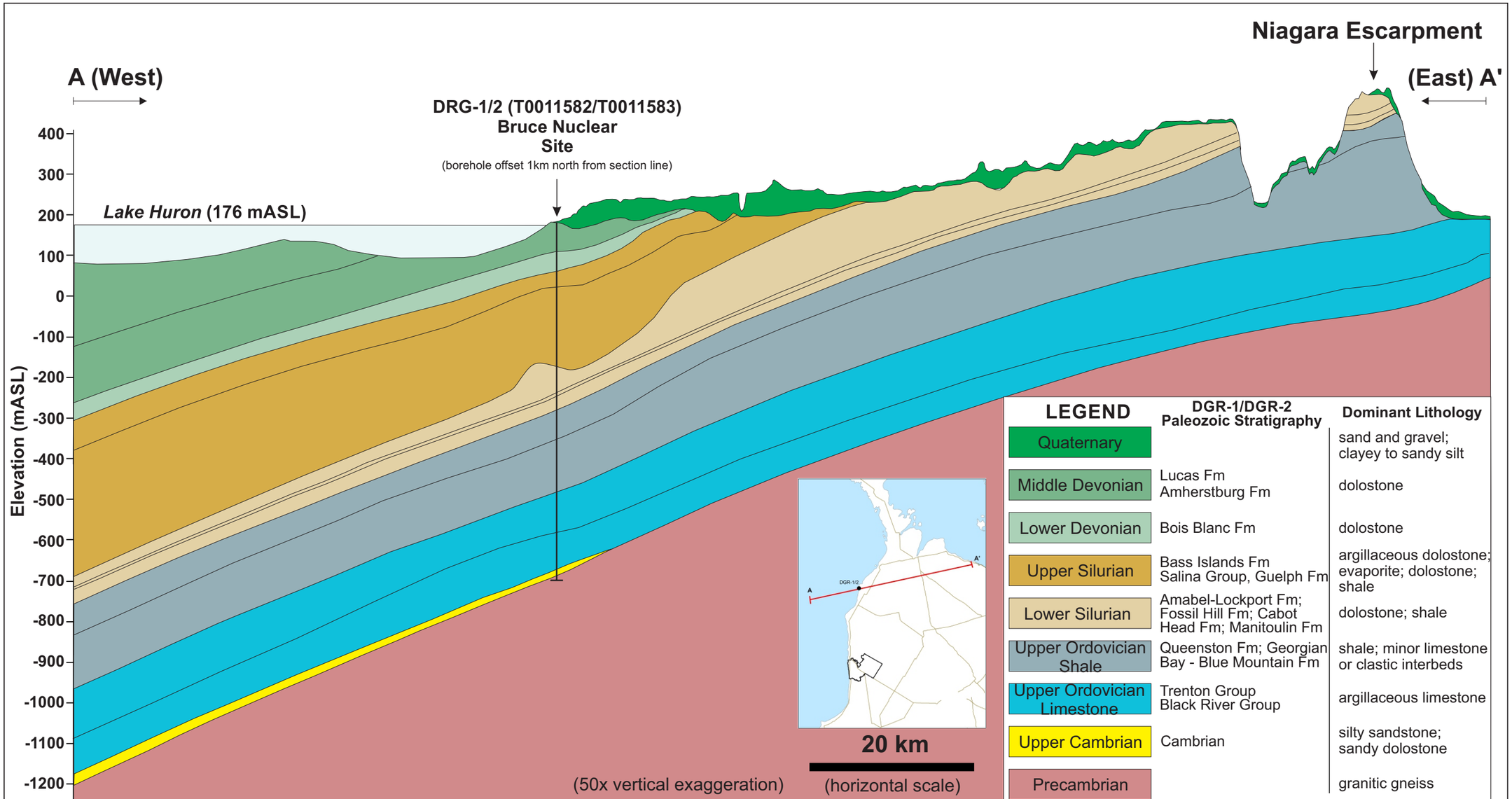
Bedrock Geology of Southern Ontario

FIGURE 2

DESIGN: NMP
CAD/GIS: VMS
CHECK: KGR
REV: 0

DATE: 10/7/2015

Geofirma Engineering Ltd



Data Source: after NWMO, 2011

FIGURE 3 - Regional Geological Cross-Section of the Eastern Flank of the Michigan Basin

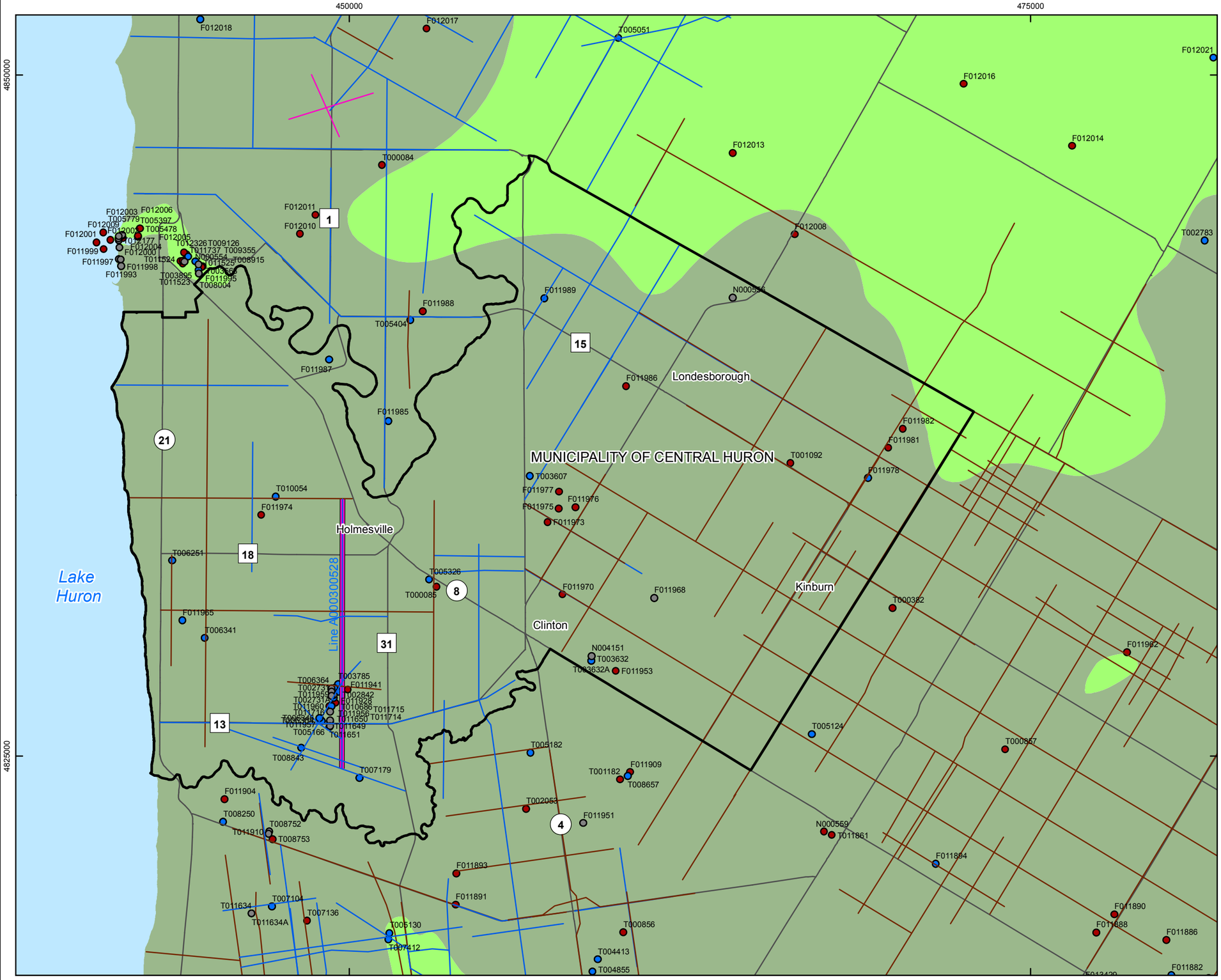
PROJECT No: 10-214-11.40

Phase I Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

Prepared by: NMP/VMS
Reviewed by: KGR/SNS
Date: 03/12/2015

Geofirma Engineering Ltd

"P:\Projects\2010\10-214 NWMO APM Site Screening\10-214-11 Central Huron\40 2D Seismic and BH Geophys\Report\Figures\Working Files\10-214-11-40_CentralHuron_Fig3_Cross_Section_EasternFlankMichiganBasin.cdr"



LEGEND

- Municipality of Central Huron
- Highway/Major Road
- Waterbody
- OGSRL Well
- OGSRL Well with Geophysics Log
- OGSRL Wells Not Used in Study

Seismic Lines

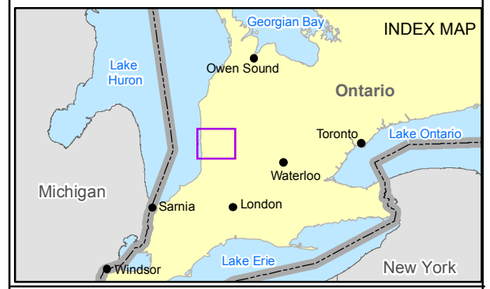
- Pre 1975
- 1975 - 1985
- 1985 - 1995
- Acquired 2D Seismic Data

Bedrock Geology

Middle Devonian

- Dundee Fm
- Lucas Fm

Fm = Formation



SCALE 1:140,000

0 1.25 2.5 5 7.5 10

Kilometres

COORDINATE SYSTEM: UTM NAD83 Zone 17N
SOURCE:
Basemap Layers: LIO, MNR, ESRI
Geology: OGS, 2007
Wells: OGSRL, 2014
Seismic Lines: Sigma Exploration, 2015
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NORTH

PROJECT No. 10-214-11.40

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

TITLE

Bedrock Geology, Oil and Gas Wells and Existing 2D Seismic Data of the Central Huron Area

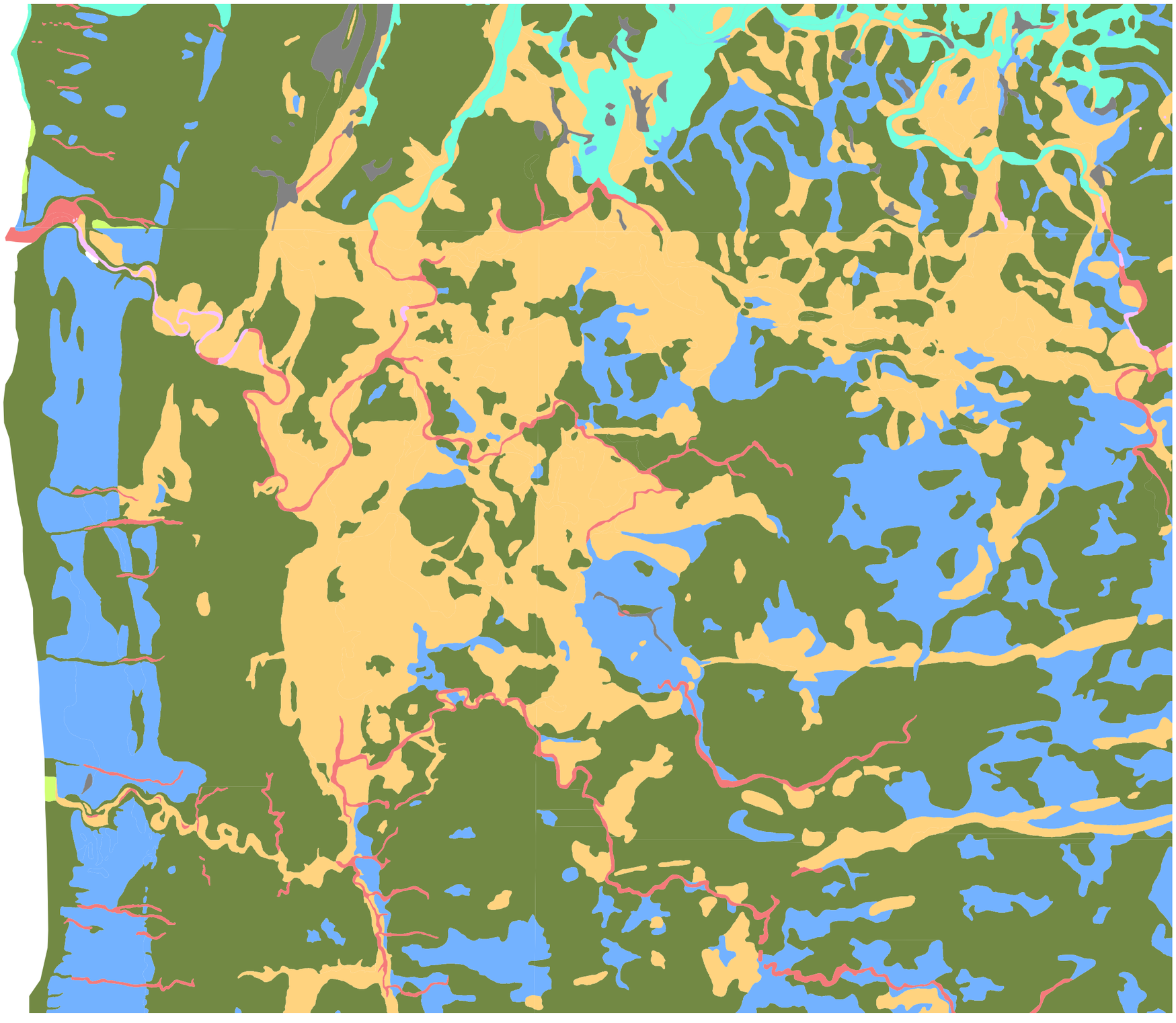
FIGURE 4

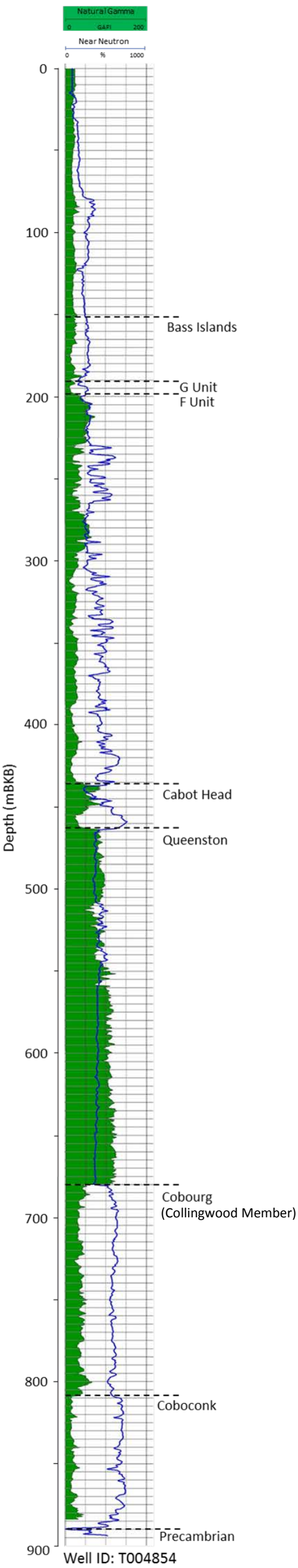
DESIGN: ADG
CAD/GIS: ADG/VMS
CHECK: KGR/SNS
REV: 0A

DATE: 9/3/2015

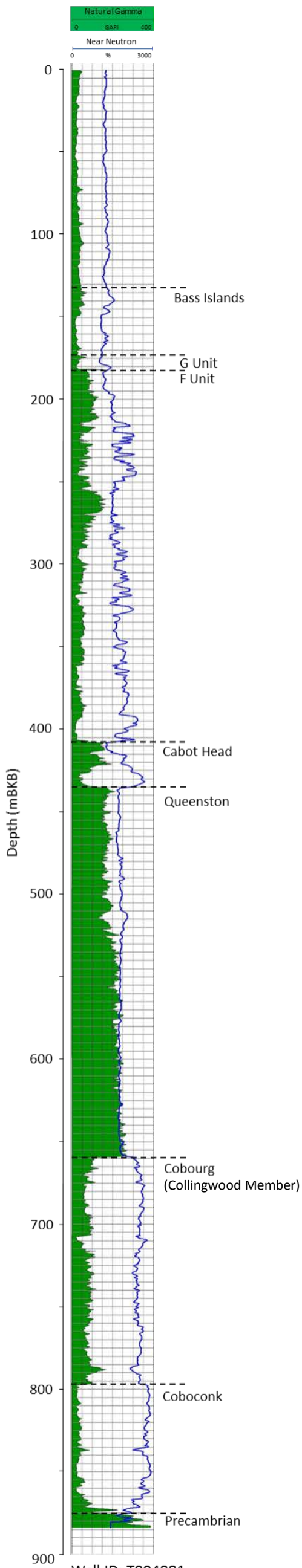
Geofirma Engineering Ltd

G:\Data\Project\Sedimentary_Site_NWMO\10-214-11_CentralHuron\CentralHuron_Maps\CentralHuron_2DSeismic_Report_Maps\10-214-11-40_CentralHuron_Fig4_BedrockGeologyOilGasWells.mxd

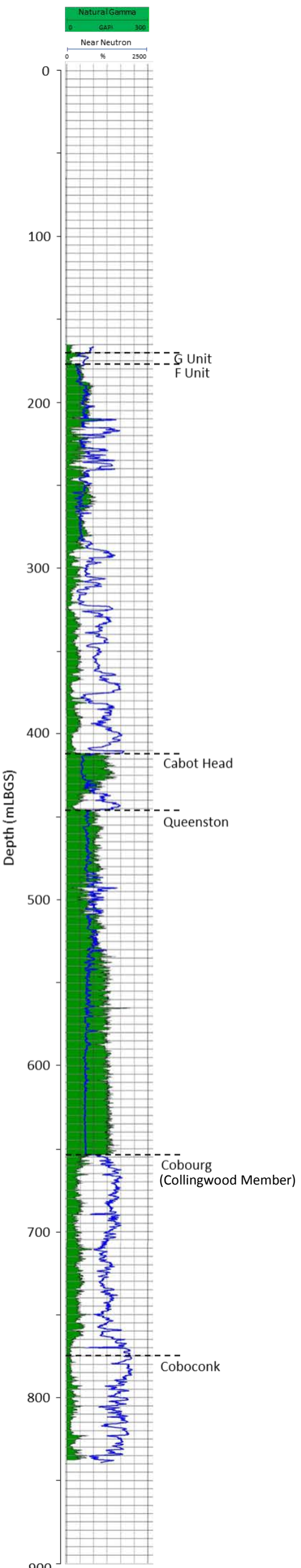




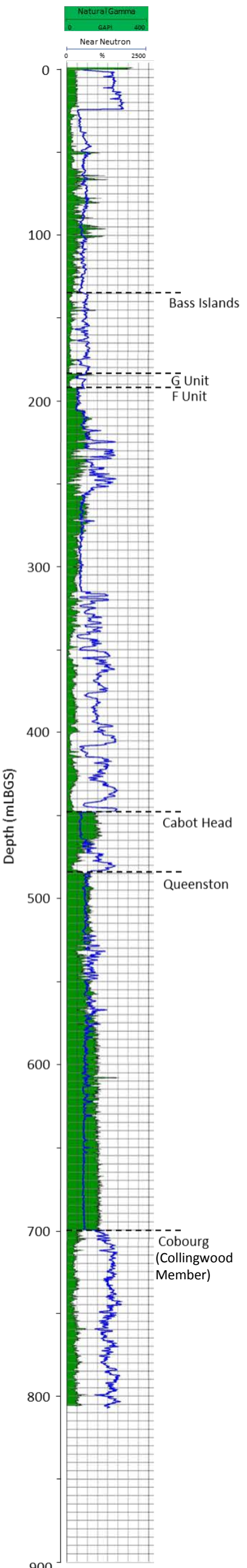
Well ID: T004854
Well Name: Pacific, Greenock 1-32-VIII
Armstrong and Carter (2010) Reference Well



Well ID: T004881
Well Name: Pacific, Culross 4-25-V
Armstrong and Carter (2010) Reference Well



Well ID: T011812
Well Name: DGR-4



Well ID: T011926
Well Name: DGR-5

FIGURE 6 - Geophysical Signatures of Key Formation Tops

PROJECT No: 10-214-11-40

NWMO Phase I Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

Prepared by: SNG
Reviewed by: SNS
Date: 13-Mar-15

Geofirma Engineering Ltd

"P:\Projects\2010\10-214 NWMO APM Site Screening\10-214-11 Central Huron\40 2D Seismic and BH Geophys\Report\Figures\Working Files\10-214-11.40_Fig 6_Anchor Picks_R0.pptx"

450000 475000 500000

4850000

4825000

MUNICIPALITY OF CENTRAL HURON

Londesborough

Holmesville

Kinburn

Clinton

Lake Huron

Line A0003005-18

Tipperary Pool

Tipperary South Pool

Tuckersmith 30-III-SHR Pool

Bayfield Pool

A

A'

B

B'

1 4 8 13 15 18 21 31

LEGEND

- Municipality of Central Huron
- Highway/Major Road
- Waterbody
- Acquired 2D Seismic Data
- OGSRL Well
- OGSRL Well with Geophysics Log
- Pinnacle Reef
- Oil and Gas Pool
- Cross-Section
- Cambrian Sandstone

Bedrock Geology

Middle Devonian

- Dundee Fm
- Lucas Fm
- Amherstburg Fm

Lower Devonian

- Bois Blanc Fm

Fm = Formation

INDEX MAP

Georgian Bay, Lake Huron, Owen Sound, Ontario, Toronto, Lake Ontario, Waterloo, Michigan, Sarnia, London, Windsor, Lake Erie, New York

SCALE 1:200,000

0 1 2 4 6 8

Kilometres

COORDINATE SYSTEM: UTM NAD83 Zone 17N
SOURCE:
Basemap Layers: LIO, MNR, ESRI
Cambrian Sandstone: Bailey & Cochrane, 1984a
Geology: OGS, 2007
Oil and Gas Wells and Pools: OGSRL, 2014
Pinnacle Reefs: OGS, 2011
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NORTH

PROJECT No. 10-214-11.40

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

TITLE

Orientation of Geological Cross-Sections through the Central Huron Area

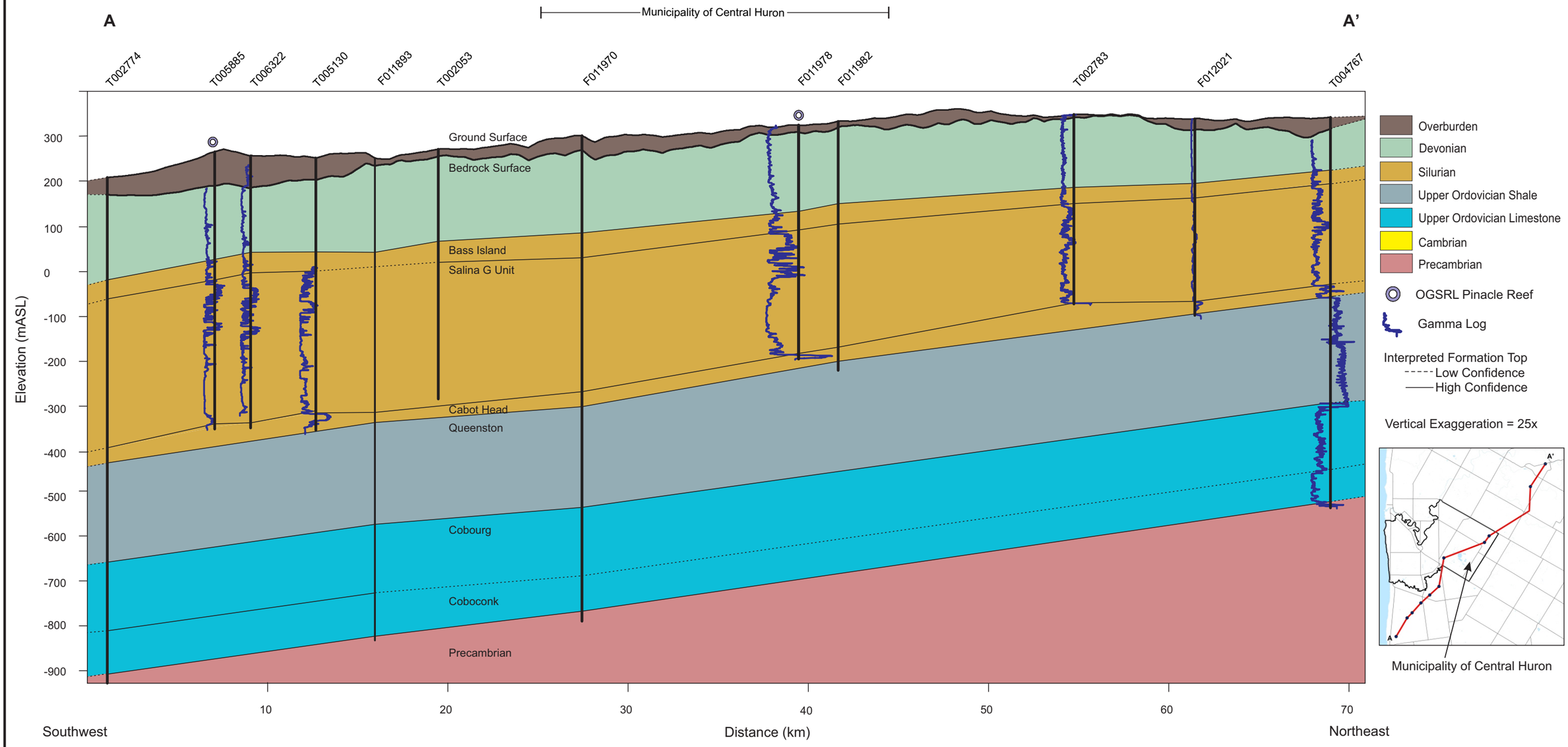
FIGURE 7

DESIGN: ADG
CAD/GIS: ADG/VMS
CHECK: KGR/SNS
REV: 0

DATE: 10/7/2015

Geofirma Engineering Ltd

G:\Data\Project\Sedimentary_Site_NWMO\10-214-11_CentralHuron\CentralHuron_Maps\CentralHuron_2DSeismic_Report_Maps\10-214-11-40_CentralHuron_Fig7_BedrockGeologyOilGasCrossSection.mxd



Cross Section A-A’

Geological Cross Section A-A' in the Central Huron Area
NWMO Phase I Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

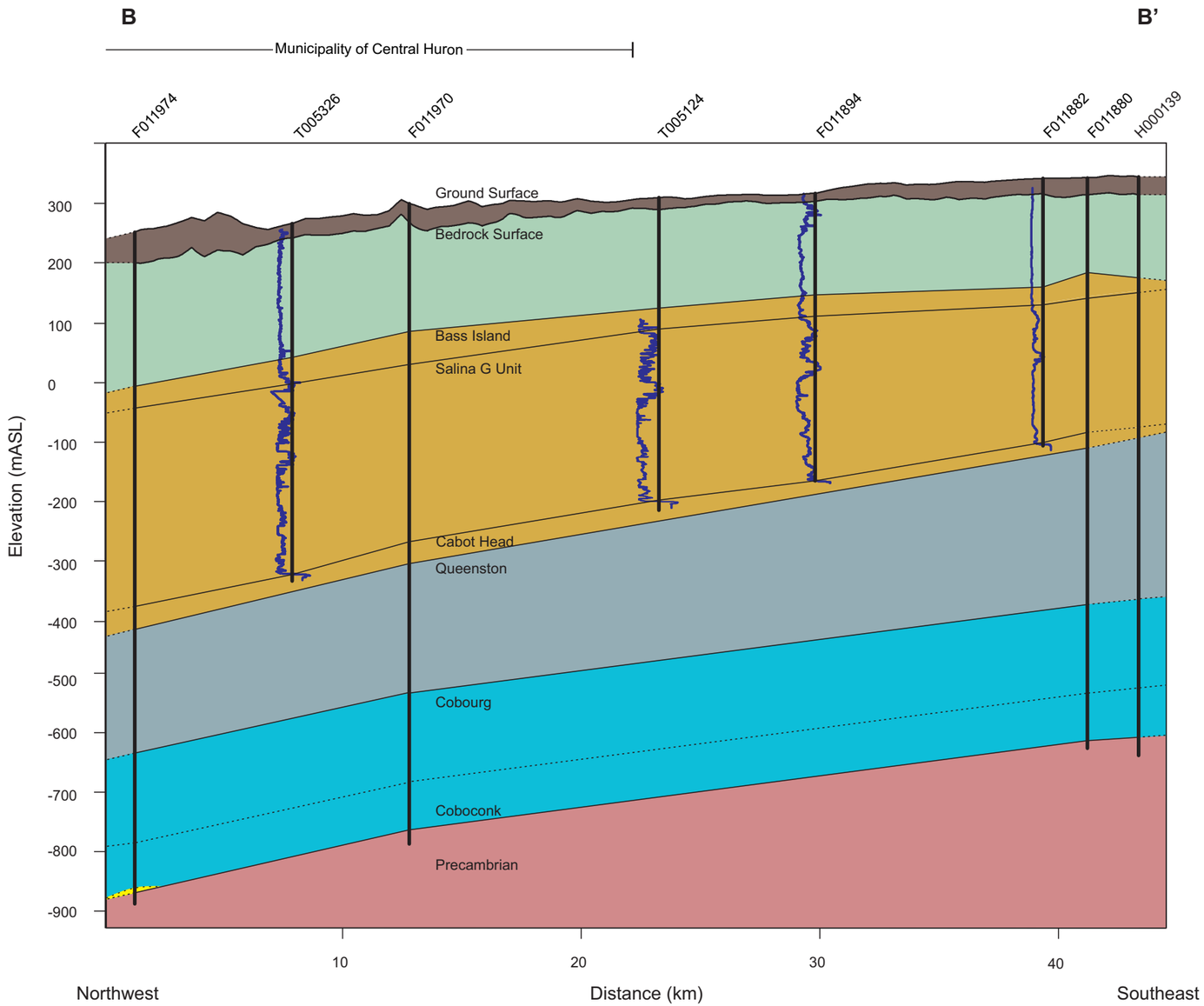
FIGURE 8

Doc. No.:10-214-11-40_CentralHuron_Fig8_CrossSectionA.cdr

Prepared by: NDR/ADG
Reviewed by: KGR/SNS
Date: Mar 12, 2015

Source:
Wells: OGSRL, 2014
Pinnacle Reef: OGS, 2011

Geofirma Engineering Ltd



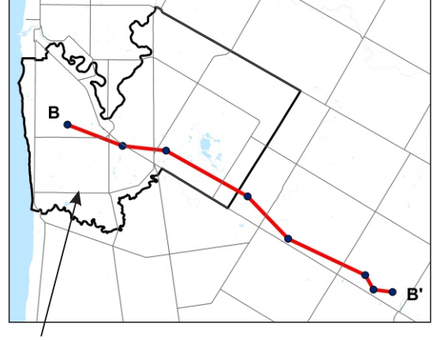
Cross Section B-B’

Overburden
Devonian
Silurian
Upper Ordovician Shale
Upper Ordovician Limestone
Cambrian
Precambrian

Gamma Log

Interpreted Formation Top
---- Low Confidence
—— High Confidence

Vertical Exaggeration = 25x



Municipality of Central Huron

Geological Cross Section B-B' in the Central Huron Area
NWMO Phase I Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

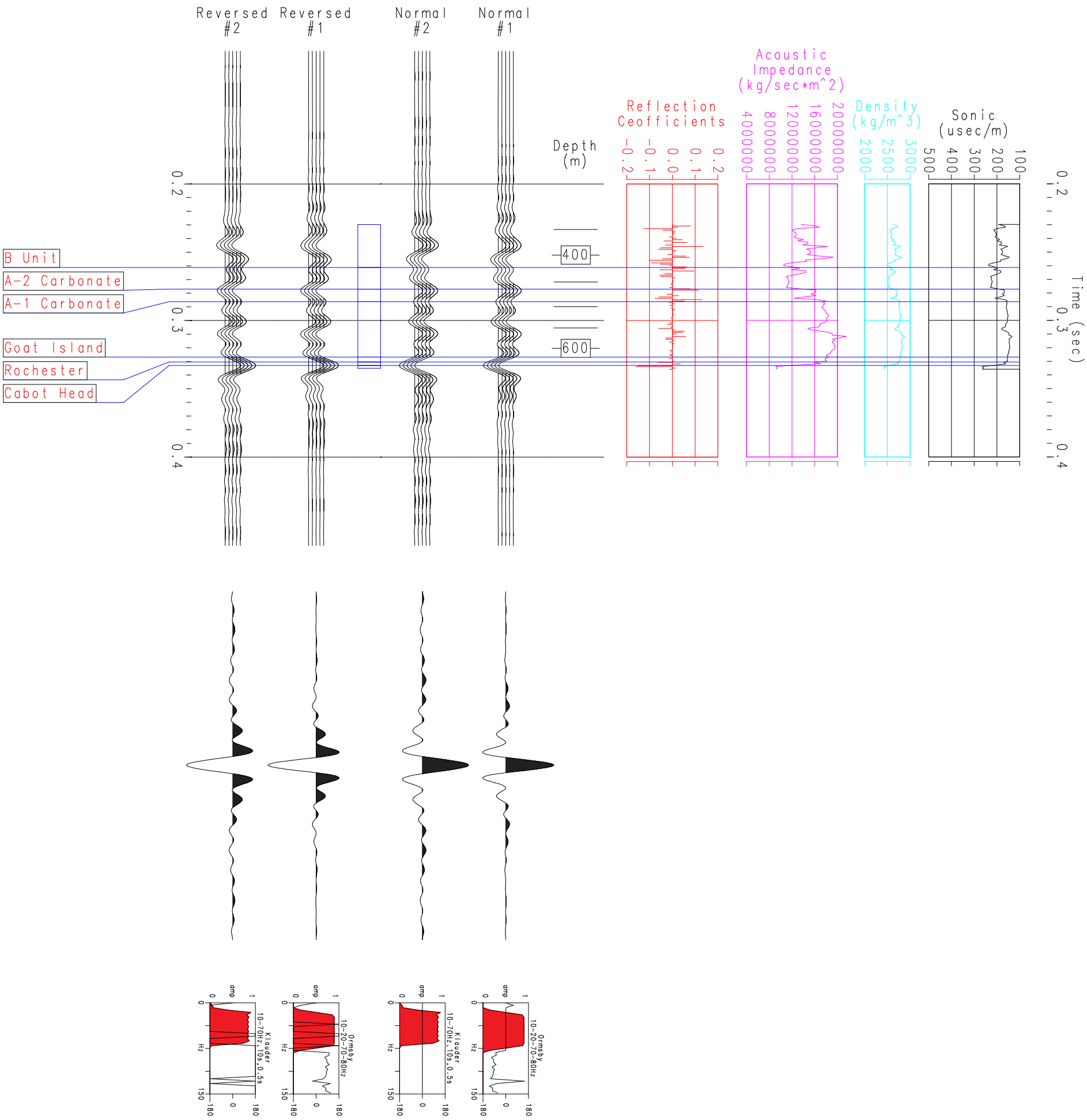
FIGURE 9

Doc. No.:10-214-11-40_CentralHuron_Fig9_CrossSection_B.cdr

Prepared by: NDR/ADG
Reviewed by: KGR/SNS
Date: Mar 12, 2015

Source:
Wells: OGSRL, 2014

Geofirma Engineering Ltd



Source: Borehole Geophysical Logs: OGSRL, 2014

Figure 10 - Synthetic Seismogram for OGSRL Borehole T005166

PROJECT No: 10-214-11.40

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

Prepared by: ADG
Reviewed by: KGR/SNS
Date: 17/04/2015

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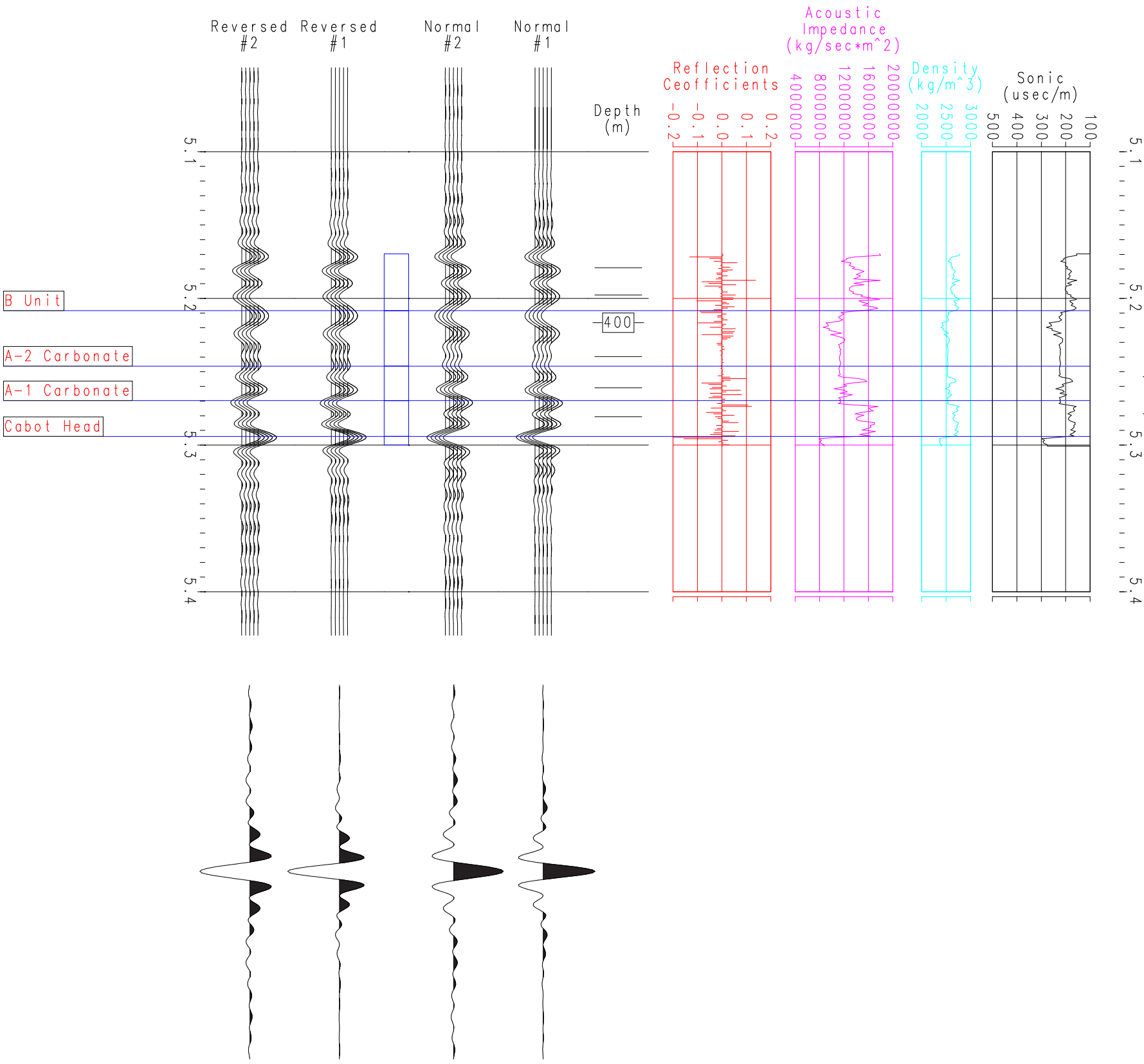
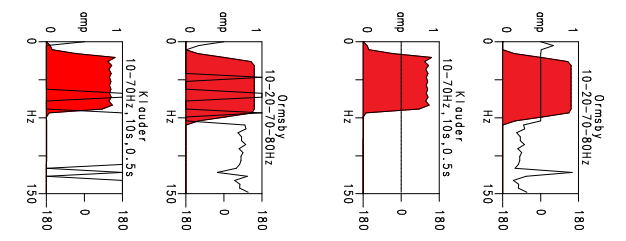
"P:\Projects\2010\10-214 NWMO APM Site Screening\10-214-11 Central Huron\40 2D Seismic and BH Geophys\Report\Figures\Working Files\10-214-11-40_CentralHuron_Fig10_12_Synthetic Seismograms.cdr"





Source: Borehole Geophysical Logs: OGSRL, 2014

Figure 11 - Synthetic Seismogram for OGSRL Borehole T005326

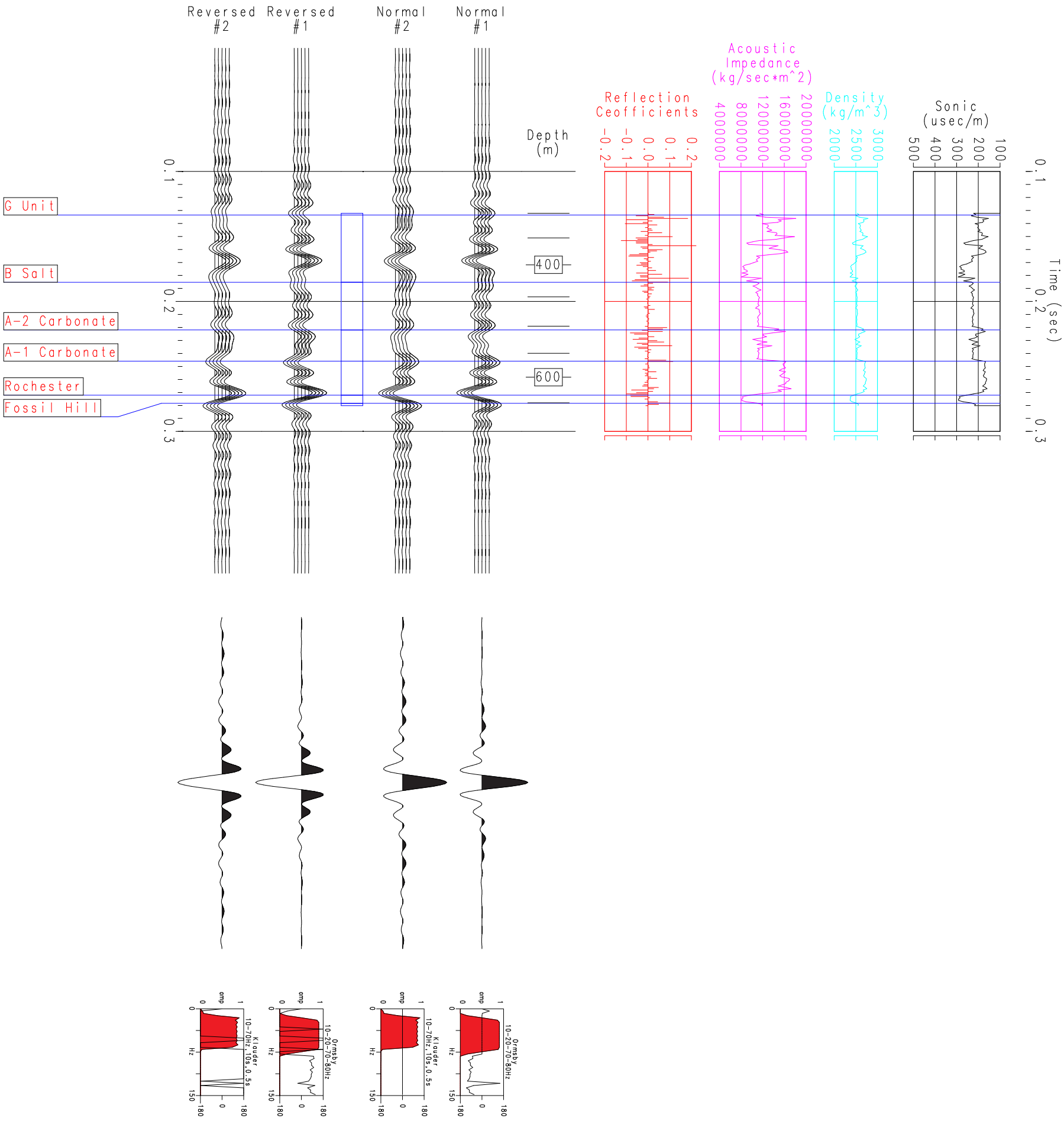
PROJECT No: 10-214-11.40

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

Prepared by: ADG
Reviewed by: KGR/SNS
Date: 17/04/2015

Geofirma Engineering Ltd

"P:\Projects\2010\10-214 NWMO APM Site Screening\10-214-11 Central Huron\40 2D Seismic and BH Geophys\Report\Figures\Working Files\10-214-11-40_CentralHuron_Fig10_12_Synthetic Seismograms.cdr"



Source: Borehole Geophysical Logs: OGSRL, 2014

Figure 12 - Synthetic Seismogram for OGSRL Borehole T010054

PROJECT No: 10-214-11.40

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

Prepared by: ADG
Reviewed by: KGR/SNS
Date: 17/04/2015

Geofirma Engineering Ltd

"P:\Projects\2010\10-214 NWMO APM Site Screening\10-214-11 Central Huron\40 2D Seismic and BH Geophys\Report\Figures\Working Files\10-214-11-40_CentralHuron_Fig10_12_Synthetic Seismograms.cdr"

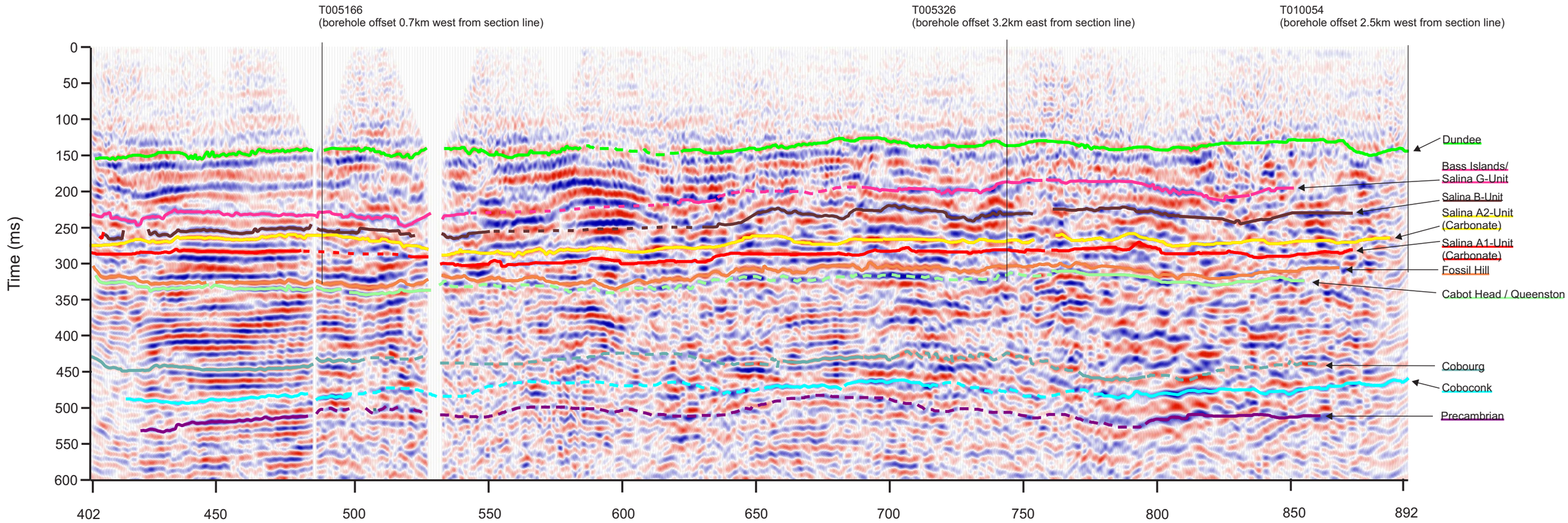


Figure 13 - 2D Seismic Interpretation of Line A00300528 in the Municipality of Central Huron

PROJECT No: 10-214-11

NWMO Phase 1 Geoscientific Desktop Preliminary Assessment, Processing and Interpretation of Borehole Geophysical Log and 2D Seismic Data

Prepared by: NMP/ADG
Reviewed by: SNS
Date: 16/04/2015

Geofirma Engineering Ltd

"P:\Projects\2010\10-214 NWMO APM Site Screening\10-214-11 Central Huron\40 2D Seismic and BH Geophys\Report\Figures\Working Files\10-214-11-40_CentralHuron_Fig13_CrossSection_SeismicLine.cdr"