NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Preliminary Assessment for Siting a Deep Geological Repository for Canada's Used Nuclear Fuel

MUNICIPALITY OF CENTRAL HURON, ONTARIO

FINDINGS FROM PHASE ONE STUDIES

APM-REP-06144-0124

OCTOBER 2015

About the NWMO and its work

The Nuclear Waste Management Organization (NWMO) was created by Canada's nuclear energy generators in 2002 as a requirement of the *Nuclear Fuel Waste Act*. The Act requires the NWMO to study, recommend and then implement a plan for the long-term management of used nuclear fuel in Canada.

The NWMO approaches its work with the following vision: the long-term management of Canada's nuclear waste in a manner that safeguards people and respects the environment, now and in the future.

The NWMO is guided by five fundamental values:

Integrity: We will conduct ourselves with openness, honesty and respect for all persons and organizations with whom we deal.

Excellence: We will pursue the best knowledge, understanding and innovative thinking in our analysis, engagement processes and decision-making.

Engagement: We will seek the participation of all communities of interest and be responsive to a diversity of views and perspectives. We will communicate and consult actively, promoting thoughtful reflection and facilitating a constructive dialogue.

Accountability: We will be fully responsible for the wise, prudent and efficient management of resources, and be accountable for all our actions.

Transparency: We will be open and transparent in our process, communications and decision-making, so that the approach is clear to all Canadians.

The work of the NWMO is subject to federal regulatory oversight and is regulated under the *Nuclear Safety and Control Act*. The NWMO's work is required to meet all applicable regulatory standards and requirements for protecting the health and safety of persons, the environment and national security, and to respect Canada's international commitments on the peaceful use of nuclear energy. For financial surety, its work is also required to be fully funded by the waste-producing organizations through independently managed trust funds.

Preface

Since initiating the siting process in May 2010, the Nuclear Waste Management Organization (NWMO) has worked collaboratively with interested communities to implement Adaptive Phased Management (APM), Canada's plan for the safe, long-term care of used nuclear fuel. At this early point in the multi-year site selection process, the focus of work is on exploring potential to meet specific requirements to safely host a deep geological repository and Centre of Expertise, the core components of Canada's plan.

Findings summarized in this document have emerged from studies conducted as part of Phase 1 of the Preliminary Assessment, the initial phase of study in Step 3 of the nine-step process for selecting a site. This document reviews the outcome of desktop studies that explored the potential to find a site that can safely and securely contain and isolate used nuclear fuel from people and the environment for the long time period required. It also summarizes learning that transpired through working with the community to build understanding about APM, and to explore the project's potential to align with the long-term vision of the community in a way that contributes to its well-being.

The Municipality of Central Huron is one of nine communities currently engaged in exploring potential interest in hosting this national infrastructure project. Findings from its Phase 1 Preliminary Assessment are intended to support the Municipality and the NWMO in taking stock of the community's potential to meet the requirements for hosting APM facilities. These assessments also provide the basis upon which the NWMO identifies a smaller number of communities to be the focus of the next phase of more detailed studies.

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The journey of the Municipality of Central Huron in the APM process began in May 2012 when the community, through its Mayor and Council, approached the NWMO to learn more about the program. This request came in response to an open invitation from the NWMO to communities and groups to learn more about Canada's plan. Highlights of Central Huron's engagement to date in this Learn More process are provided below.

The Municipality has actively pursued learning opportunities to become better informed about the project and nuclear waste management in general. The costs associated with these learning activities were covered by the NWMO as part of funding programs provided to interested communities.

In June 2012, members of Council received a Learn More briefing from the NWMO and toured the Western Waste Management Facility at the Bruce nuclear site to begin to learn about the project and to see how used nuclear fuel is currently managed on an interim basis.

The Municipality's Council passed a resolution in September 2012 requesting an initial screening of the community's potential suitability for the project. This request came with the understanding the community could end its involvement in the Learn More program at any time.

A small community delegation also attended the International Conference on Geological Repositories, a conference that was convened in Toronto and brought together a range of international experts, to learn about how other countries are approaching site selection
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processes. In November 2012, the NWMO met with community officials to review the plan for conducting the initial screening and to confirm details of the work.

NWMO shared information about the resource programs available to communities in the site selection process to support learning about APM and to explore the community's interest in the project. These resource programs continued to support the participation of Central Huron throughout each stage of the community's involvement. Central Huron used resource program funds for administrative costs associated with participation in the Learn More program, as well as to help conduct a Community Improvement study.

Council asked that the NWMO make information about the project and the site selection process readily available to community members; and in December 2012, a kiosk with information about the APM Project was established in the Central Huron Community Centre in Clinton. Smaller document stands with information about the project and the site selection process were also set up in locations such as the municipal administration office.

Upon completing the initial screening in February 2013, the NWMO and the third party consultant that conducted the work presented findings to Council. Copies of the final report (summary version as well as detailed report) were also provided. The report's findings indicated "*the review of readily available information and application of the five initial screening criteria did not identify obvious conditions that would exclude the Municipality of Central Huron from further consideration in the site selection process.*"

At the invitation of Council, the NWMO convened a two-day open house in Central Huron in March 2013 to share initial screening results and information about the APM Project and site selection process with the community. The open house was advertised in local newspapers, on the radio, and online. Individuals and groups who met with the NWMO during this event included members of Council and municipal staff, students, representatives from the business community, families, seniors, farmers, and other community members.

Following the initial screening presentation and community open house, Council expressed an interest in learning more about Step 3, Preliminary Assessment, which is the next step in the site selection process. Upon request, the NWMO provided a briefing on the preliminary assessment phase of work to Council in June 2013.

Over the following year, the community continued to learn and reflect upon its interest in APM, and the NWMO continued to provide information about the site selection process and about Canada's plan for the long-term care of used nuclear fuel. The NWMO attended community events where invited, continued to refresh the information available at the document stands and kiosk, and responded to information requests from Council and community members.

After this period of consideration, Council passed a resolution in July 2014 expressing its interest in continuing to learn more about APM and to initiate further studies by proceeding to Step 3 for the first phase of preliminary assessment activities.

The Municipality appointed an APM project coordinator to begin to liaise with the NWMO to support and guide the community's participation in the process.

To further support ongoing dialogue with the community, the NWMO opened a local office and Learn More Centre (LMC) in the community in March 2015. The Central Huron LMC was equipped with a permanent set of displays, videos, and printed material. NWMO staff, working

from the office several days each month, were available to address questions, concerns, and comments from community members dropping by the office.

The community's APM project coordinator helped organize a multi-day open house and tours of interim used fuel storage facilities for groups of community members. A well-attended, two-day open house was held in Holmesville in April 2015. At the open house, NWMO specialists used interactive exhibits, videos, poster displays, and printed materials to help explain various aspects of APM and answer questions about the project.

Community members, elected officials, and senior Municipal staff participated in Learn More briefings and site tours at the Western Waste Management Facility, located at the Bruce nuclear site, in April and July 2015.

In August 2015, a small group of community members visited the NWMO's Mobile Transportation Exhibit, which features a full-sized, licensed used fuel transportation cask, to provide an opportunity to learn more about the robust transportation regulations, policies, and procedures that must be met.

Throughout late 2014 and early 2015, the NWMO worked with community members to develop a community profile. The development of the profile involved desktop review of existing reports and other material, and conversations with a cross-section of community members to understand community priorities, objectives, and interests for the area over the long term. Drafts of the profile were reviewed by community members through a series of open office events at the NWMO Learn More Centre in August 2015 as well as through dozens of one-on-one and group discussions with a cross-section of community members throughout the spring and summer of 2015. The community profile helped provide a basis for initial conversation about the extent to which the APM Project could support community goals and objectives if the project were to be sited in the Municipality of Central Huron.

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The objective of the site selection process, through several phases of progressively more detailed assessments, is to arrive at a single location for both the deep geological repository for Canada's used nuclear fuel and the Centre of Expertise. The preferred site will need to ensure safety and security for people and the environment, and contribute to the well-being of the area. Selecting a site will require many more years of detailed technical, scientific, and social study and assessments, and much more engagement with interested communities, as well as potentially affected First Nation and Métis communities, and surrounding communities. With nine of the original 22 communities still engaged in exploring their interest and suitability for hosting the APM Project, the site selection process must provide a basis for progressively identifying a smaller number of communities for more detailed assessment. Through increasingly more detailed studies, communities with strong potential to meet the project's specific requirements will be identified to become the focus of further assessment.

This process of stepwise reflection and decision-making will be supported by a sequence of assessments and engagement that will enable the NWMO and communities to learn more about the suitability of each potential siting area and make decisions about where to focus more detailed work. Communities may choose to end their involvement at any point during the site evaluation process until a final agreement is signed, subject to all regulatory requirements being met and regulatory approvals received.
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1. INTRODUCTION

1.1 The Purpose of This Document

Since May 2010, the Nuclear Waste Management Organization (NWMO) has worked with interested communities to implement Adaptive Phased Management (APM), Canada's plan for the long-term care of used nuclear fuel. The NWMO has worked collaboratively with interested communities to begin to explore their potential to meet site selection requirements for locating the deep geological repository and Centre of Expertise, the core components of Canada's plan.

Following a road map for decision-making that was developed collaboratively through two years of public engagement, the site selection process is now advancing through a multi-year series of steps and engagement to ensure, above all, that the site which is selected is safe and secure, and meets the highest scientific, professional, and ethical standards.

This document, together with a series of supporting reports, captures learning to date from the Phase 1 Preliminary Assessment conducted with the Municipality of Central Huron, Ontario.

Findings summarized in this document have emerged from studies conducted as part of Phase 1 of the Preliminary Assessment – the initial phase of study in Step 3 of the nine-step site selection process. The document reviews the outcome of desktop studies that explored the potential to find a site that can safely and securely contain and isolate used nuclear fuel from people and the environment for the long time period required. It also summarizes the learning that has emerged through working with the community to help them understand the safety of the project, and explore the potential for the project to align with the values and aspirations of the community over the long term and contribute to the well-being of the community and area.

The findings presented in this Phase 1 report are intended to provide input to early stock-taking of the potential for the community to meet the requirements to host the APM facilities. It is also intended to be an aid in NWMO decision-making to identify the smaller number of communities as the focus of more detailed Phase 2 studies, should the community be willing to continue in the process.

1.2 Towards Partnership

Although the focus of this assessment is the Municipality of Central Huron, it is understood that a broader partnership involving potentially affected First Nation and Métis communities, and surrounding communities would be needed in order for the project to proceed in this or any other area.

Through working with Central Huron and other communities involved in the site selection process in Phase 1 activities, and initial outreach with First Nation and Métis communities in the vicinity and surrounding communities, the nature and shape of the partnerships required to implement the APM Project are beginning to emerge. This project will only proceed with the involvement of the interested community, potentially affected First Nation and Métis communities, and surrounding communities working in partnership to implement it.

1.3 A Matter of Responsibility

For decades, Canadians have been using electricity generated by nuclear power reactors in Ontario, Quebec, and New Brunswick. Over 2.5 million used fuel bundles have been produced. When used nuclear fuel is removed from a reactor, it is considered a waste product, is radioactive, and requires careful management. Although its radioactivity decreases with time, chemical toxicity persists, and the used fuel will remain a potential health risk to people and the environment for many hundreds of thousands of years. Canada's used nuclear fuel is now safely stored on an interim basis at licensed facilities located where it is produced. Putting in place a plan for the long-term, safe, and secure management of used nuclear fuel for the protection of people and the environment is an important responsibility that Canadians share. Through dialogues with citizens and Aboriginal peoples across Canada, the NWMO has heard that this generation wants to move forward in dealing with our used nuclear fuel, believing it to be imprudent and unfair to future generations to wait any longer.

1.4 The Foundation of Canada's Plan

The Government of Canada selected Canada's plan for the long-term management of used nuclear fuel in 2007. The plan, called Adaptive Phased Management, involves the development of a large national infrastructure project in an informed and willing host community. The project involves the long-term containment and isolation of used nuclear fuel from people and the environment in a deep geological repository in a suitable rock formation. It also involves the development of a Centre of Expertise and transportation plan.

As required by the *Nuclear Fuel Waste Act*, 2002, the NWMO is responsible for implementing Canada's Plan. The NWMO is committed to carrying out its work collaboratively with interested and affected citizens and organizations in a manner that is socially acceptable, technically sound, environmentally responsible, and economically feasible.

Adaptive Phased Management (APM) – At a Glance:

- Was developed through a nationwide dialogue between 2002 and 2005
- Was selected as Canada's plan by the Government of Canada in 2007, consistent with the *Nuclear Fuel Waste Act*
- Key features include:
  - Safe and secure centralized containment and isolation of used nuclear fuel in a repository deep underground in a suitable rock formation
  - A series of steps and clear decision points that can be adapted over time
  - An open, inclusive, and fair siting process to identify an informed and willing host community
  - Opportunities for people and communities to be involved throughout the implementation process
  - Optional temporary shallow storage at the central site, if needed
  - Long-term stewardship through the continuous monitoring of used fuel
  - Ability to retrieve the used fuel over an extended period should there be a need to access the waste or take advantage of new technologies
  - Financial surety and long-term program funding to ensure the necessary money will be available for the long-term care of used nuclear fuel

1.5 The Site Selection Process

Through a collaborative process in 2008 and 2009, the NWMO worked with interested Canadians to develop the decision-making framework for selecting a site for the project. The site selection process is laid out in the NWMO's document: *"Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel"* (NWMO, 2010).

The site selection process is designed to ensure safety, security, and protection of people and the environment. Reflecting the guidance provided by Canadians, the site selection process is built on a set of principles that reflects the values and priorities of Canadians on this issue. The process also contains a number of steps these Canadians told us need to be part of the decision-making process to ensure it is an appropriate one for Canada, as set out in the table on the next pages.

Phase 1 Preliminary Assessments are conducted as part of Step 3 activities early in the site selection process. Several additional steps must be completed over the course of the next several years before a preferred site will be identified, and environmental assessment and regulatory review will be sought. Interested communities may leave the site selection process at

any time during this process until a final agreement is signed, subject to all regulatory requirements being met and regulatory approval received.

It is fundamental to the siting process that only an informed and willing community be selected to host the project as evidenced by a compelling demonstration of willingness involving community residents. The project will only be implemented in an area in which robust safety requirements can be met and well-being will be fostered.

Table 1-1: Steps in the Site Selection Process – At a Glance

Getting Ready	**The NWMO publishes the finalized siting process, having briefed provincial governments, the Government of Canada, national and provincial Aboriginal organizations, and regulatory agencies on the NWMO's activities**. The NWMO will continue briefings throughout the siting process to ensure new information is made available and requirements which might emerge are addressed.
Step 1	**The NWMO initiates the siting process with a broad program to provide information, answer questions and build awareness among Canadians about the project and siting process.** Awareness-building activities will continue throughout the full duration of the siting process.
Step 2	**Communities identify their interest in learning more, and the NWMO provides detailed briefing. An initial screening is conducted.** At the request of the community, the NWMO will evaluate the potential suitability of the community against a list of initial screening criteria.
Step 3	**For interested communities, a preliminary assessment of potential suitability is conducted.** At the request of the community, the NWMO will conduct a feasibility study collaboratively with the community to determine whether a site has the potential to meet the detailed requirements for the project. Regional engagement will be initiated, and an initial review of transportation considerations will be conducted. Interested communities will be encouraged to inform surrounding communities, including potentially affected Aboriginal communities and governments, as early as possible to facilitate their involvement.
	Phase 1: For interested communities passing the Initial Screening, a preliminary desktop assessment is conducted. Some communities may be screened out based on these assessments.
	Phase 2: Field investigations and expanded regional engagement proceed with smaller number of communities.
Step 4	**For interested communities, potentially affected surrounding communities are engaged if they have not been already, and detailed site evaluations are completed.** In this step, the NWMO will select one or more suitable sites from communities expressing formal interest for regional study and/or detailed multi-year site evaluations. The NWMO will work collaboratively with these communities to engage potentially affected surrounding communities, Aboriginal governments and the provincial government in a study of health, safety, environment, social, economic and cultural effects of the project at a broader regional level (Regional Study), including effects that may be associated with transportation. Involvement will continue throughout the siting process as decisions are made about how the project will be implemented.

Step 5	**Communities with confirmed suitable sites decide whether they are willing to accept the project and propose the terms and conditions on which they would have the project proceed.**
Step 6	**The NWMO and the community with the preferred site enter into a formal agreement to host the project.** The NWMO selects the preferred site, and the NWMO and community ratify a formal agreement.
Step 7	**Regulatory authorities review the safety of the project through an independent, formal and public process, and if all requirements are satisfied, give their approvals to proceed.** The implementation of the deep geological repository will be regulated under the *Nuclear Safety and Control Act* and its associated regulations to protect the health, safety and security of Canadians and the environment, and to respect Canada's international commitments on the peaceful use of nuclear energy. Regulatory requirements will be observed throughout all previous steps in the siting process. The documentation produced through previous steps, as well as other documentation that will be required for a licence application, will be formally reviewed by regulatory authorities at this step through an Environmental Assessment, and if this assessment is successful, then licensing hearings related to site preparation (and possible construction) of facilities associated with the project. Various aspects of transportation of used nuclear fuel will also need to be approved by regulatory authorities.
Step 8	**Construction and operation of an underground demonstration facility proceeds.**
Step 9	**Construction and operation of the facility**.

1.6 Initial Community Involvement

Communities involved in this stage of work entered the site selection process by expressing interest in learning more about Canada's plan for the long-term management of used nuclear fuel and the APM Project (Step 2) as part of an open invitation process.

With this expression of interest, the NWMO undertook an Initial Screening as part of Step 2 studies and began working with the community as they learned about the project and reflected upon their interest in it. The purpose of the Initial Screening was to determine whether, based on readily available information and five screening criteria, there were any obvious conditions that would exclude the community from further consideration in the site selection process.

For communities that successfully completed an Initial Screening and decided to enter Step 3 of the site selection process (Preliminary Assessments), the NWMO began working with the community to conduct a preliminary assessment. The purpose of Preliminary Assessments is to continue the learning and reflection process within the community, begin to involve potentially affected First Nation and Métis communities and surrounding communities in the process, and further explore the potential for the community to meet the detailed requirements for the project with more detailed scientific and technical studies.

Twenty-two communities have entered the site selection process since it began in 2010. There are nine communities involved in the site selection process (eight are in Phase 2 of Step 3; one – Central Huron – is in Phase 1 of Step 3). Figure 1-1 maps the locations of these communities in Saskatchewan and Ontario.



Figure 1-1: Communities Involved in the Site Selection Process

1.7 Approach to Preliminary Assessments

Preliminary Assessments address siting factors and criteria as described in the NWMO's document: "*Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel*" (NWMO, 2010). Preliminary Assessment studies in Step 3 of the siting process are being conducted in two phases, with the opportunity for stock-taking by both the community and the NWMO throughout. The two-phased approach to assessments is discussed in "*Preliminary Assessment of Potential Suitability – Feasibility Studies*" (NWMO, 2011).

- ***Phase 1:*** Assessments are conducted with all communities that successfully completed an Initial Screening and asked to be the focus of a Preliminary Assessment. This phase involves desktop studies to explore the potential to meet safety requirements, and includes studies of engineering, geoscientific suitability, environment and safety, and transportation. This phase also involves community-learning about the project, and engagement and reflection on the potential for the project to foster the well-being of the community and fit with its long-term vision. Working with communities, this phase also explores early indications as to whether it would be possible to sustain interest in learning through subsequent phases of work required to support informed decision-making and a compelling demonstration of willingness at a future stage. This phase begins to involve potentially affected First Nation and Métis communities and surrounding communities in a dialogue about the project that would continue in future phases. This phase of work is completed in a year or more.

- ***Phase 2:*** Assessments are conducted with a smaller number of interested communities selected by the NWMO based on the outcome of Phase 1 studies. Phase 2 work will further assess potentially suitable areas through detailed technical studies and field investigations. This phase also involves more detailed exploration of the potential to foster the well-being of the community. Learning and engagement are expanded to involve First Nation and Métis communities and surrounding communities in exploring the potential to foster the well-being of the larger area, interest in the project, and the foundation to work together in partnership to implement the project. Together, the NWMO, potentially suitable communities, First Nation and Métis communities in the vicinity, and surrounding communities will reflect upon the suitability of the community and area to host the APM Project. Phase 2 Preliminary Assessments are expected to require a number of years complete.

The NWMO has adopted an integrated approach to Preliminary Assessments, with assessments focused on safety and community well-being through study of many technical, scientific, and social requirements for the project.

In assessing the siting factors and criteria, four overarching research questions have guided this early phase of Preliminary Assessment, and have been a focus of reflection by both the NWMO and the community. These questions are discussed in more detail in "*Preliminary Assessment of Potential Suitability – Feasibility Studies*" (NWMO, 2011).

1. Safety, security and protection of people and the environment are central to the siting process. ***Is there potential to find a safe site?***

   Safety was examined through several perspectives:
   - **Potential to find a site with suitable geology.**
   - **Potential to safely construct the facility at the potential site.**
   - **Potential for safe and secure transportation to the potential site.**
   - **Potential to manage any environmental effects and to ensure safety of people and the environment.**

2. The project will be implemented in a way that will foster long-term well-being of the community. ***Is there potential to foster the well-being of the community through the implementation of the project, and what might need to be put in place (e.g., infrastructure, resources, planning initiatives) to ensure this outcome?***

3. At a later step in the process, the community must demonstrate it is informed and willing to host the project. ***Is there potential for citizens in the community to continue to be interested in exploring this project through subsequent steps in the site selection process?***

4. The project will be implemented in a way that will foster the long-term well-being of the surrounding area. ***Is there potential to foster the well-being of the surrounding area and to establish the foundation to move forward with the project?***

These broad questions were addressed through a series of studies as outlined in Figure 1-2.

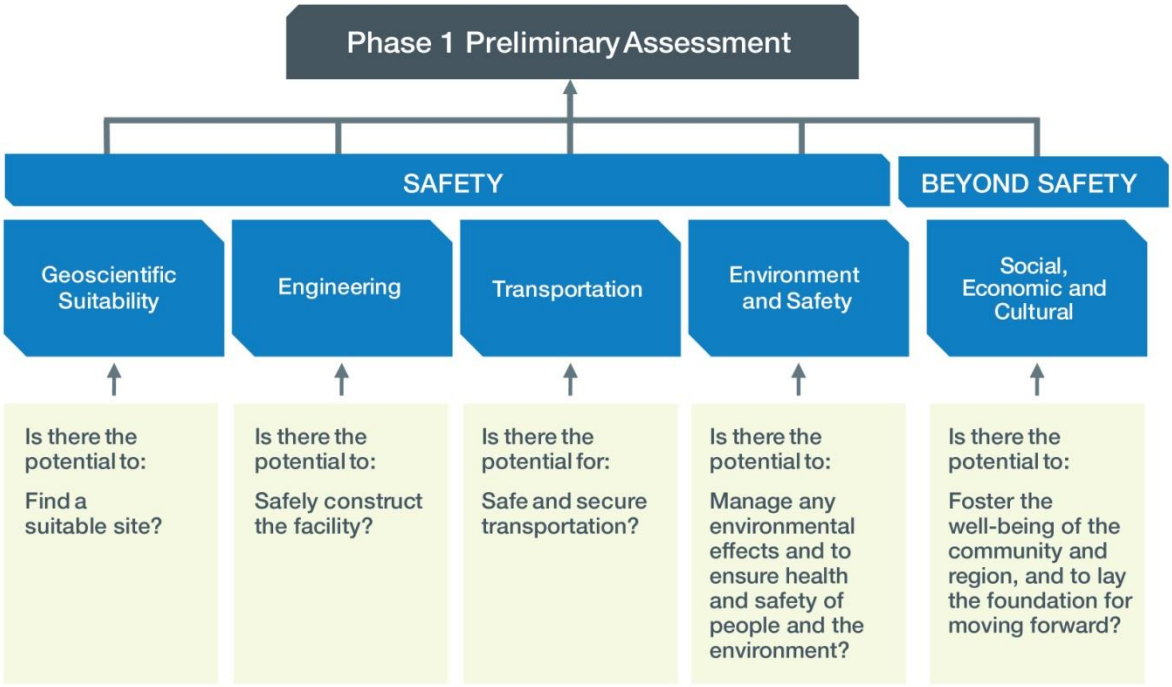


Figure 1-2: The Phase 1 Preliminary Assessment Studies

In Phase 1, studies have involved a range of activities. Some activities have been completed by expert consultants, such as the assessment of the geological characteristics of the area, which is one of several studies focused on assessing the potential to find a safe site. Other activities were completed in partnership with the community; for instance, exploring the potential for the project to be implemented in a way that contributes to the long-term well-being of the community. Throughout, the NWMO has worked with community leaders to engage residents, and begin to reach out to potentially affected First Nation and Métis communities and surrounding communities, and others in the area to involve them in the work. In Phase 2, these studies will be expanded through commencement of fieldwork and broadened engagement with communities progressing to Phase 2.

As discussed in the NWMO site selection process, the suitability of potential sites is assessed against a number of site evaluation factors, organized under six safety functions a site would need to satisfy to be considered suitable (NWMO, 2010). Phase 1 safety assessment studies initiated exploration of a subset of these factors using a desktop study approach. Phase 2 assessments could include field studies and borehole investigations, which will allow for a broadening of the assessment to more comprehensively address the evaluation factors. The six safety evaluation factors are as follows:

- ***Safe containment and isolation of used nuclear fuel:*** Are the characteristics of the rock at the site appropriate to ensuring the long-term containment and isolation of used nuclear fuel from humans, the environment and surface disturbances caused by human activities and natural events?

- ***Long-term resilience to future geological processes and climate change:*** Is the rock formation at the siting area geologically stable and likely to remain stable over the very long term in a manner that will ensure the repository will not be substantially affected by geological and climate change processes such as earthquakes and glacial cycles?

- ***Safe construction, operation and closure of the repository:*** Are conditions at the site suitable for the safe construction, operation and closure of the repository?

- ***Isolation of used fuel from future human activities:*** Is human intrusion at the site unlikely, for instance through future exploration or mining?

- ***Amenable to site characterization and data interpretation activities:*** Can the geologic conditions at the site be practically studied and described on dimensions that are important for demonstrating long-term safety?

- ***Safe transportation:*** Does the site have a route that exists or is amenable to being created that enables the safe and secure transportation of used fuel from storage sites to the repository site?

A number of factors beyond safety were identified for assessment of the potential for the project to foster the well-being of the interested community (NWMO, 2010). Phase 1 community well-being studies were focused on each community that expressed interest in learning about the project. For this reason, the studies addressed the subset of factors pertaining to the community. Phase 2 studies are designed to expand the assessment to consider factors related to the surrounding area, including potentially affected First Nation and Métis communities, and surrounding communities. The factors beyond safety are as follows:

- **Potential social, economic and cultural effects during the implementation phase of the project, including factors identified by Aboriginal Traditional Knowledge.**

- **Potential for enhancement of the community's and the region's long-term sustainability through implementation of the project, including factors identified by Aboriginal Traditional Knowledge.**

- **Potential to avoid ecologically sensitive areas and locally significant features, including factors identified by Aboriginal Traditional Knowledge.**

- **Potential for physical and social infrastructure to adapt to changes resulting from the project.**

- **Potential to avoid or minimize effects of the transportation of used nuclear fuel from existing storage facilities to the repository site.**

To ensure a broad, inclusive, and holistic approach to assessment in these areas, a community well-being framework was identified to help understand and assess the potential effects of the APM Project. This framework was used to help explore the project, understand how the community and the surrounding area may be affected should the project be implemented in the community, and identify opportunities to leverage the project to achieve other objectives important to people in the community and surrounding areas.

1.8 Next Steps

The objective of the site selection process, through several phases of progressively more detailed assessment, is to arrive at a single location for the deep geological repository and Centre of Expertise. It will take several more years of detailed technical, scientific and social study and assessments, and more engagement with interested communities, potentially affected First Nation and Métis communities, and their neighbours, before a preferred safe site for the project can be confirmed.

With nine communities continuing to explore potential interest and suitability for hosting the project, the siting process must provide a basis to progressively narrow the focus to communities with strong potential to meet requirements until a single preferred site and area is identified. These decisions will be supported by a sequence of assessments and engagement designed to enable the NWMO and communities to learn more about the potential suitability of each area and decide whether to proceed to the next stage.

The process of narrowing down the communities engaged in site selection commenced in Fall 2013 and will continue gradually over several years as more technical and social assessments are completed.

- In November 2013, the NWMO implemented an initial phase of narrowing down based on the results of Phase 1 Preliminary Assessments for an initial group of eight communities (English River First Nation, Pinehouse, Creighton, Ear Falls, Ignace, Schreiber, Hornepayne, and Wawa). Four of these communities with strong overall potential to meet the site selection requirements were identified as warranting further study through Phase 2 assessments. These communities are Creighton, Ignace, Schreiber, and Hornepayne.

- In January 2014, the NWMO concluded siting studies in the Municipality of Arran-Elderslie and the Town of Saugeen Shores. Early findings indicated the Town of Saugeen Shores has very limited potential to contain areas that would meet the geoscientific site evaluation factors outlined in the site selection process document. Similarly, the Municipality of Arran-Elderslie does not contain sufficient land areas that have the potential to meet these factors (Geofirma, 2014; NWMO, 2014a).

- In June 2014, the Council of the Township of Nipigon passed a Resolution to discontinue its involvement as a potential host community for Canada's plan for the safe, long-term management of used nuclear fuel. The decision followed review of an interim report (NWMO, 2014b; DPRA, 2014; Golder, 2014), which the NWMO prepared at the request of the Township to report on preliminary assessment work completed in the community so far.

- In December 2014, the NWMO further narrowed down the remaining interested communities based on the results of Phase 1 Preliminary Assessments for the three communities located in Bruce County (Brockton, Huron-Kinloss, and South Bruce). Two of these communities with strong potential to meet the site selection requirements were identified as warranting further study through Phase 2 assessments. These communities are Huron-Kinloss and South Bruce.

- In January 2015, the NWMO completed the first phase of preliminary assessment for the six communities that remained in Phase 1 in northern Ontario (Blind River, Elliot Lake, Manitouwadge, Spanish, The North Shore, and White River). The City of Elliot Lake, Town of Blind River, and Townships of Manitouwadge and White River were assessed as having strong potential to meet site selection requirements and were identified as warranting further study through Phase 2 assessments.

- Phase 2 Preliminary Assessment studies were initiated with the smaller number of communities with strong potential to host the APM Project, and are expected to take a number of years to complete. Over this period, field studies will be conducted, and engagement will be broadened. Building on earlier studies, Phase 2 studies include preliminary geoscientific- and environment-focused field investigations, more detailed social and economic studies, awareness building, and deepening learning and reflection by the interested community, and broadening of engagement to involve potentially affected First Nation and Métis communities and surrounding communities in learning and assessment of the suitability of the area.

- In February 2015, the NWMO concluded work in two communities based on initial geoscience evaluations conducted as part of Phase 2 Preliminary Assessment studies. Initial Phase 2 geological field work in the vicinity of Creighton, Saskatchewan and Schreiber, Ontario revealed that areas assessed near both communities have geological complexities that reduce the likelihood of finding a suitable site for either area to safely host a used nuclear fuel repository (Geofirma, 2015; Golder 2015; NWMO 2015a, 2015b).

- By the end of the second phase of study, one or possibly two communities with strong potential to meet requirements to host the facility will be the focus of Step 4, Detailed Site Characterization. This step will include extensive studies to assess and confirm safety, and may require a number of years to complete. Findings will support identification of the preferred location that will be the focus of a regulatory approvals process led by the Canadian Nuclear Safety Commission (CNSC).

1.9 Moving Forward in Partnership

Each community engaging in Phase 1 Preliminary Assessments has helped initiate the process of relationship building that is needed to support the implementation of APM. The NWMO has learned a great deal from communities over the course of these initial studies about working together to envision the project and how best to implement the project with those potentially affected.

Through work with interested communities, and initial outreach to potentially affected First Nation and Métis communities, and surrounding communities, the NWMO is learning about the nature and shape of partnerships that will be required to implement the APM Project together. Involving surrounding communities and First Nation and Métis communities in the vicinity in learning and decision-making will be an important focus of activity of Phase 2 work with communities that proceed in the siting process. The implementation of Canada's plan will only proceed with the involvement of the interested community, potentially affected First Nation and Métis communities, and other communities in the surrounding area working in partnership to implement the project.

As Canada continues along the path of implementing APM, it will take our best knowledge and expertise, the continued leadership of communities, and all of us working together to ensure the safe long-term management of Canada's used nuclear fuel.

1.10 Organization of Report

Findings from the Phase 1 for the Municipality of Central Huron are outlined in the chapters of this report. The chapters are based on a series of supporting technical documents, each of which is identified in the relevant chapter.

Report Overview

- ***Chapter 2*** – Brief introduction to the community.
- ***Chapter 3*** – Preliminary assessment of Engineering, which explores the potential to safely construct the facility at the potential site.
- ***Chapter 4*** – Geoscientific preliminary assessment, which explores the potential to find a suitable site within the community.
- ***Chapter 5*** – Preliminary Environment and Safety assessment, which explores the potential to manage any environmental effects and to ensure safety of people and the environment.
- ***Chapter 6*** – Preliminary assessment of Transportation, which explores the potential for safe and secure transportation to the potential site.
- ***Chapter 7*** – Preliminary Social, Economic and Cultural assessment, which explores the potential to foster the well-being of the community and surrounding area, and potential to create the foundation for community and area confidence and support needed to implement the project.
- ***Chapter 8*** – Taking into account the assessment in each of the major fields of investigation, this chapter concludes with reflections on potential suitability of the community and area and a discussion of the work that would be required if a decision were made to proceed to further studies.

2. INTRODUCTION TO THE MUNICIPALITY OF CENTRAL HURON

The Municipality of Central Huron is located in southwestern Ontario in the central area of Huron County. The Municipality was formed on January 1, 2001 when the Town of Clinton, Township of Hullett, and Township of Goderich were amalgamated. Central Huron is located on the east shore of Lake Huron. Figure 2-1 shows Central Huron in its regional context.

According to the 2011 Census data, the total population of the Municipality is 7,951. Central Huron includes agricultural areas, interspersed with rural and recreational settlements and a number of natural areas. Settlement areas include Auburn, Blue Water Beach, Clinton, Harlock, Holmesville, Kinburn, Londesborough, Porter's Hill, and Summerhill.

There are a number of First Nations and Métis communities in the vicinity of Central Huron including the Chippewas of Kettle and Stony Point, Aamjiwnaang, Walpole Island, Six Nations, and the Saugeen Ojibway Nations. The Georgian Bay Council of the Métis Nation of Ontario is in the vicinity. The Historic Saugeen Métis are also located in the vicinity.

A more in-depth discussion of Central Huron and the surrounding area is contained in the Community Profile (AECOM, 2015) and is woven throughout the chapters of this report, including the geoscientific characteristics of the Central Huron area, the natural environment, transportation infrastructure, and the people and activities that contribute to the well-being of the community.



Figure 2-1: Central Huron and Surrounding Lands

Safety: Potential to Find a Site That Will Protect People and the Environment Now and in the Future

Any site that is selected to host the Adaptive Phased Management (APM) Project must be demonstrated to be able to safely contain and isolate used nuclear fuel for a very long period of time. The preferred site will need to address scientific and technical siting factors that acknowledge precaution and ensure protection for present and future generations.

A fundamental component of APM is the long-term containment and isolation of used nuclear fuel in a deep geological repository. The ability of the deep geological repository to safely contain and isolate used nuclear fuel relies on the form and properties of the waste, the human-made or engineered barriers placed around the waste, and the natural barriers provided by the host rock formation in which the repository will be located.

Transportation is an important consideration in the assessment of the safety of any site. In order for a site to be considered technically safe, a transportation route must be identified, or be capable of development, by which used nuclear fuel can safely and securely be transported to the site from the locations at which it is currently stored. Physical security aspects of the project and site, and potential to meet Canadian Nuclear Safety Commission (CNSC) requirements, are also important and will be assessed at a later phase of study.

The potential to find a safe site is examined from four perspectives. In each, a strong potential must be demonstrated to meet or exceed the regulatory expectations of the CNSC, the guidance of the International Atomic Energy Agency (IAEA), and evolving international best practice. The four perspectives are:

Engineering – Is there the potential to safely construct the facility in the area?
Geoscientific suitability – Is there the potential to find a site in the area with suitable geoscientific characteristics?
Environment and safety – Is there the potential to manage any environmental effects and to ensure health and safety of people and the environment in the area?
Transportation – Is there the potential for safe and secure transportation from interim storage facilities to a site located in the area?

In Central Huron, Preliminary Assessments at this phase of work focus on the potential to find broad siting areas within the Municipality that meet engineering, geoscientific, environment and safety, and transportation requirements at a high level. Should the community be selected to proceed to Phase 2, the next phase of work will involve identification of specific locations for more detailed studies. These safety-related studies, particularly those related to understanding geoscientific suitability and environmental effects, would be conducted collaboratively with the community, potentially affected First Nation and Métis communities, and surrounding communities.

Throughout this work, the NWMO will look to First Nation and Métis communities in the vicinity as practitioners of Traditional Knowledge to help, to the extent they wish, to guide the decisions involved in site selection and to ensure the factors and approaches used to assess the site appropriately interweave Traditional Knowledge.

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3. PRELIMINARY ASSESSMENT OF ENGINEERING

3.1 Engineering Assessment Approach

The objective of the engineering preliminary assessment is to assess the potential to safely construct and operate the Adaptive Phased Management (APM) facility in the Municipality of Central Huron. The chapter also identifies infrastructure that would be required to safely construct and operate the facility in Central Huron. This chapter presents a brief description of the facilities to be constructed and the characteristics of used fuel, identifies additional infrastructure requirements for the project in this community, and concludes with a community-specific estimate of cost. The findings of the preliminary assessment to determine the engineering feasibility to safely construct the facility in Central Huron are presented at the end of this chapter.

3.2 Characteristics of the Material to Be Managed: Used Nuclear Fuel

For decades, Canadians have been using electricity generated by nuclear power reactors in Ontario, Quebec, and New Brunswick. When used nuclear fuel is removed from a reactor, it is considered a waste product, is radioactive, and requires careful management. Although its radioactivity decreases with time, chemical toxicity persists and the used fuel will remain a potential health risk for many hundreds of thousands of years. For this reason, used fuel requires careful management essentially indefinitely.

The nuclear fuel in Canadian (CANDU) reactors is natural uranium dioxide (UO_2), which is pressed into ceramic pellets and placed inside a fuel element or sheath made of a zirconium-tin alloy. The most common type of fuel bundle contains 37 fuel elements that are welded to end plates to form a bundle.

Each fuel bundle has a length of about 500 millimetres, a diameter of about 100 millimetres, and a mass of about 24 kilograms. Other types of CANDU fuel bundles have similar dimensions and mass, but differ in the number or configuration of the fuel elements. The reference design for a deep geological repository assumes an average out-of-reactor cooling period of 30 years, which results in a thermal output of 3.5 watts per bundle.

A standard CANDU fuel bundle is illustrated in Figure 3-1.



Figure 3-1: CANDU Fuel Bundle

To date, Canada has produced over 2.5 million used fuel bundles. If Canada's existing reactors operate to the end of their planned lives, including planned refurbishments, the inventory that will need to be managed in the APM facility could be four million bundles or more, depending on future operating experience. The NWMO reviews projected used fuel inventories annually, and has assumed a reference used fuel inventory of 4.6 million used CANDU fuel bundles (Garamszeghy, 2013).

The repository will need to be large enough to contain and isolate the volume of used fuel from existing plants in Canada. The specific amount of used fuel to be placed in the repository will be agreed with the community using the best information available at the time, and an open and transparent consultation process involving surrounding communities and others who are interested and potentially affected. Regulatory review processes and approvals, which are required by law before the project can proceed, will be based on a specific fuel inventory and will involve an open and transparent consultation process.

3.3 Conceptual Description of the APM Facility

Conceptual reference designs have been developed by the NWMO as a basis for planning and costing. Some aspects of the reference design may be refined through discussions with potential host communities and those in the surrounding area to ensure that it better addresses their values, needs, and preferences, while still maintaining its primary safety functions. Some aspects of the reference design will also be refined through technology development and demonstration programs conducted in Canada and internationally. Other aspects of the design can only be confirmed once a potential site has been identified and site-specific technical and scientific studies have been completed. Canada's plan, called Adaptive Phased Management, is designed to be implemented collaboratively with an informed and willing host community.

The reference design of the APM facility is a complex with a combination of surface and underground structures designed to provide multiple engineered and natural barriers to safely contain and isolate Canada's used nuclear fuel over the long term. The APM facility will require a dedicated surface area of nominally 600 metres by 550 metres for the main surface buildings and about 100 metres by 100 metres for the ventilation shaft area, which can vary with actual site characteristics. In addition, the APM facility will need an excavated rock management area of about 700 metres by 700 metres for the rock excavated from the underground repository; its location would be determined in collaboration with the community.

An illustration of the conceptual APM facility is shown in Figure 3-2.

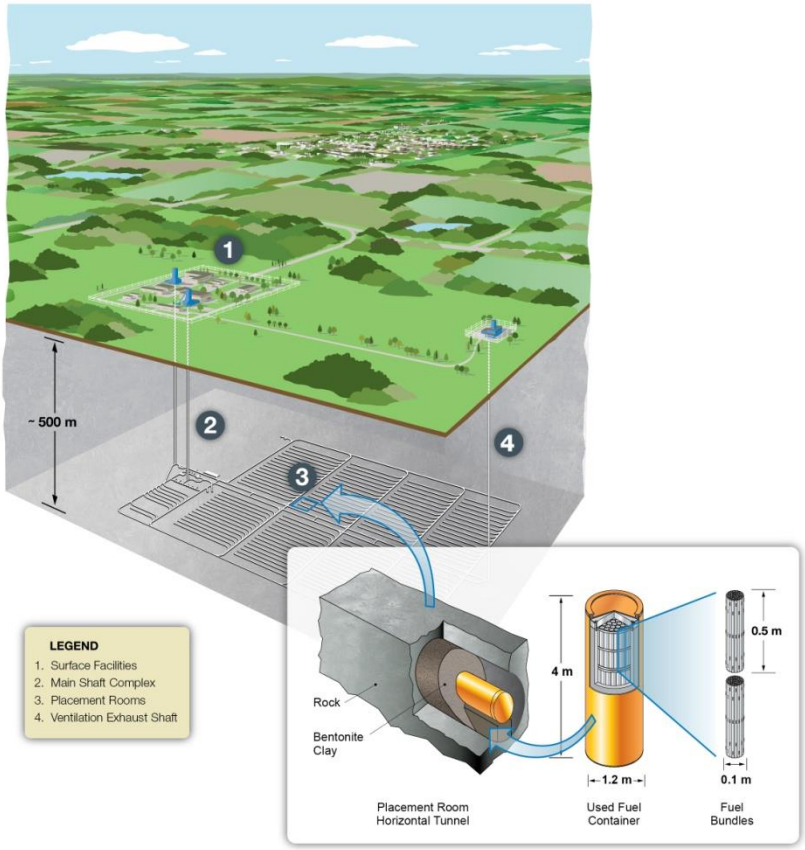


Figure 3-2: Illustration of an APM Facility

The underground footprint of the repository will depend on a number of factors, including the particular characteristics of the rock at the preferred site, the final design of the repository, and the inventory of used fuel to be managed.

The layout of the underground repository has been developed for a projected reference inventory of 4.6 million used CANDU fuel bundles. It would require a subsurface area of about two kilometres by three kilometres at a depth of approximately 500 to 1000 metres or more within a suitably thick and competent rock formation such as the Ordovician Cobourg Formation (limestone). The exact depth and layout will depend on the characteristics of the chosen site.

3.4 APM Surface Facilities

The used nuclear fuel will be transported from the licensed interim storage facilities at the reactor sites to the APM facility in transportation packages certified for road, rail, and ship (CNSC, 2013). The packages will be received at the Used Fuel Packaging Plant, where the used fuel bundles will be transferred into corrosion-resistant used fuel containers. The used fuel containers will be filled, sealed, inspected, and dispatched for placement in the underground repository.

The APM surface facilities consist of a Nuclear Security Protected Area for all buildings and activities associated with the receiving, handling, and storage of used nuclear fuel, and a

Balance of Site for the remaining buildings and activities. The Nuclear Security Protected Area includes the Used Fuel Packaging Plant, the shaft buildings, auxiliary building, quality control offices, laboratory, active waste handling facilities, switch yard, and transformer area.

The Balance of Site includes the administration building, fire hall, security monitoring room, cafeteria, warehouse, water and sewage treatment plants, fuel storage tanks, water storage tanks, air compressor building, concrete batch plant, and sealing materials compaction plant. An excavated rock management area for the excavated rock from the underground repository would also be required; its location would be determined in collaboration with the community.

The principal APM surface facilities are illustrated in Figure 3-3. The key structures in the APM surface facilities are described below.

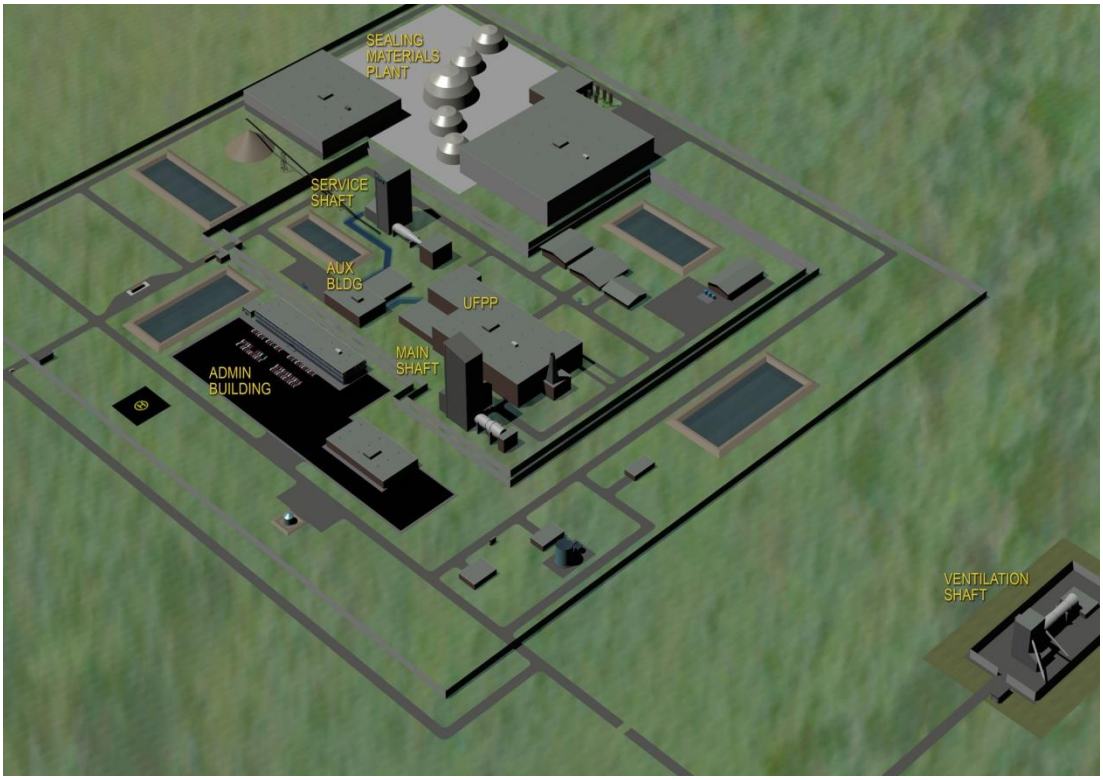


Figure 3-3: APM Surface Facilities

3.4.1 Used Fuel Container

The used fuel container is one of the principal engineered barriers in the multi-barrier deep geological repository concept. The key features of the design of the used fuel container are corrosion resistance, mechanical strength, geometry, capacity, and compatibility with surrounding sealing materials such as bentonite clay.

The reference design of the used fuel container employs an outer corrosion-resistant material, and an inner supporting material. The container is designed for a load of 45 megapascals, which will withstand the combined mechanical and hydraulic pressures in a repository, including

glacial events with up to three kilometres of ice combined with lithostatic loads at 500 metres* depth, and the swelling pressure of the bentonite buffer seal surrounding the container. The NWMO is examining several used fuel container designs for the deep geological repository and will further study, test, and refine these designs over time.

The deep geological repository will require thousands of used fuel containers over the operating period. The used fuel containers and supporting components will be manufactured and assembled at the Container Manufacturing Plant, which could potentially be located in the community or surrounding region. For each year of operation, hundreds of used fuel containers will need to be manufactured and shipped to the repository site.

An example of a design for a used fuel container is illustrated in Figure 3-4. It employs an outer corrosion-resistant shell and an inner vessel for strength. This reference container holds 360 used fuel bundles distributed in six layers of 60 bundles per layer in three steel baskets (with two bundle layers per basket). Other configurations with differing numbers of bundles are also possible. The final design will affect the number of containers required.

For a reference used fuel inventory of 4.6 million bundles, a total of 12,800 of these used fuel containers would be placed in the repository. At a placement rate of 333 containers per year (i.e., one to two containers per working day), the used fuel containers would be placed underground over a 38-year operating period.

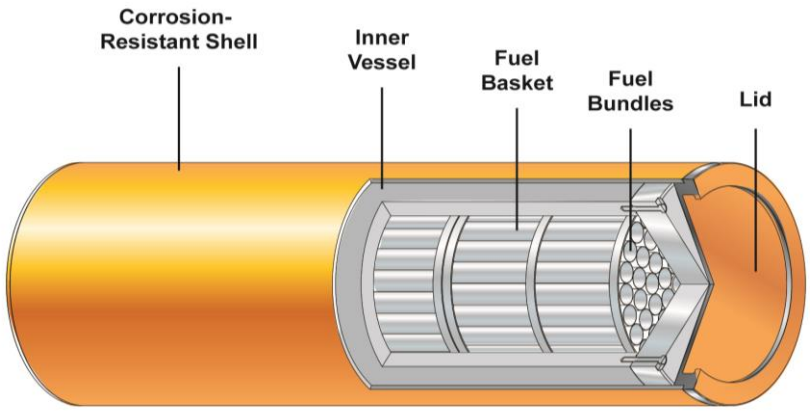


Figure 3-4: Example of a Used Fuel Container for a Deep Geological Repository

3.4.2 Used Fuel Packaging Plant

The Used Fuel Packaging Plant is an important facility for transferring Canada's used nuclear fuel from interim storage to a deep geological repository. The Used Fuel Packaging Plant encompasses all necessary areas and equipment for receiving used fuel transported from the interim storage sites to the repository, receiving empty containers, loading used fuel into the containers, and sealing, inspecting, and dispatching filled containers for underground transfer and placement in the deep repository. There are also provisions for cutting open and emptying

* Design basis for the reference used fuel container is 800 metres depth

any used fuel containers that do not fulfill specified requirements following non-destructive testing and examination.

To ensure reliable delivery of used fuel containers to the deep geological repository, the plant includes storage areas for used fuel, empty containers, and filled containers. Used nuclear fuel will be packaged and placed in the repository as it is received; thus it is expected there will be only minimal storage of used fuel in the Used Fuel Packaging Plant for a short duration of time.

A conceptual layout of the Used Fuel Packaging Plant is illustrated in Figure 3-5.

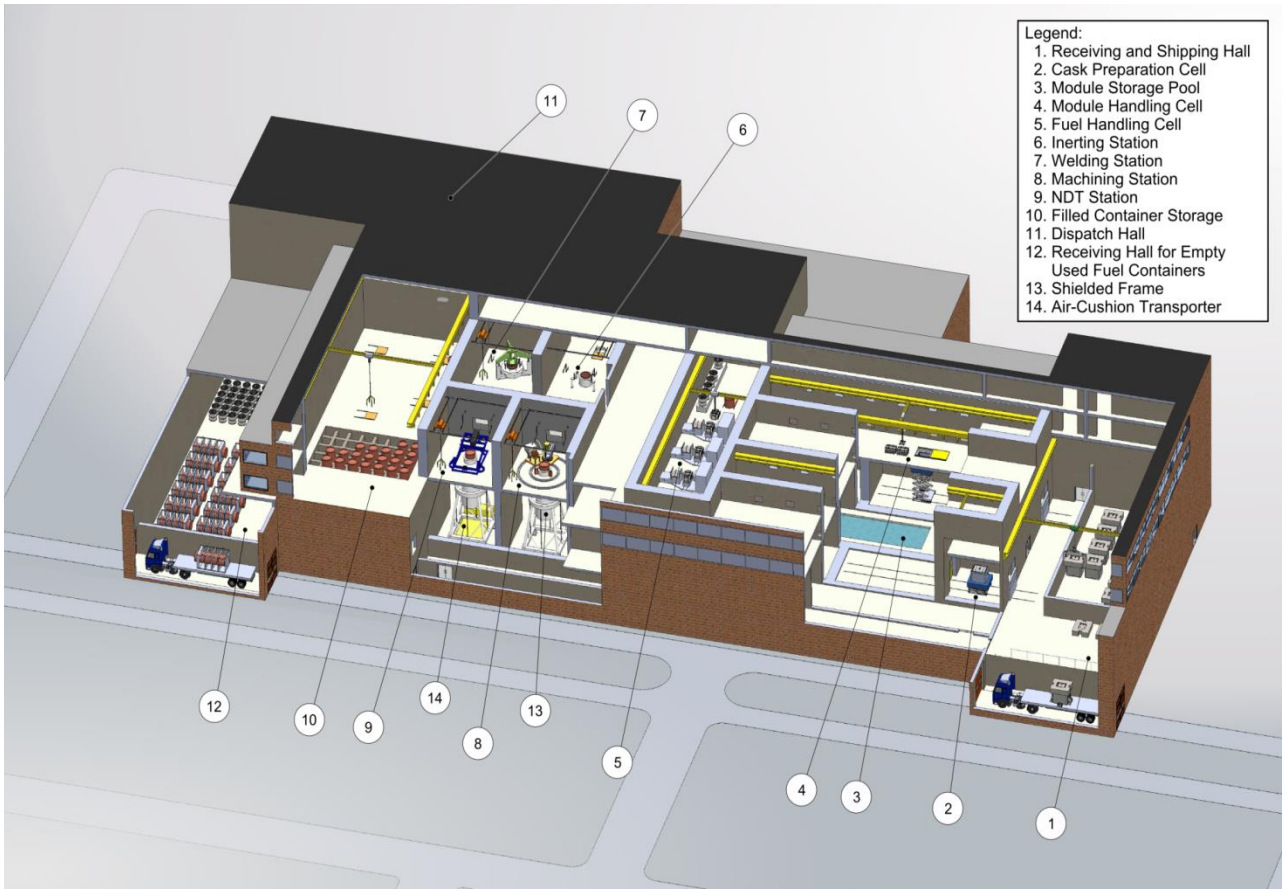


Figure 3-5: Conceptual Layout of a Used Fuel Packaging Plant

3.4.3 Sealing Materials Production Plants

Sealing Material Production Plants provide materials for the clay-based and cement-based engineered barriers in the repository that backfill and seal excavation openings, and inhibit groundwater movement, microbial activity, and radionuclide transport in the region surrounding the used fuel containers.

The sealing materials prepared at the production plants include materials such as:

- Highly compacted bentonite blocks;
- Dense backfill composed of bentonite and aggregate;

- Light backfill composed of bentonite and sand;
- Gapfill composed of bentonite pellets;
- Shaft seal composed of bentonite and sand; and
- Low-heat high-performance concrete.

Crushed rock and sand for the backfill and concrete will be imported to the site and stockpiled for use in the compaction plant where presses will be used to prepare dense backfill blocks and gapfill material (Figure 3-6). Aggregate will be brought to site for use in the Concrete Batch Plant.



Figure 3-6: Example of a Large Press for the Sealing Materials Compaction Plant

3.4.4 Shafts and Hoists

The conceptual reference design for the APM Project includes three shafts to facilitate the transfer of rock, material, equipment and people between the surface facilities and the underground repository. The three shafts are:

- Main Shaft: Conveys the used fuel containers within a shielded transfer cask;
- Service Shaft: Conveys personnel, equipment, waste rock and sealing materials; and
- Ventilation Shaft: Will handle the majority of the repository exhaust to the surface and will be equipped as an emergency egress hoist.

The headframes of the three shafts will be durable and easily maintainable structures that provide a high level of protection against weather-related disturbances. All shafts will be concrete-lined as needed to minimize the inflow of water and to provide a durable, easy-to-maintain surface.

During closure, the shafts will be sealed, and all headframes and peripheral equipment will be removed.

3.5 Underground Facilities

The deep geological repository is a network of underground tunnels and placement rooms for used fuel containers, supporting infrastructure, and provision for an underground facility for site-specific demonstration of repository technology.

The repository is expected to be constructed at a single elevation at a depth of about 500 to 1000 metres or more below ground surface. The exact depth will be determined as part of the detailed site characterization and final design. Excavation of rock is done with controlled drill and blast or with the use of rock boring technology.

An example design and layout of a repository based on the in-room placement of used fuel containers is illustrated in Figure 3-7. This approach for container placement is consistent with reference repository design developed by the national radioactive waste management organization in Switzerland (NAGRA). Each placement room is designed to be 2.5 metres in diameter with a length of about 425 metres and a centre-to-centre room spacing of 20 metres. Within a placement room, the used fuel containers have a centre-to-centre spacing of eight metres.

Each used fuel container is placed onto a pedestal that is made from highly compacted bentonite. The placement room around the used fuel container is filled with bentonite pellets. Each group of placement rooms, or a “placement panel,” would require about three to four years to develop and would be excavated in parallel with container placement operations in a previously completed panel in another area of the repository.

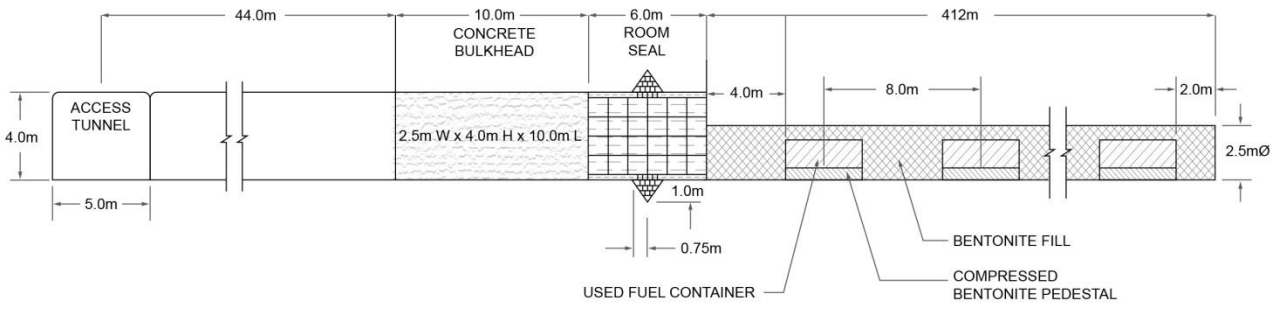


Figure 3-7: Horizontal In-room Placement of Used Fuel Containers

The placement room spacing and used fuel container spacing are conservatively designed to ensure the repository meets thermal-mechanical design requirements.

The repository layout is expected to have a rectangular configuration with two central access tunnels and two perimeter tunnels connected by perpendicular tunnels that provide access to the used fuel container placement rooms. The placement rooms are grouped in panels, as illustrated in Figure 3-8. The exact arrangement of the panels will depend on the site (e.g., to avoid any potential fractures in the rock mass).

After used fuel container placement, a six-metre-thick bentonite seal and a 10-metre-thick concrete bulkhead will be used to seal the entrance to the placement rooms. Monitoring equipment will be installed to confirm the performance of the repository system.

The repository design includes provision for an underground demonstration facility (UDF) located near the main shaft and service shaft area. The purpose of the underground demonstration facility is to support site-specific verification of geological conditions, verification of repository technology and procedures, and long-term studies or monitoring of engineered barrier materials or processes.

An example underground layout for a deep geological repository is illustrated in Figure 3-8.

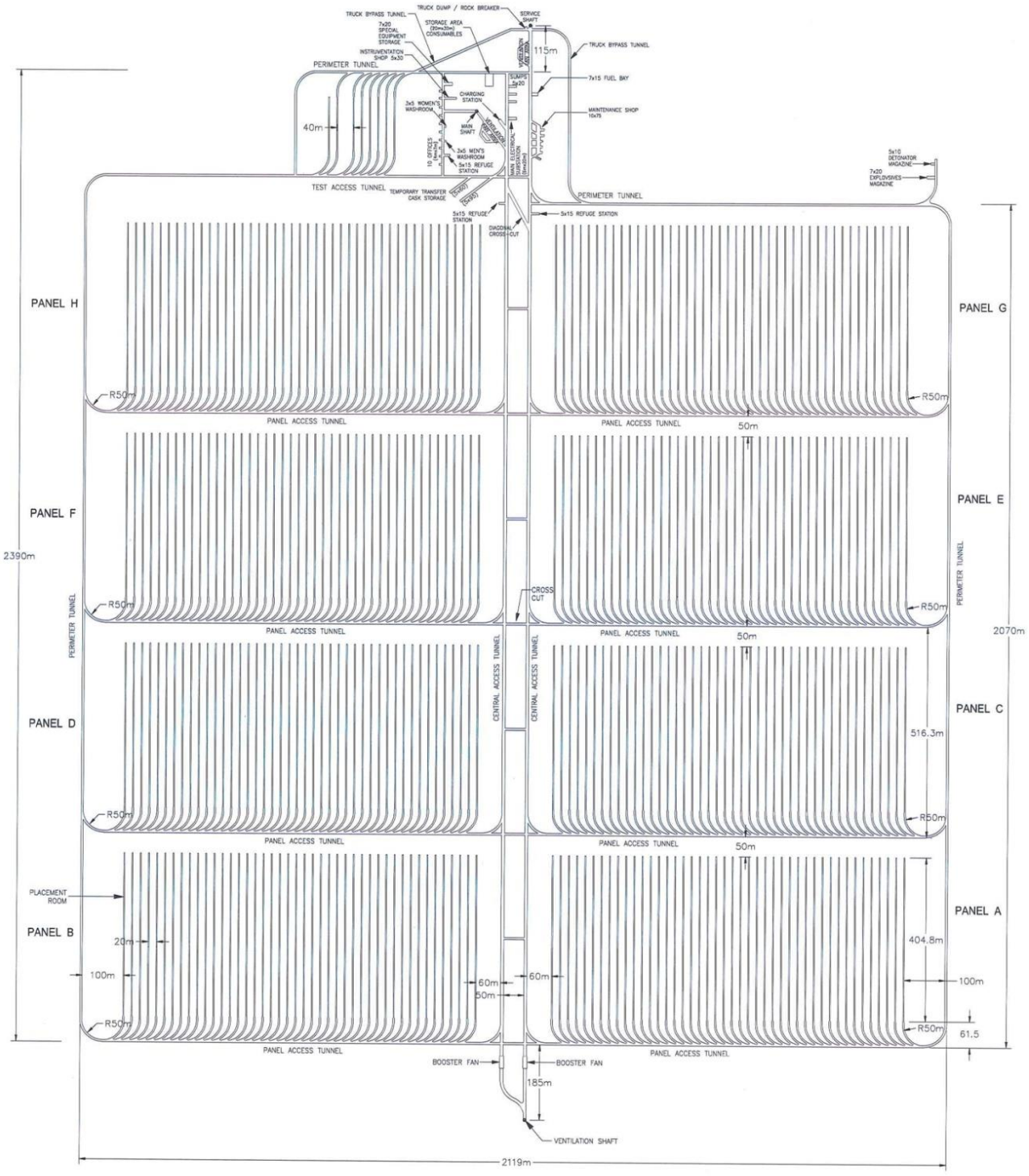


Figure 3-8: Example of an Underground Layout for a Deep Geological Repository

3.6 Centre of Expertise

A Centre of Expertise will be established for the one or more communities in which a site has been selected for detailed evaluation (Step 4 of the siting process). The centre will be located in or near the community, as determined with the community. Its purpose will be to support the multi-year testing and assessment of the site on technical safety and community well-being-related dimensions, which are key components of the site selection process. It will be the home for an active technical and social research and technology demonstration program during this period, involving scientists and other experts in a wide variety of disciplines, including geoscience, engineering, and environmental, socioeconomic, and cultural impact assessment. The technologies and monitoring processes involved in the operation of a deep geological repository may be of interest and have applications in the community beyond the deep geological repository. This will be explored with the community. The design details of the Centre of Expertise would be developed with the community, potentially affected First Nation and Métis communities, and surrounding communities, with their preferences in mind. Discussion of the design details is also an important opportunity for involvement of youth. The Centre of Expertise could also be designed as a focus for engaging members of the community to learn more about the project, and to view the scientific and engineering work-in-progress involved in site assessment, through public viewing galleries and interactive displays. The centre could be created as a small science centre, highlighting and demonstrating the science and technology being used to determine whether the site is suitable. It may be developed as a meeting place and learning centre for the community, and as a destination that welcomes interested visitors from the region and beyond.

Should the site ultimately be selected to host the deep geological repository, the Centre of Expertise would be expanded to include and support construction and operation of an underground facility designed to confirm the characteristics of the site. The centre would become a hub for knowledge sharing across Canada and internationally.

As with some other aspects of the project, the exterior design of facilities, and the way they are incorporated into the landscape of the area, will be a subject of discussion and shared planning with those living in the area.

3.7 Engineering Feasibility in the Central Huron Area

The Municipality of Central Huron and the surrounding region is underlain by a thick sequence of sedimentary rock (see Chapter 4). The surface land is characterized as flat-lying, which is amenable for the construction of an APM facility. The Municipality of Central Huron contains existing infrastructure that could be used for the APM Project, including highways and high-voltage transmission lines. The closest rail line runs through the Municipality in proximity to Highway 8 from Clinton to Goderich, and provides opportunities to develop intermodal transfer points. Goods and materials would be transferred from rail to truck, and then travel by road to the repository site located in Central Huron.

To implement the APM Project at a particular site in the Municipality of Central Huron, it is anticipated the following infrastructure would be needed:

- Main APM surface facilities including:
  - Used Fuel Packaging Plant
  - Main Shaft, Service Shaft and Ventilation Shaft Complexes
  - Sealing Materials Production Plants
  - Administration Building, Fire Hall, and Cafeteria
  - Quality Control Offices and Laboratory
  - Water Treatment Plant
  - Sewage Treatment Plant
  - Storage Areas and Commons Services
  - Stormwater run-off ponds
- Upgrade a few tens of kilometres of highway to provide access to the APM facility;
- A few tens of kilometres of high-voltage transmission line to supply up to 32 megawatts of electricity;
- A few kilometres of water pipe to supply up to 200 cubic metres of water per day from a surface water body (alternatively, source could be nearby drilled water wells);
- A Centre of Expertise;
- Provision for accommodation for temporary workers for the limited period of construction; and
- An excavation rock management area within a few tens of kilometres of the APM facility.

As well, there are opportunities for a number of components associated with the APM repository to potentially be developed locally to improve the well-being of the community or surrounding region. These include a Container Development Laboratory and a Container Manufacturing Plant, as well as infrastructure associated with the transportation of used fuel from the interim storage locations to the site of the APM facility.

The development of this infrastructure has been assumed in the APM repository design and cost estimate included for financial planning purposes.

3.8 Engineering Costs for Central Huron

The APM facility is a large national infrastructure project funded by the waste owners. A cost estimate for a deep geological repository and a used fuel transportation system has been developed for a reference inventory of 4.6 million used fuel bundles (see Section 3.2).

The estimated cost for the APM facility in the Municipality of Central Huron – that is the deep geological repository and surface handling facilities, as well as the Centre of Expertise – is assumed to be bounded by the $20.1 billion (2010 $) cost estimate for an APM facility developed in crystalline rock. (The transportation costs from the interim storage facilities at the reactor sites to the central APM facility in Central Huron have been calculated separately and are discussed in Chapter 6.) This cost estimate includes site selection and approval, construction, operation, extended monitoring, decommissioning, and closure.

A summary of the project cost estimate for an illustrative implementation schedule is given in Table 3-1. The first year of project implementation, year Y01, is 2010. The cost estimate

includes labour, materials and equipment, fuel, utilities, taxes, fees, accommodation, communication, and other expenses.

Table 3-1: Estimated APM Facility Expenditures by Implementation Phase

Project Phase	Year	Cost 2010 $ ($ billion)
Site Selection & Approvals	Y01 – Y15	$1.5
Construction	Y16 – Y25	$3.6
Operation	Y26 – Y63	$12.0
Extended Monitoring	Y64 – Y133	$1.8
Decommissioning & Closure	Y134 – Y163	$1.2
	Total	**$20.1**

The annual cash flow for the deep geological repository is illustrated in Figure 3-9.

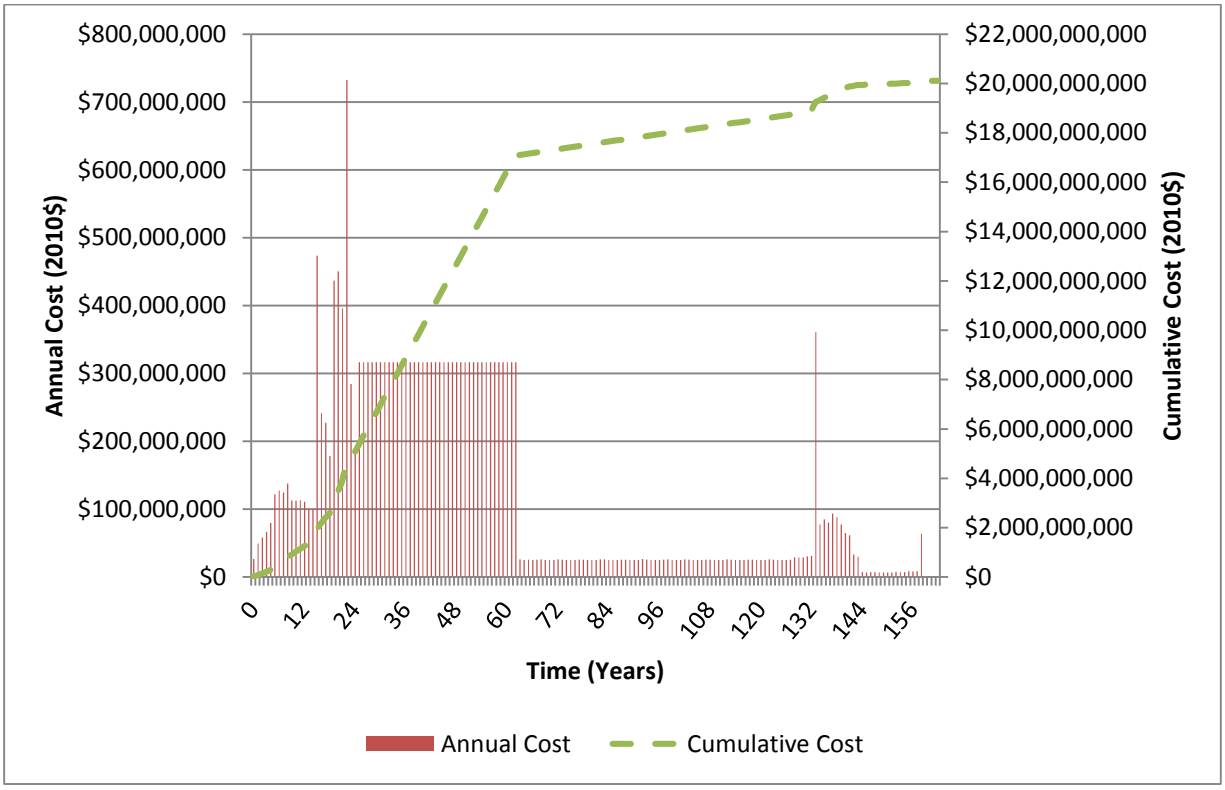


Figure 3-9: Estimated APM Facility Cash Flow

3.9 Engineering Findings

The engineering assessment of the Municipality of Central Huron found the APM facility has the potential to be safely constructed and operated. The surface land is characterized as generally flat-lying, and sufficient space exists outside protected and settlement areas to successfully locate the surface facilities. Additional information on the physical geography of the area is presented in Section 4.3. There are few surface topography features that would limit the construction and operation of the surface and underground facilities required by the APM Project. Further, the Municipality of Central Huron is located close to key infrastructure for the APM facility, including highways and high-voltage transmission lines (see transportation discussion in Chapter 6).

There are opportunities for new businesses and additional infrastructure associated with the APM repository to potentially be located in the community to enhance economic development and community well-being. This infrastructure could include the Container Development Laboratory and the Container Manufacturing Plant. The development of these facilities would be determined collaboratively with the community.

As more information on the geology and characteristics of potential candidate sites becomes available in later phases of the APM Project, and further input is obtained from the community and surrounding region, the APM facility design, layout, infrastructure, and engineering feasibility will be further refined.

4. PRELIMINARY ASSESSMENT OF GEOSCIENTIFIC SUITABILITY

4.1 Geoscientific Preliminary Assessment Approach

The objective of the Phase 1 geoscientific desktop preliminary assessment is to assess whether the Municipality of Central Huron contains general areas that have the potential to satisfy the geoscientific evaluation factors outlined in the site selection process document (NWMO, 2010). This chapter presents a summary of a detailed desktop geoscientific preliminary assessment conducted by Geofirma Engineering Ltd. (Geofirma, 2015a). The identification of potentially suitable areas focused on the area within the boundaries of the Municipality (Figure 4-1). Areas beyond the municipal boundaries were not considered. However, for the purpose of the assessment, geoscientific information was collected and interpreted over a larger area comprising the Municipality of Central Huron and its surroundings. The larger area is referred to in this chapter as the "Central Huron area", and is the entire area shown in Figure 4-1.

The Phase 1 geoscientific desktop preliminary assessment built on the work previously conducted for the initial screening (AECOM, 2013) and included the following activities:

- Assembly and detailed review of available geoscientific information such as geology, structural geology, natural resources, hydrogeology, and overburden deposits (surficial deposits);
- Interpretation of available geophysical data;
- Interpretation of available borehole geophysical data and a selected 2D seismic reflection line to provide information on the geometry and potential structural features of the subsurface bedrock geology;
- Terrain analysis studies to help assess overburden (surficial deposits) type and distribution, bedrock exposures, accessibility constraints, watershed and subwatershed boundaries, and groundwater discharge and recharge zones;
- Assessment of land use and protected areas including parks, conservation reserves, heritage sites, and source water protection areas; and
- The identification and evaluation of general potentially suitable areas based on systematic assessment of key geoscientific characteristics and constraints that can be realistically assessed at this stage of the assessment.

The details of these various studies are documented in a main Geoscientific Suitability Report (Geofirma, 2015a) and three supporting documents: Terrain Analysis (JDMA, 2015); Geophysical Interpretation (PGW, 2015); and Borehole Geophysical Well Log and 2D Seismic Data Interpretation (Geofirma, 2015b).

4.2 Geoscientific Site Evaluation Factors

As discussed in the NWMO site selection process, the suitability of potential sites is evaluated in a staged manner through a series of progressively more detailed scientific and technical assessments using a number of geoscientific site evaluation factors, organized under five safety functions that a site would need to ultimately satisfy in order to be considered suitable (NWMO, 2010).

- ***Safe containment and isolation of used nuclear fuel:*** Are the characteristics of the rock at the site appropriate to ensuring the long-term containment and isolation of used nuclear fuel from humans, the environment and surface disturbances caused by human activities and natural events?

- ***Long-term resilience to future geological processes and climate change:*** Is the rock formation at the siting area geologically stable and likely to remain stable over the very long term in a manner that will ensure the repository will not be substantially affected by geological and climate change processes such as earthquakes and glacial cycles?

- ***Safe construction, operation and closure of the repository:*** Are conditions at the site suitable for the safe construction, operation, and closure of the repository?

- ***Isolation of used fuel from future human activities:*** Is human intrusion at the site unlikely, for instance through future exploration or mining?

- ***Amenable to site characterization and data interpretation activities:*** Can the geologic conditions at the site be practically studied and described on dimensions that are important for demonstrating long-term safety?

The assessment was conducted in two steps. The first step assessed the potential to find general potentially suitable areas within the Municipality using key geoscientific characteristics that can realistically be assessed at this stage of the assessment (Section 4.4.1). The second step assessed whether identified general potentially suitable areas have the potential to ultimately meet all the safety functions outlined above (Section 4.4.2).

The remainder of this chapter provides an overview of the geoscientific characteristics of the Central Huron area (Section 4.3), followed by a summary of the geoscientific assessment of suitability (Section 4.4).

4.3 Geoscientific Characteristics of the Municipality of Central Huron

The following sections provide a summary of available geoscientific information for the Central Huron area as they relate to physical geography, Paleozoic bedrock geology, Quaternary (surficial) geology, seismicity, structural geology, hydrogeology, and natural resources.

4.3.1 Physical Geography

A detailed discussion of the physical geography of the Central Huron area is provided in the terrain analysis report (JDMA, 2015). There are six physiographic regions within the Central Huron area: Horseshoe moraines, Stratford till plain, Huron slope, Huron fringe, Dundalk till

plain, and Teeswater drumlin field. Five of these physiographic regions occur within the Municipality. These physiographic regions are defined based on the presence of major topographic features (Chapman and Putnam, 2007).

The large-scale topography in the Central Huron area is controlled by bedrock topography, whereas the detailed topography is often controlled by surficial deposits and erosional landforms cut into the surficial sediments. The pattern of elevation across the Central Huron area (Figure 4-2) controls the overall pattern of drainage. The elevation gradient from west (Lake Huron) to east is from about 176 to 366 metres, with this elevation increase occurring over an approximate 35 kilometre lateral distance. The highest points, with elevations of 366 metres, are located along the Mitchell Moraine at the east edge of the Central Huron area (Figure 4-2). Steep slopes are rare in the area.

Apart from Lake Huron, the Central Huron area is devoid of large or medium-sized lakes. Waterbodies cover 11.0 square kilometres or 0.8 per cent of the Central Huron area, with seven of the ten largest lakes associated with the Hullet Marsh Complex (Figure 4-1). The largest lake is 1.3 square kilometres in extent. Wetlands cover about 5.6 per cent of the Central Huron area, and approximately 8.8 per cent of the Municipality (JDMA, 2015).

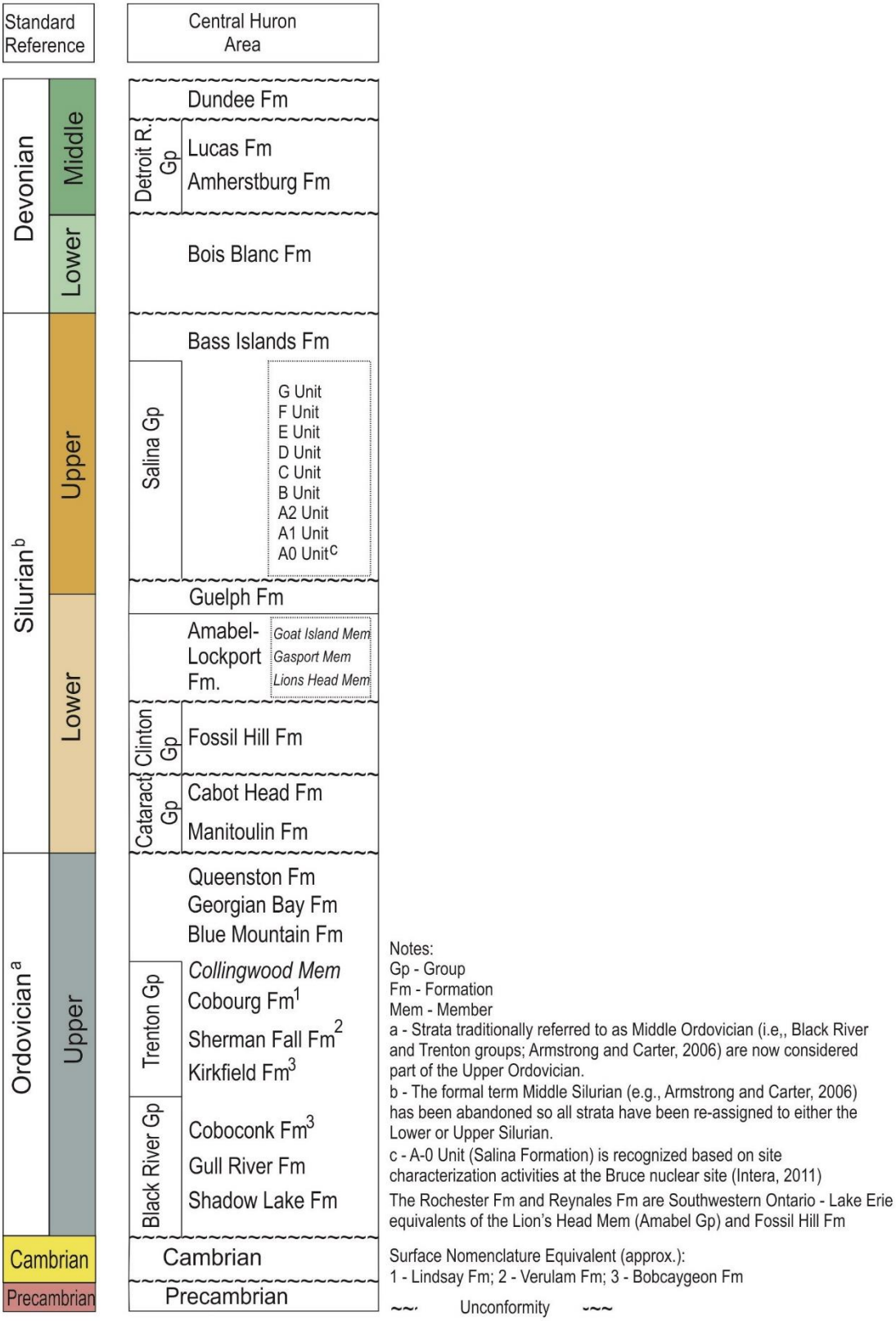
4.3.2 Bedrock Geology

Information on the bedrock geology in the Central Huron area was obtained from publicly available reports and geologic maps, as well as from the interpretation of existing 2D seismic and borehole geophysical data (Geofirma, 2015b), and from the interpretation of existing airborne geophysical data (PGW, 2015) conducted as part of this preliminary assessment. The main geoscientific desktop preliminary assessment report (Geofirma, 2015a) provides a detailed description of the regional and local geology of the Central Huron area.

Maps of subcropping bedrock at a 1:50,000 scale and fault mapping in the Central Huron area are available from the Ontario Geological Survey (OGS, 2007; OGS, 2011). The interpretation of borehole geophysical data used deep borehole data available from oil and gas exploration activities and OGS geological investigations (OGSRL, 2014a), which provided insight into the subsurface Paleozoic geology. The 2D seismic line interpreted (Line A000300528; Figure 4-3) lies within the Municipality and is of relatively low quality and low spatial resolution compared with more modern seismic acquisition systems. Also, overburden thickness and heterogeneity had a detrimental effect on the 2D seismic data quality. Relatively low resolution magnetic and gravity data provides coverage for the entire Central Huron area; higher resolution geophysical data is available for portions of the area. Detailed lithological and mineralogical information on the Paleozoic bedrock formations in the region is available from Armstrong and Carter (2010), and from studies completed as part of the work undertaken at the Bruce nuclear site for the proposed Low and Intermediate Level Waste Deep Geological Repository (AECOM and Itasca, 2011; Intera Engineering Ltd., 2011).

As shown in Figure 4-4, the Paleozoic sedimentary sequence of southern Ontario overlies the Precambrian crystalline basement of the Grenville Province of the Canadian Shield. In southern Ontario, the lithology of the Paleozoic formations is generally similar over large distances, and therefore descriptions provided by Armstrong and Carter (2010) are indicative of what can be expected for the Central Huron area. Table 4-1 illustrates the Paleozoic bedrock stratigraphy for the Central Huron area.

Table 4-1: Stratigraphy of the Central Huron Area (after Armstrong and Carter, 2010)



The initial screening of the Municipality of Central Huron (AECOM, 2013) identified the Paleozoic Upper Ordovician shale and limestone sedimentary rock units as potentially suitable for hosting a deep geological repository for used nuclear fuel. These Upper Ordovician rocks comprise a thick sequence with a distinctly bimodal composition: a carbonate-rich lower unit and a shale-rich upper unit.

The lower carbonate-rich unit of the Upper Ordovician overlies the Cambrian unit, where present, or the Precambrian basement (Figure 4-4). It is a thick sequence (approximately 200 metres thick) predominated by limestone and argillaceous limestone formations, 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 4-1). 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 local, 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 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 the 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 (approximately 200 metres) 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). 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, and lesser green, shale and siltstone with varying minor amounts of carbonate. The top of the Queenston Formation is marked by a regional erosional unconformity (Table 4-1; Armstrong and Carter, 2010).

The Upper Ordovician shale and limestone units exhibit relatively uniform thicknesses (i.e., about 200 metres each), and are known to dip uniformly to the southwest at between 0.23 degrees and one degree in the Central Huron area (e.g., Watts et al., 2009; Intera Engineering Ltd., 2011).

The depth to the top of the Cobourg Formation ranges from about 750 metres below ground surface in the eastern corner of the Municipality to approximately 885 metres below ground

surface in the western part of the Municipality (Geofirma, 2015a). Thickness of the Trenton Group, based on data from three wells in the Central Huron area, is relatively uniform and on the order of 126 to 155 metres. Within the Municipality, depth to the top of the Upper Ordovician shales (i.e., top of the Queenston Formation) ranges from approximately 530 metres below ground surface to almost 650 metres below ground surface, with a relatively uniform total thickness of the Upper Ordovician shale units ranging from approximately 216 metres to 232 metres.

Figure 4-3 shows that there are no OGS mapped subsurface faults in the Paleozoic sequence beneath the Central Huron area. The interpretation of 2D seismic Line A000300528 did not identify any faults (Geofirma, 2015b).

4.3.3 Quaternary Geology

The terrain analysis report (JDMA, 2015) provides a detailed description of the Quaternary geology of the Central Huron area. Quaternary geology mapping is available at a scale of 1:50,000 from the Ontario Geological Survey (OGS, 1997; 2010). 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 (JDMA, 2015).

As shown in Figure 4-5, the overburden covers over 99 per cent of the Central Huron area and comprises different types of glacial deposits. Glacial morainal and glaciofluvial deposits comprise the majority of Quaternary deposits at surface, covering about 53.4 per cent and 26.3 per cent of the Central Huron area, respectively.

Overburden thickness in the Central Huron area ranges from zero up to about 91 metres with an average thickness of 28 metres (Gao et al., 2006). Within the Municipality, the overburden thickness ranges from zero to 80 metres, generally increasing from east to west. The thinnest overburden occurs along the Maitland and South Maitland rivers, where bedrock is exposed locally in the channels.

4.3.4 Erosion

Geofirma (2015a) summarizes the currently available information on glacial erosion in southern Ontario. The depth of glacial erosion depends on several regionally specific factors, such as the ice-sheet geometry, topography, and history, as well as local geological conditions, such as overburden thickness, rock type, and pre-existing weathering.

Various recent studies were aimed at assessing the impact of glaciations on erosion over sedimentary rocks. A recent literature review conducted by Hallet (2011) concluded that although uncertainties remain in ice sheet reconstructions and estimates of erosion by ice and melt water, all lines of evidence indicate that, in southern Ontario, glacial erosion would not exceed a few tens of metres in 100,000 years with a conservative estimate of 100 metres per one million years for the Bruce nuclear site, approximately 50 kilometres north of the Central Huron area.

4.3.5 Seismicity and Neotectonics

4.3.5.1 Seismicity

The Central Huron area overlies the Grenville Province of the Canadian Shield and the interior of the North American continent, where large parts have remained tectonically stable for the last 970 million years (Percival and Easton, 2007). Figure 4-6 shows the location and magnitude of seismic events recorded in the National Earthquake Database (NEDB) for the period between1985 to 2014 in southern Ontario (NRC, 2015). Earthquake magnitude resolution in Figure 4-6 was improved to less than 1.0 Nuttli Magnitude for the Central Huron area and environs based on the 2007 installation of the microseismic monitoring network for site characterization work at the Bruce nuclear site, and to Nuttli Magnitude 2.0 for the remainder of southern Ontario based on an expanded POLARIS (Portable Observatories for Lithospheric Analysis and Research Investigation Seismicity) network established in 2002.

As shown in Figure 4-6, there are no recorded earthquakes within the Municipality of Central Huron since 1985, with the closest recorded earthquakes located offshore in Lake Huron about 25 kilometres southwest of the Municipality. The maximum magnitude of these events was 2.4 Nuttli Magnitude. A 4.3 Nuttli Magnitude earthquake was recorded in 2005 northeast of Owen Sound within Georgian Bay at a distance of 135 kilometres from the centre of the Municipality of Central Huron (Hayek et al., 2013).

4.3.5.2 Neotectonic Activity

Neotectonics refers to deformations, stresses, and displacements in the earth's crust of recent age or which are still occurring. These processes are related to tectonic and glacial forces acting on the North American plate.

The geology of the Central Huron area is typical of many areas of southern Ontario, which have been subjected to nine glacial cycles during the last million years (Peltier, 2003). Post-glacial isostatic rebound is still occurring across most of Ontario. Vertical velocities show present-day uplift of about 10 millimetres per year near Hudson Bay, the site of thickest ice at the last glacial maximum (Sella et al., 2007). The uplift rates generally decrease with distance from Hudson Bay and change to subsidence (one to two millimetres per year) south of the Great Lakes. The present day rebound rate in the Central Huron area approaches 0.5 millimetres per year (Mainville and Craymer, 2006). As a result of the glacial unloading, seismic events can be associated with post-glacial stress changes as a result of reactivation of existing fracture zones. In addition, natural stress release features can include elongated compressional ridges or pop-ups such as those described by McFall (1993) and Karrow and White (2002) from some areas of southern Ontario. No neotectonic features are known to occur within the Central Huron area.

Slattery (2011) completed a remote-sensing and field-based study that analyzed Quaternary landforms for the presence of seismically-induced soft-sediment deformation within five to 50 kilometres of the Bruce nuclear site. The investigation involved reviewing existing information sources (e.g., papers, reports, and maps), interpreting air photos and a LiDAR (Light Detection and Ranging) digital elevation model, and searching for liquefaction structures displayed in sediment exposures in the field. The review of existing information and interpretation of air photos was done for the entire area within 50 kilometres of the Bruce nuclear site, providing coverage of the area immediately north of the Central Huron area. No conclusive geomorphological or sedimentological evidence of post-glacial neotectonic activity was identified within the study area (Slattery, 2011).

4.3.6 Hydrogeology and Hydrogeochemistry

Information concerning groundwater use in the Central Huron area was obtained principally from the Ontario Ministry of the Environment and Climate Change (MOECC) Water Well Information System (WWIS) database (MOECC, 2014a), as well as from regional groundwater studies and source water protection studies based on interpretation of these data. The majority (91 per cent) of water wells in the Central Huron area obtain water from shallow bedrock aquifers, with the remainder of the wells obtaining water from the overburden.

The WWIS database contains a total of 4,260 water well records for the Central Huron area. Not all these water well records are complete and not all these records provide useful hydrogeological information. Of the 3,194 wells with reliable data for the Central Huron area (Figure 4-5), 299 have been identified as overburden wells and 2,895 as bedrock wells.

Most of the water well records provide useful information on well depth, lithology, well yield, and static water level. Table 4-2 summarizes the number (1,117) and type of water well records with reliable information within the Municipality.

Table 4-2: Water Well Record Summary for the Municipality of Central Huron

Well Type	No. of Well Records	Well Depth Range (metres below ground surface)		Static Water Level Range (metres below ground surface)		Well Yield (liters per minute)		
		Min	Max	Min	Max	Min	Max	Mean
Overburden	90	1.2	134.1	0.3	33.5	7.6	75.7	30.4
Bedrock	1,027	7.0	275.0	0.3	96.0	3.8	700	47.8

4.3.6.1 Overburden Aquifers

Overburden wells in the Central Huron area are generally 10 to 100 metres deep and have well yields of 10 to 70 liters per minute (MOECC, 2014a). These well yields reflect the purpose of the wells (i.e., primarily residential use) and do not necessarily reflect the maximum sustained yield that might be available from the aquifers intersected by the wells.

Noteworthy overburden aquifers within the Municipality of Central Huron identified by Ausable Bayfield Maitland Valley Source Protection Region (2011a; 2011b) include the following:

- the unconfined sand Lake Warrren Shoreline Aquifer forming a narrow band of glacioclacustrine deposits running north-south inland and parallel to Lake Huron;
- the unconfined sand and gravel Lake Huron Beach Aquifer situated along the present day shoreline of Lake Huron;
- the unconfined sand and gravel Wawanosh Kame Moraine Aquifer situated in the central part of the Municipality;
- the unconfined sand and gravel Holmesville Outwash Aquifer located between the Wyoming and Wawanosh moraines; and

- the unconfined Seaforth Moraine Aquifer located within and on the flanks of the north-south trending Seaforth Moraine situated immediately west of the Hullet Marsh Complex.

Source water protection assessment reports (Ausable Bayfield Maitland Source Protection Region, 2011a; 2011b) also provide the location of significant groundwater recharge areas within the Central Huron area, indicating areas where greater than average groundwater recharge likely occurs. These areas were mapped based on consideration of surficial geology, soils, land cover, and topography. Significant groundwater recharge occurs throughout the Municipality in flat-lying/hummocky areas with sands and gravels at surface and limited land cover.

4.3.6.2 Bedrock Aquifers

No water wells were drilled to depths of 500 metres below ground surface or greater. There are 2,895 water well records in the Central Huron area that can be confidently assigned to shallow bedrock aquifers. Shallow bedrock hydrogeological information is available primarily to depths of about 100 to 150 metres from the MOECC well records (MOECC, 2014a) based on regional use of this shallow bedrock aquifer as a source of drinking water, although some wells are shallower and some are deeper than this general depth range. Shallow bedrock is the most important source of drinking water in the Municipality of Central Huron, and is the primary source of all public and municipal water supplies located inland from Lake Huron. Shallow bedrock aquifers within the Municipality are composed of an aggregate of the upper few metres to over 100 metres of the different shallow bedrock formations present, which typically include Middle Devonian Dundee Formation limestone and Lucas Formation dolostone and limestone (Figure 4-3). Water quantity and quality within the shallow bedrock aquifer can vary dramatically across the Municipality of Central Huron as a consequence of the different chemical and physical characteristics of the individual bedrock formations. In most parts of the Central Huron area, an overlying layer of clay and silt till confines the shallow bedrock aquifer. In these areas, the low permeability silt and clay till is considered to represent an aquitard that protects the shallow bedrock aquifer.

Near the contact of the Lucas Formation with the overlying Dundee Formation in the eastern part of the Central Huron area, the Lucas limestone has been associated with localized karst (i.e., sinkhole) development (Ausable Bayfield Maitland Source Protection Region, 2011b). Such areas of karst and sinkhole development provide high quality, high yielding aquifers extensively used as sources of drinking water. Areas that drain into sinkholes are Significant Groundwater Recharge Areas under Ontario's *Clean Water Act*.

4.3.6.3 Shallow Groundwater Regime

The shallow groundwater regime includes overburden aquifers that provide drinking water supplies to residences and shallow confined bedrock aquifers that provide water supplies to both communities and residences (Waterloo Hydrogeologic Inc., 2007). The shallow groundwater regime typically extends to depths of less than 60 metres.

Groundwater flow directions within shallow systems often mimic surface water flow directions with the groundwater table generally present as a subdued reflection of topography. Shallow groundwater flow will be directed from areas of higher hydraulic head, such as highlands and drainage divides, to areas of lower hydraulic head such as valleys, depressions, and surface waters. The extent of such shallow flow systems will be defined by local, topography-controlled, drainage divides across which groundwater flow will not readily occur. Generally, for such

shallow systems, groundwater divides will coincide with surface water drainage divides. Within the Municipality of Central Huron, both overburden and shallow bedrock groundwater flows broadly to the west from the highland areas along the eastern edge of the Central Huron area towards Lake Huron (Figure 4-2).

4.3.6.4 Hydrostratigraphy

Hydrostratigraphic units are geological formations, parts of formations, or groups of formations that have similar hydrogeologic characteristics that allow for grouping into aquifers, aquitards, and aquicludes. As part of site characterization work carried out at the Bruce nuclear site, nine hydrostratigraphic (HS) units were defined (Intera Engineering Ltd., 2011). These nine hydrostratigraphic units, adjusted for minor variations in bedrock formation depth, thickness, and occurrence in the Municipality of Central Huron, are broadly anticipated to be present with similar properties to those determined at the Bruce nuclear site based on the lateral traceability and predictability of bedrock formations, with the exception that a Cambrian aquifer is not likely present where the Cambrian unit is absent. This would need to be confirmed at later stages of the site evaluation process, through the collection of site-specific information.

The Upper Ordovician shale and limestone units correspond to hydrostratigraphic units 5 and 6. The lowest, average, horizontal hydraulic conductivities (Kh) are associated with the Upper Ordovician limestones of the Cobourg, Sherman Falls, and Kirkfield formations, ranging from $4x10^{-15}$ to $1x10^{-14}$ metres per second (Intera Engineering Ltd., 2011).

4.3.6.5 Formation Hydraulic Pressures

There is no readily available information on formation hydraulic pressures at typical repository depths in the Municipality of Central Huron; however, there is detailed information on hydraulic pressures within the Paleozoic bedrock sequence from studies at the Bruce nuclear site. Formation pressures similar to those measured at the Bruce nuclear site can be broadly expected to occur in the Municipality of Central Huron.

Formation hydraulic pressures in bedrock to depths of about 850 metres below ground surface have been measured in-situ and reported for the entire Paleozoic bedrock sequence at the Bruce nuclear site using special multiple-port pressure monitoring instrumentation consisting of numerous packer-isolated test intervals installed in several deep boreholes (Intera Engineering Ltd., 2011). These ongoing hydraulic pressure measurements allow for determination of the presence of normally-pressured, overpressured or underpressured conditions within individual deep formations and estimation of groundwater flow directions within shallow and deep bedrock aquifers.

There is significant underpressuring of the Upper Ordovician shales and Trenton Group limestones of up to 250 to 300 metres expressed as environmental water head at the Bruce nuclear site (Intera Engineering Ltd., 2011). These underpressures are an important hydrogeological characteristic of these formations, indicating they would act as barriers to groundwater migration. Possible explanations for the observed underpressures include: poroelastic response to glacial unloading and flexure; poroelastic response to Cenozoic erosional unburdening; capillary pressure effects due to the presence of a separate gas phase; and/or chemical osmosis (Intera Engineering Ltd., 2011). The occurrence and persistence of these underpressures are clearly indicative of very low formation permeability and provide confidence in the very low permeabilities reported from hydraulic testing at the Bruce nuclear

site (NWMO, 2011). These hydrogeological properties indicate aquiclude conditions with no advection of brine, and a system in which gas flow would also be diffusion controlled.

There is also significant overpressuring of up to 165 metres expressed as environmental water head within the permeable Cambrian sandstone that propagates into some of the overlying Black River Group limestones and siltstones. There are also some moderate overpressures occurring within the Salina A1 and A0 Units, Goat Island, Gasport, Lions Head and Fossil Hill formations and within the middle of the Blue Mountain Formation (Table 4-1). Possible explanations for the cause of these overpressures include: hydraulic connection to a remote elevated regional recharge area (e.g., Niagara Escarpment; Canadian Shield); remnant overpressure from deep basin glacial meltwater recharge and post-glacial basin isostatic rebound; and/or up-basin regional fluid (brine or gas) migration and pressurization (Intera Engineering Ltd., 2011).

4.3.6.6 Hydrogeochemistry

Information on overburden and shallow bedrock groundwater geochemistry in southwestern Ontario, including the Central Huron area, is presented by the Ontario Geological Survey (Hamilton, 2015) and by MOECC (2014b). Within the Central Huron area, Hamilton (2015) summarizes the groundwater geochemistry of 21 wells (eight overburden, 13 bedrock) to a maximum depth of 96 metres sampled in 2007-2014. MOECC (2014b) presents water quality information for the six wells that are part of the Provincial Groundwater Monitoring Network.

There is no direct readily available information on hydrogeochemistry at typical repository depths in the Municipality of Central Huron. Geofirma (2015a) summarizes the expected hydrogeochemistry of the shallow to deep Paleozoic and underlying Precambrian bedrock within the Central Huron area based on detailed porewater and groundwater testing completed at the Bruce nuclear site (Intera Engineering Ltd., 2011) and on regional compilations of oil, gas, and salt well data completed as part of the Bruce nuclear site DGR Geosynthesis (NWMO, 2011; Hobbs et al., 2011), and by the Ontario Petroleum Institute (Carter and Fortner, 2011). Carter et al. (2015) and Skuce et al. (2015) provide recent updates to these earlier compilations for individual deep bedrock formations based on Petroleum Well Records maintained by the Ontario Oil, Gas and Salt Resources Library (OGSRL).

Hydrogeochemical data from the Bruce nuclear site shows highly saline, non-potable brines (salinities of approximately 200 to 300 grams per litre total dissolved solids in the Ordovician formations) exist at typical repository depths. The current understanding of the origin of brines within the Michigan Basin indicates they were formed by evaporation of sea water that was subsequently modified by: dilution of brines by lower salinity water; dissolution of halite by lower salinity water; and diagenetic water-rock interactions, particularly dolomitization. The data from the Bruce nuclear site is consistent with the regional scale understanding, and suggests that similar brines are present in the Ordovician rocks beneath the Municipality of Central Huron.

4.3.7 Natural Resources

The potential for natural resources in the Central Huron area is shown in Figure 4-7 and discussed in detail in Geofirma (2015a). Natural resources assessed for the area include: petroleum resources (conventional and unconventional oil and gas), metallic mineral resources, and non-metallic mineral resources (sand and gravel, bedrock resources, and salt).

Potential for petroleum resources is recognized in southern Ontario, with most of the known oil and gas pools located far to the south of the Central Huron area in the geographic triangle between London, Sarnia and Chatham-Kent. As shown in Figure 4-7, there are four oil and gas pools in the Central Huron area. They include the Tipperary and Tipperary South gas pools within the Municipality of Central Huron, and the Tuckersmith 30-III-SHR and Bayfield gas pools located south of the Municipality. All four pools are within pinnacle reefs of the Silurian Guelph Formation. In plan view, these gas pools range in size from seven to 35 hectares (OGS, 2011). Both the Tipperary and Tipperary South pools within the Municipality are depleted and currently used for natural gas storage (OGSRL, 2014b). Similarly, the Bayfield Pool, located south of the Municipality, is no longer in production and is presently being considered for natural gas storage (Tribute Resources Inc., 2015). The Tuckersmith 30-III-SHR gas pool, south of the Municipality, is currently in production. Drilling through a known pinnacle reef in the eastern part of the Municipality (Figure 4-7) did not encounter economical accumulations of hydrocarbons.

No evidence of economical hydrocarbon accumulations in or below the Upper Ordovician shales was found in the few deep boreholes drilled in the Central Huron area (OGSRL, 2014a). However, more work would be required to better understand the potential for petroleum resources in these formations in the Central Huron area, including structurally-controlled hydrothermal dolomite (Upper Ordovician carbonates) and Cambrian plays, as well as unconventional shale gas.

Many of the Paleozoic rocks found at surface or under the overburden within the Central Huron area have been extracted elsewhere across southern Ontario for their aggregate potential, for building stone, and for brick manufacture. However, there are no known licensed bedrock quarries or commercial bedrock mining operations within the Municipality of Central Huron, presumably due to the presence of thick overburden. Sand and gravel pits are operating throughout the Municipality. Most of these pits are shallow (less than eight metres depth) and located within esker, glaciofluvial outwash, ice contact, or glaciolacustrine beach deposits.

Salt beds of the Silurian Salina Group are known to be present beneath all the Municipality of Central Huron. Salt is currently being mined from the Salina A2 and B salt beds at the Goderich Mine immediately north of the Municipality, which is situated approximately 550 metres below ground surface, and extends about five kilometres from the shore beneath Lake Huron (Sifto Canada Corp., 2013). Figure 4-7 shows the predicted lateral extent of the Salina B Unit salt bed, which is the most extensive and thickest of the Salina Group salt beds. Salt beds quickly thin out east of the Municipality, with the Salina B unit being the only salt bed that underlies the entire Municipality. The Salina Group salt beds extend significantly to the west offshore under Lake Huron and to the south to Sarnia along the eastern shore of Lake Huron. As noted, the Salina B Unit salt is found below the entire Municipality, typically at depths of about 320 to 490 metres below ground surface (OGSRL, 2014a). Thickness of this salt bed within the Municipality ranges from approximately 40 to 80 metres (Sanford, 1977). The A2 Unit salt, which occurs below about 75 per cent of the Municipality, is typically found at depths of 320 to 485 metres below ground surface (OGSRL, 2014a), with a thickness of up to approximately 20 metres.

The Municipality of Central Huron is located in a sedimentary rock setting in southern Ontario, where the potential for metallic mineral resources is considered to be low.

4.3.8 Geomechanical and Thermal Properties

There are no data on geomechanical and thermal properties of the Paleozoic bedrock formations at typical repository depths within the Municipality of Central Huron. However, data

on geomechanical properties are available from detailed drilling and testing investigations at the Bruce nuclear site (Intera Engineering Ltd., 2011, Golder, 2013), and from regional compilations of geomechanical data (NWMO and AECOM, 2011; Golder, 2003). Data on thermal properties are available from detailed drilling and testing investigations at the Bruce nuclear site (Atomic Energy of Canada Ltd., 2011), and from compilations of data available in the published literature (Clauser and Huenges, 1995; Sass et al., 1984; Cermak and Rybach, 1982). Based on the lateral traceability and predictability of the Paleozoic sequence in southern Ontario, geomechanical and thermal properties of the Paleozoic sequence in the Municipality of Central Huron can be expected to be similar to those measured at the Bruce nuclear site and elsewhere in southern Ontario.

Argillaceous limestone of the Cobourg Formation has high strength, with an average Uniaxial Compressive Strength (UCS) value of 113 megapascals, thus indicating a high degree of stability for deep underground excavations (Intera Engineering Ltd., 2011; NMWO, 2011). The Sherman Fall Formation is considerably weaker than the Cobourg Formation, while formations of the Black River Group have strength values comparable with those measured for the Cobourg Formation. The Upper Ordovician shales have a moderate strength, with UCS estimated mean values of 48 megapascals, and 32 megapascals for the Queenston and Georgian Bay formations, respectively (NWMO and AECOM, 2011). The Upper Ordovician shale and limestone units at the Bruce nuclear site are very sparsely fractured and of excellent quality, with the Cobourg Formation having a rock mass designation of excellent and a rock quality designation generally ranging between 90 and 100 per cent (Intera Engineering Ltd., 2011). The measured fracture frequency is similar in all the Ordovician formations and ranges from approximately 0 to 1.7 fractures per metre, with an average value of generally less than 0.3 fractures per metre.

The mean measured thermal conductivity, thermal diffusivity, and specific heat for Paleozoic formations measured on core samples collected at the Bruce nuclear site are generally consistent with thermal property data reported in the literature for sedimentary rocks. The Cobourg Formation has slightly higher thermal conductivity than the overlying Ordovician shales and underlying Sherman Fall Formation.

Site-specific geomechanical and thermal data would need to be obtained during later stages of the site evaluation process.

4.4 Potential Geoscientific Suitability of the Municipality of Central Huron

This section provides a summary of how key geoscientific characteristics and constraints were applied to the Municipality of Central Huron to assess whether it contains general areas that have the potential to satisfy the NWMO's geoscientific site evaluation factors (Section 4.4.1). The potential of identified areas to ultimately satisfy all geoscientific evaluation factors and safety functions outlined in the NWMO's site selection process is also described (Section 4.4.2).

4.4.1 Approach

The potential for finding general areas that are potentially suitable for hosting a deep geological repository was assessed using the key geoscientific characteristics and constraints briefly described below.

- ***Geological Setting:*** The initial screening of the Municipality of Central Huron (AECOM, 2013) identified the Upper Ordovician shale and limestone units as potentially suitable host rock formations. The Paleozoic bedrock sequence within the Municipality of Central Huron is approximately 1,025 to 1,075 metres thick. Within the Municipality, the stratigraphy with depth includes: Devonian limestone and dolostone; Silurian dolostones, shales and evaporites; Upper Ordovician shales and limestones; and occasionally Cambrian sandstone overlying Precambrian basement.

  Based on available information on the geoscientific characteristics of the sedimentary sequence beneath the Municipality and surrounding region, including the Bruce nuclear site about 50 kilometres north of the Central Huron area, the Ordovician Cobourg Formation (argillaceous limestone) would be the preferred host rock for a deep geological repository for used nuclear fuel. The natural geological setting of this formation would provide the most favourable geoscientific characteristics for ensuring safety. The Cobourg Formation underlies the Municipality of Central Huron in sufficient thickness and volume (Geofirma, 2015a). It has very low hydraulic conductivity and high geomechanical strength. These favourable characteristics of the Cobourg Formation are complemented by the presence of approximately 200 metres of overlying very low permeability Ordovician shale formations, which act as an additional hydraulic barrier.

  While the other Trenton Group limestone formations (i.e., Sherman Fall and Kirkfield formations) and the Upper Ordovician shales (i.e., Queenston, Georgian Bay, and Blue Mountain formations) also have very low hydraulic conductivities, they are less preferred than the Cobourg Formation from a geomechanical perspective (i.e,. lower rock strength; Geofirma, 2015a). The limestone formations of the Black River Group are also less preferred as they have uniformly higher hydraulic conductivity values than the Cobourg Formation. There are no mapped (interpreted) subsurface faults within the Municipality of Central Huron (Figure 4-3), and the interpretation of a 2D seismic line within the Municipality did not identify any fault within the Paleozoic sedimentary sequence. The potential for faults in the Paleozoic sequence within the Municipality of Central Huron would need to be assessed during subsequent stages of the site selection process.

- ***Minimum Depth of Top of the Cobourg Formation:*** For the sedimentary sequence in the Municipality of Central Huron, it was determined that a minimum depth of 500 metres below ground surface would be preferred to maintain the integrity of a repository within the Cobourg Formation. This preferred depth would also protect the overlying 200 metres thick Upper Ordovician shale barrier under the most conservative assumptions of future bedrock removal rates due to glacial erosion (Section 4.3.4; Hallet, 2011).

- ***Protected Areas:*** All known protected areas with the Municipality of Central Huron were excluded from further consideration. These include conservation areas, NGO nature reserves, and provincially significant wetlands.

- ***Source Water Protection Areas***: Land-based water protection zones (IPZs, Intake Protection Zones) 1 and 2, and groundwater protection areas (WHPAs, Well Head Protection Areas) A, B, C and E were excluded from further consideration. The consideration of WHPAs D would need to be further assessed in collaboration with the Municipality in future studies.

- ***Natural Resources:*** The potential for natural resources in the Central Huron area is shown in Figure 4-7. There are three known pinnacle reefs of the Silurian Guelph Formation in the Municipality of Central Huron, two of which were exploited for gas in the past and are currently being used for natural gas storage (i.e., Tipperary and Tipperary South pools; Figures 4-7 and 4-8). Salt beds of the Silurian Salina Group are known to be present beneath the entire Municipality of Central Huron. At this stage of the assessment, other than the location of the known historical pools, the presence of hydrocarbons and salts within the Municipality is not considered as preventing siting the repository within the Municipality. However, the impact of salt and hydrocarbon resource potential on repository siting and safety would need to be further assessed for specific sites.

- ***Surface Constraints***: Surface features such as overburden, the limited extent of wetlands outside protected areas, the relatively flat topography, and the ease of accessibility within the Municipality of Central Huron were not found to be siting constraints at this stage of the assessment. Overburden cover is extensive and locally thick within the Municipality, and wetlands cover about 8.8 per cent of the Municipality. Water bodies cover a relatively small area.

Figure 4-8 shows the key geoscientific characteristics and constraints used to assess whether the Municipality of Central Huron contains areas that have the potential to satisfy NWMO's geoscientific site evaluation factors. The figure shows protected areas, earth science ANSIs, wildlife management areas, source water protection areas, built-up areas, and the potential for natural resources. The legend of the figure also includes a two kilometre by three kilometre box to illustrate the approximate extent of the subsurface area that would be needed for a repository.

4.4.2 Potential for Finding General Potentially Suitable Areas

The consideration of the key geoscientific characteristics and constraints discussed above revealed the Municipality of Central Huron contains large areas that have the potential to satisfy NWMO's geoscientific evaluation factors. However, as discussed below, the assessment identified a number of uncertainties that would need to be addressed during subsequent evaluation stages. These include the impact of salt and hydrocarbon resource potential on repository siting and safety. Also, the assumption of transferability of geoscientific characteristics and understanding based on regional data and data from the Bruce nuclear site to the Municipality of Central Huron would need to be confirmed. At this early stage of the assessment, the boundaries of these general potentially suitable areas are not yet defined. The location and extent of these areas would be further refined during subsequent site evaluation stages.

The Municipality of Central Huron is underlain by a predictable, laterally extensive, near-horizontally bedded Paleozoic sedimentary sequence. Based on information from three wells that were drilled to the Precambrian basement (T006364, F011970, F011974) within the

Municipality (Figure 4-3; Geofirma, 2015a), the thickness of the Paleozoic sequence in this area is approximately 1,025 to 1,075 metres.

Depth contour mapping (Geofirma, 2015a) shows the preferred Cobourg Formation is found at depths greater than the preferred minimum depth (500 metres below ground surface) under the entire Municipality. The depth to the top of the Cobourg Formation varies from about 750 metres below ground surface in the eastern corner of the Municipality to approximately 885 metres below ground surface towards the western part of the Municipality. Based on information from well T006364 (Figure 4-3), the Cobourg Formation is interpreted to be approximately 55 metres thick within the Municipality. The thickness of the overlying Upper Ordovician shale formations is estimated to be relatively uniform and more than 200 metres (Section 4.3.2). No faults have been mapped within the Paleozoic sedimentary sequence in the Municipality of Central Huron (Figure 4-3), and the interpretation of a 2D seismic line within the Municipality did not identify any subsurface fault (Geofirma, 2015b).

Known potential for economically exploitable natural resources in the Municipality of Central Huron is associated with hydrocarbons in the Silurian Guelph Formation and salt resources of the Salina Group.

There are two known historical hydrocarbon pools within the Municipality, the Tipperary and Tipperary South pools (Figure 4-7), which historically produced gas from pinnacle reefs of the Guelph Formation. These depleted pools are currently being used for natural gas storage (Section 4.3.7). South of the southern municipal boundary, the historic Bayfield gas pool is also being considered for gas storage, and the Tuckersmith 30-III-SHR pool is actively producing gas from a pinnacle reef of the Guelph Formation (Figure 4-7). The pinnacle reefs associated with all these hydrocarbon pools were recognized as positive gravity anomalies during the interpretation of available geophysical data (PGW, 2015). Similar gravity anomalies exist in the Municipality, but it is unknown if these anomalies reflect the existence of additional reefs. In any case, their stratigraphic occurrence is approximately 300 metres above the preferred Cobourg Formation. At this stage, other than the location of the known historical pools, the presence of hydrocarbons within the Municipality is not considered as preventing siting the repository within the Municipality. However, the impact of hydrocarbon resource potential on repository siting and safety would need to be further assessed for specific sites.

Salt beds of the Silurian Salina Group are known to exist beneath the entire Municipality, extending significantly in the surrounding region to the south and west, including beneath Lake Huron. The Salina salt beds thin towards the east (Figure 4-8). The Salina B and A2 salt beds, mined at Goderich, are the thickest. The thickness of the Salina B salt ranges from approximately 80 metres in the western portion of the Municipality to about 40 metres towards the east. The Salina A2 salt is approximately 20 metres thick towards the western portion of the Municipality, pinching out towards its eastern portion (Sanford, 1977). At this stage of the assessment, the presence of salt beds is not considered as a constraint. The Salina Group salt beds occur more than 330 metres above the top of the preferred Cobourg Formation (Geofirma, 2015a). If salt were to be mined above the repository location, the vertical distance between the salt and the Cobourg Formation is likely to isolate and maintain the integrity of a repository. The impact of salt resource potential on repository siting and safety would need to be further assessed.

The largest built-up area in the Municipality is that associated with the settlement area of Clinton. Smaller built-up areas are found in Holmesville, Londesborough, Kinburn, and along and close to the Lake Huron shoreline (Figure 4-8).

There are three designated provincially significant wetlands in the Municipality of Central Huron: the Hullet Marsh Complex in the southwestern portion of the Municipality, and the Holmesville Creek Complex and Trick's Creek Swamp in the central part of the Municipality. The Hullet Wildlife Management Area encompasses the Hullet Marsh Complex and surrounding lands. In the northwestern portion of the Municipality, there are two conservation areas and one NGO nature reserve, all relatively small in size (Figure 4-8). There are two earth science ANSIs located in the central and southeastern parts of the Municipality (Figure 4-8).

The wellhead protection area, zones A to C, associated with the Clinton well supply system extends northeast of the settlement area of Clinton, in the central portion of the Municipality. Smaller wellhead protection areas (zones A to C) are found along the Lake Huron shoreline (Figure 4-8). The wellhead protection area, zone E, associated with the Century Heights well supply, straddles part of the northern boundary of the Municipality. Part of the Goderich surface water intake protection zone occupies a small portion of the northwestern corner of the Municipality.

Accessibility throughout the Municipality of Central Huron is easy using the existing road network. Topography is relatively flat, although relatively distinct topographic features are identified associated with the Maitland and Bayfield rivers, as well as with smaller rivers and the Wyoming moraine (Figure 4-2). There are also small, non-designated wetlands and extensive overburden deposits with thicknesses of up to approximately 80 metres locally (Section 4.3.3). At this early stage of the assessment, topographic features, wetlands outside protected areas, and overburden thickness are not considered as key constraints for the identification of general potentially suitable areas.

In summary, the assessment of the above geoscientific characteristics and constraints indicates the Municipality of Central Huron contains large potentially suitable areas, outside protected areas, source water protection zones, and built-up areas (Figure 4-8). The depth to the top of the preferred Cobourg Formation beneath the Municipality ranges from about 750 to 885 metres below ground surface, which is greater than the preferred minimum depth of 500 metres below ground surface.

While the general potentially suitable areas within the Municipality of Central Huron appear to have favourable geoscientific characteristics for hosting a deep geological repository, there remain a number of uncertainties that would need to be addressed during subsequent stages of the site evaluation process. These include the impact of salt and hydrocarbon resource potential on repository siting and safety. Also, the assumption of transferability of geoscientific characteristics and understanding based on regional data and data from the Bruce nuclear site to the Municipality of Central Huron would need to be confirmed.

4.4.3 Evaluation of General Potentially Suitable Areas in the Municipality of Central Huron

This section provides a brief description of how the identified general potentially suitable areas were evaluated to verify if they have the potential to satisfy the geoscientific safety functions outlined in the NWMO's site selection process (NWMO, 2010) and discussed in Section 4.2. At this early stage of the site evaluation process, where limited geoscientific information is available, the intent is to assess whether there are any obvious conditions within the identified potentially suitable areas that would fail to satisfy the geoscientific safety functions.

4.4.3.1 Safe Containment and Isolation of Used Nuclear Fuel

This function requires the geological, hydrogeological, chemical and mechanical characteristics of a suitable site: promote long-term isolation of used nuclear fuel from humans, the environment and surface disturbances; promote long-term containment of used nuclear fuel within the repository; and restrict groundwater movement and retard the movement of any released radioactive material. This requires the repository be located at a sufficient depth, typically around 500 metres or more below ground surface, in a sufficient rock volume with characteristics that limit groundwater movement.

As discussed in the previous sections, the geology of the Municipality of Central Huron is consistent with the regional geological framework. The Municipality is entirely underlain by a predictable and laterally extensive Paleozoic sedimentary sequence that was deposited approximately 540 to 359 million years ago.

Given the predictability of the Paleozoic bedrock stratigraphy in the region, the Cobourg Formation, which is considered the preferred host rock in this assessment (Section 4.4.1), is interpreted to extend laterally beneath the general potentially suitable areas identified within the Municipality. Based on information from historic oil and gas wells (OGSRL, 2014a), the top of the Cobourg Formation within the potentially suitable areas is interpreted to be at depths greater than the minimum 500 metres below ground surface (see Section 4.4.1). The thickness of the Cobourg Formation at the Bruce nuclear site is approximately 30 metres (Intera Engineering Ltd., 2011); data from well T006364 within the Municipality indicate that the Cobourg Formation in the potentially suitable areas identified is expected to be about 55 metres thick (Geofirma, 2015a). Given its thickness and lateral extent, the Upper Ordovician Cobourg Formation would provide a sufficient volume of rock to physically contain and isolate a deep geological repository for used nuclear fuel.

While there is limited site-specific information on the geoscientific characteristics of the Cobourg Formation beneath the general potentially suitable areas, it is expected that they will be similar to the characteristics of the Cobourg Formation beneath the Bruce nuclear site, approximately 50 kilometres north of the Central Huron area. As described in Sections 4.3.6.4 and 4.3.8, the Cobourg Formation is characterized by very low hydraulic conductivities and a very low frequency of fractures. These are favourable characteristics for the containment and isolation of used fuel. In addition, the Cobourg Formation in the general potentially suitable areas is overlain by approximately 200 metres of very low permeability Upper Ordovician shale formations that would provide multiple natural barriers for repository isolation.

Given the regional predictability of the Paleozoic bedrock sequence, the hydrogeological and hydrogeochemical conditions beneath the general potentially suitable areas in the Municipality of Central Huron are expected to be relatively similar to those beneath the Bruce nuclear site (Section 4.3.6). The deep groundwater regime within the Upper Ordovician shale and limestone units beneath the Bruce nuclear site, including the Cobourg Formation, is described as diffusion dominated and isolated from the shallow groundwater, which is generally limited to the upper 200 metres below ground surface. There are no interpreted or OGS mapped faults within the identified general potentially suitable areas (Figure 4-3; Geofirma, 2015a). The isolated nature of the deep groundwater system is further supported by the regional hydrogeochemical setting (Section 4.3.6.5). Regional chemistries of the deep brines indicate they were formed by evaporation of seawater, which was subsequently modified by fluid-rock interaction processes. Limited evidence for recent dilution by meteoric or glacial waters was found within the regional geochemical database. The nature of the deep brines, in particular their high salinities and

distinct isotopic signatures, suggests long residence times and indicates the deep system has remained isolated from the shallow groundwater system.

In summary, the review of available geoscientific information did not reveal any obvious conditions that would fail the identified potentially suitable areas to satisfy the containment and isolation function. Potential suitability of these areas would need to be further assessed during subsequent stages of the site evaluation process.

4.4.3.2 Long-term Resilience to Future Geological Processes and Climate Change

This safety function requires the containment and isolation functions of the repository are not unacceptably affected by future geological processes and climate changes, including earthquakes and glacial cycles. A full assessment of these processes requires detailed site-specific data that would be collected and analyzed through detailed surface and subsurface investigations. The assessment would include understanding how the site has responded to past glacial cycles and geological processes, and would entail a wide range of studies involving disciplines such as seismology, hydrogeology, hydrogeochemistry, paleohydrogeology, and climate change. At this desktop preliminary assessment stage of the site evaluation process, the long-term stability function is evaluated by assessing whether there is any evidence that would raise concerns about the long-term stability of the general potentially suitable areas identified in the Municipality of Central Huron.

The Paleozoic sedimentary sequence in the Central Huron area, including the identified general potentially suitable areas, is underlain by Precambrian crystalline basement of the Grenville Province, the southeastern-most subdivision of the Canadian Shield. The Precambrian Grenville Province is generally considered to have been relatively tectonically stable since approximately 970 million years ago (Section 4.3.5). As shown in Figure 4-6, there have been no recorded earthquakes within the Municipality of Central Huron since 1985, with the closest recorded earthquakes located offshore in Lake Huron about 25 kilometres southwest of the Municipality. The maximum magnitude of these events was of 2.4 Nuttli Magnitude. In addition, there are no mapped subsurface faults extending into the sedimentary sequence of the Central Huron area, and interpretation of a 2D seismic line within the Municipality did not identify the presence of any potential fault (Geofirma, 2015b).

The geology of the Central Huron area is typical of many areas of southern Ontario, which have been subjected to nine glacial cycles during the last million years (Peltier, 2003). Glaciation is a significant past perturbation that could occur in the future. Findings from studies conducted in other areas of southern Ontario (NWMO, 2011) suggest the deep subsurface Paleozoic sedimentary formations have remained largely unaffected by past perturbations such as glaciations (Sections 4.3.4 and 4.3.5).

As discussed in Section 4.3.5, land in the Central Huron area is still experiencing isostatic rebound following the end of the Wisconsinan glaciations. The estimated rebound is fairly small (about 0.5 millimetres per year) and should not affect the long-term stability of a deep geological repository. As also mentioned in Section 4.3.5, a neotectonic study conducted by Slattery (2011) concluded the area within a radius of up to 50 kilometres from the Bruce nuclear site has not likely experienced any post-glacial neotectonic activity. Hallet (2011) conducted a study on glacial erosion caused by the Laurentide Ice Sheet in southern Ontario, including the potentially suitable areas identified in the Municipality of Central Huron. The study concluded that potential future glacial erosion rates in the area would be limited, with a conservative estimate of erosion

of only 100 metres per one million years, which would not affect the integrity of a deep geological repository located at a depth of 500 metres or more below ground surface.

In summary, available information indicates the identified general potentially suitable areas in the Municipality of Central Huron have the potential to satisfy the long-term stability function. The review did not identify any obvious conditions that would cause the performance of a repository to be substantially altered by future geological and climate change processes. The long-term stability of the potentially suitable areas would need to be further assessed during subsequent stages of the evaluation process through detailed multidisciplinary site-specific geoscientific and climate change site investigations.

4.4.3.3 Safe Construction, Operation and Closure of the Repository

This safety function requires the characteristics of a suitable site to be favourable for the safe construction, operation, closure, and long term performance of the repository.

There are few surface constraints that would limit the construction of surface facilities in the general potentially suitable areas identified in the Municipality of Central Huron. The general potentially suitable areas are characterized by a relatively flat topography with limited obvious topographic features, and they contain enough surface land outside protected areas, source water protection zones, and major water bodies to accommodate the required repository surface facilities.

From a constructability perspective, although no site-specific information on rock strength characteristics and in-situ stresses was found for the Municipality of Central Huron, there is abundant information from other locations in southern Ontario that could provide insight into what would be expected for the area. Given the greater depth of the Cobourg Formation in the Municipality of Central Huron, there is potential for higher in-situ stresses for a proposed DGR in this formation. However, available information on strength and in-situ stresses in the region suggests the Upper Ordovician Cobourg Formation has favourable geomechanical characteristics and is amenable to the excavation of stable underground openings. As discussed in Section 4.3.8, the sedimentary sequence at repository depths in the Central Huron area is expected to have favourable geomechanical characteristics based on available information from the Bruce nuclear site (Intera Engineering Ltd., 2011). This would need to be confirmed at later stages of the site evaluation process through collection of site-specific data.

Overburden cover in the potentially suitable areas is extensive, with thicknesses within the Municipality typically ranging from zero up to about 80 metres locally. At this early stage of the evaluation, it is anticipated that overburden cover is not a limiting factor for the construction and operation of a potential repository in the general potentially suitable areas.

In summary, the identified general potentially suitable areas have good potential to satisfy the safe construction, operation, and closure function.

4.4.3.4 Isolation of Used Fuel from Future Human Activities

A suitable site must not be located in areas where the containment and isolation functions of the repository are likely to be disrupted by future human activities. These include areas containing economically exploitable natural resources or groundwater resources at repository depth.

As discussed in Section 4.3.7, the mineral potential in the identified general potentially suitable areas includes only local extraction of sand and gravel, which is limited to very shallow depths and would not have an effect on a deep geological repository hosted in the deeper Cobourg Formation. The potential for shallow bedrock resources in the Municipality is constrained by the presence of thick overburden.

The salt beds of the Salina Group are known to occur beneath the general potentially suitable areas identified in the Municipality of Central Huron (Section 4.3.7 and Figure 4-7). The Salina B and A2 salt beds, which are mined at Goderich, are up to approximately 80 metres and 20 metres thick, respectively, within the Municipality. There are also two historical gas pools in the general potentially suitable areas identified within the Municipality. These pools produced gas from pinnacle reefs of the Guelph Formation, approximately 300 metres above the preferred Cobourg Formation, and currently are being used for gas storage. At this stage of the assessment, other than the location of the known historical pools, the presence of hydrocarbons and salts within the Municipality is not considered as preventing siting the repository within the Municipality. However, the impact of salt and hydrocarbon resource potential on repository siting and safety would need to be further assessed during future stages of the site evaluation process. As discussed in Section 4.3.7, the potential for groundwater resources at typical repository depths (i.e., within the Cobourg Formation) in the Central Huron area is extremely low.

In summary, potential for the containment and isolation function of a repository in the general potentially suitable areas to be disrupted by future human activities would need to be further assessed.

4.4.3.5 Amenability to Site Characterization and Data Interpretation Activities

To support the case for demonstrating long-term safety, the geoscientific conditions at a potential site must be predictable and amenable to site characterization and data interpretation. Factors affecting the amenability to site characterization include: geological heterogeneity; structural and hydrogeological complexity; accessibility; and the presence of lakes or overburden with thickness or composition that could mask important geological or structural features.

As discussed in Geofirma (2015a), the Paleozoic sedimentary sequence beneath the Central Huron area is consistent with the regional geological framework for southern Ontario. The Paleozoic bedrock stratigraphy is characterized by a near-horizontally bedded, undisturbed “layer cake” geometry that is laterally extensive and traceable beneath southern Ontario. Although subject to site-specific confirmation, current evidence strongly suggests transferability of geologic properties and attributes is possible within this predictable sedimentary sequence.

Quaternary overburden deposits within the general potentially suitable areas identified in the Municipality (Figure 4-5) have thicknesses ranging from zero to 80 metres locally (Section 4.3.3). Given the regional geological framework, the “layer cake” geometry and the predictability of the subsurface Paleozoic sequence, the thickness of the overburden cover is not likely to affect the ability to characterize the subsurface bedrock formations beneath the identified general potentially suitable areas. The general potentially suitable areas identified in the Municipality of Central Huron are accessible for site characterization activities using the existing road network.

In summary, evidence suggests the sedimentary geologic setting and attributes beneath the general potentially suitable areas within the Municipality would be amenable to site characterization for the purpose of developing a repository safety case.

4.5 Geoscientific preliminary assessment findings

The objective of the Phase 1 geoscientific preliminary assessment was to assess whether the Municipality of Central Huron contains general areas that have the potential to satisfy the geoscientific site evaluation factors outlined in the NWMO's site selection document (NWMO, 2010).

The preliminary geoscientific assessment built on the work previously conducted for the initial screening (AECOM, 2013) and focused on the Central Huron area (Figure 4-1). The assessment was conducted using available geoscientific information and key geoscientific characteristics that can be realistically assessed at this early stage of the site evaluation process. These include: geology; structural geology; surface conditions; protected areas; and the potential for economically exploitable natural resources. Where information for the Central Huron area was limited or not available, the assessment drew on information and experience from other areas with similar geological settings in southern Ontario. The geoscientific desktop preliminary assessment included the following review and interpretation activities:

- Assembly and detailed review of available geoscientific information such as geology, structural geology, natural resources, hydrogeology and overburden deposits (surficial deposits);
- Interpretation of available geophysical data;
- Interpretation of available borehole geophysical data and a selected 2D seismic reflection line to provide information on the geometry and potential structural features of the subsurface bedrock geology;
- Terrain analysis studies to help assess overburden (surficial deposits) type and distribution, bedrock exposures, accessibility constraints, watershed and subwatershed boundaries, and groundwater discharge and recharge zones;
- Assessment of land use and protected areas including parks, conservation reserves, heritage sites and source water protection areas; and
- The identification and evaluation of general potentially suitable areas based on systematic assessment of key geoscientific characteristics and constraints that can be realistically assessed at this stage of the assessment.

The geoscientific desktop preliminary assessment indicates the geological setting in the Municipality of Central Huron has a number of favourable characteristics for hosting a deep geological repository for used nuclear fuel. The assessment identified the Ordovician Cobourg Formation (limestone) as the preferred host rock formation for a used nuclear fuel deep geological repository. Beneath the Municipality, the normally 55 metres thick Cobourg Formation occurs below the minimum preferred repository depth of 500 metres below ground surface and is overlain by approximately 200 metres of low permeability shales.

While the Municipality of Central Huron appears to contain large areas with favourable geoscientific characteristics, there are inherent uncertainties that would need to be addressed during subsequent stages of the site evaluation process. The assumption of transferability of geoscientific characteristics and understanding based on regional data and data from the Bruce nuclear site to the Municipality of Central Huron would need to be confirmed. Also, the impact of salt and hydrocarbon resource potential on repository siting and safety would need to be further assessed.

Should the Municipality of Central Huron be selected by the NWMO to advance to Phase 2 study, and remain interested in continuing with the site selection process, several years of progressively more detailed studies would be required to confirm and demonstrate whether they contain sites that can safely contain and isolate used nuclear fuel.

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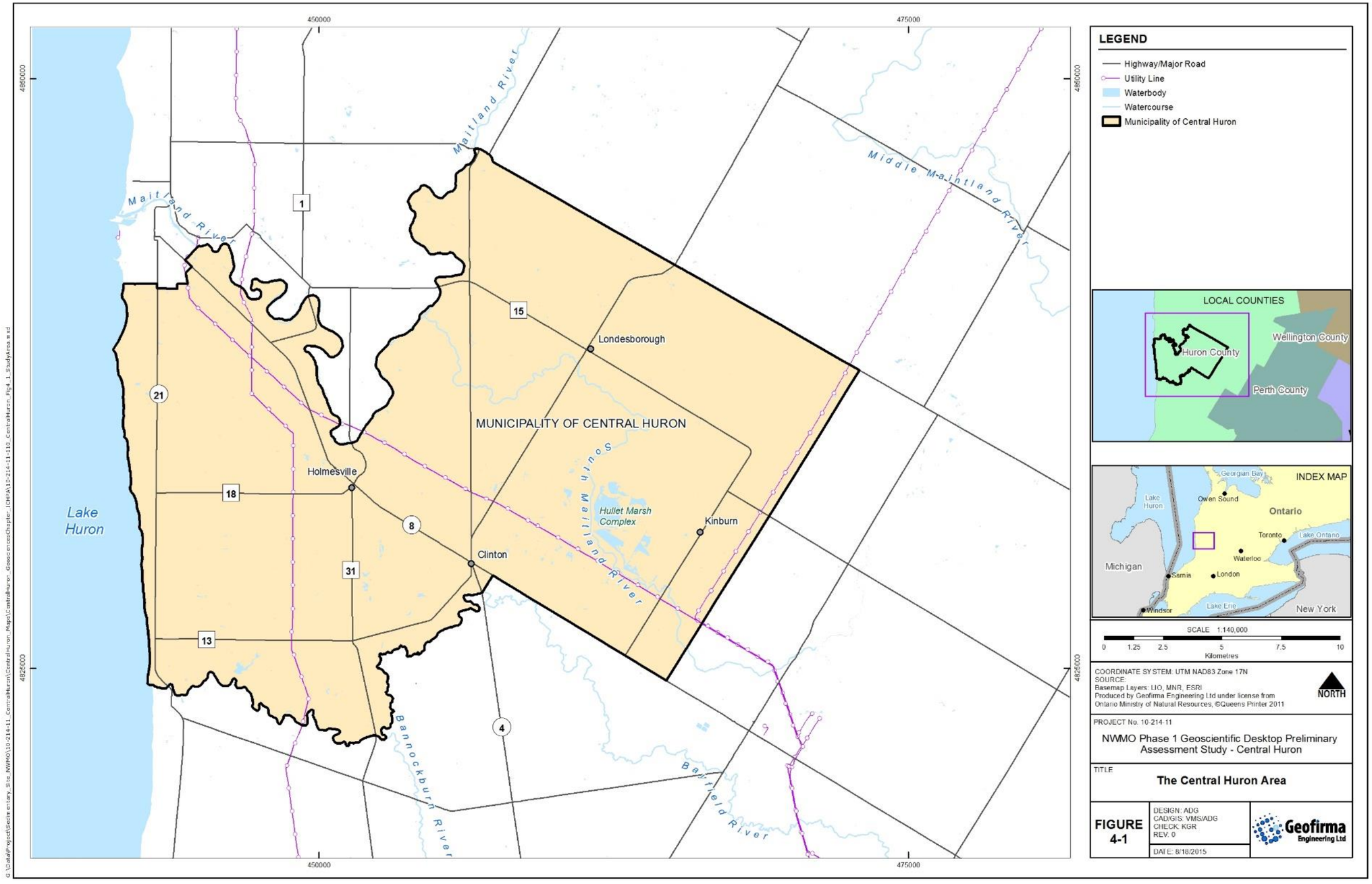


Figure 4-1: The Central Huron Area

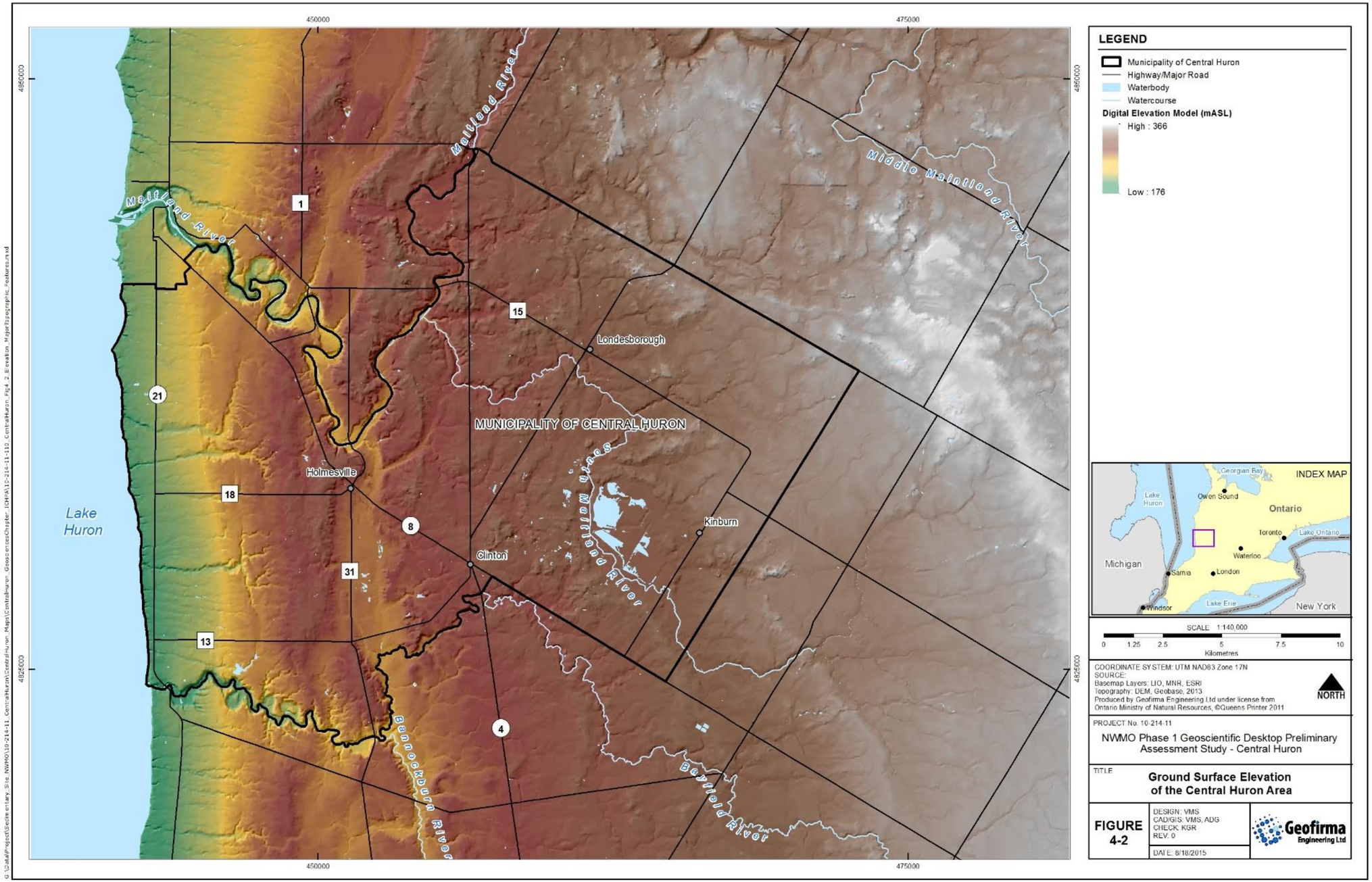


Figure 4-2: Ground Surface Elevation of the Central Huron Area

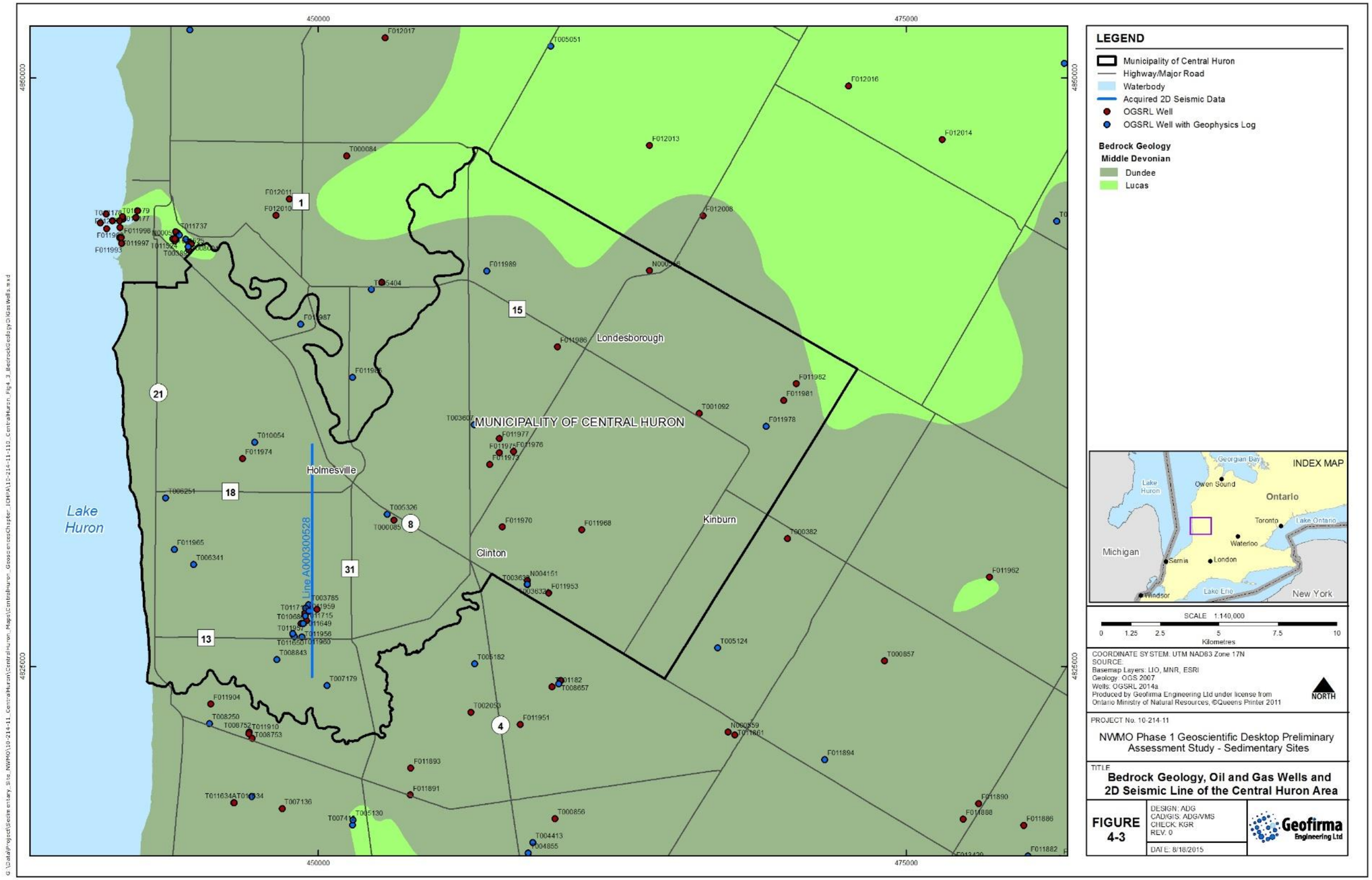
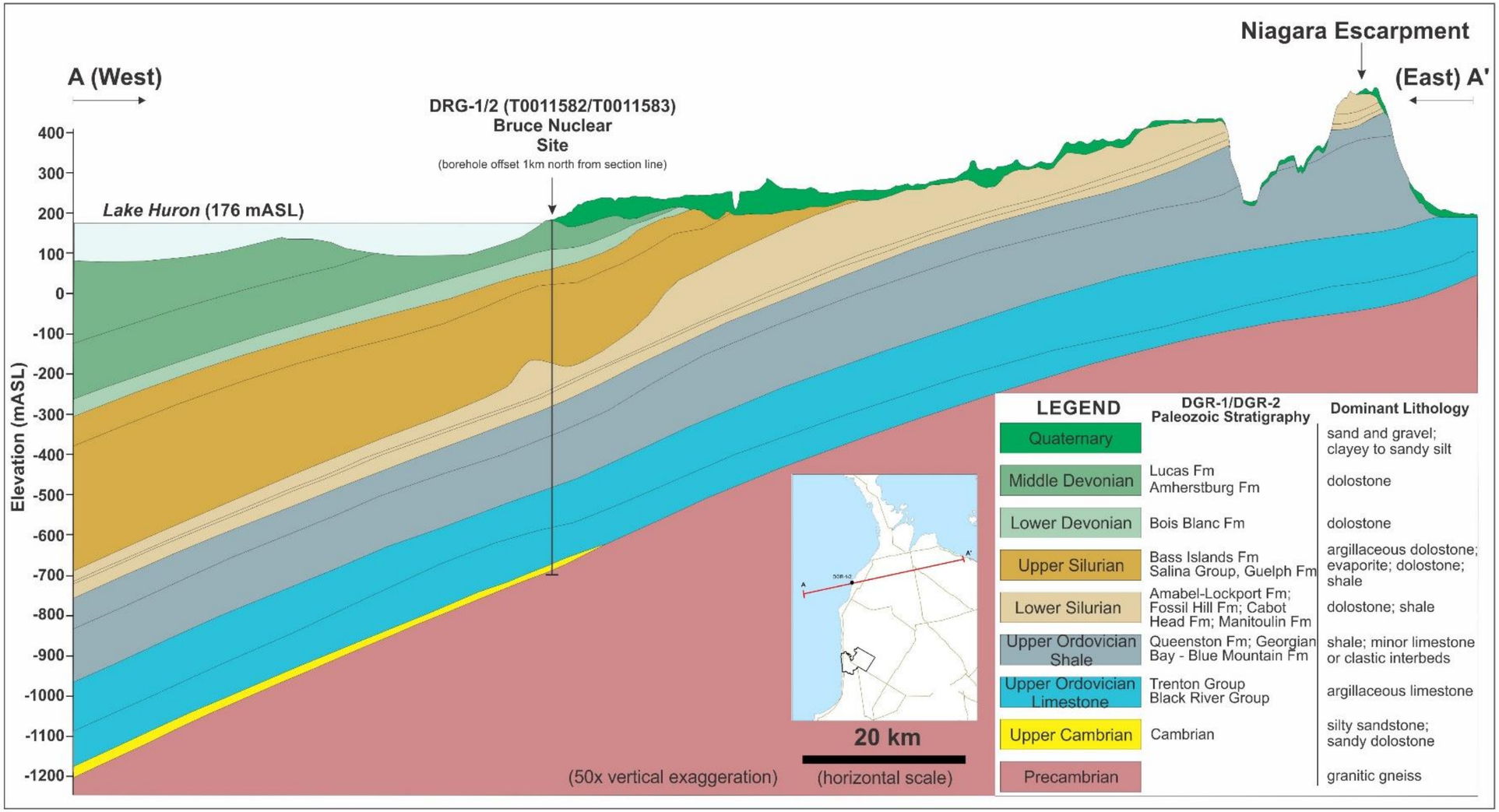


Figure 4-3: Bedrock Geology, Oil and Gas Wells, and 2D Seismic Line of the Central Huron Area



Data Source: after NWMO, 2011

FIGURE 4-4 - Regional Geological Cross-Section of the Eastern Flank of the Michigan Basin

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NWMO Phase 1 Geoscientific Desktop Preliminary Assessment Study - Central Huron

Prepared by: NMP/VMS
Reviewed by: KGR
Date: 08/18/2015

Geofirma Engineering Ltd

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Figure 4-4: Regional Geological Cross-Section of the Eastern Flank of the Michigan Basin

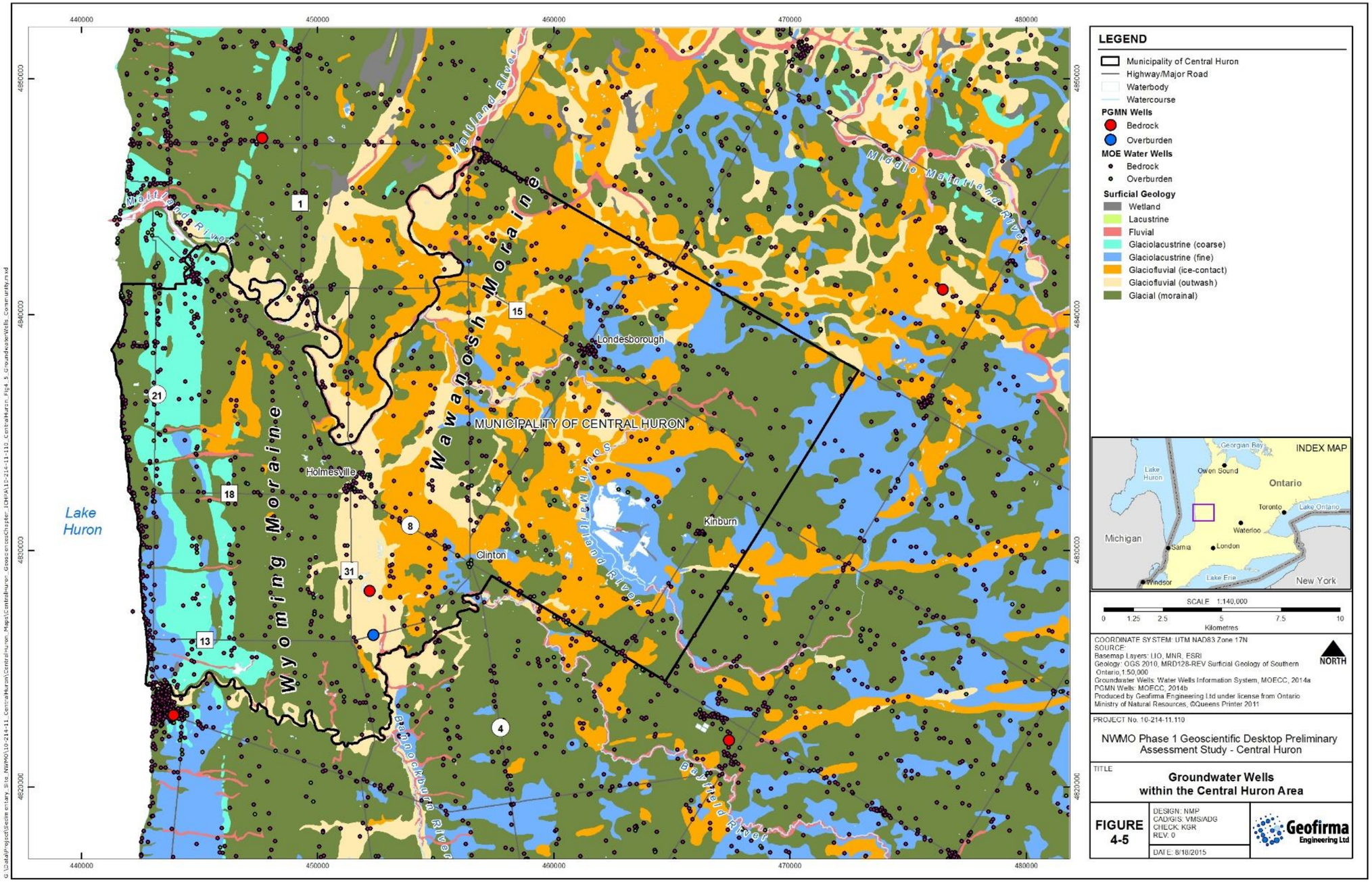


Figure 4-5: Quaternary Geology and Groundwater Wells of the Central Huron Area

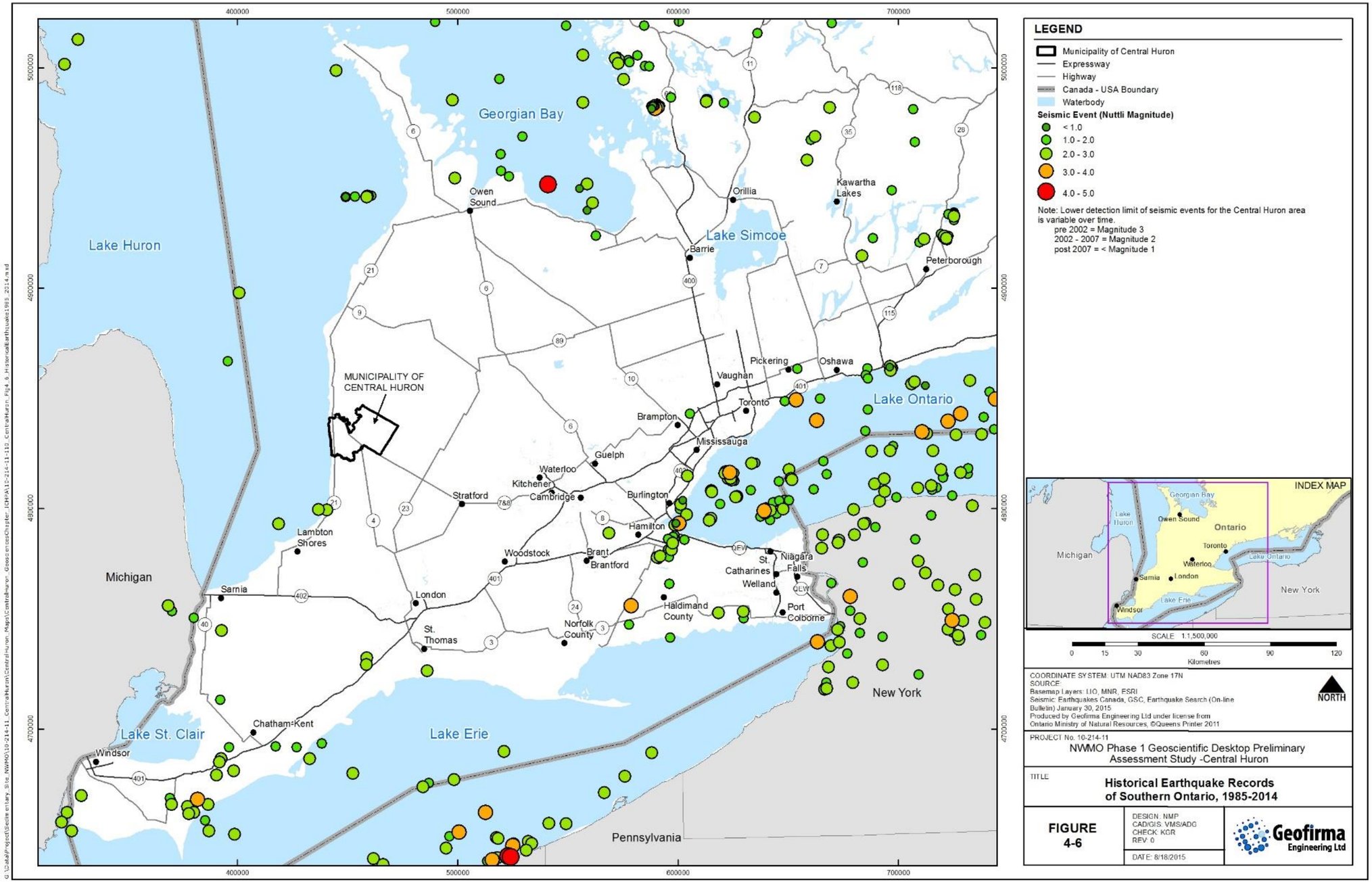


Figure 4-6: Historical Earthquake Records of Southern Ontario, 1985-2014

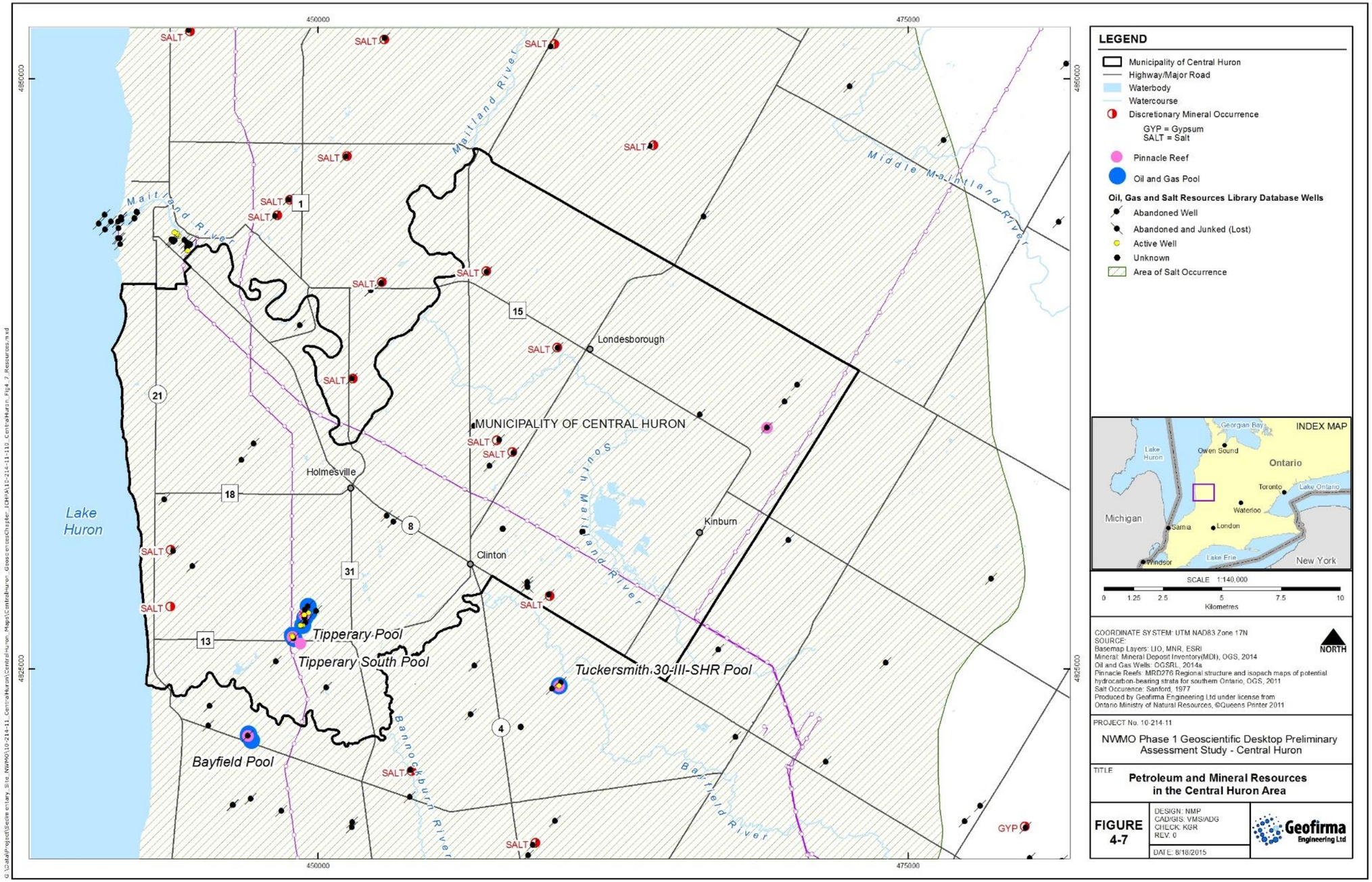


Figure 4-7: Petroleum and Mineral Resources of the Central Huron Area

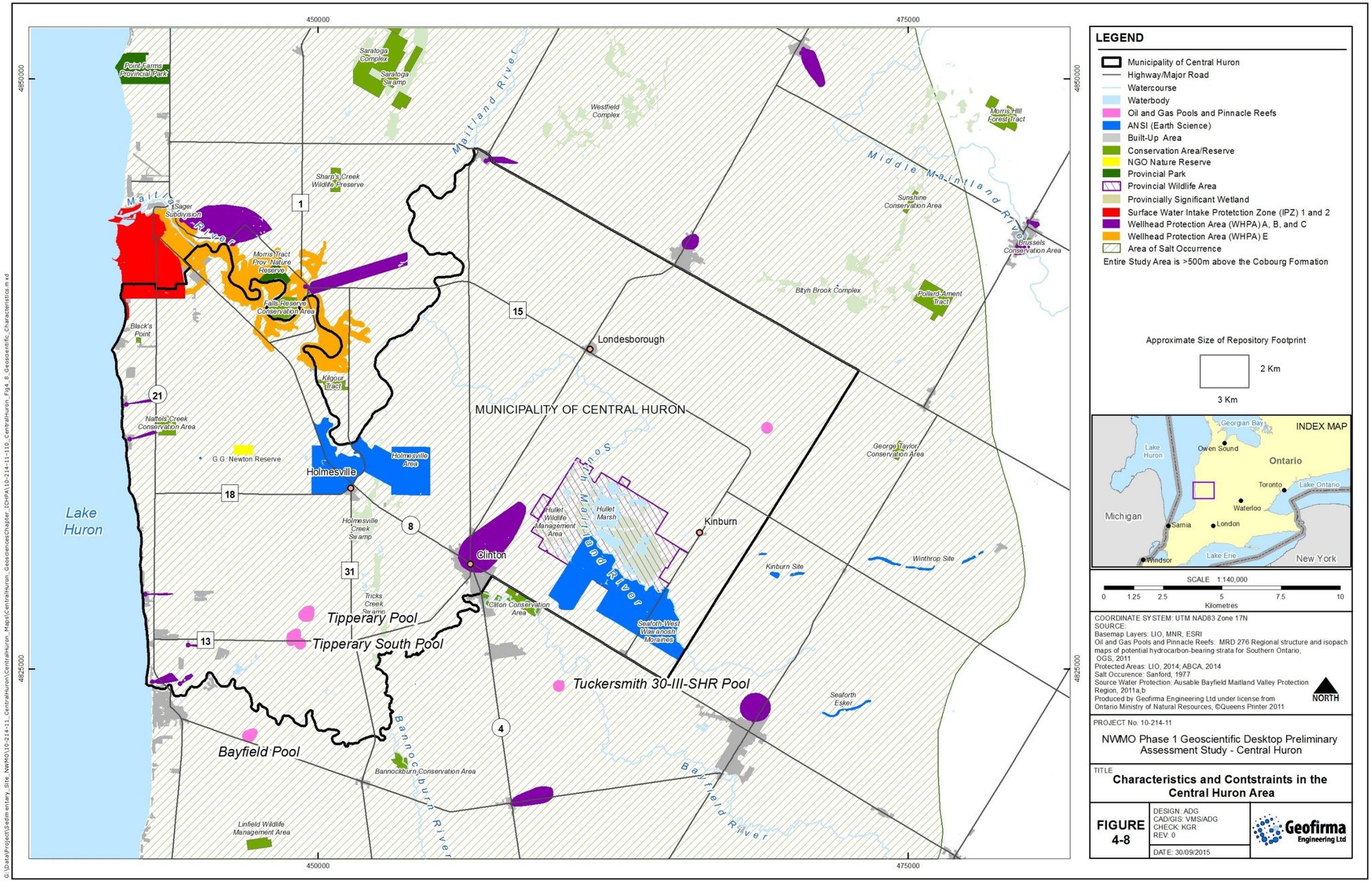


Figure 4-8: Key Geoscientific Characteristics and Constraints in the Central Huron Area

5. PRELIMINARY ENVIRONMENT AND SAFETY ASSESSMENT

5.1 Environment and Safety Assessment Approach

The objective of this preliminary assessment is to assess the potential to ensure the health and safety of people and the environment in the Municipality of Central Huron, and to explore the potential to manage any environmental effects that might result from the Adaptive Phased Management (APM) Project. This environment and safety assessment considered the following questions:

1. Is there anything in the natural environment that would preclude siting the repository somewhere in the Municipality of Central Huron?
2. If the repository is located somewhere in the Municipality of Central Huron, would environmental effects that could not be managed be likely to occur during siting, construction, operation, or decommissioning and closure of the repository?
3. If the repository is located somewhere in the Municipality of Central Huron, would postclosure health or environmental effects that could not be managed be likely to occur?

The assessment presented here takes into account the following factors:

- Safe containment and isolation of used nuclear fuel;
- Safe construction, operation, and closure of the repository; and
- Potential to avoid ecologically sensitive areas and locally significant environmental and cultural features.

The assessment is conducted at a desktop level (i.e., based on readily available information). It is expected that surface natural environment information is not uniformly available within the Municipality of Central Huron, so that a lack of identified features in some locations could simply be due to data limitations. It is also clear there is limited information at typical repository depths, which limits the ability to make substantive comments on long-term postclosure safety beyond those presented in the geoscientific assessment (Chapter 4). It is intended that suitability of potential siting areas will be further evaluated in a staged manner through a series of progressively more detailed scientific and technical studies. As part of these future activities, discussions with interested communities, potentially affected First Nation and Métis communities, and surrounding communities, as well as field studies, would be undertaken to aid in the characterization of environmental conditions.

The Initial Screening criteria include that there must be sufficient available land and that the available land must be outside protected areas, heritage sites, provincial parks and national parks (NWMO, 2010). This chapter begins to provide information on environmental features in the Municipality of Central Huron that may help inform the identification of potential suitable sites during subsequent stages of the site selection process.

The information presented in this chapter includes the following:

- General description of the environment;
- Assessment of potential effects on people and the environment in various project phases through closure and monitoring; and
- Assessment of postclosure safety aspects.

5.2 Description of the Environment

The environment and safety assessment is conducted within the Municipality of Central Huron, also referred to as “Central Huron”, as shown on Figure 4-1.

A detailed description of the environment for the Municipality of Central Huron is provided in Golder (2015). Summary information is presented here.

5.2.1 Communities and Infrastructure

Figure 5-1 shows the location of the Municipality of Central Huron, as well as the infrastructure and major land use within the Central Huron area, including the locations of protected lands, source water protection areas, and settlement areas.

The Municipality of Central Huron is 456 square kilometres in size (LIO, 2013), with a population of 7,591 (Statistics Canada, 2013). Central Huron is located in the centre of Huron County along the eastern shore of Lake Huron between the communities of Goderich and Bayfield. More information on the Municipality of Central Huron is provided in Chapter 7.

There are a number of First Nations and Métis communities in the vicinity of Central Huron including the Chippewas of Kettle and Stony Point, Aamjiwnaang, Walpole Island, Six Nations, and the Saugeen Ojibway Nations. The Georgian Bay Council of the Métis Nation of Ontario is in the vicinity. The Historic Saugeen Métis are also located in the vicinity.

Highway 8 passes in a northwest-southeast orientation through the centre of the Municipality of Central Huron, Highway 21 runs from north to south along the western boundary of the Municipality of Central Huron, following the Lake Huron shoreline, and Highway 4 runs northward up to the community of Clinton. A rail corridor runs through Central Huron from Goderich to Clinton en route to Stratford; a railway line also branches from Clinton south to Exeter, parallel to Highway 4. A number of transmission lines cross through Central Huron including a 500 kilovolt transmission line running from north to south along the Lake Huron shoreline, a 115 kilovolt transmission line running southeast from Goderich to north of Seaforth, and a 230 kilovolt transmission line running parallel to the easternmost boundary of the Municipality. A natural gas pipeline crosses Central Huron in a southeasterly direction from Goderich through Clinton and along the southern boundary of the Municipality. The area is serviced by one airport. There is one operating landfill, one landfill that is currently inactive, and one waste water treatment plant in the Municipality of Central Huron.

One provincial wildlife management area (Hullet Wildlife Management Area), two conservation areas (Naftels Creek and Black’s Point) and one nature reserve (George G. Newton Nature Reserve) are located in the Municipality of Central Huron. A number of additional ecological features, including provincially significant wetlands, occur within Central Huron, and are described in more detail in Golder (2015). There is a provincial park, a nature reserve, and 13 additional conservation areas located just outside the Municipality of Central Huron.

The Ontario Archaeological Sites Database through Past Portal identified 20 known archaeological sites in the Municipality of Central Huron, with ten recorded as early (pre-contact) aboriginal campsites or findspots, four identified as Middle or Late Woodland aboriginal sites, three historic Euro-Canadian, and three without information (OMTCS, 2015). There are 17 municipal or provincial designated heritage properties (Huron County, 2015; OHT, 2015) and no federally designated historic sites (Parks Canada, 2015) in the Municipality of Central Huron.

The presence of local heritage sites would need to be confirmed in discussion with the community and potentially affected First Nation and Métis communities.

As discussed in Section 4.3.7, water wells in Central Huron obtain water from the overburden or shallow bedrock. The Ontario Ministry of the Environment and Climate Change (MOECC) Water Well Information System (WWIS) database contains 1,117 records for the Municipality of Central Huron. These 1,117 water wells generally range from 1.2 to 135 metres in depth, with two deeper wells at 235 metres and 275 metres (MOECC, 2014). No potable water supply wells are known to exploit aquifers at typical repository depths in the Municipality of Central Huron or anywhere else in southern Ontario. The Municipality of Central Huron obtains its municipal water supply from overburden and shallow bedrock aquifers. Shallow groundwater also supports private domestic, agricultural, and industrial use.

There are nine wellhead protection areas (WHPAs) located within or extending into the Municipality of Central Huron, and one surface water intake with an intake protection zone (IPZ) extending into Central Huron. The locations of municipal wells and their WHPAs are shown on Figure 5-1.

5.2.2 Natural Environment

As described in Chapter 4, the Municipality of Central Huron is entirely covered by overburden, which includes glacial till, glaciofluvial outwash, and ice-contact deposits forming hummocky terrain. The eastern part of the Municipality includes a portion of the low relief Stratford till plain and adjacent fine-grained glaciolacustrine deposits. The central part of the Municipality of Central Huron is dominated by the Wawanosh moraine, characterized by an area of interbedded till and glaciofluvial ice-contact deposits. In the western part of the Municipality of Central Huron, the Wyoming moraine forms well-defined north-south ridge crests parallel to the Lake Huron shoreline (Cooper and Fitzgerald, 1977). The land surface in Central Huron ranges from a maximum elevation of about 366 metres above sea level to a minimum of about 176 metres above sea level along the shores of Lake Huron. There is a general downward slope from east to west towards Lake Huron.

The bedrock geology in the Municipality of Central Huron consists of a thick Paleozoic sedimentary sequence, deposited approximately 540 to 359 million years ago. The sedimentary stratigraphy includes layers of shale, carbonate, and evaporate units (Johnson et al., 1992), which lie unconformably over the Precambrian crystalline basement, characterized by gneisses and metamorphic rocks of the Grenville Province of the Canadian Shield (Percival and Easton, 2007; White et al., 2000). Within the Salina Formation of the Paleozoic sedimentary sequence, salt beds are present beneath Central Huron. In addition, there are two known (and now depleted) historic hydrocarbon pools; these reservoirs are currently being used for natural gas storage. As discussed in Chapter 4, further studies would be needed to assess the potential for hydrocarbon resources.

The Municipality of Central Huron is located within a temperate and humid continental climate zone, with hot, humid summers and cold winters. In the summer, active weather such as showers and thunderstorms occur, and Central Huron can experience severe thunderstorms and even occasional tornadoes during the summer. Most precipitation falls from the late summer through the winter months due to snow squall activity. In winter, the proximity to Lake Huron results in lake effect snow squalls.

Figure 5-2 shows the significant natural features within Central Huron, including watershed boundaries, significant valleys, deer wintering areas, spawning sites and nesting areas for species of interest. This information will be further developed in the future through discussions with interested communities and potentially affected First Nation and Métis communities, as well as field studies, should the community proceed in the site selection process.

The Municipality of Central Huron is located within the St. Lawrence Drainage Area. Most of the northern part of the Municipality of Central Huron is within the Maitland tertiary watershed while the southern part is within the Ausable tertiary watershed. The most prominent drainage features in the Municipality of Central Huron are the Maitland and Bayfield rivers. Drainage is generally from east to west into Lake Huron. Water bodies occurring within the Municipality of Central Huron are mostly streams and rivers that are warm water tolerant, with some cool and cold water in the tributaries. In the Bayfield River, at least 45 species of fish and 14 species of mussels have been confirmed (Schnaithmann et al., 2012). The Maitland River supports recreational fishing including rainbow trout, salmon, and smallmouth bass (MVCA, 2013). These rivers are actively managed and support provincial and federal biodiversity initiatives as well as supporting local sport fishing and tourism.

The Municipality of Central Huron lies within the Deciduous Forest Region where woodlands consist primarily of American beech and sugar maple, together with basswood, red maple, and oak on the northern limit of the Carolinian Forest (CCC, 2013). In areas where agriculture dominates, terrestrial features and areas are generally associated with valley lands along watercourses and within wetlands. There are no forest management units assigned by the Ontario government for this part of the province. Forests are managed jointly by the Ontario Ministry of Natural Resources (OMNR), municipalities, and Conservation Authorities; they contain important sustaining areas for wildlife such as feeding, wintering, and calving sites for deer, and concentration and nesting areas for raptors, herons and waterfowl. Hunting of white-tailed deer, waterfowl, and wild turkey is common in permitted areas.

Although Central Huron is primarily an agricultural landscape, it is located at the transition of Ontario forest zones and in line with known bird migration routes along the eastern shore of Lake Huron. The area has been subject to a large number of ecological studies resulting in the identification and recording of numerous Species at Risk (SAR) within this area. Habitats within Central Huron directly or indirectly support the needs of 57 designated SAR listed as Endangered (END), Threatened (THR) or Special Concern (SC) (NHIC, 2013; OMNR, 2015; Ontario Nature, 2015; BSC, 2006; BCI, 2013a,b, 2014, 2015; Jones et al., 2013; Dobbyn, 1994 and CO, 2012) either under the provincial *Endangered Species Act* (ESA), 2007, or the federal *Species at Risk Act* (SARA), 2002. These species include: seven mammals, 22 birds, eight herpetofauna, 12 fish and aquatic species, three invertebrates, and five plants. Further data collection through site-specific surveys and potential discussions with interested communities and potentially affected First Nation and Métis communities would be needed to refine habitat use and suitability for these species, should the community proceed in the site selection process.

5.2.3 Natural Hazards

Natural hazards may be important with respect to operational and postclosure safety of the repository. Potential natural hazards that could occur in the Municipality of Central Huron are described in the Environment Report (Golder, 2015). A preliminary qualitative assessment of natural hazards is summarized in this section. These identified natural hazards represent ways in which the natural environment could potentially affect the APM Project during the various

phases of implementation (see Table 3-1). As with all large-scale construction projects, the design process will take into account the site-specific characteristics of the natural environment, and mitigate the risks associated with occurrence of these natural hazards, as appropriate.

- Earthquakes – Low risk – Located in a seismically stable region of the Michigan Basin in southwestern Ontario and has a low seismic hazard rating (NRCan, 2015) (see Chapter 4 for additional information).
- Tornadoes/Hurricanes – Possible risk – Located in an area with a low to moderate tornado frequency (less than 2.7 tornadoes per year per 10,000 square kilometres), but where there is a potential for F2–F5 tornadoes (Sills et al., 2012) and is located outside the geographic area where hurricanes typically occur. It is noted that an F3 tornado struck the Town of Goderich and the Municipality of Central Huron on August 21, 2011 (The Weather Network, 2013).
- Flooding – Possible risk – Possible risk of flooding in some areas during spring freshet due to moderately-sized catchment areas, modified stream channels, and relatively flat Lake Huron shoreline. Risk will vary based on specific location.
- Drought – Low risk – Risk of drought is low and unlikely to affect the viability of local water sources.
- Snow/Ice – Moderate risk – Total average annual snowfall is moderate (350 centimetres), and significant snowfall events are possible due to lake effect snow squall activity during the winter period.
- Fire – Low risk – Land use is largely agricultural, with wooded areas covering 10 per cent of land. Locations of historical fires are unknown. In wooded areas, fires could be initiated by lightning strikes or human activity.
- Landslide – Low risk – General risk of landslide is low due to stable slopes of modest gradients and low seismic hazard rating. Risk will vary based on specific location.
- Tsunami – Low risk – Low due to low seismicity and geology of the lake basin and near shore areas.

5.2.4 Environment Summary

Table 5-1 presents summary information for the Municipality of Central Huron taken from the Environment Report (Golder, 2015).

Table 5-1: Summary of Environmental Features within the Municipality of Central Huron

Environmental Feature	Summary
Areas	
Known Heritage Sites (Including Archaeological Sites)	Yes
Provincial Parks, Conservation Reserves	Yes
Wetlands	Yes
Infrastructure	
Availability of Major Water Source Within 5 kilometres	Yes
Major and Minor Road Access	Yes
Major Utility Alignments	Yes
Nearby Communities	Yes

Environmental Feature	Summary
Land Use	
Water Body/Wetland Coverage	1% / 8.8%
Active Agriculture	Yes
Active Forestry	No
Active Trapping and Hunting	Yes
Active Sport or Commercial Fishery	Yes
Natural Environment	
Potential Habitat Area for Endangered/Threatened/Species at Risk	Yes
Presence of Known Important Terrestrial Habitat Areas	Yes
Presence of Known Important Aquatic Habitat Areas	Yes
Areas of Natural and Scientific Interest (ANSIs) and Earth or Life Science Sites	Yes
Natural Hazards	
Occurrence of Forest Fires	Low
Potential for Earthquakes	Low
Potential for Tornadoes or Hurricanes	Possible Tornado; Low Hurricane
Potential for Flooding, Drought, Extreme Snow and Ice	Possible Flooding; Low Drought; Moderate Snow/Ice
Potential for Landslides	Low

5.3 Potential Environmental Effects

This section presents the results of a high-level screening assessment performed to identify potential interactions between the APM Project and the environment. The assessment considers:

- Activities associated with each project phase through closure and monitoring;
- Potential interaction of the activities with the environment;
- Environmental components that could be affected by the interaction;
- Potential effects of the interaction with the environmental components; and
- The potential for mitigation measures to avoid or minimize adverse effects.

The interactions, effects, and mitigation measures are determined by reference to existing Canadian and international environmental assessments, and not through site-specific analyses. Lastly, a judgment of the significance of residual adverse effects is made assuming implementation of feasible management or mitigation.

Since specific candidate site(s) within the Municipality of Central Huron have not been defined, the assessment reflects general conditions across the area. A full environmental assessment would be completed for any preferred site once determined, in accordance with the *Canadian Environmental Assessment Act.*

The environment is described by individual environmental components, each of which represents physical, biophysical, or social features that could be affected by the project. Environmental components used to understand the potential for environment effects at this preliminary assessment phase are as follows:

- Atmospheric Environment: air quality, noise, vibration, and light;
- Subsurface Environment: geology, hydrogeology, and groundwater quality;
- Aquatic Environment: surface water quality, surface water quantity and flow, sediment quality, and aquatic habitat and communities including sensitive species;
- Terrestrial Environment: vegetation communities, soil quality, wildlife habitat and communities, natural heritage features, and sensitive species;
- Radiation and Radioactivity: radiation dose to humans, including members of the public and project workers, and radiation dose to non-human biota; and
- Cultural Resources: Aboriginal heritage resources and Euro-Canadian heritage resources.

5.3.1 Potential Effects during the Site Selection Process

As explained in Section 1.5, the site selection process includes the identification of potential sites within the smaller number of communities and subsequent detailed investigations of preferred sites in communities that continue in the site selection process. These investigations could involve field surveys to better characterize the site-specific environment, including drilling and testing of boreholes, and environmental surveys. Activities may include line cutting and temporary road construction activities to construct access routes to sites undergoing detailed evaluation.

Table 5-2 summarizes the generic project-environment interactions that could occur during the site selection process. These activities may result in environmental effects associated with noise, vegetation clearing for site access and increased traffic. Site-specific project-environment interactions for the Municipality of Central Huron would need to be evaluated during subsequent steps of the site selection process.

Implementation of an environmental management plan for these activities would be expected to reduce the effects. For example, drilling fluids associated with site exploration boreholes would be contained at the site and disposed of appropriately. In addition, the location of drill sites and the alignment of roads for access to drill sites (if required) would be determined collaboratively with the community and potentially affected First Nation and Métis communities, and be designed to avoid protected areas, habitat areas for species of conservation concern, and heritage sites. Timing of activities would be managed to mitigate effects on biota if any potential interactions are identified.

Overall, no project-environment interactions are identified that would prevent activities associated with site selection in the Municipality of Central Huron.

Table 5-2: Potential Interactions with the Biophysical Environment during Site Selection Process

Environmental Component	Main Considerations	Is there Potential for an Effect?	Is Management and Mitigation Possible?	Are Significant Residual Effects Anticipated?
Atmospheric Environment	Vehicle emissions, dust, noise, light	Yes	Yes	No
Subsurface Environment	Change in groundwater quality and flow from site clearing	Yes	Yes	No
Aquatic Environment	Change in surface water quality and flow from site clearing, disturbance to aquatic habitat or biota from access construction	Yes	Yes	No
Terrestrial Environment	Clearing and disturbance to terrestrial habitat or biota from access construction, noise, increase in traffic	Yes	Yes	No
Radiation and Radioactivity	None – no additional radiation beyond natural background	No	—	—
Cultural Resources	Disturbance of archaeological resources from clearing	Yes	Yes	No

5.3.2 Potential Effects during Construction

The Construction Phase comprises the development of the selected site, construction of facilities, utilities and infrastructure necessary to support development and operation of the project, and excavation of the underground facilities and some of the placement rooms. During this phase, surface and underground facilities will be installed and commissioned, and will be ready to begin receiving used fuel. This phase could take 10 or more years to complete. A general description of the facility is provided in Chapter 3. Site preparation and construction would occur following completion and approval of an environmental assessment under the *Canadian Environmental Assessment Act*, and after applicable permits have been obtained.

A sizeable workforce would be expected. The substantial infrastructure available in the Municipality of Central Huron and its surrounding area is likely sufficient to accommodate the temporary construction workers.

Lay-down areas with storage and yard facilities for materials and equipment will also be necessary. It is assumed that new access road and railway systems may be required to provide access to the project site.

Temporary infrastructure to support the construction workforce and activities, including sewage treatment, water supply, and waste management facilities, would be made available at the project site until permanent infrastructure (i.e., powerhouse, water treatment plant, sewage treatment plant, landfill) is established. Electricity for site preparation activities and for early construction activities would be provided either by direct connection to existing lines or by diesel

generators. Heating for construction trailers and any temporary worker accommodations is assumed to use natural gas or propane.

During site preparation, the main activities would include clearing existing vegetation, levelling the site, and installing site drainage systems to manage surface run-off. Fuel storage and water storage tanks would also be located at the site to facilitate construction activities.

The major activity during construction would be the development of underground facilities. Repository construction begins with shaft sinking and full development of underground tunnels and service areas. This will include development of the Underground Demonstration Facility. The service shaft, waste shaft and upcast ventilation shaft would be excavated by controlled drill and blast techniques. Repository access tunnels would also use controlled drill and blast techniques or rock boring technology, designed to minimize damage to the surrounding rock. Once the shafts and access tunnels are complete, the first panel of placement rooms would be excavated. The remainder of placement room excavations would take place during the Operation Phase.

For a 4.6 million fuel bundle repository, storage of the excavated rock is expected to require an area of about 700 metres by 700 metres, with a height between three metres and six metres. A small portion of the excavated rock would be maintained on-site to support aggregate operations, with the balance transferred to the excavated rock management area, whose location would be determined collaboratively with the community and area (Chapter 3). The excavated rock management area will include a stormwater run-off pond to collect and manage the effluent before release to the environment in accordance with applicable regulatory requirements. Any mitigating measures required will form part of the overall environmental management program that will be developed in detail in later steps of the site selection process.

The construction of both above ground and underground facilities will require dewatering, as well as surface water run-off management, during the construction stages. If present, intermediate and deep groundwater generated during dewatering will require treatment for dissolved solids (e.g., iron and manganese) prior to release into the environment, whereas shallow groundwater and surface water run-off is not likely to require significant treatment. Water taking and water discharge into the environment will be strictly managed in accordance with provincial regulations.

During this phase, it would also be necessary to construct the permanent surface buildings and complete installation of common services, including waste management systems, utilities, and process and potable water supplies. Given that landfill space in the Municipality of Central Huron may be limited, it is assumed that a landfill could be constructed and operated at the project site throughout the Construction, Operation, Extended Monitoring, and Decommissioning and Closure Phases. It is assumed that an aggregate (rock crushing) plant and a concrete batch plant would need to be established on-site, and then operate as necessary until the repository is closed.

Buildings and facilities that are designated to be within the Nuclear Security Protected Area of the complex would be surrounded by a security fence, and lighting would be provided along the fence and at building entrances. A perimeter fence around the entire complex would also be installed. The fenced portion of the site is anticipated to occupy an area of about 600 metres by 550 metres; with an additional fenced portion measuring about 100 metres by 100 metres located some distance away, housing a ventilation shaft. During this phase, water would be

required primarily for drilling and excavation, for concrete mixing, and for worker drinking and personal use. Service water would be provided from a local, suitable source.

Current planning assumptions indicate the duration of this period would be about 10 years. The material requirements during this phase (water, cement, rock movement, traffic) would be of a scale and nature similar to other large mine or construction projects.

Table 5-3 summarizes the project-environment interactions that are expected to occur during the Construction Phase. This phase is the most disruptive to the biophysical environment. Construction activities may result in environmental effects associated with vegetation clearing, drilling and blasting, excavation, excavated rock storage, hardening of surfaces, placement of infrastructure, surface water and groundwater management, emissions from vehicles and equipment, dust, noise, and increased traffic.

In-design mitigation measures and implementation of an environmental management plan would reduce the environmental effects. Measures may include selection of infrastructure and corridor locations to avoid protected areas, habitat areas for communities or species of conservation concern, or heritage sites. Equipment will be designed to control emissions to air or to reduce noise. Dewatering for subsurface construction, surface water drainage management, operational and potable water supply, and waste water management would be designed and implemented in compliance with applicable regulations.

Within the Municipality of Central Huron, it is anticipated, based simply on the land area, that sites exist that avoid protected areas, and therefore, site preparation and construction activities could be undertaken. Feasibility will be reliant on appropriate understanding of environmental conditions at the site scale, in-design mitigation, and compliance with an environmental management plan designed around applicable legislation.

Overall, no project-environment interactions are identified that would prevent activities associated with site preparation and construction in the Municipality of Central Huron.

Table 5-3: Potential Interactions with the Biophysical Environment during Construction

Environmental Component	Main Considerations	Is There Potential for an Effect?	Is Management and Mitigation Possible?	Are Significant Residual Effects Anticipated?
Atmospheric Environment	Vehicle and equipment emissions, dust, noise, light, vibration due to underground blasting	Yes	Yes	No
Subsurface Environment	Change in groundwater quality and flow due to withdrawal for supply, drawdown for drilling and construction dewatering, and management of run-off from hardened surfaces	Yes	Yes	No

Environmental Component	Main Considerations	Is There Potential for an Effect?	Is Management and Mitigation Possible?	Are Significant Residual Effects Anticipated?
Aquatic Environment	Change in surface water quality or flow, disturbance to aquatic habitat or biota due to placement of infrastructure and required water supply, vibration due to underground blasting	Yes	Yes	No
Terrestrial Environment	Clearing and disturbance to terrestrial habitat or biota from infrastructure or rock pile placement, noise, vibration from underground blasting, increase in traffic	Yes	Yes	No
Radiation and Radioactivity	Doses to humans and biota from radon and natural rock activity	Yes	Yes	No
Cultural Resources	Disturbance of archaeological resources from clearing, placement of infrastructure, underground blasting	Yes	Yes	No

5.3.3 Potential Effects during Operation

The Operation Phase includes the receipt, packaging, and placement of used fuel in the repository. For a used fuel inventory of 4.6 million bundles, repository operations would last about 38 years (Chapter 3). Facility operations would only begin when all approvals, including a Canadian Nuclear Safety Commission (CNSC) operating licence, have been received.

All used fuel manipulations will take place in the Used Fuel Packaging Plant. This is a multi-storey reinforced concrete structure designed for receiving empty used fuel containers, receiving filled transportation casks, transferring used fuel bundles from the transportation casks to the used fuel containers, and sealing, inspecting, and dispatching filled used fuel containers for placement in the repository. Each placement site would be sealed following container placement. Once all sites in a placement room are sealed, the entire room would be closed and sealed.

Most steps in the packaging process are remotely operated, taking place in radiation-shielded rooms. Radioactive areas are maintained at a slightly negative pressure to preclude the spread of contamination. Ventilation air is cleaned, filtered, and monitored prior to leaving the facility. Radioactive releases during normal operation are anticipated to be a very small fraction of the regulatory limits.

To meet regulatory requirements, the safety analysis will investigate the consequences of upsets and accidents occurring during the Operation Phase. While the specific events to be analyzed will be defined in the future, such occurrences as loss of power, loss of ventilation, and dropping of a container will be addressed to verify and demonstrate robustness of the design. Analysis of similar events at other proposed used fuel repositories indicates the consequences are anticipated to be well below the regulatory limits.

An environmental monitoring system will be established to monitor for environmental effects, to optimize facility performance, and to demonstrate regulatory compliance. The environmental monitoring program would consist, as a minimum, of the following components:

- Groundwater Monitoring;
- Stormwater/Surface Water Monitoring;
- Air Quality Monitoring;
- Meteorological Monitoring; and
- Seismic and Vibration Monitoring.

Maintenance of the equipment and facilities, including safety checks and inspections, would be routinely undertaken during this phase. Support activities that would be carried out include preparation of buffer, backfill and repository sealing materials used in borehole and placement room sealing, rock crushing, and concrete mixing. The main external supplies would be the containers and the clay seal materials, which would be shipped through the area to the site.

The Operation Phase also includes continued excavation of additional placement rooms, which could involve drilling and blasting, tunnel boring, removal of rock, and continued operation of the excavated rock management area.

Raw water for the site would be sourced locally at the rate needed to meet the demands of site personnel, concrete production, sand production, and dust control. Water is not required for cooling of the used fuel.

Sewage collected from all serviced buildings will be piped to a Sewage Treatment Plant for treatment to provincial standards prior to discharge.

Several ponds will be established to effect either process water or stormwater control. All the ponds will be lined over their base and embankments with polyethylene for protection and to prevent water infiltration into the ground. Collected flows will be quality monitored and treated as required before being directed to downstream process (e.g., aggregate crushing plant) or to the off-site discharge.

Low- and intermediate-level radioactive waste will be handled as separate waste streams.

Active solid waste may be generated in the Used Fuel Packaging Plant, the Auxiliary Building, and the active liquid waste treatment process. These wastes would consist of such things as modules from the incoming transport containers, filters, spent resins, and cleaning materials.

Active solid wastes that are not or cannot be decontaminated to free-release limits will be placed into approved transportation containers and shipped to a licensed long-term management facility.

Active liquid waste may be generated in the Used Fuel Packaging Plant and the Auxiliary Building. These wastes would originate from decontamination of used fuel modules, cell wash downs, and the wet decontamination of irradiated fuel transport casks and containers. Active liquid waste would be managed in two facilities – a storage building and a waste treatment building – with the storage building incorporating secondary containment for spills or leaks. Most of these liquids will be cleaned on-site and returned to the environment with any residuals being sent to disposal.

Monitoring would be conducted throughout the Operation Phase, including a period of time after the last used fuel containers have been placed prior to the start of decommissioning.

Activities could include emissions monitoring, environmental monitoring, repository performance monitoring, and maintenance activities. Postclosure monitoring is discussed in Section 5.4.

Table 5-4 summarizes the project-environment interactions that are expected to occur during the Operation Phase. Implementation of an environmental management plan, well-defined operating procedures, and follow-up on a comprehensive monitoring program would be expected to reduce the environmental effects.

Overall, no project-environment interactions are identified that would prevent operating the repository in the Municipality of Central Huron.

Table 5-4: Potential Interactions with the Biophysical Environment during Operation

Environmental Component	Main Considerations	Is There Potential for an Effect?	Is Management and Mitigation Possible?	Are Significant Residual Effects Anticipated?
Atmospheric Environment	Vehicle and equipment emissions, dust, noise, light, vibration due to underground blasting	Yes	Yes	No
Subsurface Environment	Change in groundwater quality and flow due to withdrawal and dewatering, and management of run-off from hardened surfaces and the excavated rock pile	Yes	Yes	No
Aquatic Environment	Change in surface water quality or flow, disturbance to aquatic habitat or biota due to placement of infrastructure and required water supply, run-off from surfaces and the rock pile, and vibration due to underground blasting	Yes	Yes	No
Terrestrial Environment	Disturbance to terrestrial habitat or biota from infrastructure or rock pile placement/run-off, noise, vibration from underground blasting, increase in traffic	Yes	Yes	No
Radiation and Radioactivity	Doses to humans and biota from radon, natural rock activity and repository operation	Yes	Yes	No
Cultural Resources	Disturbance to local enjoyment of the area	Yes	Yes	No

5.3.4 Potential Effects during Decommissioning and Closure

The Decommissioning and Closure Phase of the project would begin once placement operations have been completed, sufficient performance monitoring data have been collected to support approval to decommission, a decommissioning licence has been granted, and the community has agreed to proceed to this phase. This phase would end when the repository has been sealed and all surface facilities have been decontaminated and removed. Monitoring would continue for a period of time as determined in discussion with regulatory authorities and the community. The main activities undertaken during this phase would include the following:

- Decontamination, dismantling, and removal of surface and underground infrastructure and facilities, including water intake structures;
- Sealing of tunnels, shafts and service areas;
- Sealing of all surface boreholes and those subsurface boreholes not required for monitoring;
- Closure of the on-site landfill (if present); and
- Monitoring as necessary.

Once the repository is sealed and all buildings and facilities are removed, the area must be shown to meet regulatory limits for the agreed-upon end-state land use. This would include landscaping and restoration of natural habitat on the site.

Before the facility is closed, used fuel handling activities would cease, all the underground placement rooms would be sealed and any related radiological emissions would stop. During closure, any residual radioactive materials would be removed. Structures used for radioactive work would be carefully dismantled to limit the amount of dust produced. Any radioactive soil would be managed in accordance with applicable regulations or guidelines. The radiological releases are anticipated to be a small fraction of regulatory limits and no greater than those during the Operation Phase.

Table 5-5 summarizes the project-environment interactions that are expected to occur during the Decommissioning and Closure Phase. The potential environmental effects are expected to be similar to those encountered during site preparation and construction, with the exception of the presence of residual radioactive materials.

The implementation of an environmental management plan specific to this phase of the project, along with continued occupational dose management programs, would reduce potential effects on humans and the environment. More generally, the net effect of the decommissioning would be to reduce the surface footprint of the repository and therefore would be, in general, beneficial to the environment after completion.

Overall, no project-environment interactions are identified that would prevent decommissioning and closing the repository in the Municipality of Central Huron.

Table 5-5: Potential Interactions with the Biophysical Environment during Decommissioning and Closure Activities

Environmental Component	Main Considerations	Is There Potential for an Effect?	Is Management and Mitigation Possible?	Are Significant Residual Effects Anticipated?
Atmospheric Environment	Vehicle and equipment emissions, dust, noise, and light	Yes	Yes	No
Subsurface Environment	Change in groundwater quality and flow due to closure of system for withdrawal for supply and management of run-off from hardened surfaces and the rock pile	Yes	Yes	No
Aquatic Environment	Change in surface water quality or flow, disturbance to aquatic habitat or biota due to removal of infrastructure, run-off from the rock pile and required water supply	Yes	Yes	No
Terrestrial Environment	Clearing and disturbance to terrestrial habitat or biota from infrastructure or rock pile removal, noise, increase in traffic	Yes	Yes	No
Radiation and Radioactivity	Doses to humans and biota from radon and from residual radioactivity during infrastructure removal operations	Yes	Yes	No
Cultural Resources	Disturbance to local enjoyment of the area	Yes	Yes	No

5.3.5 Potential Effects during Monitoring

The conceptual project design makes provision for up to two periods of monitoring; however, specific details would be developed in collaboration with the local community and approved by the regulatory authority. The first of these periods would occur during operation after the placement activities are completed and prior to the initiation of the Decommissioning and Closure Phase. The other monitoring period may occur during decommissioning. Activities during these monitoring periods could involve monitoring conditions in the repository itself, as well as monitoring environmental factors in the geosphere and biosphere (i.e., subsurface and surface environments).

Monitoring activities may require human presence. Such activities could include managing boreholes and acoustic monitors, and conducting air, water, and biology surveys or sampling. These would likely use existing borehole sites and roads. When compared with the

environmental effects associated with the earlier project phases, potential environmental effects associated with conducting this monitoring are likely to result in fewer environmental effects and are therefore not discussed further.

Following site restoration and a period of monitoring, and with community agreement, a licence to abandon the site would be requested from the regulator. In this regard, “abandon” (a term that exists within the regulatory framework) means that the site would not require ongoing regulatory controls and licensing by the CNSC. While further monitoring would not be legally required, monitoring could be continued depending on arrangements with the local community. It is possible that permanent markers would be installed to inform future generations of the presence of the sealed repository.

5.4 Postclosure Safety

5.4.1 Postclosure Performance

In the repository design, the radioactivity is initially contained within the used nuclear fuel. The bulk of the used fuel (98 per cent) is solid ceramic uranium dioxide.

The used nuclear fuel is sealed in durable metal containers and placed in an engineered structure excavated deep within a stable rock formation. The layout of the repository would be a network of tunnels and placement rooms designed to accommodate the rock structure and stresses, the groundwater flow system, and other subsurface conditions at the site. A clay buffer material would surround each container, and backfill material and other seals would close off the rooms and fill the shafts.

The rock and deep groundwater that surround the repository would provide stable mechanical and chemical conditions that would promote containment of the wastes for long times.

After closure, the repository would initially (within about 100 years) heat up to a maximum temperature of around 100 degrees celsius and then slowly cool back to ambient rock temperatures. Within several thousand years, natural groundwater within the rock would seep back into the facility and re-saturate the space in the clay buffer and room backfill. During this same period, the majority of the initial (and more radioactive) fission products in the used fuel would decay to stable, non-radioactive elements. However, the residual radioactivity is still hazardous, and would include long-lived fission products, actinides, and uranium decay products.

The potential effects of the used fuel repository over the very long term would be from potential releases of radionuclides and other non-radioactive contaminants leached or dissolved from the placed used fuel. These contaminants could migrate into the bedrock and deep groundwater, and could eventually reach the surface environment.

5.4.2 Postclosure Safety Assessment

To support the design and to check the long-term site safety, a postclosure safety assessment would be performed. In this assessment, computer models are applied to a suite of analysis cases to determine potential effects on the health and safety of persons and the environment. The assessment time frame typically extends from closure until the time at which the maximum impact is predicted, with a one-million-year baseline adopted based on the time period required

for the used fuel radioactivity to decay to essentially the same level as that in an equivalent amount of natural uranium.

The postclosure assessment examines potential consequences from various postulated scenarios, ranging from likely to “what if”. The Normal Evolution Scenario represents a reasonable extrapolation of the site and repository, and accounts for anticipated significant events such as glaciation. Sensitivity studies assume degraded performance of various components of the multi-barrier system to demonstrate the conclusions are not especially sensitive to uncertainties in the input information. Disruptive Scenarios postulate the occurrence of unlikely events leading to possible penetration of barriers and abnormal loss of containment.

Assessing the postclosure suitability of the Municipality of Central Huron and specific sites therein for hosting the used fuel repository requires substantive site-specific information on the geology at repository depth. The suitability of the local geology for hosting a repository is discussed in Chapter 4. This geoscience assessment addresses factors such as the following:

- ***Safe containment and isolation of used nuclear fuel:*** Are the characteristics of the rock at the site appropriate to ensuring the long-term containment and isolation of used nuclear fuel from humans, the environment and surface disturbances caused by human activities and natural events?

- ***Long-term resilience to future geological processes and climate change:*** Is the rock formation at the siting area geologically stable and likely to remain stable over the very long term in a manner that will ensure the repository will not be substantially affected by geological and climate change processes such as earthquakes and glacial cycles?

- ***Safe construction, operation and closure of the repository:*** Are conditions at the site suitable for the safe construction, operation, and closure of the repository?

- ***Isolation of used fuel from future human activities:*** Is human intrusion at the site unlikely, for instance through future exploration or mining?

- ***Amenable to site characterization and data interpretation activities:*** Can the geologic conditions at the site be practically studied and described on dimensions that are important for demonstrating long-term safety?

At present, due to the limited site-specific information on the geology available at this stage in the assessment process, it is not possible to conduct a detailed postclosure safety assessment. Therefore, the current postclosure safety assessment conclusion is the same as the assessment presented in Chapter 4, where it is judged that the Ordovician Cobourg limestone Formation would be the preferred host rock. However, it is possible to draw on the results from a number of postclosure safety assessments examining similar but hypothetical sites and repository designs, in order to build confidence in long-term safety.

Five major postclosure safety assessments for a deep geological repository for used CANDU fuel have been carried out over the last 20 years, with four assessments performed for hypothetical sites on the Canadian Shield and one assessment performed for a hypothetical site in the Michigan Basin (AECL, 1994; Goodwin et al., 1996; Gierszewski et al., 2004; NWMO, 2012; NWMO, 2013). Similar studies assessing repository concepts in sedimentary rock

environments have also been published in other countries, notably France (Andra, 2005) and Switzerland (Nagra, 2002). Although the geologic environment and details of the repository concept vary from study to study, all studies found that management of used nuclear fuel in a deep geological repository is a safe, viable option for protecting humans and the environment from the associated long-term hazards. A brief summary of the scenarios analyzed in the Canadian postclosure safety assessments is provided to illustrate this point.

The most likely scenario by which any radionuclide from a deep geological repository can reach the biosphere is through transport from a failed or defective container through the water within the rock porosity. Due to the multiple engineered barriers and the relatively impermeable nature of the suitable formations of the Michigan Basin sedimentary rock at suitable sites, the analyses show that most of the radioactivity would remain trapped within or near the repository and decay away. The small amounts reaching the biosphere after thousands or millions of years lead to maximum dose rates for suitable sites that are orders of magnitude below the regulatory dose limit (i.e., 1.0 milliSievert (mSv) per year) and the Canadian background dose rate (i.e., roughly 1.8 milliSieverts per year).

The potential chemical toxicity hazard posed by a deep geological repository has also been examined (NWMO, 2012; NWMO, 2013). While the used fuel does not contain hazardous chemicals, it is largely uranium (a heavy metal), and it contains small amounts of other elements that can be toxic in sufficiently high concentrations. Safety assessments indicate the natural and engineered barriers can provide effective protection against transport of potentially hazardous elements from the repository. In practical terms, there would be no noticeable effect at the site or surrounding environment.

The preliminary assessment of geoscientific suitability described in Chapter 4 also confirms the presence of salt formations beneath the Municipality of Central Huron. These formations include the Silurian-age Salina B and A-2 salt beds, which have thickness ranging between 40 metres and 80 metres, and up to approximately 20 metres, respectively, and thin eastward eventually pinching out well below ground surface. These salt layers, as they currently exist, provide a very low permeability natural barrier. At all locations the salt layers are more than 330 metres above the top of the preferred Ordovician Cobourg Formation. The Cobourg Formation is blanketed by more than 200 m of Ordovician-age shales (a low permeability natural barrier), and potable groundwater resources do not exist below approximately 150 metres depth.

Natural resources, such as the laterally extensive salt formations and isolated occurrences of pinnacle reef gas reservoirs, may increase the possibility of exploratory drilling at a future repository site. This could be mitigated first by siting the repository so that it avoids areas where petroleum hydrocarbons occur, including pinnacle reefs, and second, by ensuring that its passive safety is not influenced in the near and long term by locating it away from existing resource extraction operations (such as the Goderich salt mine). Finally, it is noted that these resources exist in Silurian-age sediments occurring far above the preferred repository horizon in the Cobourg Formation. Any future exploration would identify the Silurian rock formations as the drilling targets, and that would mitigate against deeper drilling and possible intersection with a repository.

The illustrative post-closure safety assessment performed for a conceptual repository located at a hypothetical site along the eastern flank of the Michigan Basin within southern Ontario (NWMO, 2013) is helpful to understand safety implications. This 2013 assessment assumes the repository is located at 500 metres depth within the Cobourg Formation, approximately 290 metres below a permeable rock layer, and found that all regulatory acceptance criteria could be

achieved with large margins. In part, this is due to the presence of the aforementioned 200 metres of low permeability shale cap rock overlying the repository horizon within the Cobourg Formation.

It is anticipated given the similarity in geologic setting that an acceptable safety case could be developed for a properly sited repository within the Municipality of Central Huron. Should Central Huron be the focus of continued studies, further iterations of safety cases developed in relation to specific study sites, including the impact of salt and hydrocarbon resource potential on repository siting, would be required to confirm that all technical siting requirements can indeed be met.

5.5 Climate Change Considerations

5.5.1 Near-Term Climate Change

Due to the long duration of the project, it is prudent to consider how climate change might have an influence on the repository site.

Over the course of the project lifespan from site preparation to closure, regional climate parameters such as temperature, precipitation, and wind could be altered. These changes could lead to, for example, an increase or decrease in surface waters, extent of forestry, local agriculture, storm frequency and intensity, or the frequency of forest fires.

While such changes could affect the schedule, they will have essentially no effect on the safety of the repository during the Operation Phase. As noted earlier, water is not required to maintain cooling of the used fuel, so any interruptions to the water or power supply would have essentially no effect on public safety. The range in weather conditions would be taken into account in the design of surface facilities (e.g., by ensuring the repository shaft collars are located above areas that could be affected by flooding).

Climate change could alter habitat suitability and availability for aquatic and terrestrial biota, with a shift in the composition of plant communities towards those better adapted to warmer conditions. This shift in vegetation could, in turn, affect available habitat for terrestrial species. Development of re-vegetation plans at closure would take into account how plant community attributes may be altered in response to climate change.

During postclosure, the depth of the repository and the applied sealing measures essentially isolate the repository from all surface effects except glaciation, which is discussed in the next section.

5.5.2 Glaciation

The Michigan Basin of southwestern Ontario has been covered by ice sheets for nine major glacial cycles over the past one million years. These cycles, with a period of approximately 100,000 years, are believed to be largely related to variations in solar insolation and the location of the continents.

The continents will not change position significantly over the next million years, and the variation in solar insolation is predictable based on known earth orbital dynamics. Studies indicate that over the next 100,000 years or so, the amplitude of insolation variations will be smaller than

during the last glacial cycle (Berger and Loutre, 2002). It is also clear that the composition of greenhouse gases is presently significantly larger than usual. Such conditions could suppress the initiation of a glacial cycle for 50,000 years or longer. Beyond this time, a larger reduction in solar insolation is anticipated, and therefore a stronger trigger to initiate a new glacial cycle will occur.

While the timing of the onset of the next cycle cannot be determined, the first ice sheet advance over the repository site is not anticipated to occur within the next 60,000 years, with even longer delays (up to 500,000 years) proposed in some studies (Berger and Loutre, 2002; Archer and Ganopolski, 2005). This implies that a significant time period is available for radioactivity levels in the used fuel to decay prior to glacial onset.

Glacial/interglacial cycling will affect hydrogeological conditions in the overburden and shallow bedrock groundwater zones. Future ice sheets will cause significant changes in the surficial physical environment and the shallow groundwater zone in relation to the formation of permafrost, altered hydraulic pressures and flow rates, and penetration of glacial recharge waters. In low porosity, low permeability systems, geochemical and isotopic data suggest that only the upper, actively circulating groundwater system was affected by past glaciations, with deeper, denser, high-salinity waters largely unaffected.

The effects of glaciation on a deep geological repository have been assessed for a hypothetical site in the Michigan Basin (NWMO, 2013). The study shows that for a sufficiently deep repository with no nearby fractures, the net impact would not be significantly different from that associated with the assumption of a constant climate and the potential effects on people and the environment would be well below regulatory limits.

Site-specific studies are necessary to understand potential effects over the long term that could occur because of the presence of the closed used fuel repository. Subject to these studies, it is assumed that the repository can be placed sufficiently deep that it would not be affected by glaciation.

5.6 Environment and Safety Findings

Based on the available environmental information and the anticipated project activities, no environmental conditions have been identified that would preclude siting the repository somewhere within the Municipality of Central Huron. The assessment has identified some specific areas that would be excluded as they contain protected areas, or historic hydrocarbon pools. Subsequent to the identification of more specific potential siting areas, a more definitive environmental evaluation could result in the exclusion of additional areas based on such things as, for example, the presence of migration routes, geological pinnacle reefs, the proximity to important habitats, and cultural sensitivity. Discussions with interested communities, potentially affected First Nation and Métis communities, and surrounding communities, as well as field studies, would be needed to fully characterize the environmental conditions in these potential siting areas.

The findings also indicate that the Site Selection, Construction, Operation, Decommissioning and Closure, and Monitoring Phases will result in effects to the environment. Because many of these effects would be similar to other large industrial or mining projects, it is anticipated that the long-term interactions or potential environmental consequences can be managed or mitigated through a combination of in-design features, operating procedures, and implementation of a

sound environmental management plan. These mitigating measures would be defined in later phases of the project as more information becomes available.

At present, due to the limited site-specific information on the geology at depth available at this stage in the assessment process, it is not possible to conduct a site-specific postclosure safety assessment. The current postclosure safety conclusion is therefore the same as the assessment in the geoscientific suitability chapter (Chapter 4), where it is judged that the Ordovician Cobourg limestone formation would be the preferred host rock. The impact of salt and hydrocarbon resource potential on repository siting and safety would need to be further assessed. Site-specific safety assessments would be created at later phases of the project when more information on the local geology becomes available.

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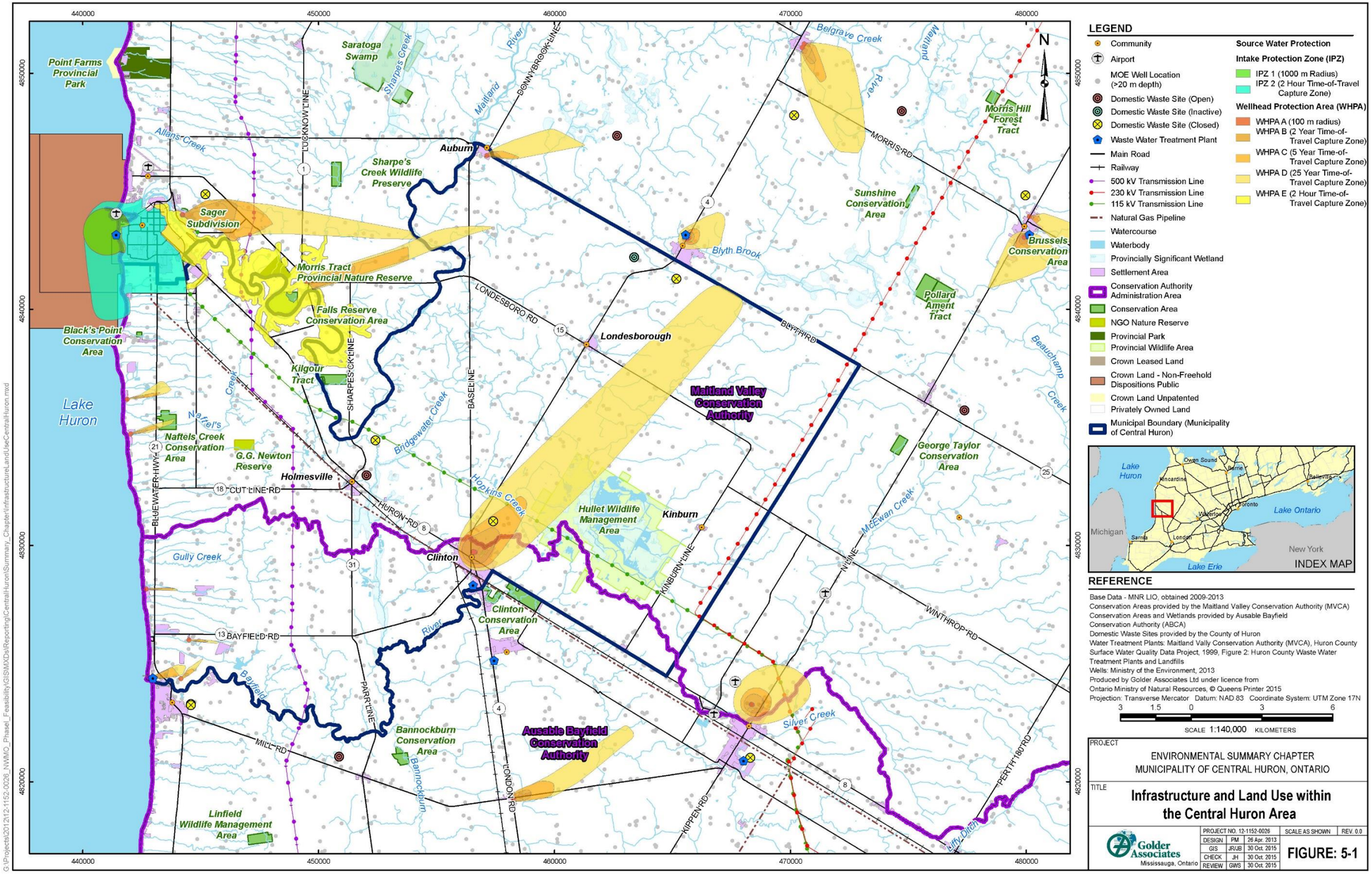


Figure 5-1: Infrastructure and Land Use within the Central Huron Area

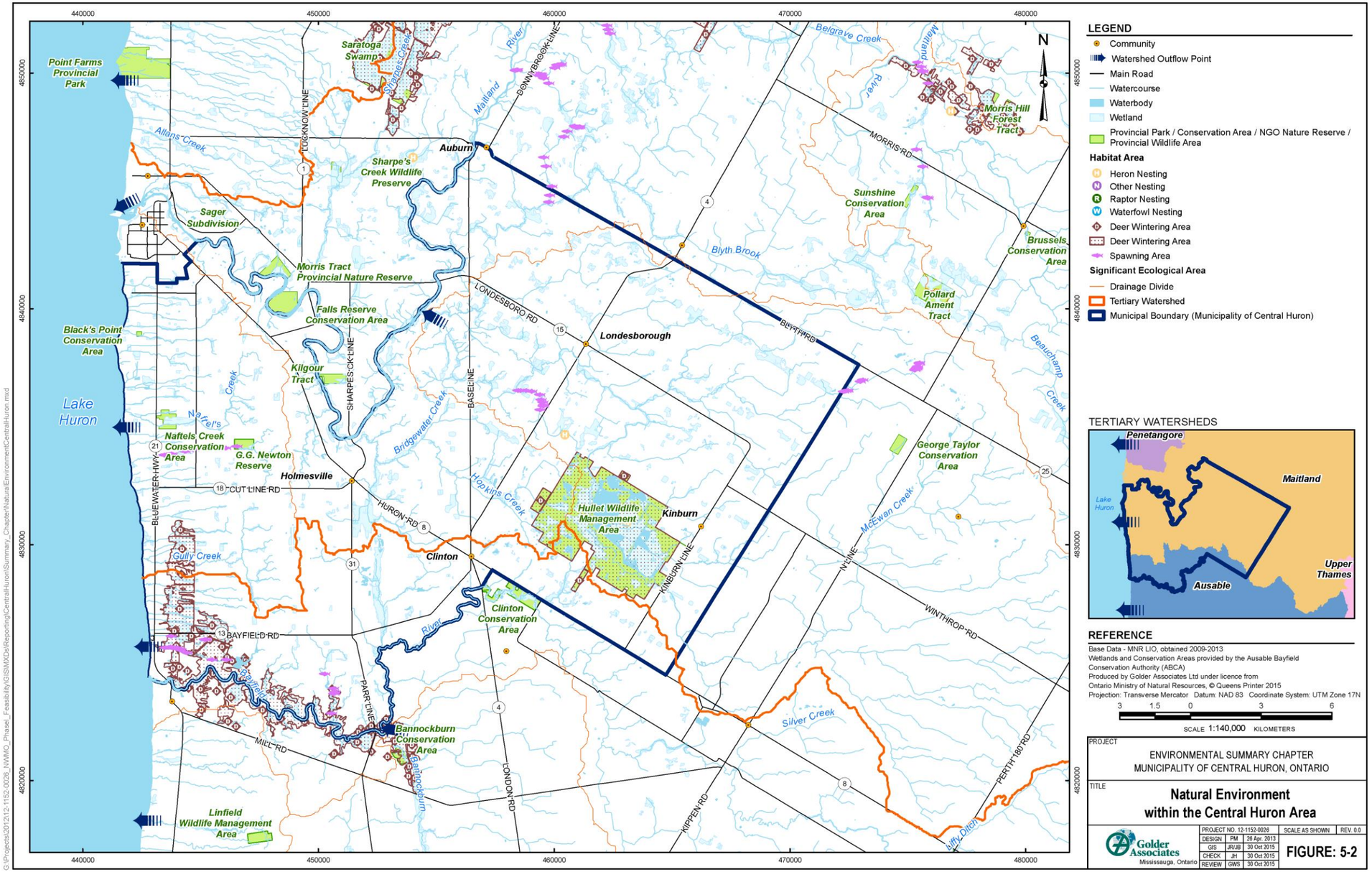


Figure 5-2: Natural Environment within the Central Huron Area

6. PRELIMINARY ASSESSMENT OF TRANSPORTATION

6.1 Introduction

Canada's used nuclear fuel is currently located at seven interim storage sites located in four provinces. The ability to transport used nuclear fuel using existing or developing transportation systems is an integral element of a long-term management plan.

For more than 40 years, Canadian and international experience has demonstrated that used nuclear fuel can be transported safely and securely. The NWMO is committed to maintaining this high standard of safety and will meet or exceed regulatory safety requirements. The NWMO is employing the Adaptive Phased Management (APM) Project management approach in planning and operating its transportation program. In support of this approach, the NWMO is monitoring and incorporating lessons learned from successful used fuel and radioactive material transportation programs in Canada and in other countries.

The approach taken in preparing this chapter serves two functions. First, it describes the comprehensive transportation safety regulation and oversight processes that the NWMO will meet, and how the NWMO plans to meet them. Second, it presents results of a desktop analysis that was prepared based on publicly available transportation information, supplemented by information provided by the community and observations during staff visits to selected communities. As part of Step 3 of the Siting Process, a preliminary assessment was prepared and focused on the following question: "Can a transportation route be identified or developed for the safe and secure transportation of used nuclear fuel to the site from the locations at which it is stored?" The findings of the transportation assessment on the feasibility of locating the APM Project in the Central Huron area are presented at the end of the chapter.

In reviewing the available and/or developing transportation infrastructure, there is no intent to select a preferred mode of transportation or a preferred route, or to commit to specific operational details related to a future transportation system. These activities will be addressed through a future dialogue with federal, provincial, and local authorities, and communities along potential transportation routes as a large group with a shared interest.

6.2 Regulatory Framework

The safe and secure transportation of used nuclear fuel is regulated through a comprehensive, multi-agency framework of regulations, oversight, and inspections. The process builds on the legal and traditional roles of federal, provincial, and local agencies.

The responsibility for regulating the safe transportation of used nuclear fuel in Canada is jointly shared by the Canadian Nuclear Safety Commission (CNSC) and Transport Canada. The *Nuclear Safety and Control Act*, 1997, the *Packaging and Transport of Nuclear Substances Regulations*, 2015, and the *Nuclear Security Regulations* authorize the CNSC to regulate all persons who handle, offer for transport, transport, or receive nuclear substances. The *Transportation of Dangerous Goods Act*, 1992 and Transport Canada's *Transportation of Dangerous Goods Regulations* regulate the safe commercial transport of listed hazardous goods, including used nuclear fuel.

The CNSC and Transport Canada regulations follow the International Atomic Energy Agency's (IAEA) Safety Standards Series regulations (Requirements No. TS-R-1) (IAEA, 2000). The

CNSC and Transport Canada regulations cover the certification of the package design, the licence to transport, security planning, training requirements for the shipper and transporter, emergency response planning, and communication procedures. These requirements are in addition to the normal commercial vehicle and rail operating and safety regulations, and are similar to those used internationally. Packages designed for the transport of used nuclear fuel in Canada must be certified by the CNSC.

The provinces are responsible for developing, maintaining and operating the road infrastructure, for conducting safety inspections of the commercial vehicles and their drivers, and for law enforcement. Local governments provide traffic law enforcement and emergency response resources in the event of a transportation incident. The interaction and cooperation between these agencies provides for a comprehensive regulatory and oversight process, ensuring the safe and secure transportation of used nuclear fuel.

6.2.1 Canadian Nuclear Safety Commission

The *Nuclear Safety and Control Act*, 1997, established the CNSC as the responsible agency for regulating possession of radioactive materials; for the design, testing, and certification of transport packages; and for regulating the safe and secure transport of nuclear substances in Canada. The CNSC works closely with Transport Canada in creating safety regulations, reviewing transportation operations, transport security and emergency response plans, training of the persons involved in transporting radioactive substances, and the oversight of radioactive material shippers.

The CNSC's *Packaging and Transport of Nuclear Substances* and *Nuclear Security Regulations* set out a comprehensive framework for the transportation of radioactive material, including the package design requirements, operational controls during transport, security from threats, loading and unloading, and inspection and maintenance requirements for the package. The regulations also require quality control at every step of the transport process.

The CNSC establishes the criteria and certifies the design of all Type B transport packages (the type required to transport used fuel), including those to be used by the NWMO. The CNSC requires that a Type B package pass strict testing that simulates transportation accident conditions, such as the package being in a collision, being hit by sharp objects, being engulfed in a petroleum fuel fire, and being submerged in 200 metres of water. During these tests, the package must be able to meet the public protection requirements for the radioactive material while in transport.

6.2.2 Transport Canada

The *Transportation of Dangerous Goods Act*, 1992, and the *Transportation of Dangerous Goods Regulations* regulate the transportation of all dangerous goods within Canada, including the classification, packaging, labelling, documentation, safe handling, emergency response planning, training, and conveyance of such goods. To perform this function, Transport Canada has classified all dangerous goods into nine classes. Used nuclear fuel is designated as Class 7, "Radioactive Material."

The Transport Canada regulations prescribe the labels and safety marks that must be placed on any package and vehicle while transporting dangerous goods. These labels and placards provide valuable information to emergency responders when they respond to an accident and assist them in determining what safety precautions are needed as they carry out their life-saving

and fire-fighting duties. Transport Canada requires that all persons handling, transporting, and/or offering to transport dangerous goods must be trained in the safe handling of the materials as applicable to their assigned duties.

Transport Canada and the provinces have a shared responsibility for the safety of trucks, and their operators. For highway vehicles, this includes the licensing of vehicles, vehicle safety inspections, and the qualification and hours of service requirements for operators. For rail, Transport Canada inspects the operating companies for compliance with vehicle, operations, signals, track, motor, and crew safety regulations. The provinces, through an Administrative Agreement process, have taken the lead for enforcing compliance with Transport Canada's safety requirements.

6.2.3 Provincial and Local Safety Responsibilities

Provinces have the legal authority for regulating all highway transportation functions, and through the Administrative Agreements with Transport Canada, they can enforce safety regulations for Class 7 shipments. Along with Transport Canada, the provinces enforce vehicle and driver safety through both scheduled and random inspections.

The provinces also develop, maintain, and operate the provincial highway systems over which the NWMO shipments will travel. Some of these systems have operating limitations caused by weather, soils, highway geometry, tunnels, or bridges. As the provinces adopt their transportation improvement plans, some of these limitations may be addressed, thereby improving the system.

Local governments, through their first responders, provide the initial resources when responding to emergency and law enforcement incidents. They are also enabled to enforce local and provincial regulations governing safety and commercial vehicle operation. Local communities are responsible for developing, operating, and maintaining local streets and roadways.

6.3 Transportation Safety

The NWMO will be the responsible party for shipping Canada's used nuclear fuel to a repository. The reference plan is to use the Used Fuel Transportation Package (UFTP) for the transport of used fuel. In July 2013, the CNSC re-certified the UFTP as meeting their current regulations (CNSC, 2013).

6.3.1 CANDU Used Nuclear Fuel

CANDU nuclear fuel is a solid uranium dioxide ceramic pellet and is used to produce electricity for Canadians. The pellets are placed into a corrosion resistant metal tube of a zirconium-tin alloy. Typically, 37 of these tubes are mounted together in a cylindrical array called a fuel bundle. After the fuel bundle expends its heat producing energy, it is removed from the reactor and placed in a pool of water to cool. Additional information on used nuclear fuel is provided in Section 3.2.

The radioactivity of used fuel initially drops quickly following removal from the reactor. After being out of the reactor for seven to 10 years, the radioactivity has decayed by 99 per cent, and the fuel bundles are placed into interim dry storage containers. The fuel is held in these containers until readied for transport to a repository. Based on the current Preliminary Waste

Acceptance Criteria, the used fuel accepted for transport to the repository facility will have been out of the reactor for 10 years or more. However, the reference design for a deep geological repository assumes an average out-of-reactor cooling period of 30 years.

6.3.2 Used Fuel Transportation Package

The NWMO will be transporting the used fuel bundles to the APM repository facility in the UFTP, which will be certified by the CNSC to the regulations in force at the time of shipment.

To be certified, the UFTP, among other things, must pass a series of performance tests as specified in the CNSC regulations, thereby demonstrating its ability to withstand severe impacts, fire, and immersion in deep water*. These tests are designed to ensure the radioactive material is not released during a transportation accident and radiation levels outside the package are well below the regulatory dose limits.

The UFTP is a cube about two metres in size (see Figure 6-1). When filled, the UFTP will carry approximately five tonnes of used CANDU fuel. The total package weight, when filled, is about 35 tonnes. As shown in Figure 6-1, the UFTP can hold a total of 192 bundles of used CANDU fuel in two storage racks, which are called modules. The UFTP body is manufactured from a single piece of stainless steel with walls approximately 27 centimetres thick.

The seal between the package lid and body is provided by a double gasket and the lid is attached with 32 bolts. Seal integrity is tested prior to and after each shipment.

* For more information on package performance tests, see http://nuclearsafety.gc.ca/eng/licenseesapplicants/packagingtransport/certification-process-for-transport-packages.cfm.

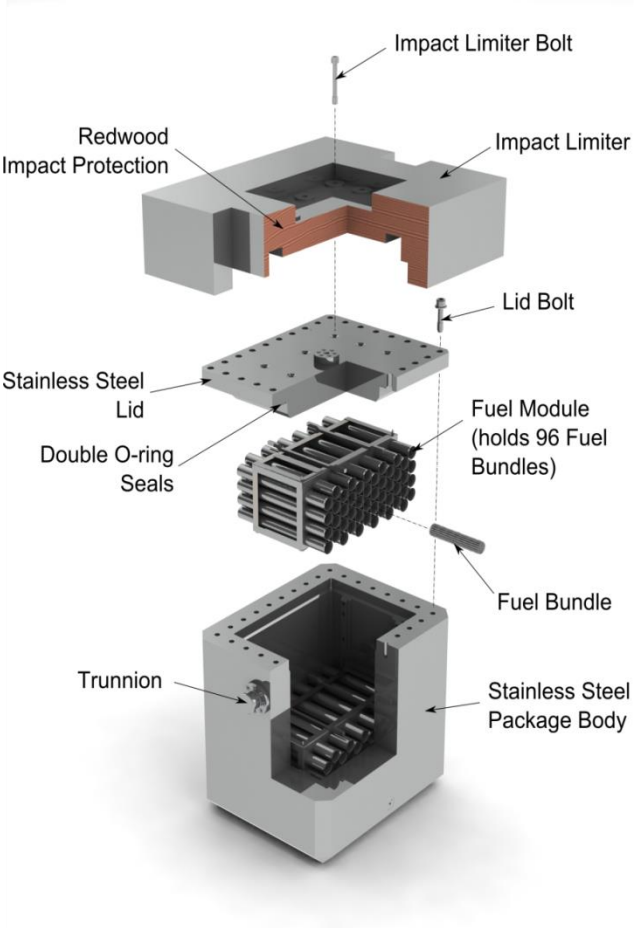


Figure 6-1: Used Fuel Transportation Package

6.3.3 Commercial Vehicle Safety

Commercial vehicle and driver safety are important to the NWMO. All commercial vehicles carrying dangerous goods are subject to Transport Canada safety requirements and inspection. NWMO vehicles will be inspected for safety defects at the points of origin and destination. They are also subject to scheduled and random safety inspections by Transport Canada and the provinces as they travel the roadways. This is standard practice within the Canadian transport industry and for radioactive material shipments internationally.

6.3.4 Radiological Safety

Packages used to transport used fuel are designed in accordance with the requirements prescribed by the CNSC's *Packaging and Transport of Nuclear Substances Regulations*. The CNSC regulations are based on standards set by the IAEA and tested through use and practice. The objective of the regulations is to ensure the radiation levels from the package will allow safe handling and transport, and, in the event of an accident, the package will prevent a radiological release that exceeds applicable regulatory criteria.

The packages are designed to shield radiation such that levels on the outside of the package are below prescribed limits. Through procedures minimizing the handling of the package, the total radiation dose to the handling and transport personnel can be kept at a low level.

Experience from existing shipments both within Canada and internationally demonstrates this goal can be readily achieved.

6.3.5 Radiological Dose

Radiation is found in many forms. People are exposed to natural background radiation every day from the ground, building materials, air, food, outer space (cosmic rays), and even from elements occurring naturally in the body. The CNSC *Radiation Protection Regulations* have set an annual radiation dose limit of one milliSievert (mSv) per year for members of the public to limit exposure from nuclear-related activities. The radiation dose is about half of the average background radiation dose received by Canadians (1.8 milliSieverts per year). For comparison, the typical dose received from one dental X-ray is approximately 0.01 milliSieverts.

Radiological doses to the public from used fuel transport have been calculated for members of the public. Three scenarios were identified to estimate radiological doses to the public: 1) residents along the transport route; 2) persons sharing the transport route; and 3) persons sharing the refueling and rest stops. The highway mode was conservatively chosen as the example since the shipments will be sharing the roadway and refueling stops with the public, and there will be a larger number of shipments using this mode.

Table 6-1 shows the annual maximum individual dose to the public for each of the three scenarios (Batters et al., 2012). In all cases, the maximum individual dose to the public under routine transport and accident conditions is well below the regulatory public dose limit of 1.0 milliSievert per year.

Table 6-1: Maximum Public Individual Dose due to Used Fuel Transported by Road

Annual Dose	Distance to package	Frequency (per year)	Dose (mSv/year)	Assumptions / Comments
During Transport				
Resident along Transport Route	30 metres	620 shipments	0.000013	Person living 30 metres from route exposed to all 620 shipments (including one unplanned stop)
Public in Vehicle sharing Route	10 metres	2 shipments	0.00022	Person in vehicle 10 metres from transport package for one hour twice per year
During ½ hour Rest Stop				
Public in Vicinity at Rest Stop	15 metres	31 shipments	0.00012	Trucks alternate between 10 rest stops. Person present at given stop five per cent of time (i.e., five per cent of shipments)

The NWMO is committed to protecting its workers, drivers, and the public, and will apply the “As Low As Reasonably Achievable (ALARA) principle” in the design of the transportation system and during operations. This includes the proper use of shielding and dosimetry combined with the application of radiation control techniques and operating procedures. As part of the NWMO’s transportation planning process, additional dose studies will be conducted for workers (i.e., drivers, inspectors, emergency responders).

6.4 Used Fuel Quantities and Transport Frequency

The reference used fuel inventory being used for the APM preliminary assessments is 4.6 million fuel bundles (Garamszeghy, 2011). The distribution of the fuel bundles is provided in Table 6-2. Using the UFTP, the NWMO Transport Program anticipates it will require about 24,000 truck trips over 38 years to move the inventory to the repository site.

The APM facility is designed to process approximately 120,000 used fuel bundles per year, which equates to receipt of approximately 620 UFTPs per year. However, the total number of shipments will depend on the chosen transport mode. For instance, a tractor-trailer can transport one 35 tonne UFTP at a time; whereas rail shipments may contain multiple UFTPs in a single train.

Table 6-2: Estimated Used Fuel Quantities by Owner

Owner	Number of Used Fuel Bundles
Ontario Power Generation	4,026,000
AECL	32,600
Hydro-Québec	268,000[a]
New Brunswick Power	260,000
Total (rounded)	**4,600,000**

Note:
[a] The 268,000 fuel bundle inventory assumes refurbishment of the Gentilly 2 Nuclear Generating Station. In 2012, Hydro-Québec announced their decision to permanently shut down Gentilly 2. The actual fuel bundle inventory for Gentilly 2 is approximately 130,000 bundles.

6.5 Used Fuel Transportation Experience

Used nuclear fuel has been transported routinely in Canada since the 1960s, with over 500 used nuclear fuel shipments having been made to date (Stahmer, 2009). Since the closing of AECL's reactor at Rolphton, Ontario, the number of shipments annually has averaged between three and five shipments per year.

Used fuel shipments are common in other countries, such as the United Kingdom, France, Germany, Sweden, and the United States. Over the past 40 years, worldwide there have been more than 23,000 shipments of used fuel. Great Britain and France average 550 shipments per year, mainly by rail. In the United States, used fuel shipments take place mainly by road and approximately 3,000 shipments have been made to date. In Sweden, approximately 40 trips by water are made between the reactor sites and the central storage facility each year.

Internationally and in Canada, there have been no serious injuries, health effects, fatalities, or environmental consequences attributable to the nature of the used nuclear fuel being transported.

6.6 Transportation Operations

6.6.1 Responsibility

The NWMO will have overall responsibility for transportation of used nuclear fuel to the repository. This includes planning, licensing, training, safe operation, security, and tracking of all shipments. The NWMO will work with the CNSC, Transport Canada, the provinces, and local agencies to ensure workers and first responders are adequately trained prior to commencing shipments. The NWMO will ensure that all transportation equipment, packages, and transportation activities (for road and rail shipments) meet regulatory requirements.

The NWMO transportation process is planned to begin with loading the used fuel into the UFTP by the fuel owner. The NWMO will certify that the packages are loaded in accordance with CNSC and Transport Canada regulations. Upon dispatch, the vehicle and drivers will be subject to a safety inspection. The vehicle, UFTP, and driver records would also be inspected at the repository for compliance with Transport Canada and provincial licensing, vehicle safety, record keeping, and hours-in-service requirements.

The driver of the vehicle will be responsible for package safety during transport. The driver will ensure that all documentation, labelling, and safety requirements have been met prior to departure and continue to be met en route. The shipments must have a security escort who is responsible for the physical security of the package and vehicle, communications, tracking, and monitoring of the locks and seals.

First response to radiological emergencies will be provided by trained first responders in accordance with the command and control process as described in the Emergency Management Framework for Canada, local and provincial plans, and existing mutual aid agreements. The NWMO will co-ordinate its planning with the provinces and first responders along the preferred routes to provide used fuel-specific training and to conduct exercises. It is anticipated that the existing agreements between nuclear facilities in Ontario, Manitoba, Québec, and New Brunswick will be expanded to accommodate the requirements of NWMO shipments.

6.6.2 Communications

A NWMO central command centre will provide a single point of contact for all transportation-related communications. This allows quick access to shipment information and tracking, and would serve as a single point of contact for incident commanders, the CNSC, and Transport Canada. Communications during a trip would be in accordance with a Transportation Security Plan, which will require review and approval by the CNSC.

The function of the transport command centre is anticipated to be similar for all shipments, independent of mode. The centre will be responsible for tracking all shipments and normal vehicle communications, and in the event of a transport incident, it will be the primary contact for incident commanders. The transport command centre will notify local emergency response agencies for assistance, such as the local police, fire, and the emergency response teams. There will also be a return-to-normal operations and recovery plan to address those activities needed to return the shipment to normal operations and complete the trip to the repository.

6.6.3 Security

Security is focused on preventing diversion, physical damage, or sabotage of the UFTP. Security will be multi-layered, consisting of a combination of intelligence gathering; engineered, deterrent and response measures to protect the UFTP; use of information safeguards to protect shipment information; and multi-agency response agreements.

Security provisions during transportation will ensure the used nuclear fuel will receive adequate physical protection against threats and will be in accordance with the requirements of the CNSC's *Nuclear Security Regulations* pursuant to the *Nuclear Safety and Control Act*. The CNSC Regulatory Guide G-208 "Transportation Security Plans for Category I, II or III Nuclear Material**"** (CNSC, 2003) will be used for guidance to establish and implement Transportation Security Plans.

6.6.4 Emergency Response Planning

Emergency response resources include local law enforcement, fire fighting, first responders, medical triage, and leaders of affected communities. The NWMO will work with the CNSC, Transport Canada, the provinces, and local responders to encourage cooperative emergency response planning, and to identify and address training and exercise needs.

The NWMO will work with the CNSC and local response agencies to coordinate planning and preparedness activities based on the CNSC's *HazMat Team Emergency Response Manual for Class 7 Transport Emergencies (INFO-0764, Rev. 2)* (CNSC, 2009) and Transport Canada's *Emergency Response Guidebook* (Transport Canada, 2012). Additionally, the NWMO will incorporate the current *Emergency Management Framework* (Public Safety Canada, 2011) guidance agreed to by Public Safety Canada and the provinces and local response agencies.

6.7 Transportation Logistics to the Municipality of Central Huron

Figure 6-2 presents a generalized description of the highway and railroad transport processes for used nuclear fuel from interim storage sites to an APM repository site. An APM repository site located in Central Huron would be accessible by truck via existing roadways and a service road to the receiving facilities.

The Municipality of Central Huron straddles the end of Highway 8 near the eastern shore of Lake Huron. A photograph of Highway 8 running through Central Huron is presented in Figure 6-3. The Goderich-Exeter Railway (GEXR), operated by Genesee and Wyoming, Inc., which is the Canadian subsidiary of Genesee and Wyoming, Inc., runs through the Municipality. The short line railway interchanges with the transcontinental railroad, the Canadian National Railway (CN), in London and Toronto.

If rail is a preferred mode, rail service could be extended from the GEXR to a service spur leading directly to the receiving facility at the repository.

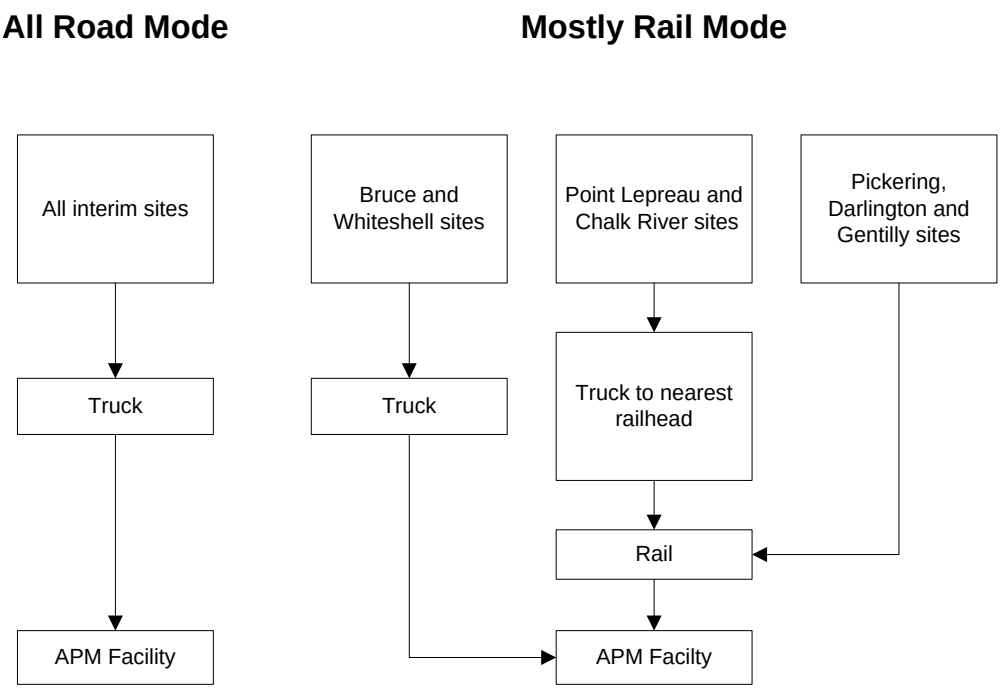


Figure 6-2: Example Transport Processes for Used Nuclear Fuel



Figure 6-3: Highway 8 Running Through Central Huron

6.7.1 Existing Transport Infrastructure

Travel distances from the interim storage sites to a repository site in Central Huron, Ontario are summarized by mode of transportation in Table 6-3.

Table 6-3: Transport Summary from Interim Storage Sites to Central Huron, Ontario

Transport Scenario	Transport Mode	Number of Shipments	Return Distance (kilometres)
All Road	Road	24,000	15,310,000
Mostly Rail	Road	11,700	2,200,000
	Rail	1,400	1,359,000

6.7.2 Road Transport from Interim Storage to a Repository

The shortest transport routes and associated distances for road transport are provided in Table 6-4. In general terms, the road system begins at the interim storage site and uses local roads to access the provincial highway system. The provincial highway system includes Highways 401, 4, 8, and 21, which lead to Central Huron. As planned, an existing local access road would be used or a new road constructed to provide access from Highway 8 or a local road to the repository site.

In Step 3 of the APM Siting Process, the following transportation question is to be answered:

“Can a transportation route be identified or developed for the safe and secure transportation of used nuclear fuel to the site from the locations at which it is stored?”

To address this question, the following transportation characteristics were considered:

1. Is there a continuous public road system connecting the interim storage facilities to the community capable of supporting an average of two heavy trucks per day for the duration of a 38-year transportation campaign?
    a. Are there design, operating, or structural deficiencies that would limit the use of a segment of the roadway system by heavy trucks (e.g., weight limits for bridges, or narrow lanes)? If so, is there a transportation improvement program in place to address those deficiencies?
    b. Are there two or more serviceable routes providing access from the interim storage facilities to the community? (Required by the *Nuclear Security Regulations*). If not, is one planned?
    c. Are there travel limitations regarding the use of the roadway by heavy trucks due to reoccurring weather or seasonal conditions?

2. Are there emergency response resources for those roadways providing access from the Canadian national roadways to the community, and what are their capacities?

Table 6-4: All-Road Transport of Used CANDU Fuel Bundles from Interim Storage Sites to Central Huron, Ontario

Interim Storage Site	Distance Site to DGR (kilometres)	Number of Shipments	Return Distance (kilometres)
1 – Whiteshell	2,100	2	8,400
2 – Bruce	100	10,220	2,044,000
3 – Pickering	240	4,150	1,992,000
4 – Darlington	270	6,720	3,629,000
5 – Chalk River	620	30	37,200
6 – Gentilly	900	1,500	2,700,000
7 – Point Lepreau	1,690	1,450	4,901,000
	Totals (Rounded)	**24,000**	**15,310,000**

In this assessment, transportation distances are determined by the shortest routes between the interim storage sites and the repository. Preferred routes will be determined by the NWMO with the involvement of communities.

Truck access from the interim storage sites to Central Huron, Ontario can be accomplished entirely by existing road ways. Based on Ontario Ministry of Transportation records, there are no significant impediments to travel between the interim storage sites and the Municipality. The average daily travel (vehicle) count for Highway 8 north of Central Huron is 6,050 vehicles per day (MTO, 2009), and the Central Huron segment of Highway 21count is 8,550 vehicles per day. Two trucks a day more to the existing traffic count would be a small addition (less than one per cent).

The Ontario Ministry of Transportation Southern Highway Program (MTO, 2012) includes the widening of Highway 8 through Kitchener from 4 to 6 lanes. The program also includes the resurfacing of Highway 21 from Sheppardton to Kingsbridge and Amberley to Kincardine.

The local road system within Central Huron supports the current residential uses, and is not generally built to support a high volume of large trucks on a routine basis. Therefore, local road upgrades and/or an access road may be required to service a potential repository site.

The network of roads in southwestern Ontario is well developed hence Central Huron is accessible via numerous alternative routes, although they involve additional mileage.

Emergency response resources are provided by the volunteer Fire Department based at the Central Huron Fire Station in Clinton, the Huron County Emergency Medical Services (EMS), and the Ontario Provincial Police. The Fire Department is a member of the Huron County Mutual Aid Program, providing help to other communities in emergencies. The Wingham and District Hospital, part of the Listowel Wingham Hospitals Alliance, the Clinton Public Hospital, part of the Huron Perth Healthcare Alliance, and the Alexandra Marine and General Hospital in Goderich provide a full range of level health-care services including 24-hour emergency coverage.

6.7.3 Railroad Transport from Interim Storage to a Repository

In answering the question “Can a transportation route be identified or developed for the safe and secure transportation of used nuclear fuel to the site from the locations at which it is stored?” the following rail transportation characteristics were considered:

Is there a continuous rail system connecting the interim storage facilities to the community capable of supporting an average of one 15-car train per week for the duration of a long-term shipping campaign?

1. Are there design, operating, or structural deficiencies that would limit the use of a segment of the railway system by heavy trains (e.g., weight limits for bridges, track condition, sharp curves, or steep grades)? If so, is there a plan in place to address these deficiencies?

2. Are there two or more serviceable routes providing access from the interim storage facilities to the community? (Required by the Nuclear Security Regulations). If not, is one planned?

3. Is there an operating intermodal facility near the interim sites or the community? If not, could one be developed?

4. Are there travel limitations regarding the use of the railway consisting of heavy cars due to reoccurring weather or seasonal conditions?

The GEXR operates a single track from Georgetown to Goderich, Ontario. The shortest transport routes and associated distances for mostly rail mode transport are provided in Table 6-5. Rail service between the interim storage sites via an intermodal transfer near the storage sites and Clinton is also feasible.

Rail access to the Bruce nuclear site has been dismantled since the facility was constructed. The used fuel inventory from the Bruce nuclear site is assumed to be trucked to the repository site in Central Huron.

Table 6-5: Mostly Rail Transport from Interim Storage Sites to Central Huron, Ontario

Interim Storage Site	Distance Site to DGR (kilometres)	Number of Shipments	Return Distance (kilometres)
1 – Whiteshell	**2,100[a]**	**2**	**8,400**
2 – Bruce	**100[b]**	**10,220**	**2,044,000**
3 – Pickering	230	420	193,200
4 – Darlington	250	670	348,400
5 – Chalk River	**50[c]**	**30**	**3,000**
	700	3	4,200
6 – Gentilly	920	150	276,000
7 – Point Lepreau	**50[d]**	**1,450**	**145,000**
	1,790	150	537,000
Totals (rounded)	**Road**	**11,700**	**2,200,000**
	Rail	2,410	1,359,000

Notes:
[a] Road mode from Whiteshell to repository site in Central Huron
[b] Road mode from Bruce to repository site in Central Huron
[c] Road mode from Chalk River to railhead near Mattawa
[d] Road mode from Point Lepreau to railhead near Saint John
Bold text indicates road mode transportation; rail mode transportation is shown in plain text.

The NWMO's rail transportation requirement would be equivalent to one train per week carrying 10 to 12 UFTPs [an estimated total car count of between eight and 10 cars (including buffer cars), two power units and a security car]. Canadian railroads have endorsed the Association of American Railroads' OT-55 Recommended Railroad Operating Practices for Transportation of Hazardous Materials (AAR, 2013); therefore, the used fuel trains could be operated as key trains with an 80 kilometres per hour speed limit and special operating procedures.

The GEXR (operated by the Geneese and Wyoming, Inc.) runs a single track mainline from Georgetown through Stratford to Goderich. The mainline connects to both Canadian National and Canadian Pacific railroads. The GEXR moves approximately 25,000 cars per year over 291 kilometres of track hauling commodities such as road salt and fertilizer, grains, and automotive parts. MetroLinx operates two passenger trains a day over the same tracks.

From Stratford west, there is no viable alternative rail routing to the interim waste management sites. An intermodal facility could be constructed along the mainline to offer an alternate route fed by truck. This option adds mileage to the routing, but takes advantage of the railroad's capability to move multiple packages in one trip.

6.7.4 Weather

There are no vehicle weight restrictions on highways in southern Ontario during the spring thaw months. Similarly, no weather or seasonal restrictions were identified for rail transport to the Municipality of Central Huron.

6.7.5 Carbon Footprint

Carbon footprint is a representation of the impact transportation has on the environment. Greenhouse gas emissions produced by the transport of used fuel from the interim storage facilities to the repository site have been calculated for both the all-road and mostly rail transport scenarios.

All road transport of 4.6 million fuel bundles from the interim storage sites to an APM facility in Central Huron, Ontario would produce approximately 480 tonnes of equivalent carbon dioxide emissions per year. Over the 38-year operating period of the APM facility, the all road transport of used fuel would produce approximately 18,400 tonnes of equivalent carbon dioxide emissions.

Transport by mostly rail mode would produce approximately 280 tonnes of equivalent carbon dioxide emissions per year.

In comparison, an average car produces approximately 5.1 tonnes of equivalent carbon dioxide emissions per year. Emissions from intermodal handling activities are assumed to contribute about two per cent of total emissions.

6.7.6 Conventional Accidents

It is important when discussing safe transportation to make a distinction between radiological incidents and conventional traffic accidents. Incidents are controlled through the design of the transportation package and execution of operating procedures (see Sections 6.3.4 and 6.3.5). Based on international experience, the design of the container, coupled with rigorous operating procedures, is sufficient to prevent any incident from occurring.

Conventional accidents are random and unexpected. Therefore, they are considered as part of the planning process and quantified using statistical analyses based on the distance travelled. In 2009, the Ontario Ministry of Transportation reported a traffic accident rate of 1.7 collisions per 1 million kilometres travelled for Ontario (MTO, 2009), one of the lowest rates in North America. Accident frequency is proportional to the distance travelled. Using a return distance of 15.3 million kilometres, about 26 road collisions have been estimated over the 38-year operating period of the APM facility.

6.7.7 Transportation Costs to Central Huron

This section considers the used nuclear fuel transportation logistics from the existing interim storage sites to a hypothetical APM repository site located in the Municipality of Central Huron to estimate transportation costs. Existing surface mode transport infrastructure, and transport distances from the interim used fuel storage sites to Central Huron by road mode for a reference used fuel inventory of 4.6 million bundles are examined.

A summary of the transport costs (based on the APM repository design and cost estimate prepared for financial planning purposes) from the interim used fuel storage sites to a hypothetical APM repository site located in Central Huron for road and rail mode of transport is provided in Table 6-6. The cost of transporting used nuclear fuel from the seven interim storage sites to Central Huron is projected at $0.864 billion over the 38-year campaign (in constant 2010 $). The variance is $219 million under the reference case estimate, or 20.2 per cent lower.

Table 6-6: Used Fuel Transportation Program Costs – 4.6 million Bundles

Total Cost	Transportation to Central Huron	Variance to Reference Case	
Package Loading & Transportation	$864,000,000	-$219,000,000	-20.2%
Cost Breakdown			
Route and System Development	$19,000,000	$0	0%
Safety Assessment	$5,290,000	$0	0%
Capital Equipment and Facilities	$264,000,000	-$62,100,000	-19%
Operations	$407,000,000	$147,000,000	-27%
Environmental Management	$8,400,000	$0	0%
Decommissioning	$33,000,000	-$9,770,000	-23%
Program Management	$127,000,000	$0	0%
Note: All costs are rounded to three significant digits			

6.8 Transportation Findings

This transportation assessment includes two major components: a description of regulatory oversight, including how the requirements are being met by the NWMO transportation program; and a desktop analysis of transportation logistics assuming available transport infrastructure. If the APM Project were to be located in the Municipality of Central Huron, the repository would be accessible by truck and railroad using existing roadways and railways. It is assumed the necessary connecting road, railway, and intermodal infrastructure would be constructed, thereby providing access from existing transportation infrastructure to the repository. Improvements, if required, to the transportation and intermodal infrastructure would be reviewed in detail in Phase 2 studies, should the community continue in the site selection process.

The Municipality of Central Huron straddles Highway 8 extending east from the eastern shores of Lake Huron. Highways 8 and 21 serve provincial commerce in the region. These highways are maintained by the Ontario Ministry of Transportation to the highest standards.

The Ontario Ministry of Transportation's current highway investment program includes the widening of Highway 8 through Kitchener from four to six lanes, and resurfacing of Highway 21 from Sheppardton to Kingsbridge and Amberley to Kincardine. Given that these highways serve as major transportation routes in the region, it is anticipated that will continue to be maintained to a high standard, and would support repository construction, operations, and closure. The average vehicle travel on Highways 8 and 21 in the Municipality of Central Huron is between 6,050 to 8,550 vehicles per day.

If ancillary businesses and services locate near the repository (e.g., package manufacturing, testing labs, vehicle maintenance), the delivery of materials and shipment of finished goods would have access to the rest of Canada. The highways would also facilitate the safe and efficient commuting for workers from the surrounding region, as required.

Central Huron is on the Goderich-Exeter Railway, providing rail access to the region. Investment would be required to provide the infrastructure required by an NWMO intermodal

facility. Transport of used fuel from the Bruce nuclear site is assumed to be shipped to the repository site by truck.

The transport of used fuel is a highly regulated activity. The NWMO's transportation program is being developed to meet all aspects of the regulations, including packaging, radiological security, emergency response, and conventional vehicle safety requirements.

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Beyond Safety – Potential to Foster Community Well-Being With the Implementation of the Project Now and in the Future

As discussed in the previous chapters, any site that is selected to host the Adaptive Phased Management (APM) Project must be demonstrated to be able to safely contain and isolate used nuclear fuel, protecting humans and the environment over the very long term. The preferred site will need to address scientific and technical siting factors that acknowledge precaution and ensure protection for present and future generations. The previous chapters have explored, in a preliminary way, the potential to meet the safety-related requirements of the project. These requirements are fundamental, and no siting decision will be made that compromises safety.

Once confidence is established that safety requirements can be met, the potential for the project to help foster the well-being, or quality of life, of the community and area in which it is implemented becomes an important consideration. The ability to benefit from the project, and the resources that would be required from the NWMO to support achievement of this benefit, would be a consideration in the selection of a site after all safety considerations have been satisfied. The project will only be implemented in an area in which well-being will be fostered.

Preliminary Assessments begin with exploring the potential for the project to align with the vision and objectives of the community that expressed interest in the project and, in so doing, initiated studies in an area. The first phase of Preliminary Assessments (Phase 1) explores the potential for the project to help the interested community, such as Central Huron, to advance to the future it has set out for itself. It is understood that this project may not align with the vision and objectives of all communities. Through this initial work, the interested community and the NWMO may learn that the project is not a strong fit with the long-term vision and objectives of the community, and further studies may be concluded in the area.

Adaptive Phased Management involves a large project that has the potential to affect the broad area in which it is implemented. Should studies continue in an area, the next phase of work (Phase 2) is intended to explore the potential for the project to align with the vision and objectives of First Nations and Métis communities in the vicinity, and surrounding municipalities, as well as their interest in implementing the project together. The project will only proceed with the involvement of the interested community, potentially affected First Nations and Métis communities and surrounding municipalities working in partnership.

The project offers significant employment and income to a community and surrounding area, including the opportunity for the creation of transferable skills and capacities. However, with a project of this size and nature, there is the potential to contribute to social and economic pressures that must be carefully managed to ensure the well-being and sustainability of the community and area. Only through working together can the project be harnessed to maximize benefits to the area, manage any pressures that may come from the project, and ensure the project fosters the long-term well-being and sustainability of the community and area consistent with their vision for the future.

Good decision-making will require that the project is understood from all perspectives and is informed by the best knowledge and expertise. The NWMO continues to work with and learn from communities to advance the siting process together. The NWMO also continues to look to Aboriginal peoples as practitioners of Traditional Knowledge to help, to the extent they wish, to guide the decisions involved in site selection, and ensure the factors and approaches used to

assess the potential to contribute to well-being and appropriately interweave Traditional Knowledge throughout the process.

Learning to date from preliminary studies, and engagement with the interested community, is summarized in the chapter that follows.

7. PRELIMINARY SOCIAL, ECONOMIC AND CULTURAL ASSESSMENT

7.1 Approach to Community Well-Being Assessment

This chapter provides a preliminary overview of the potential for the Adaptive Phased Management (APM) Project to foster the well-being of the Municipality of Central Huron, Ontario if the project were to be implemented in the Municipality. More detailed information can be found in the Municipality of Central Huron Community Profile (AECOM, 2015a) and Community Well-Being Assessment report (AECOM, 2015b). The overview uses a community well-being framework to understand and assess how the APM Project may affect the social, economic and/or cultural life of Central Huron. It also discusses the relative fit of the APM Project for the community and the potential to create the foundation of confidence and support that would be required for the implementation of the project.

A number of factors were identified as minimum criteria to consider in the multi-year process of study to assess the potential to foster well-being (NWMO, 2010a):

- Potential social, economic, and cultural effects during the implementation phase of the project;
- Potential for enhancement of the community's and the region's long-term sustainability through implementation of the project;
- Potential to avoid ecologically sensitive areas and locally significant features;
- Potential for physical and social infrastructure to adapt to changes resulting from the project; and
- Potential to avoid or minimize effects of the transportation of used nuclear fuel from existing storage facilities to the repository site.

Factors identified by Aboriginal Traditional Knowledge will help inform this assessment. In order to ensure a broad, inclusive and holistic approach is taken to assessment in these areas, a community well-being framework was identified to help understand and assess the potential effects of the APM Project. This framework was used to help explore the project, understand how communities and the surrounding area may be affected if the project were to be implemented in the area, and identify opportunities to leverage the project to achieve other objectives important to people in the area.

The framework encourages exploration of the project through five different "lenses".

- ***People or Human Assets*** – How might the implementation of the project affect people?
- ***Economics or Economic Assets*** – How might the implementation of the project affect economic activity and financial health of the area?
- ***Infrastructure or Physical Assets*** – How might the implementation of the project affect infrastructure and the physical structures that the community has established?

- ***Society and Culture or Social Assets*** – How might the implementation of the project affect the sense of belonging within the community and among residents, and the services and network of activities created to serve the needs of community members?

- ***Natural Environment or Natural Assets*** – How might the implementation of the project affect the natural environment and the community's relationship with it?

In Phase 1 of this assessment, which is the focus of this report, the intent was to explore the potential to foster the well-being of the interested community. For this reason, the subset of factors and considerations related to the community are addressed at this time. Considerations related to First Nations and Métis communities in the vicinity, and surrounding municipalities are noted where early insight is available; however, more detailed work exploring these considerations would be conducted in Phase 2 should the area advance to the next phase of study.

7.1.1 Activities to Explore Community Well-Being

Dialogue with interested communities and those in the surrounding area is needed to begin to identify and reflect upon the broad range of effects that the implementation of the project may bring. At this early phase of work, dialogue is focused on the interested community.

In concert with the interested community, the NWMO worked to begin to develop an understanding of the community today, and its goals and aspirations for the future. To this end, information has been assembled and studied through a variety of means, including review of community plans and/or strategic planning activities, engagement activities, community visits and tours, briefings, one-on-one discussions, consultant observations, open houses, a community office and special open office events, and the development of a community profile.

7.1.2 Assumptions of the APM Project – Drivers of Community Well-Being

The APM Project is currently in the early stages of design, and for this reason, there remains flexibility in the nature and scope of its implementation. This provides an opportunity for the project to be structured and operated in a manner that suits the conditions and aspirations of the community and surrounding area. However, it is important at this early stage of the preliminary assessment to understand the potential implications of the project on the community and its surrounds. This requires some basic assumptions about the project and initial effects. The starting assumptions for this preliminary assessment include the following:

1. The on-site labour workforce required by the APM Project is in the range of 400 to 1,200 jobs, and further jobs (indirect and induced) and community wealth creation will result from project spending for goods and services and employee income spending (NWMO, 2012). The following table summarizes the estimated number of direct, on-site jobs throughout the life of the APM Project, which spans over 150 years.

Table 7-1: On-Site Workforce

APM Phase	Number of Years (Approx.)	Direct Jobs per Year (Approx.)	Primary Skills Required
Construction	10	400–1,200	Mining, engineering, geoscience, safety assessment, manufacturing, construction, trades, project management, social science, engagement, communication, transportation
Operation	30 or more	700–800	Mining, engineering, geoscience, safety assessment, manufacturing, trades support, project management, social science, engagement, transportation
Extended Monitoring	50 or more	100–150	Geoscience, safety assessment, mining
Decommissioning and Closure	30	200–300	Mining, construction, trades, geoscience, safety assessment, regulatory affairs
Long-Term Monitoring	100 or more	25–50	Environmental, health and safety monitoring

2. Realization of employment benefits within a community will depend on a variety of factors such as:

   a. Preference for local hiring and sourcing from local businesses;
   b. Training of local residents for positions in the project or in supporting services; and
   c. Planning to prepare for and leverage future opportunities.

   This project will be implemented through a long-term partnership involving the community, potentially affected First Nation and Métis communities, surrounding communities, and the NWMO. Only through engagement, dialogue and collaboration will the NWMO ensure needs are addressed at each stage of the process, and determine the specifics of how a partnership would work. For illustration purposes only, employment opportunities could be in the order of hundreds of new jobs (direct, indirect and induced) within the local area (AECOM, 2010). However, it will be up to communities to determine the nature and scope of how they wish to grow in discussions with the NWMO.

3. The NWMO is committed to working with communities and those in the surrounding area to optimize the benefits that will positively contribute to the overall well-being of the area.

The following figure provides a graphical representation of the direct and indirect effects that may result from the siting of the APM Project. The figure illustrates how the project could be the impetus for growth in population, business activity, and municipal finances for the interested community and the broader area.

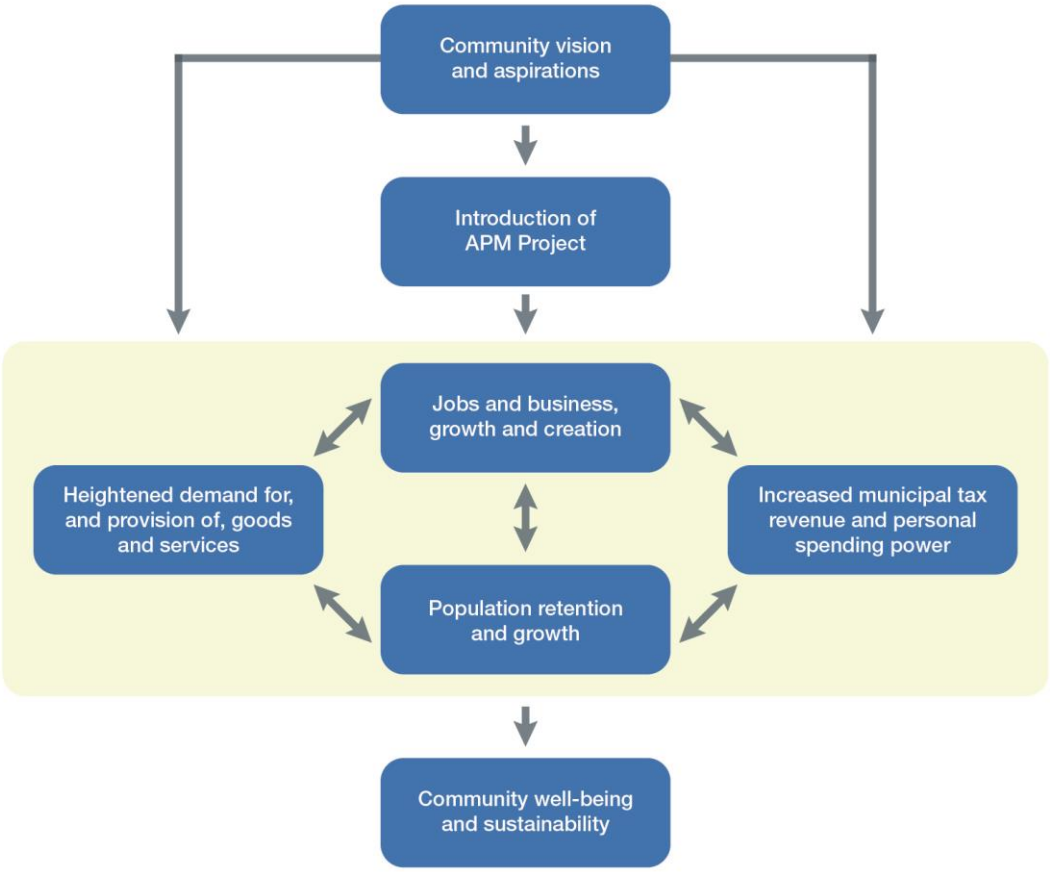


Figure 7-1: Direct and Indirect Effects From the Project

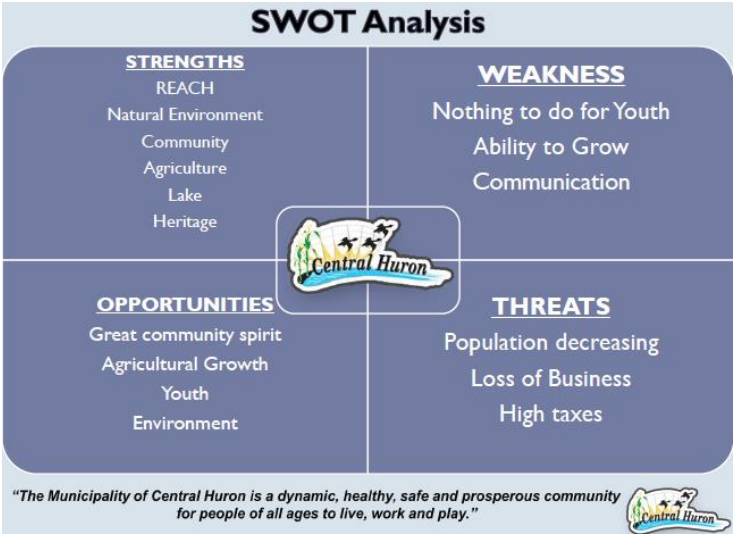
7.2 Community Well-Being Assessment – Implications of the APM Project for Central Huron

The potential effect of the project, should it be implemented in Central Huron, on the people, economics, infrastructure, social assets, and natural environment of Central Huron is discussed below. The discussion starts with an overview of the aspirations and values of the Municipality of Central Huron, as the NWMO has come to understand them. This understanding of well-being from the community's perspective is the starting point for this preliminary assessment and informs the discussion throughout.

7.2.1 Community Aspirations and Values

The Municipality of Central Huron has expressed explicit values, aspirations, and desires for its community. These have been expressed to the NWMO through conversations with the community, through Municipal planning documents, and most recently, documented in the community's sustainability plan (Central Huron, n.d.). Key themes relating to the Municipality's aspirations are summarized in this section. The preliminary assessment is measured against these values and aspirations.

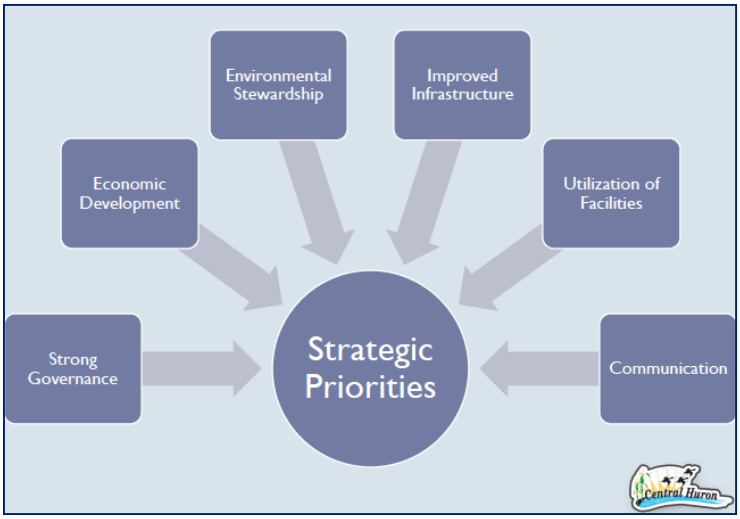
The community understands its strengths, weaknesses, opportunities, and threats (SWOT) going forward (Figure 7-2).



Source: Central Huron, n.d.

Figure 7-2: Central Huron SWOT Analysis

The community, in response to its previous SWOT analysis, identified several key strategic development priorities highlighted in Figure 7-3.



Source: Central Huron, n.d.

Figure 7-3: Central Huron Strategic Priorities

Based on interviews with a cross-section of community members, key community priorities include the following:

- Retention of youth;
- Creation of new employment opportunities in the local area;
- Provision of infrastructure services along the shoreline such as water and sewage;

- Management of soil erosion along the shoreline;
- Management of agricultural run-off into water courses and Lake Huron;
- Re-focusing the REACH facility into a sustainable entity with a strong focus on agricultural development;
- Attraction of new businesses that will be compatible with the agricultural base of the community; and
- Rejuvenation of small town main streets through retention and attraction of retail and service businesses.

Some of these issues arise from the attrition of local employment opportunities and the out-migration of residents (particularly youth) to London and other job centres in and beyond the region, where employment opportunities are more plentiful and/or fulfilling. The large agricultural operations although growing in size are not labour intensive; rather they are very capital intensive. They rely heavily on advancements in agricultural science and technology to optimize plant and animal production, and they invest heavily in large modern equipment, new barns and storage facilities, and advanced operating technologies.

The current Strategic Plan (Central Huron, n.d.) identifies other priorities and high-level actions for community involvement, effective use and management of community assets, and planning for improvements to existing infrastructure as well as plans for new infrastructure and environmental protection. With respect to infrastructure, the provision of water and sewer services along the shoreline is a key initiative.

A detailed description of the principles and goals is set out in the Community Profile Report that supports this assessment (AECOM, 2015a).

The following sections describe the implications of the APM Project for each of the community well-being “lenses” or asset categories.

7.2.2 Implications for Human Assets

Over the period of 2001 to 2011, Central Huron’s population decreased 2.8 per cent (Statistics Canada, 2002; Statistics Canada, 2013). This represents the second highest population decrease among municipalities in Huron County for this time period. Youth are leaving to seek employment outside the community. An examination of demographic cohorts reveals that the Municipality’s population is aging. Cohorts above 45 years old are growing, with the greatest growth occurring in the 85 years old and over cohort. Cohorts under 45 years old are all showing decline.

Central Huron has a skill and labour force profile indicative of a rural community with a strong quotient of skilled trades, retail occupations and trades, transport, and equipment operations. Since 2001, there has been a noticeable decline in primary industry occupations and a strong growth in management occupations as well as social science, education, government service, and religious occupations.

Agriculture is the dominant industry and has the largest labour concentration within the Municipality, followed by retail trade, and health care and social assistance. However, there has been major consolidation of farming holdings leading to large operations that are very capital intensive with few employees.

There are several primary and secondary schools available to the community (five of seven are located in Clinton), which offer varying levels of education programs, ranging from child care/nursery to high school. Facilities are managed by the Avon Maitland District School Board, the Huron Perth Catholic District School Board, and the Huron Christian School. Because of its central location within the County, Clinton also serves residents outside Central Huron.

The proportion of residents with university and college degrees, certificates and diplomas has increased since 2006. For the most part, individuals attending post-secondary education institutions must travel outside the community. However, some courses are offered at the REACH facility in conjunction with Fanshawe College and the University of Guelph. Hospital services are provided in Clinton and nearby communities such as Goderich, Wingham, and Seaforth. For those with special health-care needs, hospitals in London are within a one-hour drive. The Clinton Family Health Team (CFHT) serves residents of the Municipality and the surrounding area. Emergency services are provided at a regional level by the Ontario Provincial Police and Huron County EMS Ambulance Service. Central Huron has one fire department located in Clinton, the Central Huron Fire Station. However, the Municipality is also served by other stations located nearby in the municipalities of Goderich, Blyth, Bluewater, and East Huron. All together, the community education and health services meet the needs of the current population.

The APM Project has the potential to have a positive effect on the Human Assets of Central Huron. The project will bring direct, indirect, and induced jobs that can provide the foundation for population growth and youth retention. The APM Project will also help to diversify the economic base of the community.

While it is expected that some people involved in the construction and operations of the project will chose to reside in other nearby communities, it is equally plausible that hundreds of jobs could be held by people residing in Central Huron. With additional community development and support provided by the NWMO, it is possible that these job numbers could be increased. New jobs will bring spouses, partners and families, and increase the population in Central Huron. The increased population will, in turn, be a boost to Central Huron socially and economically, and will be a catalyst for spin-off growth and business development. This potential chain of events aligns well with the aspirations of the community.

Local skills and labour supply would diversify and expand with the increased population, and as a result of the on-site and in-community job opportunities. Indirect and induced jobs will also create opportunities for skills diversification and attract new residents with different types and levels of expertise while providing incentives for youth to remain in the community. The APM Project will capitalize on the existing labour force skills and expertise, and attract other highly educated and skilled workers. This influx of new jobs and incomes would also create new revenue sources for local businesses and the Municipality itself. In the case of the Municipality, some of the additional revenues could be applied to infrastructure and services investments.

The project will also provide opportunities for ongoing training, as well as provide opportunities for following generations to pursue education paths to take advantage of careers associated with the project. There are strong positive educational benefits from the APM Project, including an increased population driving expanded enrolment and educational programming opportunities including the REACH facility and further developing partnerships with post-secondary institutions such as Fanshawe College, University of Guelph, and others. The APM Project will include an international Centre of Expertise that will attract national and international attention.

While the APM Project and the associated increase in population will place heightened demand on existing health and safety facilities and services, there is further potential to expand and improve the existing levels of service by attracting new specialized health-care professionals to the area who could provide the resources to better serve and support all age groups in the community. The project may also act as a catalyst to bring more health services to the community itself. Proper planning would need to take place to ensure that potentially heightened social issues, generally associated with any large project that substantially increases local populations, are managed well in advance.

In summary, it can be expected that the APM Project would bring positive net benefits to the Human Assets of Central Huron if the project were to be implemented in the area. It would help the Municipality realize its aspirations and goals, and it would drive development and expansion in other aspects of its community well-being.

7.2.3 Implications for Economic Assets

The economy of Central Huron is largely based on agriculture and related services. Farm consolidation is ongoing with large operators buying up and absorbing traditional small farms. The Bluewater Youth Centre (a youth correctional centre) was a major employer (200 staff) in the community that closed in May 2012.

Agriculture is the dominant sector in the economy of Central Huron. Larger farms have become the norm for Central Huron and the region. Central Huron is a “top tier municipality” for agricultural production value in the Province of Ontario (Statistics Canada, 2012b).

Central Huron has an unemployment level of 5.2 per cent (Statistics Canada, 2013), which is below the Ontario average of over seven per cent. The unemployment level, in part, reflects out-working, out-migration, and people retiring from the labour force.

The Municipality has a labour force participation rate that has been declining, and now stands at roughly 65 per cent. This suggests a significant component of the available labour force (those up to 65 years of age) is not active, and also implies a large portion of the working age group in community is either retired or simply not looking for work. The average household income in Central Huron in 2012 was approximately $81,000.

Apart from agriculture, much of the labour force in Central Huron finds employment in jobs outside the Municipality. Clinton and lands within the Municipality adjacent to the Town of Goderich are the primary commercial concentrations in Central Huron, and they offer employment in retail and service sector jobs. The surrounding rural areas have a strong agricultural presence, and agricultural jobs are available in production and processing.

Agriculture in Central Huron, as it is throughout Huron County, is in rapid transition to large-scale capital-intensive operations. Recent times have also seen a dramatic increase in farmland values. These rising values create more taxes, which benefit the Municipality, but they also incent small operators to sell in the face of higher taxes to realize real estate appreciation. Additionally, many large farms either sever off or demolish unwanted farm residences and buildings, and this has the effect of both lowering their tax assessment and the flow of tax revenue to the Municipality.

Retail and service businesses in the settlement areas of Central Huron are experiencing significant challenges due to market forces often beyond their control. It is a common practice for local residents to drive to larger retail centres looking for selection and prices. Business

closures and vacant stores are common in the settlement areas of the Municipality. Shoreline residents also tend to travel outside the Municipality for most purchases, or, in the case of seasonal residents, they bring many of their supplies from their place of departure or home.

Central Huron has a cottage population along the shoreline and they do not tend to venture inland to visit or shop. Their orientation is north and south. Tourism is constrained in the Municipality because commercial accommodation and retail/service outlets that cater to tourists are limited. There are also other communities along the shoreline that are currently better positioned to attract tourists, and this puts Central Huron at a competitive disadvantage. Central Huron has attractions such as the Hullet Wildlife management area, which attracts many visitors for dog trials and hunting. However, there are limited options for them to stay locally and they seek accommodation in nearby municipalities and patronize businesses there. Central Huron aspires to attract tourists, and it recognizes that for this to happen, public and private infrastructure needs to be put in place. A downtown revitalization strategy is being developed to make the towns more attractive for visitors and businesses.

Outdoor recreation plays some part in the local economy as cottagers and visitors are drawn to the Lake Huron shoreline and the lifestyle it affords. Lake Huron is the dominant physical feature that plays a strong role in the recreation and tourism potential of the Municipality.

Municipal finances are currently healthy, given that expenditures do not exceed revenues and debt levels are manageably low. Going forward, to meet the needs of infrastructure and other services, additional financial resources will be required. Residential properties make up 59 per cent of property value assessment and the shoreline properties are the largest contributor in this category. Farmland accounts for roughly 34 per cent of the assessment base. Commercial, industrial and other uses combined make up the remaining seven per cent.

Should the APM Project locate in Central Huron, the net economic effects will be positive. A key attribute is the direct and indirect job creation it will bring to the community. Further induced employment will also occur in the community as a result of income spending by direct and indirect workers. The presence of long term, well-paying job opportunities will change the economic complexion of the community, and help diversify and grow its economic base. Out-migration of youth will slow as younger people will be able to find work locally. In-migration will also occur as Central Huron will become an employment centre with growing opportunities. These outcomes align well with the community's aspirations.

An increased number of residents with well-paying jobs means that household incomes and expenditures will rise. The availability of increased job opportunities and associated wealth for more households may help reduce any tensions created by income disparity.

More households and greater expenditures open up market opportunities for local businesses to service the expanding needs of a growing and more affluent population. These conditions will, in turn, help to reverse the decline in existing businesses and also bring new business into the community thereby adding to the vitality and diversity of the local retail/service fabric.

The economic buoyancy created among residents and local businesses will have positive implications for municipal finance. The assessment base will grow and it will be more equitably spread across industry, residential, and commercial components. This, too, is a key aspiration for the community as it seeks to increase and diversify its tax base, which is currently heavily reliant on the residential sector, particularly along the shoreline.

The APM Project is of a scope, scale, and longevity that businesses will be attracted to the community to take advantage of the opportunities for the supply of goods and services to the project itself and the population it has brought into the community. If the project were to be located in Central Huron, many years into the future, the community would need to be proactive in looking at where new businesses can locate and the support services they will require for long-term operation.

Some have expressed the view that the APM Project may result in perceived effects on agricultural products, thereby affecting the viability of area agriculture. Although this issue will need to be addressed with appropriate study and actions, it should be noted that despite nearly five decades of nuclear operations in the region, there have been no documented negative effects of this nature.

The effect of the APM Project on recreation has the potential to be both positive and negative. In the short term, initial concerns about safety of the facility may make the area less attractive to cottagers and tourists until a greater understanding of the project has been developed among them. Conversely, the population that migrates to the community to take advantage of jobs, and the visitors who come to the community to visit and learn about the facility, may present a new market for local tourist operators.

There may be some concern among cottagers and visitors around the perceived effects of the APM Project on the shoreline communities. Therefore, the NWMO will need to work with the communities to address concerns and explore opportunities to maintain and enhance well-being in the shoreline areas. While tourism is not fully developed at this point in time in Central Huron, it is important to note that tourism and recreational activities in the community or the wider region do not appear to have been affected by the ongoing presence of the nuclear site operations in the region.

The APM Project appears to present Central Huron with the potential for strong economic uplift through long-term economic diversity and increased stability. However, this uplift would need to be carefully planned for and managed if the community is to realize its full potential. The community may need support to ensure it is “project ready”, many years into the future. For Central Huron to optimize project benefits, it would be helpful to support education and training of the labour force, municipal administration and residents, and provide advice to local businesses on project opportunities.

7.2.4 Implications for Infrastructure

Recent sales data indicate average housing prices are between $225,000 and $250,000. Housing growth is modest at approximately 1.5 per cent per year between 2006 and 2011 (Statistics Canada, 2013).

Central Huron has three Plans of Subdivision, but growth is limited because of servicing constraints. Servicing partnerships may need to be put in place with adjacent municipalities (i.e., Goderich and Bluewater) to enable implementation of subdivision and shoreline developments.

The Municipality of Central Huron is largely served by Hydro One for local electricity transmission and distribution services. Erie Thames Powerlines is the local power distributor for Clinton. Union Gas provides natural gas to Clinton and other parts of the Municipality.

Landfill services are provided by Mid-Huron Landfill Site located in Holmesville. This facility is now very close to full capacity, and, as a result, the Municipality is confronted with the priority need to find replacement capacity either within its own borders or to transfer waste to a disposal facility beyond its borders.

Central Huron has transportation infrastructure to meet the needs of some businesses. However, it lacks proximity to a 400 series highway. This constrains convenient/efficient transport of goods to manufacturers and markets. The Goderich Harbour is a key deep-water port on the Great Lakes - St. Lawrence Seaway. Plans are underway to expand the harbour. This will enable expanded shipments of salt and grain. Air transport is enabled by a facility in Goderich. Air transport for larger air shipments and personal travel is available in London. Freight service in Central Huron is served by the Goderich-Exeter Railway (GEXR), which is Canada's first short line railway. The GEXR is headquartered in Goderich and runs through Central Huron.

The APM Project has the potential to create net positive benefits on the physical assets of Central Huron. The APM Project will bring an influx of individuals and families to the community thereby providing impetus for increased housing development and variety and associated servicing in the community. The development and absorption of new and existing homes will reinforce property prices and increase tax rolls.

Although there is a strong upside for housing with the APM Project, there is also a potential downside that needs to be managed. If demand strongly outstrips supply, price escalation will occur and the complement of affordable housing may be very low. A further note with respect to housing is that, during the construction phase, a strong uptake of commercial accommodation within the wider region by workers could take place with the consequence that tourists and travellers might be displaced at certain points in time. Within Central Huron, commercial accommodation is very limited at the moment. Over the course of implementing the project, attention will need to be paid to maintaining an equitable housing supply/demand balance as well as protection of regional tourist/traveller accommodations and other related services to prevent unwanted consequences in that industry.

The APM Project would be expected to stimulate the upgrading and expansion of infrastructure and services to accommodate new growth in the community. Central Huron is well connected by a road network to communities within the region and beyond. It is also serviced by air and marine transportation in nearby communities. The GEXR provides short line freight rail service connecting to the wider rail network. The community and the NWMO would need to work cooperatively to effectively plan, build, operate, and manage each of the physical asset components if the project were to be implemented in the Municipality.

7.2.5 Implications for Social Assets

The community facilities and programs available to the Municipality of Central Huron are a source of pride, and, in many cases, are the social hubs of the community for all age groups. Youth recreational programs are integral avenues for social activity for many families in the area. These facilities and programs provide a social focal point not only for the local community, but they also help to foster relationships and ties with the surrounding communities. Recreational tournaments are supported by the availability of recreational facilities that are vital to the social fabric of the community. While some newer facilities have been built in the community, other centres and services are going through a process of consolidation.

Central Huron has a strong tradition of building culture through local festivals, service clubs, sports organizations, and volunteer opportunities. The many clubs and organizations identified in the Municipality are indicative of a community that is interested in its past and nurturing social vitality for going ahead. The equitable distribution of services and facilities across the Municipality presents challenges at times, but the municipal administration is proactive in trying to ensure balance by continuing to build consensus and cohesion.

Central Huron is characterized by three constituent communities that have shaped the Municipality. The first is located along the Lake Huron shoreline, which is a waterfront community that is oriented toward family recreation and cottaging. The second group is the farming community located inland east of Highway 21. The third community is formed by the residents of inland settlement areas of which Clinton is the largest.

Central Huron has a strong relationship with agriculture. Much of the culture, spirit, and economy of the community centres on agriculture.

The rural areas of the Municipality have been transitioning away from small farms to large-scale operations. This trend has contributed to depopulation of the rural areas, and has had a subsequent ripple effect into the smaller towns as their hinterland populations are no longer there to sustain their commercial and social interests.

Much of the development along the shoreline is seasonal cottages on small lots. There are some trailer park developments and a limited number of larger homes created through cottage conversions. This is an area in transition, but the pace of change is constrained until water and sewage infrastructure is in place. Many residents along the shoreline come from other areas of southern Ontario and Michigan. Cottage occupants tend to shop north and south in Goderich and Bayfield, respectively, and infrequently venture inland to other settlement areas within the Municipality.

The residents in the inland settlement areas are confronted with declining and aging populations. Local businesses are declining as well, and storefront vacancies are apparent in all these communities.

There is some frustration in the former Township of Goderich (the shoreline community) regarding the amount of taxes paid and the availability of services they feel are important to them. The Municipality understands their desire and immediate need for water and sewage infrastructure, but lacks the necessary financial resources and means to rapidly move this forward. Despite this financial constraint, the Municipality is actively engaged in forming a partnership with Bluewater and Goderich to enable the provision of some infrastructure.

The APM Project has the potential to help the community to meet the aspirations and priorities of the overall community and the subgroups within it.

In the shoreline community, the APM Project can help generate the financial resources to enable needed water, sewage, and erosion control infrastructure. Within the settlement communities (e.g., Clinton), the project can generate employment and population growth, both of which will help revitalize these communities. With the farm community, the APM Project can be beneficial by enhancing youth retention through education and employment opportunities, and by contributing to agricultural business growth through generating revenue that would support research and development and environmental stewardship activities.

For the community as a whole, the APM Project will create new sources of financial capital that could be reinvested in community infrastructure, services, education, and further economic development initiatives in agriculture and other sectors. With the Municipality and the NWMO working in close collaboration, there is the potential all this could be achieved in harmony with Central Huron's overall objective to preserve and build upon its rural/agricultural identity.

Faced with these circumstances, the Municipality and the NWMO will need to work closely together to address community questions related to the project. Effort and innovation will be required to preserve the unique social character of the Municipality, and align the project to foster well-being across the community for all the major social groups. Based on limited engagement of community members to date, there appears to be an interest in learning more about the APM Project and its suitability for the Municipality.

7.2.6 Implications for Natural Environment

Community well-being is enhanced when the natural environment is available to all residents for their enjoyment, and to support community goals for the sustainable use of resources. At the moment, there are some pressures on the environment in Central Huron from a number of factors such as lake levels, invasive species, diminishment of woodlands and wetlands, and water quality in shoreline areas. Initial evaluation of potential environmental effects associated with the project suggests the APM Project is unlikely to have a significant negative effect on the natural environment attributes within the Municipality. Rather, the implementation of the project may provide resources to help address local environmental challenges, such as to preserve or restore woodland, or enhance water quality in the shoreline area.

One provincial wildlife management area, two conservation areas, and one nature reserve are located within the Municipality of Central Huron. The Municipality of Central Huron also contains Areas of Natural and Scientific Interest (ANSIs), International Biological Program sites, and wetlands, three of which are Provincially Significant Wetlands (PSWs). Concerns regarding water quality in streams, rivers, and Lake Huron have been expressed by some residents.

As would be the case with any large project, natural areas might be affected during the construction, operation, and decommissioning phases of the project. Effective mitigation and environmental protection measures will ensure the overall environmental integrity of the area is maintained. In addition, the project may generate increased resources and funding to manage and improve environmental conditions through conservation initiatives, reforestation, shoreline management, agricultural run-off control, and sustainable agricultural practices. It appears at this point in time that no significant negative environmental effects are likely during the construction, operation and decommissioning phases of the used fuel repository itself. Project implementation is many years away and this provides sufficient time to make effective plans that will protect environmental interests.

The APM Project contains some flexibility with respect to on-site building designs and energy use to be consistent with environmental and social values. For example, the ability to use renewable sources of electric power, where feasible, coupled with energy-efficient building designs might limit the overall carbon footprint of the project. In addition, there may be potential for the project site to provide areas for re-forestation and/or agricultural uses, which are aspirations for the community. In this case, the APM Project may have a substantial positive influence on the natural environment in Central Huron.

7.2.7 Summary of APM and its Implications for Central Huron

Based on the foregoing discussion, the APM Project has the potential to be a fit for the community of Central Huron. If implemented collaboratively, the APM Project has the potential to enable the aspirations of many community residents and through this, foster well-being as Central Huron defines it. Based on discussions with community officials and residents, it is felt the APM Project could generate desired population and economic growth, and provide the Municipality with the human and fiscal resources necessary to shape its future and well-being.

Central Huron has the ability to take on additional growth. It has a desire for managed growth, and has a complement of municipal services and transportation infrastructure to support this objective. With respect to infrastructure, the existing transportation networks are suitable for the APM Project, with direct access to highway and rail resources and access to air resources within the broader region.

The project can be developed in a manner that could enhance the local natural environment. Effective mitigation would ensure the quality of the natural environment is maintained, and, where desired, and as appropriate municipal revenues derived from the project could be directed to fund environmental initiatives such as reforestation, shoreline management, and sustainable agriculture.

Going forward, the Municipality and the NWMO will need to work closely together to create understanding of the APM Project, and to collaborate on appropriate strategies and actions to optimize the project implementation to meet the needs of the municipality and that of all constituent community groups.

Table 7-2: Overall Community Well-Being Implications – Central Huron

Criteria / Measures	Community Well-Being is Enhanced When …	Current Central Huron Profile		Possible Central Huron Profile with APM Project		Observations and Implications
OVERALL COMMUNITY WELL-BEING (CWB) IMPLICATIONS						
Human Assets	Population growth occurs and youth are retained in the community	Neutral	➖	Enhanced	➡	• The APM Project would enable desired population growth, which is an aspiration for the community. • Youth would be retained through increased employment opportunities and new residents would be attracted to the area. • Educational resources would be enhanced and new facilities could be developed.
Economic Assets	Employment opportunities are available and tax base increases to fund community services and facilities	Neutral	➖	Enhanced	➡	• There will be increased employment opportunities and a more diverse range of jobs would be available. • Increased funding through a wider tax base would provide the financial resources to fund infrastructure projects, educational developments, community and recreational facilities and programs, and social services and organizations. • The increased jobs from the APM Project would be the catalyst to enhance community well-being.
Infrastructure	Infrastructure is maintained or improved to meet the needs of the community	Neutral	➖	Enhanced	➡	• The APM Project, while placing increased demands on some of the infrastructure and services, would overall provide increased funding to improve and enhance existing services. • The community can leverage increased revenues from a growing population to invest in new infrastructure.
Social Assets	Opportunities exist for recreation and social networking. Community is cohesive, and community character is enhanced	Neutral	➖	Enhanced	➡	• The APM Project, collaboratively implemented, has the potential to foster community cohesion and well-being by enabling the attainment of overall community aspirations and that of many constituent community groups. • There is a need to foster understanding about the project and to align it with community interests.
Natural Environment	Natural areas, parks and conservation reserves are preserved and maintained for use and enjoyment	Maintained	➖	Maintained	➖	• Forested areas, shorelines, and water courses are under stress. • Some natural areas might be affected by the APM Project. Effective mitigation and environmental protection measures will ensure that the overall environmental integrity of the area is maintained. • It is understood at this point in time that no significant negative environmental effects are likely during the construction, operation, and decommissioning phases of the used fuel repository itself. • Municipal revenues created by the project would enable investment in environmental initiatives such as reforestation, shoreline management, and sustainable agriculture.

Legend	
Declining - Negative	⬅
Neutral - Stable	➖
Increasing - Enhanced - Positive	➡
Environment - Integrity Maintained	➖
Uncertain	▲

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7.3 Criteria to Assess Factors Beyond Safety – Summary in Central Huron

The previous chapter has taken a holistic approach to the assessment, taking into account the aspirations of the Municipality and the implications of the project for community well-being. The NWMO has acknowledged the process of assessment of community well-being needs to be collaborative and reflective of the community. Before initiating the siting process, and beginning to engage interested communities in the assessment process to understand their aspirations, the NWMO identified five evaluation factors, which, at a minimum would need to be addressed.

Table 7-3 draws on information outlined in the previous discussion to understand the potential to foster well-being in Central Huron against these original factors. The table summarizes preliminary findings about the implications of the APM Project, were it to be implemented in the community, on various factors of well-being. For many evaluation factors, four measures are used: maintained, enhanced, diminished, or uncertain. For other evaluation factors, two measures are used: yes, or no. The overall conclusion using these evaluation factors and the understanding that has emerged to date is consistent with that outlined in the previous sections.

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Table 7-3: Summary Table of Criteria to Address Factors Beyond Safety – Central Huron

Factors that Address the Well-Being of a Community	Evaluation Factors to be Considered	Potential Effect of APM Project	Discussion Based on Preliminary Assessment
Potential social, economic and cultural effects during the implementation phase of the project, including factors identified by Aboriginal Traditional Knowledge	Health and safety of residents and the community	Maintained	• There is a strong safety case as outlined in Chapter 5; however, the community needs to learn more about safety and health considerations to enhance their confidence in the safety of the project. • A few municipal residents work at the Bruce nuclear site and have knowledge of nuclear matters.
	Sustainable built environments	Enhanced	• Community infrastructure and built environment could be enhanced through project activities and investments in the community.
	Sustainable natural environments	Maintained	• Effective mitigation and environmental protection measures will ensure that the overall environmental integrity of the area is maintained. • It is understood at this point in time that no significant negative environmental effects are likely during the construction, operation, and decommissioning phases of the used fuel repository. • The project would make resources available to help improve environmental conditions in the Municipality.
	Local and regional economy and employment	Enhanced	• Employment and population growth will occur in Central Huron and surrounding communities – hundreds of new jobs might be created in the area. • With these jobs comes the potential to increase population and retain youth. • Opportunities would be created for current and new local businesses to serve the project and growing population.
	Community administration decision-making processes	Enhanced	• Some local leaders have demonstrated interest in the project. • Going forward, it is expected residents will have opportunities to learn more and engage in community decision-making around the project.
	Balanced growth and healthy, livable communities	To be determined	• Central Huron has aspirations to grow its population and diversify its economy in keeping with its community vision. • The APM Project appears to be a positive fit with many community objectives and aspirations. However, more engagement and community participation is required to provide focus on key issues and solutions. • There is some concern about potential loss of productive agricultural land and potential negative effects on outputs/brand as a result of the APM Project.
Potential for enhancement of the community's and region's long term sustainability through implementation of the project, including factors identified by Aboriginal Traditional Knowledge	Health and safety of residents and the community	Maintained	• There is a strong safety case as outlined in Chapter 5; however, engagement of surrounding communities is required and further dialogue will be needed to understand and address questions and concerns about safety and health considerations related to the repository and transportation of used nuclear fuel.
	Sustainable built environments	Enhanced	• Infrastructure and built fabric will be enhanced through project activities and investments in the community and surrounding areas.
	Sustainable natural environments	Maintained	• Some natural areas may be affected during the construction, operation, or decommissioning phases of the project. • Effective mitigation and environmental protection measures will be required to ensure the overall environmental integrity of the area is maintained.
	Local and regional economy and employment	Enhanced	• Substantial employment and economic development opportunities would extend to the surrounding region.
	Community administration and local and regional decision-making processes	To be determined	• Engagement of surrounding communities needs to be initiated to ensure they will be able to make informed and effective decisions.
	Balanced growth and healthy, livable communities	Enhanced	• Surrounding area communities (such as Goderich, Huron County in general) are collectively seeking economic development and growth in the region. • The APM Project generally appears to be in alignment with these aspirations, provided it does not compromise existing economic activities (i.e., agriculture and recreation).

Factors that Address the Well-Being of a Community	Evaluation Factors to be Considered	Potential Effect of APM Project	Discussion Based on Preliminary Assessment
Potential to avoid ecologically sensitive areas and locally significant features, including factors identified by Aboriginal Traditional Knowledge	Ability to avoid ecologically sensitive areas and locally significant features	Yes	• As outlined in previous chapters, the area appears to contain suitable sites for the project, thus providing flexibility in selecting specific sites that can avoid ecologically sensitive areas and local significant features.
Potential for physical and social infrastructure to adapt to changes resulting from the project	Potential for physical infrastructure to be adapted to implement the project	Yes	• There are no major infrastructure limitations in Central Huron or the surrounding region to impede project implementation. • Central Huron and the surrounding area have multiple modes of transportation, social and economic support services, and capacity to absorb the anticipated growth in population and economic activity. • Some infrastructure investments may be required to accommodate growth and special project needs.
	Potential for social infrastructure to be adapted to implement the project	Yes	• The community of Central Huron appears to have the necessary core of social infrastructure in place to plan and adapt to changes resulting from the project.
	The NWMO resources required to put in place physical and social infrastructure needed to support the project	To be determined	• In all likelihood, Central Huron would require assistance in terms of planning, and human and financial resources. • Further studies would be required to explore the specifics of these requirements.
Potential to avoid or minimize effects of the transportation of used nuclear fuel from existing storage facilities to the repository site	The availability of transportation routes (road, rail, water) and the adequacy of associated infrastructure and potential to put such routes in place from a social perspective	To be determined	• Central Huron is well situated and connected to major urban areas. • There are marine and air facilities in surrounding communities. • The municipality has rail access. • Project transportation will need to address community, logistical, and regulatory matters across multiple provinces and multiple jurisdictions including; Ontario, Quebec and New Brunswick. • Engagement of surrounding communities is at a preliminary stage and further dialogue will be required to understand and address questions and concerns.
	The availability of suitable safe connections and intermodal transfer points, if required, and potential to put them in place from a social perspective	To be determined	• Engagement of surrounding communities and those on potential transportation routes is at a preliminary stage and further dialogue would be required to understand and address questions and concerns.
	The NWMO resources (fuel, people) and associated carbon footprint required to transport used fuel to the site	280 - 480 tonnes of equivalent carbon dioxide emissions expected to be produced per year.	• As outlined in Chapter 6, a scenario of all-road transport of 4.6 million fuel bundles from the interim storage sites to an APM facility in Central Huron would produce approximately 480 tonnes of equivalent carbon dioxide emissions per year. • In a scenario of transport mostly by rail mode, approximately 280 tonnes of equivalent carbon dioxide emissions is expected to be produced per year.
	The potential for effects on communities along the transportation routes and at intermodal transfer points	To be determined	• As outlined in Chapter 6, there is a robust technical safety case for the safe and secure transport of used nuclear fuel. • Engagement of surrounding communities and those on potential transportation routes is at a preliminary stage, and further dialogue would be required to understand and address questions and concerns.

7.4 Overview of Engagement in Central Huron

NWMO has engaged with and supported learning with Central Huron leadership and community members through a variety of means, including the following:

- Several community open houses and open office events;
- Both informal and structured interviews with community members;
- Preparation of written materials;
- Informal tours and visits with local residents;
- 'Ask the NWMO' columns in regional newspapers;
- Attendance at local events;
- Storefront community learn more centre; and
- Nuclear waste management facility tours.

Initial discussions with a cross-section of community members, briefings and conversations with community groups, and conversations with residents during open houses suggest that although there are some community members concerned about the community's participation in the siting process, or opposed to it, there is more often interest in the community to continue to learn about the APM Project and to, many years in the future, consider hosting it. To this end, opportunities for preliminary discussions were sought with the following:

- Local political leaders (e.g., Mayor and Councillors);
- Local farm operators;
- Local business owners/operators;
- Local service providers (e.g., emergency services, social services, education); and
- Residents.

Based on discussions with the above, there appears to be potential to sustain interest in the local community. There also appears to be interest in continuing to learn more and move forward with the siting process.

There is a need to engage neighbours to establish a foundation for regional consideration of the project.

7.4.1 Summary of Issues and Questions Raised

This section summarizes the key challenges, issues, and comments as heard from the community and other persons engaged.

In Central Huron, most of the people engaged were interested in learning more.

Several key interests were recurring and identify matters that the community is most interested in learning more about. The core key interests expressed included the following:

- Health, safety, and environmental risk in and around the site, Lake Huron, and along the transportation route;
- Economic benefit and opportunities for growth; and
- The implications and potential for agriculture.

In addition to these core key interests, a number of secondary key interests were also expressed and included the following:

- How the community will be engaged in the decision-making process;
- The APM Project process and description details;
- Preservation of community character and environmental quality; and
- Uses that might be permitted on the balance of site not devoted to buildings.

7.5 Community Well-Being Summary Findings

At the outset of the site selection process, the NWMO framed four key questions, respectively addressing safety, the well-being of the community, the well-being of surrounding area communities, and the potential to foster sustained interest in exploring this project through subsequent steps in the site selection process (NWMO, 2011). This section addresses and elaborates on a subset of these questions related to community well-being in the context of the Municipality of Central Huron.

The preceding discussion has looked at implementation of the APM Project in Central Huron and the implications that this might have on community well-being. Additionally, key issues and concerns identified through engagement activities have been highlighted and discussed. Through desktop research, dialogue with community members and leaders, as well as ongoing analysis, it is understood that Central Huron has an interest in learning about the APM Project and what it might mean to host it.

The Municipality of Central Huron understands that this siting process, in partnership with the NWMO, could assist their community over time to get the information they require to reflect upon their willingness to continue in the site selection process and to decide whether or not they are interested in continuing to the next phase of studies.

There appears to be potential for the APM Project to foster well-being in Central Huron. The project could enable community priorities and aspirations, and is seen by many who have been engaged to date to be a potential catalyst for the socio-economic growth and development that most in the community desire.

There is potential for sustained interest in the local community. Further engagement is required to inform this interest. At this point in time, there is no indication that Central Huron will not remain committed to learning more. More engagement is required to better understand the levels of interest throughout the Municipality and beyond.

It is necessary to understand the potential for the APM Project to foster well-being in the surrounding communities and larger area as a whole. Ongoing discussions will be required to assess the implications of the project for surrounding area communities. This project will be implemented through a long-term partnership involving the community, potentially affected First Nation and Métis communities, surrounding communities, and the NWMO.

At this point, the potential for sustained interest in the surrounding communities needs to be better understood. Some of the surrounding communities have limited experience with nuclear technologies and facilities while others are more familiar with it. Two communities in nearby Bruce County continue to be participants in the APM site selection process, and a number of

other communities expressed interest but have now been eliminated from the siting process. Further discussions will be required to gain an understanding of the potential interest in other surrounding communities. However, there appears to be growing interest to learn more about the APM Project and what it might mean for Central Huron and the region.

There are some uncertainties associated with the preceding analysis due to the preliminary nature of the work at this stage. These uncertainties and challenges include the following:

1. Among the potentially suitable land areas within the Municipality of Central Huron, smaller, specific siting areas that are socially acceptable would need to be identified.

    a. Potential siting areas identified through scientific and technical studies must be the subject of community input to identify socially acceptable land areas.

    b. Further engagement with First Nation and Métis communities in the vicinity is required, including Aboriginal Traditional Knowledge holders. The NWMO acknowledges, respects and honours that Aboriginal peoples – Indian, Inuit and Métis peoples of Canada – have unique status and rights as recognized and affirmed in s.35 of the *Constitution Act*, 1982. The NWMO is committed to respecting the Aboriginal rights and treaties of Aboriginal peoples (NWMO, 2014).

    c. An appropriate process for securing land will need to be identified, in collaboration with municipalities, private land owners, and First Nation and Métis communities in the vicinity.

2. Project implementation (including engineering, logistics and/or community well-being) must align with specific community aspirations.

    a. An acceptable project implementation plan must be identified that aligns ultimate project configuration with expectations of the community, including potentially affected land owners.

    b. Effective project planning at a broader level, involving potentially affected First Nation and Métis communities, and surrounding communities will be important for successful implementation of the project.

3. Interest in the community for further learning about the project needs to be sustained.

    a. The site selection process spans several years and interest and conversation in the community and area needs to be sustained throughout this process, including multiple election cycles.

    b. The potential effects of the project on the interested community, First Nation and Métis communities in the vicinity, and surrounding municipalities would be substantial and these communities will need support to further explore their interest and take an active role in discussions of how the project should be implemented.

c. Opposition groups may actively seek to influence community decision-making, and community leaders will need to respond to these pressures. Central Huron will require support to prepare for the next phases of the siting process if it is to proceed.

4. Transportation routes and mode(s) need to be designed and configured taking into account social values.

    a. Transportation considerations will need to be determined. Regulatory matters along routes in several provinces including, New Brunswick, Quebec and Ontario, would need to be addressed. Social questions and concerns would also need to be heard and taken into account.

5. Environment and safety evaluations need to be aligned with community input.

    a. This requires regard for input from the community and surrounding communities.

    b. This requires engagement by the NWMO and may require capacity building to enable this input, which would include Aboriginal Traditional Knowledge.

    c. Input from transportation route communities will also need to be incorporated.

8. REFLECTION ON POTENTIAL SUITABILITY

8.1 Early Findings

The site selection process outlines a road map for decision-making, which involves many steps. Over the course of these steps, the NWMO and potentially interested communities, First Nation and Métis communities in the vicinity, and surrounding municipalities reflect upon the suitability of the area to host the Adaptive Phased Management (APM) Project. This initial phase of Preliminary Assessment has focused on supporting reflection of an interested community in the area participating in the siting process.

In order to fully understand and assess the potential of an area to host the APM Project, detailed scientific and technical studies are required over many years. At this preliminary assessment phase of work, initial studies have been completed. However, more detailed study is required to assess suitability and ensure the conditions are there for the safe and secure containment and isolation of used fuel over the very long term.

The decisions people will make in the future about learning more about the project, exploring the potential to foster well-being of the community and area, and ultimately whether they are willing to host the project in the area and are prepared to support its implementation, are also key determinants of suitability. Across communities, and at this early point in the site selection process, the NWMO cannot anticipate with certainty the outcome of a dialogue that would need to continue into the future in any community and area proceeding in the site selection process to support informed decision-making. Engagement activities within the interested community would need to continue to unfold. These activities would need to be broadened to involve potentially affected First Nation and Métis communities and surrounding municipalities in the learning and decision-making process, to fully understand the suitability of an area and site to host this project.

At this early stage of work, the NWMO is able to make preliminary conclusions and observations about the potential to find a safe and secure site within the Municipality of Central Huron that will meet the robust scientific and technical requirements of the project. The NWMO is able to make preliminary conclusions and observations about the potential for the project to foster the well-being of the Municipality of Central Huron if the project were to be implemented there. The NWMO is also in a position to reflect on the uncertainties and challenges associated with proceeding with more detailed studies with the Municipality, and ultimately satisfying the conditions for successful implementation of the project.

8.2 Preliminary Conclusions

The preceding chapters of this report have examined, in a preliminary way, the potential for the Municipality of Central Huron to meet the broad range of siting conditions set for the project.

Four overriding research questions have guided this preliminary assessment and are addressed as follows:

1. There is potential to find a safe site in the Municipality of Central Huron and area.
    - There is the potential to find a site with suitable geology.
    - There is the potential to safely construct the facility at the potential site.
    - There is the potential for safe and secure transportation to the potential site.
    - There is the potential to manage any environmental effects and to ensure safety of people and the environment.

2. There is potential to foster community well-being in the Municipality of Central Huron through the implementation of the project in the area.

3. There is potential for sustained interest in Central Huron to support further learning about the project.

4. More work is needed to understand the potential for the APM Project to foster well-being in the surrounding communities and larger area as a whole. More work is also needed to understand the potential for interest in learning to be sustained. Further discussions will be required to assess the implications of the project for surrounding area communities and to better understand the potential for sustained interest in those communities.

Preliminary assessment studies conducted to date suggest there is the potential for the Municipality to be suitable for the project from the multiple perspectives of:

- Engineering logistics;
- Geoscientific suitability;
- Environmental health and safety;
- Transportation safety; and
- Social, economic and cultural effects within the community.

These Preliminary Assessment studies addressed criteria that were set out in the siting process description as was feasible in this initial phase of work.

8.3 Observations About Suitability

8.3.1 General Observations

Based on this preliminary information, there are a number of observations that support the overall conclusion that the geographic area explored in this assessment has potential to meet the robust scientific and technical requirements of the APM Project.

- The APM Project has potential to be safely located in a suitable site within the Municipality, in a manner that will protect people and the environment now and in the future.

- There is potential to find a site that does not adversely affect future options for other valued activities identified to date such as economic development, farming, and tourism/recreation. In other words, there is potential that a geologically and environmentally suitable site can be found that does not jeopardize future uses of the land and resources as the NWMO understands them today.

- From a technical perspective, there is potential to safely transport used nuclear fuel from existing storage facility sites to the general area.

Based on this preliminary information, there are a number of observations that support the overall conclusion that there is potential to foster the well-being of the Municipality of Central Huron through the implementation of the project, and there is potential to sustain interest.

- There is potential to foster community well-being in the Municipality of Central Huron through the implementation of the project in the area. The APM Project has the potential to help the community to meet the aspirations and priorities of the overall community and the subgroups within it. Based on discussions with community officials and residents, the APM Project could generate desired population and economic growth, and provide the Municipality with the human and fiscal resources necessary to shape its future and well-being.

- The project can be developed in a manner that could enhance the overall natural environment within the Municipality. Effective mitigation would ensure the quality of the natural environment is maintained and, where desired, and as appropriate, municipal revenues derived from the project could be directed to fund environmental initiatives such as reforestation, shoreline management, and sustainable agriculture. The project can be developed in a manner that would not adversely affect future options for other valued activities such as farming and tourism/recreation.

- For the community as a whole, the APM Project will create new sources of financial capital that could be reinvested in community infrastructure, services, education, and further economic development initiatives in agriculture and other sectors. With the Municipality and NWMO working in close collaboration, there is the potential this could be achieved in harmony with Central Huron's overall objective to preserve and build upon its rural/agricultural identity. Effort and innovation will be required to preserve the unique social character of the Municipality and align the project to foster well-being across the community for all the major social groups.

- There is potential for sustained interest in Central Huron to support further learning about the project. Based on limited engagement of community members to date, there appears to be an interest in learning more about the APM Project and its suitability for the Municipality. At this point in time, there is no indication that Central Huron will not remain committed to learning more. More engagement is required to better understand the levels of interest throughout the Municipality and beyond.

- With respect to surrounding communities and the larger area as a whole, further discussion will be required to assess the implications of the project and the interest of these communities in learning. Some of the surrounding communities have limited experience with nuclear technologies and facilities while others are more familiar. Two communities in nearby Bruce County continue to be participants in the APM site selection process, and a number of other communities expressed interest but have now been eliminated from the siting process.

8.3.2 Uncertainties and Challenges

Based on this preliminary information, there are uncertainties and challenges that would need to be addressed if the Municipality continues in the site selection process. These uncertainties and challenges would be important to understanding the potential to meet the requirements for locating the project in Central Huron.

Some uncertainties and challenges are a result of being at an early phase of study with limited information available. Other uncertainties and challenges have arisen as a result of the studies themselves and may be unique to better understanding the potential suitability of a particular area. The difficulty and the level of resources required to successfully address the challenges and uncertainties may vary across the interested communities and areas.

The reader is encouraged to review the full report and supporting documents for a better understanding of the challenges and uncertainties associated with meeting the requirements of the project in this Municipality. Examples of the range and type of uncertainties and challenges that would need to be considered in planning and resourcing any further studies in the Municipality include the following:

1. Geoscience studies suggest that while the Municipality appears to contain large areas with favourable geoscientific characteristics, there are inherent uncertainties that would need to be addressed during subsequent stages of the site evaluation process. The assumption of transferability of geoscientific characteristics and understanding based on regional data and data from the Bruce nuclear site to the Municipality would need to be confirmed. Also, the impact of salt and hydrocarbon resource potential on repository siting and safety would need to be further assessed.

2. Environment and safety studies suggest there is potential to implement the project safely and with respect for the environment in the area. Although the assessment has identified some specific areas that would be excluded as they contain protected areas or historic hydrocarbon pools, a more definitive environmental evaluation would be required once smaller potential siting areas have been identified. These further studies could result in the exclusion of additional areas based on such factors as, for example, the presence of migration routes, geological pinnacle reefs, the proximity to important habitats, and cultural sensitivity. Discussions with interested communities, potentially affected First Nation and Métis communities, and surrounding communities, as well as field studies, would be needed to fully characterize the environmental conditions in these smaller potential siting areas.

3. Environment and safety studies suggest that effects of the project on the environment can be managed or mitigated through a combination of in-design features, operating procedures, and implementation of a sound environmental management plan. As smaller potential siting areas are identified, these mitigating measures would need to be identified and their effectiveness confirmed.

4. Among the potentially suitable land areas within the Municipality, smaller, specific, siting areas that are socially acceptable would need to be identified.
    - Potential siting areas identified through scientific and technical studies must be the subject of community input to identify socially acceptable land areas.
    - Further engagement with potentially affected First Nation and Métis communities is required, including Aboriginal Traditional Knowledge holders in the vicinity. This may expand the framework for assessment through, for instance, insight from Indigenous science, ways of life, and spiritual considerations.
    - An appropriate process for securing land will need to be identified in collaboration with municipalities, private land owners, and First Nation and Métis communities in the vicinity.

5. Project implementation (including engineering, logistics, and/or community well-being) must align with specific community aspirations.
    - An acceptable project implementation plan must be identified, which aligns ultimate project configuration with expectations of the community.
    - Effective project planning at a broader level, involving the potentially affected First Nation and Métis communities, and surrounding communities, will be important in the successful implementation of the project.

6. Interest in further learning about the project needs to be sustained.
    - The site selection process spans several years and interest and conversation in the interested community needs to be sustained throughout this process, including multiple election cycles.
    - The potential effects of the project on the interested community, First Nation and Métis communities in the vicinity, and surrounding municipalities could be substantial and these communities will need support to further explore their interest and take an active role in discussions of how the project should be implemented.
    - Opposition groups may actively seek to influence decision-making, and community leaders will need to respond to these pressures. Central Huron will require support for the next phases of the siting process if it is to proceed.

7. Transportation routes and mode(s) need to be designed and configured taking into account social values.
    - Transportation considerations will need to be determined. Regulatory matters along routes in several provinces, including New Brunswick, Quebec, and Ontario, would need to be addressed. Social questions and concerns would also need to be heard and taken into account.

8. Environmental and safety evaluations need to be aligned with community input.
    - This requires regard for input from the interested community and surrounding communities.
    - This requires engagement by the NWMO and input from the interested community and surrounding communities. This may require capacity building to enable this input, which could include Aboriginal Traditional Knowledge.
    - Input from transportation route communities will also need to be incorporated.

8.4 Partnership

The site selection process outlines a road map for decision-making, which involves many steps. Over the course of these steps, the NWMO, potentially interested communities, First Nation and Métis communities in the vicinity, and surrounding municipalities reflect upon the suitability of the area to host the APM Project.

The implementation of the project will have an effect on the broad area in which it is sited. Potentially affected First Nation and Métis communities, and surrounding municipalities, also need to be involved in decision-making about the project and planning for its implementation should it proceed in the community. Only through working together can the project be harnessed to maximize benefits to the community and area, manage any pressures that may come from the project, and ensure the project fosters the long-term well-being and sustainability of the community and area consistent with their vision for the future. This project will only proceed with the involvement of interested communities, First Nation and Métis communities in the vicinity, and surrounding municipalities working in partnership.

As identified in the site selection process description (NWMO, 2010), the NWMO has committed to respect Aboriginal rights and treaties in the siting decision, and take into account that there may be unresolved claims between Aboriginal peoples and the Crown. Furthermore, as outlined in the NWMO Aboriginal Policy (NWMO, 2014), the NWMO acknowledges, respects and honours that Aboriginal peoples – Indian, Inuit and Métis peoples of Canada – have unique status and rights as recognized and affirmed in s.35 of the *Constitution Act*, 1982. The NWMO is committed to respecting the Aboriginal rights and treaties of Aboriginal peoples.

8.5 The Way Forward

Through a multi-year sequence of engagement and assessments, the NWMO will lead a gradual narrowing down of communities and areas in the process to eventually arrive at a single preferred site with an informed and willing host.

The outcome of Phase 1 Preliminary Assessments guides an initial phase of narrowing down of communities and areas engaged in site selection studies. The NWMO will identify a smaller number of communities and areas with strong potential to meet the requirements of the project to be the focus of Phase 2 Assessments for detailed field studies and broadened dialogue.

Several more years of detailed studies would be required before confidence could be established that project requirements could be met in any potential siting area. For those that continue on in the process, a broad network of relationships would also need to be established in the area, involving the interested community, potentially affected First Nation and Métis communities, and surrounding municipalities to reflect upon the suitability of the area to host the APM Project.

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10. GLOSSARY

PRELIMINARY ASSESSMENT OF ENGINEERING

Backfill – The material used to refill excavated portions of a repository (drifts, disposal rooms or boreholes) during and after waste has been emplaced.

Barrier – A physical obstruction that prevents or delays the movement of radionuclides or other material between components in a system, for example a waste repository. In general, a barrier can be an engineered barrier which is constructed or a natural (or geological) barrier.

Bentonite – Soft light-coloured clay formed by chemical alteration of volcanic ash. It is composed essentially of montmorillonite and related minerals of the smectite group. Bentonite is used as backfill and buffer material in repositories.

Borehole – A cylindrical excavation, made by a drilling device. Boreholes are drilled during site investigation and testing and are also used for waste emplacement in repositories and monitoring.

CANDU – Canada deuterium uranium.

Limited access area – A designated area containing a nuclear facility and nuclear material to which access is limited and controlled for physical protection purposes.

Lithostatic pressure – Pressure due to the weight of overlying rock and/or soil and water.

Nuclear security protected area – A designated area within a nuclear facility to which access is restricted, controlled and guarded for security and physical protection purposes (i.e., an area that contains the used nuclear fuel).

Protected area – An area inside a limited access area containing Category I or II nuclear material and/or sabotage targets surrounded by a physical barrier with additional physical protection measures.

Repository – A nuclear facility where waste is emplaced for disposal.

Repository, geological – A facility for disposal of radioactive waste located underground (usually several hundred metres or more below the surface) in a geological formation to provide long-term isolation of radionuclides from the biosphere.

Used fuel – Irradiated fuel bundles removed from a commercial or research nuclear fission reactor. (Adapted from the *Nuclear Fuel Waste Act*.)

Advection – A process by which dissolved or suspended substances (e.g., natural constituents, artificial tracers, contaminants) are transported by the bulk motion of a fluid medium (e.g., water, air).

Aquiclude – A medium with very low values of hydraulic conductivity (permeability) which, although it may be saturated with groundwater, is almost impermeable with respect to groundwater flow. Such geologic media will act as boundaries to aquifers and may form confining strata.

Aquifer – A geological unit or structure that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs. A confined aquifer is bound by low permeability formations such that it is under pressure. An unconfined aquifer is one whose upper groundwater surface (water table) is at atmospheric pressure.

Aquitard – A confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores groundwater.

Argillaceous – Largely composed of, or containing, clay-size particles (less than 4 microns) or clay minerals.

Arkose – A feldspar- rich (feldspathic) sandstone, commonly coarse- grained and pink/reddish in color, where feldspars mineral content is ≥ 25%.

Basement (rock) – The crust of the Earth (Precambrian igneous and metamorphic complex) underlying the sedimentary deposits.

Bedrock – Consolidated rock that underlies soil or other unconsolidated material.

Brine – Water with a salinity greater than 100,000 milligrams per litre (greater than 100 grams per litre) total dissolved solids.

Canadian Shield – A large plateau that occupies most of eastern and central Canada and consists of exposed Precambrian basement rocks in a stable craton. It is surrounded by younger sedimentary rocks.

Crystalline rock – A rock of igneous or metamorphic origin consisting wholly of mineral crystals.

Deformation – Any process of folding, faulting, shearing, or fabric development undergone by a rock as a result of Earth stresses; or the change in geometry of a body of rock as a consequence of Earth stresses.

Diffusion – Random movement of both ions and molecules in water from areas of higher concentration to areas of lower concentration.

Dip – The angle that a geological structural surface (bedding plane, fault, etc.) makes with the horizontal; measured in the vertical plane, perpendicular to the strike of the structure.

Dolostone – Also named dolomite, it is a sedimentary rock of which more than 50 per cent by weight consists of the mineral dolomite (magnesium carbonate). Dolostone is generally thought to form when magnesium ions replace some of the calcium ions in limestone by the process of dolomitization. Warm migrating fluids along some faults and fractures may locally dolomitize limestone, and the resulting rock, being more porous, may become a host for oil and gas deposits in an appropriate sedimentary setting and physical/chemical environment.

Drumlin – A low, smoothly rounded, elongate oval hill, mound, or ridge, of compact glacial till or drift, built under the margin of glacial ice and shaped by fluid flow beneath the glacier. The long axis of a drumlin is oriented parallel to the direction of ice movement, with a blunt nose orientated in the direction of ice movement.

Earthquake – A shaking or trembling of the Earth resulting from subterranean movement along faults.

Erosion – The process by which the surface of the Earth is worn away by the action of water, wind, or ice movement. The erosive process operates by the combined action of weathering and transportation, where first rocks are broken down (weathering), and then the smaller pieces are carried away (transportation).

Fault – A fracture or a zone of fractures that occurs as a result of brittle deformation and within which there is relative displacement of the fracture surfaces.

Formation – A body of rock identified by lithologic characteristics and stratigraphic position, which is mappable at the Earth's surface or traceable in the subsurface.

Fracture – A break in the rock mass, including cracks, joints, faults, and bedding partings.

Geomechanics – A branch of Geology that embraces the fundamentals of structural geology and knowledge of the response of natural materials to deformation.

Geophysics – The study of the Earth by quantitative physical methods, including seismic reflection and refraction, gravity, magnetic, electrical, electromagnetic and radioactivity methods.

Glaciation – The formation, movement, advance and recession of glaciers or ice sheets.

Gravity data – Data gathered by measuring variations in the Earth’s gravitational field caused by differences in the density of subsurface rocks.

Groundwater (or Ground water) – In general, water contained in geologic formations below the Earth’s surface. In the context of a DGR, the term is specifically applied to water that is relatively unconstrained by low permeability media and, therefore, free to flow under the influence of hydraulic gradients. This includes water within the connected pore space between mineral grains in unconsolidated sediment or in a fractured or porous rock matrix, as well as water in permeable, connected structures in the subsurface.

Hydraulic conductivity – Ease with which water can move through a volume of rock, and is measured in unit length (e.g., metres) per unit time (e.g., seconds).

Hydraulic Head – Fluid mechanical energy per unit weight of fluid, which correlates to the elevation that water will rise to in a well.

Hydrogeochemistry – Branch of Geochemistry that studies the chemical characteristics of ground and surface waters and their interaction with the rock environment of an area.

Hydrogeology – Branch of Geology that studies the movement and characteristics of subsurface waters.

In-situ stress – The current state of stresses in a rock mass/region, representing the magnitude of, and direction in which, the rock is being compressed due to crustal movement.

Isostatic rebound – Rise of land masses that were depressed by the huge weight of ice sheets.

Karst – A type of topography that is formed in limestone, gypsum or other soluble rocks primarily by dissolution. It is typically characterized by the formation of sinkholes, caves and underground drainage.

Laurentide Ice Sheet – The last glacier that advanced over North America during the Wisconsinan glacial episode.

Limestone – A sedimentary rock composed of the mineral calcite (calcium carbonate). Where it contains appreciable magnesium carbonate, it is called dolomitic limestone. Typically, the primary sources of this calcite are the shells of marine organisms.

Lithology – Set of physical characteristics of a rock, including colour, grain size, and mineralogy.

Moraine – A glacially formed accumulation of unconsolidated glacial debris (i.e., soil, rock). Moraines are deposited as sheets or piles of debris directly from the ice of the glacier on/in which the debris is carried. Various types of moraines exist and their classification is based on where they were deposited with respect to the front of the glacier.

Neotectonics – Neotectonics refers to deformations, stresses and displacements in the Earth's crust of recent age or which are still occurring.

Ordovician – The second period of the Paleozoic Era extending from 444 to 485 million years ago; also refers to rocks formed, or sediments laid down, during this period (e.g., Ordovician carbonates).

Outwash – Stratified detritus (i.e., sand and gravel) removed or "washed out" from a glacier by meltwater streams, and deposited in front of or beyond the end moraine or the margin of an active glacier.

Overburden – The silt, sand, gravel, or other unconsolidated material overlying the bedrock surface, either by having been transported or formed in place.

Paleo- – Prefix used when referring to something "ancient" or "old."

Paleohydrogeology – Branch of Hydrogeology concerned with the study of ancient hydrologic processes, regimes and associated hydrologic features preserved in the rock.

Permeability – Is a measure of the relative ease of fluid flow under a hydraulic gradient, and is a function only of the medium through which the fluid is moving.

Pinnacle Reef – A small reef patch, consisting of coral growing sharply upwards (with slopes ranging from 45° to nearly vertical). In southern Ontario, ancient, fossilized pinnacle reefs occur in the Guelph Formation and can become oil and gas traps when they are capped by anhydrite or shale.

Porewater (or Pore Water) – Water within the connected pore space between mineral grains in low- permeability sediments or rocks, for which flow under the influence of hydraulic gradients is inhibited. In contrast with groundwater, which flows into or can be sampled from boreholes over time scales of days to months, laboratory techniques are generally required to extract porewaters from the sediment or rock matrix.

Precambrian – All geologic time before the beginning of the Phanerozoic Eon, preceding about 542 million years ago; also refers to rocks formed, or sediments laid down, during this period (e.g., Precambrian gneiss).

Quaternary – Period of time of the Earth extending from approximately 2.6 million years ago until present time.

Sandstone – A medium-grained clastic sedimentary rock that may be deposited by water or wind, and is composed of abundant sand size particles, with or without a fine-grained matrix (clay or silt), and cemented (commonly silica, iron oxide or calcium carbonate); i.e., the consolidated equivalent of sand.

Sedimentary rock – Rock formed by the accumulation of layers of clastic and organic material or precipitated salts.

Seismicity – The frequency or magnitude of earthquake activity in a given area. Also refers to the geographic and historical distribution of earthquakes.

Seismology – The study of seismic waves from earthquakes to investigate the structure and processes within the Earth.

Shale – A fine-grained detrital sedimentary rock, formed by the compaction and cementation of clay, silt, or mud. It may have a fine laminated structure which gives it fissility; i.e., preferred plane(s) along which the rock splits readily.

Stratigraphy – The study of the age relation of rock strata, including the original succession (order of placement), form, distribution, composition, fossil content, geophysical and geochemical properties, and the environment of origin and geologic history of a rock mass. The science primarily involves the description of rock bodies, and their organization into distinctive, mappable units based on their properties and features.

Till (Glacial) – A deposit of sediments laid down by glacial processes without the action of water. Types of till are classified based on their particle size (i.e., clay- rich till) or based on the processes of deposition (i.e., lodgment till, ablation till)

Tectonics – The study of the interplay between the plates that make up the outer part of the Earth, which usually results in earthquakes, creation of mountains, and fault movement, among others.

Terrain – An area of ground with a particular physical character.

Thermal conductivity – Ease with which heat can move through a volume of rock, and is measured in unit energy (e.g., Watt) per unit distance (metre) and unit temperature (Kelvin).

Topography – Detailed description or drawing of the physical relief of a place or region, especially in the form of contour maps.

Total Dissolved Solids – The quantity of dissolved material in a sample of water.
Uniaxial Compressive Strength – Represents the capacity of a material to withstand axially applied mechanical compressive forces. The strength is usually expressed in units of stress.

Watershed – An area that drains all precipitation received as a runoff or base flow (groundwater sources) into a particular river or set of rivers. Synonymous with drainage basin and catchment.

PRELIMINARY ASSESSMENT OF ENVIRONMENT AND SAFETY

masl – metres above sea level.

ANSI – Area of Natural and Scientific Interest – An official designation by the Province of Ontario applied to areas of land and water that represent significant geological (earth science) and biological (life science) features.

Crown leased land – Crown land acquired by the Ministry of Natural Resources for reasons based on ecological sustainability, including ecosystem health, the protection of natural and cultural assets, recreation, and/or the protection of people and property.

Crown land – **Non-Freehold Dispositions Public** – Crown land that is a tenure holding, usually for a set term and a specific purpose (e.g., Lease, Licence of Occupation, Land Use Permit, Beach Management Agreement and Easement), excluding permanent disposition in the form of a patent.

Crown land – **Unpatented Public Land** – Crown land that has never been granted or sold by the Crown to people or organizations for their private use and is under the mandate or management of the Ministry of Natural Resources.

Crown reserves – Crown lands that have been withdrawn from dispositioning under Section 21 of the *Crown Minerals Act*.

Safety case – An integrated collection of arguments and evidence to demonstrate the safety of a facility. It includes a Safety Assessment, complemented by additional arguments and evidence in order to provide confidence in the long-term safety of the facility.

Postclosure – The period of time following closure of a repository, after the shafts have been sealed and surface facilities have been decommissioned.

PRELIMINARY ASSESSMENT OF TRANSPORTATION

Designated Licensing Authority – The position designated as being accountable to manage the regulatory interface with the Canadian Nuclear Safety Commission (CNSC) (any verbal or written exchange of information with a representative of the CNSC).

Role – A set of duties, responsibilities and accountabilities, usually associated with a particular job. Roles generally define who does what.

Testing – Performed to demonstrate that a structure, system, equipment, component or software meets specified requirements, or to substantiate the predicted performance.

PRELIMINARY SOCIAL, ECONOMIC AND CULTURAL ASSESSMENT

Community well-being – In the NWMO site selection process, community *well-being* is defined by the community to reflect its long-term vision, goals and objectives. Although there is no single definition, communities often include in their consideration elements relating to such things as economic health, the environment, safety and security, spiritual dimensions, social conditions, and enhancing opportunities for people and communities. The NWMO has adopted a Sustainable Livelihoods framework to encourage broad reflection and discussion by the community, inclusion of multiple perspectives, community leadership in the discussion, and establishment of a broad foundation for the assessment. The framework is expected to evolve over time as dialogue and reflection continue.