

Canada's Deep Geological Repository for Used Nuclear Fuel – Update on the Site Evaluation Process and Interweaving of Aboriginal Traditional Knowledge

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Abstract

The Nuclear Waste Management Organization (NWMO) is responsible for implementing Adaptive Phased Management (APM), the approach selected by the Government of Canada for the long-term management of used nuclear fuel generated by Canadian nuclear reactors. The ultimate objective of APM is the centralized containment and isolation of Canada's used nuclear fuel in a Deep Geological Repository (DGR) in a suitable crystalline or sedimentary rock formation. In May 2010, the NWMO initiated a nine-step site selection process to seek an informed and willing community to host Canada's deep geological repository. As of April 2015, twenty-two communities expressed interest in learning more about the project. This paper provides an update on the site evaluation process and describes the approach, methods and criteria used in the assessments, focusing on geological and community well-being studies. Engagement and field activities to interweave Aboriginal Traditional Knowledge with western science are also discussed.

1. Introduction

The Nuclear Waste Management Organization (NWMO) is responsible for implementing Adaptive Phased Management (APM), the approach selected by the Government of Canada for long-term management of used nuclear fuel generated by Canadian nuclear reactors. The ultimate objective of APM is the centralized containment and isolation of Canada's used nuclear fuel in a Deep Geological Repository (DGR) in a suitable crystalline or sedimentary rock formation at a reference depth of approximately 500 m (1,640 ft). The actual depth will be determined on a site specific basis. The repository will consist of access and service shafts and a series of tunnels leading to placement rooms where used fuel will be sealed in competent rock using a multi-barrier system which includes long-lived specially designed containers, clay-based sealing materials and the rock itself. The used fuel will be monitored throughout all phases of implementation and will also remain retrievable for an extended period of time. Through a collaborative process in 2008 and 2009, NWMO worked with interested Canadians to develop the decision-making framework for selecting a site for the Project. 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 Canadians told us need to be part of the decision-making process to ensure it is an appropriate one for Canada. These steps are illustrated in Figure 1 and described in more detailed in NWMO's site selection process document [1].



Figure 1 Steps in the site selection process at a glance.

2. Status of the Selection Process as of April 2015

A total of twenty-two communities, three in the Province of Saskatchewan and nineteen in the Province of Ontario, 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 as part of an open invitation process. As communities expressed interest, the NWMO undertook an Initial Screening as part of Step 2 studies and began working with each community as they learned about the project and reflected upon their interest in it (Figure 1). 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. The initial screenings identified that twenty-one of the communities contained geological formations that would be potentially suitable for hosting a deep geological repository. The initial screening suggested that one community was unlikely to contain geological formations potentially suitable for hosting a deep geological repository and for this reason was not considered a suitable candidate for continuing in the site selection process (Community of Red Rock, Ontario). Screening reports for the twenty-two communities are available from NWMO's website (nwm.ca).

All the twenty-one communities that successfully completed an Initial Screening entered into Step 3 (Preliminary Assessments) of the site selection process. The ultimate objective of the Preliminary Assessment is to select one, possibly two, communities for detailed site characterizations (Step 4). The Preliminary Assessment is conducted in two phases consisting of desktop (Phase 1) and field investigations (Phase 2). Communities involved in the site selection process as of 2015 are shown in Figure 2.

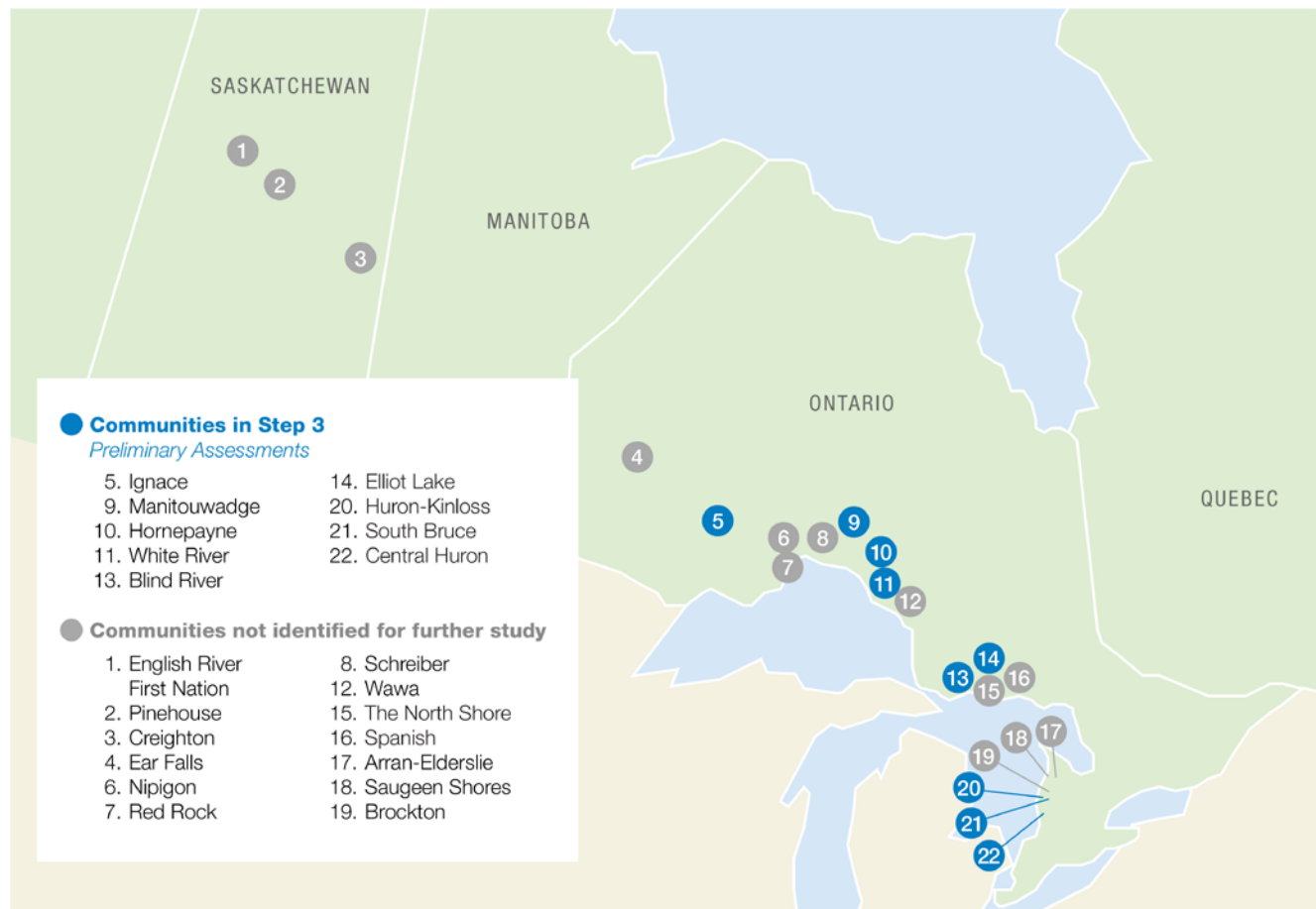


Figure 2 Communities involvement in the site selection process.

As of April 2015, NWMO completed desktop Preliminary Assessments (Step 3, Phase 1) for twenty of the twenty-one communities (all except Central Huron) that entered into this step. Eight communities (Creighton in Saskatchewan and Ignace, Hornepayne, Schreiber, Manitouwadge, White River, Elliot Lake and Blind River in Ontario) were assessed as having strong potential to meet site selection requirements and were identified for further study. As shown in Figure 2, the communities of English River First Nation and Pinehouse in Saskatchewan, and Brockton, Ear Falls, Spanish, The North Shore, and Wawa in Ontario, were not selected for more detailed study. Also, interim results for two other communities in southern Ontario, Saugeen Shores and Arran Elderslie, indicated that these two communities have limited potential to satisfy NWMO’s geoscientific site evaluation factors due to surface and geological constraints. The community of Nipigon in Ontario withdrew from the site selection process after receiving interim findings. Step 3 Phase 2 geological studies 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.

3. Preliminary Assessment (Step 3)

The NWMO has adopted an integrated approach to Preliminary Assessments based on a series of multidisciplinary studies, including geoscientific suitability, engineering, transportation, environment and safety, as well as social, economic and cultural considerations (Figure 3).

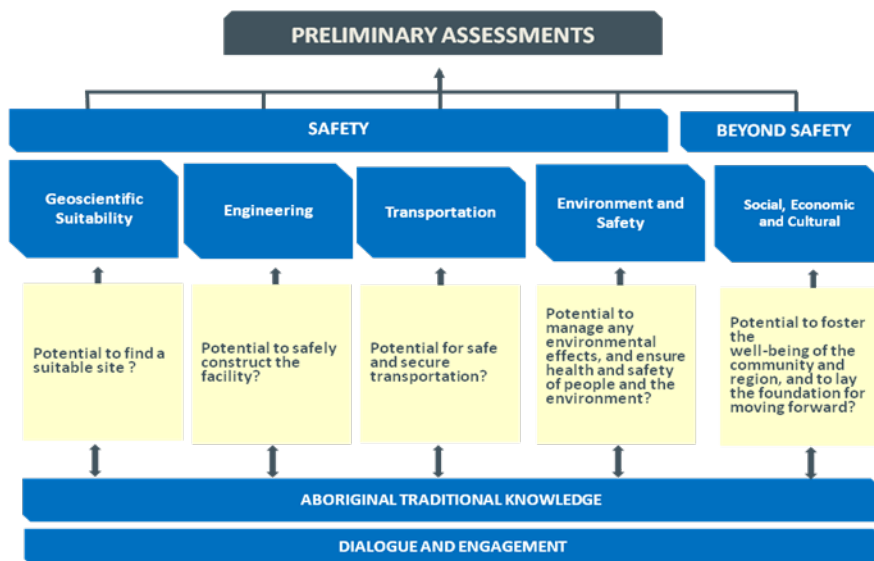


Figure 3 Structure of Step 3 Preliminary Assessments.

3.1 Geoscientific Preliminary Assessment

The objective of the geoscientific preliminary assessment is to assess whether the community areas contain siting areas that have the potential to meet NWMO's site evaluation factors [1]. The geoscientific preliminary assessment is conducted in two phases:

- **Phase 1 - Desktop Study:** Conducted for all communities electing to be the focus of a preliminary assessment. This phase involves desktop studies using available geoscientific information and a set of key geoscientific characteristics and factors that can be realistically assessed at the desktop phase of the preliminary assessment.
- **Phase 2 - Preliminary Field Investigations:** Conducted for a subset of communities selected by the NWMO, to further assess potential suitability. This phase involves field investigations that include high resolution geophysical surveys, geological mapping and the drilling of deep boreholes. The subset of communities for Phase 2 is selected based on the integrated findings of the Phase 1 preliminary assessments, considering the technical and community well-being factors illustrated in Figure 3.

The Phase 1 geoscientific desktop studies were conducted using available geoscientific information and key geoscientific characteristics that could be realistically assessed at this early stage of the site evaluation process. These included: geology; structural geology; lineaments interpreted from available geophysical surveys; distribution and thickness of overburden deposits; surface conditions; and the potential for economically exploitable natural resources. The consideration of these key geoscientific characteristics revealed that most of the communities assessed contain areas that have the potential to satisfy NWMO's geoscientific site evaluation factors with varying degrees of uncertainty. The various technical and community well-being reports for completed Phase 1 Preliminary Assessments are available from NWMO website (nwmo.ca).

In 2014, initial field investigations were initiated in communities in Phase 2 of the Preliminary Assessment (Figure 2). The objective of these initial field studies is to further assess the geoscientific suitability of the communities, and to identify smaller potentially suitable areas for more detailed studies, including detailed geological mapping. In addition to the already available surface and subsurface geoscientific information, the location and size of potentially suitable areas identified in Phase 1 assessments were refined through a detailed analysis and interpretation of the newly acquired field data. This included the following key activities:

- Acquisition and processing of high resolution airborne magnetic and gravity surveys over the four general areas identified in Phase 1 Geoscientific Desktop Preliminary Assessment;
- Detailed interpretation of high resolution gravity and magnetic surveys to better understand the bedrock geology (e.g. geological contacts, depth and extent of rock units, lithological and structural heterogeneity, etc.);
- Detailed interpretation of surface and geophysical lineaments using newly acquired high resolution remote sensing and magnetic surveys to identify possible structural features such as fractures, shear zones and dykes;
- Observation of general geological features to confirm/ground truth geologic characteristics, including lithology, structure, bedrock exposures and surface constraints.

3.1.1 Geoscientific Site Evaluation Factors

The geoscientific suitability of potential sites is evaluated in a step-wise 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 [1]:

- ***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?

4. Interweaving Aboriginal Traditional Knowledge and Western Knowledge

Aboriginal peoples have a special relationship with the natural environment, and unique stewardship responsibilities that are part of this relationship. The knowledge that comes from this relationship with the land brings special understandings to the broad range of factors that should be considered in field studies, social assessments, and assessing benefits and effects to be managed.

As part of NWMO's promise to work in partnership with First Nation and Métis communities, there is a commitment to interweaving local Traditional Knowledge in all phases of NWMO's work. Traditional Knowledge involves Aboriginal people's unique understanding, relationship and connection of the land to their way of life.

Aboriginal Traditional Knowledge emphasizes the interrelationships between all components of the environment. It is a complex and sophisticated system of knowledge drawing on millennia of wisdom and experience. It constantly grows and expands with the experience of new generations. It is expected that this knowledge system will continue to provide a source of wisdom through the various stages of project development and implementation. To better understand Aboriginal Traditional Knowledge and the interrelationships, the NWMO draws on the wisdom of the NWMO Council of Elders. This Council has membership from many First Nation and Métis communities across Canada and acts as an advisory body to the NWMO.

The Council of Elders provides counsel on the application of Traditional Knowledge in the implementation of Adaptive Phased Management. Through its advice to the NWMO, the Council of Elders will protect and preserve Aboriginal Traditional Knowledge and provide advice on issues that could enhance the development and understanding of Aboriginal Traditional Knowledge in the implementation of APM.

The NWMO expects that integrating Aboriginal Traditional Knowledge into the identification and assessment of potentially suitable sites will lead to an expanded set of considerations to assess the suitability of a site, new and different approaches to data collection and interpretation, and a perspective on ways of life that will be important to inform more detailed studies.

The NWMO is currently working, and will continue to work, together with Aboriginal communities in potential siting areas to respectfully apply Traditional Knowledge to both technical safety and community well-being aspects of the site selection process.

As an example, prior to the commencement of geological mapping activities, a traditional ceremony was performed by a local Elder on the land where some of the mapping activities were planned. The ceremony reminded both participating members of the local Aboriginal and non-Aboriginal communities, contractors and NWMO staff that as humans, we are dependent on the land for sustaining life. One aspect in particular was stressed and that was the importance of water and its preservation as a clean resource for all life.

As we move forward the NWMO recognizes that any collection or documentation of Traditional Knowledge will be of interest to the community beyond the scope of the NWMO project and NWMO will agree to manage that information in partnership with the community accordingly.

The NWMO will look to Aboriginal people to share Aboriginal Traditional Knowledge with the NWMO to the extent that they wish to. The NWMO will ensure that Aboriginal intellectual property is protected, as agreed with the Aboriginal people who choose to share that knowledge.

5. Community Well-Being and Engagement

Engagement of communities has been focused on building awareness and understanding of the project. It has also focused on collaboratively planning the implementation and advancement of the technical studies, which is critical to building both NWMO and community understanding of potential for safety in the area. The NWMO continues to work with people in the area to plan the timing of studies and avoidance of sensitive areas, as well as reviewing the findings from initial studies once they are available. Importantly, engagement has focused on beginning to identify smaller siting areas in which to focus more detailed study, taking into account the perspectives of those in the area.

Phase 2 preliminary assessments deepen the exploration of the potential for the project to foster the well-being of the area and to sustain learning which will build confidence in the project. Broadened engagement with potentially affected First Nation and Métis communities and surrounding municipalities is intended to support more detailed reflection and assessment and shared project planning at a broader level. Understanding how to foster the well-being of the broader area through the implementation of the project, and identifying siting areas for more detailed study together with those in the area, are important to laying the foundation for partnership.

The APM Project requires establishing a long-term partnership that first begins with the interested community, and only then seeks to extend out to involve First Nation and Métis communities and surrounding municipalities. Engagement of Aboriginal peoples and surrounding communities is at a very early stage, and is a focus of Phase 2 assessments for the smaller number of communities identified for more detailed study. Alignment of the project with the values, priorities and objectives of

Aboriginal peoples, surrounding communities and together with their level of interest in learning, is a critical consideration in assessing the suitability of any particular site. This project will only proceed with the involvement of the interested community, First Nation and Métis communities in the area and surrounding municipalities working together to implement it.

The shape and form of the partnership required to advance the project in an area, the identification of partners and the distribution of risks costs and benefits among them, is expected to emerge through dialogue over the course of the siting process. This is expected to be the case as questions such as how can the project be implemented in a manner that fosters the well-being of the broad area in a way which is meaningful to communities, and how to best ‘fit’ the project in the area, is explored with those in the area. The NWMO is committed to ensuring that those who possess land-based rights in a particular Siting area must be involved and we understand our process must take into account existing economic and political relationships. Our approach must be respectful of each area’s unique circumstances.

Studies conducted to date suggest the project has the potential to substantially contribute to the well-being of many of the interested communities involved in the siting process.

6. References

- [2] Nuclear Waste Management Organization (NWMO), “Moving Forward Together: Process for Selecting a Site for Canada’s Deep Geological Repository for Used Nuclear Fuel”, Toronto, Canada, May 2010, pp.24 – 30. (Available at http://www.nwmo.ca/sitingprocess_theprocess).