

SITING CANADA'S DEEP GEOLOGICAL REPOSITORY FOR USED NUCLEAR FUEL- AN UPDATE ON THE TECHNICAL SITE EVALUATION PROCESS

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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. Potential candidate sites are assessed over a period of many years against both technical and social site evaluation factors. The screening-down process is advancing - from an initial starting point of 22 communities in the process, nine communities are now the focus of more detailed technical and community well-being studies. This paper provides an update on the site evaluation process and describes the approach, methods and criteria used in the assessments, focusing on technical studies. 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. 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 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, NWMO worked with interested Canadians and Aboriginal Peoples in 2008 and 2009 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 people 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 site selection process as of May 2016

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 (Figure 2). As communities expressed interest in learning more about the project, 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.

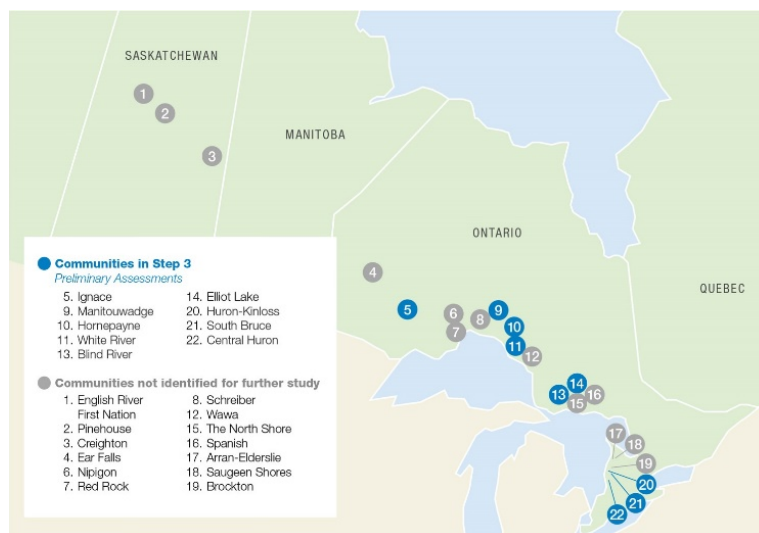


Figure 2 Communities involvement in the site selection process as of May 2016

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 could be potentially suitable for hosting a deep

geological repository. Screening reports for the twenty-two communities are available from NWMO's website (nwmo.ca).

All twenty-one communities that successfully completed an Initial Screening continued to express interest in learning more, and entered into Step 3 (Preliminary Assessments) of the site selection process.

3. Preliminary Assessments

The Preliminary Assessments follow an integrated approach 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).

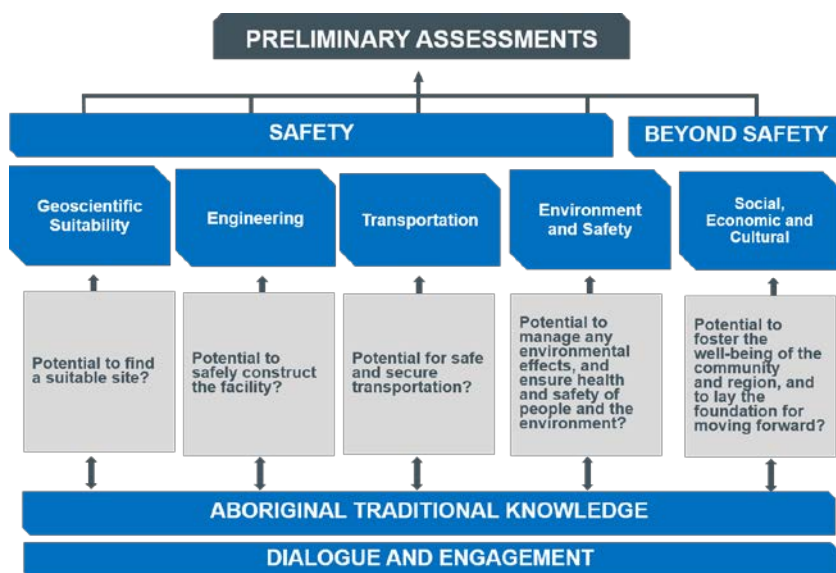


Figure 3 Components of the Preliminary Assessment

The geoscientific Preliminary Assessments are conducted in two phases consisting of desktop studies followed by field investigations. The ultimate objective of the Preliminary Assessments is to select one community for detailed site characterization (Step 4). As of September 2015, NWMO completed desktop Preliminary Assessments for all twenty-one communities. Desktop preliminary assessment reports for the twenty-one communities are available from NWMO's website (nwmo.ca). Nine communities were assessed as having strong potential to meet the site selection requirements and were identified for further study, including field investigations (Figure 2). A more detailed description of ongoing field investigations is provided in two companion papers [2, 3].

3.1 Geoscientific Preliminary Assessments

The objective of the geoscientific preliminary assessments 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 gradually initiated in a number of communities in Phase 2 of the Preliminary Assessment. 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 for crystalline sites:

- Acquisition and processing of high resolution airborne magnetic and gravity surveys over the 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;
- Geological mapping to confirm/ground truth geologic characteristics, including lithology, structure, bedrock exposures and surface constraints.

3.2 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 many 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?

A detailed list of site evaluation that are used to assess the geoscientific potential suitability of sites is provided in NWMO's site selection document [1].

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.

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. For example, prior to walking the land for geological mapping, traditional ceremonies were performed by local Elders on the lands where some of the mapping activities were planned. The ceremonies 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. References

- [1] 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 (Available at www.nwmo.ca).
- [2] A. DesRoches, J. Siddorn, A. Palmer, M. Bates, M. Ben Belfadhel, S. Hirschorn, “ The utility of high-resolution geophysical data for assessing geoscientific suitability of crystalline bedrock”, 3rd Canadian Conference on Nuclear Waste Management, Decommissioning and Environmental Restoration Ottawa Marriott Hotel, Ottawa, ON, Canada, September 11-14, 2016.
- [3] A. Parmenter, A. Man, C. Piller, M. Ben Belfadhel, S. Hirschorn “Geological mapping approach and method for assessing suitability of crystalline rocks for hosting Canada’s deep geological repository for used nuclear fuel”, 3rd Canadian Conference on Nuclear Waste Management, Decommissioning and Environmental Restoration Ottawa Marriott Hotel, Ottawa, ON, Canada, September 11-14, 2016.