

nwmo

NUCLEAR WASTE
MANAGEMENT
ORGANIZATION

SOCIÉTÉ DE GESTION
DES DÉCHETS
NUCLÉAIRES

Implementing Adaptive Phased Management 2012 to 2016



MARCH 2012





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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.



Preface

The Nuclear Waste Management Organization (NWMO) is responsible for the implementation of Adaptive Phased Management, Canada’s plan for the safe, long-term care of used nuclear fuel. Adaptive Phased Management involves the development of a large infrastructure project that will include a deep geological repository and a centre of expertise for technical, environmental and community studies.

The NWMO invites all Canadians and Aboriginal peoples of Canada to learn more and become involved in the management of Canada’s used nuclear fuel. To support this involvement and demonstrate our commitment to transparency and accountability, the NWMO publishes an annual update to its five-year strategic plan, titled *Implementing Adaptive Phased Management*. The plan is regularly assessed, strengthened

and redirected as appropriate in the face of new information and comments we receive through our engagement initiatives.

Implementing Adaptive Phased Management 2012 to 2016 was released in draft for public review between October and December 2011. Following the review period, the Plan was revised to reflect comments received.

The NWMO welcomes all suggestions and ideas about our work and how we can help you learn more about Adaptive Phased Management.

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Executive Summary

The Nuclear Waste Management Organization (NWMO) is responsible for the long-term care of Canada's used nuclear fuel. *Implementing Adaptive Phased Management 2012 to 2016* describes our five-year work program.

Adaptive Phased Management, Canada's long-term plan for used nuclear fuel, is a management system and a technical method. The management system is based on phased and adaptive decision-making supported by public engagement and continuous learning. The end point of the technical method is a repository deep underground in a suitable rock formation. The NWMO's primary motivation is safety – to protect people and the environment from highly radioactive used nuclear fuel. This objective and common vision underpins all the work of the NWMO. All aspects of the NWMO's work will meet or exceed all applicable Canadian and international regulatory standards and requirements for protecting the health, safety and security of humans and the environment.

The focus of the 2012 to 2016 period will be on siting and working with potentially interested communities as they move through the many steps of the siting process. When communities request screening and assessments of the suitability of potential sites, the NWMO will be ready to support the process through activities such as learning more, site evaluation and engagement. We expect that the site selection process will advance over the five-year period such that the NWMO must be ready to undertake detailed site investigations in the latter half of the period. The NWMO will continue to refine generic designs and safety cases for a repository in both crystalline and sedimentary rock formations, and submit these to the Canadian Nuclear Safety Commission for a pre-project review. Throughout the planning period, engagement and social research will continue. Attention to sound governance and assurances around program funding will be maintained. Investing in people and the skills key to program success and continuity will remain a priority.

As the NWMO moves to this new phase, it carries with it the lessons and good practices of the past. The NWMO-led three-year study (2002 to 2005) created the foundation for the safe, long-term care of used nuclear fuel. Since the Government's

selection of Adaptive Phased Management for the long-term management of used nuclear fuel in 2007, the NWMO has transitioned from a small study group to a sustainable implementing organization. From 2007 through 2009, the NWMO has built the organization, putting in place a comprehensive governance structure and expanding staff resources with technical research and social research expertise and skills key to implementing Adaptive Phased Management. Much activity has been directed to engaging interested Canadians and Aboriginal peoples in the development and implementation of our plans, including the principles and process to guide selection of a site for the underground repository for used nuclear fuel and its associated facilities. In 2008 and 2009, the NWMO conducted a two-year dialogue with Canadians about the design of a process to select an informed, willing host community that is fair and transparent, and meets the expectations of citizens. The site selection process has been designed to ensure, above all, that the site which is selected is safe and secure, and meets the highest scientific, professional and ethical standards. In May 2010, the NWMO launched the process to select an informed, willing community to host this national infrastructure initiative. The NWMO has begun the process of working with communities that wish to explore hosting the Adaptive Phased Management project, and those who would be affected by the siting of the project, including surrounding communities, Aboriginal peoples, the region and transportation communities as a group.

The plan for the next five years is organized along seven strategic objectives outlined in the following pages. This 2012–2016 strategic plan is a 'living' document that is regularly assessed, strengthened and redirected in the face of new information, advances in science and technology, changes in societal values and evolving public policy. Adaptive Phased Management will only proceed as quickly as Canadians, successful technology development and demonstration, and the regulatory authorities allow.

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.

Strategic Objectives

The NWMO will:

- » Build sustainable, long-term relationships with interested Canadians and Aboriginal peoples of Canada, and involve them in setting future directions for the safe, long-term management of used nuclear fuel.
- » Implement collaboratively with Canadians the process for siting a deep geological repository for the safe, long-term management of used nuclear fuel in an informed, willing host community.
- » Refine and further develop the generic designs and safety cases for a repository for used nuclear fuel in both crystalline and sedimentary rock formations, and conduct technical research and development to ensure continuous improvement, consistent with best practices.
- » Ensure funds are available to pay for the safe, long-term management of Canada's used nuclear fuel.
- » Adapt plans for the management of used nuclear fuel in response to new knowledge, international best practices, advances in technical learning, evolving societal expectations and values, and changes in public policies.
- » Maintain an accountable governance structure that provides confidence to the Canadian public in the conduct of the NWMO's work.
- » Build and sustain an effective organization with the social, environmental, technical and financial capabilities for the safe, long-term management of Canada's used nuclear fuel.

NWMO Organization

NWMO 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 Government of Canada, through the *Nuclear Fuel Waste Act* (2002), assigned responsibility for the long-term management of Canada’s used nuclear fuel to the NWMO. The NWMO was established to operate on a not-for-profit basis by Canada’s major nuclear fuel waste owners, Ontario Power Generation, Hydro-Québec and NB Power¹. The NWMO’s mission is to develop and implement, collaboratively with Canadians, a management approach for the long-term care of Canada’s used nuclear fuel that is socially acceptable, technically sound, environmentally responsible and economically feasible².

Over the period 2002 to 2005, the NWMO engaged a broad cross-section of citizens in a study to examine options for the long-term care of Canada’s used nuclear fuel. The study and the NWMO’s recommendation to the Government of Canada are available on the NWMO website at www.nwmo.ca.

In 2007, the Government of Canada, based on the NWMO’s recommendations, selected Adaptive Phased Management as the best plan for Canada for safeguarding both the public and the environment over the very long time in which used

nuclear fuel must be managed. Implementation of a deep geological repository under Adaptive Phased Management will be regulated by the Canadian Nuclear Safety Commission (CNSC) under the *Nuclear Safety and Control Act* and its associated regulations.

In 2010, the NWMO initiated the site selection process, following a two-year dialogue with Canadians to design a community-driven process for identifying the location for the deep geological repository. In 2011, many of the NWMO’s activities focused on working with communities that chose to become involved in the site selection process through the early steps of learning more about Adaptive Phased Management, the site selection process and the project.

The NWMO continues to build a multidisciplinary team with a range of experience in the fields of social research, technical research and development, public engagement, communications, finance and governance. We continue to collaborate with an extensive network of consultants, practitioners and academics from across Canada and around the world to ensure that our work benefits from the best available knowledge.

¹ In 2004, through a transfer order, the Government of New Brunswick assigned responsibility for all aspects of the provincially owned nuclear generating assets to a new subsidiary corporation, NB Power Nuclear.

² In addition to used nuclear fuel, the operation of nuclear reactors produces low and intermediate level waste that is managed at the reactor sites and Ontario Power Generation’s Western Waste Management Facility. See glossary for more information about low and intermediate level waste.

Regulatory Oversight of Adaptive Phased Management

All aspects of the NWMO's work will meet or exceed all applicable regulatory standards and requirements for protecting the health, safety and security of humans and the environment.

Implementation of a repository under Adaptive Phased Management falls within federal jurisdiction and will be regulated under the *Nuclear Safety and Control Act (NSCA)* and its associated regulations. The Canadian Nuclear Safety Commission (CNSC) is Canada's regulatory authority, and regulates the use of nuclear energy and materials to protect the health and safety of people and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy.

Under section 26 of the *NSCA*, activities associated with a nuclear facility, such as preparing a site, construction, operation or decommissioning, can occur only in accordance with a licence issued by the CNSC. The Adaptive Phased Management repository will be subject to the CNSC's comprehensive licensing system, which covers the entire life cycle of the repository. This stepwise approach will require a licence for each phase of the repository life cycle. A licensing decision by the CNSC on a repository can be taken only after an environmental assessment has been approved under the *Canadian Environmental Assessment Act*.

The transportation of used nuclear fuel is regulated by the CNSC and Transport Canada. Compliance will also be required with federal plans such as the *CBRNE Resilience Strategy for Canada* and the *Federal Nuclear Emergency Plan*.

Although Canada's constitutional division of powers confers the authority to regulate nuclear energy to the federal government, it does not exclude provincial and territorial authority to regulate related matters within their domain. Some aspects of siting or construction of the project may be governed by provincial legislation:

- » Most provinces and territories include nuclear substances in legislation and regulations addressing the transportation of dangerous goods within that province or territory.
- » Provincial governments are responsible for protecting public health and safety, property and the environment within their borders, which often includes provincial emergency preparedness legislation.
- » Provincial governments are responsible for the regulation of resource exploration and/or extraction (e.g., drilling and underground mining) and Crown land management (e.g., disposition of provincial lands).
- » Provincial legislation requiring the assessment of potential environmental effects of an activity, plan or program may apply to some aspects of this work. Legislation governing endangered species, environmental protection, heritage protection or preservation, water resources protection, occupational health and safety, employment standards or labour relations may be relevant.
- » Various permits, licences and approvals will be required, and provincial policies and guidelines may be applicable at the site selection stage.
- » Municipalities, which derive their authority from provincial legislation, may have requirements such as permits, codes, standards and/or bylaws that also need to be addressed.

Canada's Plan for Used Nuclear Fuel

Canada's plan for the long-term care of used nuclear fuel is known as **Adaptive Phased Management**. Used fuel will be safely and securely contained and isolated from people and the environment in a deep geological repository in a suitable rock formation using a multiple-barrier system. A fundamental tenet of Canada's plan is the incorporation of learning and knowledge at each step to guide a process of phased decision-making. **Adaptive Phased Management** is designed to be flexible and respond to new learning, social priorities and evolving public policy.

The development of the long-term management facility for Canada's used nuclear fuel is a national infrastructure project (see *The Project*). The facility is to be sited in an informed, willing host community. The process for identifying the site reflects the ideas, experience and best advice of a broad cross-section of Canadians who participated in dialogues conducted over a two-year period to design the process to select a site.

Adaptive Phased Management moves towards a goal that Canadians themselves identified: safe, secure, long-term containment and isolation of used nuclear fuel produced in Canada with flexibility for future generations to make their own decisions and adapt to experience and societal changes.

Adaptive Phased Management

- » 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

Canadians' objectives for the long-term management of used nuclear fuel, as identified during the study phase:

- » **Fairness:** To ensure fairness (in substance and process) in the distribution of costs, benefits, risks and responsibilities, within this generation and across generations.
- » **Public Health and Safety:** To protect public health from the risk of exposure to radioactive or other hazardous materials and from the threat of injuries or deaths due to accidents.
- » **Worker Health and Safety:** To protect workers from and minimize hazards associated with managing used nuclear fuel.
- » **Community Well-Being:** To ensure the well-being of all communities with a shared interest.
- » **Security:** To ensure the security of facilities, materials and infrastructure.
- » **Environmental Integrity:** To ensure that environmental integrity is maintained over the long term.
- » **Economic Viability:** To ensure the economic viability of the used nuclear fuel management system, while simultaneously contributing positively to the local economy.
- » **Adaptability:** To ensure a capacity to adapt to changing knowledge and conditions over time.

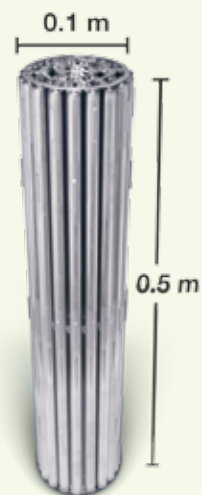
Used Nuclear Fuel

Used nuclear fuel is a by-product of the generation of electricity by nuclear power plants. It remains radioactive for a long period of time, and the material must be contained and isolated from people and the environment essentially indefinitely. Canada's used nuclear fuel is currently safely managed in facilities licensed for interim storage at nuclear reactor sites in Ontario, Quebec and New Brunswick, and at Atomic Energy of Canada Limited's nuclear research sites in Manitoba and Chalk River Laboratories in Ontario.

Canadian nuclear power plants are fuelled by natural uranium, formed into ceramic pellets which are encased in Zircaloy tubes welded together in the shape of a fireplace log weighing approximately 24 kilograms. Once the fuel bundle has been used to generate electricity, it is removed from the reactor. Physically, the bundle looks the same as when it was placed in the reactor. When used nuclear fuel is removed from a reactor, it is considered a waste product, is radioactive and requires careful management. It is first placed in a water-filled pool where its heat and radioactivity decrease. After seven to 10 years, the used bundles are placed in dry storage containers, silos or vaults. The containers have a minimum design life of 50 years. 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.

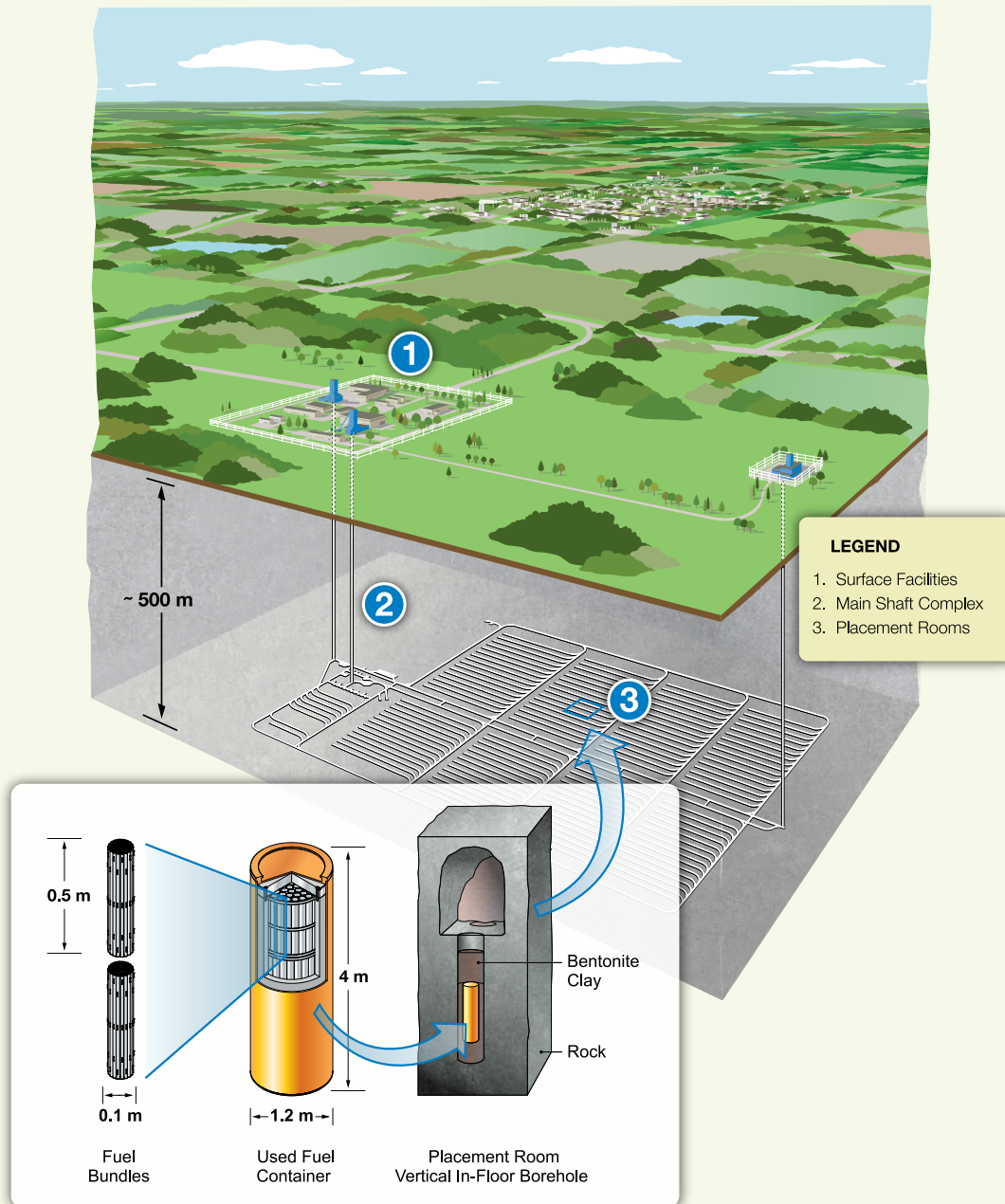
About 85,000 used nuclear fuel bundles are generated in Canada each year. Over 40 years, Canada's nuclear power program has produced just over two million used nuclear fuel bundles. A small amount of used nuclear fuel, and components, is also created at research and development facilities operated by Atomic Energy of Canada Limited, and Canadian university facilities. If the entire inventory of used nuclear fuel bundles could be stacked end-to-end like cordwood, it would fit into a space the size of six hockey rinks, from the ice surface to the top of the boards.

The NWMO has a legal obligation to provide long-term management of all Canada's used nuclear fuel, that which exists now and that which will be produced in the future.



The Project

This national infrastructure project will include the development of a deep geological repository and used fuel transportation system, and a national centre of expertise.



Deep Geological Repository

The deep geological repository is a multiple-barrier system designed to safely contain and isolate used nuclear fuel over the long term. It will be constructed at a depth of approximately 500 metres, depending upon the geology of the site, and consist of a network of placement rooms for the used fuel (see diagram). This project requires a dedicated surface area of about 100 hectares (250 acres) for surface buildings and associated facilities. Underground, the repository requires a subsurface area in suitable host rock of about 2.5 kilometres by 1.5 kilometres (375 hectares/930 acres). As well, regulatory or other requirements may limit activities in the immediate area surrounding the surface facilities.

Used nuclear fuel will be loaded into specially designed and certified containers at the reactor sites and transported to the repository site where it will be repackaged in corrosion-resistant containers for placement in the repository. The containers will be transported underground to one of many placement rooms. The containers will be placed in vertical or horizontal boreholes drilled into the rock and sealed with bentonite clay, a proven effective sealing material.

The used fuel will be monitored and retrievable throughout all phases of implementation consistent with the precautionary approach required by Canadians. Once the host community and the NWMO decide to close the site, the access tunnels will be backfilled and sealed and the NWMO will seek the appropriate regulatory approvals prior to decommissioning. Following successful decommissioning, the NWMO will seek appropriate regulatory approvals for postclosure monitoring.

A robust safety case must be developed to demonstrate that the project can be safely implemented at the site, including transportation, and that it can meet or exceed the requirements of regulatory authorities and the host community.

Transportation of Used Nuclear Fuel

Used nuclear fuel is currently safely stored in facilities licensed by the Canadian Nuclear Safety Commission (CNSC) at sites where it is produced. Placing all Canada's used nuclear fuel in a single central location will require transportation from these interim storage facilities to the deep geological repository. Depending on the location of the site, this may involve road, rail or water transport, or a combination of the three. The NWMO will need to demonstrate to regulatory authorities and citizens the safety and security of any transportation system before transport of used nuclear fuel to the repository can begin. Transportation of the material will have to meet the stringent requirements of Transport Canada and the CNSC prior to an operating licence being issued and will be subject to ongoing compliance monitoring.

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. 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 design details of the centre of expertise would be developed with the community and the surrounding region, with their preferences in mind. The centre of expertise could 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 the construction and operation of an underground facility designed to confirm the characteristics of the site. The centre of expertise would become a hub for knowledge sharing across Canada and internationally.

A Partnership Approach

The deep geological repository and centre of expertise will have a significant impact on any community and region in which they are located. It is a multi-generational project that will be developed in phases. The repository will be sited and constructed over two to three decades. The used nuclear fuel will be placed in the facility over a period of three decades or more, and then monitored for an extended period of time prior to decommissioning.

The project will provide significant economic benefits. It offers direct employment for hundreds of people at the facility for many decades and many more indirect jobs in the host region and host province, with the opportunity to develop transferable skills and capacities. Implementation of the project will involve scientists, engineers, tradespeople and many others. The project may contribute to social and economic pressures that will need to be carefully managed to ensure the long-term health and sustainability of the community. For example, the potential influx of temporary construction workers may increase demand for social and physical infrastructure. To minimize social costs and help communities adapt to the opportunities and challenges of the project, the need for assistance, such as job training, affordable housing and infrastructure, would be examined.

Project implementation will require a long-term partnership between the community and the NWMO to ensure that the project fosters well-being and sustainability of the community, consistent with its vision for the future. The pace and manner of project development will be determined in partnership with the community.

Planning Priorities for 2012 to 2016

To guide implementation of Adaptive Phased Management, the NWMO established seven strategic objectives. The objectives identify program areas in the implementation of Adaptive Phased Management and the planning priorities for 2012 to 2016.

First developed in 2007, the objectives were the subject of public review and discussion in 2007 and 2008. Subsequent evolution of the strategic objectives reflects advancement in the implementation of Adaptive Phased Management, as planning milestones are met and major areas of focus for the used nuclear fuel program evolve.

On an annual basis, the NWMO publishes for review and comment the rolling five-year

implementation plan for Adaptive Phased Management, to confirm support for the strategic direction and to invite suggestions on the associated work programs. The strategic objectives also provide the framework for the annual planning and reporting on our activities. The seven strategic objectives are briefly outlined in the table that follows.

Strategic Objectives 2012–2016

The NWMO will:

- » Build sustainable, long-term relationships with interested Canadians and Aboriginal peoples of Canada, and involve them in setting future directions for the safe, long-term management of used nuclear fuel.
- » Implement collaboratively with Canadians the process for siting a deep geological repository for the safe, long-term management of used nuclear fuel in an informed, willing host community.
- » Refine and further develop the generic designs and safety cases for a repository for used nuclear fuel in both crystalline and sedimentary rock formations, and conduct technical research and development to ensure continuous improvement, consistent with best practices.
- » Ensure funds are available to pay for the safe, long-term management of Canada's used nuclear fuel.
- » Adapt plans for the management of used nuclear fuel in response to new knowledge, international best practices, advances in technical learning, evolving societal expectations and values, and changes in public policies.
- » Maintain an accountable governance structure that provides confidence to the Canadian public in the conduct of the NWMO's work.
- » Build and sustain an effective organization with the social, environmental, technical and financial capabilities for the safe, long-term management of Canada's used nuclear fuel.

In May 2010, the NWMO initiated a multi-year process for selecting an informed, willing community to host a national facility for the long-term care of used nuclear fuel. Over the period 2012 to 2016, the NWMO will continue to implement the process to decide where to contain and isolate Canada's used nuclear fuel for the long term.

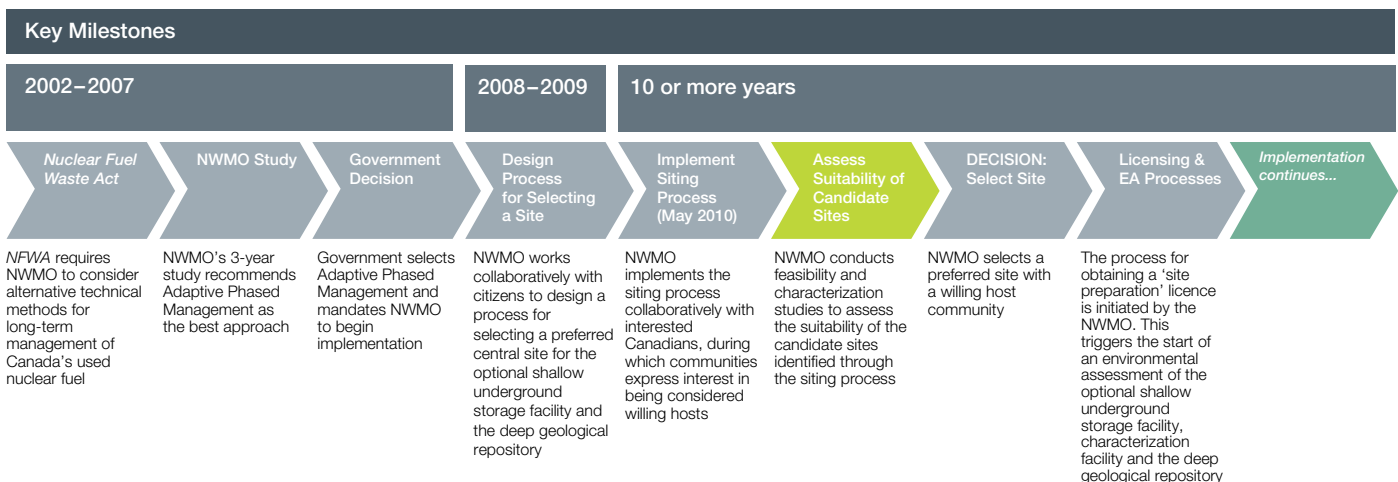
The site selection process is described in *Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel*, May 2010, available on the NWMO website at www.nwmo.ca. The process is the product of a two-year dialogue with Canadians and is designed to guide the selection of an informed, willing host community.

The nine-step site selection process spans from communities learning about the project to construction and operation. The process is designed to be community-driven – communities determine if and when they wish to work with the NWMO. In the planning period, the NWMO expects a number of potentially interested communities to request site assessments, and the NWMO will support the community in its initial learning about the project and how its long-term well-being or quality of life might be fostered through its participation in the project.

The NWMO is committed to periodically reviewing the implementation of the process with Canadians to ensure that it continues to meet needs and expectations, and to make process refinements, if required. The NWMO is committed to stepwise decision-making and will only proceed to the next step after careful consideration and with the support of communities participating in the process.

The NWMO will continue to build the organization to strengthen internal resources and capabilities, and support technical and social research programs to ensure continuous improvement and adaptation to new knowledge and best practices. The NWMO will continue to engage Canadians in these activities.

To ensure that resources are available when required to manage the requests for information and knowledge building, the NWMO has identified a number of milestones for the next five-year planning period. In particular, the NWMO is working towards completion of preliminary assessment studies and the selection of one or two sites to be the focus of detailed site characterization.



» Build Sustainable Relationships

The NWMO will build sustainable, long-term relationships with interested Canadians and Aboriginal peoples of Canada, and involve them in setting future directions for the safe, long-term management of used nuclear fuel.

Engagement is one of the five fundamental values that guide the work of the NWMO. Involving Canadians and Aboriginal peoples of Canada at all stages and in key decisions is critical to meeting the challenges of the long-term management of used nuclear fuel. Through open, transparent and inclusive engagement processes, the NWMO will continue to build awareness and understanding of Adaptive Phased Management and will seek and respond to a diversity of views and perspectives. Interweaving of Aboriginal worldviews and knowledge systems with Adaptive Phased Management will strengthen the long-term management of used nuclear fuel. Our commitment to engagement and shared decision-making helps ensure that Adaptive Phased Management continues to respond to the values and concerns of Canadians. Building awareness and confidence in Adaptive Phased Management, and the NWMO as implementer, will continue throughout the planning period.

During the period 2012 to 2016, engagement will focus on strengthening established relationships to sustain program momentum. This includes engagement activities, such as information sessions, briefings, and joint projects and partnerships, which will be undertaken with municipal, provincial, federal and Aboriginal governments, and interested individuals and organizations. The organization will continue to work with the NWMO Elders Forum and Municipal

Forum. The NWMO will also work together with potentially affected Aboriginal peoples as holders of Traditional Knowledge, to be active participants in the site selection process and to share that knowledge with the NWMO to the extent they wish. The NWMO will also continue to build knowledge and understanding and establish relations with a broader audience through expanding its outreach to organizations, and the broader public at large, with engagement, provision of information and dialogue.

Over the past several years, much of the NWMO's work has focused on developing plans, policies and processes collaboratively with Canadians to support the implementation of Adaptive Phased Management. Our engagement activities related to the broad Canadian public. As the siting phase of the implementation of Adaptive Phased Management progresses, the engagement program is evolving to include more directly the communities and regions interested in hosting the project. Over the next five years, we will build relationships with communities that wish to explore hosting the Adaptive Phased Management project, and those who would be affected by the siting of the project, including surrounding communities, Aboriginal peoples, the region and transportation communities as a group. Engagement of youth is also a continuing priority given the long-term nature of the project and the need for intergenerational transfer of knowledge to support project implementation.

The NWMO recognizes that there are Aboriginal peoples in all areas of Canada where the NWMO's work will take place. The NWMO acknowledges, respects and honours that Aboriginal peoples – Indian, Métis and Inuit peoples of Canada – have unique status and rights as recognized and affirmed in s.35 of the *Constitution Act* (1982). Understanding the nature of any impacts of the implementation of Adaptive Phased Management on Aboriginal rights, treaties and land claims and how Aboriginal peoples should be accommodated as a result of any impacts is an important component of the NWMO's work. The NWMO needs to ensure effective consultation with Aboriginal peoples and that all those affected have the opportunity for meaningful involvement. The NWMO acknowledges that the Crown has a legal duty to consult and accommodate and will support the Crown's work to meet its obligations.

Going Forward

In the period 2012 to 2016, the NWMO will:

- » Continue work to increase awareness among Canadians and Aboriginal peoples of Canada about Adaptive Phased Management, the site selection process and the NWMO;
- » Implement communications and media relations programs to help interested individuals and organizations understand Adaptive Phased Management;
- » Seek comment from interested individuals and organizations on the NWMO's plans and the implementation of Adaptive Phased Management;
- » Brief Canada's nuclear host communities about progress in implementing Adaptive Phased Management, including planning for eventual transportation of used nuclear fuel from their communities to the deep geological repository;
- » Develop and sustain relationships with communities that choose to engage in the site selection process and the surrounding areas;
- » Develop and sustain relationships with municipal associations to better understand local governments' points of view, and work with them to implement Adaptive Phased Management;
- » Develop and maintain relationships with the federal government, and provincial and local governments in nuclear provinces to help coordinate and support their roles in the implementation of Adaptive Phased Management;
- » Develop and maintain relationships with national, provincial and regional Aboriginal organizations, and keep them and their members apprised of progress in the implementation of Adaptive Phased Management and the site selection process;
- » Continue to seek the advice of Elders and Aboriginal youth, and develop awareness and learning opportunities for NWMO staff about cultures, traditional practices, protocols and governance of Aboriginal peoples;
- » Continue to work with potentially affected Aboriginal peoples, including Traditional Knowledge holders, recognizing the diversity of cultures and languages, practices and approaches among Aboriginal communities; the identification of sacred areas; understanding traditional laws, practices and use of land; and protection of species to sustain community life;
- » Continue to work with Natural Resources Canada to implement the memorandum of understanding on the NWMO's obligations with respect to the Crown's constitutional duty to consult;
- » Build a multi-generational view of the long-term management of used nuclear fuel through engagement, education and outreach involving young Canadians, including Aboriginal youth;
- » Assess the effectiveness of the NWMO website and other communication vehicles to identify opportunities for improvement;
- » Assess effectiveness of NWMO engagement activities; and
- » Continue to report publicly on the input that the NWMO receives and how this advice has been considered.

In 2012, the NWMO will:

- » Provide briefings and information upon request to interested individuals and organizations about Adaptive Phased Management and the site selection process;
- » Continue to support communities and regions as they explore their early interest in the project and the siting process; the form of support provided will be determined in collaboration with these communities;
- » Provide briefings and information to governments to support their participation in the implementation of the site selection process and to ensure that they have the information needed to address inquiries from communities;
- » Meet on request with nuclear community organizations and their committees, such as the Canadian Association of Nuclear Host Communities (CANHC), and regional health committees;
- » Convene with municipal associations individually and as a forum through meetings, briefings, conferences, trade shows and special events;
- » Continue to seek advice on interweaving Aboriginal Traditional Knowledge and Western science, and respectful engagement of Aboriginal peoples;
- » Continue broad-based briefings for Aboriginal organizations and engagement of Elders;
- » Continue to develop communications materials, DVDs, exhibits and information kits to support the siting process and for a range of audiences;
- » Continue to implement the NWMO Corporate Social Responsibility Program;
- » Continue to develop and implement an NWMO education, outreach and capacity-building strategy for young Canadians and Aboriginal youth that incorporates both technical and social disciplines;
- » Continue to seek the perspective of Canadians with the use of web-based tools and other activities; and
- » Continue to participate in regional and national environmental initiatives.

Collaboratively Implement the Site Selection Process

The NWMO will implement collaboratively with Canadians the process for siting a deep geological repository for the safe, long-term management of used nuclear fuel in an informed, willing host community.

In 2010, the NWMO initiated the site selection process. The development of the process began in 2008 with a variety of engagement activities to ensure that a diversity of perspectives was considered. The product of this collaborative process is described in *Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel*, May 2010, available on the NWMO website at www.nwmo.ca. Implementation of the process, including the selection of an informed and willing community and demonstration of a safe and secure transportation system, must meet the expectations of Canadians. It must also address their key issues, such as the protection of humans and the environment, fairness and regulatory oversight. Collaboration, shared decision-making and willingness underpin the siting process.

The decision about an appropriate site will be made over a series of steps (see *Steps in the Siting Process – At a Glance*, and the complete description of the siting process cited above). It is expected that individual communities will proceed through the process at a pace and in a manner that reflect their needs and preferences. The siting process begins with a period of learning and capacity building for communities. Screening and preliminary assessments (feasibility studies) of potential sites will be done in partnership with communities as they come forward and express interest. A community may end its involvement in the process at any point up to and until the final agreement is signed. Over time, refinements to the siting process may be necessary as experience is gained, and the process is designed to be adaptive.

Steps in the Siting 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.
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 <i>Nuclear Safety and Control Act</i> 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 steps in the siting process. The documentation produced through previous steps, as well as other documentation that will be required, will be formally reviewed by regulatory authorities at this step through an Environmental Assessment and then licensing hearings related to site preparation and 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. The NWMO will develop the centre of expertise, launched in Step 4, to include and support the construction and operation of an underground demonstration facility designed to confirm the characteristics of the site before applying to regulatory authorities for an operating licence. Designed in collaboration with the community, it will become a hub for knowledge-sharing across Canada and internationally.
Step 9	Construction and operation of the facility. The NWMO begins construction of the deep geological repository and associated surface facilities. Operation will begin after an operating licence is obtained from regulatory authorities. The NWMO will continue to work in partnership with the host community in order to ensure the commitments to the community are addressed throughout the entire lifetime of the project.

The business plan assumes that over the five-year period, some communities will elect to move through sequential steps of screening, preliminary assessment (feasibility study) and detailed site evaluations. It is also assumed that the NWMO will select communities from among those that have formally expressed interest for detailed site characterization and initiate this intensive phase of work in the latter half of the planning period. Work plans for the 2012–2016 period will ensure that the NWMO is prepared to support all aspects of the site selection process.

Successful implementation of the siting process will require a good understanding of regional priorities, politics and key players. The NWMO will assist interested communities in engaging surrounding communities, the region, and provincial and Aboriginal governments, in a regional study of environmental, social, cultural and economic effects, and detailed site investigations. Involvement of regional representatives will help ensure that the broad range of potential effects associated with implementation at a particular site are recognized and considered. Involvement of those along the transportation route, as a large group with a shared interest, will ensure that effects associated with the transportation of used nuclear fuel are taken into account in decision-making on a preferred site. The NWMO must work to assist provincial governments to become informed and ready to support community interest, and address inquiries about Crown land, and provincial regulations and approvals.

Throughout the siting process, the NWMO will support and assist communities to build understanding of Adaptive Phased Management and how the project may affect a community's ability to achieve its long-term plan; to engage citizens, surrounding communities and Aboriginal peoples; and to assess community willingness to host the project. Funding will be provided to support interested communities as they work through each step. To assist communities in capacity building, the NWMO will provide funding and support through a program collaboratively developed with communities involved in the site selection process.

In the next few years, technical support to the siting process will focus on assessing the suitability of potential sites through geoscientific characterization and evaluation studies in interested communities. Beyond ensuring safety, the NWMO's commitment to any host community is that its long-term well-being or quality of life will be fostered through its participation in this project. The technical program will be complemented by a phased and progressively more detailed assessment of the suitability of a site in terms of environmental, social, cultural and economic factors. The NWMO expects to be ready to begin detailed site evaluations on one or more sites, during the planning period, including further geological investigations, safety assessments, social and economic impact assessments, and the application of Aboriginal Traditional Knowledge, all in collaboration with the interested communities and surrounding areas.

Transportation is an important consideration in the assessment 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. Beyond safety, transportation is also an important consideration in identifying and assessing effects on community well-being. The NWMO will need to demonstrate the safety and security of any transportation system to the satisfaction of regulatory authorities, and citizens, before transportation of used nuclear fuel to the repository can begin. Work in this area will include engaging: regulatory authorities at all levels to understand their expectations; transportation experts and those working in the field to understand issues and concerns; nuclear station communities as they will be affected by any transportation plan; and communities along the transportation route as a large group with a shared interest to raise questions or concerns to be addressed in the process. Communication materials continue to be developed to support existing DVDs, backgrounders and engagement activities to respond to public and media concerns that are raised.

The NWMO is also developing the institutional policies, practices and structures required to support the different phases of the siting process.

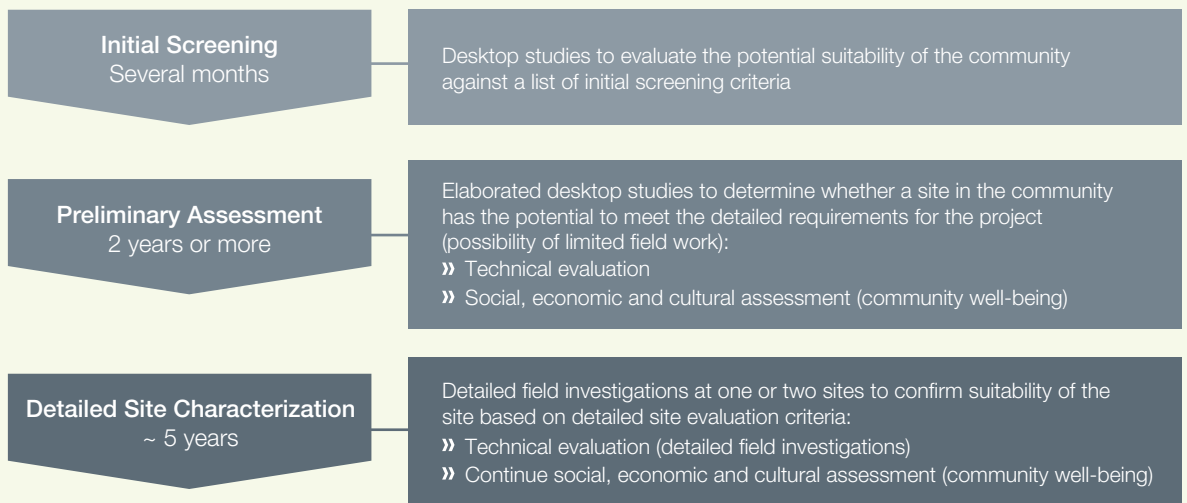
The NWMO will work to ensure that implementation of the siting process is inclusive, fair and transparent, and continues to build trust and confidence in the NWMO and its operations.

Any site that is selected to host this facility must be demonstrated to be able to safely contain and isolate used nuclear fuel for a very long period of time, and the community must be informed and willing to host the facility. The objectives of the site selection process and the main site evaluation stages are outlined below.

The site selection process is designed to use a partnership-based approach to:

- » Ensure that any community that is selected to host this facility is both informed about the project and willing to host it;
- » Ensure that any site that is selected to host this facility will safely contain and isolate used nuclear fuel for a very long period of time in an appropriate geological formation and that there is an acceptable way of transporting used nuclear fuel to the site;
- » Assist the potentially interested host community to consider carefully and thoroughly the project's potential benefits and risks when deciding whether to express interest, and ultimately, willingness to host the project;
- » Involve surrounding communities, regions and other jurisdictional levels potentially affected by the project and the transportation of used nuclear fuel in the identification and assessment of public health, environmental, social, economic and cultural effects of the project as part of a broader regional assessment;
- » Involve First Nations, Métis and Inuit who are potentially affected by the implementation of this project; and
- » Help foster an ongoing public conversation on questions to be answered and issues to be addressed throughout the site selection process.

Main Site Evaluation Stages in Brief



Preliminary Assessment of Potential Suitability

The NWMO will be ready to begin preliminary assessment studies in early 2012, subject to the interest and preferences of communities that choose to continue to participate in the process.

These studies are designed to assess, in a preliminary way, the suitability of a community and associated site(s) to host the project. These studies are an opportunity for both the community and the NWMO to explore four key questions that will be important in assessing the suitability of communities for this project.

Key Questions to Be Addressed

<p>Safety, security and protection of people and the environment are central to the siting process. Is there the potential to find a safe site?</p>	<p>At a later step in the process (Step 5), the community must demonstrate it is informed and willing to host the project. Is there the potential for citizens in the community to continue to be interested in exploring this project through subsequent steps in the site selection process?</p>
<p>The project will be implemented in a way that will foster the long-term well-being of the community. Is there the 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?</p>	<p>The project will be implemented in a way that will foster the long-term well-being of the surrounding area. Is there the potential to foster the well-being of the surrounding area and region, and establish the foundation to move forward with the project?</p>

Work will be conducted in two phases with the opportunity for stock-taking by both the community and the NWMO at the end of each phase. Some communities with relatively low potential to be suitable for the project may be screened out of the process at the end of the first phase of work. By the end of the second phase of work, one or two of the communities may be selected for the next step in the site selection process: detailed studies over a five-year period (Step 4). The communities selected for Step 4 detailed studies will be those that hold the most potential for successful implementation of the project based on work that the NWMO and community complete together to explore these key questions.

Key Activities

The feasibility study is designed to be implemented through a partnership involving the interested community and the NWMO.

Phase One Activities

- | | |
|--|--|
| <ul style="list-style-type: none">» Are expected to take a year or more to complete» Will focus on desktop studies and engagement of the community» Begin formal engagement with surrounding communities» Build on earlier work completed as part of the site selection process | <ol style="list-style-type: none">1. Agreement is made between the NWMO and accountable authorities in the community on how the work will proceed.2. Scientific and technical studies are conducted to further explore the potential suitability of the geology in the area and to identify potentially suitable smaller siting areas. This involves desktop studies by the NWMO.3. The potential effects of the project on the long-term well-being of the community are further explored through desktop studies and engagement of community residents. The NWMO and accountable authorities work together to complete this work.4. Accountable authorities in the surrounding area, including Aboriginal communities, are engaged to identify questions and concerns which will need to be addressed. The NWMO and accountable authorities work together in this engagement.5. The NWMO and the community take stock of work to date and findings about the potential suitability of the community. |
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Phase Two Activities

- | | |
|--|---|
| <ul style="list-style-type: none">» Are expected to take a year or more to complete» Will focus on field studies in the community» Expand regional engagement with launch of a regional study» Build on work completed during Phase One feasibility studies | <ol style="list-style-type: none">1. The NWMO and the accountable authorities in the community confirm the plan for Phase Two activities.2. Limited scientific and technical field studies are conducted to further assess potential suitability of identified siting areas. This includes initial exploration of transportation considerations. This work is conducted by the NWMO.3. The potential effects of the project on the long-term well-being of the community are further explored through interviews and studies. The NWMO and accountable authorities work together to complete this work.4. Citizens in the community are engaged to help refine the list of potential siting areas. The NWMO and accountable authorities work together in this engagement.5. Accountable authorities in the surrounding area, including Aboriginal communities, are engaged in a regional study to explore and assess potential effects on the well-being of the broader region as well as potential interest in the project. The NWMO and accountable authorities in the community work together in this engagement.6. A third-party review group reviews the NWMO's work. Members of this group are selected by the NWMO and accountable authorities in communities involved in the site selection process.7. The NWMO and the accountable authorities in the community take stock of work to date and findings about the potential suitability of the community and siting area(s).8. The NWMO identifies which communities and associated sites are eligible to proceed to Step 4 for Detailed Evaluations. |
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Going Forward

In the period 2012 to 2016, the NWMO will:

- » Complete work to explore safety considerations through preparation of illustrative postclosure safety assessment of the deep geological repository to the Canadian Nuclear Safety Commission (CNSC) for pre-project review;
- » Continue work to explore technical safety considerations through preparation of generic used fuel transportation risk assessment;
- » Continue to support communities in developing capacity to consider their interest in the site selection process;
- » Continue to support communities in responding to the values-based requirements of the process, including appropriate engagement of citizens and transparency;
- » Continue to seek advice of municipal associations and Aboriginal organizations on materials and tools to support a community-driven siting process;
- » Continue to develop mobile exhibits and tools to support local and regional-based discussions of Adaptive Phased Management and siting;
- » Prepare generic options for transport of used nuclear fuel from interim storage sites to a long-term management facility to assess potential sites and transportation routes;
- » Refine tools and methods for geoscientific assessment of candidate sites in both crystalline and sedimentary rock settings;
- » Provide engineering designs and preliminary safety assessments to support evaluation of candidate sites;
- » Refine tools and methods for assessment of sites in terms of environmental, social, cultural and economic factors, including factors identified by Aboriginal Traditional Knowledge and traditional approaches to land use mapping and planning;
- » Refine tools and methods for informing and engaging citizens in decision-making;
- » Engage interested communities in discussions to explore and help assess the extent to which the project might contribute to the well-being of the community;
- » Conduct initial screenings (Step 2), upon request of communities;
- » Conduct preliminary assessments (feasibility study) (Step 3), upon request of communities and in collaboration with them;
- » Engage surrounding communities, regions and Aboriginal peoples in discussions to explore and assess the extent to which the project might contribute to their well-being as early in the site selection process as possible;
- » Develop an approach to select one or more suitable sites from among interested communities for regional study and/or detailed site evaluation (Step 4) as well as a process to communicate reasons for decisions;
- » Begin detailed site evaluations (Step 4) at one or more suitable sites from among interested communities and in collaboration with them;
- » Identify preferred transportation modes and potential routes associated with each interested community under consideration (Step 4) and welcome existing nuclear station communities and communities along the transportation route as a large group with a shared interest to raise questions or concerns to be addressed in the process;
- » Organize and help conduct regional studies for one or more communities moving to detailed site evaluations;

- » Establish NWMO presence in potential host communities that have elected to participate in detailed site evaluation studies to provide information, showcase displays, and support public capacity-building and engagement activities;
- » Establish centres of expertise in communities selected for detailed site characterization to support technical and social assessments and discussion of community well-being issues;
- » Convene workshops on siting-related topics;
- » Conduct research on partnership and power-sharing frameworks for consideration in structuring of a formal agreement with the host community, once selected; and
- » Explore long-term knowledge transfer considerations, such as markers and archives, as part of international collaborative research efforts (Nuclear Energy Agency).

In 2012, the NWMO will:

- » Complete illustrative postclosure safety assessment in crystalline rock for CNSC pre-project review;
- » Continue to prepare and refine generic used fuel transportation risk assessment;
- » Continue, advance and report on ongoing and formal discussion of specific ethical and social considerations that should be addressed in the site selection process;
- » Work in partnership with communities as they proceed through the siting process;
- » Implement, support and further develop the *Learn More Program* for community capacity building to meet the needs of communities and surrounding areas;
- » Provide appropriate support to any community, interested individual or group to contribute to shaping the knowledge platform on which this project and the site selection process is implemented;
- » Provide detailed briefings on the project, the Adaptive Phased Management site selection process and progress in its implementation, as requested by interested communities or organizations (Step 2);
- » Conduct initial screenings upon request of interested communities (Step 2);
- » Develop memoranda of understanding with communities electing to proceed to preliminary assessments (feasibility studies) (Step 3);
- » Conduct preliminary assessments upon request of interested communities with potentially suitable sites (Step 3);
- » Develop and implement local and regional outreach plans to deepen understanding of regional perspectives and begin building relationships with opinion leaders in the broader area;
- » Continue to engage Aboriginal peoples at the local and regional level through collaborative work with Treaty organizations, communities, and regional or provincial Aboriginal organizations involved in the siting area;
- » Continue to develop communication materials to support learning and dialogue on transportation considerations;
- » Advance dialogue on transportation considerations with regulatory authorities at all levels of government, transportation experts and those working in the field;
- » Continue to seek advice from municipal associations regarding ways to communicate transportation plans and engage with communities that may be on a transportation corridor for used nuclear fuel; and
- » Continue review of experience and best practices with transportation of hazardous materials, including transportation of nuclear wastes in Canada and internationally to identify lessons that apply to Adaptive Phased Management.

» Optimizing Repository Designs and Further Increasing Confidence in Safety

The NWMO will refine and further develop the generic designs and safety cases for a repository for used nuclear fuel in both crystalline and sedimentary rock formations, and conduct technical research and development to ensure continuous improvement, consistent with best practices.

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 engineered barriers placed around the waste and the natural barriers provided by the rock formation in which the repository will be located. The preferred site will be in a rock formation with desirable characteristics (geological, hydrogeological, chemical and mechanical) that support containment and repository performance to meet or exceed the regulatory expectations of the Canadian Nuclear Safety Commission (CNSC), the guidance of the International Atomic Energy Agency and the experience in other countries.

The NWMO's technical program supports Adaptive Phased Management in three key areas: siting, conceptual engineering design and costing, and safety assessment. Underlying work in these key areas is a base program in which technical program activities in geosciences, safety assessment, repository engineering, environmental sciences and regulatory affairs are carried out in Canada and with international partners to ensure that the best knowledge and understanding are being applied. The NWMO's technical program objectives are reviewed and updated annually to ensure that they are consistent with the strategic direction from the NWMO Board of Directors and planning assumptions related to progress in implementing Adaptive Phased Management. The Plan incorporates feedback from the Independent Technical Review Group (ITRG – described on page 32). A strong technical program ensures that Adaptive Phased Management benefits from knowledge and innovation in the long-term care of used nuclear fuel from Canada and abroad, including Finland, France, Japan, Sweden,

Switzerland, the United Kingdom and the United States. It also ensures that NWMO staff sustain the expertise required to implement the adaptive program.

The NWMO is beginning to move from the research phase of our technical program to the engineering phase. Over the next five years, physical prototypes of the repository storage container will be designed and manufactured. This work is being undertaken in conjunction with Canada's universities and national research laboratories. It will incorporate the best available design practice and the state-of-the-art in manufacturing technologies, and demonstrate our ability to meet the rigorous engineering requirements of the repository environment. Further, a container engineering and test facility will be established for both the repository and transportation containers. This facility will be used to continue to investigate manufacturing technologies and for prototype testing. In the course of the conduct of preliminary assessment studies, potential routes and modes will be assessed and discussed. The NWMO will also work closely with waste owners in planning for future transport of used nuclear fuel from the facilities where it is currently stored on an interim basis.

In order to support understanding and broad dialogue on safety considerations, and in particular the development of the safety case, communication materials written in plain language will be prepared. This material will include periodic reports on work to date as well as discussion of the parameters and assumptions being used in the development of the generic safety case and how detailed information about a site, once known, will be used to refine work in the future.

Going Forward

In the 2012 to 2016 time period, technical program activities will complete work to update reference designs and safety cases, complete a CNSC pre-project review of repository design and postclosure safety in crystalline and sedimentary rock, and identify design optimization opportunities in advance of submission of site preparation and construction licences in the 2018 time frame. Further studies, analyses and joint activities will continue with international partners to improve understanding of key processes and confidence in the safety case for a deep geological repository.

In the period 2012 to 2016, the NWMO will:

- » Complete illustrative postclosure safety assessment of a used fuel repository;
- » Complete CNSC pre-project review of used fuel deep geological repository designs and safety case;
- » Complete optimization study of repository container geometry and used fuel capacity;
- » Assess copper coating technology for repository containers;
- » Complete preliminary design, fabrication and testing of an alpha prototype repository container and used fuel transportation package;
- » Complete a further update to the conceptual design and cost estimate for Adaptive Phased Management;
- » Continue work to explore technical safety considerations through preparation of generic used fuel transportation risk assessment, including assessment of used fuel transportation modes;
- » Maintain and improve performance assessment models, including groundwater flow, containment release and transport, and coupled thermal-hydraulic-mechanical processes;
- » Improve the system level safety assessment model with respect to capabilities, speed and validation;
- » Further increase confidence in the deep geological repository safety cases;
- » Further enhance scientific understanding of processes that may influence repository safety;
- » Continue the NWMO's involvement in joint research activities and international programs at the Äspö Hard Rock Laboratory in crystalline rock in Sweden and at the Mont Terri Laboratory in sedimentary rock in Switzerland; and
- » Establish a prototype container test facility.

In 2012, the NWMO will:

- » Issue the report *APM Technical Program Activities for the Period 2013 to 2018*;
- » Complete optimization study of repository container geometry and used fuel capacity;
- » Assess copper coating technology for repository containers;
- » Complete used fuel transfer logistics analysis;
- » Complete safety analyses for an Adaptive Phased Management deep geological repository in crystalline rock;
- » Complete annual review of the NWMO's Adaptive Phased Management Technical Program by the Independent Technical Review Group (ITRG);
- » By June, investigate options for the timing of the initiation of the regulatory approvals process; and
- » Prepare generic used fuel transportation risk assessment.

Crystalline and Sedimentary Rock Formations

Canadian and International studies have demonstrated that a multi-barrier used nuclear fuel repository can be safely implemented within both sedimentary and crystalline rock formations. These types of rocks are being actively considered in several countries. Finland and Sweden are developing their used nuclear fuel repositories in crystalline rock. France and Switzerland are investigating sedimentary formations. Japan and other countries are considering both crystalline rocks and sedimentary rocks for their repository programs. Given the regional variability of these two geological formations, the selection of one formation over the other is a function of site-specific conditions and availability.

Sedimentary rocks are produced by the accumulation of sediments into topographic depressions on the surface of the Earth (e.g., lakes, oceans, bays and rivers). Such sediments may be produced by the erosion of previously existing rocks or the precipitation of dissolved minerals. The deposited sediments are gradually compacted by the weight of overlying beds and transformed into solid sedimentary rocks by a process called lithification. Sedimentary rocks are classified according to grain size and composition. Sedimentary rocks with large grain sizes are referred to as conglomerates or breccias. Fine-grained sedimentary rocks are commonly classified as argillaceous sediments and may be referred to as claystone and shales.

Crystalline rocks consist of crystallized material and are further classified into igneous and metamorphic rocks. Igneous rocks are typically formed from the cooling and crystallization of magma from deep within the Earth. Granite is a good example of an igneous rock formed under the Earth's surface. Occasionally, igneous rocks are formed on the surface of the Earth by volcanic eruptions and are referred to as volcanic rocks. Metamorphic rocks are formed from pre-existing igneous or sedimentary rocks. These rocks are transformed (metamorphosed) by being compressed by the action of plate tectonics, which causes temperature and pressure to increase. The process of metamorphism reorganizes the existing minerals in the rock by changing the original crystal grain sizes or realigning minerals. Examples of metamorphic rocks include marble, serpentinite, quartzite, argillite, slate and gneiss.

» Provide Financial Surety

The NWMO will ensure funds are available to pay for the safe, long-term management of Canada's used nuclear fuel.

Canadians expect that the money necessary to pay for the long-term care of used nuclear fuel will be available when it is needed and will be fully funded by the waste producers. Financial surety has the objective of determining what costs can reasonably be expected to occur over the life of the project, along with a contingency for unexpected events, and then designing a system that collects enough money from the waste producers and protects this money to ensure that the entire cost can be covered under a variety of social and economic circumstances, and within the required time frame.

The Adaptive Phased Management project will be implemented in phases and spanning many decades. It has an estimated cost of \$16 billion to \$24 billion (2010 \$). The final cost will depend on such factors as the number of fuel bundles to be managed, timing of construction and geology of the site.

The NWMO completed a full update of these estimates in 2011. The updated cost estimate covers many decades of Adaptive Phased Management lifecycle activity for the deep geological repository and related transportation of used fuel. The updated cost estimate for the Adaptive Phased Management program, based on a reference scenario of 3.6 million bundles, is \$18 billion (based on 2010 \$). When stated in present value terms, which takes into account inflation and fund growth, the cost is \$7 billion (also in 2010 \$). These cost estimates include costs to

develop, construct and operate a central long-term facility, including a deep geological repository and transportation for the used nuclear fuel to the repository, which are carried out and funded by the NWMO. Reactor site storage is carried out and directly funded by the individual waste owners.

The eventual cost of this project may differ from these estimates, depending on the quantity of used nuclear fuel and other factors. The NWMO must estimate what costs can reasonably be expected to occur over the lifetime of the project, along with a contingency for unexpected events. The NWMO is committed to providing regular assessments on all these factors to ensure that sufficient funds are set aside.

The NWMO will also be monitoring any development in new reactors and new owners of used nuclear fuel, applying the appropriate principles to the update of the funding formula when the specific circumstances arise.

As required by the *Nuclear Fuel Waste Act*, the Annual Report of the NWMO must outline the funding formula for the next fiscal year to ensure funds required to cover the full cost of implementation of Adaptive Phased Management is borne by the waste producers and an explanation of assumptions is provided. Trust funds must be maintained and annual contributions made by major waste producers, reflecting the updated funding formula.

The Nuclear Fuel Waste Act

The *Nuclear Fuel Waste Act (NFWA)* assigns responsibility to the major owners of used nuclear fuel to make financial provisions for its long-term management. The *Act* required each of the four waste owners to make annual deposits to trust funds established for this purpose.

The *NFWA* built in explicit provisions to ensure that the trust funds are maintained securely and used only for the intended purpose.

Going Forward

In the period 2012 to 2016, the NWMO will:

- » Incorporate revised baseline cost estimates for Adaptive Phased Management into the annual trust fund deposit calculation by 2012;
- » Continue to publish the audited financial statements of the Members' nuclear fuel waste trust funds as they are provided by the financial institutions (see www.nwmo.ca), and provide updates to confirm that the waste owners are meeting their financial obligations;
- » Estimate and publish the financial implications of potential future scenarios of varying volumes of used nuclear fuel, when available; and
- » Monitor the development of new reactors and new owners of used nuclear fuel, applying the appropriate principles to update the funding formula when the specific circumstances arise.

Adapt Plans

The NWMO will adapt plans for the management of used nuclear fuel in response to new knowledge, international best practices, advances in technical learning, evolving societal expectations and values, and changes in public policies.

A fundamental tenet of Adaptive Phased Management is the ongoing incorporation of new learning and knowledge to guide decision-making. We are committed to re-evaluating decisions where warranted, maintaining the option to change course and being prepared to act on new knowledge or information. Developments throughout the implementation of Adaptive Phased Management may pose technical and ethical challenges. The NWMO's approach and response to these challenges will be critical to the success of Adaptive Phased Management.

The NWMO has identified five fundamental values – integrity, excellence, engagement, accountability and transparency – that inform all its work. A series of principles to guide the siting process, identified in dialogue with Canadians, further builds on this framework. Through regular engagement of citizens, specialists and potentially affected communities, the NWMO monitors, reviews, reports and discusses the challenges of Adaptive Phased Management and changes in the management of used nuclear fuel, especially in the areas of technology development, societal expectations, and energy and environmental policy.

The NWMO continues to learn from best practices and experience with project implementation in Canada and other countries. Through its ongoing participation in the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD), the NWMO regularly reports on its work and participates in an exchange of best international practices in such areas as safety case development, community-based site selection processes and citizen engagement.

A program that is implemented over a long time will have many opportunities to improve safety and performance, enhance effectiveness, build understanding, reduce uncertainty and address

societal concerns. One of the strengths of Adaptive Phased Management is the incorporation of new learning and knowledge.

Developments in environmental and energy policies are particularly relevant to Adaptive Phased Management. For example, nuclear reactor refurbishment projects and new nuclear reactor units would produce new quantities of used nuclear fuel, potentially with different characteristics. The NWMO has a process for ongoing monitoring, review and discussion of the potential implications of these developments on the quantities and characteristics of used nuclear fuel that the NWMO may be asked to manage in the future. During the planning period, it is anticipated that industry plans to move forward with nuclear new build may result in requests for the NWMO to confirm its understanding of and readiness to address a range of used fuel types and volumes for long-term management. The NWMO will work closely with waste owners to stay abreast of industry plans for nuclear new build. The NWMO will work cooperatively with the industry to exchange plans, best practices and experiences in managing different types of radioactive waste in Canada, and identify areas for potential cooperation among waste owners. The NWMO will continue to engage Canadians to ensure continued alignment with values and expectations.

Consistent with the NWMO Transparency Policy and Engagement Procedure, the NWMO reports regularly on its progress in implementing Adaptive Phased Management and especially in response to the advice of Canadians and the changing external environment.

The NWMO also seeks formal opportunities, such as House of Commons Standing Committees, for open and transparent review of the implementation of Adaptive Phased Management at key milestones and decision points.

Continuous Learning

One of the cornerstones of the Adaptive Phased Management program is a commitment to continuous learning from new developments and experience, and adapting and refining plans for all aspects of the long-term management plan for Canada's used nuclear fuel. The NWMO continually monitors and reviews international research, experience, activities and events for lessons learned and as an opportunity to reflect on whether refinements are needed to our plans. This includes developments resulting from the Fukushima events in 2011 and aftermath in Japan.

Going Forward

In the period 2012 to 2016, the NWMO will:

- » Support the site selection process by furthering understanding of best practices in engagement, capacity building, impact assessment and sustaining community well-being;
- » Advance learning and exchange experiences on such issues as retrievability, monitoring, and intergenerational knowledge transfer through collaboration with interested academics and organizations in Canada and internationally, including the OECD Nuclear Energy Agency's Radioactive Waste Management Committee, Integration Group on the Safety Case and Forum on Stakeholder Confidence;
- » Continue to research citizen priorities and concerns relating to Adaptive Phased Management;
- » Build understanding of the interweaving of Aboriginal Traditional Knowledge and other assessment approaches into implementation;
- » Post research papers and the results of engagement activities on the NWMO website;
- » Publish reviews of developments in used nuclear fuel reprocessing and alternative used nuclear fuel management technologies;
- » Publish an annual update on current and future potential inventories of used nuclear fuel quantities and types;
- » Publish a preliminary technical assessment of Generation III reactor used fuel on deep geological repository design and safety;
- » Seek the input of Canadians on how the implementation of Adaptive Phased Management should be adapted in response to current and projected inventories of used nuclear fuel;
- » Continue to monitor developments in energy and environmental policy;
- » Continue to monitor, assess and discuss the impact of potential new nuclear reactor units on the long-term management of used nuclear fuel; and
- » Continue work to identify and plan for a range of scenarios reflecting possible changes in societal capacity to implement Adaptive Phased Management in the future.

In 2012, the NWMO will:

- » Advance the framework for preliminary assessments (feasibility studies) with advice and input from Aboriginal organizations, incorporating Aboriginal Traditional Knowledge provided by Traditional Knowledge holders;
- » Publish a review of developments in used nuclear fuel reprocessing and alternative used nuclear fuel management technologies; and
- » Publish an update on current and future potential inventories of used nuclear fuel quantities and types.

» Ensure Governance and Accountability

The NWMO will maintain an accountable governance structure that provides confidence to the Canadian public in the conduct of the NWMO's work.

The NWMO's governance comprises the Member organizations, the Board of Directors and its Advisory Council. The NWMO is subject to the requirements of the *Nuclear Fuel Waste Act (NFWA)* and oversight by the Minister of Natural Resources Canada. The NWMO's implementation of a repository as part of Adaptive Phased Management will be regulated under the *Nuclear Safety and Control Act (NSCA)* 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. A licensing decision by the Canadian Nuclear Safety Commission (CNSC) on an Adaptive Phased Management repository can only be taken after the environmental assessment has been completed under the *Canadian Environmental Assessment Act*. All aspects of the NWMO's work will meet or exceed all applicable regulatory standards and requirements for protecting the health, safety and security of humans and the environment.

MEMBERS

Ontario Power Generation, NB Power Nuclear and Hydro-Québec are the founding Members of the NWMO. The Membership Agreement and bylaw sets out Member roles and responsibilities in supporting the objectives of the *NFWA* and NWMO's implementation mandate. The NWMO regularly briefs its member organizations.

BOARD OF DIRECTORS

The Board of Directors is responsible for oversight of the organization and taking a leadership role in the development of the corporation's strategic direction. The Members appoint the Board of Directors. There are currently nine members of the Board of Directors, representing a range of perspectives from both within and outside the nuclear industry, including capabilities in ethics, Aboriginal culture and finance management. The membership of the Board is profiled on the NWMO website.

ADVISORY COUNCIL

The *NFWA* requires that the governing body of the NWMO appoints an Advisory Council to review and comment on its study, and following the Government's selection of a long-term management approach for used nuclear fuel, on the NWMO's triennial reports. The Board of Directors appointed the Advisory Council in 2002, with membership renewed in 2008. In addition to meeting its statutory obligations, the Council provides independent guidance and advice to the NWMO. Current membership of the Advisory Council represents a broad range of expertise, including geosciences, nuclear engineering, strategic communications, environment, medicine, political science and Aboriginal Traditional Knowledge. This group of individuals is knowledgeable in nuclear waste management issues and experienced in working with citizens and communities on a range of public policy issues. The membership of the Advisory Council is profiled on the NWMO website.

In 2012, the Council's membership will be renewed, including the appointment of new members, in anticipation of the future phases of the NWMO's work. The NWMO Board will ensure appointments remain consistent with the requirements of the *NFWA* and take into account the range of expertise required to support the regional and local activity associated with Adaptive Phased Management site selection. As the NWMO's work leads to the selection of an informed and willing host community, and as affected Aboriginal organizations and host region are identified, the *NFWA* requires that representatives from these communities be included in the Advisory Council. This is in addition to members with expertise in a broad range of scientific, technical and social scientific disciplines, as well as expertise in Traditional Aboriginal Knowledge, as outlined in the *Act*.

POLICIES AND PROCEDURES

The NWMO will continue to develop its internal governance which is certified to the ISO 9001:2008 Management System. Work on the integrated internal governance will continue with the implementation of additional policies and procedures, or enhancements to existing governance. One of NWMO's targets is to be certified to the CSA Z1000 Occupational Health and Safety Management System and ISO 14001 Environmental Management System in the first half of 2012.

INDEPENDENT TECHNICAL REVIEW GROUP

The Board of Directors established the Independent Technical Review Group (ITRG) in 2008 to regularly review the NWMO's technical research program on used nuclear fuel. The ITRG conducts annual reviews to inform the Board and Advisory Council whether the NWMO technical program is based on credible scientific and technical approaches and methodologies; is consistent with international practices; and will broaden and advance the NWMO's technical knowledge to adequately support implementation of Adaptive Phased Management. The four members bring extensive internationally recognized expertise in the technologies associated with nuclear waste geological repository projects acquired through experience in Canada, the United Kingdom, Sweden and Switzerland. Members of the ITRG are appointed by the NWMO Board on a three-year basis and may be reappointed. The members are profiled on the NWMO website. Reports of the group are also published on the NWMO website.

PEER REVIEWS

The NWMO will continue to seek opportunities for peer review of its work and to invite independent comment. This will benefit program design and delivery, contribute to overall program quality, and help to enhance public confidence in the NWMO's implementation plans and decision-making.

REPORTING

The NWMO maintains high standards of reporting to demonstrate integrity, excellence, engagement, accountability and transparency in the implementation of Adaptive Phased Management. The NWMO reports regularly on its progress and especially in response to the advice of Canadians and the changing external environment.

The *NFWA* requires the NWMO to issue annual reports and triennial reports. In each case, reports are to be submitted to the Minister of Natural Resources Canada and to the public at the same time. The Minister must table the reports in Parliament and issue statements on each report.

INTERNATIONAL COMMITMENTS

The NWMO will continue to report internationally on its progress at meetings of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention)*. Under the *Joint Convention*, Canada must demonstrate that it is meeting international commitments to manage radioactive waste and used nuclear fuel safely. The NWMO will contribute to Canada's reporting at the 2012 and 2015 conventions as part of the delegation led by the CNSC.

Triennial Report

The *Nuclear Fuel Waste Act* sets out very specific reporting requirements for the triennial reports. The first triennial report was issued in 2011, and the next triennial report will be issued in 2014. The triennial reports include:

- a) a summary of [the NWMO's] activities respecting the management of nuclear fuel waste during the last three fiscal years, including an analysis of any significant socio-economic effects of those activities on a community's way of life or on its social, cultural or economic aspirations;
- b) its strategic plan for the next five fiscal years to implement the approach that the Governor in Council selects under section 15 or approves under subsection 20(5);
- c) its budget forecast for the next five fiscal years to implement the strategic plan;
- d) the results of its public consultations held during the last three fiscal years with respect to the matters set out in paragraphs a) and b); and
- e) the comments of the Advisory Council on the matters referred to in paragraphs a) to d).

Going Forward

In the period 2012 to 2016, the NWMO will:

- » Convene regular meetings of NWMO Members, Board of Directors, Board Committees and Advisory Council;
- » Coordinate annual reviews of the NWMO's technical program by the Independent Technical Review Group, and publish the reports of the Review Group;
- » Conduct assessments and audits of internal governance to maintain and achieve certifications to management system standards for quality, safety and environmental management;
- » Interact with the CNSC on Adaptive Phased Management in the pre-project period consistent with the terms of the service agreement that identifies the CNSC's early involvement in the Adaptive Phased Management Project prior to submission of a licence application. These areas include participating in public meetings to provide information on the regulator's role, identifying regulatory requirements for a repository and providing regulatory review of conceptual Adaptive Phased Management repository designs and preliminary safety cases;
- » Report to Canadians on its progress in implementing Adaptive Phased Management. The NWMO will submit its Annual Report to the Minister of Natural Resources Canada and the public in the first quarter of each year, including its second triennial report in March 2014;
- » Publish the five-year strategic plan, *Implementing Adaptive Phased Management*;
- » Publish the minutes of the meetings of the Board of Directors, the Advisory Council, and the Independent Technical Review Group and their reports;
- » Report internationally on progress for the long-term management of Canada's used nuclear fuel at the 2012 and 2015 meetings of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*; and
- » Undertake membership review, and make appointments to the Advisory Council to ensure members bring a broad range of expertise.

»» Build and Sustain a High-Performing Organization

The NWMO will build and sustain an effective organization with the social, environmental, technical and financial capabilities for the safe, long-term management of Canada's used nuclear fuel.

Management of used nuclear fuel is a very long-term responsibility. The NWMO must be steady, stable and long term in its outlook and actions. The NWMO must have access to a sufficient and sustainable number of trained and skilled personnel. This requires investment in the organization to ensure resource capacity, capability, expertise, and sound administrative and management policies and practices, that provide a foundation for operations and demonstrate commitment to staff development.

The NWMO has a strong set of skills and competencies resident in its current staff. It will be important to ensure this expertise is retained and further developed over the years to come. The long time frames associated with management of used nuclear fuel give rise to the additional priority of intergenerational knowledge management. Qualified human resources will be required to support program implementation and operations spanning decades. The preservation and transfer of knowledge and institutional memory across generations will be integral to supporting lengthy decision-making processes and the integration of technical, scientific and social information over long periods of time.

We will require expertise and capabilities in a range of fields, including, but not limited to, repository design and construction, environmental assessment, socio-economics, ethics, finance, public engagement, Aboriginal Traditional Knowledge, siting, information management and waste management technology. Investment in human resources, skills training and networks of specialists will be important to build and sustain a capability for inquiry, assessment and decision-making to support the implementation of Adaptive Phased Management. These specialists will be critical to implementing the siting process, developing host community interest and partnerships, and undertaking the technical and socio-economic site investigations.

As the NWMO proceeds with the implementation of Adaptive Phased Management and builds partnerships to facilitate this implementation, capacity at the local and regional levels to participate in the implementation of the deep geological repository and associated facilities will become a critical component of the larger organization required to implement Adaptive Phased Management. Capacity building at the local and regional level will be important.

Going Forward

In the period 2012 to 2016, the NWMO will:

- » Continue to grow and develop its staffing and contractor capability through initiatives, such as focused recruitment campaigns when appropriate, alliances with appropriate educational institutions, development of third-party expertise, training and development programmes, and succession planning;
- » Continue to invest in business systems and processes throughout the business planning period to support the growing organization;
- » Continue a graduate training program to support maintenance of institutional memory and transfer of information to future generations;
- » Take into account future needs for regionally based staff and local information offices to support the site selection process in communities electing to enter the process; and
- » Continue to work with potential host communities and regions to build capacity to participate in the site selection process, and ultimately for the host community and region to participate in the implementation and operation of the deep geological repository and associated facilities.

The Road Ahead

The NWMO invites all Canadians and Aboriginal peoples of Canada to stay involved in Adaptive Phased Management of Canada's used nuclear fuel. *Implementing Adaptive Phased Management* is updated annually to guide the five-year planning period ahead. As such, the Plan is regularly assessed, strengthened and redirected, as needed.

Adaptive Phased Management will proceed as expeditiously as Canadians, successful technology demonstration and the regulatory authorities allow. Implementation of the site selection process for the deep geological repository for used nuclear fuel has begun. This community-led process is supported by the resources and work programs described in this plan.

Glossary

Deep geological repository is a facility for the placement of used nuclear fuel deep underground where both natural and engineered barriers contain and isolate it from humans and the environment. There is the potential for retrieving the used nuclear fuel.

Fuel bundle for CANDU nuclear reactors is manufactured by sintering uranium oxide powder into pellets. The pellets are loaded into Zircaloy (an alloy of the metal zirconium) tubes, which are then welded into a bundle of tubes – a fuel bundle. Each bundle contains about 1,000 uranium oxide pellets.

Intermediate-level nuclear waste consists primarily of used reactor core components, and resins and filters used to keep reactor water systems clean. It requires shielding to protect workers during handling. Intermediate-level waste is stored mainly in steel-lined concrete containers that have been set into the ground.

Long-term management of used nuclear fuel involves containment and isolation of the radioactive material. The radioactivity decreases substantially with time, due primarily to the decay of short-lived radionuclides. The radioactivity of used nuclear fuel decreases to about one percent of its initial value after one year, decreases to about 0.1 percent after 10 years and decreases to about 0.01 percent after 100 years. After approximately one million years, the radioactivity in used nuclear fuel approaches that of natural uranium.

Low-level nuclear waste consists of common industrial items that have become contaminated with low levels of radioactivity during routine cleanup and maintenance at the nuclear generating stations. Low-level waste includes mops, rags, paper towels, temporary floor coverings, floor sweepings, protective clothing and hardware items such as tools. It consists of paper, plastics, metal, rubber, cotton and other miscellaneous materials. Low-level waste can be safely handled using normal industrial practices and equipment without any special radiation protection.

Retrievability is the ability to remove the used nuclear fuel from where it has been placed.

Safety is the protection of individuals, society and the environment, from the harmful or dangerous effects of used nuclear fuel, now and in the future.

Used nuclear fuel means the irradiated fuel bundles removed from a commercial or research nuclear fission reactor. Used nuclear fuel is classified as a high-level nuclear waste.

For more information, please contact:

Nuclear Waste Management Organization

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