



# Implementing Adaptive Phased Management 2018 to 2022

**DRAFT FOR PUBLIC REVIEW**  
**SEPTEMBER 2017**

**nwmo**

NUCLEAR WASTE  
MANAGEMENT  
ORGANIZATION      SOCIÉTÉ DE GESTION  
DES DÉCHETS  
NUCLÉAIRES



# Implementing Adaptive Phased Management 2018 to 2022

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# Mission

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The purpose of the NWMO 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 feasible.

# Vision

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The long-term management of Canada's nuclear waste in a manner that safeguards people and respects the environment, now and in the future.

# Values

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## 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.

**Note:** We are currently reviewing our statement of values, to consider opportunities to refresh them.

# Introduction

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

Each year, the NWMO publishes an update to its five-year strategic plan, titled *Implementing Adaptive Phased Management*. Before doing so, we release our plan in draft form for public review. This document, *Implementing Adaptive Phased Management 2018 to 2022 – Draft for Public Review*, invites your comments through to November 30, 2017. Once the review period is complete, we will revise the Implementation Plan to reflect comments received.

We are currently in the site selection phase of implementing APM. This document provides an overview of the work that is planned over the next five-year period as we narrow our focus to one preferred site for the repository. The plan is a living document that is regularly assessed, strengthened and redirected in the face of new information, direction and guidance from communities, advances in science and technology, insight from Indigenous Knowledge, changes in societal values, and evolving public policy.

The NWMO has a deep commitment to safety – safety of people and the environment from used nuclear fuel over the long term, and safety throughout all phases of activity, from removing the waste from interim storage sites, transporting it to the deep geological repository, emplacing it in the repository, decommissioning the site and long-term monitoring. All aspects of the NWMO's work will meet or exceed applicable federal and provincial regulatory standards and requirements for protecting the health, safety, and security of humans and the environment.

This Implementation Plan lays out a work plan that will ensure safety.

As our work has become more focused, so too has this year's planning document. This evolution of our plans and the way we present them will continue over the coming years. We hope you find this plan easy to review and comment on.

**This document provides an overview of the work that is planned over the next five-year period as we narrow our focus to one preferred site for the repository.**

The NWMO welcomes all suggestions and ideas about our work and how we can help you learn more about Canada's plan for used nuclear fuel. Please share your thoughts by November 30, 2017. We look forward to hearing from you.

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# About Canada's Plan for Used Nuclear Fuel

Canada has been generating electricity from nuclear power for more than half a century. Used nuclear fuel is a by-product of this process. It gives off radiation and is a potential health and safety hazard unless properly managed. For practical purposes, used nuclear fuel remains hazardous, essentially indefinitely.

There are currently just under 2.7 million used nuclear fuel bundles safely stored in interim storage facilities that require long-term management. As of 2017, it is expected that up to 5.4 million used fuel bundles could be produced to the end of the life of the current nuclear generating facilities.

The Government of Canada, through the *Nuclear Fuel Waste Act (NWFA, 2002)*, assigned responsibility for the long-term management of Canada's used nuclear fuel to the NWMO. The NWMO was established by Canada's major nuclear fuel waste owners – Ontario Power Generation (OPG), Hydro-Québec and New Brunswick Power Corporation – to operate on a not-for-profit basis.

Canada's plan, called Adaptive Phased Management (APM), emerged through a three-year dialogue with Canadians (2002–2005). It is a management system and technical method.

## Adaptive Phased Management at a Glance

### Technical Method

- Centralized containment and isolation of used nuclear fuel in a deep geological repository
- Continuous monitoring
- Potential for retrievability
- Optional step of shallow underground storage \*

### Management System

- Flexibility in pace and manner of implementation
- Phased and adaptive decision-making
- Responsive to advances in technology, research, Indigenous Knowledge, and societal values
- Open, inclusive and fair siting process to seek an informed and willing host
- Sustained engagement of people and communities throughout implementation

\* Temporary shallow storage at the deep geological repository is optional and not currently included in the Nuclear Waste Management Organization's implementation plan.

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 that will contain and isolate Canada's used nuclear fuel deep underground in a suitable rock formation. A safe and secure transportation system will be developed to transport used nuclear fuel from the facilities, where it is currently stored on an interim basis, to the centralized site. The project also involves the development of a Centre of Expertise for technical, environmental and community studies.

In 2010, the NWMO initiated a process to select a site for the repository, one where there is suitable rock and an informed and willing host. The project will only proceed with the involvement of the interested community, First Nation and Métis communities in the area, and surrounding communities, working in partnership to implement it. Collaboration, shared decision-making and willingness underpin the siting process. More information about this process is available at [www.nwmo.ca/sitingprocess](http://www.nwmo.ca/sitingprocess).

**The project will only proceed with the involvement of the interested community, First Nation and Métis communities in the area, and surrounding communities, working in partnership to implement it.**

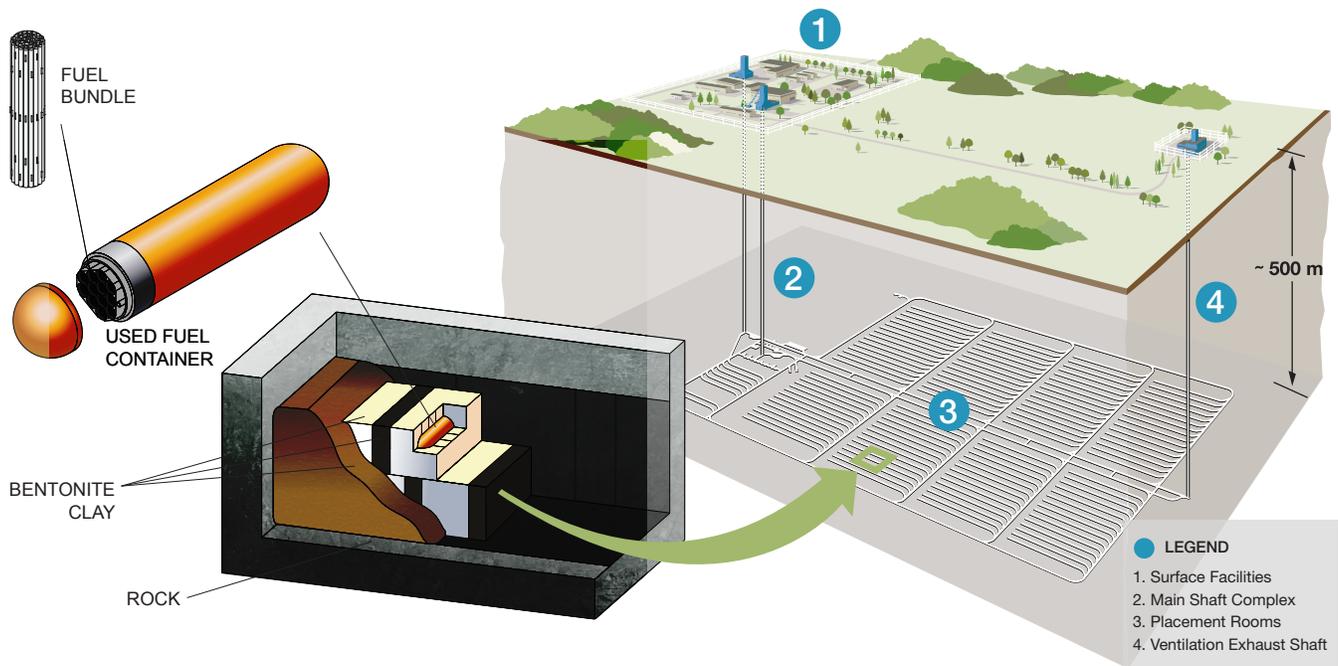
# Key Components of the Repository

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 nuclear fuel.

Surface facilities provide processes and equipment for receiving, inspecting, repackaging, and moving used fuel to the main shaft to transfer underground, as well as emplacement in the repository.

Before being transported underground to the repository, the used fuel is placed into specialized containers and encased in a bentonite buffer box in a Used Fuel Packing Plant (UFPP). Once underground, these buffer boxes are to be stacked (e.g., two high) in the horizontal placement room, and any spaces are backfilled with bentonite pellets.

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



For a more fulsome description of the project, please see *Description of a Deep Geological Repository and Centre of Expertise for Canada's Used Nuclear Fuel* at [www.nwmo.ca/Backgrounders](http://www.nwmo.ca/Backgrounders).

# Regulatory Oversight

In implementing Canada's plan, the NWMO is committed to meeting or exceeding all applicable regulatory standards and requirements for protecting the health, safety, and security of people and the environment.

Implementation of a deep geological repository 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), as Canada's independent regulatory authority, regulates the use of nuclear energy and materials to protect the health, safety, and security of Canadians and the environment; and to implement Canada's international commitments on the peaceful use of nuclear energy. The CNSC also disseminates objective scientific, technical and regulatory information to the public.

Under section 26 of the *NSCA*, activities associated with a nuclear facility can occur only in accordance with a licence issued by the CNSC. The repository for Canada's used nuclear fuel will be subject to the CNSC's comprehensive licensing system, which covers the entire life cycle of the repository, from site preparation, to construction, operation, decommissioning (closure and post-closure), and abandonment (release from CNSC licensing).

This stepwise approach will require a licence for each phase of the repository life cycle. The process for obtaining a "site preparation" licence will be initiated by the NWMO. The NWMO would submit an application for a Licence to Prepare Site (and possibly construct) to the CNSC. A licensing decision by the CNSC on a repository can be taken only after the successful completion of the environmental assessment, following the process established under the *Canadian Environmental Assessment Act*. More information about the CNSC's licensing process is available at [www.cnscccsn.gc.ca](http://www.cnscccsn.gc.ca).

The transportation of used nuclear fuel is jointly regulated by the CNSC and Transport Canada.

Although the CNSC is the main licensing authority, it administers its licensing system in co-operation with other federal and provincial government departments and agencies in areas such as health, environment, transport, and labour.

# Planning Timelines

The pace and manner of progressing through the site selection process will necessarily reflect timelines shaped by communities and the time required to complete the rigorous process of assessing and confirming safety. For the purpose of resource planning and ensuring readiness to move forward to each phase of work, we make planning assumptions about timing.

The following graphic provides a glimpse of planning estimates for upcoming milestones, and where they fall within the broader historic and future milestones of the project.

Developing Canada's plan	2002	The NWMO is created.
	2005	The NWMO completes three-year study with interested individuals, including specialists, Aboriginal people and the Canadian public.
	2007	Government of Canada selects APM and mandates the NWMO to begin implementation.
Developing the siting process	2008 to 2009	Work takes place, with citizens, to design a process for selecting a preferred central site for the deep geological repository and Centre of Expertise.
Identifying a site using the siting process	2010	The siting process is initiated, with a program to provide information, answer questions and build awareness.
	2012	22 communities initially express interest. In collaboration with interested communities, the NWMO conducts initial screening of each.
	2012 to 2015	Preliminary studies are conducted to further assess suitability. Areas with less potential to meet project requirements are eliminated from further consideration.
	2015 to 2022	The NWMO expands assessment to include field studies. Areas with less potential are eliminated from further consideration.
	2018 to 2022	<b>Narrowing down process and subsurface studies continue.</b>
	2023	A single preferred site is identified.
Towards construction	2024	Detailed site characterization begins. Construction of the Centre of Expertise begins.
	2028	Licensing applications submitted.
	2032	Construction licence granted (estimate).
Beginning operations	2040 to 2045	Operations of the deep geological repository begin.

# Strategic Objectives

Our Implementation Plan for the next five years is organized along eight strategic objectives, as described on the pages that follow. These objectives evolve as implementation of APM progresses. We continue to report publicly on the input we receive, and how this advice is considered in adapting plans.

- 1 BUILD SUSTAINABLE RELATIONSHIPS**
- 2 COLLABORATIVELY IMPLEMENT THE SITE SELECTION PROCESS**
- 3 DEMONSTRATE SAFETY AND FEASIBILITY OF REPOSITORY AND ENGINEERED-BARRIER DESIGN**
- 4 PLAN FOR CONSTRUCTION AND OPERATION OF CENTRE OF EXPERTISE AND DEEP GEOLOGICAL REPOSITORY**
- 5 CONTINUOUSLY IMPROVE TECHNICAL KNOWLEDGE**
- 6 DEVELOP TRANSPORTATION PLANS**
- 7 PROVIDE FINANCIAL SURETY**
- 8 ENSURE GOVERNANCE AND ACCOUNTABILITY**

# 1 BUILD SUSTAINABLE RELATIONSHIPS

**Objective:** 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. The NWMO will continue to adapt plans for the management of used nuclear fuel in response to evolving societal expectations and values, insight from Indigenous Knowledge, and changes in public policies.

During the period 2018 to 2022, engagement will focus on strengthening established relationships to sustain program momentum. Engagement will include 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 Council of Elders and Youth and the Municipal Forum. The NWMO will also work with and learn from Indigenous Knowledge holders, providing opportunities for them to share their knowledge with us.

In the early days of its mandate, much of the NWMO's work focused on developing plans, policies and processes collaboratively with Canadians to support the implementation of APM. Its engagement activities focused on the broad Canadian public. As the siting phase of implementing APM progresses, the engagement program has evolved to focus more directly on the communities interested in learning more about the project, First Nation and Métis communities in the area, and surrounding communities.

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 has a number of policies and plans that guide its work, including its Aboriginal Policy and Indigenous Knowledge Policy. We recognize that there are Aboriginal peoples in all areas of Canada where our work will take place. We acknowledge, respect and honour that Aboriginal peoples – Indian, Métis and Inuit peoples of Canada – have unique status and rights as recognized and affirmed in section 35 of the *Constitution Act* (1982).

We are also guided by an evolving Ethical and Social Framework with roots in conversations that took place during the early phases of work. A fundamental tenet of APM is the commitment to adapt plans for the management of used nuclear fuel in response to evolving societal expectations and values, insight from Indigenous Knowledge, technical advances, and changes in public policies.

Advances in technology development, such as for recycling or reprocessing used nuclear fuel, may also create new opportunities for governments and energy producers. The NWMO reports regularly to the public on its progress in implementing APM, as it adapts to direction obtained through engagement activities and the changing external environment.

## Indigenous Engagement

Inclusion of Indigenous perspectives is an essential element of the NWMO's work. This value system is manifest in many ways as we implement the APM project, from oversight by our Indigenous Relations team, cultural awareness training for all staff and contractors, guidance drawn from the NWMO's ground-breaking Indigenous Knowledge policy, and daily engagement with First Nations and Métis communities. As we embark on the next five years, we continue to interweave Indigenous Knowledge with Western science and reflect on what we learn from ceremony and traditional teachings.

**In addition to the activities described on the previous page, in the period 2018 to 2022, the NWMO will:**

- » Continue work to increase awareness among – and consider comments from – Canadians and Aboriginal peoples of Canada about the implementation of APM, the site selection process and the NWMO, and report publicly on input received;
- » Work to increase youth awareness and understanding of the project and capacity for future decision-making related to APM;
- » Brief Canada's nuclear host communities about progress in implementing APM, including planning for eventual transportation of used nuclear fuel from their communities to the deep geological repository;
- » Develop and sustain relationships with:
  - interested communities that chose to engage in the site selection process, First Nation and Métis communities in the area, and surrounding communities;
  - national, provincial and regional Aboriginal organizations, to keep them apprised of progress in implementing APM and the site selection process;
  - municipal associations, in order to better understand local governments' points of view, and work with them to implement APM; and
  - the federal government, provincial and local governments;
- » Continue to work with potentially affected Aboriginal peoples, including Indigenous Knowledge holders, in recognizing the diversity of cultures and languages, practices, and approaches within Aboriginal communities; in identifying sacred areas; in understanding traditional laws, practices, and use of land; and in protecting the environment to sustain community life;
- » Work towards applying the recommendations of the Truth and Reconciliation Commission, the advice of the Council of Elders and Youth, and the seven sacred teachings of love, trust, sharing, honesty, humility, respect and wisdom to build a path towards fostering reconciliation in all aspects of implementing APM;
- » Advance learning and exchange experiences on technical and engagement issues such as retrievability, monitoring, and intergenerational knowledge transfer through collaboration with interested academics and organizations in Canada and internationally; and
- » Continue to monitor changes in the external landscape such as developments in energy and environmental policy and the impact of potential new nuclear reactor units on the long-term management of used nuclear fuel.

## 2 COLLABORATIVELY IMPLEMENT THE SITE SELECTION PROCESS

**Objective: The NWMO will implement collaboratively with communities the process to select a site suitable for locating the deep geological repository and Centre of Expertise in a safe location in an area with an informed and willing host.**

The period 2018 to 2022 will see an acceleration of activities towards collaboratively implementing the site selection process. These activities will include continuing to narrow down the number of study areas, moving toward partnership and undertaking subsurface studies through deep borehole drilling.

The decision about an appropriate site will be made through a series of steps, consistent with Canada's plan and the siting process roadmap identified in 2010.

Through working with communities that have come forward to participate in the site selection process, and through initial outreach with First Nation, Métis and surrounding communities, the nature and shape of the partnerships required to implement the APM project together are beginning to emerge.

Funding and resources are provided to support communities as they build their capacity and understanding of the project, engage in discussions with community members and neighbours, reflect on their interest in the project and participate in discussions to explore partnership. Going forward, the NWMO will begin to make investments in the well-being of communities in recognition of their participation and advancement of field activities.

Successful implementation of the siting process requires a good understanding of regional priorities, politics and key players. Interested communities, First Nation and Métis communities, and surrounding communities are reflecting on environmental, social, cultural, and economic effects as well as increasingly detailed site investigations. Involving people in the broad area will help ensure that the range of potential effects, both positive and negative, associated with implementation at a particular site are recognized and considered.

In the next few years, technical support to the siting process will focus on assessing the suitability of potential sites through geoscientific and environmental evaluation studies in the vicinity of interested communities. Beyond ensuring safety, the NWMO's commitment is that the long-term well-being or quality of life of the community and area will be fostered through participation in this project.

The NWMO keeps provincial governments briefed on APM so they are ready to support community interest, and address inquiries about Crown land, and provincial regulations and approvals. Over the five-year planning period, the NWMO expects to continue to seek provincial authorizations as required for initial borehole drilling.

In addition to the activities described on the previous page, in the period 2018 to 2022, the NWMO will:

- » Undertake engagement activities to understand and test potential in the area for advancing the project in partnership and to seek input on field studies and assessment work in study areas;
- » Initiate limited borehole drilling and expand field studies to inform the assessment of geoscientific, engineering, environmental and safety factors, and factors identified by Indigenous Knowledge holders in areas with strong potential to meet the requirements of the project;
- » Continue to explore technical safety considerations through illustrative post-closure safety assessments of the deep geological repository;
- » Continue to narrow down the number of study areas over the course of assessments through ongoing stock-taking of findings with communities. Areas with relatively low potential to be suitable for the project will be screened out; and
- » Continue to develop exhibits and other plain language communication materials and audio-visual tools to support local- and area-based discussions of APM and siting.



### 3 DEMONSTRATE SAFETY AND FEASIBILITY OF REPOSITORY AND ENGINEERED-BARRIER DESIGN

**Objective:** The NWMO will conduct testing of the engineered-barrier system in order to demonstrate that it meets safety requirements, and can be produced effectively and efficiently.

The ability of the deep geological repository to safely contain and isolate used nuclear fuel relies on 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 long-term containment and repository performance to meet or exceed the regulatory expectations of the CNSC. The repository will be consistent with the guidance of the International Atomic Energy Agency (IAEA) and experience in other countries.

Over the next five years, our technical program will further develop engineering designs and demonstrate their effectiveness. Physical prototypes of the long-lived repository containers will be manufactured and tested. This work will incorporate robust design practices and proven manufacturing technologies, and demonstrate the NWMO's ability to meet the rigorous requirements of the repository environment. Specialists at our facility will continue to investigate manufacturing and prototype testing technologies.

A fundamental tenet of APM is the ongoing incorporation of new learning and knowledge to guide decision-making. The NWMO is committed to re-evaluating decisions where warranted, maintaining the option to change course and being prepared to act on new knowledge or information. As this program is implemented over a long time, we will take advantage of many opportunities to improve safety and performance, enhance effectiveness, build understanding, and reduce uncertainty.

In addition to the activities described on the previous page, in the period 2018 to 2022, the NWMO will:

- » Prepare preliminary site specific safety assessments incorporating data collected through borehole drilling and preliminary environmental baseline investigations;
- » Maintain a prototype test and demonstration facility for engineered-barrier evaluations;
- » Update the conceptual designs and cost estimate for APM as required, and initiate design and development of used fuel handling systems;
- » Complete design, fabrication, and testing of prototype repository containers, buffer, and emplacement systems;
- » Conduct independent peer reviews of specific aspects and features of the engineered-barrier design and seek reviews of the engineered-barrier system testing program;
- » Maintain and improve safety assessment models, including groundwater flow, containment release and transport, and coupled thermal-hydraulic-mechanical processes; and
- » Further enhance scientific understanding of processes that may influence repository safety.

The NWMO has a deep commitment to safety – safety of people and the environment from used nuclear fuel over the long term, and safety throughout all phases of activity, from removing the waste from interim storage sites, transporting it to the deep geological repository, emplacing it in the repository, decommissioning the site and long-term monitoring.

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

## 4 PLAN FOR CONSTRUCTION AND OPERATION OF CENTRE OF EXPERTISE AND DEEP GEOLOGICAL REPOSITORY

**Objective: The NWMO will advance planning and capabilities for the construction and operation of the deep geological repository and the associated Centre of Expertise.**

Once a preferred site is selected for the APM project, there will be an escalation of activity on many fronts in the local and regional area. These activities include a range of verification and demonstration activities. Processes will also be initiated to support the future construction and operation of the deep geological repository and related surface facilities.

The NWMO is committed to working closely with communities to initiate planning for these important future phases of work. As part of its 2018 to 2022 work plan, the NWMO will continue to work with communities engaged in the site selection process to initiate important preparatory work in support of this eventual expansion of local activity at the selected site. Activities during this period will include planning for detailed site characterization, regulatory submissions, and construction and operation phases of the project. Advance planning will expedite progress at the site once the preferred location is identified and will prepare communities to participate in the project through associated jobs and services.

### **Getting Ready for Activity at the Site: Planning for Future Regulatory Approvals**

The NWMO's overriding objective in implementing the APM project on behalf of Canadians is safety and security. The NWMO will have to demonstrate that the project meets or exceeds strict regulatory requirements to protect the health, safety, and security of people and the environment, while also respecting Canada's international commitments.

The NWMO will prepare comprehensive and high-quality plans and processes to conduct site investigations and associated technical studies based on relevant municipal, provincial and federal requirements for the project.

## Planning and Designing the Centre of Expertise

The Centre of Expertise will be located in or near the area selected to host the deep geological repository. The centre's key purpose initially will be to support the multi-year program of technical testing and verification, and to support ongoing planning and discussion with community members. It would later be expanded to support construction and operation of the deep geological repository.

The Centre of Expertise will be home to an active technical and social research and technology demonstration program. It will involve scientists and other specialists in a wide variety of disciplines, including geoscience, engineering, and environmental, socio-economic, and cultural impact assessment. The centre will become a hub for knowledge sharing across Canada and internationally. The high level of international collaboration will be expanded as the centre welcomes scientists and visitors from other countries who wish to benefit from the work being led at Canada's national facility.

## Building Local Capacity and Employment Opportunities

APM is a large national infrastructure project that will result in significant economic benefits to the area, including jobs for the initiating community and First Nation and Métis communities in the area and within the province. It is a multi-generational project that will be developed and implemented in phases over more than 150 years. The project will generate hundreds of direct, indirect, and induced jobs involving scientists, engineers, trades people, and others with transferable skills and capacities in the siting region for many decades.

The number of jobs sourced from the siting area will depend in part on the location of the repository and the capacity of communities in the siting area, economic region and province. The NWMO will seek to maximize job opportunities in the local area and to build capacity in communities to secure jobs on the project.

### **In addition to the activities described above and on the previous page, in the period 2018 to 2022, the NWMO will:**

- » Develop work plans and assess resource requirements to progress detailed site characterization, environmental assessments, engineering designs, and safety case development for the selected siting area in support of the future licensing application;
- » Advance the definition of the concept and scope for the national Centre of Expertise that will be constructed in the selected siting area;
- » Continue to build a stronger local staffing presence in potential siting areas through locally based NWMO staff and provide local contracting opportunities for the project;
- » Invest in building skills and capacity of youth and community members in the municipal, First Nation and Métis communities engaged in the site selection process to position them to secure jobs related to future phases of the APM Project, or other large projects in the area; and
- » Continue to interact with the CNSC consistent with the terms of a special project arrangement prior to submission of a licence application. These activities include providing briefings to the Commission on the progress of APM implementation.

## 5 CONTINUOUSLY IMPROVE TECHNICAL KNOWLEDGE

**Objective: The NWMO will continuously improve technical knowledge in collaboration with universities and international partners, and adapt plans consistent with international best practices.**

In support of APM, the NWMO contributes to and learns from best practices and experience with project implementation in Canada and other countries. The NWMO continues to participate in the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) to exchange information in such areas as safety case development.

We also participate in international research projects. The APM technical program conducts joint research projects with international organizations and counterparts in other countries, including Sweden, Switzerland, Finland, France, Korea, Japan, and the United Kingdom. Partnering with other radioactive waste management organizations allows the NWMO to foster international co-operation on technology research and development; learn from other countries' experience; and keep abreast of developments in geoscience and safety case development for various host rock formations.

Research partnerships with universities also play an important role in ensuring the NWMO's technical work is scientifically rigorous.

The NWMO regularly reports on new learning within the larger context in which we work. We maintain a watching brief on used nuclear fuel reprocessing and alternative used nuclear fuel management technologies ([www.nwmo.ca/adaption](http://www.nwmo.ca/adaption)). We also monitor potential inventories of used nuclear fuel quantities and types for implications to repository design ([www.nwmo.ca/HowMuchFuel](http://www.nwmo.ca/HowMuchFuel)).

**In addition to the activities described on the previous page, in the period 2018 to 2022, the NWMO will:**

- » Advance understanding of relevant processes through collaboration with universities in Canada and internationally, with the results presented in journal articles, conference papers, and technical reports;
- » Continue to partner in the installation, monitoring and analysis of experiments at the Mont Terri Rock Laboratory Project and Grimsel Test Site, both in Switzerland, along with researchers from Switzerland, France, Spain, Germany, Belgium, and the United States;
- » Continue to participate in national and international conferences and workshops sponsored by organizations such as the Canadian Nuclear Society, the NEA, and the IAEA, including participation in the OECD NEA's Radioactive Waste Management Committee and Integration Group on the Safety Case, the NEA's Thermodynamics Database Project, and BIOPROTA, an international forum on biosphere modelling for radioactive waste facilities;
- » Continue to host an annual Geoscience Seminar to bring together researchers from academia and industry; and
- » Continue to support, along with the Natural Sciences and Engineering Research Council of Canada (NSERC), graduate students through the NSERC's Industrial Postgraduate Scholarships Program.



## 6 DEVELOP TRANSPORTATION PLANS

**Objective:** The NWMO will establish safe, secure and socially acceptable plans for transporting used nuclear fuel.

Transportation of used nuclear fuel is an important element of the APM project, as the fuel will be transported from current interim storage sites to the repository.

As part of the process of selecting a site, a transportation route must be identified, or have the potential to be developed. Transportation planning and evaluations must fully address regulatory requirements for safely transporting used nuclear fuel through different provinces. From a technical perspective, used nuclear fuel can be transported safely and securely, with radiological safety assured through robust transportation packages.

In addition to technical requirements, social acceptance and community well-being are important considerations in identifying transportation routes. Therefore, the NWMO will need to demonstrate the safety and security of any transportation system to regulatory authorities and citizens before transportation of used nuclear fuel to the repository can begin. Transportation is an important focus of public engagement in order to understand societal considerations, questions and concerns.

**In addition to the activities described on the previous page, in the period 2018 to 2022, the NWMO will:**

- » Undertake transportation logistics studies and risk assessments;
- » Consider road and rail transport for a variety of used fuel transportation package designs;
- » Develop updated package designs for transportation containers, with consideration of ‘beyond-design basis’ scenarios;
- » Seek CNSC design approval certificates for road and rail transport packages as appropriate;
- » Continue ongoing dialogue in municipal and First Nation and Métis communities near siting areas and with municipal associations and Aboriginal organizations regarding ways to communicate about transportation plans. Engage with communities that may be on a transportation corridor for used nuclear fuel;
- » Conduct dialogue and use public attitude research techniques to explore public understanding, questions and concerns;
- » Develop a Transportation Planning Framework based on input received and share a draft for public dialogue, refinement and confirmation; and
- » Continue review of experience and best practices with transportation of hazardous materials, including transportation of nuclear waste in Canada and internationally, to identify lessons that apply to APM.



## 7 PROVIDE FINANCIAL SURETY

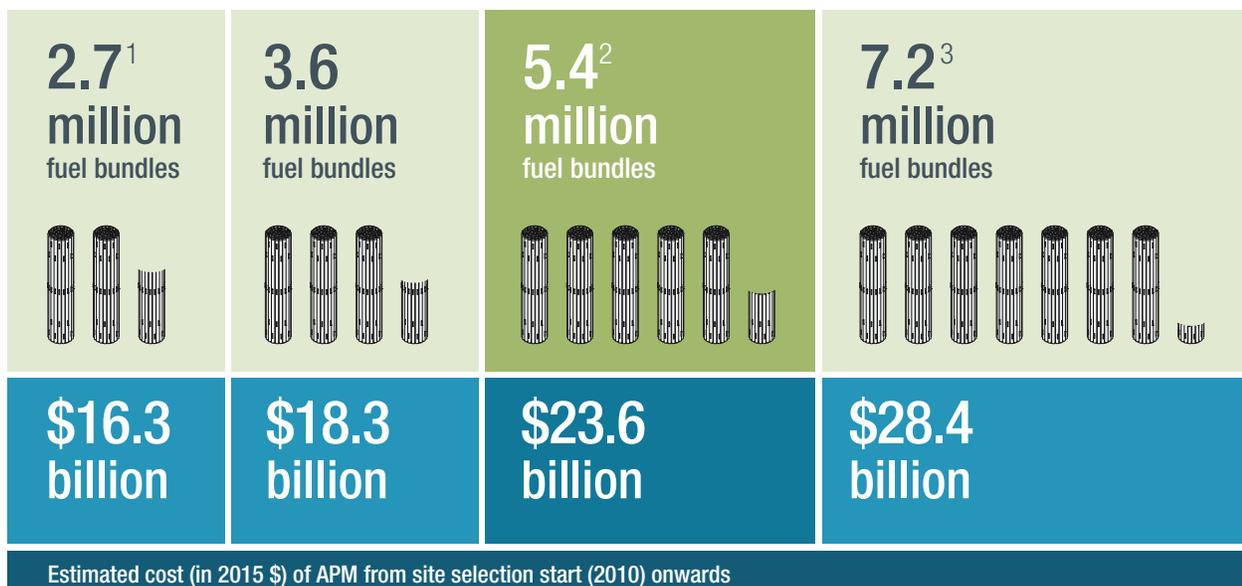
**Objective:** The NWMO will ensure funds are available to pay for the safe, long-term management of Canada's used nuclear fuel.

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 that the APM project will be fully funded by the waste producers. The NWMO has the objective of determining what costs can reasonably be expected to arise over the life of the project, along with a contingency for unexpected events. It also has responsibility to design 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.

APM cost estimates include costs to develop, construct and operate a long-term facility, including a deep geological repository and Centre of Expertise, and transport the used nuclear fuel to the repository. Interim reactor site storage is carried out and directly funded by individual waste owners and therefore not included in the APM cost estimates.

The NWMO completed a full update of these estimates in 2016. The updated cost estimates cover many decades of APM life cycle activity for the deep geological repository and related transportation of used nuclear fuel. The eventual cost of the project is impacted by many factors, including the volume of used nuclear fuel to be managed, the location of the facility, surrounding infrastructure, rock type and characteristics, design of the repository, and length of time allocated to monitoring the site following fuel placement.

The following table shows how estimated costs might differ depending on the amount of used nuclear fuel to be managed.



<sup>1</sup> Existing volume as of June 2016

<sup>2</sup> Maximum projected inventory based on life expectancy of existing nuclear reactors, including announced refurbishment and life extension plans

<sup>3</sup> Potential inventory if decision is made to construct new commercial reactors

## ***The Nuclear Fuel Waste Act (NFWA)***

The planning, development and implementation of the APM project is funded by the major owners of used nuclear fuel in Canada: Ontario Power Generation, New Brunswick Power Corporation, Hydro-Québec, and Atomic Energy of Canada Limited (AECL). The *NFWA* (2002) requires each of these four companies to establish independently managed trust funds and make annual deposits to ensure the money to fund this project will be available when needed.

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

As required by the *NFWA*, trust funds must be maintained, and annual contributions made by major waste producers, reflecting the updated funding formula. At the end of 2016, trust fund balances were at \$4 billion.

**In addition to the activities described on the previous page, in the period 2018 to 2022, the NWMO will:**

- » Annually assess all factors that impact APM cost estimating and funding requirements;
- » Continue to publish the audited financial statements for nuclear fuel waste trust funds, established by the Members and AECL, as they are provided by the financial institutions (see [www.nwmo.ca/trustfunds](http://www.nwmo.ca/trustfunds)), and provide updates to confirm that they are meeting their financial obligations;
- » 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; and
- » Complete the next full update of the APM cost estimate (2021).

**APM cost estimates include costs to develop, construct and operate a long-term facility, including a deep geological repository and Centre of Expertise, and transport the used nuclear fuel to the repository. Interim reactor site storage is carried out and directly funded by individual waste owners and therefore not included in the APM cost estimates.**

## 8 ENSURE GOVERNANCE AND ACCOUNTABILITY

**Objective: 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 structure comprises 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. The NWMO's implementation of a repository as part of APM will eventually be regulated under the *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.

### MEMBERS

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

### BOARD OF DIRECTORS

The Board of Directors is responsible for oversight and taking a leadership role in development of the corporation's strategic direction. The Members elect 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 Aboriginal culture and financial management.

### ADVISORY COUNCIL

The *NFWA* requires that the Board of Directors appoints an Advisory Council to review and comment on the NWMO's work, in triennial reports. In addition to fulfilling its legislated reporting requirements, the Council meets regularly with the NWMO's senior management, closely following the development of the organization's plans and activities, and providing ongoing counsel and advice. At any time, the Council may choose to deliberate in camera. The Board of Directors appointed the Advisory Council in 2002, with membership renewed at regular intervals.

Membership of the Advisory Council represents a broad range of expertise, including geotechnical engineering, chemical engineering, nuclear engineering, engagement, public affairs, nuclear community relations, environment, sustainable development, law, political science, municipal affairs and government relations, Aboriginal relations, Indigenous Knowledge, and community-based research. 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.

## MANAGEMENT SYSTEM

The NWMO operates its integrated management system for activities supporting the long-term management of nuclear waste. As part of its plan to ensure excellence and accountability in governance, the organization maintains certifications to ISO 9001:2008 for quality, ISO 14001:2004 for environment, and CSA Z1000:2015 for health and safety management.

In addition to maintaining conformance to these standards, the NWMO's management system is augmented to meet the requirements of CSA N286-12 Management System Requirements for Nuclear Facilities, which includes nuclear waste facilities. The NWMO's integrated management system ensures the organization is well equipped to implement its vision. The focus on safeguarding people is fully aligned with the CSA N286-12 management system principle that safety is the paramount consideration guiding decisions and actions.

## INDEPENDENT TECHNICAL REVIEWS

The NWMO will continue to seek external expert review of and comment on its technical program. As the technical program moves from research into design, fabrication, and demonstration, the nature of the technical reviews will increasingly focus on specific design aspects and features. The results of these reviews would help guide the technical program and inform NWMO stakeholders.

## PEER REVIEWS

The NWMO will continue to seek opportunities for peer review of its work and to invite independent comment, including the Adaptive Phased Management-Geoscientific Review Group (APM-GRG). 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 APM. 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 and to the public at the same time. The Minister must table the reports in Parliament and issue a statement on each report.

## INTERNATIONAL COMMITMENTS

The NWMO will continue to support Canada's international obligations under 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 next contribute to Canada's reporting at the 2018 and 2021 conventions.

# 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 radioactive 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 radioactive waste** consists of common industrial items that became contaminated with low levels of radioactivity during routine cleanup and maintenance at 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 special radiation protection.

**Optional shallow underground storage facility** would involve building a shallow rock cavern storage facility at the chosen site for the deep geological repository. This is included in Adaptive Phased Management (APM) as an option. This option is not expected to be needed and is not included in the current Implementation Plan.

**Retrievability** is the ability to remove the used nuclear fuel from where it has been placed. Retrievability is an important component of APM and was included on the direction of Canadians. It is part of a risk management approach to allow corrective action to be taken if the repository does not perform as expected or if new technologies emerge in the future that could significantly improve the safety of used fuel long-term management. While used nuclear fuel will be retrievable as part of APM, the process will become progressively more demanding as the used fuel containers are sealed in the placement rooms, and then years later when access tunnels and shafts are eventually backfilled and sealed.

**Safety** in this report refers to 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 removed from a commercial or research nuclear fission reactor. Used nuclear fuel is classified as a high-level radioactive waste.

**Note about terminology:** In this document, we use the terms Aboriginal, Indigenous, First Nations and Métis. Our intention in the writing is to honour and respect people, nations and communities, as well as historical and contemporary understandings.

Share Your Thoughts on

## Implementing Adaptive Phased Management 2018 to 2022

DRAFT FOR PUBLIC REVIEW

1. The draft plan is built around eight strategic objectives. Are the objectives that we have identified appropriate? Have we missed key areas?

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2. The draft plan identifies work and activities we propose to undertake to accomplish these objectives. Have we set out appropriate activities?

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3. The draft plan is intended to anticipate the challenges ahead and plan for them. Over the next five years, what are the key challenges that will need to be addressed?

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4. What will the NWMO need to put in place to respond to these challenges?

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5. Other comments, questions or suggestions?

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Name (optional): \_\_\_\_\_

Organization (if appropriate): \_\_\_\_\_ Date: \_\_\_\_\_

Address: \_\_\_\_\_

Email: \_\_\_\_\_ Tel.: \_\_\_\_\_

Would you like your comments posted on the NWMO website?  Yes  No

Please reply by  
November 30, 2017, to:  
**Lisa Frizzell**  
Vice President,  
Stakeholder Relations



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learnmore@nwm0.ca

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# Implementing Adaptive Phased Management 2018 to 2022

**DRAFT FOR PUBLIC REVIEW  
SEPTEMBER 2017**

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NUCLEAR WASTE  
MANAGEMENT  
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SOCIÉTÉ DE GESTION  
DES DÉCHETS  
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