

# **INTEGRATED STRATEGY** FOR RADIOACTIVE WASTE

Report submitted to Canada's Minister of Natural Resources

June 2023





MANAGEMENT ORGANIZATION

NUCLEAR WASTE SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

## Land acknowledgment

The Nuclear Waste Management Organization (NWMO) acknowledges that we have worked in many different Indigenous territories since the inception of the organization. We are grateful to the Indigenous and municipal communities that have worked with us over the past 20 years.

We further acknowledge that today we are working in northwestern Ontario in the traditional territory of Wabigoon Lake Ojibway Nation with the community of Wabigoon Lake Ojibway Nation and the Township of Ignace.

In southern Ontario, we are working in the traditional territory of Saugeen Ojibway Nation (SON) with the two SON communities – Chippewas of Nawash Unceded First Nation and Chippewas of Saugeen First Nation – and the Municipality of South Bruce.

We further acknowledge that in both the northwest and the south, we have the privilege of working with other First Nations and organizations, with Métis communities and the Métis Nation of Ontario, and many municipal communities that have all expressed an interest in learning about our work.

As part of our commitment to Reconciliation, we recognize both the historic and current injustices far too many Indigenous communities endure. We pledge to do our part to encourage well-being in communities with which we work.

## **Executive summary**

Canada can take a lot of pride in its position as a world leader in the development and deployment of nuclear technologies, a position established over decades and a strong foundation of technical excellence and operational know-how upon which we can build. Now more than ever, nuclear energy is recognized as a vital tool in meeting climate targets, achieving a net-zero emissions economy by 2050 and ensuring a continued safe and secure energy system in the face of global challenges. Achieving these goals successfully depends on more than just having the right technology and resources in place; Canadians and Indigenous peoples want assurance that there is a long-term strategy for the radioactive waste that results.

The Government of Canada already took the important step of modernizing Canada's radioactive waste management framework through publication, in March 2023, of a revised Policy for Radioactive Waste Management and Decommissioning (hereafter referred to as the Policy).<sup>1</sup> As part of the government's radioactive waste management policy review, in fall 2020, Canada's Minister of Natural Resources tasked the Nuclear Waste Management Organization (NWMO) with leading a separate engagement process with Canadians, Indigenous peoples and industry representatives to inform the development of an integrated long-term management strategy for all Canada's radioactive waste, in particular low- and intermediate-level waste for which there are not currently long-term plans in place.<sup>2</sup> The task recognized the NWMO's 20 years of expertise in engaging Canadians and Indigenous peoples on plans for the safe, long-term management of used nuclear fuel. In developing this, the NWMO was asked to provide:

- A description of the current waste management situation in Canada in terms of current and future volumes, taking into account potential small modular reactor waste, characteristics, locations and ownership of the waste;
- An update on current plans and progress in advancing long-term management and disposal solutions for Canada's wastes, as well as the gaps that must be addressed;
- Conceptual approaches for dealing with our current and future radioactive waste inventory, including technical options for long-term management or disposal of the various waste types and options for the number of long-term waste management facilities in Canada; and
- Considerations regarding the staging, integration, establishment and operation of long-term waste management facilities.

This Canadian Integrated Strategy for Radioactive Waste (ISRW) is the beginning of a new era in waste management in Canada. It represents a next step, an evolution in waste disposal in Canada. This strategy is a first for Canada and closes the gaps in waste disposal of all Canada's radioactive waste from current electricity generation and production of life-saving medical isotopes, with an eye to the future.<sup>3</sup>

Since that original tasking, the importance of this strategy has taken on new relevance as new technologies such as small modular reactors are beginning to move forward. These reactors would also produce waste that would have to be safely managed. This strategy has been written with flexibility to incorporate these wastes into the appropriate waste stream using Canada's waste classification: high-level waste, including used nuclear fuel, intermediate-level waste, low-level waste, and uranium mine and mill waste. The strategy has also been developed to ensure respect for Indigenous rights and treaties is foundational to future activities.

This integrated strategy is informed by the Policy, what we heard from our engagement with Canadians and Indigenous participants, and the expert input received from the various studies commissioned during this process. Where the Policy provides direction, this integrated strategy does not duplicate or extend the Policy's mandate. As a result, the draft ISRW recommendations that were published for public review in August 2022 have been modified to reflect Policy direction.

This strategy makes two fundamental recommendations and sets out four implementation principles to ensure Canada has long-term disposal facilities for all its radioactive wastes. The recommendations and implementing principles are as follows and are further defined in this report:

Recommendation 1	Intermediate-level waste and non-fuel high-level waste to be disposed of in a deep geological repository with implementation by the NWMO	
Recommendation 2	Low-level waste to be disposed of in multiple near surface disposal facilities with implementation by waste generators and waste owners	
Implementing principle 1	Consent of the local communities and Indigenous peoples in whose territory future facilities will be planned must be obtained in siting.	
Implementing principle 2	Design of facilities should prioritize the protection of water.	
Implementing principle 3	Long-term caretaking should be established for disposal facilities.	
Implementing principle 4	We need to take action now and not defer to future generations.	

### **Radioactive waste in Canada**

Canada has been a leader in the development and application of nuclear technologies for over half a century, relying on nuclear energy to power communities and supply radioisotopes for nuclear medicine and other innovative research, and valuable industrial applications. These activities create radioactive waste that are classified according to the degree of containment and isolation that is necessary to ensure the safety of people and the environment. In Canada, there are four general classes of radioactive waste:

- High-level waste (HLW);
- Intermediate-level waste (ILW);
- Low-level waste (LLW); and
- Uranium mine and mill waste.

Each class of waste requires its own type of storage and disposal methods commensurate with its shortand long-term risk from the radioactivity and/or heat it generates. All radioactive waste in Canada is safely managed in accordance with international standards at facilities licensed by the Canadian Nuclear Safety Commission (CNSC). However, not all radioactive waste in Canada has long-term disposal plans.

### Gaps in long-term disposal plans for radioactive waste in Canada

The table below represents the approximate volumes and percentage of radioactive waste with no longterm disposal plans that were identified as part of the development of this integrated strategy. This includes both current and projected future waste from existing nuclear facilities. It is important to note that about 84 per cent of the radioactive waste in Canada has an existing long-term waste management plan. Of the 16 per cent of the total radioactive waste that has no long-term waste management plan, 14 per cent is low-level waste, and only about two per cent is intermediate-level waste with less than 0.01 per cent of total volume being non-fuel high-level radioactive waste.

Waste type	Volume (m³)	Percentage of total radioactive waste in Canada			
High-level waste (non-fuel) <sup>4</sup>	<10	<0.01			
Intermediate-level waste	51,000	2			
Low-level waste	294,000	14			
Uranium mine and mill	No gaps – Existing plans in place	_			
Approximately 84 per cent of total radioactive waste in Canada already has long-term waste disposal plans.					

### Table 1: Waste with no long-term disposal plan

### **Technical options and inventories**

Based on an international benchmarking study, the following potential options were identified to address the gaps in long-term waste management plans for radioactive waste specifically for low- and intermediate-level waste in Canada. Rolling stewardship is not a disposal option and does not represent international best practice. However, it was included in the engagement process to provide participants with a range of long-term management solutions (storage and disposal) to best inform the strategy.

### Near surface disposal facility options:

- 1. Engineered containment mound
- 2. Concrete vault
- 3. Shallow rock cavern

#### Deep disposal options:

- 4. Deep geological repository
- 5. Deep borehole

#### Long-term storage:

### 6. Rolling stewardship

The above options were assessed from a technical perspective against the volume and characteristics of the inventories of low- and intermediate-level waste that were provided by the waste generators and waste owners. The volume included projected inventories based on existing CANDU (Canada Deuterium Uranium) reactor fleet and lifecycle assumptions and did not include volume of waste that may be generated from future technologies such Small Modular Reactors (SMR). A further study on <u>cost</u> <u>estimates</u> of implementing the various technical options was also conducted to help with the assessment of various options.<sup>5</sup>

Based on this technical assessment, Canada's low-level waste should be disposed of in the types of near surface disposal facilities mentioned above. However, the engineered containment mound is suitable and most economical for bulk low-level waste such as soil, given the low concentration of radionuclides and the large volume of this type of waste. The concrete vault is suitable for all low-level waste, given the increased containment and structural integrity provided; however, taking economics into account, it is most suitable for non-bulk radioactive waste.

Based on the technical assessment, the disposal options for intermediate-level waste could be a deep geological repository or a deep borehole. However, the most suitable option is a deep geological repository as the deep borehole option was found to be approximately 10 times more expensive per cubic metre, of waste than a deep geological repository. Furthermore, the deep borehole option is only capable of disposing of part of the intermediate-level waste inventory due to its size limitations.

### **Integrated strategy**

Over the course of two years of engagement with Canadians, Indigenous peoples and industry representatives, as well as review of international best practices for optimum technical solutions, the NWMO has developed the following integrated strategy for the various radioactive waste streams in Canada. There are three existing gaps where some low-level, intermediate-level and non-fuel high-level radioactive wastes do not currently have disposal plans.

To address these gaps and consistent with what the NWMO heard from stakeholders and Indigenous peoples and the direction of the Policy, two fundamental recommendations, and four implementation principles have been developed to ensure that Canada has disposal facilities for all its radioactive wastes. The strategy is shown in the table and illustration that follow; it does not replace existing long-term disposal projects currently in progress, but rather includes these plans.

Waste classification	Type of waste	Existing long- term disposal plan	Current responsibility for implementation	Integrated strategy
High-level waste (HLW)	Used fuel	Yes	NWMO	No change – Deep geological repository
	Non-fuel	No	-	Deep geological repository
				Responsibility for implementation of long-term waste disposal plan: NWMO
Intermediate- level waste (ILW)	ILW produced in various nuclear facilities	No	_	Deep geological repository Responsibility for implementation of long-term waste disposal plan: NWMO
	ILW produced at Nuclear Power Demonstration facility and Whiteshell Reactor 1	Yes	Canadian Nuclear Laboratories	No change – In-situ decommissioning
Low-level waste (LLW)	Port Hope historic LLW	Yes	Canadian Nuclear Laboratories	No change – Port Hope Area Initiative
	LLW owned by Atomic Energy of Canada Limited at Chalk River	Yes	Canadian Nuclear Laboratories	No change – Near surface disposal facility
	LLW produced at Nuclear Power Demonstration facility and Whiteshell Reactor 1	Yes	Canadian Nuclear Laboratories	No change – In-situ decommissioning
	LLW produced in various nuclear facilities	No	_	Multiple near surface disposal facilities
				Responsibility for implementation of long-term waste disposal plan: Waste generators/owners
Uranium mine and mill waste <sup>6</sup>	Tailings facilities near point of generation	Yes	Uranium mines and mill tailings companies, and applicable provincial and federal governments	No change – Disposal facilities near point of waste generation

### Table 2: Integrated strategy for all current and projected radioactive waste

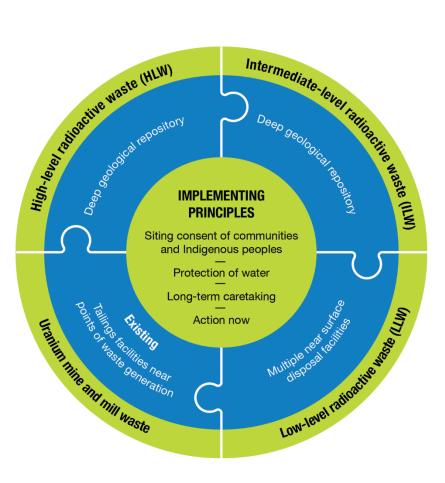


Figure 1: Canada's Integrated Strategy for Radioactive Waste

# Recommendations and principles for implementation of Canada's Integrated Strategy for Radioactive Waste

### **Recommendations**

# RECOMMENDATION 1: INTERMEDIATE-LEVEL WASTE AND NON-FUEL HIGH-LEVEL WASTE TO BE DISPOSED OF IN A DEEP GEOLOGICAL REPOSITORY WITH IMPLEMENTATION BY THE NWMO

- The NWMO, as Canada's leading organization for deep geological disposal, to site and build a deep geological repository for Canada's intermediate-level waste (ILW) and non-fuel high-level waste (HLW), with funding provided by waste generators and waste owners.
- The NWMO to prepare a detailed plan defining the process to select a site for the repository, inclusive of engagement strategy and funding approach, taking into account experience and learnings gained from implementing other siting processes for nuclear facilities. This siting process is separate from the NWMO's work to site Canada's plan for used nuclear fuel.
- This plan is to outline the process to determine the technical and social acceptability requirements for siting a repository, consistent with the Policy, and the implementing principles outlined hereafter.
- This plan is to also include the expected timelines for siting and construction of the repository.
- It is expected that defining the site selection process could take 12 to 18 months, at which point the NWMO will report back to Natural Resources Canada on the approach.

### RECOMMENDATION 2: LOW-LEVEL WASTE TO BE DISPOSED OF IN MULTIPLE NEAR SURFACE DISPOSAL FACILITIES WITH IMPLEMENTATION BY WASTE GENERATORS AND WASTE OWNERS

- Waste generators and waste owners to site and build near surface disposal facilities for those lowlevel waste with no long-term disposal plan, consistent with international best practices, considering characteristics, volume, proximity to the existing interim waste facilities, community acceptance and technical considerations.
- The option of multi-waste producer facilities or centralized regional facilities to also be explored to balance the number of facilities with the distance that the waste would need to be transported. Centralized regional facilities could provide economies of scale and could ensure fair access to disposal facilities for small waste generators. Regional facilities could be provincial, cover multiple provinces or be multiple facilities within one province, depending on several factors such as volume of waste, transportation distances and cost.
- More detailed implementation plans by waste generators and waste owners to be developed in an open and transparent manner, with early and ongoing engagement consistent with the Policy.

### Implementing principles

Based on extensive input from Canadians and Indigenous peoples, the following four implementing principles were highlighted as a priority for any new waste facilities to be developed as part of the strategy; these are further described in Chapter 4.

### IMPLEMENTING PRINCIPLE 1: CONSENT OF THE LOCAL COMMUNITIES AND INDIGENOUS PEOPLES IN WHOSE TERRITORY FUTURE FACILITIES WILL BE PLANNED MUST BE OBTAINED IN SITING.

This consideration was prioritized by the majority of participants in the engagement sessions. Consent of the impacted Indigenous communities is also aligned with Canada's measures taken for the implementation of the *United Nations Declaration on the Right of Indigenous Peoples Act (UNDA)*. This critical consideration extends to all future disposal facilities for radioactive waste. Indigenous communities in siting areas must have early and meaningful engagement and ongoing involvement in all phases of any waste disposal project, regardless of size, through capacity building among Indigenous peoples, information sharing and collaboration.<sup>7</sup> In addition, laws, regulatory processes and Indigenous consultation protocols, developed and implemented in areas where future facilities will be planned, should be respected.

# IMPLEMENTING PRINCIPLE 2: DESIGN OF FACILITIES SHOULD PRIORITIZE THE PROTECTION OF WATER.

The Policy requires that radioactive waste management, including disposal, be carried out in an integrated manner that prioritizes the health, safety and security of people and the environment, which includes water.<sup>8</sup> While safety can be demonstrated from a technical standpoint regardless of location, it may be difficult to obtain societal support for facilities located in close proximity to major sources of drinking water. This was a priority for most participants in the NWMO's engagement processes who felt strongly that waste disposal sites should not be built near sources of drinking water as they felt these could contaminate it and affect their way of life. While participants indicated that facilities should be located away from any major water sources, the reality of the Canadian landscape is that this would not be feasible. Protection of water is paramount, and therefore, any disposal facilities must meet the highest standards of environmental and water protection.

## IMPLEMENTING PRINCIPLE 3: LONG-TERM CARETAKING SHOULD BE ESTABLISHED FOR DISPOSAL FACILITIES.

There should be oversight of the waste and of the facilities for as long as future generations deem it to be necessary to ensure that the environment remains protected. This means that the knowledge of the type of waste, its location and their associated monitoring plans need to be transferred to future generations to determine whether they continue to be adequate or necessary. This is consistent with the Policy, which "recognizes the time frames associated with the management of radioactive waste and the associated obligations to ensure ongoing responsibility of radioactive waste disposal facilities, locations, and sites once closed, so it remains safe and secure for people and the environment in perpetuity".<sup>9</sup> In addition, Indigenous communities with nuclear waste facilities should be part of conversations around land stewardship. This is consistent with expectations on waste generators and waste owners in the Policy to work in partnership with Indigenous peoples to gain a greater understanding of their Indigenous Knowledge and advice with regards to radioactive waste management and decommissioning projects.

# IMPLEMENTING PRINCIPLE 4: WE NEED TO TAKE ACTION NOW AND NOT DEFER TO FUTURE GENERATIONS.

There is a need to have and implement an integrated strategy for all Canada's radioactive waste with a sense of urgency rather than leaving this to future generations. This is consistent with the Policy requirement on waste owners and generators to collaborate with other waste owners or generators on their plans for the advancement, development and implementation of comprehensive and nationally integrated radioactive waste management solutions in a timely manner, and to decommission facilities, locations and sites within an appropriate time frame to reduce the burden on future generations.<sup>10</sup> The implementation of the ISRW will require firm ongoing commitment and support from government, with a structure that will be empowered to deliver on the objectives of the strategy, regardless of changes in government. This urgency to take actions must be appropriately balanced with Canada's commitment to Reconciliation with Indigenous peoples.

### Summary of engagements

In 2021, the NWMO began engaging with waste generators and waste owners and interested Canadians and Indigenous peoples, conducting public opinion research, hosting a summit to hear from diverse voices, listening to citizens in a series of engagement sessions in communities where waste is stored today, hosting roundtable discussions, and organizing technical workshops. In total, the NWMO engaged in over 75 activities offered in a variety of formats (see Figure 2 that follows) over a period from January 2021 to April 2023, with a total of nearly 4,000 participants. The NWMO committed to reporting on the engagement process throughout and created a project hub to make information available to participants throughout the process – <u>radwasteplanning.ca</u>.

### Indigenous engagement

The NWMO is committed to Reconciliation and to ensuring relationships with Indigenous communities are fostered in a meaningful way.

As part of engagement on this integrated strategy, the NWMO sought to gain Indigenous perspectives and recommendations, from those who participated, to foster existing relationships, and create new ones to share thoughts, priorities and concerns. The NWMO humbly acknowledges that while efforts were made to engage on a broad level with Indigenous communities, there were some limitations to comprehensive engagement, including no engagement with Inuit participants. While the term "Indigenous" is used in the report, it encompasses only the First Nation and Métis participants listed in the <u>What We Heard Report – Indigenous Engagement</u>, and comments reflected are not meant to represent these voices as a whole.<sup>11</sup>

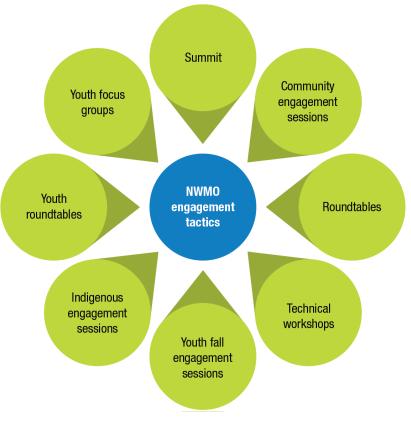


Figure 2: ISRW engagement activities

### Key themes arising from NWMO engagement activities

The following summarizes the key themes that emerged during engagement on Canada's Integrated Strategy for Radioactive Waste.

### **KEY THEME 1 – SAFETY IS PARAMOUNT**

The most prominent theme that emerged throughout the engagement was the importance of safety in every aspect of the development and implementation of the Integrated Strategy for Radioactive Waste. Participants prioritized safety over cost efficiency. As a key priority, safety should be considered through a long-term lens so that the strategy is able to respond to future risks and ensure safety in unpredictable and potentially unstable future conditions in the environment, government, society and technology.

### **KEY THEME 2 – THE TIME TO ACT IS NOW**

There is a need for an integrated strategy, and the approach to the long-term management of low-level and intermediate-level waste should be determined. There was general agreement that it was the right thing to do to have and to implement a plan for all Canada's radioactive waste, and to do so with a sense of urgency rather than leaving this to future generations.

### **KEY THEME 3 – COMMUNICATION AND TRANSPARENCY**

Participants were adamant that clear, fact-based, inclusive communication that provides context in a relevant, accessible and unbiased way is essential. Transparency, including clear, open and ongoing communication about decisions and processes, is very important. Transparency about the waste and any potential risks associated with it is also needed, as is effective communication providing context when necessary. Some participants expressed the importance of having more visibility of waste inventories, as they exist today, and what could be expected in the future.

### **KEY THEME 4 – TRUST AND RELATIONSHIPS WITH INDIGENOUS COMMUNITIES**

Meaningful engagement and ongoing relationship building with Indigenous communities must be central to developing and implementing the plan. Listening to Indigenous peoples is important to restore trust, bridge relationships and affirm the importance of Reconciliation. Ensuring that Indigenous Knowledge was incorporated along with western science was also identified as important to a strategy that would address the far future, as well as more immediate considerations. Participants wanted the strategy to reflect Indigenous communities' right to Free, Prior and Informed Consent and to avoid exploitative practices with respect to Indigenous involvement.

### **KEY THEME 5 – EDUCATION AND ENGAGEMENT**

Full engagement is required to achieve real buy-in for a strategy that will work for people in Canada, and the importance of youth engagement was emphasized. Education is vital to enable potentially impacted people and communities to be appropriately informed, and needs to be further integrated into discussions to help Canadians and Indigenous peoples understand the unique challenges posed by radioactive waste and how safety is assured. Learning from science-based best practices internationally was also identified as an important pathway to ensuring both public safety and cost effectiveness, which are both important, now and in the long term. Youth saw a need for an intergenerational education strategy to cultivate a sense of responsibility for the long-term strategy implementation among young people.

### **KEY THEME 6 – SUSTAINABILITY AND THE ENVIRONMENT**

In addition to the safety of the community and its residents, minimizing the carbon footprint and protecting the environment, in particular water, over the long term were important. Participants shared that we needed to be mindful of the climate emergency to ensure that every aspect of this strategy is sustainable, considers the risks posed by climate change, respects the environment and protects waste sources for all future generations. The goals of minimizing environmental impacts should be viewed through a life cycle approach and include the construction of facilities and transportation of radioactive waste. Participants were acutely aware of the history of environmental racism in Indigenous communities, and environmental justice is a key consideration when discussing how many facilities to build and where.

### **KEY THEME 7 – TRANSPORTATION**

Participants had many questions about the risks associated with transportation and the consequences of transportation accidents on the safety of the radioactive waste being transported, and generally preferred to minimize the transportation of radioactive waste to reduce any associated risks. Other concerns around transportation included cost, potential increase of greenhouse gas emissions and potential environmental impacts from building new access roads. Participant views on the relative risks of transportation influenced their views on having one central repository for low-level waste and for intermediate-level waste, or having multiple disposal facilities closer to where the waste is produced. There was an expressed desire to be included in plans for transportation in traditional territories.

# KEY THEME 8 – SHARED RESPONSIBILITY FRAMEWORK/INDEPENDENCE OF ACCOUNTABLE ENTITY

There were varying perspectives regarding who should be responsible for the oversight of the strategy. There were differences of opinion about the role of industry, but there was general agreement that there should be a single entity with appropriate expertise that is independent from the implementers, subject to regulated safety and environmental oversight. The governance of such an entity was subject to different ideas, with some suggesting that the oversight governance should be comprised of industry, civil society organizations, and Indigenous peoples, and others focusing on ensuring the oversight remained independent and included the right expertise. There was broad support for the waste owners to finance the strategy.

### **KEY THEME 9 – ROLLING STEWARDSHIP AND WASTE DISPOSAL**

A majority supported the idea of finding solutions to permanently dispose of the waste now, and not leaving the decision for future generations. Uncertainty about climate change, and whether changes to government or society in the long term could leave waste vulnerable under indefinite storage arrangements were some of the concerns that were cited. Participants wanted to see intermediate-level waste treated the same as high-level waste and disposed of in a deep geological repository. However, there were others that saw rolling stewardship as the preferred strategy, in particular for low-level waste, because of considerations such as potential future technology innovations, ensuring that the waste was not forgotten, and the ability to constantly monitor the waste to ensure that any environmental impacts could be identified and remediated before causing significant harm, especially to the water table.

### **KEY THEME 10 – COLLOCATION AND CENTRALIZATION**

There was a range of responses from participants who felt minimizing the number of facilities could have advantages. Participants acknowledged the difficulty in finding willing and informed host communities, and obtaining the Free, Prior and Informed Consent of Indigenous peoples made multiple sites more challenging. However, there were concerns about the impact of a single location on the transportation of waste. Some participants cautioned about the importance of ensuring appropriate technical arrangements for different waste types located in the same facility, while others noted the cost advantages of consolidating expertise and facilities in a single location.

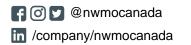
The majority preferred using a centralized facility for intermediate-level waste to enable greater control and oversight over its long lifespan, with potential cost and time savings. Centralizing intermediate-level waste was seen as preferable to limit potential risk exposure to one location instead of potentially endangering multiple ecological zones. The idea of collocation and centralization was more broadly supported for intermediate-level and high-level waste, than it was for low-level waste and intermediate-level waste. The volumes of low-level waste are greater, and participants generally felt that leaving it nearer to the sites where it was generated or stored, rather than transporting it vast distances, was preferable. Regardless of the option preferred, community willingness was identified as a pillar for any disposal facility.

### **KEY THEME 11 – A STRATEGY BY AND FOR CANADIANS AND INDIGENOUS PEOPLES**

It was clear that participants want this to be a strategy created by and for Canadians and Indigenous peoples and that this is key to have buy-in. An inclusive strategy is a reflective strategy. In addition, the ISRW should consider the unique conditions and environment of Canada, including the size of the country, the diversity of Canadians and Indigenous peoples, and the changing climate.

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