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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Canadian Nuclear Laboratories

Integrated Waste Strategy










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CNL acknowledges that its operations across Canada occur on the unceded, traditional territories of Indigenous Peoples, and we recognize the unique history, spiritual beliefs, cultural practices and languages of these communities. We are also firmly committed to being an active participant in Canada's journey on the road towards healing and reconciliation.

EXECUTIVE SUMMARY

The Canadian Nuclear Laboratories (CNL) Integrated Waste Strategy presents the guiding framework for the lifecycle strategies for the management of all types of waste at CNL-operated sites across Canada. The scope of the Integrated Waste Strategy includes the strategies for clean, hazardous, and radioactive wastes (solid and liquid) that have been generated and are in storage, and wastes that will be generated in the future. The CNL Integrated Waste Strategy seeks to answer three key questions in regard to waste management approaches:

1. Where are we today?
2. Where do we want to get to?
3. What actions are needed to get there?

The wastes that CNL manages are the result of over 75 years of pioneering work by Atomic Energy of Canada Limited (AECL), and now CNL. From this work, scientific breakthroughs and contributions have resulted in positive impacts for Canadians and people across the world. The by-product of this work at CNL sites to advance clean energy and contribute to health sciences is the clean, hazardous, and radioactive waste that CNL is committed to managing safely. CNL is recognized as a leader in implementing solutions for some of Canada's largest environmental challenges. The CNL priority to restore and protect Canada's environment is realized through the cleanup (decommissioning and environmental remediation), and waste management work that is currently ongoing. These experiences and existing waste management capabilities create the foundation for where we are today and support development of optimal and sustainable strategies going forward.

Looking forward, CNL recognizes that waste management decisions need to be guided by core principles, by science and innovation, and by learning from others through collaboration and engagement. For the CNL Integrated Waste Strategy, there is a clear focus on holistic waste lifecycle solutions, which recognize and reflect the inherent flexibility required in strategic decision-making. The lifecycle focus prioritizes minimizing the burden on future generations, and CNL is positioned as the Canadian leader in transitioning from rolling stewardship (continued storage) approaches for radioactive waste management to final disposal solutions. The CNL Near Surface Disposal Facility is the key example of this, and as a LLW disposal facility, this proposed Facility would enable the remediation and clean-up of legacy wastes and affected lands by providing a safe, monitored disposal solution. The lifecycle focus also results in the need for new capabilities and facilities, which will be used to retrieve, characterize, process, package, and store waste leading up to disposal. These new capabilities and facilities represent a key element of the strategy of where we are going.

CNL is committed to developing strong relationships with Indigenous Peoples. This is cultivated through fostering meaningful opportunities for dialogue and participation. At CNL, there is clear recognition of the important role that Indigenous Peoples perform in Canada and appreciation of the responsibilities that they have as stewards of the environment. The journey involves listening and learning, and CNL encourages Indigenous participation to help identify how CNL can incorporate Indigenous knowledge in waste management projects and activities in the future. This collaboration represents a key element of how CNL will realize elements of this Integrated Waste Strategy and the overall CNL waste strategy.

The CNL Integrated Waste Strategy is a summary-level document that consolidates the detailed plans from various teams across CNL. It serves as a communication tool, a planning tool, and a decision-making tool. The CNL Integrated Waste Strategy *reflects* waste management decisions, activities, and projects, and *informs* future decisions about lifecycle plans. The CNL Integrated Waste Strategy remains a document that will be periodically updated to reflect CNL's progress on key actions and define upcoming strategic priorities and supporting activities.

EXECUTIVE SUMMARY

Class of Waste		Key Elements of the Strategy	Lifecycle Disposition Pathways
Clean Waste	Waste Hierarchy	• Implementing radiological and hazardous substances clearance processes for impacted or potentially impacted materials to enable the disposal of non-radiological and non-hazardous wastes • Increase recycling opportunities as available	Reuse, recycling, or disposal through third-party (off-site) facilities
Hazardous Waste (Non-Radiological)		• Characterizing wastes for handling, storage, transportation and/or further processing • Implementing radiological clearance processes for impacted or potentially impacted materials • Ensuring that compliance with regulations provides the foundation for lifecycle management processes	Reuse, recycling, processing and/or disposal through third-party (off-site) facilities
Radioactive Low-Level Waste (Solid)		• Characterizing wastes for radiological and non-radiological contaminants for handling, storage, transportation and future disposal • Processing and packaging to meet storage, transportation and disposal requirements • Implementing waste diversion approaches to minimize waste volumes requiring storage or disposal • Consolidating waste at CRL • Time-phasing waste generation from cleanup work (decommissioning and environmental remediation) • Utilizing existing infrastructure and assets where suitable • Developing and implementing new capabilities (facilities and technologies) for optimized lifecycle management and enabling future clean-up work • Incorporating industry best practices and innovations as part of a fit-for-use approach at CNL • Driving continuous improvement to improve safety, effectiveness and efficiency	• LLW disposal in the proposed Near Surface Disposal Facility • Long-term management in the Port Granby and Port Hope Long-Term Waste Management Facilities • In-situ disposal for the NPD and WR-1 Facilities
Radioactive Intermediate-Level Waste (Solid)			• Disposal in the recommended national Deep Geological Repository for Canadian ILW • In-situ disposal for the NPD and WR-1 Reactors
Radioactive High-Level Waste (Solid)		• Developing and implementing new capabilities (facilities and technologies) for retrieval, processing, storage, and transportation to accelerate the remediation of legacy facilities • Consolidating waste at CRL • Conditioning and stabilization of research reactor fuels to meet disposal Waste Acceptance Criteria	Disposal in the Nuclear Waste Management Organization's Deep Geological Repository for Used Fuel
Radioactive Liquid Waste		• Characterizing wastes for radiological and non-radiological contaminants • Optimizing the amount of wastes that are treated and compliantly discharged • Minimizing secondary wastes and post-processed waste from Radioactive Liquid Waste treatment • Utilizing existing infrastructure and adding new capabilities/facilities for Radioactive Liquid Waste	• Solidified waste to be managed as LLW or ILW • Discharge of treated liquids verified to meet effluent discharge limits

EXECUTIVE SUMMARY

Focus Action	Summary of Actions	Targeted Waste Class
Lifecycle Plans	Improve and optimize lifecycle plans with a focus on: • Transitioning from storage framework to disposal frameworks for radioactive wastes • Detailed lifecycle mapping of waste for discrete projects/programs • Minimizing the potential for re-work with a focus on creating "disposal ready" waste packages	All
Indigenous Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with Indigenous Peoples on the overall strategy and discrete projects.	All
Stakeholder Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with internal (CNL) and public stakeholders.	All
Sustainability	Track CNL's performance against key sustainability measures for waste management to identify, evaluate and implement continuous improvement actions.	All
Waste Forecasts	Continue to improve and optimize the CNL-wide Waste Forecast data based on improved characterization data and time-phased profiles.	All
Clean Waste Disposal	In collaboration with surrounding communities, establish long-term disposal solutions (e.g., landfill/capacity expansions) to enable the disposal of non-radiological waste.	Clean
CRL Enabling Facilities for Nuclear Liabilities	Progress the planning and implementation of the following enabling facilities/capabilities: • Environmental Remediation (including Groundwater Processing) • High-Level Waste (HLW) Conditioning • HLW & Intermediate-Level Waste (ILW) Storage • ILW and Low-Level Waste (LLW) Processing • Radioactive Liquid Processing System(s) • Retrieval Systems for legacy HLW and ILW • Transportation Package (Cask) Handling • Tritiated Heavy Water Management • Utility and Security Infrastructure Enhancement	LLW, ILW, HLW, Radioactive Liquids
ILW Disposal	Drive CNL's evolution from processing and packaging for *storage* to processing and packaging for *disposal*, while evolving CNL's plan to align with the national Integrated Strategy for Radioactive Waste.	ILW
In-Situ Disposal	Complete the regulatory approval processes for the in-situ disposal of the NPD and WR-1 Reactors, and implement the in-situ decommissioning approach.	LLW and ILW
LLW Disposal	Complete the regulatory approval process for the Near Surface Disposal Facility at the CRL site and begin construction.	LLW
Waste Certification	Improve and optimize the CNL waste assurance processes to include a Waste Certification process for disposal readiness.	LLW and ILW
HLW Disposal	Evaluate and confirm the approach/strategy to convert research reactor fuels and other enriched fuels into a configuration to meet the Waste Acceptance Criteria for the planned national Deep Geological Repository.	HLW

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Chalk River Laboratories Main Campus Aerial View

1. INTRODUCTION

1.1 PURPOSE

The Canadian Nuclear Laboratories (CNL) Integrated Waste Strategy provides the framework for the lifecycle management of all types of waste at all CNL-operated sites across Canada. The overarching goals of the CNL Integrated Waste Strategy are to:

- Ensure integration of the management of waste across CNL-operated sites;
- Define optimal routes for all CNL-managed wastes using a lifecycle approach;
- Identify and enable waste management opportunities and efficiencies; and
- Enable the safe and effective reduction of Atomic Energy of Canada Limited's (AECL) waste liabilities.

The CNL Integrated Waste Strategy aims to answer three important questions:

1. Where are we today?
2. Where do we want to get to?
3. What actions are needed to get there?

The CNL Integrated Waste Strategy is a document that summarizes CNL's waste management lifecycle plans, recognizing the overall CNL waste strategy includes discrete projects and plans. The Integrated Waste Strategy is also used to both *reflect* and *inform* decisions related to managing waste across CNL. The Integrated Waste Strategy is a communication, planning, and decision-making tool.

Figure 1-1: CNL's Waste Strategy

CNL is operated under the Government-Owned, Contractor-Operated (GOCO) model. Waste is considered a liability, which is owned by AECL, as a representative of the Government of Canada. CNL is the operator, which is responsible for developing and implementing safe and effective strategies and approaches for waste management. AECL provides technical and performance oversight for all CNL activities, and the two organizations work closely together to implement the lifecycle approach for waste management at sites across Canada that AECL is responsible for.

AECL owns the waste. CNL manages waste. AECL and CNL are both committed to safety and efficiency for the waste management lifecycle.

1. INTRODUCTION (continued)

1.2 SCOPE

The CNL Integrated Waste Strategy includes the framework for the management of the following types of waste (see Glossary for full definitions):

- Clean Waste (Conventional, Non-Hazardous, Non-Radioactive)
- Hazardous Waste (Non-Radioactive)
- Radioactive Solid Waste
    - Low-Level Radioactive Waste (LLW), including Mixed LLW
    - Intermediate-Level Radioactive Waste (ILW), including Mixed ILW
    - High-Level Radioactive Waste (HLW)
- Radioactive Liquid Waste

Environmental effluents, including liquid and gaseous effluents, are not considered waste and are out-of-scope for this Integrated Waste Strategy.

The CNL Integrated Waste Strategy is a living document that is reviewed and updated as process and significant project changes are implemented, and waste routes are optimized or, as a minimum, every five years.

1.3 WASTE STRATEGY GUIDING PRINCIPLES

In establishing and optimizing strategies for waste management, CNL makes decisions that are guided by science and aligned to values and principles. The following statements, which were developed through various engagements throughout 2022, represent the Waste Strategy Guiding Principles and Objectives to inform strategic and technical decisions:

1. **Demonstrated excellence in safety performance**, in terms of worker safety, safety of the public, and protection of the environment, both now and in the future.
2. **Transparency and meaningful engagement of stakeholders, knowledge holders, and rights holders**, including CNL employees, the Canadian Nuclear Safety Commission (CNSC), Indigenous Peoples in Canada, and public stakeholders.
3. **Minimized burden on future generations** through accelerated nuclear liability reduction initiatives and timelines, and a focus on permanent disposition of wastes.
4. **Optimized efficiency in the management of waste materials**, with a focus on waste minimization, and underpinned by deliverable technical strategies and plans resulting in consolidated ‘fit for purpose’ capabilities and facilities.
5. **Strategic alignment with CNL’s Sustainability planning and targets**, including the pursuit of opportunities for carbon reduction and climate resilience, as well as minimization of environmental impacts.
6. **Technical alignment to the Nuclear Waste Management Organization (NWMO)-led Canadian Integrated Strategy for Radioactive Waste**, as part of Canada’s Radioactive Waste Policy Review.
7. **Technical and strategic alignment with domestic and international best practices**, with adaptations of relevant good practices to align with the Canadian regulatory and social environment, and inclusive of the CNL-specific challenges, constraints and drivers.
8. **Optimized total lifecycle strategies**, based on deliverable technical strategies, baselines, and plans in alignment with CNL’s current and future missions.
9. **Optimized value for money for Canadians**, in terms of both project costs and lifecycle liability impacts, with full recognition of how money spent will benefit CNL, the surrounding communities, and the people of Canada.
10. **Optimized alignment to other CNL Programs and Missions**, including the pursuit of new Science and Technology initiatives, new facilities, and new programs of work.

1. INTRODUCTION

1.4 SITE OVERVIEWS

For more than 75 years, Atomic Energy of Canada Limited (AECL), and now CNL have operated sites to establish Canada as a world leader in nuclear science and technology. During that time, some profound benefits on a national and global scale have been realized including the use of Canada Deuterium Uranium (CANDU) reactors to help Ontario transition away from coal as a source of electricity and the use of medical isotopes from the National Research Universal (NRU) reactor and the National Research Experimental (NRX) reactor at the Chalk River Laboratories (CRL) site that have improved the health of an estimated one billion people over 60 years. From the beginning, AECL - and now CNL – studied and improved the way that nuclear waste is stored with a priority on the safety of workers, the public, and the environment.

As of 2023, only the CRL site has an enduring operational mission of nuclear science and technology. All of the other CNL-operated sites are undergoing cleanup, which includes facilities decommissioning and environmental remediation; all of which generates clean, hazardous and radioactive waste that must be managed. The work at the Port Hope Area Initiative (PHAI), Whiteshell Laboratories (WL) , Nuclear Power Demonstration (NPD), Douglas Point (DP), Gentilly-1 (G-1), Northern Transportation Route (NTR) and La Prade sites represents some of the largest and most complex cleanup projects in Canada. Each of these sites are summarized in the subsequent sections, recognizing the shared commitment to environmental stewardship and responsible waste management.

Chalk River Laboratories

Located in eastern Ontario, the CRL site is Canada's largest science and technology complex. The CRL site is approximately 9,000 acres and has been in operation for over 75 years. The CRL site has been identified as the only CNL-operated site with a long-term enduring mission.

The CRL site has an extensive history of nuclear science and technology activities. These activities formerly included the production of radioisotopes used to treat or diagnose over 20 million people in 80 countries every year. The CRL site has an enduring science and technology mission, with focus on:

- Advancing Clean Energy (Small Modular Reactors, Hydrogen Technologies, Reactor Sustainability, and Advanced Fuels)
- Advancing and Supporting Nuclear Health Sciences (Nuclear Medicine, Radiopharmaceuticals, and Radiation Research)

The nuclear science and technology activities at the CRL site have led to the production of radioactive and other hazardous wastes. Such wastes have been carefully managed at dedicated areas, such as waste management areas, since the 1950s in alignment with relevant good practices of the time. While the majority of the CRL site remains undisturbed, certain areas, including the waste management areas have been contaminated to varying degrees. As there remains a significant amount of buried waste, soil contamination and groundwater contamination exists. Therefore, remedial actions are required to reduce risks to the environment. This decommissioning and remediation mission, otherwise known as the Clean-up Mission, at the CRL site has included the safe decommissioning and demolition of over 110 structures and facilities since 2015, with a future scope of work planned over the next 60 years.

Responsible decommissioning and radioactive waste management is necessary in order to clean up the CRL site, protect the environment, and make way for new buildings that will support the ongoing nuclear science and technology mission at the CRL.

1. INTRODUCTION

1.4 SITE OVERVIEWS

Port Hope Area Initiative

Located in southern Ontario, the Port Hope Area Initiative (PHAI) represents the Government of Canada's commitment to clean-up and safely manage historic low-level radioactive waste currently located in the municipalities of Port Hope and Clarington. The PHAI is a community-recommended solution to a longstanding environmental issue that is being carried out as two projects – the Port Hope Project and the Port Granby Project:

- The Port Hope Project involves the cleanup of approximately 1,200,000 m^3 of historic low-level radioactive waste from sites located in Port Hope, the construction of the Port Hope Long-Term Waste Management Facility, and the long-term monitoring and maintenance of the new facility. The primary goal of the Port Hope Project is to return remediated sites to their pre-construction state or to a better condition, with a vision of creating areas for recreational uses such as walking trails and a lookout point.
- The Port Granby Project is an initiative for the safe, long-term management of historic low-level radioactive waste located in the Municipality of Clarington. Historic low-level radioactive waste was relocated from an existing waste management facility on the shoreline of Lake Ontario, to the new Port Granby Port Hope Long-Term Waste Management Facility. The historical facility was remediated in 2020, and the purpose-built Port Granby Port Hope Long-Term Waste Management Facility was capped and closed in 2021. This Facility provides safe long-term management of approximately 800,000 m^3 (1.3 million tonnes) of historic waste, with no intent for future retrieval.

1. INTRODUCTION

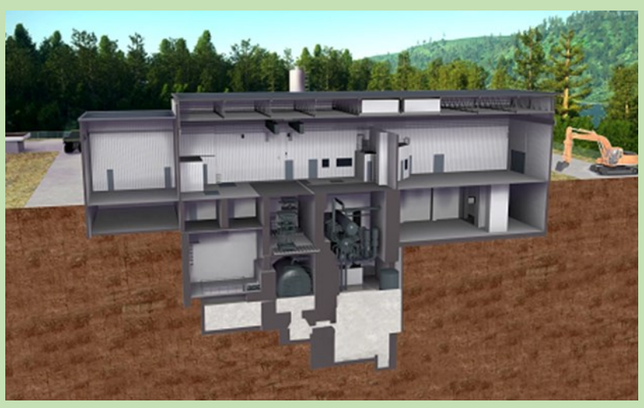
1.4 SITE OVERVIEWS

Whiteshell Laboratories

Located in eastern Manitoba, Whiteshell Laboratories (WL) is an 11,000 acre former research site that is currently being decommissioned and remediated. The WL site is the second largest of AECL's sites operated by CNL. It was established in 1963, with a focus on the largest organically cooled, heavy water moderated nuclear reactor in the world, the WR-1 Reactor. The WL site includes various non-nuclear buildings and nuclear facilities, including the Shielded Facilities, as well as a radioactive waste management area and storage canisters for used fuel awaiting consolidation to CRL. Several buildings and facilities, such as the Active Liquid Waste Treatment Centre and Decontamination Center have been safety decommissioned. Since 2003, the focus at WL has been on the cleanup mission while continually protecting the environment.

Nuclear Power Demonstration

Located in eastern Ontario, the Nuclear Power Demonstration (NPD) reactor is a shut-down reactor, which was Canada's first nuclear power reactor to supply electricity to the electrical distribution grid. Operations started in 1962, and NPD served as an important training facility for reactor engineers and operators. Following shutdown of the reactor, the fuel and power generating equipment was removed from the site and transferred to the CRL site. The NPD site currently consists of a limited number of structures and several temporary structures which are being added to support the decommissioning project work.



CNL has proposed to decommission the WR-1 and NPD Reactors through an in-situ disposal process where the end state is to encase radioactivity in a stable, proven form to allow for continued decay with long-term care and maintenance activities for an agreed period. In-situ disposal has been used successfully at a number of nuclear sites worldwide.

Through in-situ disposal, the remaining reactor components and systems remain underground inside the thick concrete foundation structure which is then filled with grout and the current above ground structures demolished. The grouted structure would then be capped with concrete and covered with an engineered barrier.

This approach minimizes the risks to the health, safety and security of the public, workers and the environment. The resulting below-grade structure would be monitored until the radioactive levels reach background levels.

1. INTRODUCTION

1.4 SITE OVERVIEWS

Douglas Point

Located in southwestern Ontario, the Douglas Point Facility is comprised of the reactor building, service building, turbine building and administration wing, an area for storing concrete canisters containing used nuclear fuel and several outbuildings. The Douglas Point reactor, which is permanently shut down and partially decommissioning, is 200-megawatt electric prototype CANDU reactor.

The Douglas Point Waste Facility is located on the Bruce Power nuclear site. Lifecycle decommissioning plans for the reactors are currently being developed and would be subject to review and acceptance by the Canadian Nuclear Safety Commission.

Gentilly-1

Located on the southern Quebec, Gentilly-1 is a shutdown prototype nuclear reactor that was operated from 1972 to 1977. The reactor was a prototype 250-megawatt (equivalent) boiling light water power reactor built as a joint project between Hydro-Québec and AECL in order to advance reactor technologies.

The Gentilly-1 reactor is currently in a 'safe shutdown state'. This means that the reactor is not operating, fuel has been transferred from the reactor to storage canisters on-site (awaiting consolidation to CRL), and the facility is being left in place to allow for radioactive decay. Lifecycle decommissioning plans for the reactors are currently being developed and would be subject to review and acceptance by the Canadian Nuclear Safety Commission.

Northern Transportation Route

Located in the Northwest Territories and northern Alberta, the Northern Transportation Route (NTR) is an initiative to clean up small quantities of uranium-impacted soil that resulted from spillage during the past handling of uranium ore at points along the 2,000 kilometre route of waterways and portages between Port Radium and Fort McMurray.

Formal investigations were conducted and NTR sites with higher radiation levels were cleaned up from the 1990s to 2011. Through the NTR initiative, remaining uranium-ore spillage would be collected and transported south to appropriate licensed storage facilities in Alberta.

La Prade

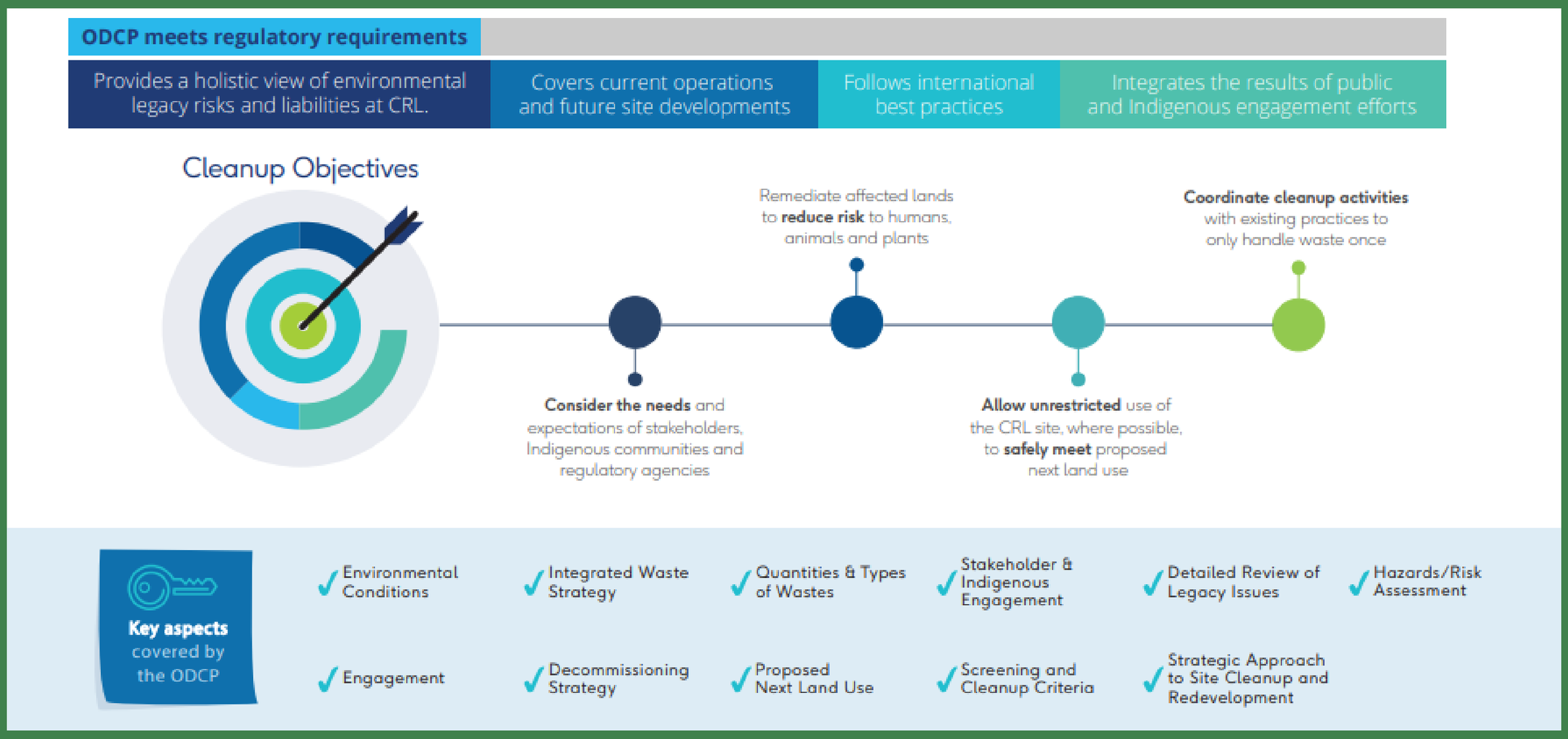
Located near the Gentilly-1 site in south-central Quebec, the La Prade site is used to store an AECL-owned inventory of heavy water. The La Prade site would be closed once the inventory of heavy water is consolidated at the CRL site.

CRL's Overview Decommissioning and Cleanup Plan

The Overview Decommissioning and Cleanup Plan (ODCP) provides the holistic and strategic approach to cleanup in support of revitalization efforts under way at CRL. These revitalization efforts are leading to the creation of an open campus environment dedicated to world-class research and development in nuclear science and technology. The plan provides an overview of the future redevelopment opportunities created by decommissioning and removing obsolete buildings and infrastructure within the built up area of the site. It highlights the framework for several new facilities that would be required as part of CNL's commitment to growing the research conducted at CRL and outlines the environmental remediation efforts underway to reduce and effectively manage Canada's nuclear liabilities.

At CRL, the Overview Decommissioning and Cleanup Plan and Integrated Waste Strategy are complementary plans The Overview Decommissioning and Cleanup Plan highlights several additional essential enabling facilities, capabilities and factors that are required for effective cleanup of the CRL site. Many of these new enabling facilities are related to waste management, with the recognition that CNL needs the facilities and capabilities to enable the lifecycle management of radiological waste liabilities across the CNL site.

The Overview Decommissioning and Cleanup Plan presents an overview of the decommissioning and remediation strategy, and a summary of environmental conditions across the site detailed by each Management Unit. The Management Units consist of groupings of historical waste management areas, support facilities, and experimental research installations.



In support of the Overview Decommissioning and Cleanup Plan, the CRL Community Advisory Panel was established in 2021 to create a forum to bring new voices from the community into the dialogue between CNL and the surrounding communities. Through the Community Advisory Panel , CNL aims to increase understanding, grow our appreciation of our communities' diverse perspectives, and enable members of the community to access first-hand knowledge about CNL activities.

While the focus of the Community Advisory Panel is on decommissioning and remediation of the CRL site, the engagement continuously incorporates considerations for waste management.

1. INTRODUCTION

1.5 WASTE INVENTORY AND FORECAST

The key to the systematic development of the CNL Integrated Waste Strategy depends upon an accurate base of information that describes the quantities and characteristics of the wastes that have been generated (inventory) and the waste that will be generated (forecast) [IAEA, 2016]. More detailed definitions of these distinct elements are outlined below:

Waste Inventory: *Waste data that reflects generated (existing) waste. The data may include parameters such as volume, mass, and chemical, radiological and physical characteristics.*

Waste Forecast: *Projection/estimation of future waste data such as volume, mass, and chemical, radiological and physical characteristics that is based on one or more of actual analyses of the waste, process knowledge (e.g., waste origin), internal and external Operating Experience, knowledge of waste processes to be employed, and calculations.*

The waste inventory and forecast represents a quantification of the scope of the CNL waste management lifecycle. The forecast, like any type of estimate is subject to a range of uncertainty aligned with the extent and accuracy of characterization activities and level of planning and design detail that have been completed to-date. There is specific focus on tracking radioactive waste inventories and forecasts due to the unique challenges and regulatory requirements for radioactive waste management. The subsequent tables present a summary of CNL's existing waste inventories and lifecycle forecast, with solid radioactive waste volumes aligned with the most recent public reporting by AECL. These inventories and forecasts will continue to be updated and publicly shared through Natural Resources Canada, as well as other CNL documentation.

Table 1-4.1: Existing Inventory of Waste Across CNL (as of 2022)

Class of Waste	Type of Waste (m^3)					
	Non-Radioactive		Radioactive			
	Clean	Hazardous	LLW	ILW	HLW	Liquids
Chalk River	200,000*	10,000*	350,476	5,830	143	3,500
Douglas Point	0	0	62	6	89	0
Gentilly-1	0	0	1	2	13	0
La Prade	0	0	0	0	0	500
Northern Transportation Route	0	7,800	0	0	0	0
NPD	0	0	2,289	389	0	0
Port Hope Area	0	0	1,572,781	0	0	0
Whiteshell	60,000	500	20,515	989	29	30
TOTAL	260,000	10,500	1,946,124	7,216	274	4,030

The CRL Clean and Hazardous Waste Inventories reflect planning assumptions from over 75 years of operations and are subject to change based on upcoming site assessments and investigations.*

Table 1-4.2: Lifecycle Waste Forecast including Current Inventories

Class of Waste	Type of Waste (m^3)					
	Non-Radioactive		Radioactive			
	Clean	Hazardous	LLW	ILW	HLW	Liquids
Chalk River	1,100,000	10,000 (5,000 – 50,000)	829,922 (600,000 – 900,000)	6,432 (5,000 – 12,000)	143	12,000/year*
Douglas Point	70,000	0	731 (500 – 1,000)	264 (200 – 400)	89	<10/year
Gentilly-1	67,000	0	908 (600 – 1,000)	319 (300 – 500)	13	<10/year
La Prade	0	0	0	0	0	0
Northern Transportation Route	0	7,800	0	0	0	0
NPD	n/a	0	2,289	389	0	0
Port Hope Area	n/a	0	2,083,000 (Up to 2,300,000)	0	0	150,000/year **
Whiteshell	77,000	2,000	45,217 (28,000 – 80,000)	1,435 (1,000 – 1,800)	29	<100/year
TOTAL	1,314,000	19,800 (14,000 -60,000)	2,962,067 (2,714,000 – 3,284,000)	8,839 (6,500 – 14,400)	274	n/a

At CRL, over 95% of the Radioactive Liquid Waste Forecast is projected to be leachate from the proposed Near Surface Disposal Facility Waste Water Treatment Plant. *
At Port Hope, over 99% of the Radioactive Liquid Waste Forecast will come be leachate treated at the Port Hope and Port Granby Waste Water Treatment Plants. **

Figure 1-4: CNL Managed Sites Map

1. INTRODUCTION

1.5 PROGRESS ON CNL'S PREVIOUS WASTE STRATEGY ACTION PLAN

Table 1-5: Process Summary of Key Actions for Previous Revision of the CNL Integrated Waste Strategy

Key Action from Previous Revision (2019)	Progress Summary
Continuing to update and refine waste inventory and forecasting.	CNL has refined and updated the CNL-wide waste forecasts based on a) new characterization data, b) reviews of historical data, and c) revised time-phasing based on plans, opportunities, constraints, and risks.
Continuing to develop characterization program and technical improvements.	CNL has expanded it's capabilities for waste characterization, including improved internal governance and standards, new approaches and procedures (such as the Waste Characterization Handbook), new technologies, and the new CRL Waste Characterization Facility.
Continuing to identify and improve transport capabilities across CNL.	CNL has procured, licensed, fabricated, and commissioned over twenty new Type B Transportation Packages to safely transport ILW, as well as the associated on-site transfer and handling equipment. CNL has completed the licensing of the Used Fuel Transportation Package for select fuel types to support the consolidation of the WL fuel inventory at the CRL site. CNL has also continued to demonstrate it's commitment to excellence through safe and compliant execution of LLW and ILW transportation operations, and repatriation programs.
Identifying planning and technical gaps across the ERM program.	CNL has made significant progress in developing strategies for the various types of waste that had planning/technical gaps that were identified in 2019. Areas of significant development from 2019-2022 included work on tritiated heavy water; legacy used fuel and co-stored ILW retrieval and processing approaches; enhanced capabilities and capacities for transportation and storage capabilities for LLW, ILW and HLW; and LLW characterization and processing.
Identifying and implementing processing capabilities for LLW requiring additional processing to enable it to meet the proposed Near Surface Disposal Facility Waste Acceptance Criteria.	CNL designed, licensed, commissioned and is currently operating the new Sort and Segregation Facility at the CRL site (Appendix C). CNL has also initiated a project to establish another processing facility (Waste Processing and Reduction Facility) to complement the Sort and Segregation Facility.
Ensuring sufficient LLW storage capability is maintained at CRL prior to proposed Near Surface Disposal Facility availability.	CNL has established and implemented a Near Surface Disposal Facility monitoring and mitigation strategy. This includes tracking actual rates of LLW generation against forecasts, and the LLW storage capacity available prior to the Operational Phase of the Near Surface Disposal Facility. Increased CRL storage capacities are in development.
Defining and implementing an ILW strategy which focuses on producing waste which is ready for disposal.	CNL has established and initiated the implementation of a multi-faceted ILW retrieval, processing and storage strategy, which utilizes reconfigured existing assets along with plans for new approaches and infrastructure.
Identifying and implementing liquid waste processing capability at CRL to meet future CNL needs.	CNL has initiated the Tritiated Heavy Water Management Program, including the progression of the design of the Heavy Water Detritiation Facility Project. CNL has also progressed the Stored Liquid Waste Project's Hazard Reduction System and updates to the CRL Waste Treatment Centre.
Expanding HLW dry storage capability at CRL in a phased manner.	CNL has completed the Phase 1 expansion of the existing CRL Waste Management Area for used fuel storage in concrete canisters. Phase 2 expansion is currently underway.
Implementing a program of work to ensure HLW meets the NWMO used fuel Deep Geological Repository Waste Acceptance Criteria.	CNL initiated the Shielded Facilities Program and progressed the options analyses processes to identify required capabilities and capacities to convert HLW into a disposal-ready configuration.

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

The CNL Waste Management Function provides oversight of waste management activities at all CNL-operated sites and has responsibility to ensure that all CNL waste-related activities throughout the Waste Management Lifecycle (Figure 2-2) follow a consistent waste management process that protects the workers, the public, and environment, and remains complaint with applicable regulatory and licensing requirements. The Waste Management Function helps waste generators and waste receivers to demonstrate and document the commitment to environmental stewardship by maintaining a high level of quality and excellence in all CNL activities in a work culture that prioritizes safety and fosters continual improvement.

2.1 CLASSIFICATION OF WASTE

In general alignment with international and domestic regulatory guidance, CNL classifies waste as non-radioactive waste consisting of "clean" or conventional waste and hazardous waste, as well as radiological wastes, which is subdivided into three classes: LLW, ILW, and HLW. HLW is also commonly referred to as irradiated fuel or used fuel. Although Canadian standards acknowledge that LLW can be subdivided further to include Very Low-Level Waste (VLLW), CNL incorporates VLLW as part of LLW rather than as a separate waste stream to be managed. A sub-class of each of the three classes of radioactive waste are Mixed Wastes, which include hazardous constituents. Radioactive Liquid Wastes are not a separate class, but have been broken out separately in this Integrated Waste Strategy.

Table 2 -1: Classification of Waste

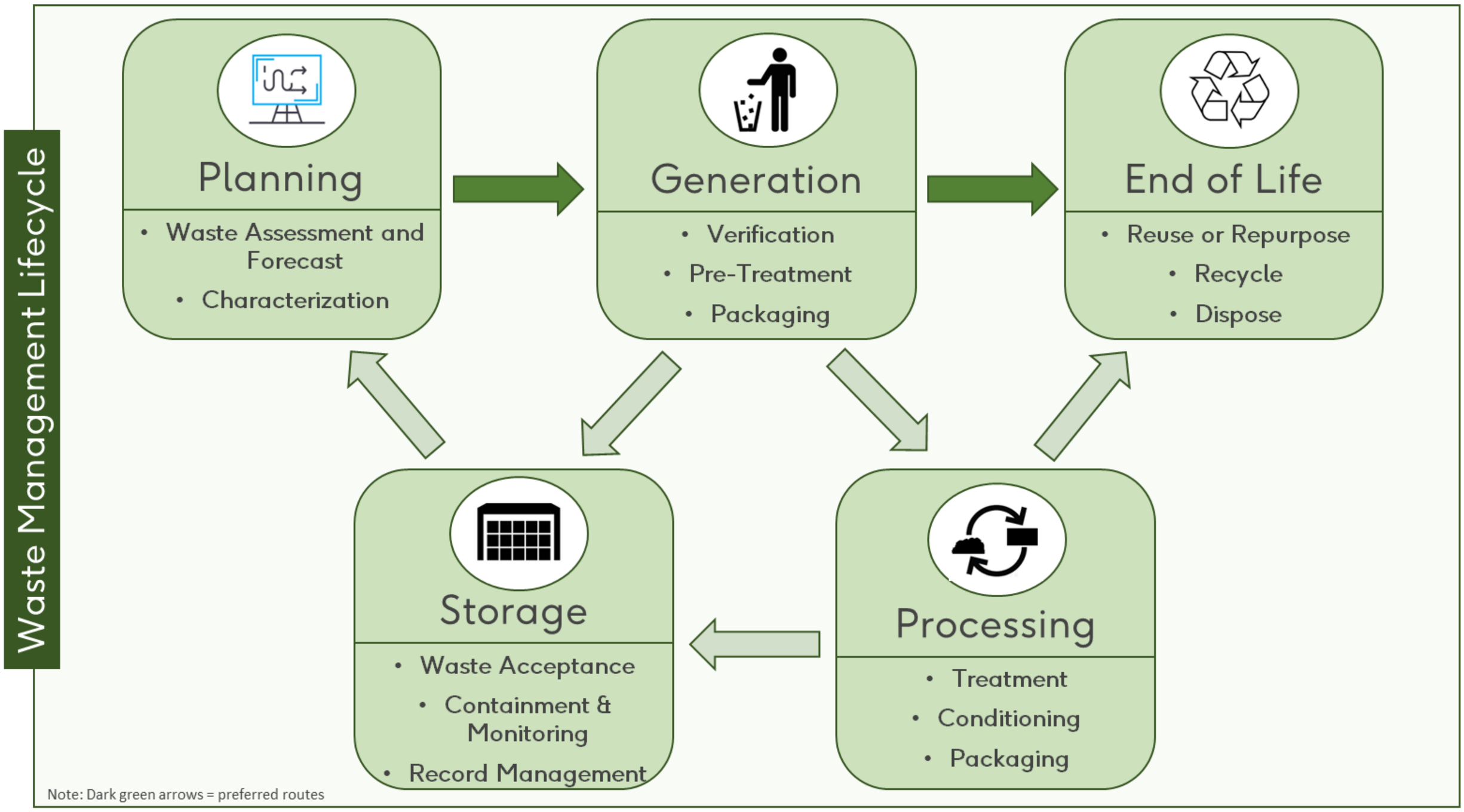
Class*	Definition	Examples
Non-Radioactive Waste	Any waste material that is declared to be non-radioactive by its history, location and use.	
Clean Waste	Non-hazardous material that is declared to be non-radioactive by its history, location and use; or non-hazardous material that has been determined to meet regulatory requirements for unconditional clearance	Building materials and demolition debris Organic materials; Office waste
Hazardous Waste	Solid, liquid or gaseous waste material, other than a radioactive material, that may pose a potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed, and as specified in applicable regulations.	Asbestos-containing waste; Chemical wastes; Hydrocarbon-contaminated soils; PCB-containing wastes;
Radioactive Waste	A gas, liquid, sludge, or solid that has been declared as a waste and contains a nuclear substance in excess of the clearance or exemption criteria and without foreseeable use	
Low-Level Radioactive Waste	LLW contains material with radionuclide content above established unconditional clearance levels and exemption quantities (set out in the *Nuclear Substances and Radiation Devices Regulations* [Government of Canada, 2015]), but generally has limited amounts of long-lived radionuclides. LLW requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in near surface facilities.	Radiologically contaminated soils; Surface contaminant equipment and building materials (metal, concrete, wood, bagged waste)
Intermediate-Level Radioactive Waste	ILW generally contains long-lived radionuclides in concentrations that require isolation and containment for periods greater than several hundred years. ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal. Due to its long-lived radionuclides, ILW generally requires a higher level of containment and isolation than can be provided in near surface repositories.	Cemented Target Material; Irradiated reactor components; Wastes with elevated concentrations of long-lived radionuclides (e.g., actinides)
High-Level Radioactive Waste	HLW is used nuclear fuel that has been declared as Radioactive Waste and/or is waste that generates significant heat via radioactive decay. HLW typically has levels of activity concentration in the range of 10^4 to 10^6 TBq/m^3. HLW is associated with penetrating radiation, and thus shielding is required. HLW also contains significant quantities of long-lived radionuclides necessitating long-term isolation.	Used fuel elements, bundles and baskets

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

2.2 WASTE MANAGEMENT LIFECYCLE

The CNL Waste Management Lifecycle represents a series of iterative and often non-linear stages including planning, generation, transport, processing, storage and disposal of waste. The Waste Management Lifecycle reflects a 'cradle-to-grave' or "cradle-to-cradle" approach. It recognizes the importance of holistic lifecycle planning prior to generation and that there are significant differences in details between waste classes and waste streams. It represents all classes of waste, recognizing the significant different in details between different waste classes and streams. Although not explicitly labelled, the arrows represent waste movements including on-site transfers and/or off-site transportation activities.

Figure 2-2: Waste Management Lifecycle



2.3 WASTE HIERARCHY

The CNL Waste Hierarchy is a framework for waste management decision making that applies waste minimization techniques to reduce the quantity of all waste types (Non-radioactive, Hazardous, and Radioactive Waste) requiring disposal, to as low as practicable. Across all CNL-operated sites, these techniques shall be considered in order, at the onset of all planned work, i.e., at source. The techniques are: prevent, reduce, reuse, recycle, and dispose.

The Waste Hierarchy is applied at all stages of the Waste Management Lifecycle. The effective use of diversion, recycle and reuse pathways requires ongoing options analysis and characterization.

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

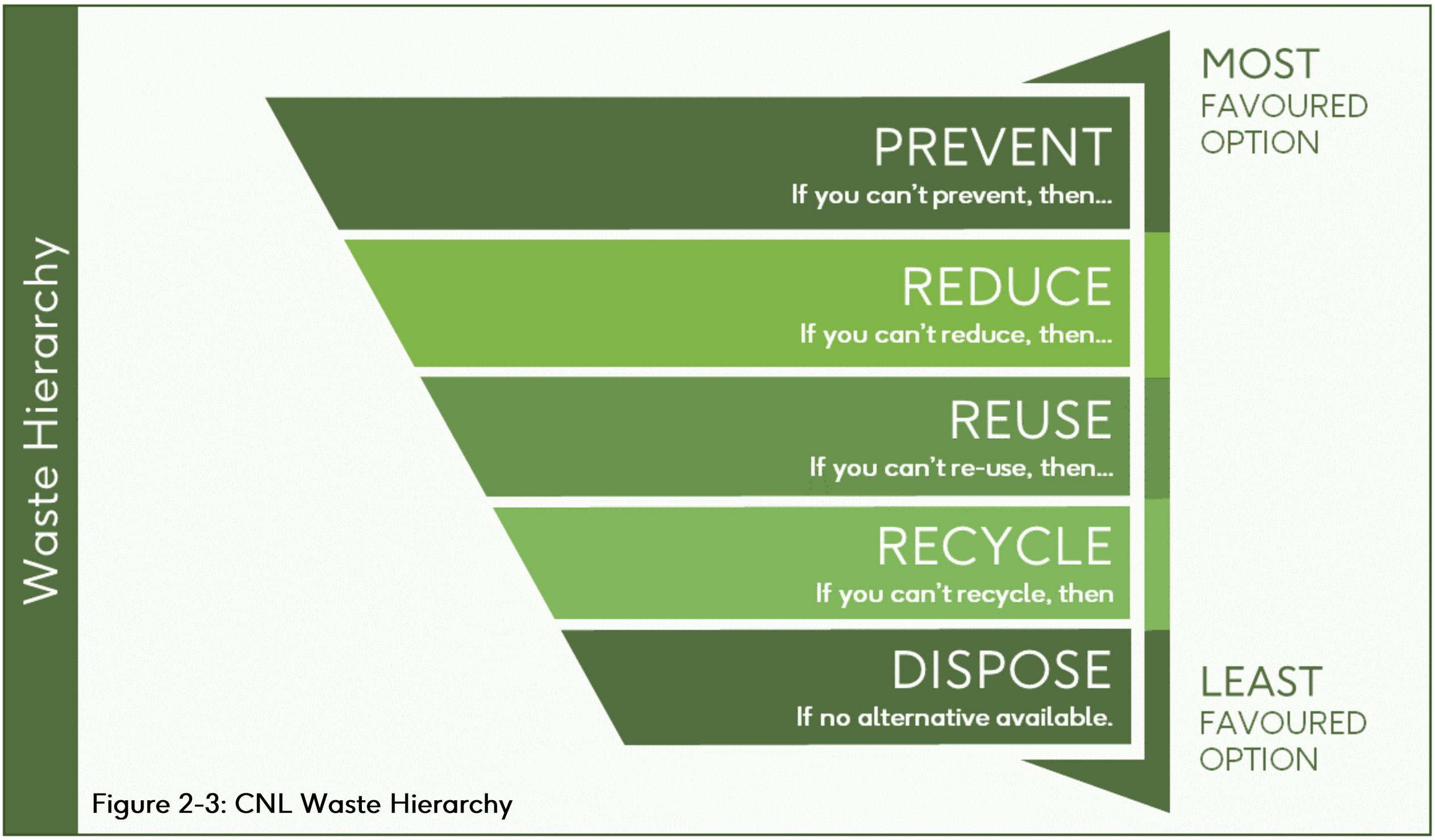


Figure 2-3: CNL Waste Hierarchy

Hierarchy Steps	Waste Strategy Examples
Prevent	Avoid generation of wastes; Planning for decommissioning at the design stage; Minimizing the use of single-use disposables
Reduce	Segregation of waste classes and streams; Prioritizing the durability and reusability of equipment
Reuse	Reusing concrete and ground materials on-sites; reusing surplus equipment; detritiating tritiated heavy water; utilizing mobile systems that can be used at multiple projects/sites
Recycle	Recycling of metals, plastics, paper products, wood products; off-site metal melt processing of LLW metals
Dispose	Landfill disposal of demolition waste; future disposal of LLW in the Near Surface Disposal Facility; future disposal of used fuel of the national Deep Geological Repository

Waste minimization usually requires a trade-off between the benefits accrued and the safety implications or cost of achieving those benefits. In addition, implementation of a waste minimization strategy is always an optimization exercise that takes into consideration factors such as worker doses, the cost of recovering materials, the availability of disposal routes for specific types of waste, the quantities of waste generated in each category, and the duration and cost of interim storage of waste compared with the estimated ultimate disposal cost [IAEA, 2007].

2. WASTE MANAGEMENT AT CNL-OPERATED SITES

The following regulatory documents are a key part of the CNSC's regulatory framework for waste management and decommissioning:

- REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*
- REGDOC-2.11.1, Waste Management, Volume I: *Management of Radioactive Waste*
- REGDOC-2.11.1, Waste Management, Volume III: *Safety Case for Disposal of Radioactive Waste*
- REGDOC-2.11.2, Decommissioning
- REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*

The following CSA Group standards complement the CNSC's regulatory framework on waste management:

- N292.0, *General Principles for the Management of Radioactive Waste and Irradiated Fuel*
- N292.1, *Wet Storage of Irradiated Fuel and Other Radioactive Materials*
- N292.2, *Interim Dry Storage of Irradiated Fuel*
- N292.3, *Management of Low- and Intermediate-Level Radioactive Waste*
- N292.5, *Guideline for the Exemption or Clearance From Regulatory Control of materials That Contain, or Potentially Contain, Nuclear Substances*
- N292.6, *Long*
- *-Term Management of Radioactive Waste and Irradiated Fuel*
- N292.7, *Deep Geological Disposal of Radioactive Waste and Irradiated Fuel*
- *N292.8, Characterization of Radioactive Waste and Irradiated Fuel*
- N294, *Decommissioning of Facilities Containing Nuclear Substances*

2.4 NATIONAL CONTEXT OF POLICY AND GOVERNANCE

In Canada, matters that relate to nuclear activities and substances are under the jurisdiction of the Government of Canada. Natural Resources Canada (NRCan) is responsible for determining Canada's nuclear energy policies, including those that concern radioactive waste. In 2023, the Government of Canada released Canada's Policy for Radioactive Waste Management and Decommissioning [NRCan, 2023). The policy communicates a vision and a summary of the roles and responsibilities of the Government of Canada, as well as waste producers and owners [CNSC, 2022]. This modernized policy underpins this version of the CNL Integrated Waste Strategy.

The Canadian Nuclear Safety Commission (CNSC) is responsible for the regulatory oversight of the management of radioactive waste, including, as applicable, handling, processing, transport, storage and disposal of that waste. The CNSC's regulatory framework consists of laws passed by Parliament, as well as licences and regulatory documents issued and/or used by the CNSC to regulate the nuclear industry [CNSC, 2022].

The responsibility for ensuring safe transport of nuclear substances, including radioactive waste, is jointly shared between the CNSC and Transport Canada. The basic philosophy that has guided the development of CNSC regulations for transport is that safety is incorporated in the design of the transport package. Package designs are combined with additional regulatory controls including labelling, placarding, and quality assurance and maintenance records, and allow for radioactive material to be carried safely in all modes of transport such as road, rail, air and sea [CNSC, 2022].

2.5 INTERNATIONAL GUIDANCE AND BENCHMARKING

As long-term strategies and solutions for the safe management of radioactive waste evolve, the Government of Canada must continue to demonstrate how it meets its international obligations under the terms of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* [IAEA, 1997] [CNSC, 2022].

Consistent with its statutory mandate "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world", the IAEA's activities include: developing and transferring nuclear technologies for peaceful purposes to its Member States; contributing to the strengthening of the global nuclear safety framework and strengthening the security of nuclear material and facilities [IAEA, 2023]. The IAEA suite of documentation, including General Safety Requirements and Technical Documents, inform CNL's approach to waste management.

As a learning organization, CNL is actively involved in international collaboration projects, and pursues academic partnerships and benchmarking opportunities to help identify, evaluate, and implement new approaches for waste management.

CNL Integrated Waste Strategy

Regulatory Framework for Waste Management at CNL-Operated Sites

International

Legal Requirements	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
	Agreement Between the Government of Canada and the IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons
Guidance	IAEA Publications: Safety Standards, Technical Documents (TECDOCS, Conference Proceedings, Nuclear Energy Series)
Standards	International Standards Organization (ISO) Standards

National (Canada)

Policy	*Policy for Radioactive Waste Management and Decommissioning* (NRCan)
Strategy	*Integrated Strategy for Radioactive Waste* (NWMO)
Regulatory Framework	*Nuclear Safety and Control Act* (Government of Canada)
	Impact Assessment Act (Government of Canada)
	CNSC Regulations
	Site Licenses and Certificates for Transportation Packages
	Regulatory Documents, including REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada*
Standards	Canada Standards Association (CSA) Standards: N286, N292-series, and N294

Provincial

Provincial Waste Management Acts and Regulations

Municipal

Municipal Waste By-Laws

CNL

Policy	Environment Policy & Nuclear Safety Policy
Strategy	Integrated Waste Strategy
Requirements	Waste Function Requirements, Standards, and Processes
Site-Specific Requirements, Processes, and Clean-up Plans	
Project-Specific Waste Management Approaches	

National Policy for Radioactive Waste Management

In 2020, the Government of Canada initiated the process to modernize Canada's radioactive waste policy. This process included engagement with the public, the Canadian nuclear industry, and Indigenous communities. The revised and modernized policy was released in 2023. In this national policy, the following three key areas were prioritized in terms of federal government commitments:

1. Health, safety, and security of people and the environment;
2. Inclusive engagement, openness, and transparency;
3. Canada's commitment towards building partnerships and advancing reconciliation with Indigenous peoples; and
4. Global Excellence in radioactive waste management and decommission.

The Government of Canada's vision for radioactive waste management and decommissioning is as follows:

- The generation of radioactive waste is minimized to the extent reasonably achievable, and waste management is optimized, taking into account health, safety, security, environmental and socio-economic considerations;
- The management of radioactive waste, including its storage and disposal, must ensure that both human health and the environment will be protected, now and in the future, to reduce the burden on future generations;
- All radioactive waste and decommissioning activities and all radioactive waste management facilities, locations, and sites are safely managed by waste generators and/or owners and regulated by Canada's nuclear regulator, the CNSC, to protect human health, safety, security and the environment now and over the long term, and to ensure nuclear non-proliferation;
- Radioactive waste generators and/or owners, governments, Indigenous peoples, scientific experts, current and prospective nuclear host communities, and other interested Canadians regularly collaborate on and contribute, in an open and transparent manner, to the planning, development, review and implementation of an Integrated Strategy for Canada's Radioactive Waste;
- The government commits to the implementation of the United Nations Declaration on the Rights of Indigenous Peoples in consultation and collaboration with Indigenous peoples, with regards to radioactive waste management and decommissioning;
- By 2050, key elements of Canada's radioactive waste disposal infrastructure are in place, and planning is well under way for the remaining facilities necessary to accommodate all of Canada's current and future radioactive wastes; and
- Canada's advances in technology and approaches to radioactive waste management and decommissioning, its consistent fulfillment of international commitments and obligations, and its contributions to international discourse and practices in these areas establish Canada as a centre of expertise and leadership.

Integrated Strategy for Radioactive Waste

In the fall of 2020, the Minister of Natural Resources Canada tasked the Nuclear Waste Management Organization (NWMO) with leading an engagement process with Canadians and Indigenous Peoples to inform the development of an integrated long-term management strategy for all of Canada's radioactive waste, in particular low- and intermediate-level waste, as part of the government's radioactive waste management policy review. In 2023, following a public comment period in 2022, the NWMO released the Integrated Strategy for Radioactive, which provided the following recommendations:

1. Intermediate-level waste and non-fuel high-level waste to be disposed of in a deep geological repository with implementation by the NWMO.
2. Low-level waste to be disposed of in multiple near surface disposal facilities with implementation by waste generators and waste owners.

This strategy also document four key implementing principles [NWMO, 2023].

Transportation is an essential element of the CNL Integrated Waste Strategy. CNL, and previously AECL, have been safely transporting radioactive materials (including waste) throughout Canada for over 60 years. Future transportation activities are focused on the consolidation of radioactive wastes (LLW, ILW, and HLW) at the CRL site, recognizing that >90% of the AECL-owned inventory of solid radioactive waste (other than LLW managed at the Port Hope Area Initiative) is already located at the CRL site.

Across Canada, all aspects of the packaging and transportation of radioactive waste is regulated by the CNSC and Transport Canada. Every radioactive waste shipment meets the requirements in the Canadian *Packaging and Transport of Nuclear Substances Regulations* [Government of Canada, 2015], which are based on the IAEA's *Regulations for the Safe Transport of Radioactive Materials* [IAEA, 2018].





3. CNL'S WASTE STRATEGIES

3.1 CLEAN WASTE STRATEGY

Vision of Excellence for Clean Waste Management:

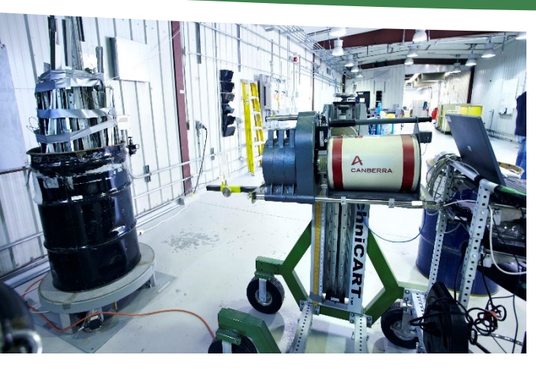
All CNL sites demonstrate a commitment to reducing, reusing and recycling waste, with waste performance metrics that demonstrate continuous improvement. The off-site disposition of waste for recycling or disposal strengthens or establishes mutually beneficial relationships with surrounding municipalities and/or supply chain vendors.

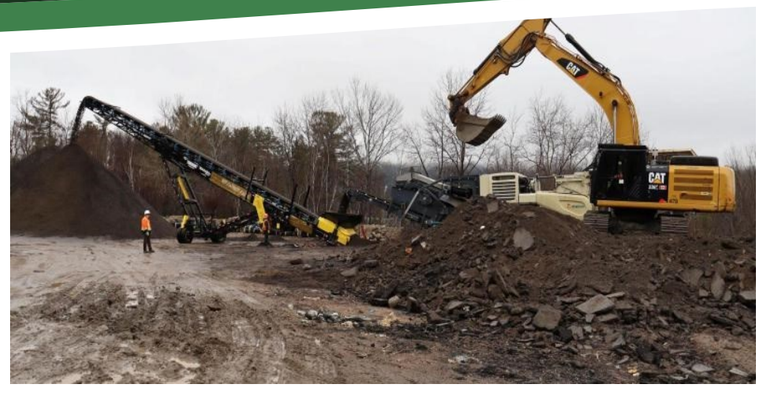
Clean Waste Strategy Overview:

All waste that is released from CNL-operated sites as 'Clean Waste' meets unconditional radiological clearance criteria as per the *Nuclear Substances and Radiation Devices Regulations* [Government of Canada, 2015]. Clean Waste will be managed with a focus on reducing, reusing (or repurposing), recycling, recovering, and residual disposal. CNL sites will dedicate resources and prioritize efforts to minimize the quantities of waste that cannot be reused or recycled. CNL will continue to use existing or new partnerships with local municipalities or supply chain partners for recycling or disposal capabilities and capacities.

Key Elements of the Clean Waste Strategy:

1. CNL's radiological clearance program is implemented to ensure all wastes released from site meet unconditional radiological release criteria.
2. The quantity of clean waste that requires disposal is minimized by reusing and repurposing as much waste as practical, and recycling as much waste that cannot be reused as practical.
3. Opportunities to leverage user-friendly sorting systems at the source/point of generation are identified and implemented.
4. Existing assets are utilized to convert decommissioning waste into a reusable form.
5. Procurement of goods and materials factor in waste minimization objectives by considering durability, packaging, reusability, recyclability, and end-of-life waste management.
6. There is an ongoing investment into awareness, communication, and education campaigns to optimize clean waste management practices focused on reducing, reusing, and recycling.
7. There are continued efforts to physically sort and segregate legacy, operational, and decommissioning wastes to maximize the amount of waste that can be managed as clean, as opposed to radioactive waste.
8. Long-term agreements with local recycling facilities are established and/or maintained to ensure recycling throughput capacities and capabilities are sufficient to support various CNL-operated sites.
9. Residual waste is disposed of in off-site landfills.
10. Long-term agreements with local municipalities or supply chain partners are maintained and/or expanded to provide local disposal capacities (e.g., landfill expansion or lifecycle extension projects).
11. Waste audits and surveillance activities are performed to identify opportunities for improvement.





3. CNL'S WASTE STRATEGIES

3.2 HAZARDOUS WASTE STRATEGY

Vision of Excellence for Hazardous Waste Management:

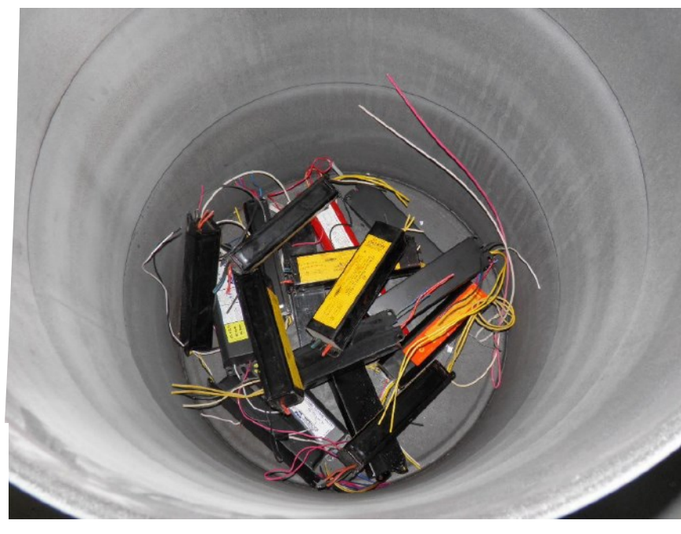
All CNL sites demonstrate a commitment to safely managing Hazardous Wastes in accordance with the inherent hazardous characteristic through compliance monitoring, focused efforts on waste minimization, and demonstrated continued improvement. The off-site disposition of Hazardous Wastes for processing or disposal strengthens or establishes mutually beneficial relationships with surrounding municipalities and/or supply chain vendors.

Hazardous Waste Strategy Overview:

All waste that is released from CNL-operated sites as 'Hazardous Waste' meets radiological clearance criteria. All Hazardous Wastes are managed throughout the lifecycle to meet regulatory requirements. Hazardous Wastes are minimized to the extent practical, starting with initial procurement efforts through end-of-life segregation activities. Hazardous Waste are transferred to regulated third-party sites (operated at the municipal or by supply chain vendors) for processing and/or disposal.

Key Elements of the Hazardous Waste Strategy:

1. CNL's radiological clearance program is implemented to ensure all Hazardous Wastes released from sites meet unconditional radiological release criteria.
2. Hazardous Wastes are handled (packaged, segregated, stored, and disposed) in accordance with the inherent chemical hazard characteristics present or potentially present.
3. The quantities of Hazardous Wastes are minimized, to the extent practical, throughout the Waste Management Lifecycle.
    a) Hazardous Wastes are minimized through "green procurements" strategies, in alignment with the national *Greening Government Strategy* [Government of Canada, 2020].
    b) Hazardous Wastes are minimized through limited use of hazardous materials for operational and cleanup activities.
    c) Hazardous Wastes are minimized through dedicated efforts to segregate hazardous from non-hazardous materials.
4. Hazardous Wastes are managed in compliance with the provincial regulations applicable to the CNL site of generation.
5. Hazardous Wastes are characterized, segregated, and packaged to meet Transportation of Dangerous Good Regulation.
6. Sort and segregate legacy, operational, and decommissioning wastes to maximize the amount of waste that can be managed as hazardous, as opposed to radioactive (mixed) waste.
7. Hazardous Wastes are characterized, segregated, and packaged to meet the Waste Acceptance Criteria of the off-site processing or disposal facility.
8. Waste audits and surveillance activities are performed to ensure compliance and identify opportunities for improvement.



3. CNL'S WASTE STRATEGIES

3.3 LOW-LEVEL (SOLID) RADIOACTIVE WASTE STRATEGY

Vision of Excellence for Radioactive LLW Management:

CNL is recognized as a national leader in LLW management with a shift from storage to safe disposal of LLW in the Near Surface Disposal Facility. Port Hope and Port Granby Long Term Waste Management Facilities continue to provide safe, long-term solutions for safe storage of LLW. The in-situ disposal of legacy reactors at NPD and WR-1 is approved and implemented. CNL demonstrates a commitment to innovation and continuous improvement for LLW management practices as part of the ongoing commitment to lifecycle environmental stewardship.

Radioactive LLW Strategy Overview:

LLW will be characterized, processed and packaged to enable passive safe storage. LLW from the Port Hope Area Initiative will be emplaced in the Port Hope Long-Term Waste Management Facility. LLW will be consolidated from other CNL-operated sites at the CRL site. Existing storage capacities will be utilized, with new facilities and capabilities established for LLW processing and storage. LLW will be disposed of in the proposed Near Surface Disposal Facility. Where a safety case can be demonstrated and approved, LLW may be disposed of in-situ (e.g., NPD and WR-1).

Key Elements of the Radioactive LLW Strategy:

1. Minimize the volume of LLW requiring disposal to optimize storage and disposal liabilities.
2. Implement waste diversion strategies to minimize the quantity (volume) of waste requiring storage and future disposal, including the use of commercial third-party processing and/or recycling facilities.
3. Consolidate LLW from Gentilly-1, Douglas Point and Whiteshell Laboratories at CRL.
4. Characterize LLW identifying quantity and type of radioactive isotopes to enable fully informed decision making regarding safety, packaging, storage, transportation, treatment, and disposal.
5. To the extent practical, sort and segregate LLW at the point of generation, including segregation of LLW and clean waste which would require radiological clearance monitoring.
6. Pre-disposal management of LLW will minimize the need for future re-work or double-handling.
7. Process LLW destined for the Near Surface Disposal Facility, where, required, to ensure it is storage-ready and meets the Near Surface Disposal Facility Waste Acceptance Criteria.
8. Pursue in-situ disposal of suitable LLW through the proposed approaches for in-situ decommissioning of the NPD and WR-1 Reactors if the safety case is demonstrated and approved.
9. Align decommissioning and environmental remediation strategies and execution to LLW storage and disposal availabilities (e.g., deferral of major clean-up projects until the Near Surface Disposal Facility is operational).
10. Implement technical approaches that optimize the use of existing assets and infrastructure, where suitable, and ensure strategic compatibility between existing and planned facilities.
11. Establish new facilities and capabilities to enable the pre-disposal management of LLW, including enhanced sort and segregation capabilities.
12. Establish a robust Waste Certification Program to support future disposal in the Near Surface Disposal Facility.
13. Emplace LLW generated from the Port Hope Area Initiative into the Port Hope Long-Term Waste Management Facility.
14. Once operational, dispose of existing and future LLW in the Near Surface Disposal Facility.
15. Ensure LLW management strategies and supporting processes have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.
16. Ensure record management maintains accurate and comprehensive records that are maintained in perpetuity.

CNL Integrated Waste Strategy

The Near Surface Disposal Facility is being proposed to provide a permanent, safe and secure containment of LLW, most of which has and will continue to be generated at the CRL site due to ongoing scientific research. Today, the LLW is stored in compliance with regulations, but that storage is not a permanent solution. CNL recognizes the need to minimize the burden on future generations, and the Near Surface Disposal Facility demonstrates the commitment to safely disposition the legacy waste now. The Near Surface Disposal Facility is a key enabling capacity for the cleanup of CNL sites and to drive the transition from LLW storage to LLW disposal.

The proposed Near Surface Disposal Facility is a purpose-built facility that would feature an engineered containment mound built with multiple layers to fully encase up to 1 million cubic metres of solid LLW, effectively isolating the material from the environment. The design of this facility has effectively leveraged technical inputs from similar disposal facilities that are currently in operation around the world. The proposed Near Surface Disposal Facility would also include support facilities such as a Wastewater Treatment Plant.

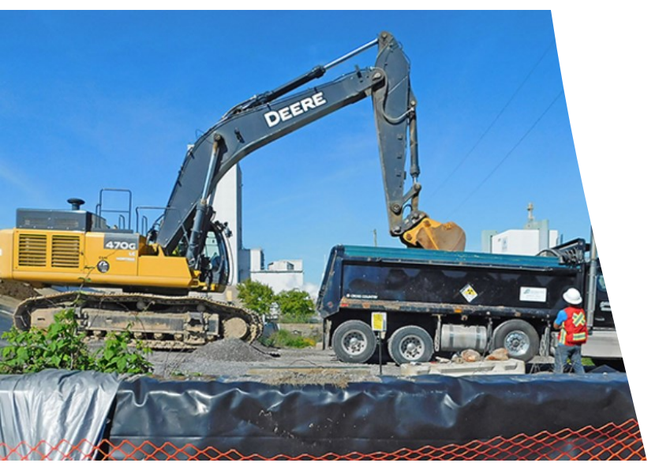
The Near Surface Disposal Facility would only accept LLW. Any waste that is emplaced in the Near Surface Disposal Facility would be characterized and confirmed to meet the Waste Acceptance Criteria. CNL will develop and implement a formal Waste Certification Program as a key quality management element of Near Surface Disposal Facility operations.

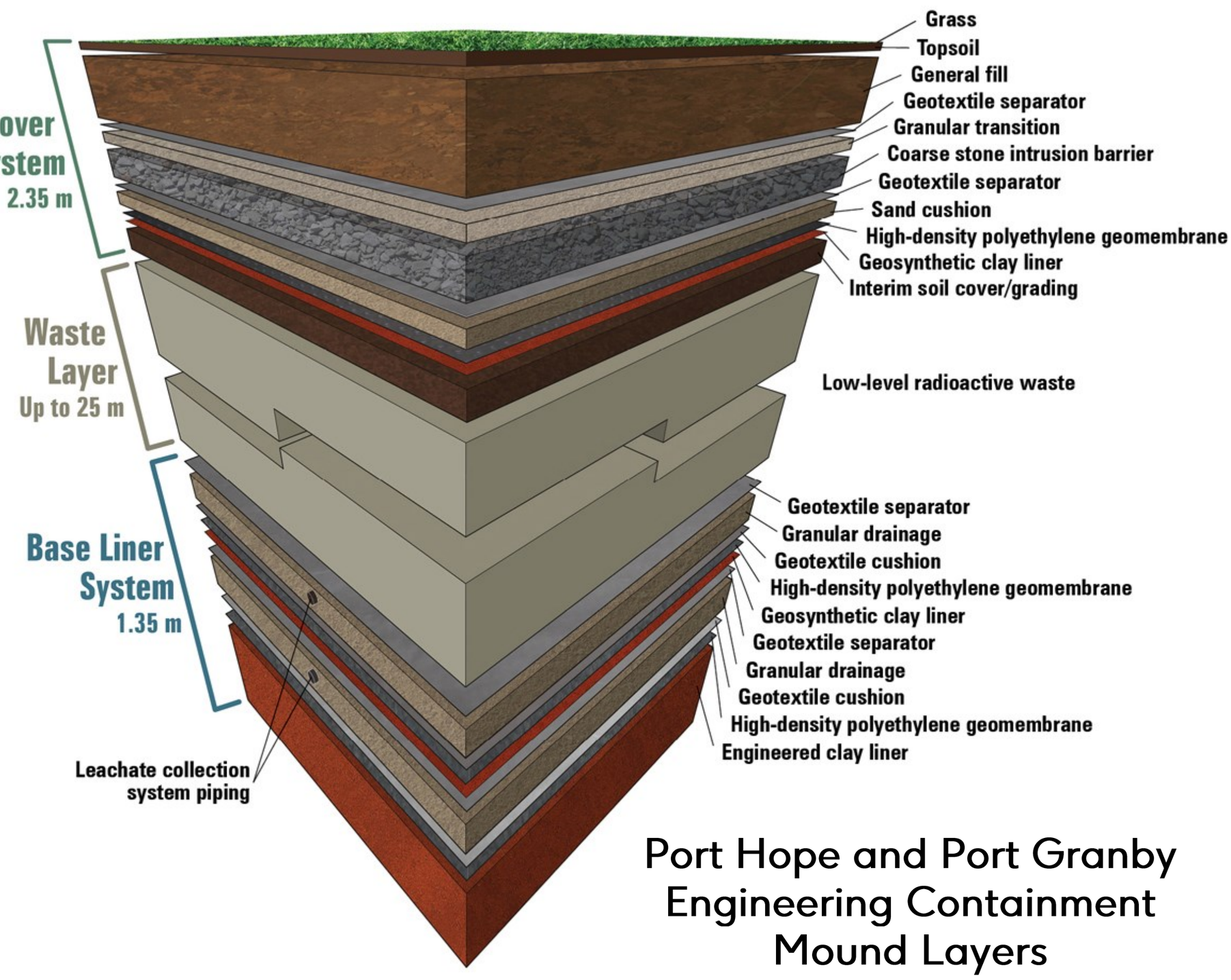
It is important to recognize disposal does not mean abandonment. Following closure of the proposed Near Surface Disposal Facility , CNL would have institutional controls in place for at least 300 years, or as long as regulatory agencies deem necessary.

Near Surface Disposal Facility Rendering for the Operational Phase (2030-2080)

Near Surface Disposal Facility Rendering for the Post-Closure Monitoring Phase (Post-2080)

Port Granby Waste Water Treatment Plant and Long-Term Waste Management Facility





Port Hope and Port Granby Engineering Containment Mound Layers

3. CNL'S WASTE STRATEGIES

3.4 INTERMEDIATE-LEVEL (SOLID) RADIOACTIVE WASTE STRATEGY

Vision of Excellence for Radioactive ILW Management:

CNL is recognized as a global leader in radioactive waste (ILW) management. ILW is consolidated at the CRL site for safe interim storage until disposal infrastructure is in place, in alignment with Canadian *Integrated Strategy for Radioactive Waste* [NWMO, 2023]. The in-situ disposal of legacy reactors at NPD and WR-1 is approved and implemented. CNL demonstrates a commitment to innovation and continuous improvement of ILW management practices as part of the ongoing commitment to lifecycle environmental stewardship.

Radioactive ILW Strategy Overview:

ILW will be characterized, processed and packaged to enable passive safe storage until a geological disposal facility is available. ILW will be loaded into fit-for-use packages that optimize safety for workers and the environment, optimize storage capabilities, and will be designed and used in consideration of future disposal requirements. While existing infrastructure will continue to be utilized, there will be a continuous drive to evolve to above-ground and/or climate-controlled storage configurations that permit accessibility for long-term monitoring and surveillance of the integrity of the packages. There will be an increased focus on creating 'disposal ready' ILW. Disposal solutions for ILW will continue to be evaluated, with CNL focused on aligning with the development and implementation of the NWMO's *Integrated Strategy for Radioactive Waste*.

Key Elements of the Radioactive ILW Strategy:

1. Minimize the volume of ILW to optimize storage and disposal liabilities, with a focus on point of generation waste segregation and volume reduction technologies/approaches.
2. Consolidate ILW from Gentilly-1, Douglas Point and Whiteshell Laboratories at the CRL Waste Management Areas.
3. Characterize ILW to ensure accurate and comprehensive records are available to support storage, transportation and future disposal.
4. Process ILW, where required, to address hazardous constituents and ensure waste is storage-ready and transportation-ready, as well as disposal-ready to the extent possible.
5. Align decommissioning and remediation strategies and plans to ILW storage options and availability.
6. Align CNL's ILW Strategy to the national *Integrated Strategy for Radioactive Waste*:
    a) CNL recognizes the current recommendation for a single, national Deep Geological Repository for ILW, which provides a planning assumption for this Integrated Waste Strategy.
7. Implement Waste Diversion strategies to minimize the quantity of waste requiring storage and future disposal.
8. Pursue in-situ disposal of suitable ILW through the proposed approaches for in-situ decommissioning of the NPD and WR-1 Reactors if the safety case is demonstrated and approved.
9. Utilize processing approaches to produce waste forms suitable for storage and future disposal.
10. Implement technical approaches that optimize the use of existing assets and infrastructure, where suitable, and ensure strategic compatibility with existing and planned facilities.
11. Establish new facilities and capabilities to enable the pre-disposal management of ILW, including capabilities to recover legacy ILW, process (or condition) ILW into a disposal-ready configuration, and provide safe storage of ILW.
12. Drive continuous improvement and standardization to align with improved understanding of ILW disposal readiness.
13. Ensure ILW management strategies and supporting processes have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.

Chalk River Laboratories Waste Management Area B, which includes approximately 6000 Tile Holes that provide storage for ILW and/or HLW, and over 100 Bunkers (Cylindrical and Rectangular) that provide storage of ILW.

3. CNL'S WASTE STRATEGIES

3.5 HIGH-LEVEL RADIOACTIVE WASTE STRATEGY

Vision of Excellence for Radioactive HLW Management:

CNL develops and operates world-class facilities for used fuel management that enables accelerated recovery and conditioning of legacy HLW. CNL has credible and deliverable lifecycle plans for the entire inventory of AECL-owned HLW, resulting in the disposal of all HLW in the NWMO's Deep Geological Repository. CNL demonstrates a commitment to innovation and continuous improvement as part of the ongoing commitment to environmental stewardship.

Radioactive HLW Strategy Overview:

HLW, which is comprised of irradiated or used fuel, will be managed with the objective of disposing of the entire inventory of AECL-owned HLW in the NWMO's planned national Deep Geological Repository [NWMO, 2022]. The optimization of long-term safety and security for pre-disposal management of HLW involves the consolidation of this inventory at the CRL site. The majority of this inventory is similar to CANDU HLW and is expected to meet the NWMO's Waste Acceptance Criteria for the Deep Geological Repository, while a portion is anticipated to require conditioning. This portion of the inventory includes over 100 tonnes of non-CANDU uranium oxide fuel, chemically reactive fuel, mixed oxide fuel, and enriched fuel.

Key Elements of the Radioactive HLW Strategy:

1. Maintain comprehensive safety and security infrastructure and programs for all elements of HLW management.
2. Analyze HLW to ensure accurate and comprehensive records are available to support storage, transportation, and future disposal.
3. Meet all obligations for international agreements, such as the requirements of Safeguards Management oversight by the IAEA.
4. Consolidate HLW from Gentilly-1 and Whiteshell Laboratories at the CRL Waste Management Areas.
5. Utilize existing infrastructure for HLW storage and expand the capacities for HLW storage at the CRL site in a phased approach.
6. Establish new facilities and capabilities to enable the pre-disposal management of HLW, including:
    a) Retrieval capabilities to recover legacy HLW from existing storage configurations;
    b) Characterization capabilities to identify, classify, and quantify HLW;
    c) Conditioning and packaging capabilities to convert HLW (particularly research reactor fuels or other experimental fuels) into a storage and disposal-ready configuration;
    d) Storage capabilities for the storage of recovered and/or conditioned HLW until the waste can be transported to the NWMO Deep Geological Repository.
7. Communicate and collaborate with the NWMO on their progression of the Deep Geological Repository.
8. Ensure all HLW has been conditioned and/or packaged into a configuration that meets the NWMO Waste Acceptance Criteria no later than 2065.
9. Drive continuous improvement and standardization to align with best practices for HLW disposal readiness.
10. Ensure HLW management strategies and supporting processes have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.

Eligible fuels and fuel-containing materials have been and will continue to be repatriated to their country of origin, as applicable, which avoids creating HLW. Over the period of 2015 through 2022, over 180 repatriation shipments were safely and securely completed through various projects including the NRU/NRX Highly-Enriched Uranium Fuel Repatriation Project and Target Residue Material Repatriation Project [CNL, 2021]. *By definition, any material eligible for repatriation is not considered a waste.*

CNL Integrated Waste Strategy

Interior view of the CRL Fuel Packaging and Storage Building

CNL HLW Storage

Future HLW Disposal (NWMO)

LEGEND

1. Surface Facilities
2. Main Shaft Complex
3. Placement Rooms
4. Ventilation Exhaust Shaft

Graphic taken from the Nuclear Waste Management Organization

CNL Integrated Waste Strategy

Evolution of Waste Management Practices at Chalk River Laboratories

Clean Waste

Landfill On-site: 1950s to present

Radiological Clearance Program: 2008 – Present

Waste Analysis Facility: 2009 to present

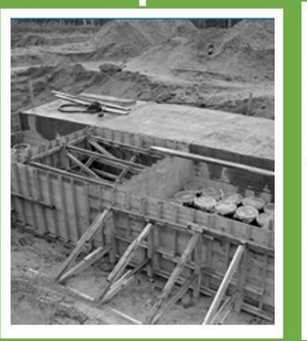
Landfill Off-site 2016 - Present

Concrete Crushing Facility: 2017 to present

LLW

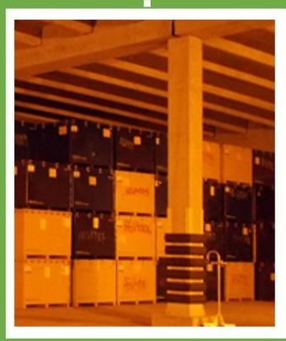
In Ground Sand Trenches: 1946 - 2002

In Ground Asphalt Trenches: 1955 - 1959



Cylindrical Bunkers: 1979 – Present

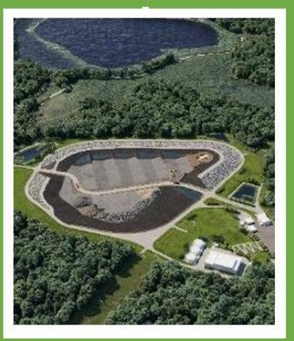
Above Ground Container Storage: 2007 – Present



Sort & Segregation: 2020 - Present

Recoverable Surface Storage: 2017 -Present

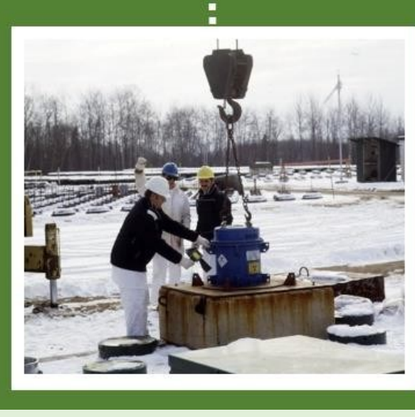
NSDF: Future



ILW

Rectangular Bunkers: 1959 - 1979

Tile Holes: 1956 – Present



Cylindrical Bunkers: 1979 – Present

ILW Storage Array: 2026 -

Waste Processing Facilities: 2026 – 2075

Recommended Deep Geological Repository (Off-Site): 2050 -

HLW

Tile Hole Storage 1963 - Present

Fuel Packaging and Storage 2015 - Present

Concrete Canister Storage 1988 - Present

Waste Processing 2033 – 2065

Proposed NWMO Deep Geological Repository (Off-Site): 2055 - 2065

3. CNL'S WASTE STRATEGIES

3.6 RADIOACTIVE LIQUID WASTE STRATEGY

Vision of Excellence for Radioactive Liquid Waste Management:

CNL is implementing a plan to leverage modern, existing Radioactive Liquid Waste facilities, and establishing new capabilities and facilities at CRL and WL. CNL also demonstrates a commitment to continuous improvement, recognizing that new facilities will continue to provide quantifiably improved performance.

Radioactive Liquid Waste Strategy Overview:

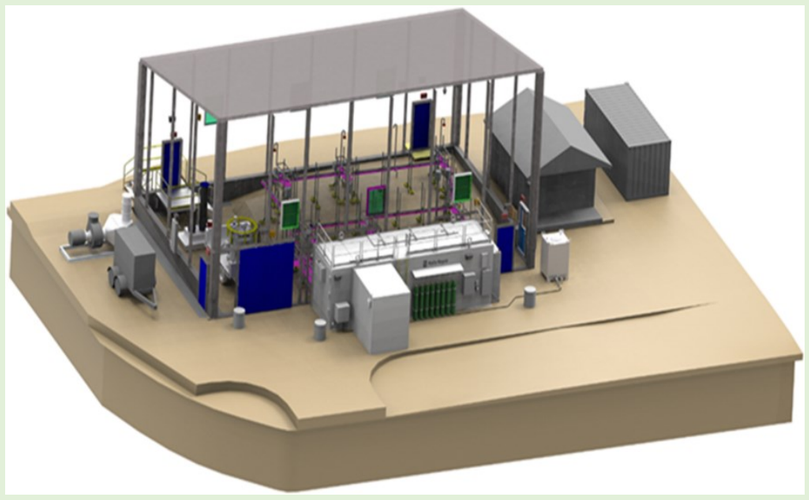
Radioactive Liquid Waste will be minimized, characterized, processed, and dispositioned through existing facilities and future/planned facilities. Existing facilities include the CRL Waste Treatment Centre, CRL pump and treat buildings, and the Port Hope and Port Granby Waste Water Treatment Plants. Planned facilities include the Near Surface Disposal Facility Wastewater Treatment Plant. The disposition pathways for Radioactive Liquid Waste include solidification of liquids to solid LLW or ILW. Other treatment approaches will remove the contaminants, with treated liquids sampled to ensure they meet effluent discharge limits.

Key Elements of the Radioactive Liquid Waste Strategy:

1. Minimize the volume of Radioactive Liquids Wastes that are generated during operational and decommissioning activities.
2. Characterize Radioactive Liquid Wastes to identify and quantify radiological and non-radiological contaminants.
3. Optimize the use of technologies and treatment approaches that separate radioactivity from the liquids, enabling environmental discharges along with reduced volumes of post-processing (secondary) waste.
4. Identify, evaluate, and implement opportunities for select Radioactive Liquid Wastes to be reused/re-purposed at CRL, such as through the use of grout formulas for radioactive waste stabilization.
5. Consider any secondary wastes generated in the selection and implementation of Radioactive Liquid Waste treatment.
6. Process Radioactive Liquid Wastes generated from operational activities at CRL through the Waste Treatment Centre, resulting in an effluent that can be safely and compliantly discharged, or a solidified waste that can be managed as LLW or ILW.
7. Process Radioactive Liquid Waste generated from decommissioning and remediation at WL through either the Low-Level Liquid Waste Treatment System (focused on treatment and discharge) or the Intermediate-Level Liquid Waste Treatment System (focused on solidification).
8. Treat surface water and groundwater from the Port Hope Long-Term Waste Management Facility, the Port Granby Long-Term Waste Management Facility, and the future Near Surface Disposal Facility at their respective Waste Water Treatment Plants.
9. Establish new capabilities and/or facilities to treat and manage Radioactive Liquid Waste at CRL, recognizing the Waste Treatment Centre is nearing the end of the design life.
10. Establish a detritiation capability to convert the tritiated heavy water inventory from a liability into an asset (virgin heavy water) that can be reused for nuclear or non-nuclear applications.
11. Establish Radioactive Liquid Waste management contingency capabilities and capacities.
12. Ensure any Radioactive Liquid Waste solidification systems incorporate full consideration for disposal readiness of any output wastes.
13. Drive continuous improvement and standardization to align with industry innovations for Radioactive Liquid Waste management.
14. Ensure Radioactive Liquid Waste management strategies and supporting processes/capabilities have flexibility to adapt to uncertainties with legacy waste and future CNL research and operations.

Current Radioactive Liquid Waste Facilities

Future Radioactive Liquid Waste Facilities



Current Facilities Photographs: Port Granby Waste Water Treatment Plant; CRL Spring B Pump and Treat Building; Port Hope Waste Water Treatment Plant; CRL Waste Treatment Centre
Planned Facilities Graphics: Stored Liquid Waste Hazard Reduction System; Heavy Water Detritiation Facility (2); Near Surface Disposal Facility Waste Water Treatment Plant

Table 3A – Waste Management Lifecycle Overview by Class

Lifecycle Element	Clean Waste	Hazardous Waste	Radioactive Liquid Waste
Planning	Planning for the Waste Management Lifecycle, with implementation of the Waste Hierarchy.		
Characterization	Radiological clearance monitoring (surface and volumetric); Confirmation of no hazardous constituents	Gas Chromatography; Mass Spectrometry; Organic Vapour Analysis; Toxicity characteristic leaching procedure (TCLP), Radiological clearance monitoring (surface and volumetric)	Sample Analysis – Gamma Spectrometry, Gross Alpha/Beta Counting; Liquid Scintillation, Mass Spectrometry, pH Test
Generation	Segregation of waste streams for reuse, recycling, or disposal	Segregation of hazardous waste from clean waste; Segregation of different classes of hazardous waste (Class 1-6, and 8)	Collection and containment; Pre-treatment of solids
Packaging	Cardboard Boxes; Paper Bags Plastic Bags; Unpackaged	Pails (Plastic); Drums (Metal and Plastic)	Totes; Tanks
Transportation (On-Site)	Commercial waste collection vehicle	Commercial waste collection vehicle	Drain Line System(s), Totes (IP-1, IP-2, or Type A)
Transportation (Off-Site)	Commercial waste collection vehicle	Commercial waste collection vehicle	Drums (IP-1, IP-2, or Type A)
Storage	Staging for transportation	Hazardous Waste Storage Buildings	Drums; Tanks
Processing	Segregation of waste streams for reuse, recycling, or disposal	Biological treatments; Chemical treatments (e.g., neutralization); Physical treatments (e.g., separation or extraction); Thermal treatments (e.g., incineration)	Evaporation, Filtration, Ion Exchange, Physical Separation, Solidification (Bituminize, Cementation or Polymerization)
End of Life (Reuse or Recycle)	Reuse of surplus equipment and select materials (e.g., concrete rubble); Recycling of e-waste, glass, metals, organics, paper products, and plastics	Land treatments of impacted soils; Regeneration of acids/bases; Recovery of components/ organics; Recycling of batteries	Environmental discharge (of liquids that meet environmental release criteria); Reuse for solidification or decontamination
End of Life (Disposal)	Local municipal or commercial landfills regulated at the provincial level	Post-treatment disposal in municipal or commercial landfills regulated at the provincial level	Solidification as LLW or ILW; Secondary Waste as LLW or ILW
Implementing Organization for Disposal	CNL and Municipal Agencies	Municipal Agencies or Supply Chain Vendors	CNL

Table 3B – Waste Management Lifecycle Overview by Class

LLW	ILW	HLW	Lifecycle Element
Planning for the Waste Management Lifecycle, with a focus on waste minimization and diversion.			**Planning**
Alpha Spectroscopy, Dose Measurement, Gamma Spectroscopy, Liquid Scintillation Counting, Mass Spectroscopy, Neutron Counting, Radiochemical Analysis (Analytical and Wet Chemistry Techniques), Radiography; Toxicity Characteristic Leaching Procedure, Visual Examination		Computational models; Dose measurement; Radiochemical Analysis; Safeguards accounting (IAEA)	**Characterization**
Containment of contamination; Handling with respect to ALARA principle; Point-of-generation segregation into streams;	Contact or remote-handling; Containment of contamination; Point-of-generation segregation	Criticality control; Remote handling & monitoring	**Generation**
Drums, Engineered Waste Bags, Metal Containers (B-25s and B-1000s), Sealand Containers	Drums, Metal Containers (B-25s and B-1000s)	Element Storage Cans, Used Fuel Baskets	**Packaging**
Metal Overpacks (as required)	Shielded Transfer Flasks (as required)	Shielded Transfer Flasks (e.g., Fuel Basket Transfer Flask, F-055)	**Transportation (On-Site)**
IP-1 and IP-2 Containers (Drums, Engineered Waste Bags, Sealand Containers), Type A Packages	Type A Packages and Licensed Type B Packages (e.g., OPTIMUS L and H)	Licensed Type B Transportation Packages (e.g., OPTIMUS H, Used Fuel Transportation Package, NAC-LWT)	**Transportation (Off-Site)**
Historical WMAs (Trenches), Recoverable Surface Storage Areas, Shielded Modular Above Ground Storage (SMAGS) Buildings	Bunkers, SMAGS Buildings, Tile Holes	Concrete Canisters, MACSTORs, Tile Holes	**Storage**
Decontamination; Mechanical Segmentation and Size Reduction; Sorting and Segregation	Decontamination, Macroencapsulation; Microencapsulation (for CTM); Compaction; Waste Segregation	Cladding removal and stabilization; Disassembly and sectioning; Pellet formation; Reactivity reduction	**Processing**
Limited: off-site metal melt processing for reuse in the nuclear industry	Not applicable.	Not applicable for HLW (Potential repatriation of non-waste fuels)	**End of Life (Reuse or Recycle)**
Emplacement in Near Surface Disposal Facility or long-term waste management facility; In-situ disposal of NPD & WR-1	Emplacement in a national ILW Deep Geological Repository (disposal facility); In-situ disposal of NPD & WR-1	Emplacement in the national used fuel Deep Geological Repository (disposal facility)	**End of Life (Disposal)**
CNL	NWMO (Recommendation)	NWMO	**Implementing Organization for Disposal**

4. CNL'S FORWARD-LOOKING PLANS

CRL is the only CNL-operated site that has an enduring nuclear mission. The other sites are planning for, or are actively undergoing decommissioning and site closure. The CRL site also has the most substantial and complex radiological waste inventories, in comparison to other CNL sites. As a result, there is a strong focus on the CRL site for forward-looking plans for waste management.

The strategic long-term plan for CNL is enabled through a revitalized CRL site. The CRL main campus is being carefully restored through an integrated strategy of facility decommissioning, environmental remediation, and waste management, which are, in turn, coupled with the construction of new state-of–the-art research facilities. The decommissioning and waste management activities support this plan and improve accessibility to the site and ensure the protection of worker, the public, and the environment.

There are two broad themes:

1. Waste Management Processes, Operations, and Projects: *to support CNL missions;*
2. Waste Management Enabling Capabilities: *to enable the lifecycle management of all CNL managed current and future wastes.*

4.1 FUTURE VISION OF WASTE MANAGEMENT CAPABILITIES

In developing the lifecycle waste strategy for existing waste and future-generated waste, CNL has identified the following facility needs to complement existing capabilities and capacities:

- LLW: *Enhanced characterization capabilities/facilities; enhanced LLW processing capabilities/facilities; expanded LLW surface storage capacities; LLW disposal capability (i.e., Near Surface Disposal Facility)*
- ILW: *Enhanced characterization capabilities/facilities (including radiological monitoring); legacy ILW retrieval systems; ILW processing capabilities/facilities (for Cemented Target Material and Remote-Handled ILW); expanded and enhanced above-ground ILW storage capacities/facilities*
- HLW: *Enhanced characterization capabilities/facilities; HLW conditioning capabilities (to convert select fuels into a configuration eligible for disposal in the national NWMO Deep Geological Repository); expanded and enhanced above-ground HLW storage capacities/facilities*
- Radioactive Liquid Waste: *Enhanced characterization capabilities/facilities; processing capabilities for WL higher hazard liquids; processing facility for Near Surface Disposal Facility waste water, Stored Liquid Waste Treatment System(s), and the replacement capability for CRL's Waste Treatment Centre*

In 2022, CNL released *Vision 2030: A Strategy for a Sustainable CNL – A Vision for the Future of CNL* [CNL, 2022]. Vision 2030 articulates a path for CNL to become a more sustainable, high-performing national laboratory, recognized as a Canadian asset by the general public, viewed as a trusted supplier to customers in the private and public sector and a partner and collaborator with academia, and sought after as an employer of choice, delivering work of national importance.

The Vision 2030 strategy is intended to harness CNL expertise and realign organization focuses on three key priorities: restoring and protecting the environment, advancing clean energy for today and tomorrow, and contributing to the health of Canadians.

Integrated waste management is a key element of realizing Vision 2030; not just for the environmental clean-up mission but to support the efforts to advance clean energy and contribute to health sciences.

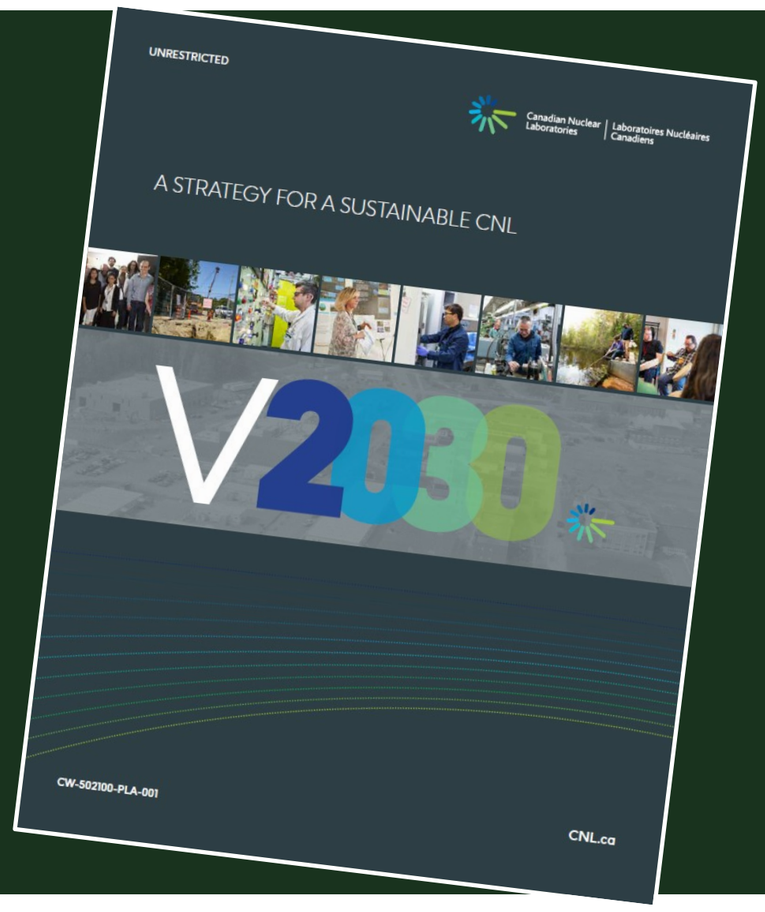
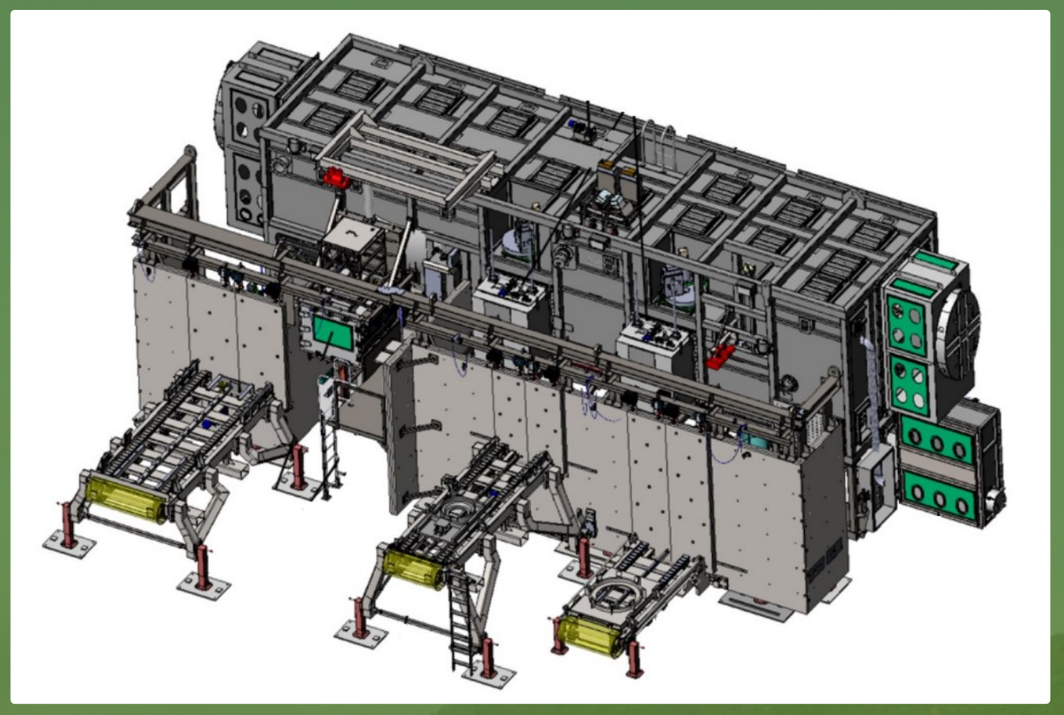


Table 4-1: Waste Infrastructure Summary (Current and Future)

	Lifecycle Element	Clean and Hazardous	LLW	ILW	HLW	Radioactive Liquid Waste
CURRENT	Characterization	Mobile Equipment; Waste Analysis Facility	Commercial Laboratories; Mobile Equipment; Sample Management Office; Waste Characterization Facility	Analytical Chemistry Laboratories; Commercial Laboratories	Analytical Chemistry Laboratories; Fuel and Materials Cells	Sample Management Office; Analytical Chemistry Laboratories
	Processing	Concrete Crushing Facility, Twin Lakes; Waste Analysis Facility	Sort and Segregation Facility; Waste Handling Building; Waste Processing Facility; Waste Reception Centre	NRU Rod Bays; Shielded Facilities; Universal Cells	Fuel Packaging and Storage Building; NRU Rod Bays; Shielded Facilities; Universal Cells	Passive Barriers ; Port Granby and Port Hope Waste Water Treatment Plants; Spring B Pump and Treat Facility; Waste Treatment Centre
	Storage	On-Site Landfills for Clean Waste; Hazardous Waste Storage Buildings	Bunkers, Legacy Trenches/Vaults; Quonsets, Recoverable Surface Storage; SMAGS Buildings;	Bunkers (Cylindrical and Rectangular), SMAGS Buildings; Mixed Waste Storage Buildings; Standpipes; Tile Holes	Concrete Canisters; Fuel Packaging and Storage Building; NRU Rod Bays; Tile Holes	La Prade Heavy Water Storage; NRU Rod Bay Tanks; Stored Liquid Waste Tanks; Waste Treatment Centre Tanks
FUTURE	Characterization	Mobile Equipment (New Technologies and Systems)	Mobile Equipment for In-Situ or Point-of-Generation Characterization; Waste Characterization Laboratory	Standpipes and Bunker Waste Retrieval System; Tile Hole Retrieval Systems; Waste Characterization Laboratory	In-Facility Capabilities; Tile Hole Retrieval Systems	Commercial Laboratories; Waste Characterization Laboratory; Waste Water Treatment Plants
	Processing	Asphalt Recycling and Reuse; Wood Shredding and Recycling	Waste Reduction and Processing Facility	ILW and Cemented Target Material Conditioning Capability/Facility; Sorting and Conditioning Unit; Waste Reduction and Processing Facility	HLW Conditioning Capability/Facility	Intermediate-Level Liquid Waste Treatment System; Waste Water Treatment Plant; Stored Liquid Waste Hazard Reduction System; Waste Treatment Centre Replacement Capability
	Storage	None planned.	Expanded Recoverable Surface Storage Areas	Conditioned ILW Storage Facility; ILW Storage Area; Reconfigured SMAGS	HLW Storage Facility; New Concrete Canisters	Waste Treatment Centre Replacement Capability

Facilities Being Built
(Construction Phase)

CRL HLW Concrete Canister Storage Expansion



WL Sorting and Conditioning Unit

Planned Facilities
(Detailed Design Phase)

Detritiation Capability

CRL Cask Facility

Conceptual Waste Management Capabilities
(Options Analysis Phase)

Modern Waste Management Campus Vision to support recovery and conditioning of legacy ILW and HLW

4. CNL'S FORWARD-LOOKING PLANS

4.2 STRATEGIC OPPORTUNITIES AND RISKS

Within CNL, there is an active commitment to risk and opportunity management for near-term and lifecycle plans and projects. The CNL Waste Strategy Program maintains a program-level Risk Register, with strategic risk mitigation plans and opportunity realization strategies. In alignment with recommended project management principles, Risk Registers are also actively maintained for each waste management project. At a program level, the top five risks and opportunities are presented in the following tables.

Table 4-2.1: Key Strategic Risks

Risk Description	Sites	Impacted Waste Class
If the proposed Near Surface Disposal Facility is not approved, there will be a lack of a disposal pathway for LLW, which would result in significant deferral of CNL's legacy cleanup mission.	CRL, DP, G-1, WL	LLW
If the in-situ decommissioning approach for the NPD and WR-1 reactors is not approved, new decommissioning and waste management approaches will be required, which would result in significant new scope for waste processing, transportation, storage and disposal.	CRL, NPD, WL	LLW & ILW
If there is a significant change to current planning assumptions related to clean-up criteria (land use end state), there is a risk that more waste will be generated, which would result in significant new scope for waste processing, transportation, storage and disposal.	CRL, WL	Hazardous & LLW
If there is an emergent driver to close the CRL Waste Treatment Centre as it nears the end of it's design life, there is a risk that CRL will have limited capacity to manage Radioactive Liquid Waste, which would result in the need to implement alternative approaches.	CRL	Radioactive Liquid Waste
If there is a deferral of current efforts to accelerate the remediation of CRL Waste Management Areas, there is an enhanced risk of storage integrity challenges, which would result in the need for remedial action to maintain safety and environmental protection.	CRL	LLW, ILW, & HLW

Table 4-2.2: Key Strategic Opportunities

Opportunity Description	Sites	Impacted Waste Class
Through the expansion of CNL's Environmental Remediation Mission Area capacities and capabilities, CNL has the opportunity to continue to accelerate CNL's legacy cleanup mission ahead of earlier timelines and commitments.	CRL, DP, G-1, WL	All
Through the construction of the Near Surface Disposal Facility, CNL has the opportunity to lead Canada in the transition from storage to permanent, safe disposal of radioactive waste.	CRL	LLW
Through the construction of new waste management enabling facilities, CNL has the opportunity to create significant economic benefits for the surrounding communities, including local Indigenous Peoples.	CRL	LLW, ILW, & HLW
Through the CNL Fuel Program, CNL has the opportunity to establish the capability to convert ILW and HLW (including fuel types from emerging technologies such as Small Modular Reactors) into a disposal-ready configuration to enable future (off-site) disposal.	CRL, G-1, DP, WL	HLW
Through CNL's Science and Technology Mission Area, CNL has the opportunity to develop and implement new technologies and approaches for discrete elements of the waste management lifecycle.	All	All

4. CNL'S FORWARD-LOOKING PLANS

4.4 WASTE STRATEGY NEAR-TERM ACTION PLAN

Through agreements with the Government of Canada via AECL, CNL is required to plan and deliver on broad commitments for safe, efficient and effective waste management in support of operations, decommissioning and environmental remediation programs. CNL's waste management strategy (Figure 1-1) requires significant resourcing and focus to bridge the strategy-to-execution gap. The Waste Strategy Program maintains a detailed Action Log, with select summary actions listed in the following table to represent key elements of the waste strategy implementation plan, which will continue to leverage the experience, knowledge and perspectives of CNL resources from across Canada.

Table 4-4: Integrated Waste Strategy Action Plan

Focus Action	Summary of Actions	Targeted Waste Class
Lifecycle Plans	Improve and optimize lifecycle plans with a focus on: • Transitioning from storage framework to disposal frameworks for radioactive wastes • Detailed lifecycle mapping of waste for discrete projects/programs • Minimizing the potential for re-work with a focus on creating "disposal ready" waste packages	All
Indigenous Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with Indigenous Peoples on the overall strategy and discrete projects.	All
Stakeholder Engagement	Use the CNL Integrated Waste Strategy as a mechanism for engagement with internal (CNL) and public stakeholders.	All
Sustainability	Track CNL's performance against key sustainability measures for waste management to identify, evaluate and implement continuous improvement actions.	All
Waste Forecasts	Continue to improve and optimize the CNL-wide Waste Forecast data based on improved characterization data and time-phased profiles.	All
Clean Waste Disposal	In collaboration with surrounding communities, establish long-term disposal solutions (e.g., landfill/capacity expansions) to enable the disposal of non-radiological waste.	Clean
CRL Enabling Facilities for Nuclear Liabilities	Progress the planning and implementation of the following enabling facilities/capabilities: • Environmental Remediation (including Groundwater Processing) • High-Level Waste (HLW) Conditioning • HLW & Intermediate-Level Waste (ILW) Storage • ILW and Low-Level Waste (LLW) Processing • Radioactive Liquid Processing System(s) • Retrieval Systems for legacy HLW and ILW • Transportation Package (Cask) Handling • Tritiated Heavy Water Management • Utility and Security Infrastructure Enhancement	LLW, ILW, HLW, Radioactive Liquids
ILW Disposal	Drive CNL's evolution from processing and packaging for *storage* to processing and packaging for *disposal*, while evolving CNL's plan to align with the national Integrated Strategy for Radioactive Waste.	ILW
In-Situ Disposal	Complete the regulatory approval processes for the in-situ disposal of the NPD and WR-1 Reactors, and implement the in-situ decommissioning approach.	LLW and ILW
LLW Disposal	Complete the regulatory approval process for the Near Surface Disposal Facility at the CRL site and begin construction.	LLW
Waste Certification	Improve and optimize the CNL waste assurance processes to include a Waste Certification process for disposal readiness.	LLW and ILW
HLW Disposal	Evaluate and confirm the approach/strategy to convert research reactor fuels and other enriched fuels into a configuration to meet the Waste Acceptance Criteria for the planned national Deep Geological Repository.	HLW

5. ENGAGEMENTS AND REGULATORY OVERSIGHT

5.1 REGULATORY OVERSIGHT

In Canada, matters related to nuclear activities and substances are under the jurisdiction of the Government of Canada. For all CNL-operated sites, the CNSC provides regulatory oversight.

The CNSC mandate is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public.

The CNSC is responsible for the regulatory oversight of the management of radioactive waste, including, as applicable, handling, processing, transport, storage and disposal of that waste. The CNSC's regulatory framework consists of laws passed by Parliament, as well as licences and regulatory documents issued and/or used by the CNSC to regulate the nuclear industry. The following are the statutes used to regulate and oversee the nuclear industry in Canada; the statutes include the management of radioactive waste:

- *Nuclear Safety and Control Act*
- *Nuclear Energy Act*
- *Nuclear Fuel Waste Act*
- *Nuclear Liability and Compensation Act*
- *Impact Assessment Act*
- *Canadian Environmental Protection Act*
- *Fisheries Act*

Several Government of Canada departments are involved in administering this federal legislation. When multiple regulators are involved, the CNSC establishes joint regulatory groups to coordinate and optimize the regulatory efforts necessary. In addition, the nuclear industry is subject to the provincial legislation and regulations in force in the individual provinces and territories where nuclear-related activities are carried out. Where an overlap occurs in jurisdictions and responsibilities, the CNSC takes the lead in efforts to harmonize regulatory activities, including those of joint regulatory groups that involve provincial and territorial regulators.

When making regulatory decisions about the management of radioactive waste, the CNSC will seek to achieve its objectives by considering certain key principles in the context of the facts and circumstances of each case, as follows:

- The generation of radioactive waste is minimized to the extent practicable by the implementation of design measures, operating procedures and decommissioning practices.
- The management of radioactive waste is proportionate to its radiological, chemical and biological hazard to the health and safety of persons, to the environment and to national security.
- The assessment of future impacts of radioactive waste on the health and safety of persons and the environment encompasses the period of time during which the maximum impact is predicted to occur.
- The predicted impacts on the health and safety of persons and the environment from the management of radioactive waste are no greater than the impacts that are permissible in Canada at the time of the regulatory decision.
- The measures needed to prevent unreasonable risk to current and future generations from the hazards of radioactive waste are developed, funded and implemented as soon as reasonably practicable.
- The trans-border effects on the health and safety of persons and the environment that could result from the management of radioactive waste in Canada are not greater than the effects experienced in Canada.

All content in this section has been taken directly from the CNSC [CNSC, 2022].

5. ENGAGEMENTS AND REGULATORY OVERSIGHT

5.2 PUBLIC ENGAGEMENTS

CNL is committed to organizational transparency, ensuring that Indigenous Peoples, the general public, local communities, elected and appointed government officials, and other industry stakeholders are properly informed about activities carried out at CNL sites. This commitment is met through the company's Public Information Program, a communications program that was developed to build public awareness and trust, and to encourage transparent and proactive communication with its various stakeholders. CNL's Public Information Program includes specific communications to stakeholders, public access to information related to routine activities, radiological and non-radiological emissions, and non-routine items or events at the different sites managed by CNL [CNL, 2021].

Through the Public Information Program, CNL routinely reports the results of environmental management programs to sustain open and transparent communication with stakeholders and to assure that the impacts are below regulatory limits. For waste management, this Program enables communication on:

- Historical practices in recognition that CNL, and formerly AECL, have been safely managing radioactive wastes since 1952
- Current approaches to waste management at sites across Canada
- Future plans for waste management, recognizing the increasing desire and intention to engage as part of the decision-making process

For discrete projects, such as the Port Hope Area Initiative Project or Near Surface Disposal Facility, there are focused engagement efforts. For the strategic view of waste management across CNL, this Integrated Waste Strategy is intended to serve as an important communication tool for public and Indigenous Peoples awareness, and engagement.

Port Hope Area Initiative Public Information Program

The PHAI Public Information Program ensures effective communication with the Port Hope and Port Granby communities to build and maintain confidence in CNL and the PHAI. An adaptive approach allows CNL to proactively share information and remain responsive to a diverse audience including residents, property owners, businesses, municipalities, media and special interest groups.

CNL is committed to sharing information in a manner that earns public trust, identifies and understands issues and values, and builds and maintains community acceptance and support of the PHAI.

Ongoing dialogue and opportunities to provide feedback ensure that the communities are knowledgeable about upcoming work and project activities and questions, issues and concerns are identified and addressed [CNL, 2022].

5. ENGAGEMENTS AND REGULATORY OVERSIGHT

5.3 INDIGENOUS ENGAGEMENT

Engagement activities include meetings, information sharing, site tours and opportunities for observation and field demonstrations of project activities. CNL has also worked to establish memorandums of understanding, long-term relationship agreements, and environmental monitoring programs with Indigenous Peoples surrounding various CNL sites.

In 2016, CNL began an Indigenous Engagement Program to directly support the environmental assessment processes for three decommissioning and waste management projects (NPD, Near Surface Disposal Facility, and WR-1 projects). The Program has grown and encompasses CNL's entire operations where CNL conducts business across Canada. This work is guided by a commitment to developing strong relationships with First Nations, Métis and Indigenous organizations. This is cultivated through meaningful opportunities for dialogue and participation. This journey relies on listening and learning, and CNL has worked to better understand the culture, needs and challenges of Indigenous First Nations and Métis. This includes the manner in which communities wish to be engaged.

CNL is on a reconciliation journey to learn about the history of Indigenous Peoples in Canada and to take meaningful actions. CNL is building positive long-term relationships with Indigenous Peoples based on mutual understanding and respect. CNL and Indigenous Peoples are collaborating in several key areas, employment, training, economic development capacity building and environmental monitoring.

Looking forward, CNL recognizes that the participation of Indigenous People in our waste management work ensures that we properly consider traditional Indigenous knowledge, and that is a key consideration in our future planning. All of these engagements and activities are being carried out under a commitment to collaboration and mutual respect, and with the goal towards ongoing participation and relationship-building.

Mechanisms for Engagement:

- Community Events
- Committees (Community Advisory Panel [CRL], Environmental Stewardship Council [CRL], Public Liaison Committee [WL])
- Long-Term Relationship Agreements and/or Memorandums of Understanding
- Open Houses
- Presentations
- Public Information Sessions
- Site Tours
- Social Media (Posts and YouTube videos)
- Webinars

6. SUSTAINABILITY IN WASTE MANAGEMENT

Across CNL, there is a clear understanding that the actions of today have implications for tomorrow. This is why CNL has embraced sustainability as an organization, and why sustainable principles and practices are incorporated into all of the CNL waste activities – to minimize the burden we place on future generations.

To organize these efforts, CNL has aligned with AECL's strategy to identify 14 focus areas of sustainability where CNL will deliver continuous improvement in our work. CNL has also adopted a holistic approach to this work which ensures that CNL planning and goals are fully aligned with the Government of Canada's vision for a more sustainable Canada.

CNL enterprise-wide waste management exemplifies key elements to directly enable improved performance is focus areas, with the CNL Integrated Waste Strategy as a key mechanism to drive environmental and social elements of CNL's sustainability strategy [CNL, 2022].

Recognizing CNL's need for new waste management enabling infrastructure, there are opportunities to incorporate elements of social and governance objectives into the strategy implementation. New facilities also have to demonstrate optimized lifecycle carbon accounting and energy efficiency targets.

Figure 6-1: CNL Sustainability Focus Areas and Objectives

Environmental	Social	Governance
Carbon Emissions Energy Efficiency Climate Resilience Biodiversity Radioactive Waste Management Waste Management Water & Wastewater Management	Diversity & Inclusion Heath & Safety Community Engagement Indigenous Relations Sustainable Work Environment	Economic Development Sustainable Procurement

Waste Management Objective: Prevent and Minimize the production of conventional waste, wherever possible, while reusing and recycling waste when it is generated.

Performance Target #1: Diversion of Operational Waste from Landfills:
Divert at least 75% by weight of non-hazardous operational waste from landfills by 2030.

Performance Target #2: Diversion of Plastic Waste:
Divert at least 75% by weight of plastic waste from landfills by 2030.

Performance Target #3: Diversion of Construction and Demolition Waste from Landfills:
Divert at least 90% by weight of all construction and demolition waste from landfills and striving to achieve 100% by 2030.

Radioactive Waste Management Objective: Support the Government of Canada's commitment to a clean and healthy environment for Canadians.

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APPENDIX A - GLOSSARY

Clean Waste	Non-hazardous material that is declared to be non-radioactive by its history, location and use; or non-hazardous material that has been determined to meet regulatory requirements for unconditional clearance.
Hazardous Waste	Solid, liquid or gaseous waste material, other than a radioactive material, that may pose a potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed, and as specified in applicable regulations.
High-Level Radioactive Waste	HLW is used nuclear fuel that has been declared as Radioactive Waste and/or is waste that generates significant heat via radioactive decay. HLW typically has levels of activity concentration in the range of 10^4 to 10^6 TBq/m^3. HLW is associated with penetrating radiation, and thus shielding is required. HLW also contains significant quantities of long-lived radionuclides necessitating long-term isolation.
Intermediate-Level Radioactive Waste	ILW generally contains long-lived radionuclides in concentrations that require isolation and containment for periods greater than several hundred years. ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal. Due to its long-lived radionuclides, ILW generally requires a higher level of containment and isolation than can be provided in near surface repositories.
Legacy Waste	Radioactive or non-radioactive wastes from discontinued historical activities and were managed (generated, characterized, processed, packaged and stored) in a manner that was appropriate at the time but may or may not meet modern standards.
Low-Level Radioactive Waste	LLW contains material with radionuclide content above established unconditional clearance levels and exemption quantities (set out in the *Nuclear Substances and Radiation Devices Regulations* [Government of Canada, 2015]), but generally has limited amounts of long-lived radionuclides. LLW requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in near surface facilities.
Radioactive Waste	A gas, liquid, sludge, or solid that has been declared as a waste and contains a nuclear substance in excess of the clearance or exemption criteria and without foreseeable use
Waste	Residual material, generated as a result of a process, operation or activity that has no further use and is declared for reuse, recycling or disposal.
Waste Acceptance Criteria	Quantitative or qualitative criteria, specified by the Waste Receiver, for the waste to be accepted for processing, storage or disposal at a Waste Management Facility. In the case of Radioactive Waste, the Waste Acceptance Criteria is used to determine the acceptability of the Radioactive Waste and its packaging for storage or disposal in a receiving facility.

APPENDIX A - GLOSSARY

Waste Certification	The Quality Assurance System for ensuring Waste Management Processes are documented and monitored, and wastes are effectively managed to the degree necessary so the waste meet the acceptance criteria of its intended receiver.
Waste Characterization	The determination of the physical, chemical, biological, and Radiological Waste characteristics for use to determine further handling, processing, and storage or disposal requirements.
Waste Classification	Assigning waste class based on its physical, chemical, biological and radiological characteristics.
Waste Conditioning	Operations that produce a waste form suitable for handling, transport, storage and/or disposal.
Waste Disposal	Emplacement of waste in an appropriate facility without the intention of retrieval.
Waste Hierarchy	A framework for waste management decision making that applies waste minimization techniques to reduce the volume of all waste types, to as low as practicable. These techniques shall be considered in order, at the onset of all planned work, i.e., at source, and are: prevent, reduce, reuse, recycle, and dispose.
Waste Management Lifecycle	A series of stages including planning, generation, transport, processing, storage and disposal of waste.
Waste Minimization	The process of reducing the amount of waste (and activity of radioactive, if applicable) to a level as low as reasonably achievable, at all stages from the design of a facility or work activity to decommissioning through the Waste Hierarchy.
Waste Pre-Treatment	Any or all of the operations prior to waste treatment, such as collection, segregation, chemical adjustment and decontamination.
Waste Processing	Any operation that changes the characteristics of waste, including pre-treatment, treatment and conditioning.
Waste Storage	The holding of waste in a facility that provides for containment, with the intention of retrieval.
Waste Treatment	Operations intended to benefit safety and/or economy by changing the characteristics of the waste. Three basic treatment objectives are: volume reduction, removal of radionuclides from the waste, change of composition.

APPENDIX B - INTEGRATED WASTE STRATEGY PROGRESS REVIEW

Table B-1: Integrated Waste Strategy Progress Review from Last Revision

Integrated Waste Strategy Action	Progress since Integrated Waste Strategy Rev. 1 (2019)
Identify and prioritize waste characterization gaps.	CNL has established improved guidance (e.g., Waste Characterization Handbook) and expanded internal capabilities (e.g., CRL Waste Characterization Facility) in response to identified gaps.
Develop technical and programmatic improvements to address gaps with a focus on Facilities Decommissioning (FD) and Environmental Remediation (ER) across CNL.	CNL has established the Cleanup Function to provide consistent processes and procedures to enable decommissioning and remediation activities. The Cleanup Function includes the Land Use Program, the Decommissioning and Demolition Program, and the Environmental Remediation Program.
Produce long term strategies to enable reliable processes to be put in place to align with best practice.	CNL has continued to refine the development of credible, underpinned and deliverable lifecycle strategies in alignment with relevant good practices. For example, WL has a site-wide restoration and closure plan and CRL has a lifecycle liability management plan.
Ongoing inventory and forecast refinement as assumptions and risks identified are mitigated.	CNL has continued to revise and refine the quality (accuracy and precision) of both the existing waste inventories (i.e., what has been generated and is in storage) and waste forecasts (i.e., what is estimated to be generated in the future). The CNL inventories and forecasts will continue to be refined through characterization activities across all CNL-operated sites.
Review processing technology requirements (based upon previous studies), identify areas requiring further assessment and develop standard waste treatment approaches for specific waste streams and waste types.	Since 2019, CNL has implemented new capabilities for legacy LLW management, with a focus on sorting and segregation through the centralized Sort and Segregation Facility at CRL. CNL has reviewed processing techniques for various types of LLW, ILW, HLW, and Radioactive Liquid Waste. Some approaches have been selected (e.g., heavy water detritiation, approach for processing the contents of ILW Standpipes at WL), while options evaluations are ongoing for various other discrete waste challenges (e.g., used fuel conditioning).
Carry out option studies as required.	CNL has initiated or completed options studies on Cemented Target Material management, heavy water management, HLW conditioning, HLW storage, ILW processing, ILW storage, transportation package (cask) management, and various decommissioning and remediation projects. CNL regularly uses the Best Available Techniques approach for multi-criteria decision-analysis.
Review and implement interim storage and waste package options to support missions.	CNL has completed various storage options analyses to review available and planned capacities and capabilities, including an ILW Storage Strategy Review and an ongoing plan to maintain optimized LLW storage prior to the operations of the proposed Near Surface Disposal Facility. CNL has also developed a “Waste Packaging Catalogue” to document approved packages for various types of waste.

Table B-1 (continued): Integrated Waste Strategy Progress Review from Last Revision

Integrated Waste Strategy Action	Progress since Integrated Waste Strategy Rev. 1 (2019)
Proposed Near Surface Disposal Facility Project.	CNL has made significant progress on the Near Surface Disposal Facility, including the following achievements: 2019 November: *CNL submitted the revised draft Environmental Impact Statement to the CNSC that addressed comments on the previous draft* 2021 May: *CNL submitted the final Environmental Impact Statement to the CNSC with responses to public and Indigenous comments* 2021 July: *CNSC Staff confirm the licensing application package is acceptable* 2022 February: *CNSC Commission Hearing Part 1* 2022 May/June: *CNSC Commission Hearing Part 2* 2022 July: *Procedural Direction announced to enable more engagement with two Indigenous Nations*
Identify right size solution for management of waste destined for a yet to be determined ILW disposal facility.	CNL has utilized waste inventory and forecast data to improve the organizational understanding of the storage need, reflective of the various levels of ILW (i.e., Contact-Handled ILW and Remote-Handled ILW). The storage needs include consideration of pre-disposal management activities, such as processing and packaging, and include scenario analysis to reflect variability.
Continue to cooperate and coordinate with Nuclear Waste Management Organization regarding all CNL managed fuel.	CNL has continued to work closely with the NWMO to ensure the AECL-owned inventory will be disposed of in the national Deep Geological Repository. In particular, CNL has worked collaboratively on identifying, evaluating, and defining solutions for conditioning of research reactor fuels (with various physical characteristics and enrichment levels) to ensure it can be safely and compliant disposed in the NWMO Deep Geological Repository.
Prioritize projects requiring option studies, which have been identified and agreed upon with internal stakeholders and subject matter experts.	With a multi-decade plan of remediation of sites across Canada, CNL has continued to evaluate project priorities. Multiple options evaluations, of various complexity, have been completed that leverage inputs from a broad array of experts (both internal and external to CNL) and stakeholders. Further, building upon the learning from the Near Surface Disposal Facility Project, CNL has progressed relationships with Indigenous Peoples in recognition of the value that their knowledge and perspective can add to the decision-making process.
Continue to identify and assess projects until complete.	CNL continues to identify and assess a portfolio of projects with varying levels of scale and complexity, with a focus on continuous improvement of project governance, delivery and performance. For nuclear liability projects, there is a focus on lifecycle planning (e.g., any enabling facility has a project phase, an operational phase, and a decommissioning phase). Key waste management or waste generating projects that are being proactively monitored include the CRL B250 Decommissioning, CRL Cask Facility Project, CRL Controlled Area Decommissioning Project, CRL Environmental Remediation Projects (including Waste Management Areas), CRL Heavy Water Detritiation Facility Project, CRL Near Surface Disposal Facility Project, CRL NRU and NRX Decommissioning Projects, CRL Stored Liquid Waste Management Project, Douglas Point Reactor Site Decommissioning, Fuel Repatriation Projects, Gentilly-1 Reactor Site Decommissioning, Off-Site Fuel Consolidation Projects, Port Hope Area Initiative, Waste Data Tracking Systems Project, and the Whiteshell Restoration Project.

Table B-1 (continued): Integrated Waste Strategy Progress Review from Last Revision

Integrated Waste Strategy Action	Progress since Integrated Waste Strategy Rev. 1 (2019)
Roll out strategy to ensure the appropriate parties are engaged and aware of the Integrated Waste Strategy	In 2022, CNL established a new Waste Strategy Program Team. In alignment with Guiding Principle #3, this team completed over eighty (80) engagements with internal and external stakeholders and Indigenous Peoples. These engagements included presentations, workshops, discussions, and tours. The engagements were intended to both provide an overview of the Integrated Waste Strategy for awareness, and also to solicit feedback and perspectives to be incorporated in the Integrated Waste Strategy future revisions.
Ensure that all wastes continue to be captured in the Integrated Waste Strategy, and progress on identified gaps is ongoing	The scope of the CNL Integrated Waste Strategy involves all wastes at all sites. However, the CNL Integrated Waste Strategy is a summary-level document that is underpinned by hundreds of other references. The technical details on specific waste stream are within the scope of CNL's overall Waste Strategy (Figure 1-1). CNL actively monitors the implementation of preferred options to resolve technical gaps, recognizing the monitoring varies with complexity of the solution. The CNL Waste Strategy Program Team, along with the hundreds of CNL employees involved in waste management, continue to identify lifecycle gaps, risks and opportunities.
NPD Project Progress	The NPD-based team has worked closely with regulatory agencies, public stakeholders and Indigenous Peoples to progress this Project. The Environmental Impact Statement was submitted to the CNSC in 2021; a revised version will be re-submitted in 2023.
WR-1 Project Progress	The WL-based team has worked closely with regulatory agencies, public stakeholders and Indigenous Peoples to progress this Project. The Environmental Impact Statement was submitted to the CNSC in 2022 with a completeness check completed in early 2023.
Port Granby Long-Term Waste Management Facility Progress	The engineered above-ground storage mound at the Port Granby Long-Term Waste Management facility was capped and closed in 2021. This Facility now provides safe long-term management of ~800,000 m^3 (1.3 million tonnes) of waste.
Port Hope Long-Term Waste Management Facility Progress	As of 2022, approximately ~850,000 m^3 (1.4 million tonnes) of historic waste has been excavated from several sites in Port Hope and safely placed in the Port Hope Long-Term Waste Management Facility as remediation and restoration work continues.
Northern Transportation Route Project Progress	In 2021, CNL completed Phase 1 to establish temporary storage areas in Fort Fitzgerald (Alberta) and Fort Smith (Northwest Territories). Phase 2 is current underway.

Figure B-1: Northern Transportation Route Project – Phased Project Plan

APPENDIX C - CNL WASTE MANAGEMENT SUCCESS STORIES

CNL'S REPATRIATION PROGRAM

Over the period of 2015-2022, CNL safely and successfully completed over 170 repatriation shipments of used fuel (highly enriched fuel from CRL reactors) and highly-enriched uranyl nitrate (also referred to as Target Residue Material) to the United States. These materials represented some of the highest hazard nuclear liabilities in Canada and were permanently dispositioned off-site for recycling and reuse.

FUEL PACKAGING AND STORAGE FACILITY

In 2020, CNL completed the Fuel Packaging and Storage (FPS) Project to retrieve, dry, and store 96 legacy historic used fuel cans. This Project was initiated in 2004 in response to the identification of moisture in early tile holes from the 1950s and 1960s. The FPS Project safely recovered the historic used fuel cans, which were then transferred to the FPS Building to dry each of the cans and then place them into a passive and safe storage configuration.

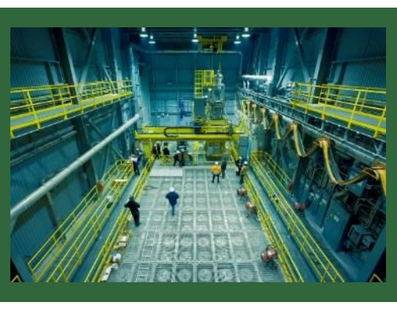
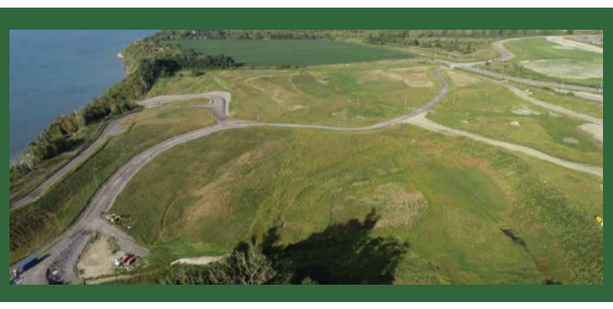
PORT GRANBY LONG-TERM WASTE MANAGEMENT FACILITY

In 2021, CNL completed the capping and closure of the engineered aboveground mound at the Port Granby Project Long-Term Waste Management Facility. This mound was closed after the emplacement of approximately 800,000 m^3 (1.3 million tonnes) of contaminated soil and industrial waste that was excavated and transferred from the Lake Ontario shoreline.

SORT AND SEGREGATION FACILITY

Over the period of 2018-2021, CNL designed, licensed, constructed and commissioned a facility to sort, segregate, and package legacy LLW. The Sort and Segregation Facility, located at CRL's Waste Management Area, is currently operational and is actively used to segregate clean waste from LLW, volume reduce suitable LLW, package LLW, and confirm it is disposal-ready.



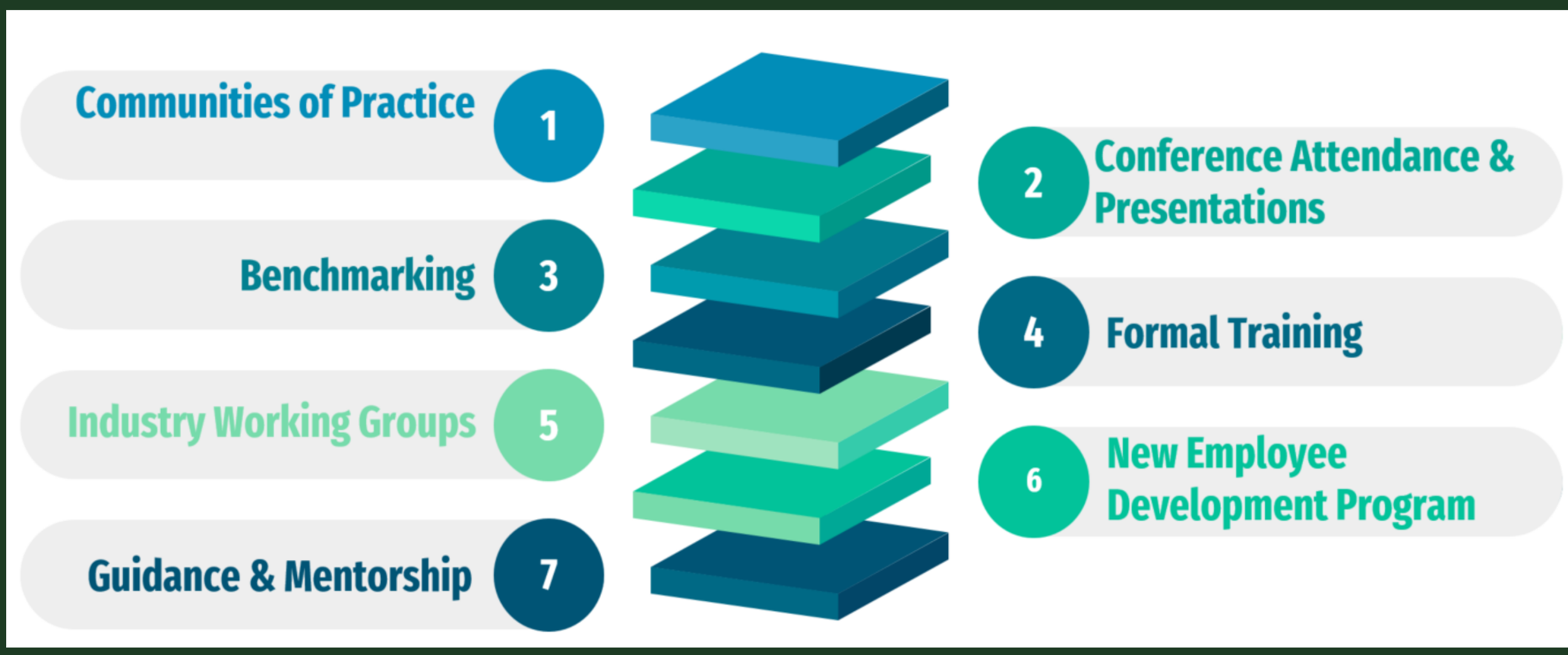




APPENDIX D - WASTE MANAGEMENT KNOWLEDGE MANAGEMENT FRAMEWORK

Waste Management Knowledge and Expertise Creation and Acquisition

Culture of Knowledge Sharing

Core Components of Expertise and Knowledge Transfer



Implementation of Lessons Learned

Knowledge Transfer Between CNL-Operated Sites

Chalk River Laboratories | Douglas Point | Gentilly-1 | Nuclear Power Demonstration | Port Hope | Whiteshell Laboratories

Transparency and Availability of Information

UNRESTRICTED

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

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This revision of the CNL Integrated Waste Strategy was developed and written by Jérôme Besner, Dr. James Doyle, Sean Gamley, Lynne Jones, and Paul Saunders, with extensive input from across CNL.