2013 INVENTORY SUMMARY REPORT

Canadian Nuclear Laboratories

Laboratoires Nucléaires Canadiens

Low-Level Radioactive Waste Management Office


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Canadian Nuclear Laboratories
Laboratoires Nucléaires Canadiens

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1.0 INVENTORY OF RADIOACTIVE WASTE IN CANADA OVERVIEW

This report is published by the Low-Level Radioactive Waste Management Office (LLRWMO) and is the definitive inventory of all radioactive waste in Canada, as of December 31, 2013. The LLRWMO was established in 1982 to carry out the responsibilities of the federal government for the management of historic low-level radioactive waste (LLRW) in Canada. When this inventory was conducted, the LLRWMO was operated by Atomic Energy of Canada (AECL) through a cost-recovery agreement with Natural Resources Canada (NRCan); the federal government department responsible for federal radioactive waste policy and that provides funding, direction and priorities for the LLRWMO.

In November 2014, Atomic Energy of Canada Limited (AECL) formed Canadian Nuclear Laboratories (CNL) as a wholly-owned subsidiary to continue delivering a wide range of programs including the LLRWMO's mandate. As this inventory is based on data up to and including December 31, 2013, all references to AECL are valid. Future editions of the Inventory of Radioactive Waste in Canada will replace references to AECL with CNL.

The information in this document provides an overview of the production, accumulation and projections of radioactive waste in Canada. Information and data on Canada's radioactive waste inventory is compiled from reporting provided by the waste owners and their waste management facilities.

In preparing this document, information and some excerpts were used from the *5th Canadian National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*.

Previous editions of the Inventory of Radioactive Waste are available on the LLRWMO website (www.llrwmo.org).

The following table presents a summary of the quantity of radioactive waste in Canada as of December 31, 2013, and the amount of waste generated in 2013.

Table i: Radioactive Waste in Canada Inventory Summary

Waste Category	Waste Inventory to end of 2013	Waste Generated in 2013
High-Level Radioactive Waste (HLRW)	10,021 m^3 (0.4%)	292 m^3 (6%)
Intermediate-Level Radioactive Waste (ILRW)	34,770 m^3 (1.5%)	180 m^3 (3%)
Low-Level Radioactive Waste (LLRW)	2,352,672 m^3 (98.1%)	4,793 m^3 (91%)
Total Cubic Metres:	2,397,463 m^3 (100%)	5,265 m^3 (100%)
Uranium Mill Tailings	216 million tonnes (54.7%)	0.7 million tonnes
Waste Rock	179 million tonnes (45.3%)	N/A*
Total Tonnes:	395 million tonnes (100%)	N/A

** N/A The status of the waste rock piles is inherently dynamic due to fluctuations in uranium prices, which determine the ratio of ore to waste rock. As a result, the annual generation rate can be deceptive and total inventory of waste rock is used to provide a more representative value.*


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1.1 Radioactive Waste Definition & Categories

Radioactive waste is any material (liquid, gas or solid) that contains a radioactive nuclear substance (as defined in section 2 of the *Nuclear Safety and Control Act*) and which the owner has determined to be waste. The Government of Canada is committed to the ongoing management of radioactive waste, by relevant responsible parties, in a safe and environmentally responsible manner.

There are three broad categories of radioactive waste:

- HIGH-LEVEL RADIOACTIVE WASTE (NUCLEAR FUEL WASTE)
- LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE (L&ILRW)
- URANIUM MINING AND MILLING WASTE (INCLUDING WASTE ROCK)

1.1.1 Processes that Generate Radioactive Waste in Canada

Radioactive waste is a by-product of Canada's use of nuclear technology. Radioactive waste is generated during various stages of the nuclear fuel cycle, including uranium mining, refining and conversion, nuclear fuel fabrication, nuclear power and research reactor operations, and decommissioning.

Figure A: Processes that Generate Radioactive Waste in Canada

Uranium Ore Mining & Processing

Milling (processing) of *uranium ore* produces *uranium concentrate.*

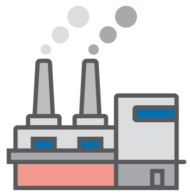
Uranium Mining & Milling Waste

Waste Rock (mineralized)
Mill Tailings

Mine Decommissioning
Mine shut down

Waste rock and uranium tailings exist at operating uranium mine and mill sites. Owing to the large volumes and low activity levels, tailings and waste rocks are decommissioned in place.

Historic LLRW (1930s-1970s)
Waste resulting from handling/transportation and processing & use



Refining

During refining, the ore concentrate from uranium milling operations is upgraded to *uranium trioxide.*

Conversion

The uranium trioxide is then converted to *ceramic grade uranium dioxide* for fabrication into fuel for CANDU reactors, or converted into uranium hexafluoride for foreign light water reactors.

Low-Level (Refining and Conversion)

Incinerable Waste
Scrap lumber, pallets, rags, paper, cardboard, rubber & plastic

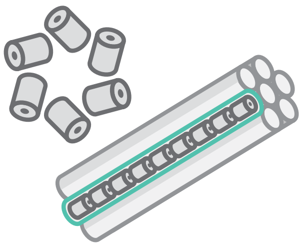
Non-Incinerable Waste
Air filters, fibreglass, PVC ductwork, floor sweepings, sandblast sand, insulation, sample bottles, scrap metal anodes

Other Waste
Recyclable scrap metal, Radioactive drain waste

Historic LLRW (1930s-1970s)
Waste resulting from handling/transportation and processing & use

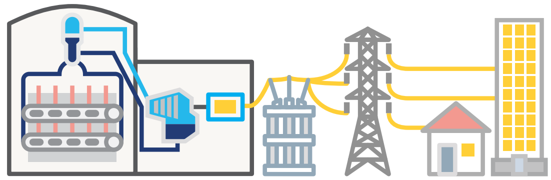
Low-Level

Other Waste
Rags, paper, gloves, oil & oil sludges, equipment & construction materials, filters & dust collectors



Fuel Fabrication and Fuel Bundle Production

During fuel fabrication, uranium dioxide is formed into pellets. *Fuel pellets* are then used in the manufacture of *fuel bundles* for reactors.



Nuclear Reactor

Fuel bundles are loaded into power reactors for the production of electricity, or into research reactors for research and development and the production of radioisotopes.

Approximately 15% of the uranium mined in Canada is used for domestic nuclear electricity production.

Low & Intermediate

Incinerable Waste
Paper, plastic, rubber, cotton, wood, organic liquids

Compactible Waste
Paper, plastic PVC suits, rubber, fibreglass, metal pieces, empty drums

Non-Processable Waste
Filters, light bulbs, cable, used equipment, metals construction debris, absorbents (sand vermiculite, sweeping compound), ion exchange resins, reactor core components, retube waste

Processable Liquids
Radioactive drain waste, chemical cleaning solutions

Low & Intermediate

Nuclear Reactor Decommissioning

1 PHASE

Incinerable Waste
Paper, plastic, rubber, cotton, wood

Compactible Waste
Paper, plastic PVC suits, rubber, fibreglass, metal pieces

Non-Processable Waste
Filters, used equipment, ion exchange resins, absorbents (sand, vermiculite, sweeping compound)

Processable Liquids
Radioactive drain waste, Decontamination Solutions

2 PHASE

Small Quantity of L&ILRW

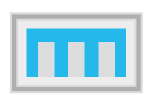
3 PHASE

Waste
Same as Phase 1
+ Active Systems (e.g. fuel channel components, calandria, reactor & shield tanks, piping, boilers)
+ Active Structures (e.g., biological shield, fuel bay)

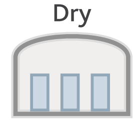
High-Level

**(Nuclear Fuel Waste)
Interim Storage**

Wet



Dry



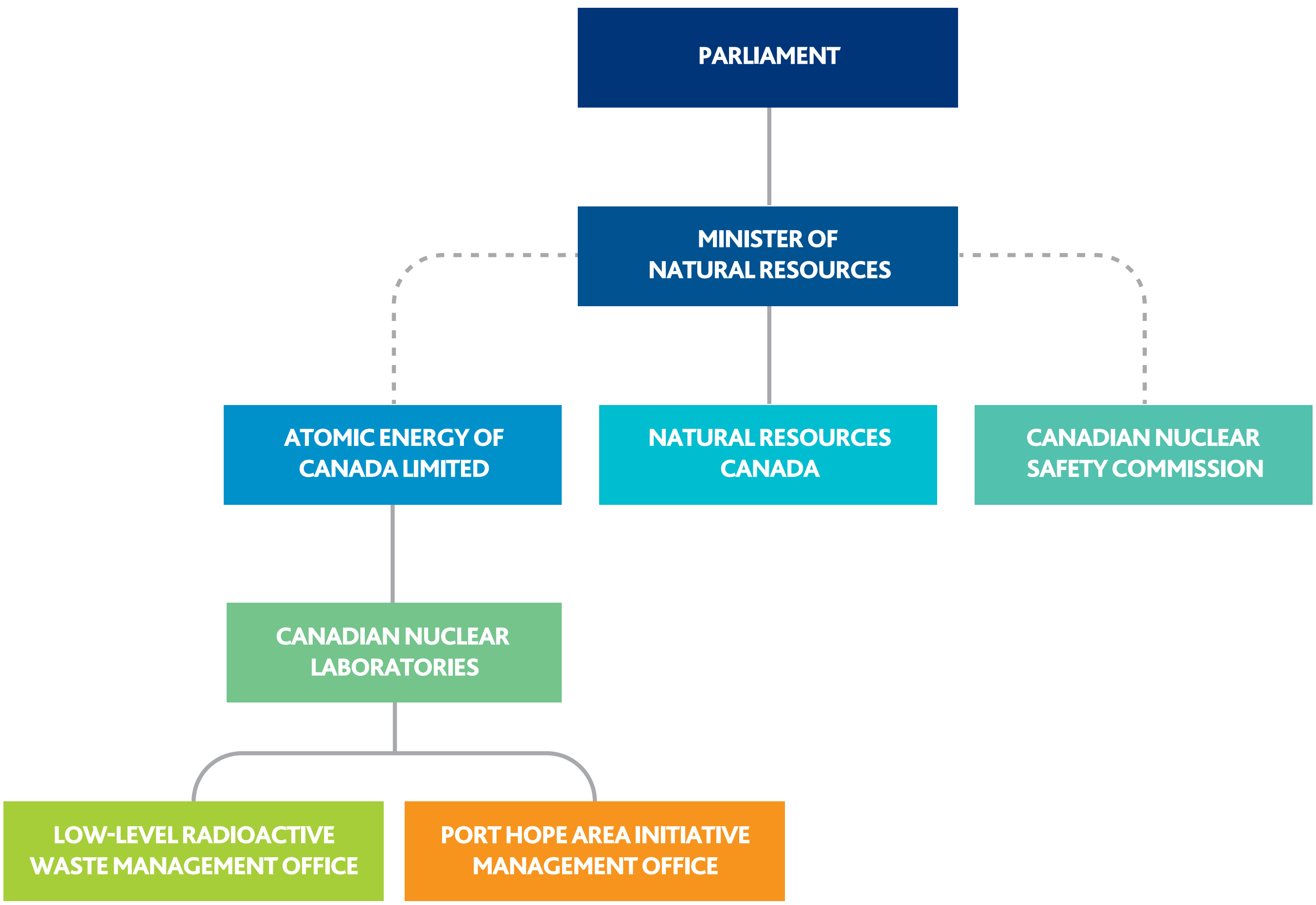
1.2 Responsibility for Radioactive Waste in Canada

Natural Resources Canada (NRCan) is the lead federal government department responsible for developing and implementing uranium, nuclear energy and radioactive waste management policies in Canada. (For more information refer to section on the Regulation of Radioactive Waste in Canada.)

In accordance with Canada's Radioactive Waste Policy Framework, the owners of radioactive waste are responsible for the funding, organization, and management of their respective waste in addition to the operation of long-term waste management facilities, as required.

In the case of historic LLRW, the Government of Canada has taken responsibility for its management on a case by case basis. It is also responsible for funding and providing oversight to a number of programs such as LLRWMO projects, the PHAI (historic LLRW) and for the Nuclear Legacy Liabilities Program (legacy waste).

Figure B: Government and Agencies Responsible for the Management of Radioactive Waste in Canada



1.2.1 The Regulation of Radioactive Waste in Canada

Radioactive waste in Canada is managed in a safe, secure and environmentally responsible manner in accordance with the requirements of Canada's independent nuclear regulator, the Canadian Nuclear Safety Commission (CNSC).

While federal departments or agencies have been assigned specific roles and responsibilities in regard to the safe management of radioactive waste, it is the CNSC that is responsible for the regulation of radioactive waste in Canada. The CNSC's mandate includes:

- regulating the use of nuclear energy and materials to protect health, safety, security and the environment;
- implementing Canada's international commitments on the peaceful use of nuclear energy; and
- disseminating objective scientific, technical and regulatory information to the public.

In regards to radioactive waste, the CNSC regulates and monitors Canada's radioactive waste management facilities to ensure they are operated safely; it imposes rigorous reporting requirements on the operators of radioactive waste management facilities, and it verifies that facilities comply with established safety requirements through inspections and audits. The CNSC's regulatory decision process is fully independent from the Government of Canada. In addition, the nuclear industry is subject to the provincial and territorial acts and regulations where nuclear-related activities are carried out. Where there is an overlap of jurisdictions and responsibilities, the CNSC takes the lead in harmonizing regulatory activities including the formation of joint regulatory groups involving provincial and territorial regulators.

1.2.2 Key Policies Governing Radioactive Waste in Canada

RADIOACTIVE WASTE POLICY FRAMEWORK (1996)

THE NUCLEAR SAFETY AND CONTROL ACT (NSCA)

THE 2002 NUCLEAR FUEL WASTE ACT (NFWA)

Radioactive Waste Policy Framework

Radioactive waste in Canada is managed in accordance with Canada's 1996 *Radioactive Waste Policy Framework*. The principles outlined in the document govern the institutional and financial aspects for disposal of radioactive waste by waste producers and owners. In summary, the principles include:

- The federal government will ensure that radioactive waste disposal is carried out in a safe, environmentally sound, comprehensive, cost-effective and integrated manner.
- The federal government has the responsibility to develop policy, to regulate, and to oversee producers and owners to ensure that they comply with legal requirements and meet their funding and operational responsibilities in accordance with approved waste disposal plans.
- The waste producers and owners are responsible, in accordance with the principle of "polluter pays", for the funding, organization, management and operation of disposal and other facilities required for their waste. This recognizes that arrangements may be different for HLRW, L&ILRW, and/or uranium mining and milling waste.

The Nuclear Safety and Control Act (NSCA)

The Government of Canada established the *Nuclear Safety and Control Act* (NSCA) to govern the development, production and use of nuclear energy and the production, possession and use of nuclear substances, equipment and information.

The CNSC regulatory framework consists of regulations and associated regulatory policies, standards and guides that apply to all nuclear industries including, but not limited to: nuclear power reactors; non-power nuclear reactors including research reactors; nuclear substances and radiation devices used in industry, medicine and research, the nuclear fuel cycle, from uranium mining through to waste management; and the import and export of controlled nuclear and dual-use substances, equipment and technology identified as a proliferation risk.

Nuclear Fuel Waste Act (NFWA)

The NFWA governs the long-term management of nuclear fuel waste (HLRW) in Canada. This Act sets out responsibilities for both the federal government and the nuclear fuel waste owners. It required the nuclear energy corporations to establish a waste management organization to develop and implement a long-term solution for the nuclear fuel waste produced in Canada. In 2002, the Nuclear Waste Management Organization (NWMO) was created to carry out this work. Under the Act, an important responsibility, among others, of the Government was to select an approach for the long-term management of nuclear fuel waste that is in the best interest of Canadians and the environment. On June 14, 2007, the Government of Canada announced that it had selected the Adaptive Phased Management (APM) approach, as recommended by the NWMO, for the long-term management of nuclear fuel waste in Canada. The NWMO is now required to implement the Government's decision pursuant to the NFWA and other relevant legislation.

The Minister of Natural Resources is responsible for administering the NFWA to ensure that the nuclear energy corporations and the NWMO comply with its requirements.

1.3 Radioactive Waste Locations in Canada

1.4 Radioactive Waste Projections

In order to assess the future requirements for the management of radioactive waste, projections of the inventory as of the end of 2016 and 2050 are also provided. The year 2016 was selected given that a new inventory will be conducted that year and will serve as a benchmark to assess the accuracy of the projections overall. The year 2050 is selected as a future reference because it is forecasted as the approximate end of operation for the Bruce Power and Darlington Generating station power reactors. Due to anticipated waste reduction activities, including incineration, waste volumes are projected to decrease in some instances.

Table ii: Future Waste Volumes (Projections to 2016 and 2050)

Waste Category	Waste Inventory to end of 2013	Waste Inventory Projected to end of 2016	Waste Inventory Projected to end of 2050[a]
High-Level Radioactive Waste	10,021 m^3	11,099 m^3	20,660 m^3
Intermediate-Level Radioactive Waste	34,770 m^3	38,762 m^3	67,738 m^3
Low-Level Radioactive Waste[b]	2,352,672 m^3	2,350,529 m^3	2,499,803 m^3
Uranium Mill Tailings	216 million tonnes	N/A	N/A
Waste Rock	179 million tonnes	N/A	N/A

Notes:

N/A – Not applicable. The known resources of uranium ore at mines that are currently in operation will be exhausted prior to 2050. No projections of uranium mine tailings or waste rock are provided due to the uncertainty associated with estimating the volume of waste from potential projects.

a Includes waste from Bruce A and Darlington to end of reactor life, which may extend slightly beyond 2050

b Due to anticipated waste reduction activities, including incineration, waste volumes are projected to decrease in some instances.

1.5 Decommissioning Definition & Process

Decommissioning is a general term for a formal process to remove something from an active status. Within the nuclear industry, decommissioning refers to those actions taken, in the interest of health, safety, security and protection of the environment, in order to retire a licensed activity/facility permanently from service.

Decommissioning of nuclear facilities, research and power reactors is considered complete once the planned decommissioning activities have been executed and all materials, waste, equipment, structures have been safely managed, including remediation of land. This ensures all risks to personnel, the public and the environment have been reduced or eliminated releasing the site/area from regulatory control requirements.

What is Decommissioning Waste?

A significant quantity of waste results from decommissioning nuclear reactors and their supporting facilities. This decommissioning waste will range from low-level radioactive waste (LLRW) to intermediate-level radioactive waste (ILRW). The LLRW is primarily mildly-contaminated building materials while the ILRW is associated with reactor core components.

The decommissioning information is listed under two separate categories which are L&ILRW and Uranium Mining & Milling Waste.

Prior to decommissioning, the fuel bundles are removed from the reactor core. Hence, this High-Level Radioactive Waste (HLRW) is not considered decommissioning waste.

Nuclear Reactor Decommissioning Phases

Based on current plans submitted to the CNSC, nuclear reactors will be decommissioned in three major phases:

- **Phase 1 (Isolate and Stabilization)**
  In this phase, decommissioning is expected to produce several hundred cubic metres of L&ILRW per reactor. Phase 1 will begin soon after reactor shutdown and last up to ten years. The purpose of Phase 1 is to isolate and stabilize the remaining reactor components for a long-term storage period to allow time for radioactivity levels to decay so that worker doses and the volume of radioactive waste generated by final decommissioning will be reduced.
- **Phase 2 (Storage-with-Surveillance)**
  This phase may last up to 65 years with very small amounts of waste generated.
- **Phase 3 (Dismantling)**
  This phase may last up to twenty years and will generate the majority of radioactive waste. At the end of Phase 3, the site would be suitable for either restricted or unrestricted use.

Note: Nuclear Fuel is removed from the reactor core prior to decommissioning.

What Decommissioning Projects are underway in Canada?

A number of decommissioning projects are underway at AECL's Chalk River and Whiteshell Laboratories under the federal government's Nuclear Legacy Liabilities Program, and generate L&ILRW. Most of the remaining nuclear infrastructure in Canada is operational or being refurbished. Preliminary decommissioning plans, including estimates of the volume of waste that will be generated during decommissioning, and financial guarantees are in place for the major facilities.

What is the Decommissioning Status of Reactors & Facilities in Canada?

Nuclear Fuel Fabrication Facilities

There were no decommissioning activities at the nuclear fuel fabrication facilities in 2013.

Power Reactors

Hydro-Québec's Gentilly-2 power reactor commenced Phase 1 of decommissioning in 2012. Final decommissioning plans, including estimated waste volumes are being developed; to date no decommissioning waste has been reported. Ontario Power Generation Reactor Units 2 and 3 at the Pickering Nuclear Generating Station are in Phase 2 decommissioning (storage-with-surveillance).

Research and Prototype Reactor and Facilities

There are three prototype power reactors, Douglas Point, Nuclear Power Demonstration (NPD) and Gentilly-1, located at Douglas Point and Rolphton, Ontario, and Bécancour, Québec, respectively. Each of these facilities has been partially decommissioned and is in Phase 2 decommissioning (storage-with-surveillance until at least 2025 at the earliest).

Decommissioning projects are ongoing at AECL's research facilities in Chalk River and Whiteshell. The WR-1 reactor at Whiteshell, (Pinawa, Manitoba) completed Phase 1 decommissioning in 1994 and is currently in Phase 2.

The University of Toronto completed decommissioning of its sub-critical assembly in 2000. Dalhousie University SLOWPOKE facility was decommissioned in 2011.

Radioisotope Processing and Use

There was no decommissioning waste generated in 2013 nor was there any inventory at the end of 2013 related to radioisotope production and use. The Nordion facility in Ottawa, Ontario, the main manufacturer of commercial isotopes, is relatively new and is not expected to generate decommissioning waste in the near future. Commercial isotope users may generate some small volumes of waste in the future during decommissioning or refurbishment of laboratories or other facilities.

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2.0 HIGH-LEVEL RADIOACTIVE WASTE (HLRW)

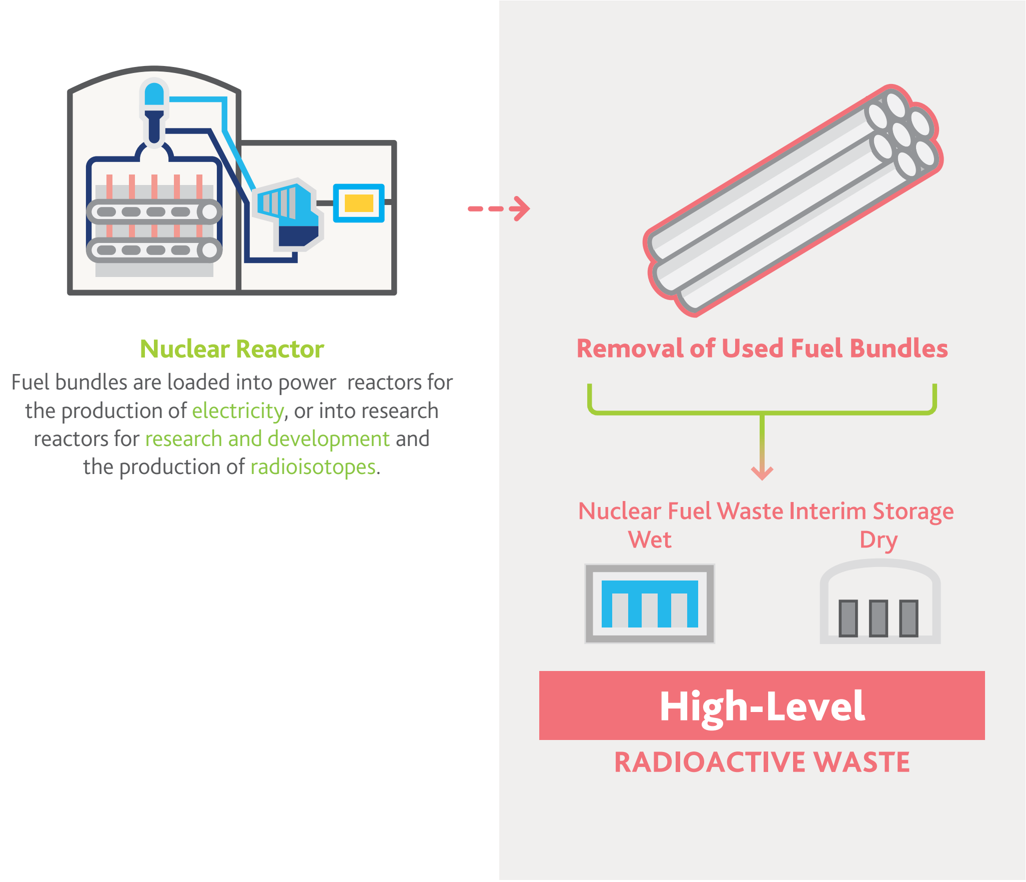
2.1 HLRW Definition

High-level radioactive waste (HLRW), as defined in the CSA standard N292.0-14, is used (irradiated) nuclear fuel that has been declared radioactive waste and/or waste that generates significant heat (typically more than 2 kilowatts per cubic metre) via radioactive decay. Some countries and agencies refer to this waste as "Spent Fuel"; however, in this report it is called HLRW because the discharged fuel is considered a waste material even when it is not fully spent.

In this report, all HLRW listed is in fact considered nuclear fuel waste as defined by Canadian legislation, namely the *Nuclear Fuel Waste Act*. The Act defines nuclear fuel waste as irradiated fuel bundles removed from a commercial or research nuclear fission reactor. However, the nuclear industry in Canada uses the term used nuclear fuel which is consistent with the CSA standard. Therefore, HLRW is used nuclear fuel resulting from the nuclear fuel cycle and includes waste from nuclear power plants, prototype and demonstration power reactors, and research and isotope production reactors.

HLRW is generated when nuclear fuel is removed from the reactors during operations or prior to decommissioning activities.

Figure C: How HLRW is generated



2.2 HLRW Locations

Where is HLRW stored in Canada?

Almost all nuclear generating stations and research reactor sites store HLRW (nuclear fuel waste) on site in either wet or dry interim storage (refer to following table).

2.3 HLRW Inventory

As of December 31, 2013, the total inventory of HLRW in Canada was 10,021 m^3 (or 2,478,197 nuclear fuel bundles as waste). The total HLRW inventory to the end of 2013 for power reactors was approximately 9,758 m^3 or 2,437,770 bundles.

As of December 31, 2013, the HLRW from the three shutdown prototype/demonstration reactors (Douglas Point, Gentilly-1, and NPD) remained at 122 m^3 (30,355 bundles). The balance of the inventory consists of 141 m^3 of HLRW (10,072 bundles, research rods, assemblies, units and items) from AECL's Chalk River and Whiteshell research reactors, as well as the McMaster Nuclear Reactor (MNR).

Table iii: HLRW Inventory - 2013

Site Name	Source Company Name	HLRW Generated in 2013		On-Site HLRW Inventory to December 31, 2013				
				Dry Storage	Wet Storage	Total Storage		
		Number of Fuel Bundles	Est Vol. (m^3)[a]	Number of Fuel Bundles	Number of Fuel Bundles	Number of Fuel Bundles	Est Vol. (m^3)[a]	Mass of Uranium (kg)
POWER REACTORS								
Bruce A	OPG	16,158	65	110,592	338,049	448,641	1,795	8,478,000
Bruce B	OPG	22,890	92	249,590	352,884	602,474	2,410	11,521,000
Darlington	OPG	19,953	80	120,151	335,150	455,301	1,821	8,712,000
Pickering A and B	OPG	13,399	54	270,804	405,255	676,059	2,704	13,422,000
Gentilly-2	Hydro-Québec	0	0	96,600	33,341	129,941	521	2,469,000
Point Lepreau	NB Power	0	0	87,480	37,874	125,354	507	2,366,558
Subtotal Power Reactors		72,400	291	935,217	1,502,553	2,437,770	9,758	46,968,558
PROTOTYPE/DEMONSTRATION/RESEARCH REACTORS								
Douglas Point	AECL	0	0	22,256	0	22,256	89	299,827
Gentilly-1	AECL	0	0	3,213	0	3,213	13	67,595
Chalk River Laboratories (items)[b]	AECL	84	1	7,349	431	7,780	131	35,599
Chalk River Laboratories (bundles)[c]	AECL	0	0	4,886	0	4,886	20	65,395
Whiteshell Laboratories[d]	AECL	0	0	2,268	0	2,268	9	21,540
McMaster Nuclear Reactor[b]	McMaster University	N/A	N/A	0	24	24	1	27
Subtotal Research Reactors[e]		84	1	39,972	455	40,427	263	489,983
TOTAL[f]		72,484	292	975,189	1,503,008	2,478,197	10,021	47,458,541

Notes:

N/A - Not available

a *HLRW volume calculated assuming a typical volume of 0.004 m^3 for a CANDU bundle, except for Chalk River Laboratories items.*

b *For research reactors, inventory is reported as the number of fuel assemblies, units and items.*

c *Includes fuel bundles from NPD reactor (4825 bundles) as well as fuel bundles from Pickering, Bruce, and Douglas Point reactors stored at Chalk River Laboratories.*

d *Includes 360 CANDU bundles and 1908 research reactor bundles from the WR-1 reactor.*

e *No HLRW is generated from ongoing activities at the four operating SLOWPOKE research reactors (École Polytechnique, Royal Military College of Canada, Saskatchewan Research Council, and University of Alberta).*

f *Includes CANDU fuel bundles as well as research rods , fuel assemblies, units and items.*

HLRW Generated in 2013

The operating power reactors generated 291 m^3 of HLRW (72,400 used nuclear fuel bundles) in 2013. There is 1 m^3 of HLRW (84 used nuclear fuel bundles at CRL) from research reactors.

Figure D: HLRW Inventory - 2013 by Waste Owner

- Hydro-Québec **521 m^3 (5%)**
- NB Power **507 m^3 (5%)**
- AECL **263 m^3 (3%)***
- OPG Total **8,730 m^3 (87%)**

Total 2013 Inventory = 10,021 m^3

* includes 1 m^3 of waste at McMaster University

Reactor Waste

Power Reactors

Operation of power reactors generates HLRW (nuclear fuel waste). In Canada, there are 22 power reactors owned by three provincial electric utilities. Ontario Power Generation Inc. (OPG) owns 20 reactors while Hydro-Québec and New Brunswick Power each own one reactor. Hydro-Québec's Gentilly-2 is now in safe shutdown. The 19 operating reactors have a total generation capacity of 15,000 megawatts of electricity.

HLRW, a by-product of nuclear power generation, is currently safely managed in facilities licensed for interim storage at nuclear reactor sites in Ontario, Quebec and New Brunswick. The waste will remain at these sites until a deep geological repository becomes operational.

Nuclear Prototype Demonstration, Research and Development Reactors

Currently, there are two nuclear research facilities in Canada licensed by the CNSC and operated by AECL in Chalk River, Ontario, and Pinawa, Manitoba. Any operational HLRW generated at these two sites is safely managed on site. There is also a small amount of HLRW resulting from past operation of nuclear power demonstration reactors, and this HLRW is currently safely managed on site or at Chalk River Laboratories.

- **Chalk River Laboratories, Chalk River, Ontario**
  Chalk River Laboratories (CRL) has two operating reactors, the National Research Universal (NRU) reactor and the Zero Energy Deuterium (ZED-2) reactor. Research and development activities at CRL include all aspects of nuclear science, reactor development, environmental science and L&ILRW management, and the production of medical isotopes.

- **Whiteshell Laboratories, Pinawa, Manitoba**
  Whiteshell Laboratories (WL) is shutdown and undergoing decommissioning. The AECL-WL decommissioning licence was renewed in December 2008 for a period of ten years. The WR-1 reactor has been partially decommissioned (currently in storage with surveillance) and the SLOWPOKE Demonstration Reactor has been fully decommissioned. The HLRW (nuclear fuel bundles) removed prior to decommissioning is stored on the WL site.

- **University Reactors**
  A small amount of fuel waste is also stored at the research reactor at McMaster University in Hamilton, Ontario. Other university reactors, listed in the table below, do not store HLRW on site.

Table iv: CNSC Licensed Operating Research Reactors

Licensee	Location	Type and Capacity
McMaster University	Hamilton, Ontario	Pool-type 5 MW(t)
École Polytechnique	Montréal, Québec	SLOWPOKE-2, 20 kW(t)
University of Alberta	Edmonton, Alberta	SLOWPOKE-2, 20 kW(t)
Saskatchewan Research Council	Saskatoon, Saskatchewan	SLOWPOKE-2, 20 kW(t)
Royal Military College of Canada	Kingston, Ontario	SLOWPOKE-2, 20 kW(t)
Atomic Energy of Canada Limited	Chalk River, Ontario	NRU and ZED-2

2.4 HLRW Projections

Future HLRW projections for 2016 and 2050 are 11,099 m^3 and 20,660 m^3 respectively, based on the assumption that no additional nuclear generating stations will be commissioned before the year 2050, and that all current operating reactors will have ceased operations by 2050.

Projected waste quantities were provided by the utilities operating the power reactors and are based on the current operating plans for each reactor. End of operations for the operating power reactors range from year 2020 to 2055. Total projected lifetime inventory of HLRW (nuclear fuel waste) from these power reactors is approximately 20,380 m^3 (5.1 million bundles).

Projected HLRW (nuclear fuel waste) inventory to 2050 for the existing prototype/demonstration and research reactors owned by AECL is approximately 274 m^3.

Figure E: HLRW Projections - 2050

Hydro-Québec **521 m^3 (3%)**

NB Power **1,052 m^3 (5%)**

AECL **280 m^3 (1%)***

OPG Total (incl. Bruce) **18,807 m^3 (91%)**

Projected 2050 Inventory = 20,660 m^3

* includes 6 m^3 of waste at McMaster University

Canadian Nuclear Laboratories
Laboratoires Nucléaires Canadiens

Table v: HLRW Projections - 2016 and 2050

Site Name	Source Company Name	Reactor Status as of Dec 2013	End of Reactor Operations	Projected HLRW Inventory to the End of 2016		Projected HLRW Inventory to the End of 2050[a,h]	
				Number of Fuel Bundles	Est. Vol. (m^3)[b]	Number of Fuel Bundles	Est. Vol. (m^3)[b]
Power Reactors							
Bruce A	OPG	Operating	2042-2054	508,159	2,033	1,156,270	4,625
Bruce B	OPG	Operating	2047-2050	671,530	2,686	1,395,353	5,581
Darlington	OPG	Operating	2049-2055	522,767	2,091	1,322,927	5,292
Pickering A and B	OPG	Operating - units 2 and 3 shutdown	2020	728,706	2,915	827,215	3,309
Gentilly-2	Hydro-Québec	Shutdown / decommissioning	2012	129,941	521	129,941	521
Point Lepreau	NB Power	Operating	2032	144,722	585	260,156	1,052
Subtotal Power Reactors				2,705,825	10,831	5,091,862	20,380
Prototype/Demonstration/Research Reactors							
Douglas Point	AECL	Shutdown and partially decommissioned	1984	22,256	89	22,256	89
Gentilly-1	AECL	Shutdown and partially decommissioned	1978	3,213	13	3,213	13
Chalk River Laboratories (items)[c]	AECL	Operating	2021 or later[g]	8,105	136	8,647	143
Chalk River Laboratories (bundles)[e]	AECL	Shutdown and partially decommissioned	1987	4,886	20	4,886	20
Whiteshell Laboratories[f]	AECL	Shutdown and partially decommissioned	1997	2,268	9	2,268	9
McMaster Nuclear Reactor[c]	McMaster University	Operating	--	36	1	85	6
Subtotal Nuclear Reactors[i]				40,764	268	41,355	280
TOTAL[d]				2,746,589	11,099	5,133,217	20,660

Notes:

N/A - Not available

a Waste forecasts to end of 2050 based on projected generation rates for 2013 if no other data was provided.

b HLRW volume calculated assuming a typical volume of 0.004 m^3 for a CANDU bundle, except for Chalk River Laboratories items.

c For research reactors, inventory is reported as the number of fuel assemblies, units and items.

d Includes CANDU fuel bundles as well as research rods, fuel assemblies, units and items.

e Includes fuel bundles from NPD reactor (4,825 bundles) as well as fuel bundles from Pickering, Bruce, and Douglas Point reactors stored at Chalk River Laboratories.

f Includes 360 CANDU bundles and 1,908 research reactor bundles from the WR-1 reactor.

g Forecasted end of operations for Chalk River Laboratories selected as 2050 to compare fuel inventories; for planning purposes, end of operations for CRL is currently indicated by AECL as indefinite.

h Projected to end of reactor operations (Bruce A and Darlington beyond 2050).

i No HLRW is generated from ongoing activities at the four operating SLOWPOKE research reactors (École Polytechnique, Royal Military College of Canada, Saskatchewan Research Council, and University of Alberta).

Canada's Plan for the Long-Term Management of HLRW

Currently, Canada's HLRW is safely stored on an interim basis at licensed facilities. The HLRW will remain at these sites until a deep geological repository solution becomes available for its long-term management.

When HLRW (nuclear fuel waste) is removed from a reactor, it remains a potential health risk for many hundreds of thousands of years and must be safely isolated from people, animals, and the environment indefinitely. The Nuclear Waste Management Organization (NWMO) was established in 2002, in accordance with the *Nuclear Fuel Waste Act*, to assume responsibility for long-term management of Canada's nuclear fuel waste. In 2007, the Adaptive Phased Management (APM) approach was selected by Canada for the long-term management of this waste. The APM is both a technical method and a management system with an emphasis on adaptability that provides containment and isolation of this waste in a deep geological repository. The end point of this plan is to identify a safe site, within a willing host community, to build a repository for managing the waste over the long term. This high-technology national infrastructure initiative will unfold over many decades and will be subject to extensive regulatory approvals and oversight. More information is available at: **www.nwmo.ca**.


RADIUM 303.

3.0 LOW & INTERMEDIATE-LEVEL RADIOACTIVE WASTE (L&ILRW)

3.1 L&ILRW Definition

L&ILRW includes all non-fuel waste arising from the activities associated with nuclear electricity generation, from nuclear research and development, and from the production and use of radioisotopes in medicine, education, research, agriculture and industry.

Low-Level Radioactive Waste

Low-level radioactive waste (LLRW), as defined in the CSA standard N292.0-14, contains material with radionuclide content above established clearance levels and exemption quantities, and generally limited amounts of long-lived radioactivity. LLRW generally does not require significant shielding during handling and interim storage. LLRW requires isolation and containment for up to a few hundred years, however, longer periods are required for LLRW containing long-lived radium or longer-lived uranium.

Examples of LLRW are contaminated materials, rags and protective clothing. It also includes contaminated soil and related waste resulting from the very early operations of Canada's radium industry.

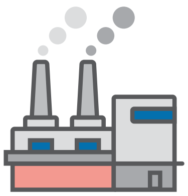
Intermediate-Level Radioactive Waste

Intermediate-level radioactive waste (ILRW) , as defined in the CSA standard N292.0-14, is waste that typically exhibits sufficient levels of penetrating radiation to warrant shielding during handling and interim storage. This type of radioactive waste generally requires little or no provision for heat dissipation during its handling, transportation and long-term management. However, some ILRW may have heat generation implications in the short term (e.g., refurbishment waste) because of its total radioactivity level. Ion exchange resins and filters are examples of ILRW.

Types of L&ILRW

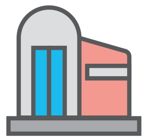
- **Historic Waste**
  LLRW that was managed in the past in a manner no longer considered acceptable but for which the current owner cannot reasonably be held responsible and for which the federal government has accepted responsibility for its long-term management.
- **Ongoing Waste**
  L&ILRW that is generated from ongoing operations and decommissioning activities of nuclear facilities that are currently operational, for example, nuclear electricity generators and research reactors. Owners or producers of ongoing waste are responsible for its management.

Figure F: How L&ILRW is Generated



Refining

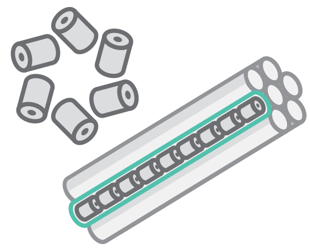
During refining, the ore concentrate from uranium milling operations is upgraded to *uranium trioxide.*



Conversion

The uranium trioxide is then converted to *ceramic grade uranium dioxide* for fabrication into fuel for CANDU reactors, or converted into uranium hexafluoride for foreign light water reactors.

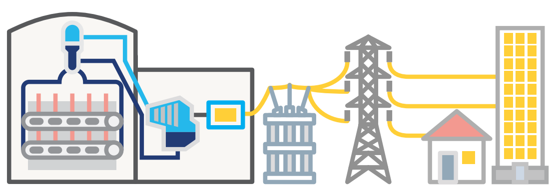
Low-Level
RADIOACTIVE WASTE



Fuel Fabrication and Fuel Bundle Production

During fuel fabrication, uranium dioxide is formed into pellets. *Fuel pellets* are then used in the manufacture of *fuel bundles* for reactors.

Low-Level
RADIOACTIVE WASTE



Nuclear Reactor

Fuel bundles are loaded into power reactors for the production of electricity, or into research reactors for research and development and the production of radioisotopes.

Approximately 15% of the uranium mined in Canada is used for domestic nuclear electricity production.

Low & Intermediate
RADIOACTIVE WASTE

3.2 L&ILRW Locations

3.3 L&ILRW Inventory

At the end of 2013, there was about 2.39 million m^3 of L&ILRW stored in Canada. Approximately 2.35 million m^3 of the overall waste is considered LLRW, with the remainder being ILRW. The intermediate-level waste includes approximately 340 m^3 of liquid ILRW stored in tanks at CRL. Most of Canada's LLRW is characterized as Historic Waste – mainly contaminated soils. Only 27% of Canada's LLRW is ongoing waste. At present, L&ILRW is safely managed throughout the country either in-situ or at interim/long-term management facilities.

Table vi: L&ILRW Inventory - 2013

Overall Category	Site Name	Responsible Party	LLRW				ILRW	
			Generated in 2013 (m^3)	Waste (m^3)	Cont. Soil (m^3)	Inventory Total (m^3)	Generated in 2013 (m^3)	Inventory Total (m^3)
ONGOING OPERATIONS WASTE	Nuclear Fuel Fabrication Facilities & Power Reactors							
	Western Waste Management Facility (WWMF)*	OPG	3,370	83,880	0	83,880	40	11,850
	Pickering Waste Management Facility	OPG	0*	0	0	0	0*	2,210[g]
	Radioactive Waste Operations Site-1 (RWOS-1) (in storage with surveillance)	OPG	0	330	0	330	0	10
	Gentilly-2	Hydro-Québec	0	1,281	0	1,281	0	344
	Point Lepreau	NB Power	94	2,911	0	2,911	0	162
	Port Hope Conversion Facility (operational)	Cameco Corp.	0	7,000	0	7,000	0	0
	Blind River Refinery (process waste)	Cameco Corp.	0	6,300	0	6,300	0	0
	Cameco Fuel Manufacturing (Zircatec)	Cameco Corp.	0	1,400	0	1,400	0	0
	Subtotal (Nuclear Fuel Fabrication etc.)		3,464	103,102	0	103,102	40	14,576
	Nuclear R&D[a]							
	Douglas Point	AECL	0	0	66	66	0	0
	Gentilly-1	AECL	0	0	1	1	0	0
	Chalk River Laboratories[b,e]	AECL	1,114	101,257	382,841	484,098	91	18,948
	Whiteshell Laboratories[e]	AECL	0	19,885	0	19,885	0	863
	Subtotal (Nuclear R&D)		1,114	121,142	382,908	504,050	91	19,811
	Radioisotope Production and Use							
	Chalk River Laboratories[c]	AECL	43	19,660	1	19,661	22	181
	Subtotal (Radioisotope)		43	19,660	1	19,661	22	181
	Subtotal (Operations)		4,621	243,904	382,909	626,813	153	34,568

Overall Category	Site Name	Responsible Party	LLRW				ILRW	
			Generated in 2013 (m^3)	Waste (m^3)	Cont. Soil (m^3)	Inventory Total (m^3)	Generated in 2013 (m^3)	Inventory Total (m^3)
ONGOING DECOMMISSIONING WASTE	**Nuclear Fuel Fabrication Facilities & Power Reactors**							
	Western Waste Management Facility (WWMF)	OPG	0	0	0	0	0	0
	Pickering Waste Management Facility	OPG	0	0	0	0	0	0
	Radioactive Waste Operations Site-1 (RWOS-1)	OPG	0	0	0	0	0	0
	Gentilly-2	Hydro-Québec	0	0	0	0	0	0
	Point Lepreau	NB Power	0	0	0	0	0	0
	Subtotal (Nuclear Fuel Fabrication etc.)		0	0	0	0	0	0
	Nuclear R&D[a]							
	Douglas Point	AECL	1	82	3	85	0	61
	Gentilly-1	AECL	0.2	743	184	927	0	27
	NPD	AECL	1.4	23.4	0	23.4	0	0
	Chalk River Laboratories[d,e]	AECL	45	2,071	91	2,162	27	92
	Whiteshell Laboratories[d,e]	AECL	125	622	116	738	0.16	22
	Subtotal (Nuclear R&D)		173	3,541	394	3,935	27	202
	Radioisotope Production and Use							
	Chalk River Laboratories	AECL	0	0	0	0	0	0
	Subtotal (Radioisotope)		0	0	0	0	0	0
	Subtotal (Decommissioning)		173	3,541	394	3,935	27	202
	Total Ongoing Waste		4,793	247,445	383,303	630,748	180	34,770
HISTORIC & DELORO WASTE	Port Hope	AECL	0	0	720,000	720,000	0	0
	Welcome	AECL	0	0	454,380	454,380	0	0
	Port Granby	AECL	0	0	438,200	438,200	0	0
	Northern Transportation Route	AECL-LLRWMO	0	0	54,403	54,403	0	0
	Greater Toronto Area - including PTBO[f]	AECL - LLRWMO / Regional Municipality of Peel, Ontario	0	0	15,941	15,941	0	0
	CRL Area D	AECL-LLRWMO	0	0	1,000	1,000	0	0
	Deloro	Ontario Ministry of the Environment	0	0	38,000	38,000	0	0
	Total Historic Waste		0	0	1,721,924	1,721,924	0	0
	TOTALS		4,793	247,445	2,105,227	2,352,672	180	34,770

Notes:

** The L&ILRW generated from power reactors Bruce A and B, Darlington, and Pickering A and B is stored at the WWMF.*

a LLRW waste generated at university research reactors is left to decay and disposed of with regular waste.

b LLRW includes all waste prior to 2005 that was not differentiated between LLRW and ILRW - ILRW has only been designated as such from Jan 1, 2005 to present.

c LLRW is total inventory, but ILRW only from Jan 1, 2005 to present.

d Decommissioning waste only from Jan 1, 2005 to present.

e Volumes are based on method of storage, and do not necessarily represent the actual breakdown of waste into low and intermediate level radioactive waste.

f GTA sites are exempted from the requirement to licence until 2016. The Passmore, Lakeshore Road and Peterborough sites were released from requirement to licence in 2009.

g Interim storage of intermediate-level reactor refurbishment waste from Pickering A.

Figure G: L&ILRW Inventory - 2013

Ongoing Operational & Decommissioning LLRW **630,748 m³ (26%)**

Ongoing Operational & Decommissioning ILRW **34,770 m³ (2%)**

Historic & Deloro LLRW **1,721,924 m³ (72%)**

At the end of 2013, there was 2,387,442 m³ of L&ILRW in Canada.

3.3.1 Historic Waste

The Low-Level Radioactive Waste Management Office, on behalf of the federal government, is responsible for the cleanup and long-term management of historic waste in Canada, with the exception of Port Hope, Ontario, where this responsibility is shared with the Port Hope Area Initiative Management Office.

In some instances, remedial actions are required on properties not owned by the federal government but where the original owner no longer exists. In these situations, the federal government may make a determination to accept responsibility for management of this waste on a case-by-case basis. In March 2001, the Government of Canada and the local municipalities in the Port Hope area of southern Ontario entered into an agreement on community-developed proposals to address the cleanup and long-term management of the bulk of Canada's historic waste, thereby launching the Port Hope Area Initiative (PHAI). In 2012, the Government of Canada announced $1.28 billion in funding to implement the PHAI.

Historic waste is stored at various locations across Canada including sites in Ontario, Alberta, and the Northwest Territories. At many of these sites, materials have been placed in interim storage pending the development and implementation of a long-term management approach. At other sites, the waste is in long-term storage. Ongoing site monitoring, inspection and maintenance are conducted at all storage and in situ sites by the LLRWMO.

The waste at some of these sites includes artefacts or surface-contaminated building materials. Other sites contain large volumes of radium-contaminated soil with low radioactivity. Larger volumes of contaminated soil that cannot be accommodated in LLRWMO storage buildings are managed at or near the source.

How did Historic LLRW originate?

Historic LLRW originated from the past due to the handling, transportation and use of uranium ore. In years past, handling and disposal practices in the industry were not as advanced as today's standard of knowledge and established guidelines. In the 1930s, uranium (pitchblende ore) was discovered in Port Radium, Northwest Territories. By 1932, Eldorado Gold Mines Limited had established a mine in Port Radium and a refining facility in Port Hope, Ontario. As the ore was shipped to southern Ontario, it first traveled along the Northern Transportation Route (NTR), a 2,200 km route comprised of waterways and portages between Port Radium, Northwest Territories and Fort McMurray, Alberta. There, rail cars were loaded with the ore and it was shipped to Port Hope, Ontario to be refined.

Between the 1930s and the 1960s some spillage occurred at the transfer points along the route as the ore was transferred to planes, boats, trucks and trains, and then to the refinery. Discovery of instances of contamination began in the early 1970s and continued with formal identification of contamination along the NTR, at the refinery in Port Hope and surrounding area, and at other areas in southern Ontario associated with radium recovery operations and radium dial painting.

How much Historic LLRW is in Canada?

The total inventory of historic LLRW is approximately 1,683,924 m^3 (as of December 31, 2013).

Port Hope Area, Ontario

The majority of historic LLRW in Canada (>95%) is located in the Port Hope area. The 1,612,580 m^3 located in the Port Hope area includes 454,380 m^3 of LLRW managed at the Welcome Waste Management Facility (Municipality of Port Hope) and 438,200 m^3 of LLRW managed at the Port Granby Waste Management Facility (Municipality of Clarington).

Northern Transportation Route (NTR), Northwest Territories-Alberta

The NTR volume of 54,403 m^3 includes 43,282 m^3 of waste at the Beacon Hill Mound contained within the Beacon Hill landfill in Fort McMurray, Alberta. The rest of the total volume relates to consolidated and unconsolidated wastes at other locations in the Sahtu and South Slave regions of the Northwest Territories and Northern Alberta.

Greater Toronto Area (GTA), Ontario

The GTA volume of 15,941 m^3 includes 9,077 m^3 of historic waste from the Passmore Avenue (Malvern) mound in Scarborough, Ontario. The rest of the total volume relates to consolidated and unconsolidated wastes at other locations in Toronto, Mississauga, Mono Mills, and Peterborough, Ontario.

Table vii: Historic LLRW Inventory - 2013 (by location)

Site Name or Location	Licensee or Responsible Party	Description of Stored Waste	Storage Method	LLRW Volume (m^3)
Port Hope	AECL	Waste and contaminated soil	In situ and consolidated storage	720,000
Welcome Waste Management Facility	AECL	Waste and contaminated soil	In situ and consolidated storage	454,380
Port Granby	AECL	Waste and contaminated soil	In situ and consolidated storage	438,200
Northern Transportation Route	AECL	Waste and contaminated soil	In situ and consolidated storage	54,403
Greater Toronto Area	AECL Regional Municipality of Peel, Ontario	Radium-contaminated soil, radium contamination fixed to structural elements in buildings	In situ and consolidated storage	15,941
Chalk River Laboratories	AECL	Packaged soil and artefacts	Consolidated storage (Buildings, containers and luggers)	1,000
Total				1,683,924

Deloro Waste

Deloro waste is LLRW that was produced from reprocessing uranium mill tailings to extract cobalt at Deloro, Ontario. While it is a result of past practices for which the original owner cannot be reasonably held responsible, it is not waste the federal government has accepted responsibility for; therefore, it is listed as a separate volume under LLRW resulting from historic practices as it does not meet the full criteria for definition as "Historic Waste."

The provincial government of Ontario has accepted responsibility for this waste and the Ontario Ministry of the Environment (MOE) is responsible for the cleanup of the former Deloro Mine Site. There is approximately 38,000 m^3 of LLRW contaminated soil and historic tailings at the site.

Deloro Waste Inventory - 2013

Site Name or Location	Licensee or Responsible Party	Description of Stored Waste	Storage Method	LLRW Volume (m^3)
Deloro Mine Site	Ontario Ministry of the Environment (OMOE)	Contaminated soil and historic tailings	In situ	38,000

3.3.2 Ongoing Waste

Ongoing waste accumulates on a regular basis and is the responsibility of its producer. L&ILRW is waste that is generated from ongoing operation and decommissioning activities of nuclear facilities that are currently operational including nuclear electricity generators and research reactors. Owners or producers of ongoing waste are responsible for its current and long-term management.

How is Ongoing L&ILRW generated?

Ongoing waste results from two distinct activities:

- OPERATIONS
- DECOMMISSIONING

Ongoing operations and decommissioning waste is generated from the following facilities:

- NUCLEAR FUEL FABRICATION FACILITIES
- POWER REACTORS
- NUCLEAR RESEARCH AND DEVELOPMENT FACILITIES (AND ASSOCIATED REACTORS)
- RADIOISOTOPE PRODUCTION AND USE FACILITIES

Note: Fabrication facilities in this section includes refining and conversion facilities

How much Ongoing L&ILRW is in Canada?

The total ongoing L&ILRW inventory as of December 31, 2013 was 665,518 m^3 (630,748 m^3 of LLRW and 34,770 m^3 of ILRW). The ongoing waste generated in 2013 was approximately 4,973 m^3 (4,793 m^3 of LLRW and 180 m^3 of ILRW).

Figure H: L&ILRW Inventory - 2013 (Ongoing Waste by Waste Owner)

- OPG **98,280 m^3 (14.8%)**
- Hydro-Québec **1,625 m^3 (<1%)**
- NB Power **3,072 m^3 (<1%)**
- Cameco **14,700 m^3 (2%)**
- AECL **547,840 m^3 (82%)**

(excludes Historic and Deloro Waste)

Figure I: L&ILRW Inventory - 2013 (Ongoing Operations & Decommissioning)

- Nuclear Fuel Fabrication Facilities & Power Reactors ILRW **14,576 m^3 (2%)**
- R&D ILRW **19,811 m^3 (3%)**
- Isotope ILRW **181 m^3 (<1%)**
- Decom ILRW **202 m^3 (<1%)**
- Decom LLRW **3,935 m^3 (<1%)**
- Isotope LLRW **19,661 m^3 (3%)**
- Nuclear Fuel Fabrication Facilities & Power Reactors LLRW **103,102 m^3 (15%)**
- R&D LLRW **504,050 m^3 (75%)**

At the end of 2013, there was 665,518 m^3 of Ongoing L&ILRW in Canada from operations & decommissioning (excludes Historic and Deloro Waste).

3.3.2.1 Operations Waste

The total ongoing operations waste inventory at the end of 2013 was 661,381 m^3 of both LLRW and ILRW combined (626,813 m^3 of LLRW and 34,568 m^3 of ILRW). Nuclear fuel fabrication facilities and power reactors account for 117,677 m^3 of the overall total.

Nuclear Fuel Fabrication Facilities and Power Reactors

In 2013, about 4,621 m^3 of LLRW and 153 m^3 of ILRW was generated from operational activities with the 19 operating power reactors in Canada generating 3,464 m^3 and 40 m^3 of LLRW and ILRW, respectively.

Ontario Power Generation Inc. (including Bruce Power Inc.) operated a total of 18 reactors and generated the majority of the waste in 2013 (3,370 m^3 of LLRW and 40 m^3 of ILRW). Hydro-Québec did not generate any operational waste in 2013 as its reactor was shut-down in 2012, and New Brunswick Power generated only 94 m^3 of LLRW and no ILRW. No L&ILRW was generated in 2013 as reported by the uranium refining, conversion companies and nuclear fuel fabrication facilities.

Radioisotope Production and Use

Waste in this category is generated by radioisotope users from across Canada and eventually sent to AECL-CRL for storage. The total inventory of radioisotope-related L&ILRW waste increased to 19,842 m^3. In 2013, approximately 43 m^3 of LLRW and 22 m^3 of ILRW was sent to AECL.

Nuclear Research and Development

Total waste inventory, as of December 31, 2013, attributed to research and development was 523,861 m^3 of L&ILRW. AECL has about 382,908 m^3 of contaminated soil resulting from its long history of nuclear research and development. This soil also contains waste that was removed from various locations across Canada including several sites within Ontario in the 1970s. In addition, some volumes of L&ILRW from other producers are managed at AECL's Chalk River Laboratories. Nuclear research and development activities at AECL generated 1,114 m^3 of LLRW and 91 m^3 of ILRW in 2013.

Table viii: L&ILRW Inventory - 2013 (Ongoing Operations Waste)

Radioactive Waste management Facility	Responsible Party	Description of Stored Waste	Storage Method	LLRW Vol (m^3)	ILRW Vol (m^3)
Western Waste Management Facility (WWMF)	OPG	Interim storage of low- and Intermediate-level reactor waste generated from Bruce A and B, Darlington, Pickering A and B	ILRW: In-ground storage structures (trenches, tileholes, in-ground containers) and above-ground storage structures (retube waste storage building, quadricells) LLRW: Above-ground storage structures (low-level storage buildings, steam generator storage buildings)	83,880	11,850
Pickering Waste Management Facility	OPG	Interim storage of intermediate-level reactor refurbishment waste from Pickering A	ILRW: Dry storage modules (DSM)	N/A	2,210
Gentilly-2	Hydro-Québec	Operational reactor waste	ILRW: ASDR and IGDRS (concrete cells) LLRW: ASDR and IGDRS (concrete cells)	1,281	344
Point Lepreau	NB Power	Operational waste, drums, filters and compactible waste	LLRW: Concrete vault structures ILRW: Concrete vault structures	2,911	162
Chalk River Laboratories	AECL	Research reactor and isotope production waste as well as external waste	ILRW: Tile holes and bunkers LLRW: Sand trenches, low-level storage buildings, above ground stockpiles, MAGS, and Bulk material landfill	120,917*	19,129*
		Contaminated soil	LLRW/ILRW: SMAGS Luggers, 205 litre steel drums, B-25 containers in SMAGS, sand trenches, above-ground stockpiles	382,841	nil
Whiteshell Laboratories	AECL	Research reactor waste and decommissioned reactor waste	ILRW: In-ground concrete bunkers LLRW: Above-ground concrete bunkers	19,885*	863*
Douglas Point Waste Management Facility	AECL	Contaminated soil	LLRW: 205-litre drums	66	nil
Gentilly-1 Waste Management Facility	AECL	Contaminated soil	LLRW: 205-litre drums	1	nil
Port Hope Conversion Facility	Cameco	Non-combustible process waste	LLRW: 205-litre drums	7,000	nil
Blind River Refinery	Cameco	Non-combustible process waste	LLRW: 205-litre drums	6,300	nil
Cameco Fuel Manufacturing	Cameco	Non-combustible process waste	LLRW: 205-litre drums	1,400	nil
Radioactive Waste Operations Site-1 (RWOS-1)	OPG	Interim storage of low- and intermediate-level reactor waste generated from Douglas Point and Pickering A	ILRW: In-ground storage structures (trenches, tileholes) LLRW: In-ground storage structures (trenches)	330	10
Total				626,813	34,568

** Volumes are based on method of storage and do not necessarily represent the actual breakdown of waste into intermediate and low-level.*

3.3.2.2 Decommissioning Waste (L&ILRW)

As of December 31, 2013, the total inventory of L&ILRW from decommissioning activities is 4,137 m^3 (3,935 m^3 of LLRW and 202 m^3 of ILRW) all of which resulted from research and development facilities, including prototype reactors. The waste generation rate for 2013 was 173 m^3 of LLRW and 27 m^3 of ILRW primarily from decommissioning waste generated at Chalk River and Whiteshell Laboratories.

Table ix: L&ILRW Inventory - 2013 (Decommissioning Waste)

Site Name/ Location	Responsible Party	Reactor Type	Description of Waste Stored	Storage Method	Reactor Status	LLRW Vol (m^3)	ILRW Vol (m^3)
Whiteshell Laboratories[a]	AECL	Research	Decommissioning waste (Jan 1, 2005 to December 31, 2013)	ILRW: In-ground, concrete bunkers LLRW: Above-ground, concrete bunkers	Phase 2 decommissioning	738	22
Chalk River Laboratories[a]	AECL	Research	Decommissioning waste (Jan 1, 2005 to December 31, 2013)	ILRW: Tile holes and bunkers LLRW: MAGS, SMAGS[c]	Phase 2 & Phase 3 decommissioning	2,162	92
Douglas Point Waste Management Facility	AECL	Prototype	Decommissioned reactor waste	Reactor building	Phase 2 decommissioning	85	61
Nuclear Power Demonstration Waste Management Facility	AECL	Prototype	Decommissioned reactor waste	Reactor building	Phase 2 decommissioning	23.4[b]	nil
Gentilly-1 Waste Management Facility	AECL	Prototype	Decommissioned reactor waste	Reactor building	Phase 2 decommissioning	927	27
Total						3,935	202

Note: Only decommissioning activities that generated waste were included in this table.

a Volumes are based on method of storage, and do not necessarily represent the actual breakdown of waste into low- and intermediate-level radioactive waste.

b Reduction in volume relative to 2010 inventory is due to repackaging of material.

c Modular Above Ground Storage (MAGS) Shielded Modular Above Ground Storage (SMAGS)

3.4 L&ILRW Projections

Projections for L&ILRW are provided below, for both 2016 and 2050, based on the inventory data as of December 31, 2013.

As stated in the overview section, the year 2016 was selected given that a new inventory will be conducted that year and will serve as a benchmark to assess the accuracy of the projections overall. The year 2050 is selected as a future reference because it is forecasted as the approximate end of operation for the Bruce Power and Darlington Generating station power reactors. Due to anticipated waste reduction activities, including incineration, waste volumes are projected to decrease in some instances.

Table x: L&ILRW Projections Summary

Waste Category	Waste Inventory to end of 2013	Waste Inventory Projected to end of 2016	Waste Inventory Projected to end of 2050[a]
Low-Level Radioactive Waste[b]	2,352,672 m^3	2,350,529 m^3	2,499,803 m^3
Intermediate-Level Radioactive Waste	34,770 m^3	38,762 m^3	67,738 m^3

Notes:

a Assuming all power reactors, except Pickering A, will be refurbished.

b Due to anticipated waste reduction activities, including incineration, waste volumes are projected to decrease in some instances.

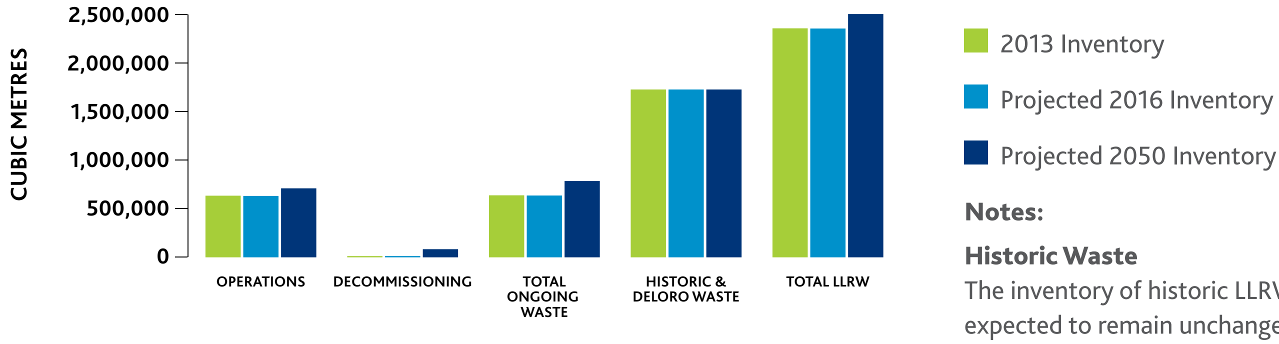
Table xi: L&ILRW Projections - 2016 and 2050

Overall Category	Site Name	Responsible Party	Projected LLRW (m^3)		Projected ILRW (m^3)	
			to end of 2016	to end of 2050[a,b]	to end of 2016	to end of 2050[a,b]
ONGOING OPERATIONS WASTE	Nuclear Fuel Fabrication Facilities & Power Reactors					
	Western Waste Management Facility (WWMF)*	OPG	93,300	148,300	15,460	26,210
	Pickering Waste Management Facility*	OPG	0	0	2,210	2,210
	Radioactive Waste Operations Site-1 (RWOS-1) (in storage with Surveillance)	OPG	330	330	10	10
	Gentilly-2	Hydro-Québec	1,281	1,281	344	344
	Point Lepreau	NB Power	2,751	1,901	162	162
	Port Hope Conversion Facility (operational)[c]	Cameco Corp.	N/A	N/A	0	0
	Blind River Refinery (process waste)[c]	Cameco Corp.	N/A	N/A	0	0
	Cameco Fuel Manufacturing (Zircatec)[c]	Cameco Corp.	N/A	N/A	0	0
	Subtotal (Nuclear Fuel Cycle)		97,662	151,812	18,186	28,936
	Nuclear R&D[d]					
	Douglas Point	AECL	66	66	0	0
	Gentilly-1	AECL	1	1	0	0
	Chalk River Laboratories[e,h]	AECL	486,856	509,881	19,239	22,065
	Whiteshell Laboratories[h]	AECL	19,885	19,885	863	863
	Subtotal (Nuclear R&D)		506,808	529,833	20,102	22,928
	Radioisotope Production and Use					
	Chalk River Laboratories[f]	AECL	19,781	21,140	231	804
	Subtotal (Radioisotope)		19,781	21,140	231	804
	Subtotal (Operations)		624,251	702,785	38,519	52,668

Overall Category	Site Name	Responsible Party	Projected LLRW (m^3)		Projected ILRW (m^3)	
			to end of 2016	to end of 2050[a,b]	to end of 2016	to end of 2050[a,b]
ONGOING DECOMMISSIONING WASTE	**Nuclear Fuel Fabrication Facilities & Power Reactors**					
	Western Waste Management Facility (WWMF)	OPG	0	29,350	0	2,020
	Pickering Waste Management Facility	OPG	0	0	0	0
	Radioactive Waste Operations Site-1 (RWOS-1) (in storage with Surveillance)	OPG	0	0	0	0
	Gentilly-2	Hydro-Québec	0	1,684	0	8,642
	Point Lepreau	NB Power	0	175	0	1,408
	Subtotal (Nuclear Fuel Cycle)		0	31,209	0	12,070
	Nuclear R&D[d]					
	Douglas Point	AECL	88	7,400	61	61
	Gentilly-1	AECL	928	11,265	27	27
	NPD	AECL	28	2,230	0	0
	Chalk River Laboratories[g,h]	AECL	2,392	9,000	121	2,512
	Whiteshell Laboratories[g,h]	AECL	918	13,990	34	400
	Subtotal (Nuclear R&D)		4,354	43,885	243	3,000
	Radioisotope Production and Use					
	Chalk River Laboratories	AECL	0	0	0	0
	Subtotal (Radioisotope)		0	0	0	0
	Subtotal (Decommissioning)		4,354	75,094	243	15,070
	Total Ongoing Waste		628,605	777,879	38,762	67,738
HISTORIC & DELORO WASTE	Port Hope	AECL	720,000	720,000	0	0
	Welcome	AECL	454,380	454,380	0	0
	Port Granby	AECL	438,200	438,200	0	0
	Northern Transportation Route	AECL-LLRWMO	54,403	54,403	0	0
	Greater Toronto Area - including PTBO[i]	AECL-LLRWMO / Regional Municipality of Peel, Ontario	15,941	15,941	0	0
	CRL Area D	AECL-LLRWMO	1,000	1,000	0	0
	Deloro	Ontario Ministry of the Environment	38,000	38,000	0	0
	Total Historic Waste		1,721,924	1,721,924	0	0
	TOTALS		2,350,529	2,499,803	38,762	67,738

Notes:
N/A - Not available
** The L&ILRW generated from power reactors Bruce A and B, Darlington, and Pickering A and B is stored at the WWMF.*
a Assuming all power reactors, except Pickering A, will be refurbished.
b Operational waste projected to end of reactor operations (Bruce A and Darlington beyond 2050).
c Cameco unable to provide waste projections due to fluctuations in inventory. Long-term waste storage is off-site.
d LLRW waste generated at research reactors is left to decay and disposed of with regular waste.
e LLRW includes all waste prior to 2005 that was not differentiated between LLRW and ILRW - ILRW has only been designated as such since, Jan 1, 2005.
f LLRW is total inventory, but ILRW only from Jan 1, 2005 to present.
g Decommissioning waste only from Jan 1, 2005 to present.
h Volumes are based on method of storage, and do not necessarily represent the actual breakdown of waste into low and intermediate level radioactive waste.
i GTA sites are exempted from the requirement to licence until 2016. The Passmore, Lakeshore Road and Peterborough sites were released from requirement to licence in 2009.

Figure J: LLRW Projections - 2016 and 2050 (Historic, Deloro & Ongoing Waste)

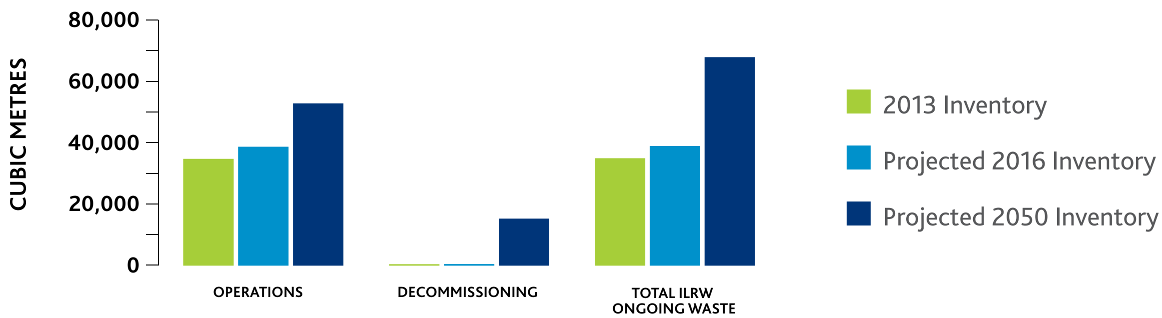


Notes:

Historic Waste
The inventory of historic LLRW is expected to remain unchanged at 1,683,924 m^3.

Deloro Waste
The inventory of Deloro LLRW is expected to remain unchanged at 38,000 m^3.

Figure K: ILRW Projections - 2016 and 2050 (Ongoing Waste)



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Ongoing Waste Projections

The L&ILRW inventory projected to 2050 from ongoing operations and decommissioning will be about 845,617 m^3 (777,879 m^3 of LLRW and 67,738 m^3 of ILRW).

Future Operations Waste

The total L&ILRW operations waste inventory as of December 31, 2013, is 661,381 m^3 and this is comprised of an estimated 626,813 m^3 of LLRW and 34,568 m^3 of ILRW. The waste will increase to approximately 702,785 m^3 (LLRW) and 52,668 m^3 (ILRW) by 2050. The projected inventory of L&ILRW waste to 2050 from ongoing operations is 755,453 m^3.

Waste from operations will continue to be a major contributor to L&ILRW inventory until approximately 2040 when Phase 3 decommissioning of some of the operating power reactors (Bruce B, Gentilly-2 and Pickering A&B) as well as Phase 3 decommissioning of some research/prototype reactors (Gentilly-1, Douglas Point and NPD) begins.

Projection of L&ILRW volumes assumes that no new major nuclear facilities, including new nuclear power reactors, will be commissioned before 2050 and, therefore, there will be no new operations sources of L&ILRW. It is also assumed that the 2013 waste generation rates will remain constant in the future unless otherwise forecasted by the producers (e.g. electric utilities).

Future Decommissioning Waste

The projected inventory of L&ILRW waste to 2050 from decommissioning is 90,164 m^3 (75,094 m^3 LLRW and 15,070 m^3 of ILRW).

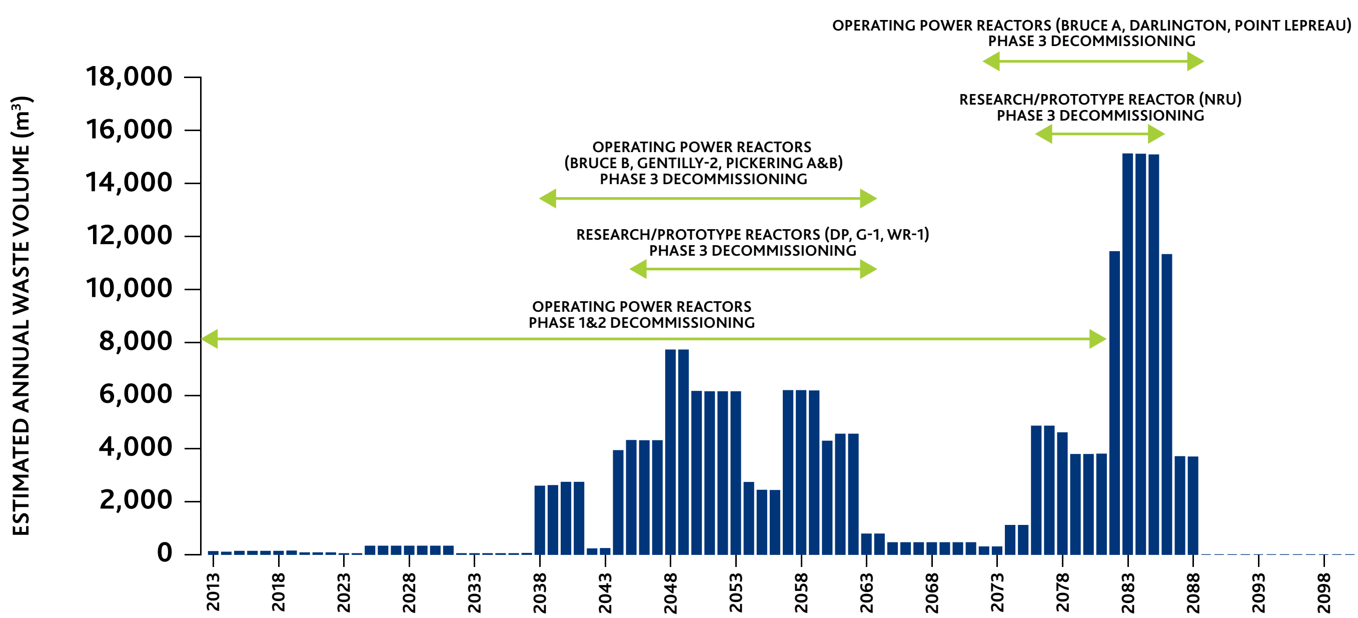
Projected inventories of decommissioning L&ILRW were provided by the waste owners and determined based on decommissioning plans submitted to the CNSC. Preliminary decommissioning plans exist for many sites with uncertainties with respect to timing and waste volumes. Decommissioning waste estimates were also obtained from each site's preliminary decommissioning plan.

The following assumptions were used in projecting decommissioning waste inventory to year 2050:

- Decommissioning or major site refurbishment may be required at the uranium refining and conversion, and fuel fabrication facilities between the years 2020 and 2025, with the exception of the Blind River refinery, which is relatively new. These activities will result in the generation of approximately 102,000 m^3 of LLRW. This volume of waste has not been included.
- The three partially decommissioned prototype power reactors will undergo Phase 3 decommissioning from year 2025 to 2060.
- Barring the decisions to extend the operating lives of currently operating power reactors, Phase 1 decommissioning of the operating power reactors will occur at various dates from 2014 through year 2045.
- Units 2 and 3 at the Pickering A nuclear generating station are currently shutdown and undergoing preparation for safe storage. Phase 1 decommissioning at each reactor will generate approximately 200 m^3 to 600 m^3 of L&ILRW.
- Decommissioning of the OPG waste management facilities is scheduled for 2061-2067. The total projected inventory of decommissioning waste to year 2050 includes approximately 160,000 m^3 and 8,000 m^3 of low-level and intermediate-level radioactive waste, respectively.

The following chart depicts the projected annual decommissioning waste volumes for the power reactors, prototype/demonstration power reactors and the Whiteshell and CRL nuclear facilities through to 2100. This timeline was selected to include complete Phase 3 decommissioning of all currently operating power reactors.

Figure L: Annual Volume of Radioactive Waste from Decommissioning of Existing Nuclear Facilities (to 2100)



4.0 URANIUM MINING AND MILLING WASTE

4.1 Uranium Mining and Milling Waste Definition

This waste is LLRW generated from uranium mining and milling activities and includes both mill tailings and waste rock, as described below.

Uranium Mill Tailings

Uranium mill tailings are a specific type of LLRW that is generated during the milling (processing) of uranium ore to produce uranium concentrate. Uranium concentrate, once refined and converted, is used to make fuel for Canadian and foreign power reactors. Today, tailings are placed in mined-out, open pits converted to tailings management facilities (TMFs). However, this was not always the case. Historically, tailings were placed in natural containment areas such as lakes or valleys, or disposed as backfill in underground mines, or placed in engineered surface containment areas.

At all of the newer operations in Saskatchewan, tailings are managed in TMFs that feature hydraulic containment during operation (so that all groundwater flow is towards the tailings facility), and passive long-term containment following decommissioning. Details of each facility can be found in the annual reports prepared for the CNSC by the waste owners.

Waste Rock

Waste rock refers to the non-ore material that is removed during mining to access the ore. Today, waste rock is separated into mineralized and non-mineralized waste rock depending on the relative concentration of uranium present in the material. Historically, waste rock has been stored on the surface or used as backfill in underground mines. However, in the past, inventories of waste rock were not consistently tracked and often mineralized and non-mineralized waste was stockpiled together.

Mineralized waste rock can include sub-economical concentrations of uranium, in addition to elevated levels of other elements such as sulphur, arsenic or nickel that could potentially cause adverse environmental effects. Non-mineralized waste rock has very low concentrations of uranium and levels of other elements below applicable standards.

There are no special long-term storage requirements for non-mineralized waste rock; however, due to the potential for contaminant transport, when exposed at surface, mineralized waste rock is typically used as mine backfill or stored in mined-out pits converted to TMFs.

Figure M: **How Uranium Mining & Milling Waste is Generated**

Uranium Ore Mining & Processing
Milling (processing) of *uranium ore* produces *uranium concentrate.*

Uranium Mining & Milling Waste

Waste Rock (mineralized) Mill Tailings

Mine Decommissioning
Mine shut down

Waste rock and uranium tailings exist at operating uranium mine and mill sites. Owing to the large volumes and low activity levels, tailings and waste rocks are decommissioned in place.

4.2 Uranium Mining and Milling Waste Locations

4.3 Uranium Mining and Milling Waste Inventory

The unit of measure used in this report for uranium mining and milling waste is tonne of dry mass, as this is the same unit used in the mining industry to track and report materials. Waste amounts can be converted to volume (m^3) using assumed or measured densities. A typical dry density for tailings would be 1.0 - 1.5 tonnes/m^3. However, tailing densities vary significantly from site to site and with location or depth at a specific site.

Uranium Mill Tailings

The total inventory of tailings is 216,111,650 tonnes. As of December 31, 2013, the inventory of tailings at closed/decommissioned sites was about 201 million tonnes. About 15 million tonnes was from the operating sites. The tailings generated in 2013 were approximately 0.7 million tonnes.

Table xii: Uranium Mill Tailings Inventory - 2013

Mine/Mill Name	Principal Source Company Name / Responsible Party	Source Company Province	Tailings Site	Generation (Tailings) in 2013 (tonnes/yr)	Total Mass of Tailings (tonnes) as of Dec 31, 2013	Waste Site Status
Operating Sites						
Key Lake[a]	Cameco Corp.	Saskatchewan	Deilmann Tailings Management Facility	334,428	5,213,815	Operating since 1995
Rabbit Lake	Cameco Corp.	Saskatchewan	Rabbit Lake In-Pit Tailings Management Facility	363,466	8,308,554	Operating since 1985
McClean Lake	AREVA Resources Canada Inc.	Saskatchewan	JEB Tailings Management Facility	1,253	1,828,500	Operating since 1999
McArthur River	Cameco Corp.	Saskatchewan	No Tailings on site	0	0	Operating since 1999
Sub-total Operating Sites				699,147	15,350,869	
Closed/Decommissioned Sites						
Cluff Lake	AREVA Resources Canada Inc.	Saskatchewan	Tailings Management Area (TMA)	0	3,230,000	Decommissioned since 2006 / ongoing monitoring
Key Lake	Cameco Corp.	Saskatchewan	Surface Tailings (Old Tailings Pond)	0	3,579,781	Closed since 1996 / ongoing monitoring
Rabbit Lake	Cameco Corp.	Saskatchewan	Surface Tailings	0	6,500,000	Closed since 1985 / being decommissioned
Beaverlodge[b]	Cameco Corp.	Saskatchewan	Surface, Sub-areal and Sub-aqueous Tailings	0	5,700,000	Decommissioned since 1982 / ongoing monitoring
Gunnar	Saskatchewan Research Council	Saskatchewan	Surface Tailings	0	4,400,000	Closed since 1964
Lorado	Saskatchewan Research Council	Saskatchewan	Surface Tailings	0	360,000	Closed since 1960
Port Radium	Aboriginal Affairs and Northern Development Canada	Northwest Territories	Surface Tailings - Four Areas	0	907,000	Decommissioned since 1984 / ongoing monitoring

Mine/Mill Name	Principal Source Company Name / Responsible Party	Source Company Province	Tailings Site	Generation (Tailings) in 2013 (tonnes/yr)	Total Mass of Tailings (tonnes) as of Dec 31, 2013	Waste Site Status
Rayrock	Aboriginal Affairs and Northern Development Canada	Northwest Territories	North and South Tailings Piles	0	71,000	Closed since 1959 / ongoing monitoring
Quirke 1 & 2 - Elliot Lake	Rio Algom Ltd.	Ontario	Quirke Mine TMA	0	46,000,000	Decommissioned / ongoing monitoring
Panel - Elliot Lake	Rio Algom Ltd.	Ontario	Panel Mine TMA, Main Basin and South Basin	0	16,000,000	Decommissioned / ongoing monitoring
Denison - Elliot Lake	Denison Mines Corp.	Ontario	Denison Tailings Management Area (TMA1, TMA2)	0	63,800,000	Decommissioned / ongoing monitoring
Spanish-American - Elliot Lake	Rio Algom Ltd.	Ontario	Spanish American TMA	0	450,000	Decommissioned / ongoing monitoring
Stanrock/Can-Met - Elliot Lake	Denison Mines Corp.	Ontario	Stanrock TMA	0	5,750,000	Decommissioned / ongoing monitoring
Stanleigh - Elliot Lake	Rio Algom Ltd.	Ontario	Stanleigh TMA	0	19,953,000	Decommissioned / ongoing monitoring
Lacnor - Elliot Lake	Rio Algom Ltd.	Ontario	Lacnor Waste Management Area (WMA)	0	2,700,000	Decommissioned / ongoing monitoring
Nordic - Elliot Lake	Rio Algom Ltd.	Ontario	Nordin WMA	0	12,000,000	Decommissioned / ongoing monitoring
Milliken - Elliot Lake	Rio Algom Ltd.	Ontario	Milliken	0	150,000	Decommissioned / ongoing monitoring
Pronto - Elliot Lake	Rio Algom Ltd.	Ontario	Pronto WMA	0	2,100,000	Decommissioned / ongoing monitoring
Agnew Lake Mines - Espanola	Ontario Ministry of Northern Development and Mines	Ontario	Dry TMA	0	510,000	Decommissioned since 1990 / ongoing monitoring
Dyno - Bancroft	EnCana West Ltd.	Ontario	Surface Tailings	0	600,000	Closed since 1960 / ongoing monitoring
Bicroft - Bancroft	Barrick Gold Corp.	Ontario	Bicroft TMA	0	2,000,000	Closed since 1964 / ongoing monitoring
Madawaska - Bancroft	EnCana West Ltd.	Ontario	Surface Tailings - Two Areas	0	4,000,000	Decommissioned / ongoing monitoring
Sub-total Decommissioned Sites				0	200,760,781	
Development Sites						
Cigar Lake[c]	Cameco Corp.	Saskatchewan	No tailings on site	0	0	Development
TOTAL				699,147	216,111,650	

Notes:

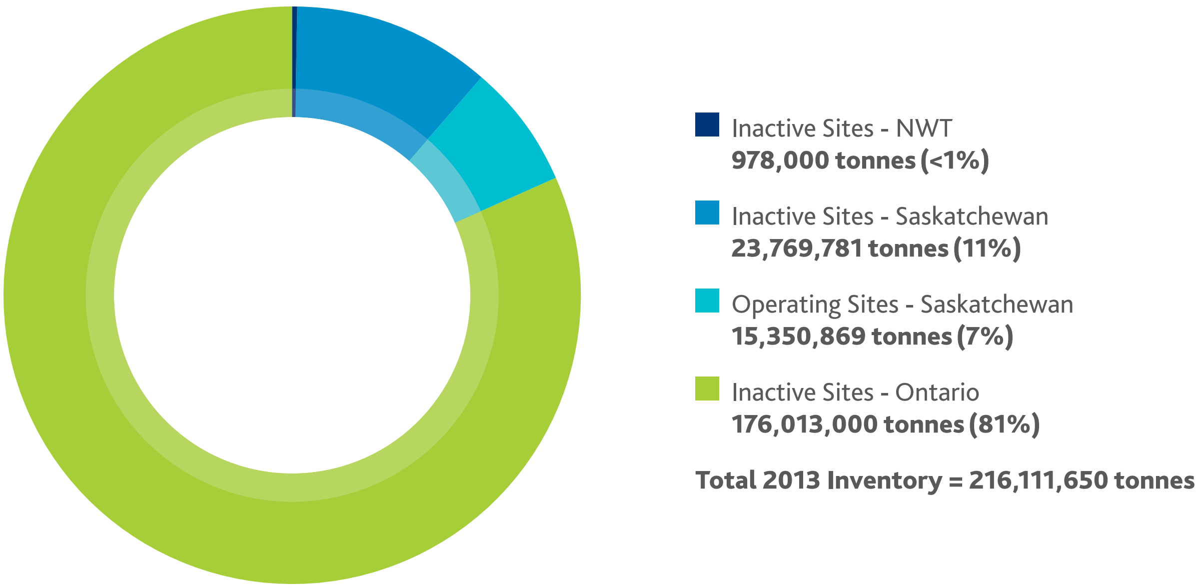
N/A - Note available

a Includes tailings accumulated from the processing of ores from McArthur River (operating since 1999).

b Total mass of tailings as of December 31, 2013 excludes 4,300,000 tonnes of tailings that have been used as backfill.

c Cigar Lake site commenced operation on March 13, 2014 (source http://www.cameco.com/businesses/uranium-operations/canada/cigar-lake).

Figure N: **Uranium Mill Tailings Inventory - 2013**



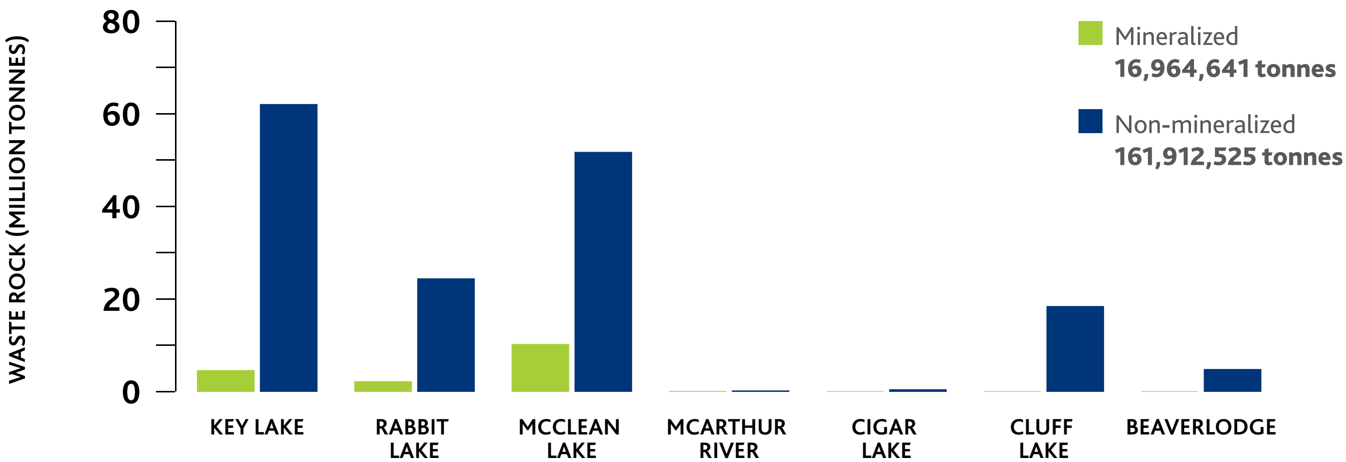
Waste Rock

The total inventory of waste rock is 178,877,166 tonnes combined mineralized and non-mineralized. Mineralized waste accounts for 16,964,641 tonnes while non-mineralized waste is 161,912,525 tonnes.

The status of the waste rock piles is inherently dynamic due to fluctuations in uranium prices, which determine the ratio of ore to waste rock. As a result, the annual generation rate can be deceptive and total inventory of waste rock is used to provide a more representative value.

The following table summarizes the total inventory of mineralized and non-mineralized waste rock from mine sites in Canada as of December 31, 2013. Waste rock data was not collected for mining operations in Ontario, the Northwest Territories, or at the Gunnar and Lorado sites in Saskatchewan as work at these sites predated current waste segregation practices.

Figure O: Waste Rock Inventory - 2013



The following table summarizes the waste rock inventory mass and site status for operating sites, closed/decommissioned sites and development sites in Canada as of December 31, 2013. The 2013 inventory of waste rock is rounded to the nearest 100 tonnes.

Table xiii: Waste Rock Inventory - 2013

Mine/Mill Name	Principal Source Company Name / Responsible Party	Source Company Province	Waste Rock Inventory[a]		Waste Site Status as of December 2013
			Mineralized (tonnes)	Non-mineralized (tonnes)	
Key Lake	Cameco Corp.	Saskatchewan	4,562,831	62,033,000	Operating Since 1995
Rabbit Lake	Cameco Corp.	Saskatchewan	2,161,600	24,381,800	Operating since 1985
McClean Lake	AREVA Resources Canada Inc.	Saskatchewan	10,200,000	51,700,000	Operating since 1999
McArthur River	Cameco Corp.	Saskatchewan	40,210	167,818	Operating since 1999
Cluff Lake	AREVA Resources Canada Inc.	Saskatchewan	N/A[b]	18,400,000	Decommissioned since 2006 / ongoing monitoring
Beaverlodge	Cameco Corp.	Saskatchewan	N/A[b]	4,800,000	Decommissioned since 1982 / ongoing monitoring
Cigar Lake	Cameco Corp.	Saskatchewan	0	429,907	Construction
TOTALS			16,964,641	161,912,525	

Notes:

N/A - Not available

a Changes in waste rock inventories may be due to milling or use as backfill, on road surfaces and for construction projects.

b Mining predated waste segregation practices currently used, therefore all waste rock is reported as non-mineralized.

4.3.1 Decommissioning Waste (Uranium Mining and Milling Waste)

Owing to the large volumes and low activity levels, uranium mine sites are decommissioned in place. Decommissioning of surface tailings sites usually includes improvement or construction of dams to provide long-term containment, flooding or covering of tailings to reduce acid generation and the release of gamma radiation and radon gas, and management/monitoring of tailings and effluent.

Waste rock and uranium tailings exist at operating uranium mine and mill sites in northern Saskatchewan and at closed or decommissioned sites in Saskatchewan, Ontario and the Northwest Territories.

4.4 Uranium Mining and Milling Waste Projections

The known resources of uranium ore at mines that are currently in operation will be exhausted prior to 2050. No projections of uranium mine tailings or waste rock are provided due to the uncertainty associated with estimating the volume of waste from potential projects. The following sections provide a brief qualitative assessment of factors affecting future uranium mining and milling waste.

Status of Future Uranium Mining and Milling Waste

Operating Sites

Future uranium production rates could increase depending on timing and market conditions. Ore grades from Cigar Lake will be higher (15% uranium) and, as a result, will reduce the tailings production rates at the McClean Lake Mill relative to uranium production. Cameco Corporation will continue to blend Key Lake special waste with high grade ore from McArthur River. At Rabbit Lake, mixing of tailings with waste rock or till prior to deposition is also being considered. Due to these possibilities, it is difficult to forecast the final tailings mass from the operating mill sites.

Closed or Decommissioned Sites

Decommissioning of uranium mill tailings generally involves management in place. The current mass of tailings at all inactive or decommissioned sites is approximately 201 million tonnes and is assumed to remain unchanged through 2050.

Development Sites

The Cigar Lake development site will become an operating site in the future; however the ore is to be milled at existing operating sites. Therefore, there will be no tailings accumulated at the site. Waste rock will be managed on site.


(713) 675-0075

5.0 REFERENCES

HLRW:

OPG - Memorandum, April 16, 2014

HQ - Email and associated documentation, February 3, 2014

NB Power - Email, February 26, 2014

Hydro-Québec - Email, February 4, 2014

AECL - Email, March 19, 2014

McMaster - Email, March 17, 2014

L&ILRW:

OPG - Memorandum, April 16, 2014

HQ - Email and associated documentation, February 3, 2014

NB Power - Email, February 26, 2014

AECL - Email, last updated April 11, 2014

Uranium Mining and Milling Waste:

AREVA - Memo from January 31, 2014

Cameco - Memo via email April 4, 2014

AANDC - Email, January 17, 2014

Sask MOE - Email, January 23, 2014

Decommissioning:

OPG - Memorandum, April 16, 2014

HQ - Email and associated documentation, February 3, 2014

NB Power - Email, February 26, 2014

AECL - Email, May 7, 2014 (data from 2010 PDPs)

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2013 INVENTORY SUMMARY REPORT

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