RADIOACTIVE WASTE MANAGEMENT PROGRAMMES IN OECD/NEA MEMBER COUNTRIES

CANADA
[2015]

NATIONAL NUCLEAR ENERGY CONTEXT

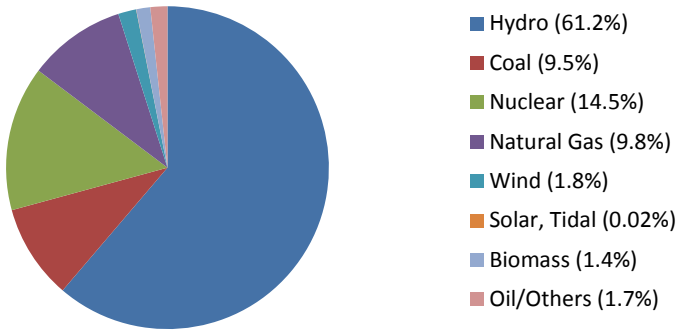
The Government of Canada supports nuclear energy as an important component of a diversified energy mix to ensure a secure and sustainable energy future for Canadians. The Canadian nuclear industry covers the entire nuclear energy fuel cycle from nuclear research and development, uranium mining and fuel fabrication, to nuclear reactor construction and operation, radioactive waste management and decommissioning. Canada has over 60 years of experience with nuclear energy, including the development of the CANDU reactor by Atomic Energy of Canada Limited.

Of the 22 CANDU nuclear power reactors in Canada, 19 are currently in full commercial operation and generate on average 15% of the total domestic electricity production, see Figure 1 below. Ontario Power Generation (OPG) is the largest nuclear power producer in Canada. It owns 20 reactors in the province of Ontario. Ontario's 2013 Long-Term Energy Plan foresees the refurbishment of up to 10 of the 20 reactors starting in 2016. Bruce Power leases and operates 8 of these reactors from OPG. Of the remaining 12 reactors, OPG currently has 10 in operation and 2 in safe shutdown. OPG is responsible for the management of the nuclear fuel waste produced by all 20 of these reactors.

In the provinces of New Brunswick and Quebec, the nuclear energy corporations, NB Power and Hydro-Québec (HQ) each have one reactor, Point Lepreau and Gentilly II, respectively. In December 2012, Gentilly II ceased operations, after 30 years of operation.

Globally, Canada is the world's 2nd largest producer of uranium, generating about 16% of global production. It has the world's third largest resource of uranium, including the two largest high-grade deposits. The currently identified economic resources of approximately 493,900 tonnes of uranium are estimated to be sufficient for nearly 40 years of production at present rates of extraction.

Figure 1: Electricity Generation in Canada in 2013



Source: Statistics Canada, 2012

SOURCES, TYPES AND QUANTITIES OF RADIOACTIVE WASTE

In Canada, radioactive waste is generated from uranium mining and processing, nuclear fuel fabrication, operation of nuclear reactors, research and development and radioisotope manufacture and use. These radioactive wastes are divided into three categories: high-level radioactive waste, low and intermediate level radioactive waste and uranium mine and mill tailings.

High-Level Radioactive Waste (HLW)

HLW in Canada is made up primarily of nuclear fuel waste, commonly referred to as used nuclear fuel by the nuclear industry, which mostly comes from the operation of nuclear power plants. It also includes the HLW produced from prototype and research reactors.

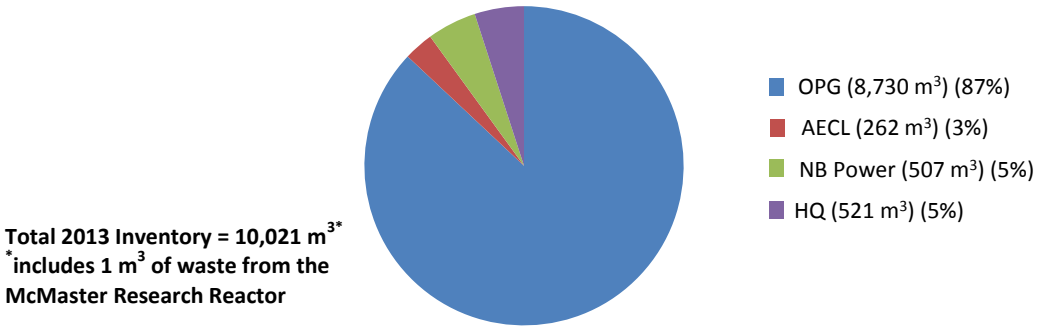
In Canada, nuclear fuel waste is defined under the *Nuclear Fuel Waste Act* (NFWA) *as irradiated fuel bundles removed from a commercial or research nuclear fission reactor*. More specifically, it includes CANDU fuel bundles discharged from power and prototype reactors, as well as the bundles from the shutdown WR-1 research reactor at Whiteshell Laboratories.

In Canada, the NFWA governs the long-term management of nuclear fuel waste – that which exists now and in the future. Currently, nuclear fuel waste is safely and securely managed at the reactors sites and at AECL's waste management facilities at Chalk River, Ontario and Pinawa, Manitoba.

Figure 2 below shows the distribution of nuclear fuel waste inventory by major waste owners. This figure depicts the estimated volume of waste to the nearest 10 m^3. At the end of 2013, the distribution of nuclear fuel waste was as follows: OPG, 87%; HQ 5%; NB Power 5%; and AECL 3%.

OPG, Canada's largest nuclear operator located in the province of Ontario, owns the greatest volume of nuclear fuel waste.

Figure 2: Nuclear Fuel Waste Inventory at the end of 2013 (estimated volume)



Source: Canada's Radioactive Waste Inventory Report, 2013

Low and Intermediate Level Radioactive Waste (L&ILRW)

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

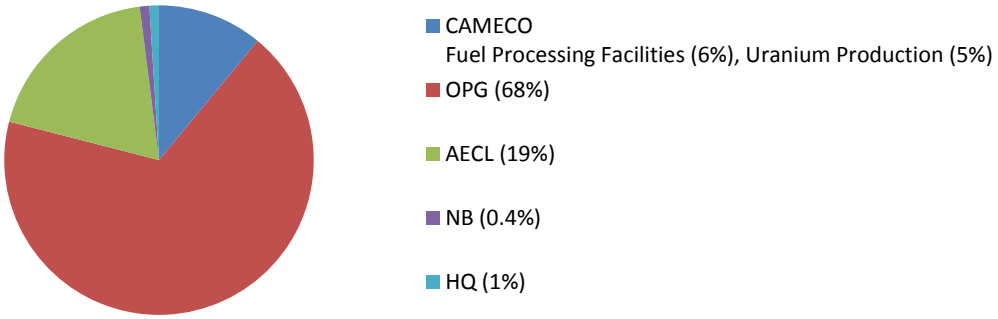
L&ILRW is divided into three broad categories as set out below.

- **Ongoing waste –** refers to waste that is generated by nuclear facilities currently in operation.

Figure 3 below shows that OPG is responsible for approximately 68% of the annual volume of L&ILRW generated in Canada which results from the production of nuclear power. AECL, on the other hand, generates approximately 19% of the annual volume of L&ILRW through its research and development activities at the Chalk River Laboratories in Ontario. AECL's waste volume also includes waste that is accepted from a number of small waste producers for long-term management.

The figure also shows that NB Power and HQ produce small volumes of L&ILRW (e.g. approximately 1% each). Cameco, one of the world's largest uranium producers, owns and operates two facilities in Port Hope, Ontario (i.e., Port Hope Conversion Facility and Cameco Fuel Manufacturing) which combined produce 6% of the ongoing L&ILRW. Cameco also operates one facility in Blind River, Ontario, which produces approximately 5% of ongoing L&ILRW from uranium production.

Figure 3: Distribution of Ongoing L&ILRW Generation in Canada (2010-2013)



Source: Canada's Radioactive Waste Inventory Report, 2013

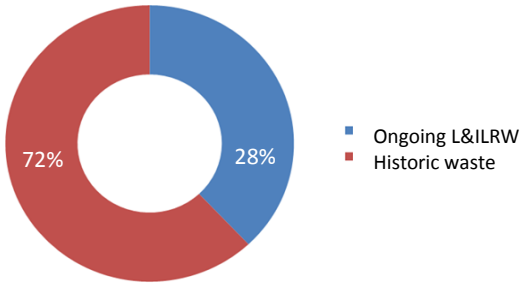
- **Canada's Nuclear Legacy Liabilities –** Legacy wastes, in the Canadian context, specifically date back to the Cold War and birth of nuclear technologies in Canada. These wastes are located at Atomic Energy of Canada (AECL) sites, and include existing radioactive wastes generated prior to April 1st, 2006 and wastes resulting from decommissioning of disused buildings and infrastructure, as well as from environmental remediation.

- **Historic low-level radioactive waste (LLRW) –** is waste that was managed in the past in a manner no longer acceptable, for which the current owner cannot be reasonably held responsible and for which the Government of Canada has accepted responsibility for long-term management. Much of the waste is contaminated soil and at the end of 2013, the volume was 1,722,000 m^3.

Figure 4 below, shows that the total volume of historic waste in Canada is greater than the amount of ongoing L&ILRW in Canada. Wastes from the implementation of Canada's Nuclear Legacy Liabilities

Program are included as part of the ongoing waste as AECL continues to generate L&ILRW from its research and development and commercial activities.

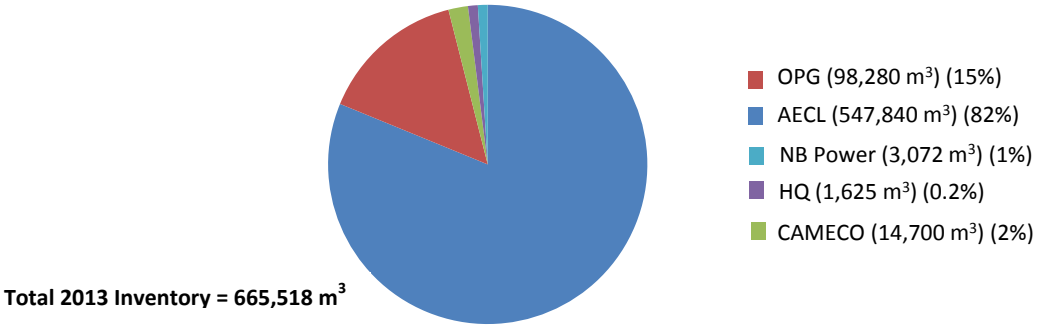
Figure 4: Distribution of Historic and Ongoing L&ILRW in Canada, 2013



Source: Canada's Radioactive Waste Inventory Report, 2013

While Ontario Power Generation, Canada's largest utility, generates the greatest volume of L&ILRW on an annual basis, as depicted in Figure 3, AECL manages, at its facilities, the greatest total volume of L&ILRW, due in large part to past research activities, as shown in Figure 5 below.

Figure 5: Distribution of the total L&ILRW inventory in Canada at the end of 2013[1]

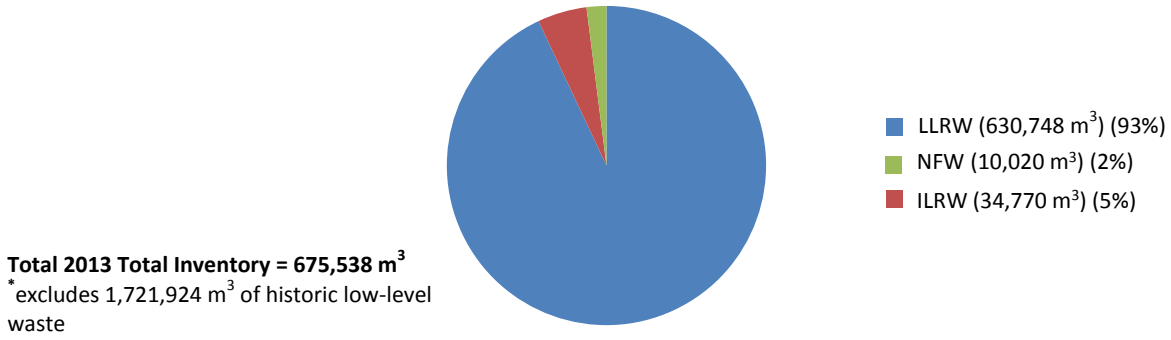


Source: Canada's Radioactive Waste Inventory Report, 2013

In summary, Figure 6 below shows the total radioactive waste inventory up to December 2013, Canada's LLRW amount is 93% of the total volume, while ILRW contributes 5% with the smaller volume of nuclear fuel waste at 2%.

[1] Excludes historic waste

Figure 6: Canada's total radioactive waste inventory at the end of 2013



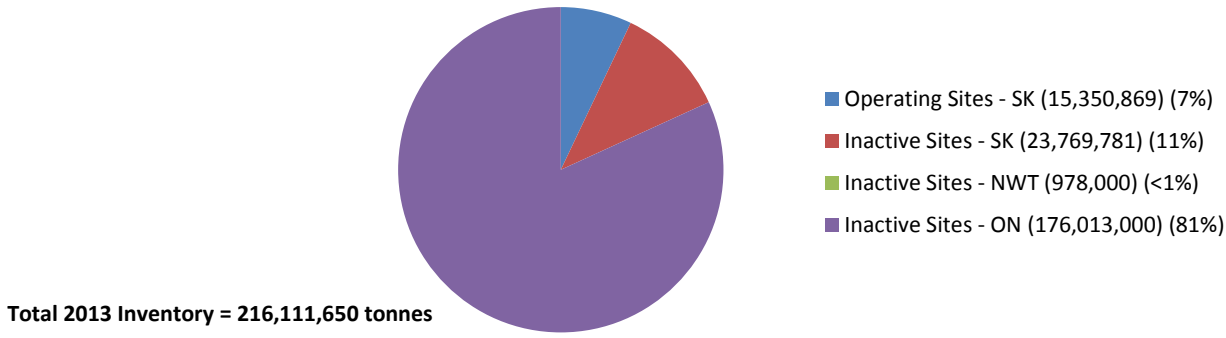
Source: Canada's Radioactive Waste Inventory Report, 2013

Uranium Mine and Mill Tailings

Uranium mine and mill tailings are a specific type of radioactive waste that is generated as a waste by-product of the mining and milling of uranium to produce uranium concentrate. These wastes are generally held in containment areas close to the milling sites. Because of their large volumes, the tailings are usually decommissioned where deposited. This is typically in mined-out open pits that have been engineered to create tailings management facilities, or in engineered above-ground tailings management facilities.

Most of the existing uranium mine and mill tailings are located in the provinces of Ontario and Saskatchewan. Of the total of twenty-four tailings sites in Canada, only three in Saskatchewan continue to receive such waste. At the end of 2013, the inventory of uranium mine and mill tailings at operational mine sites was 13.3 million tonnes dry mass. The total quantity of all Canadian uranium mine and mill tailings, from both operational and inactive or shutdown mines, is about 216 million tonnes.

Figure 7: Inventory of Uranium Mill Tailings, 2013 (tonnes)



Source: Canada's Radioactive Waste Inventory Report, 2013

RADIOACTIVE WASTE MANAGEMENT POLICIES AND PROGRAMMES

Canada's approach to radioactive waste management is founded upon the Government of Canada's 1996 Policy Framework for Radioactive Waste. The policy states that the owners of radioactive waste (e.g., OPG, NB Power, HQ, AECL, and Cameco) are responsible for developing and implementing solutions, as well as covering the full lifecycle costs, for safely and securely managing their wastes – in both the short and long term.

Under the Framework, the Government of Canada is responsible for developing policy, regulating and overseeing waste owners' compliance with approved waste management plans to ensure that the management of radioactive waste is carried out in a safe, environmentally sound, comprehensive, cost-effective and integrated manner.

Waste owners are required to develop their own management approach, individually or in cooperation with others waste owners. Those approaches are subject to regulatory review by Canada's regulator, the Canadian Nuclear Safety Commission.

In 2002, the Government of Canada passed the NFWA to ensure that a national plan for the safe and secure long-term management of nuclear fuel waste would be developed, fully-funded by the waste owners, and once approved by the Government, would be implemented. The Nuclear Waste Management Organization (NWMO), established in 2002 by the waste owners and pursuant to the NFWA, is responsible for developing the plan and ensuring sufficient funds are available to cover all of the associated costs. Following the Government's approval of the plan, the NWMO is responsible for its implementation. The Government oversees and reports on the implementation of the plan, as required by legislation.

Waste management policies

The Government's 1996 *Policy Framework for Radioactive Waste* provides the national context for radioactive waste management. The Framework states that the federal government has the responsibility to develop policy and lays out a set of principles to ensure that the management of radioactive waste is carried out in a safe, environmentally sound, comprehensive, cost-effective and integrated manner.

Canada has modern and clear federal legislation, the *Nuclear Safety and Control Act* (NSCA) at the heart of its nuclear regulatory framework. Health, safety, security and environmental aspects of the management of all radioactive wastes are regulated under the Act.

The NSCA established the Canadian Nuclear Safety Commission as Canada's independent federal nuclear regulator while the decision-making responsibility for energy supply mix and investments in electricity generation capacity, including the planning, construction, and operation of nuclear power plants, resides with the provinces and provincial electric power utilities.

Programmes and projects

Nuclear fuel waste management

Canada has an open nuclear fuel cycle and there is no plan to reprocess fuel bundles from nuclear power reactors.

In 2002, the Government of Canada brought into force the NFWA which required the nuclear energy corporations to establish a waste management organization that would assume responsibility for the long-term

management of Canada's nuclear fuel waste. In accordance with the Act, the Nuclear Waste Management Organization (NWMO) was established.

The NFWA required that the NWMO submit to the Government, a comprehensive study of options for the safe and secure long-term management of nuclear fuel waste and provide a recommendation on the most appropriate approach. Following extensive studies, comprehensive public consultation including with Aboriginal peoples and an evaluation of the social and ethical considerations of each option, the NWMO submitted its recommendation to the Government of Canada for review in November 2005. In 2007, the Government of Canada selected the NWMO's recommendation for Adaptive Phased Management (APM) as its preferred approach for the long-term management of nuclear fuel waste in Canada.

The APM approach involves centralized containment and isolation of nuclear fuel waste in a deep geologic repository, with the option of an interim shallow-underground storage facility, located at a site in an informed and willing host community. A key element of the APM approach is that it is sufficiently flexible to adjust to changing social and emerging technological developments.

Through public dialogue and consultation, the NWMO developed a site selection process aimed at identifying a willing and informed community with a suitable site to host a deep geologic repository for the long-term management of nuclear fuel waste.

The NWMO is also advancing work on the development of repository designs and safety cases, including governance and capacity building to provide the necessary, skills, expertise, and capabilities required to implement Adaptive Phased Management.

Further information about the implementation of the government-selected plan is available on the NWMO's website at www.nwmo.ca.

Implementation of the APM approach will be regulated at all stages, with the CNSC responsible for regulatory matters pursuant to the NSCA. The NWMO will be required to obtain licences from the CNSC for site preparation, construction, operation and decommissioning of the repository facilities.

Management of Canada's nuclear legacy liabilities

Nuclear legacy liabilities consist of disused nuclear facilities and associated infrastructure, a wide variety of buried and stored waste, and contaminated lands at AECL research and prototype reactor sites. These liabilities have resulted from more than 60 years of nuclear research and development (R&D) carried out on behalf of Canada by the National Research Council and Atomic Energy of Canada Limited (AECL). About 65% of the liabilities (in terms of cost) are located at AECL's Chalk River Laboratories (CRL) in Ontario, and a further 25% are located at AECL's Whiteshell Laboratories (WL) in Manitoba, which is undergoing decommissioning. Most of the remaining 10% relate to three shutdown prototype reactors in Ontario and Quebec that are being maintained in a safe storage state.

The cost of the liabilities is estimated at about $10 billion (current day dollars). The shutdown buildings and contaminated lands need to be safely decommissioned to meet federal regulatory requirements, and long-term solutions need to be developed and implemented for the wastes.

The inventory of legacy waste includes used fuel, intermediate-level and low-level solid and liquid radioactive waste, and waste (largely contaminated soils) from site clean-up work across Canada. Most of the waste is in an unconditioned form, and limited characterization information is available for the waste generated in past decades. More than half of the liabilities are the result of Cold War activities during the

1940s, 50s and early 60s. The remaining liabilities stem from research and development for nuclear reactor technology, the production of medical isotopes and national science programs.

In 2006, the Government of Canada adopted a long-term strategy to deal with the nuclear legacy liabilities and initiated a five-year start-up phase, thereby creating the Nuclear Legacy Liabilities Program (NLLP). The objective of the long-term strategy is to safely and cost-effectively reduce risks and liabilities based on sound waste management and environmental principles in the best interests of Canadians. The NLLP was established to implement the long-term strategy to address the legacy waste, redundant infrastructure and contaminated land liabilities at AECL sites. To date, the Government of Canada has committed more than $1.1 billion in funding to implement the NLLP.

The NLLP is being implemented through a Memorandum of Understanding (MoU) between NRCan and AECL whereby NRCan is responsible for policy direction and oversight, including control of funding, and AECL is responsible for implementing the work. A Joint NRCan-AECL Oversight Committee, chaired by NRCan makes decisions on the planning, delivery, reporting and administration of the current plan. NRCan represents the interests of the Government, providing policy direction and oversight; and ensuring value for money, transparency and accountability. AECL implements the work; ensures regulatory compliance, safety and effectiveness; identifies priorities and develops annual plans; reports on approved activities; and holds and administers licences, facilities, lands, materials and other asset responsibilities related to the nuclear legacy liabilities.

In February 2013, the Minister of Natural Resources announced that Canada would undertake a competitive procurement process to seek a contractor to manage the operation of AECL's Nuclear Laboratories based on a Government-owned, Contractor-operated (GoCo) management model. This new model will bring private-sector rigour and efficiencies to the management of the Nuclear Laboratories at a lower cost and risk to taxpayers. The restructuring initiative is expected to be completed in the latter half of 2015, after which time the nuclear decommissioning and waste management work covered by the NLLP will be integrated into the overall contract with the GoCo contractor.

Projects and activities carried out under the NLLP have resulted in reductions to risks and liabilities and contributed to the provision of studies, plans and facilities that will be required for subsequent phases of the strategy. Liabilities and risks have been reduced through the decontamination and dismantling of disused buildings, the recovery of buried waste, the construction of a fourth groundwater treatment system at CRL, and the shipment of certain wastes to the U.S. for treatment and disposal.

AECL and NRCan continue to further develop and advance the long-term strategy for addressing the legacy liabilities to take into account:

- Increased understanding of the nature and extent of contamination through field investigations and characterization work;
- Improved definition of the waste inventory;
- Lessons learned from implementing the NLLP; and
- Evolving international best practice.

In particular, a comprehensive review of the long-term strategy that was completed in 2013 resulted in a number of improvements, including the acceleration of the decommissioning of the WL site and more cost-effective approaches for providing the required waste management capabilities and facilities that are in keeping with best international practice.

Long-term management of L&ILRW

All ongoing L&ILRW from nuclear power production is presently stored at reactor sites. OPG, HQ, and NB Power all operate on-site storage facilities. AECL manages its ongoing production of L&ILRW on site at its CRL and provides a waste storage service at Chalk River for smaller producers on a fee-for-service basis.

Canada's two major waste owners, OPG and AECL, are pursuing initiatives to develop and implement long-term waste management solutions. OPG produces the bulk of Canada's L&ILRW on an annual basis. Its L&ILRW is safely stored at the Western Waste Management Facility (WWMF) at the Bruce nuclear site, which is located in the Municipality of Kincardine, Ontario.

In April 2002, OPG and the Municipality of Kincardine signed a Memorandum of Understanding to jointly study options for the long-term management of the wastes at the WWMF. An Independent Assessment Study (IAS) was conducted of three options:

i) enhanced processing and storage
ii) a covered above-ground concrete vault
iii) a deep geologic repository (DGR)

The IAS concluded that each of the options was feasible, they could be constructed to meet international and Canadian safety standards with a considerable margin of safety, they would not have significant residual environmental effects, and they would not have a negative effect on tourism. The study also concluded that the geology of the Bruce nuclear site was considered ideal for the DGR option.

In April 2004, Kincardine Council chose the DGR option because it had the highest margin of safety and was consistent with international best practice. Other noteworthy considerations for the choice of the preferred option are outlined below:

- The DGR would permanently isolate L&ILRW, much of which is already stored on site;
- The project would provide significant economic benefit to the residents of the municipality;
- No high-level waste or nuclear fuel waste would be allowed in the facility; and,
- The project would undergo a rigorous environmental assessment and the CNSC regulatory process would include opportunities for public input before construction is approved.

In October 2004, Kincardine and OPG signed the Kincardine Hosting Agreement, which sets out the terms under which the DGR project would proceed.

In June 2007, the proposed DGR project was referred for an environmental assessment by a review panel. In April 2011, OPG submitted its Environmental Impact Statement (EIS), Preliminary Safety Report and other documentation to the CNSC in support of a licence application for the construction of a DGR. In January 2012, under the *Canadian Environmental Assessment Act* (CEAA) and the NSCA, a three member Joint Review Panel was established to review the environmental aspects of the proposed project.

In June 2013, the Joint Review Panel determined that the EIS and other documentation were sufficient to proceed to a public hearing and public hearings were conducted in September 2013 and September 2014. Should a construction and operation licence be granted by the CNSC, the DGR could begin to receive LILRW around 2025. For more information on the project and the regulatory review process, refer to the following link http://www.ceaa-acee.gc.ca.

AECL, the other major ongoing producer of L&ILRW, stores its waste in-ground and in above-ground structures. Although not the largest producer of L&ILRW, AECL has the largest amount currently in storage as a result of its previous nuclear Research and Development (R&D) work. Under the NLLP, NRCan and AECL are assessing long-term waste management strategies for dealing with this waste.

Historic waste management

The bulk of Canada's historic low-level radioactive waste is located in the southern Ontario communities of Port Hope and Clarington. The majority of these wastes are contaminated soils that amount to a volume of roughly 1.7 million cubic meters. These materials relate to the historic operations of a radium and uranium refinery in the Municipality of Port Hope dating back to the 1930s.

In March 2001, the Government of Canada and the local municipalities entered into an agreement based on community-developed proposals to address the cleanup and long-term management of these wastes, thereby launching the Port Hope Area Initiative (PHAI). The PHAI Management Office (MO) is the proponent for the PHAI on behalf of the Government of Canada.

The PHAI will involve the long-term management of these historic wastes in two above-ground mounds to be constructed in the local communities of Port Hope and neighboring Clarington. The current phase of the PHAI involves construction of new waste management facilities and remediation of contaminated lands, and is expected to be completed in fiscal year 2021/2022. Ongoing public consultation remains a priority.

Most of the remaining historic waste to be dealt with in Canada is located along the Northern Transportation Route between Port Radium, Northwest Territories and Fort McMurray, Alberta. The waste results from the past transport of radium and uranium bearing ore and concentrates from the Northwest Territories to Fort McMurray, Alberta. In 2003, the Government of Canada completed a cleanup of contaminated sites in Fort McMurray, and the resulting contaminated soils are safely stored in a long-term, above-ground mound at the local municipal landfill. Strategies are currently being developed for the cleanup of the remaining contamination along the Northern Transportation Route, which is estimated to consist of about 11,000 cubic metres of contaminated soils.

Uranium mine and mill tailings

All currently active uranium mining sites in Canada are situated in northern Saskatchewan. However, Elliot Lake, Ontario was the major uranium mining centre in Canada for over 40 years. Since the last Elliot Lake mining facility closed in 1996, uranium mining companies have committed well over $75 million to decommission all mines, mills, and waste management areas. Water treatment and minor engineering works continue to be the main activities at these locations. Water quality within the area watershed has improved dramatically since the closure and decommissioning of the mines and currently meets Ontario Drinking Water Standards. Where appropriate and necessary, the CNSC has embarked on a programme to bring inactive uranium mining sites in Canada under regulatory control.

RESEARCH AND DEVELOPMENT

In 2007, the Nuclear Waste Management Organization (NWMO) assumed responsibility for directing and managing all aspects of the technical R&D program for Canada's nuclear fuel waste. From 1996 to 2006, the technical R&D program was funded and managed by OPG. Previously, it was largely funded by the Government of Canada and managed by AECL.

The key goal of the NWMO's technical R&D program is to support implementation of Adaptive Phased Management, the approach selected by the Government of Canada in June 2007 for long-term

nuclear fuel waste management. The R&D program focuses on long-term used fuel storage and repository engineering, geoscience, safety assessment as well as technical support to the collaborative siting process.

Cameco Corporation, AREVA Resources Canada Inc., the CNSC and the Government of Saskatchewan provide funding to support research related to uranium mine and mill tailings management. For example, both Cameco and AREVA Resources Canada support ongoing research at the University of Saskatchewan.

Both Cameco and AREVA conduct research to improve tailings management at their facilities. Cameco, in co-operation with universities and industry partners across North America, are researching methods to remove the trace metal selenium from the Key Lake mill effluent. This research will be shared with other mining companies experiencing similar concerns with tailings management. Research at AREVA has developed a method to contain arsenic as a relatively insoluble stable mineral in the Tailings Management Facility at McClean Lake, protecting nearby water resources.

The Canadian Nuclear Safety Commission funds an extramural research program to obtain knowledge and information needed to support its regulatory mission. The program provides the CNSC with access to independent advice, expertise, experience, information and other resources via contracts placed in the private sector, and with other agencies and organizations in Canada and elsewhere.

DECOMMISSIONING AND DISMANTLING POLICIES AND PROJECTS

Decommissioning nuclear facilities

Together with supporting Regulations, the NSCA requires that the shutdown and decommissioning of nuclear facilities licensed by the CNSC is carried out according to plans approved by the CNSC. The NSCA includes provisions for ensuring that applicants provide such financial guarantees for funding the decommissioning of their facilities as the CNSC may require.

Decommissioning projects are underway at the AECL research facilities at Whiteshell and CRL, and at AECL demonstration/prototype power reactor sites at Douglas Point and Rolphton in Ontario, and at the Gentilly I reactor in Quebec. These reactors, and the NRX reactor at Chalk River and the WR-1 reactor at Whiteshell, are now partially decommissioned and are in a state of "storage-with surveillance". AECL is continuing to submit decommissioning plans for components of its research facilities.

Decommissioning uranium mining facilities

Monitoring the decommissioned uranium mining facilities in the Elliot Lake area of Ontario is continuing. These facilities include the Stanrock and Denison facilities of Denison Mines Limited and the Quirke, Panel, Stanleigh, Spanish American, Milliken, Lacnor, Nordic/Buckles, and Pronto facilities of Rio Algom Limited. In Saskatchewan, decommissioning of the Cluff Lake uranium mine and mill began in 2002. AREVA Resources Canada Inc. completed decommissioning the mine and mill site in 2006 and is maintaining and monitoring the site under licence from the CNSC.

On April 2, 2007, the Government of Canada and the Government of Saskatchewan announced the first phase of the cleanup of closed uranium mine and mill sites in northern Saskatchewan (principally the Gunnar and Lorado mines). These facilities were operated from the 1950s until the early 1960s by private sector companies which no longer exist. When the sites were closed, there was no regulatory framework in

place to appropriately contain and treat the waste, which has led to environmental impacts on local soils and lakes. Work to define a preferred option for decommissioning the Gunnar mine site is underway while decommissioning is proceeding on the Lorado mine site.

TRANSPORT

In Canada, nuclear materials are routinely transported by road, rail, sea and air. The responsibility to regulate the safe transport of nuclear substances, including radioactive waste, is jointly shared between the CNSC and Transport Canada.

Transport Canada's Transportation of Dangerous Goods (TDG) Regulations deal with the transport of all classes of dangerous goods, while the CNSC's Packaging and Transport of Nuclear Substances (PTNS) Regulations are primarily concerned with health, safety and security of the public, and protection of the environment related to the special characteristics of radioactive material. Both the TDG and PTNS Regulations apply to all persons who handle, offer for transport, transport or receive nuclear substances.

All nuclear substances are transported in packages that are selected based on the nature, form and quantity or activity of the substance. There are general design requirements that apply to all package types to ensure that they can be handled safely and easily, secured properly, and are able to withstand routine conditions of transport.

Most shipments are of radioactive materials destined for use in medicine, science and industry and they generally involve routine deliveries of materials with very low levels of activity, but other more radioactive materials, including spent fuel from nuclear reactors, are also transported within Canada.

COMPETENT AUTHORITIES

The Government of Canada recognises the important contribution of the nuclear industry as well as the need to ensure safety, security, public health and the protection of the environment. Against this background, policies, legislation and regulations have been put in place in order to provide appropriate direction and oversight of radioactive waste management in Canada.

Natural Resources Canada (NRCan) is the lead federal department responsible for developing and implementing uranium, nuclear energy, and radioactive waste management policies. It provides oversight through the Nuclear Fuel Waste Bureau on the activities of the NWMO pursuant to the NFWA. NRCan also has overall responsibility for the long-term management of historic waste and legacy waste.

Other federal departments have been assigned roles and responsibilities related to the safe management of radioactive waste, including Health Canada, Environment Canada, the Canadian Environmental Assessment Agency and Transport Canada.

Health Canada recommends radiological protection standards and monitors occupational radiological exposures.

Environment Canada contributes to sustainable development through pollution prevention to protect the environment, human life and health from the risks associated with toxic substances. They are responsible for the administration of the *Canadian Environmental Protection Act.*

The Canadian Environmental Assessment Agency is a federal body accountable to the Minister of the Environment. The Agency provides high-quality environmental assessments (EA) that contribute to

informed decision making, in support of sustainable development. The Agency is the responsible authority for most federal EAs.

Transport Canada develops and administers policies, regulations and services for the Canadian transportation system including the transportation of dangerous goods**.**

The **Canadian Nuclear Safety Commission (CNSC)** is the lead federal body for regulation and oversight of operations conducted by the nuclear industry.

Atomic Energy of Canada Limited (AECL), a federal Crown Corporation is responsible for Canada's Nuclear Laboratories, which are primarily located and headquartered in Chalk River, Ontario. On November 3, 2014, AECL launched Canadian Nuclear Laboratories (CNL), a wholly-owned subsidiary to operate and manage the Nuclear Laboratories, as part of the Government of Canada's initiative to restructure the Nuclear Laboratories. CNL is responsible for managing Canada's historic and legacy radioactive waste, producing medical isotopes, servicing Canada's Nuclear Industry and conducting broader Nuclear Science and Technology (S&T).

The **Low-Level Radioactive Waste Management Office (LLRWMO)** was established by the Government of Canada in 1982 as the federal agent for the cleanup and management of historic low- level radioactive waste in Canada. The LLRWMO operates as a separate division of AECL but receives its funding and policy direction from NRCan.

The **Port Hope Area Initiative Management Office (PHAI MO)** is a fixed-term organization designated with specific responsibility to carry out the Port Hope Area Initiative.

The **Nuclear Waste Management Organization (NWMO)** is an industry led organization established in 2002 by the nuclear energy corporations in accordance with the NFWA. It is mandated with the long-term management of nuclear fuel waste and operates on a non-profit basis. The NWMO reports annually to the Minister of Natural Resources.

Key organizations that play a role in the nuclear fuel cycle

In Canada, several key companies play an important role in the nuclear fuel cycle. The major mining companies in Canada involved in uranium mining, milling, processing or refining are Cameco Corporation and AREVA Resources Canada Inc. Nuclear fuel fabrication companies are General Electric and Cameco Fuel Manufacturing Inc. Canadian companies currently responsible for nuclear power production are OPG, Bruce Power, and New Brunswick Power (NB Power).

FINANCING

With respect to financial responsibility for radioactive waste management, the CNSC requires existing operators to provide financial guarantees designed to ensure that operations take place in a responsible and orderly manner, in both the short and long term. Where a producer or owner cannot be identified, or cannot be located, or is unable to pay, responsibility rests with the federal and/or provincial governments, as managers of last resort.

Nuclear fuel waste

The requirements for financial guarantees set out in the NSCA take into account the related requirements of the NFWA. The NFWA requires that each of the nuclear energy corporations, including AECL establish segregated trust funds to pay for the full lifecycle costs associated with managing the

nuclear fuel waste over the long term. As of December 2013, a total of approximately $2.8 billion has been set aside. These funds will cover the costs associated with constructing and operating the waste management facility, including transporting, handling, maintaining and monitoring of the nuclear fuel waste at the site. These funds can only be withdrawn by the NWMO, and only after a construction or operating licence for a long-term waste management facility has been granted by the CNSC.

Low and intermediate level radioactive waste

Financial guarantee requirements under the NSCA apply to the ongoing production of L&ILRW. Financial guarantees sufficient to cover the full costs of radioactive waste management are in place for all major nuclear facilities in Canada, including nuclear power reactors, research reactors, fuel fabrication facilities, uranium processing facilities, isotope processing facilities, and waste management facilities. With respect to the long-term management of historic waste and nuclear legacy liabilities, these are financed directly by the Government of Canada.

Uranium mine and mill tailings

The CNSC requires the owners of uranium mine sites to post financial guarantees to cover the costs of decommissioning. Where an owner cannot be identified, cannot be located, or is unable to pay, responsibility for decommissioning may rest with the federal and/or provincial government, depending on the circumstances.

The 1996 Canada-Ontario Memorandum of Agreement (MoA) on cost-sharing for the long-term management of abandoned uranium mine sites recognises that present and past owners are responsible for all financial aspects of the decommissioning, and long-term maintenance of uranium mine sites, including the tailings. In the case of abandoned sites, however, the MoA outlines how both levels of government will share the long-term management responsibilities and associated costs. However, the companies that operated these sites have now completed the decommissioning work and government funds have not been required.

In 2006, the Government of Canada and the Government of Saskatchewan entered into a MoA. Under a MoA, the Government of Canada agreed to provide $12.3 million towards the costs of remediating uranium mines which operated from the 1950s until the early 1960s in northern Saskatchewan. These mines were operated by the private sector companies which no longer exist. The sites were not remediated to the standards that are in place today, which has led to environmental impacts on local soils and lakes.

PUBLIC INFORMATION

For more information, the websites of the main government and industry organisations are listed below.

Government
Canadian Environmental Assessment Agency: www.ceaa-acee.gc.ca
Canadian Nuclear Safety Commission: www.nuclearsafety.gc.ca
Low-Level Radioactive Waste Management Office: www.llrwmo.org
Natural Resources Canada: www.nrcan.gc.ca/energy/uranium-nuclear/7691
Nuclear Fuel Waste Bureau: www.nrcan.gc.ca/energy/uranium-nuclear/nuclear-fuel-waste-Bureau/7735
Port Hope Area Initiative Management Office: www.phai.ca/en/phai-2/phai-management-office
Transport Canada – Transport of Dangerous Goods Directorate: www.tc.gc.ca/eng/tdg/safety-menu.htm
Industry

AREVA Resources Canada Inc.: www.us.areva.com
Atomic Energy of Canada Ltd: www.aecl.ca
Bruce Power: www.brucepower.com
Cameco Corporation: www.cameco.com
Canadian Nuclear Association: www.cna.ca
Hydro-Québec: www.hydroquebec.com
New Brunswick Power: www.nbpower.com
Nuclear Waste Management Organization: www.nwmo.ca
Ontario Power Generation: www.opg.com