Environmental Impact Statement Summary

Nuclear Power Demonstration Closure Project

September 2017

www.cnl.ca/NPD

Canadian Environmental Assessment Registry # 80121

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Interactive Feature

You may not recognize all of the terms used in this Environmental Impact Statement Summary. In order to provide more context we have made the document interactive. All text in dark blue has a definition that will pop up if you roll your mouse over the text.

? You can also look for the blue question marks, which will reveal more information when you roll your mouse over the symbol.

Contents

The Environmental Impact Statement Summary is based on the Environmental Impact Statement prepared by Arcadis Design & Consultancy

Introduction

The Nuclear Power Demonstration (NPD) Nuclear Generating Station (NGS) was operated by Ontario Hydro from 1962 until being permanently shut down in 1987, when the responsibilities were transferred to Atomic Energy of Canada Limited (AECL), a federal corporation. It is now referred to as the Nuclear Power Demonstration Waste Facility (NPDWF). Under the federal Nuclear Safety and Control Act, the NPDWF is a Class I nuclear facility presently in interim storage and has a Decommissioning Waste Facility License that was issued in 2014 by the Canadian Nuclear Safety Commission (CNSC).

NPD as it appears today

The Nuclear Power Demonstration (NPD) site is located in Rolphton Township, in the Town of Laurentian Hills in Renfrew County, Ontario, Canada, on the south bank of the Ottawa River, about 25 km upstream of the Chalk River Laboratories (CRL) site, and approximately 200 km northwest of Ottawa.

Location of NPD

The purpose of the proposed project is to safely decommission the NPDWF, ensuring a reduction of Canadian legacy long-term liabilities and eliminating interim waste storage, while reducing worker risk and transport/waste handling risk.

The Government of Canada is interested in an approach to completing the decommissioning the NPDWF that protects the public and the environment.

The project is proposed to begin in 2019, with final site restoration occurring in 2020, and long-term care and maintenance activities proceeding from 2020 onwards. The project phases and schedule are presented in the table on the following page.

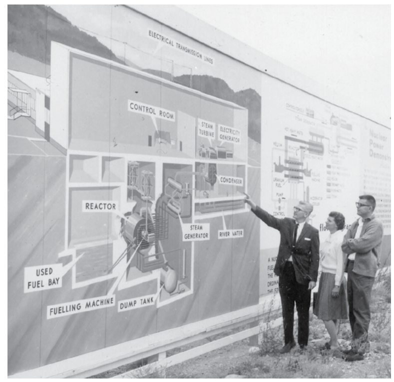
Canadian Nuclear Laboratories (CNL), a private sector company contractually responsible for nuclear sites, facilities and assets owned by AECL, is proposing to safely carry out the decommissioning of the

NPDWF. As such, CNL is the proponent for the NPD closure project.

Under Section 15 of the *Canadian Environmental Assessment Act* (*CEAA*), 2012, the CNSC is considered to be the Responsible Authority for the proposed project.

The Environmental Assessment (EA) is being carried out based on the *Canadian Environmental Assessment Act* (2012) and the CNSC (2016) Regulatory Document REGDOC-2.9.1 on *Environmental Protection: Environmental Policy, Assessments and Protection Measures*.

This Environmental Impact Statement (EIS), a required component of the EA process, has been prepared to document the findings of the EA process.



Since the 1960's NPD has drawn public interest; here visitors learn about its unique design

Decommissioning Phase	Associated Activities	Duration
Decommissioning Execution	**Assembly and operation of batch mixing plant**	2019
	Grouting of below-grade structures	2019
	Removal of above-grade structures and use as backfill	2019 - 2020
	Installation of concrete cap and engineered barrier	2019 - 2020
	Final site restoration	2020 - 2020
Institutional Controls	Long-term care and maintenance activities	2020 - 2120
Post-Institutional Controls	Facility performance during the Post-Institutional Controls phase	>2120

Description of the Project

Purpose

The purpose of the project is to safely carry out the decommissioning of the NPDWF using **the in-situ decommissioning approach** to isolate the contaminated systems and components inside the below-grade structure. All below-grade areas will be sealed with grout and concrete from an on-site batch mixing plant. Grouting is the process of placing, by pumping, a mixture of Portland Cement and water that produces a pourable, concrete-like, mixture to ensure filling of gaps and crevices throughout the facility. All above-grade structures will be demolished, size reduced and placed into the below-grade structure as backfill prior to final grouting. The footprint above the reactor vessel will be capped with reinforced concrete and the entire NPDWF covered with an engineered barrier and the ventilation stack will be retained. The NPD site will then be restored and prepared for long-term care and maintenance activities, carried out under an amendment of the current decommissioning licence.

Alternatives

The in-situ decommissioning described above is the preferred approach proposed by the project to carry out the decommissioning of the NPDWF. Three additional alternative means for decommissioning the NPDWF were considered for the project:

- Continued storage with surveillance – this alternative involves deferral of decommissioning by maintaining the current state, allowing for further radioactive decay and involving continued maintenance and monitoring at the site.
- Partial dismantling and removal – this alternative involves the removal of the reactor system and components to be transported off the NPD site and placed in interim waste storage at CRL until disposal facilities are available. The remaining above-ground structures would be demolished, emplaced in the below-grade structures before grouting, as in in-situ decommissioning.
- Full dismantling and removal – this alternative involves removal of all radioactive material to be transported off the NPD site and placed in interim waste storage at CRL until disposal facilities are available. The facility structures would be demolished and removed from the site.

Although each of the four alternative means were determined to be technically feasible based on the use of reliable technology, regulatory compliance, and cost, the in-situ decommissioning offers a lower risk option than all other alternatives. This is because differences between the other alternative means are more pronounced during future time periods where disruptive events and long-term environmental processes occur. These alternative options have greater risks of effects from these events or processes since the waste would be stored above ground. In-situ decommissioning involves emplacement and grouting of waste below ground, thereby limiting the risks.

The grouted facility

Wastes and Emissions

The forms of waste generated by the project can be divided into existing waste (e.g., materials such as concrete and stainless steel in the reactor vault, containing radiological and non-radiological contamination) and generated waste (e.g., worker protective equipment and discharge water from equipment wash out).

Radionuclides will be present in these materials in two forms:

- radionuclides embedded within metals and other materials, present due to the interaction of neutrons from the reactor operation with the structures; and,
- as contamination on surfaces, mainly resulting from the handling of fuel elements which had suffered failure of their protective cladding, enabling the release of some radionuclides.

The radionuclide inventory of the reactor was estimated using mathematical models representing the reactor materials and geometry. CNL has also taken samples of reactor components to verify the estimated inventory. Contamination in other areas of the NPDWF has been estimated based on previous measurements. These data have been combined with estimates of the amount of material that is contaminated in each room to derive an inventory for the main system, components or stored waste in NPDWF.

The inventory of non-radiological contaminants is dominated by those typically
associated with 50-year-old industrial facilities, including:

- lead: from lead paint and lead bricks, previously used as shielding;
- mercury: from instruments, such as residual contamination;

An example of demolition activities

- asbestos: from pipe insulation, floor tiles and building cladding;
- polychlorinated biphenyls (PCBs): from light ballasts which will remain due to inaccessibility; and,
- oils: evidence of a historical oil leak was found inthe tile drains and remediation was undertaken.

The project will also generate emissions, including:

- dust (from demolition, equipment sizing and onsite trucking);
- noise (from machinery, demolition and vehicles);
- diesel emissions (from machinery and vehicles);
- water (from runoff, wash out pit discharges and equipment decontamination); and,
- contaminated air (displaced from the facility during grouting and emplacement).

Visitors to a Chimney Swift Count Night view the ventilation stack at NPD, one of the largest roosts in Canada for this Species at Risk

Scope Changes

The main change that has been made to the original project scope (i.e., since submission of the Project Description), is to retain the existing ventilation stack. After reactor shutdown, the NPD ventilation stack became home to a large number of chimney swifts who roost annually in the chimney-like structure. The ventilation stack is a significant roost during the spring migration and the number of chimney swifts can reach more than 2,000 birds. CNL considered the construction of an alternative roost structure, but based on the recommendation of an expert working group, decided to retain the existing ventilation stack. The ventilation stack is expected to remain structurally sound and capable of continuing to function as a chimney swift habitat for another 50 years. This is expected to complement the timeline for recovery of the species.

Government Communications

CNL has initiated communications with Environment and Climate Change Canada (ECCC) regarding the entombment of a small number of PCB-containing light ballasts in the NPDWF, which pose significant occupational risks to remove, however in this assessment, these ballasts have been demonstrated to have no residual environmental effect by grouting in place.

CNL has also initiated communications with ECCC regarding the submittal of a request for a permit under the *Species at Risk Act* (SARA) to undertake project activities which may affect chimney swifts that use the ventilation stack at the NPD site as a roosting site.

The Ontario Ministry of Transportation (MTO) reviewed the potential traffic implications of the project and expressed no concerns.

Scope of the Environmental Assessment

In accordance with CEAA (2012) and the CNSC 2016 EIS Guidelines, this EIS takes into account:

- *the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project, and any cumulative environmental effects likely to result-from the designated project in combination with other physical activities that have been or will be carried out;*
- *the significance of the effects referred to above*
- *comments from the public — or, with respect to a designated project that requires that a certificate be issued in accordance with an order made under section 54 of the National Energy Board Act, any interested party — that are received in accordance with this Act [CEAA];*
- *mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the designated project;*
- *the requirements of the follow-up program in respect to the designated project;*
- *the purpose of the designated project;*
- *alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means;*
- *any changes to the designated project that may be caused by the environment;*
- *the results of any relevant study conducted by a committee established under section 73 or 74 [of CEAA]; and,*
- *any other matter relevant to the environmental assessment that the responsible authority [CNSC], or — if the environmental assessment is referred to a review panel — the Minister, requires to be taken into account.*

The EIS considers these factors for three spatial boundaries: the Site, Local and Regional Study Areas. The Site Study Area extends 50 m into the Ottawa River and includes areas within the NPDWF fenceline and the surrounding paved areas, the building foundations and non-essential roadways, the two landfills on the NPD site and also includes areas that will not necessarily be affected during decommissioning activities but will require work during the site restoration (e.g., due to prior contamination).

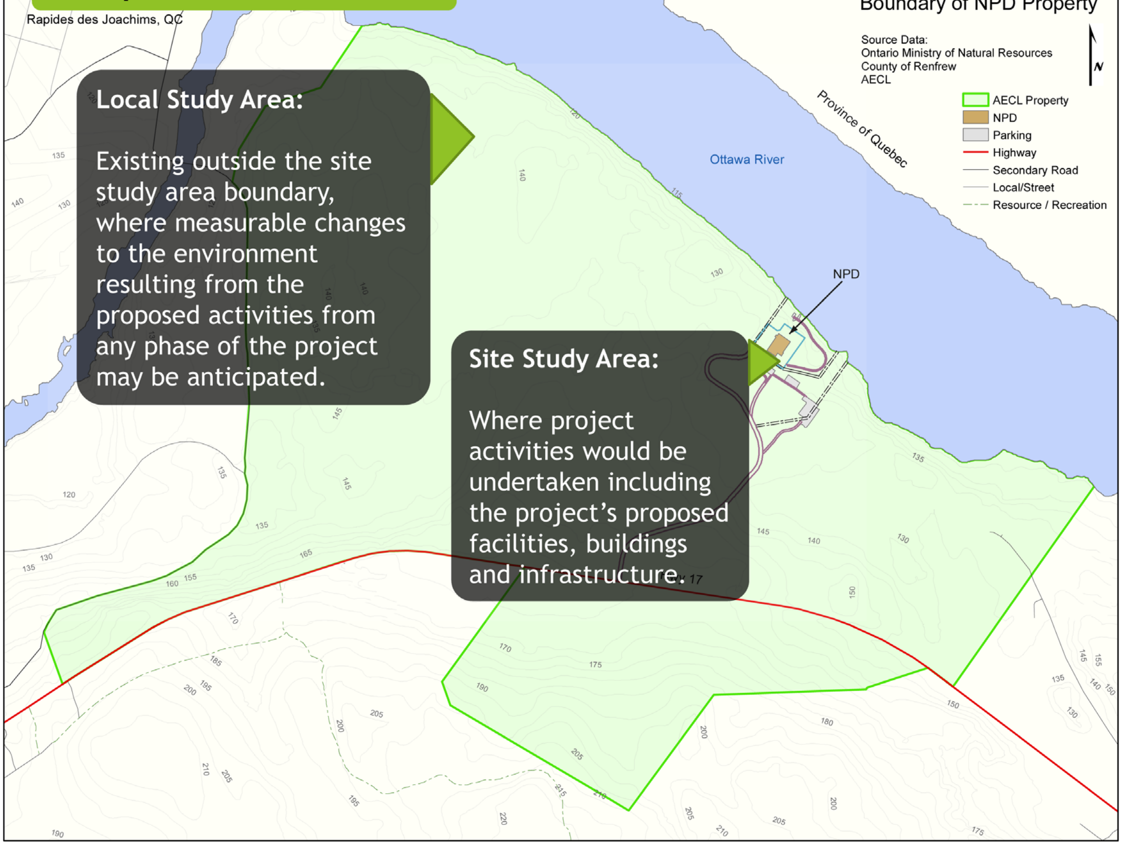
The Local Study Area goes beyond the Site Study Area and includes the entire NPD property, and also extends 50 m into the Ottawa River. The Local Study Area is defined to encompass any measurable effects of the project. The larger Regional Study Area varies between environmental components to capture the interaction of effects from the project with the effects of other projects within each component.

Aerial view of the NPD site

The EIS also considers three different project phases:

- Decommissioning Execution, or the first one to two years during which all activities associated with decommissioning of the facility including setup and operation of the batch mixing plant, grouting and demolition activities, installation of the concrete cap and engineered barrier, as well as site restoration and demobilization.
- **Institutional Controls**, or an estimated period of about 100 years following the Decommissioning Execution phase, where long-term care and maintenance and oversight would be performed by CNL in order to ensure that the disposal system performs as expected, that human safety is ensured until the short lived nuclear wastes decay to below the acceptance criteria and that problems that may impact the long-term stability of the facility can be rectified; and,
- Post-Institutional Controls, or abandonment of the site following the Institutional Controls phase.

Spatial Boundaries



Public and Stakeholder Engagement

CNL has conducted and continues to conduct EA-related public and stakeholder engagement activities, including:

- presentations, information sessions and site visits;
- project information (e.g., web content, fact sheets, etc.);
- participation in public events;
- advertising campaigns and distribution of factsheets and comment cards.

These activities have helped inform stakeholders, and have enabled the public to provide valuable feedback into the project, which helps CNL understand areas of public concern and improve the project design and EIS. Key concerns voiced from the outreach activities are listed below, along with CNL's plan to address these issues:

CNL staff member answering questions at a public information session

Issue

Incorporation into Project Design, EIS and/or Engagement

Species at Risk: How will the decommissioning affect the chimney swifts roosting in the NPD stack?

- In order to minimize the risk to the chimney swifts, CNL decided to retain the existing ventilation stack, instead of demolishing it and replacing it with an alternative habitat. This decision was made with input from a panel of experts composed of academia, government agencies and non-governmental organizations.
- Since their current roost will be retained, the project predicts that effects on chimney swifts from project activities (e.g. noise, dust, vibration and light) will be minimal, given project activities will occur between 7 am and 7 pm (i.e., during daylight hours when the chimney swifts are out foraging) wherever possible.
- A subject matter expert on chimney swifts provided advice to CNL on how to protect the chimney swifts during decommissioning activities using best practices, mitigation measures and how to monitor the impacts to the birds.

An aerial photograph of the NPD facility from the 1967-68 Annual Report

Ottawa River: How will the Ottawa River be protected?

- The Ottawa River is important for many reasons (water quality, flow, recreational use, fishing, ecology). We have captured these aspects through other Valued Components (VCs), including aquatic biota, fishing and residents' use and enjoyment of land. The EIS assesses the impact of the project on these VCs.
- Consideration was given to the benefit of in-design mitigation measures in preventing or reducing environmental effects. "In-design" mitigation measures are features included in the project design for the purpose of pre-empting possible environmental effects, based on good practice and CNL experience. For example, the use of grout to fill the structure is expected to slow down the release of contaminants to groundwater and subsequently to the Ottawa River, and allow more time for radioactive decay.

Effects of the environment on the project: Has this project examined the potential effects of an earthquake or climate change or other natural disasters on the NPD?

- The EIS assesses the effects of the environment on the project (e.g., earthquakes, tornados, climate change).
- Preliminary results have indicated that the potential radiological doses to both human and non-human biota receptors are magnitudes less than the CNSC established dose criteria which protects the public and environment under all plausible conditions.

Monitoring: How will monitoring occur around the site and how long will the NPD site be monitored post-decommissioning?

- The EIS presents a conceptual description of proposed follow-up monitoring activities for the Decommissioning Execution and Institutional Controls phases. The detailed follow-up monitoring program will be developed incorporating federal reviewer and stakeholder feedback from the draft EIS review.
- The proposed follow-up monitoring during demolition and grouting activities will include emission and effluent monitoring as well as regular chimney swift counts during their seasonal presence at NPD.
- The proposed follow-up monitoring during the Institutional Controls phase will include visual inspections and monitoring the groundwater for parameters that would be indicative a failure of a safety feature.

Financial: What is the cost of this option in comparison to alternative methods, and who is funding this project?

- A high-level cost analysis of the in-situ decommissioning option compared to other alternatives was conducted.
- Funding for the project is provided by AECL, a federal corporation.
- In response to earlier public feedback, at the October public information sessions CNL included information on the approximate costs of alternative methods.

Land Use: How will the unaffected land be released after the project is finished?

- As clarified in previous open houses and within the EIS, AECL is the federal corporation that owns the site and CNL is the operator of the NPD site contracted by AECL to perform the closure of the NPD Site.
- The final decision on dispositioning of non-impacted land on the NPD site rests with AECL.

As seen in the table above, while most of the key issues that stakeholders have brought forth have been resolved or incorporated into the design of the project, one outlier is with regards to land use of the unaffected areas of the NPD site. To address this issue, CNL has clarified through consistent messaging and communications with stakeholders that the NPD property belongs to AECL, a federal corporation. Once CNL completes the decommissioning of the NPDWF, AECL will look at the future of the lands. AECL will take into account consideration for stakeholder engagement, as appropriate, and the duty to consult with Aboriginal peoples.

Aboriginal Engagement

CNL has conducted and continues to conduct engagement activities with First Nations and Métis communities through:

- project notifications and newspaper advertisements;
- letters, email correspondence and/or phone calls to First Nation and Métis communities and/or organization representatives (accompanied by follow-up calls);
- meetings with First Nation and Métis community and/or organization representatives to discuss the project and potential impacts;
- Environment Stewardship Council Meetings (for ESC member communities);
- public information sessions, including display materials and hand-outs;
- media notifications/releases;
- webpage content;
- presentations to First Nation and Métis communities upon request;
- distributing copies of technical studies or reports upon request;
- technical meetings, upon request, to provide interested communities an opportunity to discuss more detailed technical information concerning the project;
- targeted community initiatives;
- project site visits;
- work plan development to formalize engagement processes with communities; and,
- capacity assistance, as appropriate, such as basic costs to support meetings such as hall rental or production of print materials, in-kind access to the technical expertise of CNL staff, reimbursement for some out-of-pocket expenses to participate in engagement activities such as site visits, tours, etc.

Based on the potential or established Aboriginal or treaty rights of First Nation and Métis communities in the vicinity of the project, as identified by the CNSC, the communities engaged are: Algonquins of Ontario, Algonquin Anishinabeg Nation, Métis Nation of Ontario, Williams Treaties First Nations, Union of Ontario Indians and Algonquin Nation Secretariat.

Members of the Environmental Stewardship Council learn about cultural resources management, an area of interest for First Nations, from the archaeologist on the project

Through these engagement activities, biodiversity and cultural heritage studies have been identified as topics of interest. In response, CNL has:

- provided copies to communities, where an interest has been expressed, of project documents related to biodiversity, archaeology and the NPD site in general, as well as images and topographical maps of the site;
- shared informational posters with all identified communities and/or organizations; and,
- shared updated project information with communities and/or organizations at periodic intervals.

CNL has also provided opportunities for participation of First Nations community members in archaeological assessment field studies undertaken as part of the project.

Baseline Environment

This description of baseline conditions characterizes the existing environment and processes that may be affected by the project, and trends within the study areas. It serves as the basis for determining changes and potential environmental effects associated with the project.

Atmospheric Environment

The climate in the region surrounding the NPD site is classified as humid continental, with warm summers, cold winters, and no distinct dry season. The average daily temperature ranges from a high of 20.2°C in July to a low of -12.0°C in January, with an average annual temperature of 5.6°C. The wind conditions at the NPD site are considered to travel predominantly along the Ottawa River valley. From 2011-2015, the region received an average of 779 mm of precipitation annually, with average monthly precipitation ranging from 24.7 mm to 96.9 mm per month.

A view from the NPD site; for more than 50 years, NPD has been safely operated and maintained beside the Ottawa River

Current releases to air at the NPD site are via operation of the ventilation system, generally only for short periods of time such as during the entry of personnel into the facility which requires purging the nuclear area for inspection and maintenance. These releases are below applicable guidelines. Current emissions of greenhouse gases as well as emissions from unpaved road dust, diesel combustion products, and solvent use are minimal.

Surface Water Environment

The facility currently samples and analyses water from subsurface drains located around the NPD site semi-annually for radiological and non-radiological contaminants. The facility has also characterized surface water and sediment quality in the Ottawa River. The facility samples effluent from the wells area sump prior to discharge to ensure that effluent is below release limits.

All surface drainage on the NPD site ultimately drains to the Ottawa River. The NPD property contains some wetlands and no major tributaries. A network of ditches and drains on-site directs water flow away from the facility and into the river. The Ottawa River adjacent to NPD is about 0.5 km wide and deep with a mean flow rate of 807 m^3/s. The banks of the Ottawa River generally have low to moderate slopes, although there are steep granite cliffs in sections of the Quebec shoreline. There are numerous lakes in the region and due to regional topography, these lakes eventually drain into the Ottawa River. The EIS summarizes radionuclide content of sediment in the Ottawa River near the NPD site.

Aquatic Environment

There are wetlands on the site; however, they are at a higher elevation than the NPDWF and are not the focus of the characterization of the aquatic environment. The Ottawa River near the NPD site provides habitat for a number of fish species. The stretch of the Ottawa River between the Des Joachims Dam and La Passe contains several lake-like sections separated by short rapids. Some sections of the Ottawa River near NPD reach depths of over 60 m, and the water can become thermally stratified. In this area, the Ottawa River supports diverse warmwater and coolwater fish communities, consisting of at least 55 documented species. The provincially-rare fish species includes the river redhorse.

Geological and Hydrogeological Environment

The surface of the NPD site is covered by a boulder pavement (i.e. large boulders) which, in most areas, has been left as a result of water scouring the area and removing the finer fraction of the river-lain sediments. The base rock in the Site Study Area is quartz and granite gneiss with some overburden (1.5 to 7.5 m) of alluvial sand and gravel. The small amount of overburden and relatively steep incline of the base rocks makes ground and subsurface water run off very quickly to the river. The water table position is near the top of the bedrock, and flow directions are expected to reflect topography. The Site Study Area is at an elevation of approximately 125 m above sea level (asl). The NPD site at Highway 17 has an approximate elevation of 160 m asl and continues down to the Ottawa River which has an average elevation of 111 m asl.

Groundwater sampling was conducted on the site using existing monitoring wells. Analyses were conducted for tritium, alpha and beta activity concentrations. All samples were well below the applicable benchmarks. However, exceedances of applicable guidelines were reported for manganese. CNL also monitors tritium levels in soil and vegetation.

Terrestrial Environment

The Site Study Area consists primarily of areas previously **disturbed by human activity** and contains various cultural vegetation communities. These cultural communities provide little suitable habitat to support resident terrestrial species. The Local Study area supports diverse mixed upland areas with some wetland areas scattered throughout.

A number of Species at Risk (SARs) are known to be present at the NPD site including: chimney swift, eastern milksnake, bald eagle, common nighthawk, eastern wood pewee, eastern small-footed bat, little brown myotis, northern myotis and monarch butterfly.

Forest on the NPD property

Ambient Radioactivity

Since the NPDNGS was permanently shut down in 1987, **ambient radiation** fields in the Site and Local Study Areas have been characteristic of those observed in regions with similar terrestrial and cosmic conditions that are unaffected by nuclear facilities.

Human Health

Within the Site and Local Study Areas, CNL monitors doses to employees and visitors at the NPD site. Data on baseline human health in the Regional Study Area (i.e., the Renfrew County and District and Region de l'Outaouais Health Units) were compiled from 2013 Statistics Canada health profiles, which provide statistics on indicators such as well-being, health conditions and health behaviours. Some differences were noted between the Regional Study Area and the larger population (i.e., the entire province) that were determined to be statistically significant. For example, although more physically

Fishing on the Ottawa River

active, the residents in the Renfrew County and District Health Unit are less likely to use a bike helmet and consume less fruit and vegetable than the average residents in Ontario. A higher percentage in perceived well-being (health) was observed in the Région de l'Outaouais Health Unit when compared to percentages for the province of Quebec.

Aboriginal Land and Resource Use

While access to the NPD site is currently restricted, it is likely that Aboriginal people and possibly their ancestors living in the Ottawa Valley undertook traditional activities such as: hunting, fishing, trapping, and gathering. CNL has assumed that those activities may also occur in the future.

Socio-economic Environment

The nearest population centre to the Site Study Area is Rapides-des-Joachims in Aberdeen Township, Pontiac County, Quebec. The village occupies an island in the Ottawa River just upstream from NPD. The NPD property is in Renfrew County at the northern end of County boundaries. Renfrew County had an estimated population of 86,966 in 2011. There are five towns within Renfrew County: Arnprior, Deep River, Laurentian Hills, Petawawa, Pembroke and Renfrew. Key employers include Garrison Petawawa, CNL, Renfrew County District School Board and the County itself. Hunting, trapping and angling are important activities in the Regional Study Area. Economic activities generally include forestry, resource mining, agriculture, retail, service, manufacturing and government activities, with some high-tech industry expanding in to the area more recently as well. Highway 17 is the primary transportation route in the vicinity of NPD.

Assessment and Mitigation of Environmental Effects

The assessment of effects presents an evaluation of how the project may impact the environment, how potential effects can be mitigated and how monitoring can be used to verify the EA predictions.

Lady's Slipper (*Cypripedium acaule*)

Effects Assessment Approach

Valued components (VCs) are environmental features considered that may be affected by the project and were identified to be of importance by the proponent, government agencies, Aboriginal peoples, and/or members of the public. VCs selected for the project are listed in the image below.

Terrestrial Environment
- Invertebrates: Monarch butterfly, earthworms
- Vegetation: Red maple
- Birds: Chimney swift, Bald eagle, Ruffed grouse, Mallard, Great blue heron
- Mammals: Bats, Meadow vole, Short-tailed shrew, Black bear, Eastern wolf, Muskrat
- Reptiles & Amphibians: Blanding's turtle, Eastern milksnake, Green frog

Aquatic Environment
- Benthic invertebrates
- Vegetation
- Fish: Emerald shiner, White sucker, Lake sturgeon

Human Health
- Workers
- Members of the Public

Socio-economic Environment:
- Residents – Use/Enjoyment of property
- Walleye
- White-tailed deer
- Landscape and visual setting
- Highway 17

Aboriginal Land and Resource Use
- Trapping
- Hunting
- Fishing
- Gathering
- Cultural resources and ceremonies

Valued Components selected for the EIS, by Environmental Component (underline indicates a species listed under the Species at Risk Act)

In this study, some environmental components (e.g., the atmospheric environment etc.) were identified as pathways, meaning that changes in those environmental components could result in effects to VCs in other environmental components.

For project-related effects, potential project-environment interactions were identified for each environmental component and evaluated to identify the likely effect of the change on a VC or on a pathway to VCs in other environmental components. Effects that have the potential to occur after mitigation measures have been applied are referred to as residual effects. If an adverse residual effect was identified, additional mitigation measures were developed and outlined within each environmental component. **Monitoring and follow-up activities** were also identified to verify the accuracy of the EA predictions and to determine the effectiveness of the implemented mitigation measures.

Any adverse residual effects identified would be subjected to an analysis of significance based on a series of criteria, as follows:

- magnitude;
- spatial (geographic) extent;
- duration/timing;
- frequency/probability;
- reversibility;
- effect on human health; and,
- ecological importance of VC.

Then, depending on the rating (low, moderate, high) assigned to each of those criteria, an adverse residual effect would be classified as either a minor or significant adverse residual effect.

Atmospheric Environment

Project activities will result in vehicle and equipment exhaust and greenhouse gas emissions, as well as noise and dust generation, and air displacement from within the facility. These activities have the potential to affect air quality and noise and are expected to be most prominent during the Decommissioning Execution phase. Example mitigation measures include dust suppression techniques to minimize dust generation, regular vehicle and equipment maintenance and idling restrictions to reduce emissions.

Changes in the atmospheric environment were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and resource use (described below). These changes are not expected to result in any adverse residual effects on VCs.

Monitoring for parameters of concern in air, as well as air emissions and greenhouse gas estimates will be carried out to verify the accuracy of EA predictions and the effectiveness of mitigation measures. Monitoring will occur primarily in the Decommissioning Execution phase, since this is when the most air emissions and noise are expected to occur.

Monitoring the Ottawa River

Surface Water Environment

During the Decommissioning Execution phase, project activities such as equipment wash out, levelling areas and establishing the project footprint, have the potential to affect site drainage and surface water quality through potential contamination of runoff. Example mitigation measures include runoff diversion and containment, proper washout pit design and operation, and the use of control measures for aggregate, sand and cement stockpiles, and material laydown to reduce infiltration.

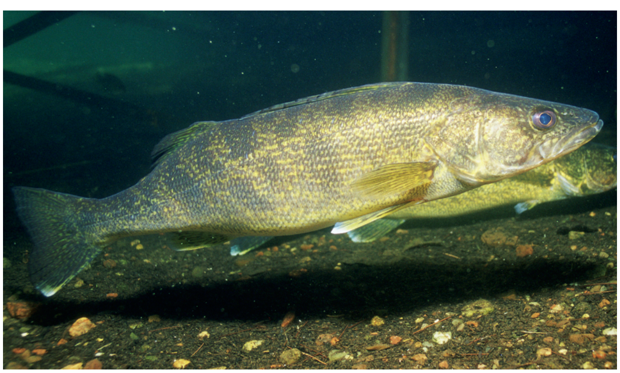
In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially reach the surface water environment. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for the release of soluble contaminants to groundwater and eventually surface water.

Changes in the surface water environment were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and resource use (described below). These changes are not expected to result in any adverse effects on VCs.

Monitoring for significant changes to surface drainage and/or water quality will be carried out to verify the accuracy of EA predictions and the effectiveness of mitigation measures. CNL will continue to monitor surface water quality in the Ottawa River during the Decommissioning Execution and Institutional Controls phase.

Aquatic Environment

In the Decommissioning Execution phase, project activities such as equipment wash out and demolition have the potential to affect aquatic biota through potential contamination of runoff. Example mitigation measures include dust suppression and runoff diversion.



A socio-economic environment VC: the walleye

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect aquatic VCs. Interactions in other environmental components also have the potential to result in changes to the aquatic environment. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for the release of soluble contaminants to groundwater and eventually to the aquatic environment.

No adverse residual effects were identified for VCs (e.g., lake sturgeon, emerald shiner) in the aquatic environment.

Monitoring and follow-up activities in other environmental components will verify the accuracy of EA predictions and the effectiveness of mitigation measures in the aquatic environment.

Geological and Hydrogeological Environment

In the Decommissioning Execution phase, project activities, such as demolition and material sizing, could affect soil quality through the potential release of contaminated particulate. Example mitigation measures include dust suppression.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for the release of soluble contaminants to groundwater.

Changes in the geological and hydrogeological environment were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and resource use. These changes are not expected to result in any adverse residual effects on VCs.

Monitoring activities such as the measurement of groundwater quality, flow and direction will be carried out during the Decommissioning Execution and Institutional Controls phases to verify the accuracy of the EA predictions and the effectiveness of mitigation measures.

Chimney swifts entering the NPD ventilation stack at sunset

Terrestrial Environment

Project activities, such as demolition and operation of machinery and vehicles, have the potential to affect terrestrial biota, through creation of dust, noise, vibration and encroachment and potentially mortality from transportation (i.e., roadkill). These interactions are expected to be most prominent during the Decommissioning Execution phase. Emissions from machinery and vehicles, and displacement of contamination in air displaced from the facility has the potential to result in exposure effects to terrestrial biota. Interactions in other environmental components also have the potential to result in changes to the terrestrial environment. Example mitigation-measures include dust and noise suppression, delineation of work areas and site sweeps for the presence of SARs.

No adverse residual effects were identified for VCs (e.g., chimney swift) in the terrestrial environment.

Monitoring activities, such as checks for SAR species on a per-event basis, and chimney swift monitoring will be carried out to verify the accuracy of the EA predictions and effectiveness of measures implemented to mitigate potential adverse environmental effects.

Ambient Radioactivity

Project activities, such as grouting the below grade structure and demolition, have the potential to affect ambient radioactivity, through the release of volatile radionuclides in air displaced from the facility and from surface contamination. These are expected to occur primarily during the Decommissioning Execution phase. Example mitigation measures include dust suppression.

Potential changes in ambient radioactivity were considered in the assessment of effects on VCs in the aquatic, terrestrial, and socio-economic environments as well as human health and Aboriginal land and resource use (described below). These changes are not expected to result in any adverse residual effects on VCs.

Monitoring activities such as routine radiation protection surveys and passive ambient air sampling will be carried out to verify the accuracy of the EA predictions and the effectiveness of mitigation measures.

Kids enjoying the Ottawa River downstream of NPD

Human Health

Project activities have the potential to increase radiation dose to workers, e.g., from the release of dust and contamination in air displaced from the facility. Mitigation measures in other environmental components, as well as work control documents and personal protective equipment will be used to reduce potential effects on worker health.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect members of the public. The assessment of human health effects incorporates local food consumption and waste use characteristics. Interactions in other environmental components also have the potential to result in changes to human health. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for release of soluble contaminants to groundwater and eventually to human health.

No adverse residual effects were identified for public or worker health.

Monitoring and follow-up activities such as radiation dose monitoring and indoor air quality monitoring, as well as activities in other environmental components will be carried out to verify the accuracy of EA predictions and the effectiveness of mitigation measures in human health.

Aboriginal Land and Resource Use

Decommissioning Execution activities could produce nuisance effects (i.e., noise and dust) for nearby hunting, trapping, fishing and gathering activities. Mitigation measures in other environmental components, such as dust suppression, timing deco mmissioning activities and periodic communication updates will be carried out to reduce potential effects on Aboriginal land and resource use.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect Aboriginal land and resource use VCs. Any potential effects on non-human biota could also impact these VCs. Interactions in other environmental components also have the potential to result in changes to Aboriginal land and resource use. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for release of soluble contaminants to groundwater and eventually to Aboriginal land and resource use VCs via surface water.

No adverse residual effects were identified for Aboriginal land and resource use VCs (e.g., gathering).

Ongoing Aboriginal Engagement activities will be used to identify any changing concerns or perceptions related to the project, develop a greater understanding of Aboriginal traditional knowledge and verify the accuracy of EA predictions related to Aboriginal land and resource use.

CNL staff at a public information session in June 2016

White-tailed deer are a popular game species in the region

Socio-economic Environment

Decommissioning Execution activities could produce nuisance effects (i.e., noise, dust and traffic) for nearby residents and land users. The project footprint could affect landscape and visual setting from the Ottawa River. Mitigation measures in other environmental components, such as dust suppression, timing of decommissioning activities and periodic communication updates will be carried out to reduce potential effects on the socio-economic environment.

In the Institutional Controls and Post-Institutional Controls phases, groundwater that comes into contact with the grouted facility may contain low levels of soluble contaminants that can potentially affect sportfish and game species (i.e., walleye and white-tailed deer). Interactions in other environmental components also have the potential to result in changes to the socio-economic environment. In-design mitigation measures (i.e., containment and isolation of contaminants) will reduce the potential for release of soluble contaminants to groundwater and eventually to socio-economic VCs via surface water.

No residual effects were identified for VCs (e.g., walleye) in the socio-economic environment.

Ongoing public and stakeholder engagement activities will be used to identify any changing concerns or perceptions related to the project and will verify the accuracy of EA predictions in the socio-economic environment.

Accidents and Malfunctions

To identify potential accident and malfunction scenarios, decommissioning activities were reviewed to identify hazards, which were assigned frequency, severity and risk ratings. Credible scenarios were grouped based on similar consequence types. Within these groups, the scenario with the greatest potential (a bounding scenario) was identified, and these were used to encompass or bound the effects of other scenarios within the group. A total of ten bounding scenarios were identified (as listed below). Of these, only scenarios 1, 2, 6, 7, 8, 9 and 10 are considered to be accidents and malfunctions. Bounding scenarios 1, 2, 3, 4, 5 are discussed as part of effects of the environment on the project.

1. Forest fire – potential release of radiological contaminants;
2. Forest fire – potential release of non-radiological contaminants;
3. Tornado – potential release of radiological contaminants (considered in Effects of the Environment on the Project);
4. Tornado – potential release of non-radiological contaminants (considered in Effects of the Environment on the Project);
5. Flood – potential release of radiological contaminants (considered in Effects of the Environment on the Project);
6. Accidental exposure to radioactivity – worker;
7. Accidental exposure to chemicals – worker;
8. Underground fire (including equipment fire) – potential release of radiological contaminants;
9. Underground fire (including equipment fire) – potential release of non-radiological contaminants; and,
10. Collapse of ventilation stack.

Each of these bounding scenarios underwent an analysis to determine the dose estimates for receptors. Based on the severity of the dose, and the probability of occurrence, all bounding scenarios were determined to have negligible risk.

Boating on the Ottawa River

Effects of the Environment on the Project

The EIS includes an evaluation of how climate change, severe weather conditions and other environmental events may interact with and potentially alter the condition and function of the project, such that there would be resultant effects on the environment or human health and safety. The events considered include:

- climate change;
- glaciation;
- forest fires;
- tornados;
- flood;
- earthquake;
- lightning strike;
- ice storm; and,
- changes to the Ottawa River.

No exceedances of relevant criteria were noted for any potential effects of the environment on the project.

Conclusion

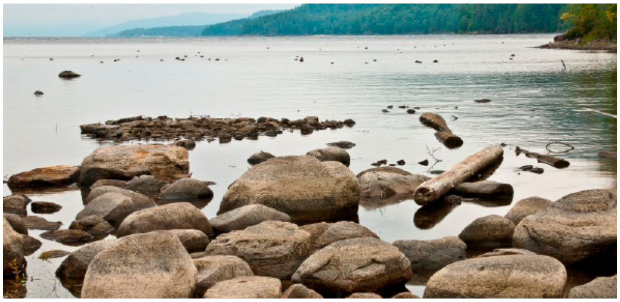
Summary of Findings

Based on the assessment summarized in this EIS, no adverse residual effects were predicted from the NPD closure project for:

- any of the selected VCs;
- the Site, Local or Regional Study Areas; and,
- any of the three phases of the project.

Cumulative effects assessments are conducted when residual effects are identified for a given project. They consider the relevant spatial and temporal boundaries and other past, present and future projects or activities whose effects could potentially overlap with the proposed project. As there are no adverse residual effects predicted (including: effects from accidents and malfunctions and effects of the environment on the project), there is no potential for cumulative effects driven by the NPD closure project.

CNL's Aboriginal, and public and stakeholder engagement programs identified interest in a number of VCs, including: water quality in the Ottawa River, chimney swift, and land use and planning. No adverse residual effects were identified for these VCs. Engagements are on-going through the EA process.



An identified interest: the Ottawa River

Conceptual depiction of NPD after decommissioning; the ventilation stack will be retained as a a habitat for the Chimney Swifts, a Species at Risk

Why are there No Adverse Residual Effects?

In-situ decommissioning provides containment and isolation of the NPDWF inventory for a sufficiently long time to ensure that the long-term environmental concentrations do not cause adverse effects to human health or the environment. The engineered barriers restricting contaminant releases from the NPDWF are:

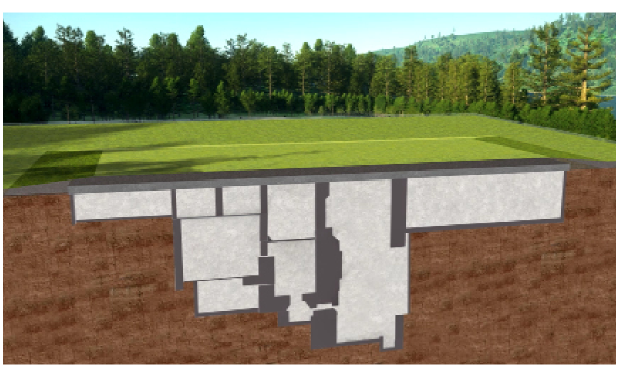
- the majority of the existing radioactivity is embedded within metals that will corrode very slowly in the chemical environment of the decommissioned NPDWF;
- the thick concrete walls of the reactor vault and structure provide barriers that slow the movement of contamination; and,
- the use of grout backfill will slow groundwater movement and create an alkaline environment that limits the solubility of key contaminants.

The isolation of contaminants is achieved by:

- historic siting of the facility in bedrock;
- active controls in the short term (e.g., limiting access to site);
- filling much of the NPDWF with grout; and,
- placing a concrete slab over the NPDWF, which lowers the probability of future inadvertent intrusion.

On a short time scale, the facility has been in storage with surveillance for over 30 years, with no impact on the environment. All of the proposed operations are known and proven technologies. In-situ decommissioning has been in use for at least 50 years.

In the long term, following the defence-in-depth principle, the assessment has demonstrated that the failure of any of the physical engineered barriers will not compromise the performance of the system. It should be noted that while time is elapsing and eventually leading to the degradation of the engineered barriers (which is taken into account in the assessment), the radioactivity is progressively decaying. The assessment has shown that the effectiveness of the engineered barriers over time and as they progressively degrade is adequate to protect the ever-decreasing radiological hazard at any given point in time.



A depiction of the grouted facility

Bedrock excavated during the construction of NPD

The EIS highlights areas of uncertainty (e.g., contaminant concentrations, contaminant transport characteristics, land use near NPD, etc.) that could affect the EIS findings. Therefore, consistent with regulatory and international best practices, these uncertainties are addressed for NPDWF as follows:

- process: it uses a systematic, transparent and auditable process for developing and analysing safety in all phases of the project;
- comparison with regulatory safety criteria: The safety assessment results are generally orders of magnitude below these criteria; and,
- range of performance indicators: a wide range of indicators (e.g., releases, environmental concentrations, doses, etc.) has been used.

In addition, a range of scenarios has been assessed, to encompass possible conditions during all project phases. The results for the various scenarios is a very valuable confidence-building measure, as it demonstrates that even under a range of different assumptions and conditions, the safety criteria are met. This illustrates the intrinsic robustness of the system, and is further supported by observations of these engineered barriers' durability under natural conditions.

Natural Analogues

The EA of the NPDWF in-situ disposal is a challenging undertaking because of the very long time periods involved. Natural analogues can be used to provide understanding and enhance confidence in the behaviour of the NPDWF over time. Natural analogues are natural or anthropogenic features that are similar to the features being assessed (e.g., isolation and containment). For the NPDWF, some of the examples of natural analogues include:

- Iron-based materials: It is assumed (in the NPDWF Postclosure Safety Assessment) that the inventory embedded in iron-based materials is released gradually. Reports of corrosion of iron-based archaeological artifacts, native metals and meteorites from various locations under a wide range of environmental conditions were consistent with the assumed range of corrosion in the Postclosure Safety Assessment.
- Concrete/grout/cement: It is assumed that the grout will gradually degrade as the cement constituents are slowly leached out upon contact with groundwater. The cement being considered for radioactive disposal systems is similar to early cements used by the Romans in the 3rd century or those used in Tiryns and Mycenae approximately 1,000 years earlier. These cements demonstrate little degradation over approximately 2,000 years.
- The cap: It is assumed that the cap starts to degrade 100 years after its emplacement and is assumed to have fully degraded (in terms of hydraulic performance) by 1,000 years after decommissioning is complete. Ancient tombs with wooden coffins have stayed dry when covered by such layers for approximately 1300 to 1500 years and are generally well preserved.

These examples illustrate similar long-term behaviour of natural systems and support the concepts of the long-term containment provided by the NPDWF.

More than 750,000 iron nails were uncovered at the First Centruy A.D. Roman Legionary Fortress at Inchtuthil, near Dunkeld, Scotland

What's next?

The NPD closure project requires an Environmental Assessment (EA) under the Canadian Environmental Assessment Act (CEAA 2012). The Canadian Nuclear Safety Commission (CNSC) is the authority responsible for making the EA decision on whether the project may proceed.

EA timeline:

Draft EIS submitted to CNSC: Sept 2017
Public Review Period (75 days): Nov 2017 - Jan 2018
Final EIS submitted to CNSC: June 2018
EA Report: Oct 2018
Public Intervention Period for Hearing (30 days): Nov 2018
Commission Hearing: Dec 2018

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