Near Surface Disposal Facility

Deep River, Renfrew County, Ontario

ENVIRONMENTAL IMPACT STATEMENT

Executive Summary

Canadian Nuclear Laboratories

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EXECUTIVE SUMMARY

Canadian Nuclear Laboratories (CNL) is proposing to construct a Near Surface Disposal Facility (NSDF) for the disposal of radioactive waste at Chalk River Laboratories (CRL) – the NSDF Project. CNL is a private-sector company that is responsible for the management and operation of nuclear sites, facilities and assets owned by Atomic Energy of Canada Limited, a federal Crown corporation. The NSDF Project is rooted in the requirements established by Atomic Energy of Canada Limited, on behalf of the Government of Canada, to substantially reduce the risks associated with the CNL legacy wastes, liabilities, and to create the conditions for the revitalization of the CRL property. The NSDF Project will enable the site revitalization through improved environmental management of Government of Canada legacy waste liabilities and the decommissioning of outdated infrastructure at the CRL property and other business locations. The current CRL waste management practice is to store radioactive waste on-site in individual facilities in accordance with current licence conditions. The proposed NSDF would accommodate the disposal of current and future radioactive waste at the site in a manner that is protective of human health and the environment.

The proposed NSDF Project is considered a “designated project” in accordance with paragraph 37(b) of the Regulations Designating Project Activities. Under section 15 of the *Canadian Environmental Assessment Act, 2012*, the Canadian Nuclear Safety Commission is considered to be the Responsible Authority for this proposed project.

A key element of the regulatory approvals process is the completion of an environmental assessment under the *Canadian Environmental Assessment Act, 2012*, the results of which are documented in this Environmental Impact Statement. The Environmental Impact Statement includes an analysis of alternatives, a process of public and Aboriginal engagement, studies of baseline conditions, and a description and assessment of project activities during the construction, operation, closure and post-closure phases of the NSDF Project. All these aspects of the Environmental Impact Statement are summarized below in this executive summary.

Analysis of Alternatives and Project Description

A comprehensive analysis of alternatives was undertaken for the type of facility, design of facility, location of facility and approach for leachate treatment to meet the needs of the project. Consideration was given to economic, environmental and technical factors. The recommended alternative for the disposal of low-level and intermediate level waste (less than one percent by volume) is to build a NSDF at the CRL property. The NSDF will be designed as an engineered containment mound, and built at near-surface level on the CRL property. The facility is expected to be operational for approximately 50 years and is designed to be expandable to receive up to 1,000,000 cubic metres of radioactive waste. The placement of the wastes in the engineered containment mound will be completed in a staged approach:

- Stage 1[1]: during which the design fill capacity is 525,000 cubic metres of waste to accommodate those currently in storage and to be generated over the next 20 to 25 years, to enable the remediation of existing contaminated lands and legacy waste management areas and create the conditions for the revitalization of the CRL property.

[1] The Environmental Impact Statement refers to these as construction stages to differentiate from assessment phases, whereas in other documentation these may be referred to as phases.

- Stage 2: during which the design fill capacity is expanded to 1,000,000 cubic metres of waste to accommodate wastes expected to be generated following the first stage, up to about 2070.

Stage 2 will allow for the inclusion of waste from future operations, decommissioning and remediation at CRL and off-site CNL facilities. A small percentage of the waste volume to be placed in the engineered containment mound will be from off-site sources (e.g., Whiteshell Laboratories, prototype reactors, commercial sources such as hospitals and universities).

The main physical works related to the NSDF Project are the engineered containment mound that will contain the waste, a wastewater treatment plant, operation support facilities and site infrastructure. The engineered containment mound will consist of multiple disposal cells and include the following systems:

- base liner system;
- leachate collection system;
- surface water management system;
- final cover system; and,
- environmental monitoring systems.

The base liner system includes a primary and secondary liner to limit the potential release of contaminated water (i.e., leachate) to the subsurface and groundwater. The surface water management system is designed to control surface water on site and prevent clean water from coming into contact with contaminated areas. The final cover system (i.e., cap for the mound) is designed to safely contain the waste and limit the infiltration of precipitation to the waste, thereby limiting leachate generation. The environmental monitoring systems will monitor air, surface water and groundwater consistent with existing CRL licence requirements.

The majority (99%) of the waste to be emplaced in the NSDF will be low-level waste. That is, material with radionuclide content above established clearance levels and exemption quantities, but generally with limited amounts of long-lived activity. The NSDF Project may also accept less than one percent by volume of intermediate-level waste. The intermediate-level wastes are wastes with higher levels of radioactivity that may require shielding for worker protection during handling, and may contain higher concentrations of longer-lived radionuclides. The NSDF will also accept mixed waste, which is radioactive waste that includes hazardous substances. All waste to be disposed at the NSDF will be required to meet the waste acceptance criteria established thus ensuring operational and long-term safety requirements.

The wastewater treatment plant is designed to treat leachate from the engineered containment mound and wastewater from the NSDF Project's supporting operations. The wastewater treatment plant will treat leachate and wastewater such that they meet discharge criteria. The effluent from the wastewater treatment plant will be discharged into an infiltration bed, to recharge the groundwater. The supporting infrastructure includes key installations such as a vehicle decontamination facility, weighing stations, laydown and stockpiling area, office and change room facilities, parking and security systems. Construction of a main access road to the NSDF site and a perimeter road will provide direct access for construction vehicles and maintenance activities, respectively. The footprint of the NSDF Project site is approximately 34 hectares.

The NSDF is required to be operational by March 2020. Development of the NSDF Project is planned in several phases. The construction phase, which includes site preparation, is anticipated to start in 2018 or as soon as the relevant regulatory permits and approvals are in place. This phase will include site clearing, development of surface water management structures, engineered containment mound liner construction, construction of the road and support facilities, and management of surface water and wastes during construction.

The operations phase is anticipated to begin in 2020 and will end in approximately 2070 (i.e., operating site life of 50 years). Activities associated with the operations phase include those activities necessary for emplacement of wastes that meet the Waste Acceptance Criteria in the engineered containment mound, including on-site transportation, staged development of disposal cells, progressive closure of these cells with installation of cover, treatment of wastewater, maintenance of facilities, and establishment of long-term monitoring systems.

Closure activities are expected to start in 2070 and continue through to 2100, after which the NSDF Project will transfer into the post-closure phase. During the closure phase, operations support facilities such as the wastewater treatment facility will be considered for continued operation leading to eventual decommissioning and removal. Secure access to the site will remain and environmental monitoring will continue.

The post-closure phase is defined by two distinct periods: Institutional Control and post-Institutional Control. The Institutional Control period begins following closure of the engineered containment mound, then includes implementation of both active and passive control throughout 2100 to 2400 (i.e., 300 years). Active controls include environmental monitoring activities and site maintenance activities; passive controls include barriers to prevent access to the NSDF site. During Institutional Control, groundwater monitoring and groundwater quality management will continue, as required, to demonstrate compliance with the safety case assumptions. The post-Institutional Control period occurs after year 2400 and continues indefinitely.

Engagement Activities

Engagement is a key component of the environmental assessment process. CNL operates an ongoing Public Information Program to inform groups about activities at CNL sites and the potential effects of these activities on the public, First Nation and Métis communities and on the environment. This Public Information Program forms the basis of communication efforts with First Nation and Métis communities and helps to direct the establishment of long-term mutually beneficial working relationships with their communities in proximity to CNL sites.

The public engagement activities included:

- two rounds of public information sessions at each of seven locations in June and October of 2016;
- provision of comprehensive project information online through websites;
- social media presence via Twitter and Facebook, including utilization of Facebook Live;
- a series of presentations and site tours for a variety of public, employee, and industry audiences;
- proactive and by request project site visits;
- detailed written responses to stakeholder questions;
- proactive media engagement; and,
- newsletters and factsheets.

In consultation with the Canadian Nuclear Safety Commission, and using tools provided through the Aboriginal and Treaty Rights Information System, CNL identified a proposed list of First Nation and Métis communities with potential interest in the NSDF Project. Engagement with First Nation and Métis communities started in October 2015 and is ongoing.

During regularly scheduled meetings the Environmental Stewardship Council, members are presented with information about CNL, CNL environmental practices, and these meetings provide opportunities for open dialogue between various stakeholder groups, local communities and CNL. Environmental Stewardship Council members share meeting information with their respective constituents. This open dialog and sharing of information is very important for CNL, ensuring that perspectives from our closest neighbours and non-governmental organizations are heard.

The main themes of the feedback received to date for the NSDF Project include waste acceptance criteria, potential effects to the Ottawa River, cultural heritage studies, potential effects of natural disasters and climate change on the project, and origins of the waste. CNL has shared results of comprehensive studies of NSDF site with local and First Nation and Métis communities where they have identified an interest. In addition, the archaeological assessment field studies included the participation of First Nations community members.

Baseline Conditions

The CRL property is located in Renfrew County, Ontario on the shore of the Ottawa River, approximately 200 kilometres northwest of Ottawa. The CRL property contains several licence-listed nuclear facilities, including the National Research Universal reactor, waste management areas, and many other nuclear and non-nuclear facilities and laboratories. Two hydro lines cross the CRL property and provide electricity for CRL operations. The property has a total area of 4,000 hectares and is within the boundaries of the Corporation of the Town of Deep River. The Federal Department of National Defence Garrison Petawawa borders the CRL property to the southeast, and the Village of Chalk River in the Municipality of Laurentian Hills is to the southwest. The Ottawa River forms the northeastern boundary of the property. The NSDF Project is located entirely within the CRL property.

Nearby population centres include the Village of Chalk River (5 kilometres west of the property) and the Town of Deep River (12 kilometres northwest of the property). Surrounding these communities are the Townships of Rolphton, Buchanan, Wylie and McKay, which with Chalk River, form the Municipality of Laurentian Hills. The Town of Deep River has approximately 4,200 residents and the Municipality of Laurentian Hills has around 2,800. The Town of Petawawa and the Canadian Forces Base Petawawa, totalling about 16,000 residents are located 20 kilometres southeast of CRL. The other population centre of interest in the region is Pembroke, with about 14,360 residents, 35 kilometres southeast of the CRL property. The closest permanent residents in the Pontiac Regional County Municipality are located 11 kilometres southeast of CRL, in the Harrington Bay area. The closest community on the Quebec side of the Ottawa River is the Municipality of Sheenboro, about 15 kilometres downstream.

The closest First Nations community is the Algonquins of Pikwàkanagàn, located at Golden Lake, approximately 50 kilometres southeast of the CRL property. The Algonquins of Pikwàkanagàn First Nations are part of the larger Algonquins of Ontario organization, which has reached an Agreement-In-Principle with the Governments of Ontario and Canada regarding a land claim in the Ottawa Valley, which they consider their traditional

homelands. In addition, the CRL property is located within the Métis Nation of Ontario's Ottawa River traditional harvesting territory.

The Ottawa River is the dominant drainage feature in the area. The CRL property contains several small drainage basins that drain directly to the Ottawa River or to smaller lakes and streams on site, which in turn drain to the Ottawa River. The CRL property is located in the Allumette Lake and Lac Coulonge reach of the Ottawa River, which extends approximately 90 kilometres between La Passe and the Des Joachims Dam. The distance from the centre of the NSDF Project site to the closest point on the Ottawa River is approximately 1 kilometre. The NSDF Project site is located in the central portion of the lower Perch Lake Basin. The Perch Lake basin houses existing waste management areas and has been affected by past operations. Perch Lake is located southwest of the NSDF Project site.

Ground surface elevations range from a low of approximately 156 metres above sea level within the low-lying and relatively flat terrain bordering the north side of Perch Lake, to a high of 197 metres above sea level along the crest of the ridge that separates the Perch Lake and Ottawa River drainage basins. The surficial geology at the NSDF Project site consists primarily of fine sands, underlain locally by glacial till and ranges in thickness from less than one metre to up to 22 metres. The bedrock generally follows surface topography.

The CRL property supports a diverse mix of upland and wetland habitats. Vegetation includes deciduous and coniferous forest and a wide variety of plant species. In the western region of the NSDF Project site, approximately 2.6 hectares of land is occupied by a former Petawawa Research Forest Plantation. The south and west boundaries of the NSDF Project site are adjoining the Perch Lake wetland complex. NSDF site-specific biodiversity studies were conducted to characterize the wildlife species and habitat, with targeted surveys for Species at Risk, with the potential to be affected. Wildlife are generally diverse and abundant.

Perch Lake provides fish habitat, including for populations of Brown Bullhead and Pumpkinseed, with Brown Bullhead as the most numerous species of fish in the lake. Perch Creek supports a fish community of Fathead Minnow, Creek Chub, and a community dominated by Creek Chub and Blacknose Shiner in the upper creek.

Land use in the region consists primarily of forestry, recreation and tourism, with limited agriculture, trapping and mining. The nearest area of considerable agriculture and dairy farming is 15 kilometres southeast on the Quebec side of the Ottawa River and 35 kilometres southeast on the Ontario side. Hunting and fishing is not permitted on the CRL property and the property is not used for traditional purposes by First Nation and Métis people, as access to the CRL property is restricted. The Ottawa River is an important recreational resource for swimming, sport fishing and boating; there is little commercial fishing opportunity. There are several sand beaches along both sides of the river that provide popular recreational sites.

The CRL property occurs within the general area of the Algonquins of Ontario Settlement Boundary. There are fourteen archaeological sites recorded in the vicinity of the CRL, but only two sites were recorded within the CRL property. An archaeological assessment was completed for the NSDF Project in accordance with the *Standards and Guidelines for Consultant Archaeologists.* Approximately 9,000 test pits have been excavated, and of these the assessment process identified 337 positive test pits, areas of heritage concern. Through further study, upon completion of the text excavations, two sites were recommended for Stage 4 mitigation.

Environmental Assessment Approach

The environmental assessment approach applied to each discipline generally includes the following main steps:

- define the scope of the assessment including input received from regulatory agencies and engagement activities;
- identify the Valued Components for each discipline upon which the assessment will focus and the associated measurement indicators and assessment endpoints for Valued Components;
- define spatial and temporal boundaries, and assessment cases used to evaluate effects;
- describe existing conditions, including the cumulative effects of previous and existing developments for each Valued Components;
- conduct a pathway analysis to identify Project components or activities with a potential to create a residual effect and describe the mitigation developed for removing pathways or limiting effects;
- conduct an assessment for each Valued Components to predict residual effects from the NSDF Project;
- conduct an assessment for each Valued Components to predict the cumulative effects of previous and existing projects and activities, the NSDF Project and potential future projects that have been proposed, but not yet approved (if applicable);
- evaluate and describe the level of certainty that can be placed on predicted residual effects;
- determine the significance of cumulative effects from the NSDF Project and potential future projects that have been proposed, but not yet approved (if applicable); and,
- identify monitoring and follow-up programs to address uncertainty.

Atmospheric Assessment Results

Air quality and greenhouses gases were selected as a Valued Components as there is a potential for the NSDF Project activities to release air and greenhouse gas emissions that could contribute to changes in air quality and incrementally to climate change. The assessment endpoint for air quality is performance against the criteria and thresholds for protection of human health and the environment. The measurement indicator considered in the air quality assessment includes changes to the concentration of non-radiological indicator compounds. The assessment endpoint for the greenhouse gas assessment is comparison to provincial and national totals. The measurement indicator for greenhouse gases include changes in emissions of carbon dioxide equivalents to provincial and national greenhouse gas totals.

During the construction and operations phases, NSDF Project activities will result in emissions associated with the operation of vehicles and equipment, as well as emissions from the decomposition of waste in the engineered containment mound. Examples of mitigation practices implemented to limit predicted residual effects include:

- implementation of CNL's Procedure for Management and Monitoring of Emissions, which includes operational control monitoring and air verification monitoring;
- dust control, primarily through water spraying or misting techniques (e.g., water trucks);

- maintenance of on-site vehicles and equipment engines in good working order;
- installation of a passive landfill gas venting system in the engineered containment mound final cover system; and,
- limiting idling of vehicles and equipment on-site.

There is a predicted residual effect on air quality from the NSDF Project. Vehicle exhaust and fugitive dust from unpaved roads is the largest contributor to particulate matter during both the construction and operations phases. Vehicle exhaust during the construction of the engineered containment mound is the largest contributor of nitrogen oxides and carbon monoxide. Predicted concentrations for the NSDF Project during both construction and operations phases are below applicable air quality guidelines and/or standards. Consequently, the residual effects from the NSDF Project on air quality was predicted to be not significant. The Procedure for Management and Monitoring of Emissions for CNL outlines the key management practices that limit air quality emissions effects, as well as the current monitoring requirements.

A residual effect to greenhouse gas emissions was identified because of the NSDF Project. The change is estimated to be less than a 0.005% increase in total provincial greenhouse gas emissions and a 0.001% increase in total national greenhouse gas emissions. Consequently, the residual effect from the NSDF Project on greenhouse gases was determined to be not significant. The Procedure for Management and Monitoring of Emissions for CNL outlines the key management practices that limit greenhouse gas emissions effects, as well as the current monitoring requirements.

Geology and Hydrogeology Assessment Results

Geology, which includes bedrock, soils and geomorphology, is recognized as an important component of the environment that may be affected by the NSDF Project and changes to geology could, in turn, lead to effects on other Valued Components selected for assessment. Acknowledging that changes to geology are considered to be important aspects of the natural and human environment, geology is referred to as an intermediate component. Results of the analysis of changes in measurement indicators for geology are provided to other disciplines for inclusion in their assessment.

Potential effects on geology are related to changes in soil quantity and quality, and geomorphology as a result of construction of the NSDF Project, and changes to soil quality from blasting activities and air emissions. Mitigation and environmental design features implemented for the NSDF Project are well-understood and include existing practices at the CRL site. For example, a Surface Water Management Plan will be implemented to limit erosion within the NSDF Project site. In addition, a Blasting Plan and Dust Management Plan will provide mitigation to limit the potential for effects on soil quality from fugitive dust generation through excavation and material transport. Consequently, no residual effects on geology are predicted as a result of the NSDF Project.

The residual effects of the project on hydrogeology are related to the alteration of groundwater levels and flows due to the construction of the NSDF Project and potential changes to groundwater quantity and quality due to leakage from the engineered containment mound following post-closure activities. Residual effects to groundwater from leakage of leachate from the engineered containment mound during operations are not anticipated due to the implementation of environmental design features, mitigation and operational monitoring

plans. Environmental design features and mitigation implemented to reduce residual effects on groundwater quantity and quality include:

- the composite base liner design will include both primary and secondary liner systems;
- the primary liner will include a leachate collection system with the secondary liner housing a leak detection system;
- the high density polyethylene geomembrane was selected as it is compatible with the leachate generated by the waste and will achieve a long service life;
- the composite base liner system will include an underlying compacted clay liner to supplement the primary and secondary liner system;
- the final cover is designed to minimize water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity;
- the engineered containment mound will have a 500-year design life;
- leachate and wastewater will be collected, treated and monitored in accordance with CNL's Effluent Verification Monitoring Program; and
- performance monitoring will be completed throughout operations and into post-closure, as required, to confirm that the engineered containment mound is functioning as intended.

Contaminant migration within the Perch Lake Basin has been studied for over 50 years and is well understood. In addition, geotechnical studies were completed focussing on the NSDF site. Using this information, a site-specific numerical groundwater flow model was developed to predict potential contaminant migration and rates of groundwater flow from the engineered containment mound to downstream receptors. Groundwater flow from the NSDF site is to the adjacent wetlands, and ultimately discharges to Perch Lake and Perch Creek. In general, minor localized changes to the directions of groundwater flow are predicted to occur in the vicinity of the NSDF Project Site as a result of captured and/or redirected water, while the overall groundwater flow paths are the same as under current conditions. However, with final cover placement, quantities of leachate generated within the engineered containment mound will decline and leachate generation rates will eventually trend toward zero through time as the length of the post-closure time period increases.

During operations and closure, all contact water and leachate will be captured and treated. During post-closure, following Institutional Control, the assessment evaluated the potential for leachate to migrate to groundwater. Contaminant migration from the engineered containment mound to groundwater through the post-closure period. The discharge of this groundwater to surface water in Perch Creek was included in an evaluation of doses to receptors discussed below in the assessment of human health and ecological health.

Groundwater will be monitored in accordance with *CSA Standard N288.7-15 Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills*.

Surface Water Environment Assessment Results

Residual effects to the surface water flow and quality Valued Component are primarily associated the construction and eventual closure of the NSDF Project, which will physically alter drainage patterns in the Perch Creek basin.

All physical works are located within the NSDF Project site, affecting a relatively small area (<5%) of the total contributing basin area for Perch Creek. A Surface Water Management Plan will be implemented to mitigate effects on surface water created by the development of the NSDF Project. The plan addresses non-contact surface water as differentiated from contact surface water that has been exposed to contaminated waste. Non-contact run-off at the NSDF site will be managed by surface water management systems, including diversion drainage, conveyance, and collection features prior to discharge to nearby wetlands, and eventually into Perch Lake.

The proposed design features are based on proven surface water management practices for controlling erosion, capturing sediment, and for safely conveying flows associated with a 1:100-year or regional storm event; the design features also take into consideration climate change effects. The Surface Water Management Plan will also address the mitigation of effects on surface water created by the installation of the final cover on the engineered containment mound. Modification to the drainage ditches and conveyance channels will be made to promote positive drainage from the site and limit erosion or abrasion of the cover. Implementation of the Surface Water Management Plan for the NSDF Project will limit changes to downstream discharge, water levels, and channel/bank stability in Perch Creek such that negligible residual effects are predicted to hydrology.

Residual effects to surface water quality are primarily associated the operation of the wastewater treatment plant and treated and untreated effluent discharge during the operations and post-closure phases. The surface water mass balance model results were screened against benchmark values to focus the assessment on those parameters that may require further treatment. Treated effluent will meet site-specific criteria developed to be protective of human health and the environment.

Monitoring of surface water quality surrounding the NSDF is already included in CNL's Environmental Monitoring Program, which is compliant with *CSA Standard N288.4-10 Environmental Monitoring at Class I Nuclear Facilities and Uranium Mines and Mills*. Effluent from the stormwater management ponds and wastewater treatment facility will be monitored in accordance with CNL's Effluent Verification Monitoring Program, which is compliant with the *CSA Standard N288.5-11 Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*. In addition, monitoring of water elevations in the adjacent wetland is proposed to determine changes from the presence of the engineered containment mound.

Aquatic Biodiversity Assessment Results

Fish and fish habitat are recognized as important components of the aquatic environment that may be affected by the NSDF Project and changes to fish and fish habitat could, in turn, lead to effects on other Valued Components, such as land and resource use. The assessment of aquatic biodiversity focused on predicting changes to species of fish that use the Perch Creek basin, including those that may also use shoreline habitat near Pointe au Baptême in the Ottawa River.

The assessment endpoint for fish and fish habitat is ongoing fisheries productivity, and the maintenance of self-sustaining and ecologically effective fish populations in support of ongoing fisheries productivity.

Self-sustaining fish populations are healthy and viable and, by definition, robust and capable of withstanding environmental change and accommodating stochastic processes. Maintaining viable fish populations is a conservation target frequently applied by conservation biologists and resource managers. Habitat availability, habitat distribution, and survival and reproduction were selected as the measurement indicators for the aquatic biodiversity Valued Components.

The potential for effects to aquatic biodiversity are primarily related to changes in groundwater, surface water, and air quality. The predicted residual effects of the NSDF Project on groundwater, surface water, and air quality are negligible to low in magnitude, and with the implementation of appropriate mitigation, are not predicted to exceed their respective regulatory guidelines and/or standards. Mitigation and environmental design features implemented for the NSDF Project are well-understood and include existing practices at the CNL site. Therefore, measurable residual effects on aquatic biodiversity are not predicted as a result of the NSDF Project.

Terrestrial Biodiversity Assessment Results

Selection of Valued Components for the terrestrial biodiversity assessment was accomplished using a coarse and fine filter approach. Coarse filter Valued Components were identified to permit an assessment of the effects of the NSDF Project to terrestrial biodiversity broadly, whereas fine filter Valued Components focus the assessment on individual biodiversity features, such as species. Combined, the coarse and fine filter Valued Components are selected to provide a holistic assessment of the potential effects of the NSDF Project on terrestrial biodiversity.

All *Species At Risk Act*-listed species with confirmed observation records within the CRL property were considered as potential Valued Components at the species level. Species with a very low likelihood of occurrence in the local study area, for which habitat was not present in the area, or for which effects of the NSDF Project were unlikely, were excluded as Valued Components.

The Valued Components selected for the terrestrial biodiversity assessment were: vegetation communities, migratory birds, Canada warbler, Eastern whip-poor-will, Golden-winged warbler, bats, and Blanding's turtle. The assessment endpoint for terrestrial biodiversity is the maintenance of self-sustaining and ecologically effective vegetation communities or wildlife populations. Ecosystem availability, ecosystem distribution, and ecosystem composition were selected as the measurement indicators for the vegetation communities Valued Component. Habitat availability, habitat distribution, and survival and reproduction were selected as the measurement indicators for the terrestrial biodiversity species Valued Components.

Residual effects to terrestrial Valued Components are primarily associated with vegetation clearing and grubbing and the associated loss or alteration of existing vegetation and topographical features; sensory disturbance from NSDF Project activities during construction and operations; and increased risk of injury/mortality on roads to Blanding's turtle due to equipment and vehicle traffic.

The cumulative effects from the NSDF Project and previous and existing activities and developments in the Regional Study Area on the population of terrestrial biodiversity Valued Components that overlaps with the Regional Study Area are predicted to be not significant for all Valued Components, with the exception of bats and Blanding's turtle. Populations of little brown myotis, northern myotis and tri-colored bats that overlap the Regional Study Area are sensitive to changes because white-nose syndrome has resulted in dramatic declines of these species across the eastern portions of their Canadian range. Therefore, the existing level of pressure on these bat species in the Base Case has likely already exceeded their resilience and adaptability limits and they

are unlikely to be self-sustaining or ecologically effective. Consequently, the cumulative effects of existing disturbance and especially the introduced white-nose syndrome are considered significant at Base Case (i.e., even before the project is included).

The NSDF Project will contribute a small increment to this existing significant adverse cumulative effect. Importantly, because vegetation clearing will be undertaken outside of the maternity roosting season, no mortality of roosting bats is expected as a result of the NSDF Project and effects or the NSDF Project to survival and reproduction are considered neutral. In addition, maternity roosting habitat is available in the Regional Study Area. Therefore, the contribution of the NSDF Project to the existing significant adverse cumulative effect to bats is predicted to be minor.

Offsetting the removal of unoccupied bat maternity roost trees is not required under the *Species At Risk Act*, however, installation of bat boxes in suitable locations in the Regional Study Area is recommended to offset the incremental contribution of the NSDF Project. Monitoring will be conducted to determine if boxes are being used.

The NSDF Project footprint would permanently remove 22 hectares of proposed Blanding's turtle critical habitat during construction. This includes habitat with the potential to be used for nesting, thermoregulation and summer inactivity. Females who use the area for nesting may experience a reduction in reproductive success until they find new areas within which to nest. In addition, the interruption or barrier to Blanding's turtles moving through the NSDF Project site will result in the need to travel longer distances around the site in search of resources and will increase their risk of injury or mortality on roads. The increase in traffic related to the NSDF Project and consequently the risk of road injury or mortality will be mitigated through a comprehensive CRL road mitigation plan, however the risk of road mortality, albeit reduced still remains.

It is possible that the level of habitat fragmentation and road mortality existing on the CRL site are significantly impacting the population of Blanding's turtle in the Base Case at an unsustainable rate. Consequently, cumulative effects from the NSDF Project and previous and existing activities and developments on the Blanding's turtle population are predicted to be significant.

The destruction of proposed critical habitat for Blanding's turtle will require a Species at Risk permit. Further studies of this population are required to determine where nesting habitats occur. In addition, a comprehensive assessment of high risk crossing locations will be completed for Blanding's turtles. Consideration will be given to the location and type of existing crossing culverts as passageways or upgrade or install new crossing structures that are conducive to Blanding's turtle safe passage under the roads.

Ambient Radioactivity and Ecological Health Assessment Results

For ecological health, representative receptor taxa were selected as Valued Components from those that are documented to occur or potentially occur in the local and regional study areas, have a relatively high potential for exposure to potentially impacted media, play a key role in the food web and for which sufficient data were available to calculate exposures and risks. In addition, special consideration was given to species that are listed as threatened or endangered.

Assessment endpoints are qualitative expressions used to assess the significance of residual effects on Valued Components and represent the key properties of the Valued Component that should be protected for future human generations (i.e., incorporates sustainability). The assessment endpoint is the protection of ecological health. Measurement endpoints represent properties of the environment, that when changed, could result in or

contribute to an effect on an assessment endpoint. Measurement endpoints for the ecological health assessment include changes in air quality, groundwater quality, and surface water quality.

Radiological dose to non-human biota may result from waterborne or airborne emissions from the NSDF Project. Dose to non-human biota from waterborne emissions is calculated during the operations phase, as well as during the post-Institutional Control period for the NSDF Project. Dose to non-human biota from airborne emissions is calculated only for the operations phase of the NSDF. This represents the bounding case, since doses to non-human biota during the post-closure would be less than the operations phase with the installation of the final cover. It is assumed that all species are exposed to a dose rate of 10 microgray per hour, which is the limiting criterion at the NSDF Project fence line. Results indicate that the predicted doses to all indicator species are below the dose benchmark values for the operations phase and post-Institutional Control period.

Non-radiological chemicals were screened by comparing concentrations to the federal guidelines that are protective of the environment. Results indicated that the predicted non-radiological concentrations in Perch Creek were less than their selected guidelines or alternate benchmarks.

Although uncertainties in the assessment exist, conservatism has been included in the modelling so that residual effects are not greater than predicted. As such, residual effects are considered to be not significant for all ecological health Valued Components during the operations phase and the post-Institutional Control period. Monitoring and monitoring programs developed for groundwater and surface water quality will be implemented to verify effects predictions for ecological health. In addition, ambient radioactivity will be measured at the NSDF site.

Human Health Assessment Results

The human health risk assessment focused on worker and public health as valued components. Assessment endpoints are qualitative expressions used to assess the significance of residual effects on Valued Components and represent the key properties of the Valued Component that should be protected for future human generations (i.e., incorporates sustainability). The assessment endpoint is the protection of human health. Measurement endpoints represent properties of the environment, that when changed, could result in or contribute to an effect on an assessment endpoint. Measurement endpoints for the human health assessment include changes in air quality, groundwater quality, and surface water quality.

Radiological dose to humans may result from waterborne or airborne emissions from the NSDF Project. Dose to humans from waterborne emissions is calculated during the operations phase, as well as during the post-Institutional Control period for the NSDF Project. Dose to humans from airborne emissions is calculated only for the operations phase of the NSDF. This represents the bounding case, since doses to humans during the post-closure would be less than the operations phase with the installation of the final cover.

The maximum estimated dose to potential critical groups during operations phase represents less than 0.01 percent of the regulatory dose limit of 1 millisieverts per year and licensing limit of 0.3 millisieverts per year. The Balmer Bay, Chalk River, Cottager, Deep River, and Mountain view potential critical groups receive the majority of their dose through airborne emissions, due to their closer proximity to the NSDF site. The Pembroke, Petawawa, and Laurentian Valley receptors receive the majority of their dose from waterborne emissions. The maximum estimated dose to critical groups during the post-Institutional Control period represents less 0.02 percent of the regulatory dose limit of 1 millisieverts per year and 0.07 percent of the licensing limit of 0.3 millisieverts per year.

Non-radiological chemicals were screened by comparing concentrations to the federal guidelines that are protective of human health. Results indicated that the predicted non-radiological concentrations in Perch Creek were less than their selected guidelines or alternate benchmarks.

Although uncertainties in the assessment exist, conservatism has been included in the modelling so that residual effects are not greater than predicted. As such, residual effects are considered to be not significant for all human health Valued Components during the operations phase and the post-Institutional Control period. Monitoring and follow-up programs are not specifically identified for human health; rather, operational monitoring and monitoring programs developed for groundwater quality will be implemented to verify effects predictions for human health.

Land and Resource Use Assessment Results

Land and resource use Valued Components were selected based on the potential for the NSDF Project to interact with the features of the land and resource use environment. In addition, Valued Components for traditional land and resource use were selected based on consideration of knowledge of traditional land and resource use practices that interact with the environment, Aboriginal and/or treaty rights, engagement. Land and resource Valued Components selected for this assessment include:

- land and resource tenures and other registered interests (land use designations, mining and aggregates, forestry and agriculture);
- outdoor tourism and recreation (parks and protected areas, fishing, hunting, trapping, non-consumptive tourism and recreation);
- archaeological sites; and
- traditional land and resource use by First Nation and Métis peoples (i.e., trapping, hunting, fishing, gathering, and cultural resources and ceremonies).

The NSDF Project is located entirely within the CRL property (i.e., Regional Study Area), which is located on federal lands. Therefore, aside from the operations and activities undertaken by CNL, other land uses of the CRL property are prohibited due to restricted public access. As such, there are land and resource use tenures and other registered interests, or outdoor tourism and recreational areas occurring within the Regional Study Area that have the potential to be disturbed. Moreover, the predicted residual effects of the NSDF Project on groundwater, surface water, air quality and terrestrial and aquatic habitat are negligible to low in magnitude and do not exceed the boundaries of the Regional Study Area (i.e., the CRL property boundary), therefore no effects on traditional and non-traditional land users beyond the property boundary are predicted. Traditional access to the Pointe au Baptême site along the Ottawa River will continue to occur and not be restricted because of the project. There are no effects anticipated to archaeological resources as most mitigation measures for archaeological resources are applied and completed in advance of ground disturbance activities. The Cultural Resource Management program will be used to identify unanticipated archaeological resources and implement adaptive management. Consequently, the NSDF Project is not predicted to result in residual effects to land and resource Valued Components.

Socio-Economic Environment Assessment Results

Socio-economic Valued Components were selected based on the potential for the NSDF Project to interact with the features of the socio-economic environment, and include:

- Labour Market;
- Economic Development;
- Government Finances;
- Housing and Accommodations;
- Services and Infrastructure;
- Quality of Life; and,
- Public Safety.

Residual effects from activities that occur during the construction phase have been identified as the primary linkage to potentially affect socio-economic Valued Components. During the construction phase, NSDF Project activities will result in residual effects from direct and indirect employment requirements, contracting and supplier opportunities, increased pressure on commercial accommodations, changes in demand for community services, and increased degradation of public transportation roads. Examples of mitigation practices implemented to limit predicted residual effects to socio-economic Valued Components include:

- continued implementation and maintenance of compliance with all applicable health and safety standards and CNL's existing environmental, safety and security programs;
- continued implementation of Canadian Nuclear Laboratories' Procedure for Management and Monitoring of Emissions, which includes operational control monitoring, air verification monitoring and environmental monitoring;
- implementation of the Dust Management Plan developed for the NSDF Project, which includes appropriate management techniques to control dust generated by the NSDF Project; and
- coordinate the transportation of construction equipment and construction materials to site with peak employee traffic times other periods of high traffic volume on Highway 17 to reduce traffic volumes.

Recognizing people's interest in understanding and participating in decisions that affect them, CNL has and will continue to proactively seek, engage, and support meaningful discussion on issues and opportunities related to the NSDF Project as part of the Public Information Program. Canadian Nuclear Laboratories' will continually evaluate both the process and the outcome of the ongoing engagement and communication activities to address and manage issues as they arise.

Accidents and Malfunctions Assessment Results

Accidents or malfunctions could take place throughout all phases of the NSDF Project as either internally-initiated events (e.g., equipment failures) or externally-initiated events (including natural hazards). Based on a review of the NSDF Project activities, and a review of other similar projects and guidance documents, 28 radiological hazards were identified.

Based on the findings of the radiological screening process, 13 malfunctions and accidents could not be screened out (i.e., were deemed to be credible events). These credible malfunction and accident events were grouped into bounding accident scenarios and a consequence assessment was completed. Hazards that were considered a normal evolution of the NSDF Project (such as failure of the cover or liner in post-closure following the end of Institutional Control in the year 2400) are evaluated under the radioactivity and human health sections; natural hazards (such as glaciation and earthquakes) are evaluated in the Effects of the Environment on the Project section. The bounding accident scenarios described in accidents and malfunctions section of the Environmental Impact Statement are listed below.

Operations and Closure Phases:

- A fire during the handling and emplacement of wastes within the engineered containment mound engulfing radioactive waste packages.
- A fire in the temporary waste accumulation area on the NSDF Project site.
- Damage to radioactive waste packages during the handling and emplacement of wastes within the engineered containment mound.

Post-closure Phase:

- Inadvertent human intrusion of the engineered containment mound following the end of institutional control; including:
  - acute exposure from well drilling; and
  - chronic exposure from living in a house and farming on top of the engineered containment mound.

The above credible malfunctions and accident scenarios were assessed for their potential effects to people and non-human biota following Canadian and international guidelines. Specific methods and input parameters for each of the scenario assessments are provided in the Performance Assessment for the NSDF Project.

In the waste package transfer and fire accident scenarios on the NSDF Project site, doses to Nuclear Energy Workers and/or members of the public are below safety criteria and meet safety objectives for the NSDF Project. Given the brief duration of exposure (i.e., up to 1 hour) and the implementation of the facility's Fire Protection Program to contain and extinguish the fire, radiological doses would not be expected to affect non-human biota at the population level.

The human intrusion assessment includes consideration of two exposure scenarios: acute and chronic. The acute exposure scenario considers intrusion into waste when drilling a well. The key exposure pathways are inhalation, exposure to contaminated land, and incidental ingestion of contaminated soil. The estimated dose to drilling workers is less than the lower intrusion dose benchmark of 1 millisievert per year. For terrestrial biota, the approximate hourly dose is lower than the radiological dose criterion for protection of non-human biota. Therefore adverse effects to human and non-human biota due to the acute intrusion scenario are not expected.

The chronic exposure scenario considers a human intruder living and farming on top of the waste. The key exposure pathways are inhalation of radon, consumption of contaminated plants, and exposure to contaminated land. Based on the results, the maximum dose to human receptors resulting from inadvertent human intrusion from living and farming on top of the waste is 5.0 millisieverts per year, occurring approximately in the year

66,000 following the end of the Institutional Control period. The dose estimate is likely to substantially overestimate the potential exposure to an intruder because it results from the very conservative assumption that no loss of radionuclide or non-radiological inventory occurs in the period between placement of waste into the mound and the occurrence of human intrusion some tens of thousands of years later. In accordance with International Atomic Energy Agency guidance, mitigation measures are required to reduce the probability of intrusion or limit its potential consequences. Mitigation measures developed for the NSDF Project to hinder intrusion include permanent markers identifying the engineered containment mound and waste, and engineered barriers. For terrestrial biota, given that the approximate hourly dose is lower than the radiological dose criterion for the protection of non-human biota, and the conservative assumptions used in the assessment, adverse effects to non-human biota due to the chronic human intrusion scenario are not expected.

CNL has a number of environmental programs and emergency response procedures in place for the operations at the CRL site, and will be implemented for the NSDF Project. In particular, the control and safe handling of hazardous materials and nuclear materials are covered under CNL's Waste Management Program and Nuclear Materials and Safeguards Management Compliance Program, respectively. Emergency procedures are covered under CNL's Emergency Preparedness Program and Fire Protection Program. The potential effects of a malfunction or accident can be further reduced or controlled through implementation of mitigation measures; the hazard analysis was incorporated into the design process to integrate mitigations directly into the NSDF Project design.

Effect of the Environment on the Project Assessment Results

Risks associated with extreme weather events (temperature fluctuations, rainfall, snowfall, flooding, and high winds), forest fires, seismic events, climate change and glaciation were reviewed as they pertain to all project facilities.

Extreme events (e.g., storms) may result in a potential interaction with infrastructure and support facilities, but this is accounted for in the design specifications and will be addressed through ongoing maintenance. For example, all building layouts will meet National Building Code requirements, and facilities meet fire code standards. The effects of the probable maximum precipitation was considered by identifying flow paths and possible risk to infrastructure.

Extreme rainfall and snowmelt events and the potential for flooding is considered in the design of the surface water management systems and design of the wastewater treatment plant. The design of these facilities consider peak storm events, snowmelt and climate change.

Should a major seismic event occur at or near the NSDF Project site, this could lead to a rupture of the containment mound liners and the leachate collection system. Failure of the liner has been assessed as part of the long-term performance of the NSDF. Size and shape of the berms and each of the elements and layers were determined using a seismic design basis, including the National Building Code requirements.

Natural events could cause erosion of the engineered containment mound cover, leading to water infiltration into the waste. The final cover is designed to limit water infiltration, to direct infiltration and surface water runoff away from the engineered containment mound waste emplacement area, and to resist degradation by surface geologic processes and biotic activity (e.g., prevent burrowing of animals) and inadvertent intruder attempts to access or excavate into the wastes waste cell. A series of drainage control features will be installed in conjunction with placement of final cover over the engineered containment mound.

Natural freeze thaw cycles could damage the linings of the engineered containment mound cover, leading to water infiltration into the waste. The engineered containment mound has been designed so that it will not be adversely affected by freeze thaw cycles.

As part of the Performance Assessment for the Project, an assessment of the consequences of a fire at the NSDF Project site, caused by a forest fire, lightning strike or other means, was completed. A scenario was developed to evaluate the effects of a fire. The evaluation concludes radiological doses to workers and member of the public are below safety criteria and meet safety objectives for the NSDF Project.

An evaluation of potential effects of glaciation concludes that by the time of glacial retreat (approximately 100,000 after present), radionuclide content will have decayed to levels that are less than what is typical for surficial uranium deposits in Canada, and will be below Canadian Soil Quality Guidelines for Uranium. Consequently, no adverse effects are predicted from a potential glaciation event at the Project.

Changes to climate that affect potential cover sustainability were considered. These can be addressed through adaptive management plans that consider projected changes in climate relevant to the local vegetation.

Conclusion

This Environmental Impact Statement describes the Project, the existing environmental conditions on the CRL site, and assesses the likely effects of the Project on the environment. The Environmental Impact Statement also includes an assessment of likely cumulative effects of the Project in combination with other past, present or reasonably foreseeable projects, as required. It describes the effects for normal conditions and as a result of accidents and malfunctions. The Environmental Impact Statement also describes and assesses the likely effects of the environment on the Project.

The development of a near surface disposal facility for radioactive waste at CRL would reduce any potential risks associated with the CNL legacy wastes, liabilities, and create the conditions for the revitalization of the CRL property. The NSDF Project would enable the remediation of contaminated lands and legacy waste management areas, and decommissioning of outdated infrastructure at the CRL property and CNL's other business locations. The current CRL waste management practice is to safely store radioactive waste on-site in individual facilities in accordance with current licence conditions. The proposed NSDF would accommodate the disposal of current and future radioactive waste at the site in a manner that is protective of human health and the environment.

Residual adverse effects were identified for air quality, hydrogeology, hydrology, surface water quality, terrestrial biodiversity, socio-economics (housing and accommodations, and services and infrastructure) and community well-being. Beneficial effects were identified for socio-economics (labour market, economic development). Based on the evaluation, each of the residual adverse effects was assessed to be not significant, with the exception of bats and Blanding's turtle. For both bats and Blanding's turtle, the Base Case is assessed to be significant because of existing cumulative effects on the species.

Overall, it is CNL's conclusion that with the identified mitigation measures, the implementation of the NSDF Project is not likely to result in significant residual adverse effects on most environmental components. For bats and Blanding's turtle, significant adverse effects are related to the existing conditions for these species and not due to the NSDF Project; the NSDF Project will contribute a small increment to existing significant adverse cumulative effect on these species.

No residual effects were identified for human health during the NSDF Project life cycle. The maximum estimated dose to the potential critical groups, that is the most exposed members of the public, during the operations period represent less than 0.01 percent of both the regulatory limit of 1 millisieverts per year and the CRL licensing limit of 0.3 millisieverts per year. During post-closure phases, the maximum estimated dose is 0.02 percent of the regulatory dose limit of 1 millisieverts per year and 0.07 percent of the licensing limit of 0.3 millisieverts per year. Residual effects on Ottawa River water quality are determined to be negligible during operations and post-closure phases and may even result in the net reduction due to remediation of legacy waste storage areas.

During operations, leachate from the engineered containment mound will be collected and treated to remove radiological and non-radiological contaminants. Tritium concentrations in Perch Creek discharging to the Ottawa River will not exceed the drinking water guideline. Surface water quality monitoring will be conducted as part of CNL's Environmental Monitoring Program to verify water quality predictions.

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