Date: December 19th 2017

From: Kerrie Blaise (Canadian Environmental Law Association)

To: Candida Cianci, Environmental Assessment Specialist
Canadian Nuclear Safety Commission

By email: cnsc.ea-ee.ccsn@canada.ca

Subject line: CELA Submission - In Situ Decommissioning of the Whiteshell Reactor (Ref No. 80124)

CEAA Reference number: 80124

Comments:

Dear Ms. Cianci,

In response to the CNSC's invite for comments (dated October 5, 2017), please find attached the Canadian Environmental Law Association's submission regarding the draft environmental impact statement for the in-situ decommissioning of the Whiteshell reactor, located in Manitoba.

Please let me know if there are any questions. Thank you for this comment opportunity.

Regards,

Kerrie

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Kerrie Blaise, Counsel
Canadian Environmental Law Association

Submission to the CNSC on the Draft Environmental Impact Statement

Re: In Situ Decommissioning of the Whiteshell Reactor in Pinawa, Manitoba (Ref No. 80124)

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SUMMARY OF RECOMMENDATIONS

Recommendation No. 1 To reflect international best practices and standards, the CNSC should clarify its preferred decommissioning strategy based on the recommendations of the IAEA and the best practices of jurisdictions with established decommissioning regimes. The CNSC should:

1. Develop a principled overall policy framework underpinning a robust, clear, and enforceable regulatory regime for the decommissioning of nuclear facilities as well as the waste that arises from nuclear and decommissioning activities;
2. Stipulate the required evidentiary basis for a licensee's preferred decommissioning strategy and provide rationally based, clear, and enforceable conditions for its implementation; and
3. Include enforceable conditions and detailed requirements for compliance within the approval for decommissioning activities.

Recommendation No. 2 The CNSC should clarify the scenarios in which in situ confinement will be considered an appropriate decommissioning strategy. Current international standards indicate that, short of an emergency scenario, this strategy should be limited to nuclear facilities that only contain short-lived or limited concentrations of long-lived radionuclides. The CNSC should provide clear definitions for what constitutes an "emergency scenario", "short-lived radionuclides", "limited concentrations" and "long-lived radionuclides" or any other criterion used to determine the viability of in situ confinement as a decommissioning strategy for nuclear facilities.

Recommendation No. 3 While the Canadian regulations and standards meet international standards for the content of a final decommissioning plan, they fall short of providing a schedule for its submission. International requirements suggest that the Canadian regulatory framework should require that a final decommissioning plan is submitted for approval prior to or within two years of permanent shutdown.

Recommendation No. 4 The Canadian regulatory framework does not provide guidance on the duration of nuclear power plant decommissioning. In the absence of a policy framework and robust regulatory regime, the best practices of other jurisdictions that provide the greatest protection for the safety and well-being of the environment and Canadians, both present and future, should be adopted. Approval for termination of decommissioning activities should not be granted unless:

1. The CNSC verifies that the licensee has demonstrated that the end state criteria as specified in the final decommissioning plan and any additional regulatory requirements have been met;
2. The end state criteria reflect the best available science and highest level of safety feasible for Canadians and the environment;
3. The public has been consulted before authorization for decommissioning is terminated, and the site of the nuclear facility is released from regulatory control.

Recommendation No. 5 The Government of Canada should develop publicly acceptable policies and strategies for managing long-lived Intermediate-Level Waste that reflects international best practices and have been developed in consultation with Indigenous peoples and the Canadian public. This should include, as a prerequisite, the development of a national classification scheme for radioactive waste that is publicly acceptable and consistent with IAEA guidance.

Recommendation No. 6 Our calculations demonstrate that approximately 800 GBq of tritium will be released to air as a result of the proposed in situ decommissioning. This means that radiation exposures to workers and farmers living nearby will be increased during entombment activities, with approximately 10 years' worth of normal tritium emissions would be emitted in an 18-month period. In light of this, CELA recommends that the tritium emissions from the alternative scenarios should have been estimated and compared.

SUMMARY OF INFORMATION REQUESTS AND DEFICIENCIES

IR#	Information Request
#1	Provide a description of the sustainability-based criteria that were used to evaluate and compare the alternative means as well as the preferred option.
#2	Describe how the four evaluation criteria (safety, technical feasibility, economic feasibility, and environmental effects), CNL design principles, principles from external sources, and CNSC licensing requirements constitute relevant sustainability considerations.
#3	Provide a comparative evaluation of the alternative means in terms of their relative contributions to sustainability.
#4	Provide a description of the process by which consideration for sustainability was incorporated throughout the assessment and design of the preferred option.
#5	Describe and demonstrate how trade offs were considered in the comparative evaluation of alternative means.
#6	Explain how short-term versus long-term impacts were weighted in the comparative evaluation of alternative means.
#7	Describe how reversibility, retrievability, diversity, and redundancy were incorporated in (a) the comparative evaluation of alternative means and (b) the design and assessment of the preferred in-situ decommissioning option.
#8	Provide in-depth plans for the long-term monitoring of the in-situ decommissioning project during the post-institutional control phase.
#9	Provide a rationale for discontinuing active controls for groundwater and surface water quality monitoring during the post-institutional control stage of post-closure.
#10	Describe how the concept of rolling stewardship will be applied in all phases of monitoring for the project.

#11	Regarding institutional control, the 2nd paragraph on page 7–2 of the Project Description (CNL, 2016) states the WR -1 Reactor site will be returned to AECL for institutional control. With the proposed entombment, CNL appears to be making commitments on the part of AECL and by extension the Government of Canada that could last for hundreds of years. The proponent must be accountable for the entire life of the project, i.e. design, construction, commissioning, operations up to and including final abandonment. Thus, as CNL's contract with AECL is for a maximum of 10 years from 2014, it is questionable whether CNL should be the proponent. We request a response from the CNSC on this issue.
#12	In 1998, AECL made a decision to decommission the Whiteshell Laboratories site. The current approved decommissioning strategy for WR-1 includes complete removal of the facility. This is described in the Comprehensive Study Report (herein "2001 Comprehensive Study Report"). This report was commissioned under CEAA 2012's predecessor legislation, with the Canadian Nuclear Safety Commission (CNSC) and Department of Fisheries and Oceans as the Responsible Authorities on EA. This Report remains in force. In the draft EIS, CNL acknowledges that entombment is "a departure from the end-state defined in the 2001 Comprehensive Study Report". However, the draft EIS argues that the proposal qualifies "as a designated project under Section 37(b) of the Regulations Designating Physical Activities of the Canadian Environmental Assessment Act 2012 as a project related to "the long term management or disposal of irradiated fuel or nuclear waste." Theforefore, as CNL is proposing to change the Report's decommissioning strategy from complete removal to entombment, CELA submits the 2001 Comprehensive Study Report should be reopened, because (1) of the magnitude of modification proposed and (2) the need to bring the revised undertaking in line with current environmental assessment law, CEAA 2012.
#13	The original 1960s (WNRE) and 1970s (WNRE and the URL site) agreements between AECL and the Manitoba Government stipulated that both locations would be returned to "green-field conditions" on their abandonment by AECL (AECL, 1994). It is questionable whether CNL's flawed proposals for containment, timeless institution control and surveillance will be considered as "green-field conditions" by the Manitoba Provincial Government.
#14	Several CNL documents are not yet available for public examination, including: • A Health and Safety Plan (HASP) which will identify workplace hazards associated with the closure period activities, specifically addressing all non-radiological COPCs.

	• A detailed safety analysis for the ISD of the WMA trenches. The absence of these documents impairs our review and also, is a deficiency of the data provided by CNL in the draft EIS.
#15	The following omissions/errors in the draft documents require rectifying: • Ag-108m and Sn-121m are absent from the nuclide inventory • No definition of couponing activities • No technical description of the engineered cover system • No technical description of the proposed grout and its properties • No discussion of hydrogen releases from grout-aluminum reactions • No discussion of collective doses • No discussion of organically bound tritium • Table 2.6.3-1 of the draft EIS omits “$ millions” in the legend • Para 6.3.1 of the Technical Document WR-1 Reactor Radiological Characterization Summary - WLDP-26100-041-000-0001 Rev. 0 states “Heavy Water and Tritium Inventory” but contains no Bq inventory for tritium • Table 3-6: Estimated Radionuclide Inventory in Primary Heat Transport System Following Shutdown (Bq) in WLDP-26000-REPT-006, EcoMetrix Ref:16-2292.3 contains incorrect half-lives

INTRODUCTION

The Canadian Environmental Law Association ("CELA") submits this report in response the Public Notice dated October 5, 2017 requesting comments on the draft environmental impact statement ("draft EIS") for the in-situ decommissioning of the Whiteshell Reactor, located in Pinawa, Manitoba.[1]

CELA is a non-profit, public interest law organization. CELA is funded by Legal Aid Ontario as a speciality legal clinic to provide equitable access to justice to those otherwise unable to afford representation for their environmental problems. For nearly 50 years, CELA has used legal tools to advance the public interest, through advocacy and law reform, in order to increase environmental protection and safeguard communities across Canada. CELA has been involved in number of nuclear facility relicensing and regulatory matters before the Canada Nuclear Safety Commission ("CNSC"), from the relicensing of nuclear generating stations (ie. Point Lepreau; Darlington) to annual regulatory oversight reporting hearings (ie. use of nuclear substances; uranium processing facilities).

Scope of Review

In this context, CELA provides a four-part report which reviews the sufficiency of CNL's draft EIS in light of international guidance on decommissioning (Part I), Canada's confluence with international frameworks (Part II), the EIS's consideration of environmental effects per the requirements of *Canadian Environmental Assessment Act, 2012* (Part III), and the effects on human health and safety resulting from the proposed project (Part IV).

Part I of this report reviews regulatory frameworks related to the decommissioning of nuclear facilities in comparison with regulatory requirements developed by the International Atomic Energy Agency ("IAEA"). Part II of the report compares Canada's practices on decommissioning to these international precedents.

Pursuant to our Participant Funding Program application, CELA has engaged the professional services of Dr. Tanya Markvart and Dr. Ian Fairlie. Parts III and IV of this report provide their expert recommendations. Part III of this report examines the compliance and adequacy of the

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[1] Canadian Environmental Assessment Agency "In Situ Decommissioning of the Whiteshell Reactor #1 Project - Public Comment Period on Canadian Nuclear Laboratories' Draft Environmental Impact Statement," (5 Oct 2017) online: http://www.ceaa-acee.gc.ca/050/document-eng.cfm?document=120750 ; Canadian Nuclear Laboratories, "Environmental Impact Statement In Situ Decommissioning of WR-1 at the Whiteshell Laboratories Site" (13 September 2017, Revision 1) WLDP-26000-ENA-001 [**Draft EIS**]

proposed project in conjunction with the requirements of the *Canadian Environmental Assessment Act, 2012* (CEAA, 2012). In particular, CELA has examined whether the project and its assessment adequately consider the environmental effects of the project, their significance, mitigation measures, adequacy of proposed follow-up programs and description of purpose of the project, alternative means of carrying out the project and other factors listed under section 19 of CEAA, 2012. Lastly, Part IV examines the deficiencies and omissions contained in CNL's draft EIS as it relates to human health, the environment and safety matters.

I. INTERNATIONAL FRAMEWORKS RESPECTING NUCLEAR FACILITY DECOMMISSIONING

This section of CELA's submission reviews the regulatory framework concerning the decommissioning of nuclear facilities compared to the regulatory requirements developed by the International Atomic Energy Agency ("IAEA") and implemented in certain jurisdictions. This submission is intended to assist the CNSC in developing appropriate licensing conditions during its review of proposals for the decommissioning of nuclear facilities.

The Canadian regulatory framework established under the *Nuclear Safety and Control Act*, its regulations, and other guidance documents are too general, provide insufficient detail, or fail to address all the relevant factors needed to guide the CNSC's review of a decommissioning proposal. Other jurisdictions have also adopted general regulatory requirements for decommissioning nuclear facilities. While they set out the expectations that licensees would have to meet in preparing and undertaking decommissioning actions consistent with IAEA requirements, the regulatory regimes reviewed do not adequately address all regulatory requirements recommended for adoption by the IAEA.

The CNSC should use the best practices of other jurisdictions and the IAEA as a guide to establish a robust and transparent waste disposal policy, decommissioning policy, and regulatory framework to assess decommissioning proposals. In the absence of specific regulations to govern the conditions for licensing, the CNSC should review decommissioning proposals with regard to specific IAEA requirements and by comparison to the highest international standards for decommissioning strategies and plans.

1. International Atomic Energy Agency Requirements

The IAEA is an independent intergovernmental organization within the United Nations created to promote peaceful applications of atomic energy worldwide for humanity's benefit while guarding against the spread of its destructive use. Under Article III of its Statute, the IAEA is authorized to establish standards of safety for protection of health and minimization of danger to life and property and to provide for the application of these standards. The IAEA establishes and publishes these standards under the IAEA Safety Standards Series and Safety Reports Series.[2]

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[2] Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. GSR Part 6, IAEA, Vienna (2016). <online: http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1652web-83896570.pdf> [**GSR Part 6**]; Decommissioning Strategies for Facilities Using Radioactive Material, IAEA SRS 50, IAEA, Vienna (2007). <online: http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1281_web.pdf> [**SRS 50**]

1.1 Decommissioning Strategies

IAEA Safety Standards Series No. GSR Part 6, Decommissioning of Facilities, establishes internationally agreed requirements for the decommissioning of facilities based on the fundamental safety objective and fundamental safety principles established in the Safety Fundamentals.[3] GSR Part 6 includes the safety requirements for all aspects of decommissioning from the siting and design of a facility to the termination of the authorization for decommissioning. The objective of GSR Part 6 is to establish the general safety requirements to be met during planning for decommissioning, during the conduct of decommissioning actions and during termination of the authorization for decommissioning.[4]

GSR Part 6 does not only apply to nuclear power plants ("NPPs"), but also, amongst others, to research reactors, other nuclear fuel cycle facilities, including predisposal waste management facilities, and research and development facilities.[5] It does not apply to radioactive waste disposal facilities or waste from mining and mineral processing.[6]

IAEA Safety Reports Series No. 50, Decommissioning Strategies for Facilities Using Radioactive Material, provides information to help decide on a decommissioning strategy. The information provided in SRS 50 applies to all facilities using radioactive material, except waste disposal facilities.[7]

Under GSR Part 6, the term 'decommissioning' refers to the actions, both administrative and technical, taken to remove some or all the regulatory controls from a nuclear facility.[8] Aspects of decommissioning must be considered throughout the five major stages of siting, design, construction, commissioning, and operation of an NPP.[9] Decommissioning is performed using a graded approach to achieve a progressive and systematic reduction in radiological hazards. Decommissioning planning and assessment is undertaken to ensure safety, protection of

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[3] International Atomic Energy Agency (IAEA), European Atomic Energy Community (Euratom), the Food and Agriculture Organization of the United Nations (FAO), the International Labour Organization (ILO), the International Maritime Organization (IMO), the OECD Nuclear Energy Agency (OECD/NEA), the Pan American Health Organization (PAHO), the United Nations Environment Programme (UNEP) and the World Health Organization (WHO), Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006). <online: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1273_web.pdf> [**SF-1**]

[4] GSR Part 6, *supra*, note 2, at 1.11, 1.14-1.15.

[5] *Ibid*. at 1.16.

[6] *Ibid*. at 1.17.

[7] SRS 50, *supra*, note 2, at 1.2 & 1.3.

[8] Except where radioactive waste is emplaced, for which the term 'closure' instead of 'decommissioning' is used.

[9] GSR Part 6, *supra*, note 2, at 1.1.

workers and the public, and protection of the environment.[10] Decommissioning is concerned with 'facilities', i.e. buildings, including their associated land and equipment. There may be areas of land that have become contaminated during operation of a facility. The cleanup of these areas is part of decommissioning.[11]

Strategies for decommissioning nuclear facilities include immediate dismantling and deferred dismantling:[12]

> *Immediate dismantling*: Decommissioning begins shortly after permanent shutdown. Equipment and structures, systems and components of a facility containing radioactive material are removed and/or decontaminated to a level that permits the facility to be released from regulatory control for unrestricted use, or released with restrictions on future use.
>
> *Deferred dismantling*: After removal of the nuclear fuel from the facility, all or part of the facility is either processed or placed in such a condition that it can be put in safe storage and the facility maintained until it is subsequently decontaminated and/or dismantled. Deferred dismantling may involve the early dismantling of some parts of the facility and early processing of some radioactive material and its removal from the facility, as preparatory steps for the safe storage of the remaining parts of the facility.

A combination of immediate and deferred dismantling may be considered based on safety or environmental requirements, technical considerations and local conditions, such as the intended future use of the site, or financial considerations.[13] Immediate dismantling is the preferred decommissioning strategy, but GSR Part 6 acknowledges that there may be situations in which immediate dismantling is not a practical strategy when all relevant factors are considered.[14]

1.1.1 Entombment

The IAEA does not consider entombment, in which all or part of the facility is encased in situ, as a decommissioning strategy in the case of a planned permanent shutdown. Entombment may be considered a solution only under exceptional circumstances (e.g. following a severe accident).[15] Additionally, the fact that radioactive material will remain on the site means that

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[10] *Ibid*. at 1.4.
[11] *Ibid*. at 1.19.
[12] *Ibid*. at 1.9.
[13] *Ibid*. at 1.10.
[14] *Ibid*. at 5.1.
[15] *Ibid*.

the facility will eventually become designated as a near-surface disposal of radioactive waste or near-surface disposal facility ("NSDF") and criteria for such a facility will need to be met.[16] Since the end state of an entombed site is equivalent to a waste disposal site, the end state cannot satisfy unrestricted release conditions; it will require some measure of institutional control well into the future.[17] This necessarily entails that, in addition to the decommissioning regulations for entombment, there will also need to be regulations for an NSDF. Since it is also unlikely that the site of the nuclear facility was assessed to serve as an NSDF, such an evaluation may need to be conducted as part of the approval process for entombment.[18] Entombment may also be considered if a waste disposal site to accept decommissioning waste does not exist. The waste disposal facility could be created at the entombment site, an NSDF, that could receive short lived or limited concentrations of long-lived radionuclides from other sites. [19]

1.1.2 Waste

SRS 50 indicates that the selection of a decommissioning strategy is dependent on waste generation and waste management. Relevant considerations include the overall national waste management strategy, the amount of waste, the types and categories of waste (both radioactive and non-radioactive) and the facilities needed to process, handle, store and dispose of the waste. When selecting a decommissioning strategy, it is important to consider national waste management policies or to seek the establishment of a policy where one does not exist.

The policy should establish both, an overall national framework for the management of all types of waste generated during decommissioning activities, and the classification of the waste and its final disposal. Each category of waste has its own unique concerns and specific management requirements. The lack of a waste management policy for any of the waste categories will introduce uncertainties in the decommissioning strategy selection process and ultimately yield an insecure strategy.[20] Notably, SRS 50 stipulates that the lack of a disposal facility is an insufficient reason for not performing immediate dismantling. Waste can be placed into an interim storage facility until a final disposal system is decided upon. Only if a nuclear programme is limited and the type of facility to be decommissioned is amenable, should entombment be the preferred option.

As an entombed facility is considered an NSDF, no or only limited amounts of long-lived

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[16] SRS 50, *supra*, note 2, at 2.4.
[17] *Ibid*. at 3.3.3.
[18] *Ibid*. at 3.4.3.
[19] *Ibid*. at 3.2.3 & 3.3.3.
[20] *Ibid*. at 3.7.

radionuclides are allowed in the entombed facility. If the necessary infrastructure for a low-level waste disposal facility is not present, then entombment may not be feasible.[21]

1.2 Decommissioning Requirements

IAEA GSR Part 6 is divided into sections that outline the requirements for the different concerns that are involved in the decommissioning of a nuclear facility:

- Section 2 establishes the requirements for safety, for protection of workers and the public and for protection of the environment.
- Section 3 establishes the responsibilities within the governmental, legal and regulatory framework associated with decommissioning.
- Section 4 establishes the requirements for the management of decommissioning.
- Section 5 establishes the requirements for selecting a decommissioning strategy.
- Section 6 establishes the requirements for the financing of decommissioning.
- Section 7 establishes the requirements for the planning for decommissioning that is done during the facility's lifetime.
- Section 8 establishes the requirements to be followed when conducting decommissioning actions.
- Section 9 establishes the requirements for determining when decommissioning has been completed, including the requirements for surveys to demonstrate the completion of decommissioning actions and the termination of authorization for decommissioning.

1.2.1 Specific Requirements

GSR Part 6 Requirement 3 stipulates that a final decommissioning plan must be supported by a safety assessment addressing the planned decommissioning actions and incidents, including accidents that may occur or situations that may arise during decommissioning be undertaken for all facilities undergoing decommissioning and for which decommissioning is planned.[22] The safety assessment must conform to the requirements of GSR Part 4, *Safety Assessment for Facilities and Activities*.[23] This IAEA requirement is implemented in Canada by CNSC's Regdoc-2.4.1, *Deterministic Safety Analysis*.

Under Requirement 4, States must establish and maintain a governmental, legal and regulatory framework within which all aspects of decommissioning can be planned and carried out

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[21] *Ibid*.

[22] GSR Part 6, *supra*, note 2, at 2.6.

[23] IAEA, Safety Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), IAEA, Vienna (2016). <online: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1714web-7976998.pdf>

safely.[24] Requirements for general responsibilities within the framework are established in IAEA, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1. These requirements apply allocating responsibilities for decommissioning. [25]

The responsibilities of a State government shall include:[26]

- Establishing a national policy for the management of radioactive waste, including during decommissioning;
- Establishing and maintaining the legal, technical and financial responsibilities for organizations involved in decommissioning;
- Ensuring that the necessary scientific and technical expertise is available for the licensee and for the support of regulatory review;
- Establishing a mechanism to ensure that adequate financial resources are available when necessary for safe decommissioning and for the management of the resulting radioactive waste.

Under Requirement 5, the regulatory body must regulate all aspects of decommissioning throughout all stages of the facility's lifetime. The regulatory body shall establish the safety requirements for decommissioning, including requirements for management of the resulting radioactive waste, and shall adopt associated regulations and guides. The regulatory body must also take actions to ensure that the regulatory requirements are met.[27]

Requirement 8 mandates the licensee to select a decommissioning strategy that is consistent with the national policy on the management of radioactive waste. The preferred decommissioning strategy shall be immediate dismantling. The selection of a decommissioning strategy shall be justified by the licensee. The licensee must demonstrate that under the strategy selected, the facility will be safe at all times and will reach the decommissioning end state, and that no undue burdens will be imposed on future generations.

Under Requirement 9, the responsibility of the financial burden for decommissioning must be set out in national legislation. To ensure safe decommissioning, these provisions must include establishing a mechanism to provide adequate financial resources and to ensure that they are available when necessary.

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[24] GSR Part 6, *supra*, note 2, Requirement 4, at 3.2.
[25] IAEA, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1 (Rev. 1), IAEA, Vienna (2016). <online: http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1713web-70795870.pdf>
[26] GSR Part 6, *supra*, note 2, Requirement 4, at 3.2.
[27] *Ibid*. Requirement 5, at 3.3.

Requirement 10 stipulates that the licensee must prepare a decommissioning plan and maintain it throughout the lifetime of the facility to show that decommissioning can be accomplished safely to meet the defined end state. The State's regulatory body must ensure that the licensee takes decommissioning into account in the siting, design, construction, commissioning and operation of the facility. For existing facilities where there is no decommissioning plan, a suitable plan for decommissioning must be prepared by the licensee as soon as possible. The plan must be periodically reviewed and updated by the licensee.

Requirement 11 stipulates that before the commencement of decommissioning actions, a final decommissioning plan must be approved by the State's regulatory body. The final decommissioning plan must cover the following:

- the selected decommissioning strategy;
- the schedule,
- type and sequence of decommissioning actions;
- the waste management strategy applied, including clearance, the proposed end state and how the licensee will demonstrate that the end state has been achieved;
- the storage and disposal of the waste from decommissioning;
- the timeframe for decommissioning; and
- financing for the completion of decommissioning.

If deferred dismantling has been selected as a decommissioning strategy, the licensee must demonstrate that such an option will be implemented safely in the final decommissioning plan. The availability of adequate financial resources to ensure that the facility is maintained in a safe condition during the deferral period and for subsequent decontamination and/or dismantling shall be demonstrated.

Interested parties must also be provided with an opportunity to examine and provide comments on the final decommissioning plan before its approval.

Requirement 14 stipulates that radioactive waste from operational activities and generated during decommissioning shall be disposed of properly. If disposal capacity is not available, radioactive waste shall be stored safely. The licensee is also required to ensure the availability of adequate processing and storage capabilities and transport packages for the radioactive waste before the commencement of decommissioning.

2. Canada

In Canada, the *Nuclear Safety and Control Act* ("*NSCA*") governs the development, production and use of nuclear energy to prevent unreasonable risk to national security, the health and safety of persons and the environment. The *NSCA* establishes the CNSC and sets out its mandate, responsibilities and powers. The *NSCA* provides the CNSC with authority to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in Canada. The CNSC, as Canada's nuclear regulator, is an independent agency of the Government of Canada.

The CNSC regulates the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. Section 26(e) of the *NSCA* prohibits the preparation, construction, operation, and decommissioning of nuclear facilities, except in accordance with a license. Section 24(5) allows the CNSC to require a licensee to provide a financial guarantee to fulfil the requirements under the *NSCA*.

Notably, while at present no such Regulations have been made, subsections 44(1)(c), (e), and (o) of the *NSCA* empowers the CNSC to make regulations respecting decommissioning. Regulations made under the *NSCA* that would apply to decommissioning include:

- *General Nuclear Safety and Control Regulations*;
- *Radiation Protection Regulations*;
- *Class I Nuclear Facilities Regulations*;
- *Class II Nuclear Facilities Regulations*;
- *Nuclear Substances and Radiation Devices Regulations*;
- *Packaging and Transport of Nuclear Substances Regulations*; and
- *Nuclear Security Regulations*.

The *Class I Nuclear Facilities Regulations* and the *Class II Nuclear Facilities and Prescribed Equipment Regulations* require that an application for a license to prepare a site (for a Class I nuclear facility only), construct, or operate a nuclear facility must include the proposed plan for the decommissioning of the nuclear facility.[28] The *General Nuclear Safety and Control Regulations* contain the general requirements that apply to all licensees, including licensees for decommissioning nuclear facilities.

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[28] *Class I Nuclear Facilities Regulations*, SOR/2000-204, s. 3 [***Class I Nuclear Facilities Regulations***]; Class II Nuclear Facilities and Prescribed Equipment Regulations, SOR/2000-205, s.3. <online: http://laws.justice.gc.ca/eng/regulations/sor-2000-204/page-1.html>

2.1 Regulatory and Standards Documents

Canadian regulators address the planning for decommissioning, decommissioning cost estimating, and provision of funds for decommissioning through a combination of the use of statutory authority granted to the CNSC, its regulations, regulatory documents,[29] licence conditions and code and standards.[30]

Regulatory documents support the CNSC's regulatory framework by expanding on expectations set out in the *NSCA*, its regulations and legal instruments, such as licences and orders. These documents provide instruction, assistance and information to the licensees.

Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*, provides guidance regarding the preparation of decommissioning plans for activities licensed by the CNSC. It also provides the basis for calculating the financial guarantees discussed in the Regulatory Guide G-206, *Financial Guarantees for the Decommissioning of Licensed Activities*. This guide describes those decommissioning planning requirements and the regulatory and policy basis for them.

The CNSC requires that decommissioning planning be completed in two phases. The preliminary decommissioning plan is filed with the CNSC as early as possible in the life-cycle of the activity or facility and should be revisited and updated as necessary. The preliminary decommissioning plan documents should include:[31]

- the preferred decommissioning strategy and end-state objectives;
- the major decontamination, disassembly and remediation steps;
- the approximate quantities and types of waste generated;
- an overview of the principal hazards and protection strategies;
- an estimate of cost;
- and the methods of guaranteeing financing for the decommissioning activities.

The detailed decommissioning plan should be filed with the CNSC before beginning decommissioning activities. This detailed decommissioning plan normally refines and adds procedural and organizational details to the preliminary decommissioning plan. Once approved by the CNSC, the detailed plan will be incorporated into a licence authorizing

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[29] CNSC Regulatory Guide G-206, Financial Guarantees for the Decommissioning of Licensed Activities (June 2000). <online: http://nuclearsafety.gc.ca/pubs_catalogue/uploads/G206_e.pdf>; CNSC Regulatory Guide G-219, Decommissioning Planning for Licensed Activities (June 2000). <online: http://nuclearsafety.gc.ca/pubs_catalogue/uploads/G219_e.pdf> [**G-219**]

[30] Decommissioning of facilities containing nuclear substances, CSA N294-09, August 2014 [**CSA N294-09**]; Management system requirements for nuclear facilities, CSA N286, 2012.

[31] G-219, *supra* note 28, at 5.1.

decommissioning.[32]

It has also become common practice for the CNSC to mandate compliance with CSA N294-09, *Decommissioning of facilities containing nuclear substances*, and other CSA standards by adding a condition to the licences issued to major nuclear facilities. Unless stipulated otherwise, the licensee would only be required to comply with the normative clauses of the CSA standard to meet the requirement of the licence condition.[33]

According to CSA N294-09, it is intended to consolidate into one document, decommissioning principles, Canadian and international decommissioning experience, international guidance and regulatory expectations that could be applied to the decommissioning of all nuclear facilities. CSA N294-09 is meant to be consistent with and supplement Canadian policy and regulatory guidance documents.[34]

There is no stated preference in either policy or regulation for a specific decommissioning strategy. While prompt decommissioning has been adopted for some smaller facilities (e.g. SLOWPOKE II research reactors), most licensees of large nuclear facilities have adopted deferred decommissioning to:[35]

- Reduce occupational doses by allowing time for radiological decay; or
- Take advantage of efficiencies of scale by coordinating the decommissioning of different facilities located on the same site.

2.1.1 Decommissioning Responsibility and Planning

The Canadian regulatory framework does not explicitly assign responsibility for the decommissioning of a nuclear facility to a specific party[36], however, CSA N294-09 does require that:[37]

> Responsibility for decommissioning shall be clearly established throughout the life cycle of a facility. This responsibility includes planning and preparing for, executing, and completing decommissioning (i.e., until the final end-state objective has been achieved, all documentation completed, and all regulatory requirements satisfied). Responsibility

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[32] *Ibid*.
[33] Candesco, International Benchmarking on Decommissioning Strategies, RSP-0303, 2014, at pg. 9. <online: http://www.nuclearsafety.gc.ca/eng/pdfs/about/researchsupport/reportabstracts/RSP-0303-Final-Report-eng.pdf> [RSP-0303]
[34] CSA N294-09, *supra* note 29.
[35] RSP-0303, *supra* note 32, at pg. 6.
[36] *Ibid*. at pg. A-4.
[37] CSA N294-09, *supra* note 29, at 4.1.1.

for the funding of the decommissioning shall be identified.

The *Class I Nuclear Facilities Regulations* require that an application for a Licence for a Class I Nuclear Facility must include the proposed decommissioning plan for the nuclear facility or of the site.[38] Both CSA N294-09[39] and G-219[40] set out the required contents of a decommissioning plan.

CSA N294-09 recommends that initial decommissioning plans should be regularly updated and reviewed to reflect: [41]

(a) changes in site conditions;
(b) changes to the proposed decommissioning objectives or strategy;
(c) changes to ownership or management structure;
(d) advances in decommissioning technology;
(e) significant modifications to the facility;
(f) updated cost and funding information;
(g) revised regulatory requirements; and
(h) revised records requirements.

2.2 Decommissioning Strategy

G-219 recommends that the following basic alternative strategies should be evaluated for each planning envelope:[42]

- Prompt removal;
- Deferred removal (to allow for the decay of relatively short-lived nuclides (e.g., half-lives of less than 10 years), or to await the availability of waste disposal capacity);
- In-situ confinement (to secure and abandon the affected portions of the facility in place); and
- combinations of the above.

CSA N294-09 recommends that the development of a decommissioning strategy should be based on one or a combination of the following:[43]

[38] *Class I Nuclear Facilities Regulations*, *supra* note 27, at s. 3.
[39] CSA N294-09, *supra* note 28, at 6.3 & Annex A.
[40] G-219, *supra* note 28, at 6.1.
[41] CSA N294-09, *supra* note 29, at 6.3.2.
[42] G-219, *supra*, note 28, at 8.0.
[43] CSA N294-09, *supra* note 29, at 6.1.2.

(a) prompt decommissioning — to decontaminate and dismantle the facility without any planned delays;
(b) deferred decommissioning
 (i) to place the facility in a period of storage-with-surveillance followed by decontamination and dismantlement; or
 (ii) to conduct activities directed at placing certain buildings or facilities in a safe, secure interim end state, followed by a period of storage-with- surveillance, and ultimately decontamination and dismantlement; and
(c) in-situ confinement — to place the facility in a safe and secure condition with the intention to abandon in-place.

Clause 6.1.3 provides guidance on the factors that should be considered when developing the decommissioning strategy.[44]

3. U.S.A.

3.1 Statutes and Regulations

The United States has extensive experience in managing the decommissioning of NPPs. Consequently, the regulatory system, Nuclear Regulatory Commission ("NRC") and Department of Energy ("DOE"), governing the decommissioning of nuclear facilities is more highly developed than in other countries. The regulatory regime for the decommissioning of civilian nuclear facilities has been defined in a series of Acts; the most important of these are:

- *Atomic Energy Act* of 1954;
- *National Environmental Policy Act* (NEPA) of 1969; and
- *Clean Air Act* (CAA) and the *Safe Drinking Water Act* (SDWA).

The NRC's decommissioning regulations are found in Chapter I of Title 10, "Energy," of the *Code of Federal Regulations* (CFR). Part 20, Subpart E, and Parts 50.75, 50.82, 51.53, and 51.95 provide the main decommissioning requirements. These rules require owners to provide the NRC with early notification of planned decommissioning activities. The rule allows no major decommissioning activities to be undertaken until after certain information has been provided. Notable elements of the American system for regulating the decommissioning of nuclear power plants that do not have counterparts in the current Canadian regulatory system include:

[44] *Ibid*. at 6.1.3.

- Requirements for certain aspects of decommissioning and licence termination of nuclear power plants are explicitly addressed in the Regulations, such as 10CFR20 Subpart E establishes the 'radiological criteria for license termination';
- NRC Regulatory Guide 1.184 provides further guidance on the actions required of nuclear power reactor licensees to meet the regulatory requirements related to decommissioning nuclear power reactors;[45]
- Several NUREG documents provide technical advice on issues related to decontamination, dismantling and site remediation;
- Extensive guidance on the development of release criteria, planning of pre-release surveys and decision making for the release of lands, buildings and materials are available in the Data Quality Objectives, MARSSIM and MARSAME publications from the NRC, EPA and other federal agencies.

The requirements for power reactor decommissioning activities may be divided into three phases:

(1) initial activities;
(2) major decommissioning and storage; and
(3) licence termination activities.

3.1.1 Initial activities

When an NPP licensee permanently shuts down a plant, the operator must submit a written certification of permanent cessation of operations to the NRC within 30 days.[46] Within two years after submitting the certification of permanent closure, the licensee must submit a Post-Shutdown Decommissioning Activities Report ("PSDAR") to the NRC. This report provides a description of the planned decommissioning activities, a schedule for accomplishing them, and an estimate of the expected costs.

The PSDAR must discuss the reasons for concluding that environmental impacts associated with the site-specific decommissioning activities have already been addressed in previous environmental analyses. Otherwise, the licensee must request a licence amendment for approval of the activities and submit to the NRC a report on the additional impacts of decommissioning on the environment.[47] After receiving a PSDAR, the NRC publishes a notice of receipt in the Federal Register, makes the report available for public review and comment, and

[45] Decommissioning of Nuclear Power Reactors, Regulatory Guide 1.184, U.S. Nuclear Regulatory Commission, 2013. <online: http://pbadupws.nrc.gov/docs/ML1314/ML13144A840.pdf>
[46] Termination of License, 10 CFR 50.82, U.S. Nuclear Regulatory Commission, 2011, § 50.82(a)(1)(i). <online: http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0082.html> [10 CFR 50.82]
[47] *Ibid*. § 50.82(a)(4)(i).

holds a public meeting in the vicinity of the plant to discuss the licensee's intentions.[48]

3.1.2 Major Decommissioning and Storage

Ninety days after the NRC receives the PSDAR, the owner can begin major decommissioning activities without specific NRC approval.[49] However, decommissioning activities conducted without specific prior NRC approval must not:[50]

- prevent the release of the site for possible unrestricted use,
- cause any significant environmental impact not previously reviewed, or
- result in there being no reasonable assurance that adequate funds will be available for decommissioning.

If any decommissioning activity does not meet these terms, the licensee is required to submit a licence amendment request, which would provide an opportunity for a public hearing.

3.1.3 Licence Termination

The owner is required to submit a Licence Termination Plan ("LTP") within two years of the expected licence termination. Before the LTP can be approved, a public meeting is held near the plant site to allow for public input. If the NRC approves the LTP, the licence is amended to allow the decommissioning to proceed.[51] If decommissioning has been completed in accordance with the approved LTP and the termination survey demonstrates that the facility and site are suitable for release, the NRC will issue a letter terminating the operating licence.[52]

3.2 Decommissioning Strategy

Licensees may choose from three alternative decommissioning strategies:[53]

- DECON, equivalent to 'immediate dismantling' under the IAEA;
- SAFSTOR, equivalent to 'deferred dismantling' under the IAEA; or
- ENTOMB, equivalent to 'in situ abandonment' under the IAEA.

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[48] *Ibid*. § 50.82(a)(4)(ii).
[49] *Ibid*. § 50.82(a)(5).
[50] *Ibid*. § 50.82(a)(6).
[51] *Ibid*. § 50.82(a)(9)-(10).
[52] *Ibid*. § 50.82(a)(11).
[53] Backgrounder on Decommissioning Nuclear Power Plants, U.S. Nuclear Regulatory Commission, 2015. <online: http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/decommissioning.html#funds>

The licensee may also choose to adopt a combination of the first two choices. The decision may be based on factors besides radioactive decay such as availability of waste disposal sites. To meet regulatory requirements, decommissioning must be completed within 60 years of the plant ceasing operations. A time beyond that would be considered only when necessary to protect public health and safety in accordance with NRC regulations.[54]

The majority of the commercial NPPs in the united states have adopted the DECON strategy. Nine of the facilities are following a SAFSTOR strategy, and one (the damaged Three Mile Island Unit 2) is in "Post Defueling Monitored Storage".[55]

4. Finland

4.1 Statutes and Regulation

In Finland, the operators of nuclear facilities are responsible for waste management and decommissioning, including related planning, and for financing the costs of future management of waste and decommissioning. The State is responsible for nuclear waste after its approved disposal and has the secondary responsibility in case a producer is incapable of fulfilling the management obligation.[56]

The Radiation and Nuclear Safety Authority (STUK), is responsible for regulatory oversight, issuing safety regulations and for the technical and safety-related review of licence applications. Aside from being a regulatory body, STUK also has administrative control of an interim storage facility for small-user radioactive waste. The detailed safety regulations are given as STUK-guides. Licensees must comply with these guides unless they establish an acceptable alternate procedure or solution with a comparable safety. The YVL guide group D is relevant to nuclear waste management and decommissioning: [57]

- Guide YVL D.2 Transport of nuclear materials and nuclear waste
- Guide YVL D.3 Handling and storage of nuclear fuel

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[54] 10 CFR 50.82, *supra* note 45 at § 50.82(a)(3); Violations, 10 CFR 52.110, U.S. Nuclear Regulatory Commission, 2007, § 52.110(c).
[55] RSP-0303, *supra* note 32, at pg. A-19.
[56] Radioactive Waste Management and Decommissioning in Finland, OECD/NEA, 2013. <online: https://www.oecd-nea.org/rwm/profiles/Finland_report_web.pdf>
[57] *Ibid*.

- Guide YVL D.4 Predisposal management of low and intermediate level nuclear waste and decommissioning of a nuclear facility[58]
- Guide YVL D.5 Disposal of nuclear waste

The main laws and ordinances regulating waste management activities are:[59]

- *Nuclear Energy Act* (1987) and *Decree* (1988)
- *Decree on the State Nuclear Waste Management Fund* (1988)
- *Radiation Act* and *Decree* (1991)
- *Environmental Impact Assessment Act* (1994)
- Act and Decree on Radiation and Nuclear Safety Authority define STUK's regulatory rights and responsibilities (1991).

4.2 Decommissioning strategy

According to Guide YVL D.4, the feasibility of decommissioning a nuclear facility must be addressed to obtain a Construction Licence. A decommissioning plan must also be submitted with the application for the Operating Licence. These plans need to be updated every 6 years.[60]

The authorization system for decommissioning is included in the amendment of the nuclear energy legislation which entered into force in 2008. A safety guide for decommissioning became effective in 2013. Development of the decommissioning technology will be followed, and the decommissioning plans and safety evaluations will be updated if substantiated by these developments. [61]

Guide YVL D.4 requirement 403 indicates that under section 7 g, subsection 1, of the Nuclear Energy Act,[62]

> the design of a nuclear facility shall provide for the facility's decommissioning. According to subsection 2, when the operation of a nuclear facility has been terminated, the facility shall be decommissioned in accordance with a plan approved by the Radiation and Nuclear Safety Authority (STUK). Dismantling the facility and other measures taken for the decommissioning of the facility may not be postponed without due cause

[58] Predisposal Management of Low and Intermediate Level Nuclear Waste and Decommissioning of a Nuclear Facility, Guide YVL D.4, draft L5, 2013. <online: https://ohjeisto.stuk.fi/YVL/D.4e.pdf> [**Guide YVL D.4**]

[59] *Supra* note 58.

[60] RSP-0303, *supra* note 32, at pg. A-40.

[61] *Supra*, note 58.

[62] Guide YVL D.4, *supra* note 57, at pg. 6.

This suggests that the preferred strategy for decommissioning NPP in Finland is Prompt Dismantling, but that all options would be considered if sufficiently justified. The decommissioning strategies for Finnish NPPs: [63]

- Loviisa NPP - Prompt Dismantling within eight years from shutdown
- Olkiluoto Units 1&2 - Deferred Dismantling with a 30-year deferral (due to likelihood of other operating units on site – Unit 3)
- Olkiluoto Unit 3 (Tentative) - Prompt Dismantling.

5. Sweden

5.1 Statutes and Regulations

In Sweden, the statues that are relevant to decommissioning of nuclear facilities include:[64]

- The Act (1984:3) on Nuclear Activities.
- The Radiation Protection Act (1988:220).
- The Act on Financing of Management of Residual Products from Nuclear Activities (2006:647)
- The Environmental Code (1998:808)

The Swedish Radiation Safety Authority (SSM) is responsible for the direct regulatory control of compliance with operations with legislation and regulations. Any new nuclear facility must be licensed according to both the Act on Nuclear Activities and the Environmental Code. In both cases, the Government grants the licence based on recommendations and reviews of the competent authorities. A licence according to the Radiation Protection Act is not required for activities licensed according to the Act on Nuclear Activities.[65]

The Regulations Concerning Safety in Certain Nuclear Facilities (SSMFS 2008:1) contains the most important regulations for management and disposal of spent fuel and nuclear waste. The regulations are also applicable for decommissioning.[66] The regulations cover application of multiple barriers and defence-in-depth, handling of detected deficiencies in barriers and the defence-in-depth, organisation, management and control of safety significant activities, actions and resources for maintaining and development of safety, physical protection and emergency preparedness, basic design principles, assessment, review and reporting of safety, operations of

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[63] RSP-0303, *supra* note 32, at pg. A-40.
[64] OECD, Radioactive Waste Management and Decommissioning in Sweden, 2013, at pg. 6 <online: https://www.oecd-nea.org/rwm/profiles/Sweden_report_web.pdf>
[65] *Ibid*.
[66] *Ibid*.

the facility, on-site management of nuclear materials and waste, reporting to SSM deficiencies, incidents and accidents, documentation and archiving of safety, final closure and decommissioning.[67]

Under Swedish law, the operator of a nuclear facility is primarily responsible for the safe handling and disposal of spent nuclear fuel and radioactive waste, as well as decommissioning and dismantling of the facility.[68]

5.2 Decommissioning strategy

No decommissioning strategy is prescribed, but section 6 of *The Regulations on Planning for and during Decommissioning of Nuclear Facilities* requires that the Licensee prepare an analysis of the decommissioning alternatives:[69]

> Section 6 Plans must identify possible decommissioning methods with estimated time requirements and ultimate objectives. Any consequences of the identified alternatives shall be investigated concerning
>
> 1. occupational radiation doses,
> 2. emissions of radioactive substances to the environment,
> 3. risk of unplanned events that may cause radiation doses or emission of radioactive substances,
> 4. handling and storage of radioactive material that arises, and
> 5. requirements of information for and training of various personnel categories.

The main decommissioning strategy for NPPs in Sweden is that of immediate dismantling. The goal is for the site to be used for future energy production after decommissioning.[70]

Dismantling commences about two years after the nuclear facility has been shut down. With a decommissioning period of about five years, a unit can be expected to be released for other uses about seven years after shutdown.[71]

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[67] *Ibid*. at pg. 7.
[68] *Ibid*. at pg. 3.
[69] RSP-0303, *supra* note 32, at pg. A-58.
[70] *Supra* note 66, at pg. 18.
[71] *Ibid*.

II. COMPARATIVE ANALYSIS OF CANADA'S NUCLEAR DECOMMISSIONING PRACTICES

The CNSC commissioned a report, *International Benchmarking on Decommissioning Strategies*, RSP-0303, from a third-party consulting service that compared the Canadian regulatory framework and standards in 2014 to the requirements of IAEA *Safety Requirements, Decommissioning of Facilities Using Radioactive Material*, WS-R-5, as well as other international jurisdictions. Since that time, WS-R-5 has been superseded by IAEA *General Safety Requirements* Part 6, GSR Part 6. While an update, GSR Part 6 has substantially the same requirements as WS-R-5. Consequently, the conclusions drawn by this report concerning the adequacy of the Canadian regulatory regimes compliance with the IAEA requirements for decommissioning of nuclear facilities remain relevant today. The report found that while many of the IAEA requirements were adequately reflected in the Canadian regulatory framework or commissioned standards, a number were not.

The Canadian regulatory framework as it relates to the decommissioning of NPPs is, in general, like the regulatory regime of most of the other countries that were reviewed in RSP-0303 (and particularly those of Finland, Italy, the UK and Sweden). Particularly because these regimes primarily address planning for decommissioning, estimating the cost of decommissioning and assuring that funding will be available. Unfortunately, none of the jurisdictions reviewed address the execution or completion of decommissioning in sufficient detail.[72]

1. Decommissioning Strategy

CNSC's regulatory guide G-219 stipulates that one of the main roles of the preliminary decommissioning planning process and plan is to document a preferred decommissioning strategy which, considering current knowledge, represents a technically feasible, safe and environmentally acceptable approach.[73] G-219, however, does not provide any guidance on which decommissioning strategies may be acceptable or preferred.

CSA N294-09 recommends that a decommissioning strategy should contain a high-level approach and rationale for decommissioning a facility, be developed early, and be updated as new information is obtained. CSA N294-09 goes on to recommend that the decommissioning strategy "*should be based on one or a combination of*" prompt decommissioning, deferred

[72] RSP-0303, *supra* note 32, at pg. 18.
[73] G-219, *supra* note 28, at s. 6.1.1.

decommissioning or in-situ confinement."[74] The standard does not mandate or recommend any one strategy.

In contrast, the Finnish regulatory regime suggests that the preferred strategy for decommissioning is Prompt Dismantling, but that all options would be considered if sufficiently justified.[75] In Sweden, the main decommissioning strategy for NPPs is that of immediate dismantling with the overarching goal the site of the nuclear facility to be eventually used for future energy production after decommissioning.[76] Although all three of the identified decommissioning strategies are available to licensees, in the United States the majority of NPPs have adopted the DECON strategy, equivalent to 'immediate dismantling', with only three facilities undergoing in-situ decommissioning.

IAEA GSR Part 6 stipulates the preferred decommissioning strategy as immediate dismantling, but that when all relevant factors are considered, there may be situations where immediate dismantling is not a practical strategy.[77] Entombment, however, is not an option in the case of a planned permanent shutdown; only under exceptional circumstances such as a severe accident).[78]

SRS 50 suggests that the selection of a decommissioning strategy is dependent on waste generation and waste management. When selecting a decommissioning strategy, it is important to consider national waste management policies or to seek the establishment of a policy where one does not exist. The policy should establish both, an overall national framework for the management of all types of waste generated during decommissioning activities, and the classification of the waste and its final disposal. [79]

Recommendation No. 1

As it stands, to reflect international best practices and standards, the CNSC should clarify its preferred decommissioning strategy based on the recommendations of the IAEA and the best practices of jurisdictions with established decommissioning regimes. The CNSC should:

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[74] RSP-0303, *supra* note 32, at pg. 19; CSA N294-09, supra note 29, at section 6.1.
[75] Guide YVL D.4, *supra* note 57, requirement 403.
[76] *Supra*, note 66 at pg. 18.
[77] GSR Part 6, *supra*, note 2, at s. 5.1.
[78] *Ibid*. at s. 1.10.
[79] SRS 50, *supra*, note 2 at 3.7.

1. Develop a principled overall policy framework underpinning a robust, clear, and enforceable regulatory regime for the decommissioning of nuclear facilities as well as the waste that arises from nuclear and decommissioning activities;
2. Stipulate the required evidentiary basis for a licensee's preferred decommissioning strategy and provide rationally based, clear, and enforceable conditions for its implementation.
3. Include enforceable conditions and detailed requirements for compliance within the approval for decommissioning activities.

2. In Situ Confinement

The IAEA does not recognize entombment or in-situ confinement as a decommissioning strategy except in exceptional circumstances. The IAEA advises that it would only be appropriate for short-lived or limited concentrations of long-lived radionuclides:[80]

> Entombment is not relevant for a facility that contains long lived isotopes because these materials are not suitable for long term surface disposal. Consequently, reprocessing facilities, fuel fabrication facilities, enrichment facilities or facilities that use or process thorium or uranium would not be appropriate for entombment. However, entombment could be a viable option for other nuclear facilities containing only short lived or limited concentrations of long lived radionuclides, i.e. in order to comply with the site release criteria.

Entombment may be considered if a waste disposal site does not exist. The waste disposal facility, an NSDF, could be created at the facility site. The NSDF could receive radioactive waste from other sites, but only waste containing short lived radionuclides.[81]

As mentioned above, CSA N294-09 identifies in-situ confinement as a possible decommissioning strategy.[82] However, jurisdictions such as Finland and Sweden have not identified it as an appropriate decommissioning strategy for NPPs. In-situ confinement has been adopted at US Department of Energy sites for the decommissioning of:[83]

- P- and R-reactors at the Savannah River Site near Augusta, Georgia;

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[80] SRS 50, *supra*, note 2 at 3.2.2.
[81] *Ibid*. at 3.3.3.
[82] RSP-0303, *supra* note 32, at pg. 19; CSA N294-09, *supra* note 28, at section 6.1.
[83] DOE EM Project Experience & Lessons Learned for In Situ Decommissioning, U.S. Department of Energy, Office of Environmental Management, Office of D&D and FE, EM-13, February 2013. <online: http://energy.gov/sites/prod/files/DOE%20EM%20Project%20Experience%20%26%20Lessons%20Learned%20for%20In%20Situ%20Decommissioning%20-%20Feb.%202013.pdf>

- Two fuel processing facilities at the Idaho National Laboratory and the U Canyon at the Hanford site near Richland, Washington; and
- The below grade portion of several small reactors facilities at Idaho National Laboratory and one at the Savannah River Site

Recommendation No. 2

The CNSC should clarify the scenarios in which in situ confinement will be considered an appropriate decommissioning strategy. Current international standards indicate that, short of an emergency scenario, this strategy should be limited to nuclear facilities that only contain short-lived or limited concentrations of long-lived radionuclides. The CNSC should provide clear definitions for what constitutes an "emergency scenario", "short-lived radionuclides", "limited concentrations" and "long-lived radionuclides" or any other criterion used to determine the viability of in situ confinement as a decommissioning strategy for nuclear facilities.

3. Submission of a Detailed Decommissioning Plan

GSR Part 6 requires that prior to decommissioning actions, a final decommissioning plan must be prepared and submitted to the regulatory body for approval.[84]

> The licensee shall inform the regulatory body (or the government, if so required) prior to shutting down a facility permanently. If a facility is permanently shut down and/or is no longer used for its intended purpose, a final decommissioning plan shall be submitted to the regulatory body for approval within a period agreed with the regulatory body (typically within two to five years of permanent shutdown).
>
> The final decommissioning plan and supporting documents shall cover the following: the selected decommissioning strategy; the schedule, type and sequence of decommissioning actions; the waste management strategy applied, including clearance, the proposed end state and how the licensee will demonstrate that the end state has been achieved; the storage and disposal of the waste from decommissioning; the timeframe for decommissioning; and financing for the completion of decommissioning.[85]

Class I Nuclear Facilities Regulations under the *NSCA* requires that an application for a licence to decommission a Class I nuclear facility must contain:[86]

[84] GSR Part 6, *supra*, note 2 at Requirement 11.
[85] *Ibid*. at 7.9-7.10.
[86] *Class I Nuclear Facilities Regulations*, *supra*, note 27, at s. 7.

(a) a description of and the proposed schedule for the decommissioning, including the proposed starting date and the expected completion date of the decommissioning and the rationale for the schedule;
(b) the nuclear substances, hazardous substances, land, buildings, structures, systems and equipment that will be affected by the decommissioning;
(c) the proposed measures, methods and procedures for carrying on the decommissioning;
(d) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;
(e) the nature and extent of any radioactive contamination at the nuclear facility;
(f) the effects on the environment and the health and safety of persons that may result from the decommissioning, and the measures that will be taken to prevent or mitigate those effects;
(g) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics;
(h) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;
(i) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security, including an emergency response plan;
(j) the proposed qualification requirements and training program for workers; and
(k) a description of the planned state of the site on completion of the decommissioning.

CSA N294-09 stipulates the contents of a final decommissioning plan must specify the detailed work program, safety and environmental protection procedures, and management systems to be followed during decommissioning.[87] Clause 7.8.2 provides a description of the specific inclusions in the final decommissioning plan based on the complexity of an NPP being decommissioned.[88] Despite the required level of detail, CSA N294-09 does not provide any requirement or guidance on when the Final Decommissioning plan is to be submitted.

The US Code of Federal Regulations 10 CFR 50.82(a)(4)(i),[89] in contrast, specifies that prior to or within 2 years following the permanent cessation of operations, the licensee must submit a Post-Shutdown Decommissioning Activities Report (PSDAR). The PSDAR will include a description of the planned decommissioning activities, with a schedule for the accomplishment of significant milestones and an estimate of expected costs. Further guidance on the format and

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[87] CSA N294-09, *supra* note 29, at 7.8.1.
[88] *Ibid*. at 7.8.2.
[89] Termination of License, 10 CFR 50.82, U.S. Nuclear Regulatory Commission, 2011.

content of the PSDAR is provided in Regulatory Guide 1.185, *Standard Format and Content for Post-Shutdown Decommissioning Activities Report*.[90]

Recommendation No. 3

While the Canadian regulations and standards meet international standards for the content of a final decommissioning plan, they fall short of providing a schedule for its submission. International requirements suggest that the Canadian regulatory framework should require that a final decommissioning plan is submitted for approval prior to or within two years of permanent shutdown.

4. Duration of Decommissioning

IAEA GSR Part 6 requires that the licensee meet the end state requirements stipulated in the final decommissioning plan and authorization for decommissioning before gaining approval for the termination of decommissioning and release of the site from regulatory control:[91]

> On the completion of decommissioning actions, the licensee shall demonstrate that the end state criteria as specified in the final decommissioning plan and any additional regulatory requirements have been met. The regulatory body shall verify compliance with the end state criteria and shall decide on termination of the authorization for decommissioning.
> …
> Inputs from the public shall be addressed before authorization for decommissioning is terminated.

CNSC's regulatory guide G-219 recommends that an end-state report should be submitted to the CNSC on completion of decommissioning:[92]

> This report should review the completed decommissioning process, noting any significant deviations from the detailed decommissioning plan. It should clearly document (using actual survey results) that the planned end-state conditions have been met and, if not, why not. The report should describe any proposed further licence requirements, or long-term institutional controls for the site.

CSA N294-09 requires that the final end state will only be considered reached and a facility

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[90] Standard Format and Content for Post-Shutdown Decommissioning Activities Report, Regulatory Guide 1.185, U.S. Nuclear Regulatory Commission, 2000. <online: http://pbadupws.nrc.gov/docs/ML0037/ML003701163.pdf>
[91] GSR Part 6, *supra*, note 2, at Requirement 15, 9.6.
[92] G-219, *supra* note 28, at 15.0.

released from regulator control once the planned decontamination, demolition, dismantling are completed, and all materials, wastes, equipment, and structures have been removed in accordance with the final decommissioning plan requirements.[93]

The US Code of Federal Regulations, 10 CFR 52.110(c) requires:

> Decommissioning will be completed within 60 years of permanent cessation of operations. Completion of decommissioning beyond 60 years will be approved by the Commission only when necessary to protect public health and safety. Factors that will be considered by the Commission in evaluating an alternative that provides for completion of decommissioning beyond 60 years of permanent cessation of operations include unavailability of waste disposal capacity and other site-specific factors affecting the licensee's capability to carry out decommissioning, including presence of other nuclear facilities at the site.

Recommendation No. 4

The Canadian regulatory framework does not provide guidance on the duration of NPP decommissioning. In the absence of a policy framework and robust regulatory regime, the best practices of other jurisdictions that provide the greatest protection for the safety and well-being of the environment and Canadians, both present and future, should be adopted. Approval for termination of decommissioning activities should not be granted unless:

1. The CNSC verifies that the licensee has demonstrated that the end state criteria as specified in the final decommissioning plan and any additional regulatory requirements have been met;
2. The end state criteria reflect the best available science and highest level of safety feasible for Canadians and the environment;
3. The public has been consulted before authorization for decommissioning is terminated, and the site of the nuclear facility is released from regulatory control.

Conclusion

Canadian standards set under the *Nuclear Safety and Control Act*, its regulations, and other guidance documents are general and currently, do not address all the relevant factors required or do not provide sufficient detail to guide the CNSC's review of a proposal to decommission a

[93] CSA N294-09, *supra* note 29, at 9.2.1.

nuclear facility. The CNSC should utilize the best practices of other countries and IAEA standards as a guide to assess decommissioning planning and develop a comprehensive decommissioning policy and regulatory framework to ensure a robust set of requirements that will adequately protect the health and well-being of the environment and Canadians, both present and future.

III. SUSTAINABILITY ANALYSIS

1. Introduction

CELA undertook a sustainability-based evaluation of the CNL's draft Environmental Impact Statement for the in-situ decommissioning of Whiteshell Reactor -1 (WR-1).[94] Our analysis rested in part on the purpose of the *Canadian Environmental Assessment Act, 2012* ("CEAA, 2012"),[95] as set out in sections 4(1)(b), (h), and (i):

> 4(1) The purposes of this Act are
> (b) to ensure that designated projects…are considered in a careful and precautionary manner to avoid significant adverse environmental effects;
> (h) to encourage federal authorities to take actions that promote sustainable development in order to achieve or maintain a healthy environment and a healthy economy; and
> (i) to encourage the study of the cumulative effects of physical activities in a region and the consideration of those study results in environmental assessments.

Our evaluation concentrated on the following essentials of incorporating appropriate attention to sustainable development concerns in environmental assessment (EA):

- Evaluation criteria and process (see Section 2),
- Consideration of trade-offs (see Section 2),
- Consideration of the precautionary principle and associated concepts (see Section 3), and
- Long-term monitoring (see Section 4).

In the following sections, we briefly describe the key deficiencies in CNL's EIS with respect to these sustainability matters. We end with a summary of our Information Requests, which would enhance CELA and the public's understanding of CNL's EIS in these regards (see Table 1).

2. CNL's Consideration of Sustainability

CELA's analysis was based on best practices in sustainability-based EA, which have been established by practitioners and scholars in the field (see Gibson, 2005; Gibson, 2017; Pope &

[94] Draft EIS, *supra* note 1
[95] *Canadian Environmental Assessment Act, 2012* (SC 2012, c 19 s 52)

Grace, 2006). In previous EIS public comment processes for proposed nuclear waste management projects, we provided in-depth explanations of how proponents should fulfill their obligations under CEAA in this regard (e.g., Markvart, 2014). In the following sub-sections, we highlight some key areas where CNL failed to adequately consider sustainability concerns in the WR-1 EIS.

2.1 CNL's Evaluation Criteria and Process

Gibson (2005) provides a comprehensive set of sustainability criteria for application in EA. They are rooted in a fundamental concern for the interconnections and interdependencies within and between human and biophysical systems and present and future generations, especially effects on inter- and intragenerational equity, ecological system integrity, and governance capacity. In addition, Gibson explains the process by which sustainability considerations should be incorporated throughout the EA process to select and evaluate the best option.

An adequate consideration of sustainability in EA should demonstrate that:

- The preferred option emerged from a comparative evaluation of options in light of their relative contributions to sustainability;
- Further evaluation of the preferred option explicitly incorporated sustainability concerns throughout; and
- Sustainability considerations influenced the design of the preferred option.

The proponent must clearly demonstrate that the preferred option would contribute social, economic, and environmental benefits to society while avoiding significant adverse effects.

CNL defined and used four criteria (safety, technical feasibility, economic feasibility, and environmental effects) in the evaluation of alternative means. But CNL did not discuss the relative contributions of the alternative means to sustainability. Nor did CNL explain the process by which it incorporated sustainability concerns in its evaluations. A clear demonstration to the public that the in-situ decommissioning option is the best option in light of contributions to sustainability requires the following additional information:

- A description of the sustainability-based criteria that CNL adopted to evaluate and compare the alternative means;
- A description of how the four criteria (safety, technical feasibility, economic feasibility, and environmental effects) that CNL used to evaluate and compare the alternative means constitute relevant sustainability considerations;

- A description of the process by which CNL incorporated consideration for net sustainability contributions in the alternative means assessment; and
- A description of the relative contributions to sustainability of the alternative means.

In Section 2.4 of the EIS, CNL presented CNL project design principles, design principles from external sources, and CNSC licensing requirements, asserting that the alternative means considered in the assessment must meet these essential design elements. But CNL did not show how these principles and requirements influenced the analysis and conclusions. The public must have a clear understanding of:

- How these essential design elements constitute relevant sustainability considerations, and
- How they were integrated in a comparative evaluation of the alternative means leading up to the selection of the preferred option.

In addition, CNL did not show how sustainability concerns influenced all components of the assessment of the preferred option, including the following analyses: environmental effects, accidents and malfunctions, cumulative effects, residual effects analysis, and effects of the environment on the project. The public must have a clear understanding of:

- How the results of these analyses influence the project's contributions to sustainability over the long term.

2.2 CNL's Consideration of Trade-Offs

One key aspect of evaluating and comparing alternatives in light of sustainability contributions is the consideration of trade-offs among the options. Gibson (2005, 2013) and others (see Morrison-Saunders & Pope, 2013) provide an in-depth explanation of trade-offs and guidelines for dealing with them in EA decision making. As Gibson (2013) explains, substantive trade-offs

> …involve choices about what purposes to serve, what alternatives to favour, what design features to incorporate, what enhancements and mitigations to consider adequate and what undertakings to approve with what conditions and implementation controls, etc. Most significantly, substantive trade-offs are about the anticipated effects resulting from these choices. They centre on what predicted damages and risks are accepted as the price to pay for what expected benefits (p.2).

CNL's 'Summary of the Evaluation of Alternatives' (Table 2.7-1) reveals important unaddressed trade-offs among the alternative means with respect to short-term versus long-term impacts as well trade-offs among worker safety versus the safety of people and the environment. For example, according to CNL's analysis, the in-situ decommissioning option would be the most favourable option in terms of worker safety during the decommissioning phase; however, it would be the least favourable option with respect to long-term impacts on groundwater quality, surface water quality, and aquatic biodiversity. It is unclear from the CNL's analysis how it weighed the safety of people and the environment, both present and future, against worker exposure and dose limits.

CNL did not explain how its evaluation of alternatives gave appropriate weight to different types of impacts. Rather, CNL used a simple gradient evaluation framework (i.e., the 'reason narrative approach') with 'most favourable' at the highest end, 'favorable' in the middle or neutral point, and 'least favorable' at the lowest end. This framework clearly did not capture the complexities in the decisions that must be made in alternative means assessment. Indeed, CNL simply identified the most desirable option by determining which option received the greatest number of 'most favourable' scores.

CELA also submits that the criteria used to rank the alternatives is problematic as it is inconsistent with existing CNSC and licensee assertions pertaining to public safety. For instance, the draft EIS states that alternative 2 would require the greatest number of offsite waste transfers from the Whiteshell site to the disposal facility, and thus was 'least favourable' because of the "increased incremental risk of a vehicle to vehicle accident."[96] This statement contrasts the assurances made by the CNSC and nuclear proponents, who provide that the transport of nuclear waste or nuclear substances does not pose a serious risk to the public.[97] Therefore, CELA submits that in order to set a sound basis for the selection of the in-situ decommissioning alternative as the preferred option, CNL must identify and discuss trade-offs in its comparative evaluation of alternative means.

3. CNL's Consideration of the Precautionary Principle

The purpose of CEAA 2012, to ensure that designated projects are considered in a careful and precautionary manner, applies to all aspects of the assessment process. One overarching concept that should be central to a precautionary approach in nuclear waste management is 'adaptive management capacity', which was incorporated in previous EIS Guidelines for the

[96] Draft EIS, *supra* note 2, p 2-28

[97] *See for instance:* http://nuclearsafety.gc.ca/eng/waste/faq/transport-of-used-nuclear-fuel/index.cfm and https://www.opg.com/generating-power/nuclear/nuclear-waste-management/Pages/transportation.aspx

preparation of OPG's EIS for the Deep Geologic Repository project for low- and intermediate-level radioactive waste. The concept of adaptive management has been widely adopted in energy and natural resource management sectors as an iterative approach to management in the face of:

- Scientific uncertainty and human error;
- Technological innovations and/or advances in scientific understanding;
- New technical or scientific information regarding the design and operation of a project;
- Changes in social and political opinion;
- Changes in policy and regulatory frameworks, including safety standards; and
- Unforeseen events (including natural disasters, malfunctions, accidents and malevolent acts).

Associated design concepts that may increase the level of adaptive management capacity in nuclear waste management facilities include reversibility, retrievability, diversity and redundancy (see OECD, 2001, 2012).

Reversibility is the possibility of reversing one or a series of decisions taken during the lifetime of a nuclear waste management project. Reversal is the actual action of changing a previous decision. The associated implication for design include making provisions for reversal should it be required. Retrievability denotes the action of recovery of the waste, which enhances the reversibility of decisions by providing an additional degree of flexibility.

Diversity and redundancy are major sources of adaptive management capacity (see Walker & Salt, 2006). The diversity requirement seeks to ensure that decision makers evaluate and compare a range of different alternatives that could achieve the same objective. If the preferred option fails there should be sufficient knowledge about other options to make adaptation feasible. The concept of redundancy is central to enhancing the safety and reliability of complex technologies. An element of a system is redundant if there are backups to do its work if it fails.

Clearly, CNL considered adaptive management in the design of its monitoring program. It is unclear, however, how the notion of adaptive management capacity influenced CNL's evaluation of alternative means and its assessment of the preferred in-situ decommissioning option. It is in the public's best interest to have a good understanding of how CNL incorporated and operationalized the concept of adaptive management capacity throughout the EIS as it is critical to the long-term safety of the proposed project.

4. CNL's Long-Term Monitoring Plans

CNL states that monitoring and follow-up programs will be carried out throughout all phases of the Project, including the closure phase (2019 to 2024) and the post-closure phase (2024 and into the future indefinitely). As CNL explains, the post-closure phase has two discrete periods: (1) institutional control and (2) post-institutional control. During the post-institutional control stage, passive (e.g., restricted access to the site) versus active controls will be in place.

It is important to note that CNL's monitoring plans for groundwater and surface water quality do not extend into the post-institutional control stage. This is a significant omission because the in-situ decommissioning option will impact groundwater and surface water quality over the lifetime of the project. Indeed, future generations will bear the costs and impacts of the project on water quality for hundreds of years to come. CNL therefore must provide a rationale for discontinuing active controls for groundwater and surface water quality monitoring during the post-institutional control stage.

Moreover, at this juncture in the EA process CNL has an opportunity to incorporate the concept of 'rolling stewardship' in planning for the long-term monitoring and safety of the in-situ decommissioning project. As the Canadian Coalition for Nuclear Responsibility explains, rolling stewardship involves:

- Plans for the accurate transmission of information from one generation to the next;
- Plans for the transfer of responsibility from one generation to the next, e.g., a 'changing of the guard' every 20 years;
- Plans for the recharacterization of the waste when necessary;
- Plans to rapidly detect and correct any leakages or other problems;
- Plans for the retrieval of waste as appropriate; and
- Plans for continual adaptive management and monitoring.

In Section 5 below we provide a summary of the major deficiencies that we identified with respect to the above described components of CNL's EIS. We end with a table that presents our associated Information Requests.

5. Summary of Deficiencies and Information Requests

CNL defined and used four criteria to evaluate the alternative means. But CNL did not incorporate the following sustainability considerations in its evaluation:

- An explanation of how the four evaluation criteria constitute relevant sustainability concerns.
- A description of the sustainability-based criteria that were used evaluate and compare the alternative means.
- An explanation of the relative contributions of the alternative means to sustainability.
- An explanation of the process by which it incorporated sustainability concerns in its evaluations.
- A clear demonstration of how sustainability concerns influenced all components of the assessment of the preferred option.

CNL set out other principles and CNSC licensing requirements, asserting that the alternative means must meet these essential design elements. But, CNL did not show how these principles and requirements influenced the analysis and conclusions.

CNL's 'Summary of the Evaluation of Alternatives' (Table 2.7-1) revealed important unaddressed trade-offs with respect to short-term versus long-term impacts as well as different types of impacts. Critical questions remain about the trade-offs among the options with respect to short-term safety impacts during decommissioning and impacts on groundwater quality, surface water quality, and aquatic biodiversity during the long-term, post-closure stage.

CNL considered adaptive management in the design of its monitoring program. It is unclear, however, how the notion of adaptive management capacity and associated concepts influenced CNL's evaluation of alternative means as well as its assessment of the preferred option.

CNL's monitoring plans for groundwater and surface water quality do not extend into the post-institutional control stage of post-closure. This is a significant omission because the in-situ decommissioning option will impact groundwater and surface water quality over the lifetime of the project. CNL must provide a rationale for discontinuing active controls for groundwater and surface water quality monitoring during the post-institutional control stage. At this juncture in the EA process CNL has an opportunity to incorporate the concept of 'rolling stewardship' in planning for the long-term monitoring and safety of the project.

To clearly demonstrate to the public that the in-situ decommissioning option is the best option, CNL must respond to the following Information Requests.

Table 1. Information Requests

IR#	Information Request
#1	Provide a description of the sustainability-based criteria that were used to evaluate and compare the alternative means as well as the preferred option.
#2	Describe how the four evaluation criteria (safety, technical feasibility, economic feasibility, and environmental effects), CNL design principles, principles from external sources, and CNSC licensing requirements constitute relevant sustainability considerations.
#3	Provide a comparative evaluation of the alternative means in terms of their relative contributions to sustainability.
#4	Provide a description of the process by which consideration for sustainability was incorporated throughout the assessment and design of the preferred option.
#5	Describe and demonstrate how trade offs were considered in the comparative evaluation of alternative means.
#6	Explain how short-term versus long-term impacts were weighted in the comparative evaluation of alternative means.
#7	Describe how reversibility, retrievability, diversity, and redundancy were incorporated in (a) the comparative evaluation of alternative means and (b) the design and assessment of the preferred in-situ decommissioning option.
#8	Provide in-depth plans for the long-term monitoring of the in-situ decommissioning project during the post-institutional control phase.
#9	Provide a rationale for discontinuing active controls for groundwater and surface water quality monitoring during the post-institutional control stage of post-closure.
#10	Describe how the concept of rolling stewardship will be applied in all phases of monitoring for the project.

IV. HUMAN HEALTH, THE ENVIRONMENT AND SAFETY

This chapter will discuss the deficiencies and omissions contained in CNL's draft EIS as it relates to human health and safety matters.

1. Technical Issues

1.1 Very Long-Lived Radionuclides

The proposed in situ decommissioning (ISD) of WR-1 would result in the subsurface reactor systems, components, structures and their associated hazards - along with the below-grade reactor- being permanently buried, and encased with grout, with an engineered cover constructed on top. CNL's "Environmental Assessment" dated April 2016 provides the following description of the project:

> Following In-Situ Decommissioning, institutional controls and surveillance activities will be required to monitor environmental performance of the <u>entombed</u> material at the WL site [emphasis added][98]

Based on this description, it is evident that in situ decommissioning means entombment and final disposal. Therefore, CNL is proposing to entomb in perpetuity, radionuclides at the Whitshell site which:

> (a) are highly radiotoxic (ie. dangerous to humans and the environment);
> (b) exist in high concentrations;
> (c) have very long radiological half-lives (ie. they will exist for hundreds of thousands of years); and
> (d) in the case of the most prevalent nuclide, tritium, exist in such large quantities that it will take at least 40 half-lives (ie. ~500 years), to decay to acceptable levels (as discussed below).

The diagram below indicates the radioactivity of the long-lived radionuclides in the proposed disposal and the extreme timescale (ie. over a million years) in which they persist.

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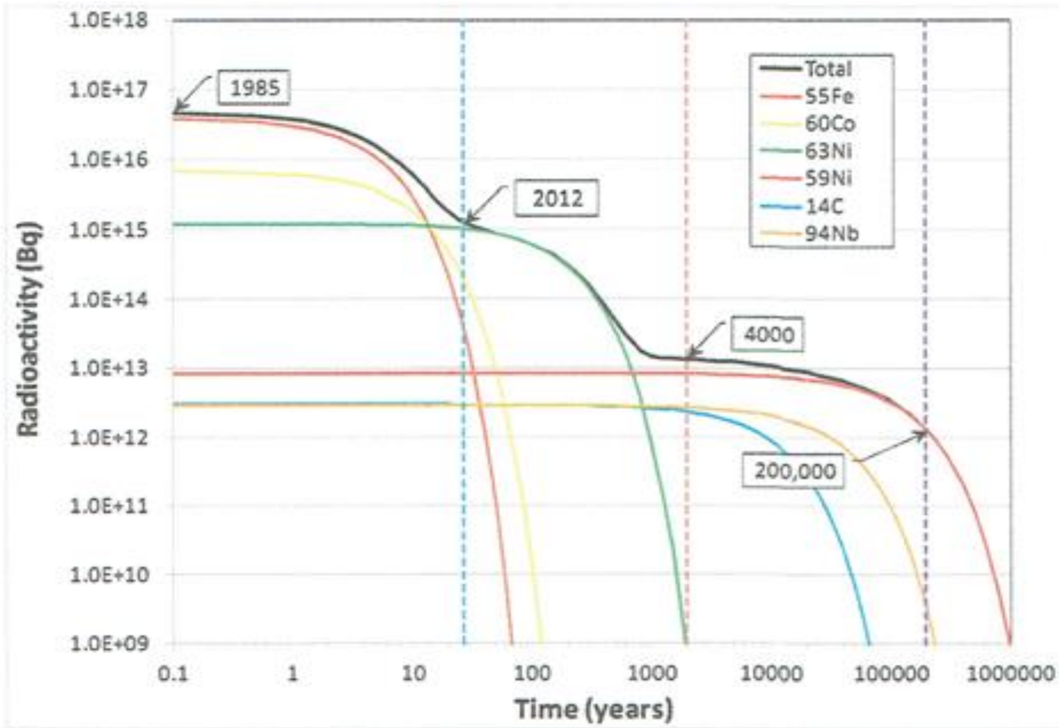
[98] Canadian Nuclear Laboratories, "Environmental Assessment – In Situ Decommissioning of the WR-1 Reactor at the Whiteshell Laboratories Site" (4 April 2016, Revision 0) WLDP-03700-ENA-001



Source: Letter dated 3 July 2016 from Baumgartner *et al* (2016) to CNSC

The very long-lived nature of these radionuclides necessitates that considerable attention be devoted to the form, and nature of their disposal. Unfortunately, the draft EIS and its supporting documents attribute little safety significance to the long-lived nature of these radionuclides. In addition, it omits serious discussion of the radionuclide, tritium (^3H), with the highest concentration (5.54E+17 Bq). Although tritium has a relatively short half-life of 12.3 years, because of its large inventory at the site, significant amounts would remain after 100 or even 300 years.

1.2 Entombment is an unacceptable means of decommissioning

As stated above, in situ decommissioning (ISD) means that subsurface reactor systems and their hazards will be permanently buried along with the below ground reactor and filled with grout. These precepts have been considered by CNSC. For instance, in response to a question on the project's description from a member of the public who asked, "Is entombment disposal," the CNSC responded, "CNSC staff understand that in situ decommissioning means entombment or in situ disposal as defined in CNSC REGDOC G-219 and CSA N294".[99]

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[99] CNSC, "Disposition Table of Public and Aboriginal Groups' Comments on Project Description – In Situ Decommissioning of Whiteshell Reaction #1 Project" e-Doc 5036069, online: http://www.ceaa-acee.gc.ca/050/documents/p80124/118863E.pdf, p 8]

Currently, Canada lacks any legislation, policy or standard with respect to the entombment of radioactive wastes. Therefore, the question arises whether entombment is an acceptable Canadian disposal strategy for nuclear reactors. Despite the paucity of Canadian content or legal standards on the subject, international standards do exist. For example, an IAEA (2007) report states:

> Section 3.2.3 Entombment is not relevant for a facility that contains long-lived isotopes because these materials are not suitable for long-term surface disposal.[100]

While this IAEA guidance did not address nuclear reactors, a more recent IAEA document (2014) states that entombment is not recommended for permanently shut down reactors. It states:

> Section 1.10**….** Entombment, in which all or part of the facility is encased in a structurally long lived material, is not considered a decommissioning strategy and is not an option in the case of planned permanent shutdown. It may be considered a solution only under exceptional circumstances (e.g. following a severe accident). [101]

As reviewed in Sections II and III of this report, the IAEA does not recognize entombment or in-situ confinement as a decommissioning strategy and yet, the CNSC has already signalled that it will give consideration to international guidance and best practice, as provided by the CNSC in already held public consultations:

> Yes, the document referenced, IAEA GSR 6, indicates that entombment is not recognized internationally, in principle, as a preferred decommissioning strategy (entombment may be considered a solution only under exceptional circumstances, such as following a severe accident).
>
> The IAEA is currently working on a document to provide guidance with respect to their position on entombment in situ decommissioning the applicability of entombment in the context of decommissioning and in particular, the regulatory requirements and expectations for applying entombment as a decommissioning option strategy.
>
> There is no scheduled date for the publication of this document; however, CNSC staff will keep apprised of its development to inform this EA and licensing review process.

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[100] IAEA (2007) "Decommissioning Strategies For Facilities Using Radioactive Material" Safety Report Series #50, IAEA, Vienna

[101] IAEA (2014) Decommissioning of Facilities. General Safety Requirements Part 6 , IAEA, Vienna, online: http://www-pub.iaea.org/MTC D/publications/PDF/Pub1652web- 83896570.pdf

> Irrespective of the IAEA guidance document, under the CNSC's regulatory framework, applicants are responsible for selecting and justifying their proposed decommissioning strategy. Consideration will be given to international guidance and best practice [emphasis added].[102]

Recommendation No. 5

The Government of Canada should develop publicly acceptable policies and strategies for managing long-lived Intermediate-Level Waste that reflects international best practices and have been developed in consultation with Indigenous peoples and the Canadian public. This should include, as a prerequisite, the development of a national classification scheme for radioactive waste that is publicly acceptable and consistent with IAEA guidance.

1.3 Very Large Quantities of Radionuclides

Table 1 below illustrates the high quantities of radionuclides still inside the Whiteshell reactor, despite it being over 30 years since its shutdown in 1985. Table 1 measures the amount in becquerels (Bq) as this is the unit for radioactive decay (ie. one nuclear disintegration occurs every second).

Table 1: Estimated Radionuclide Inventory in 2015

A. Reactor Core in Bq (Main nuclides)		
Radionuclide	**Half-life (years)**	**Amount (Bq)**
Ni-63	100	9.58E+14
Co-60	5.3	1.39E+14
Fe-55	2.7	1.77E+13
Ni-59	76,000	8.30E+12
C-14	5,730	3.00E+12
Nb-94	20,300	3.00E+12
subtotal		**1.13E+15**[103]
B. Primary Heat Transport System (Main nuclides)		
Radionuclide	**Half-life (years)**	**Amount (Bq)**

[102] CNSC, "Disposition Table of Public and Aboriginal Groups' Comments on Project Description – Nuclear Power Demonstration Closure Project" e-Doc 5029383, <online: http://www.ceaa-acee.gc.ca/050/documents/p80121/118857E.pdf> p 19

[103] The subtotal of 1.13 x 10^{15} for the reactor core is similar to the estimate of 1.16 x 10^{15} Bq quoted for 2015 in CNL (2016a) table 15. WR1 CNL Technical Document WR-1 Reactor Radiological Characterization Summary - WLDP-26100-041-000-0001 Rev. 0(1).

Cs-137	30.1	4.80E+11
Sr-90	28.8	3.10E+11
Pu-241	434	2.00E+11
Am-241	7,388	2.10E+10
Pu-240	14.3	8.70E+09
Pu-239	6,564	6.10E+09
Eu-154	8.6	3.90E+09
Pu-238	24,131	2.50E+09
Eu-155	4.8	4.80E+08
Co-60	5.3	2.43E+08
Cm-244	18.1	2.10E+08
Tc-99	209,000	1.30E+08
Am-243	0.45	1.90E+07
Np-239	0.0065	1.90E+07
Np-237	2,150,000	1.10E+06
I-129	15,700,000	2.80E+05
subtotal		**1.02 E+12**[104]
C. Biological Shield (Main nuclides)		
Radionuclide	**Half-life (years)**	**Amount (Bq)**
Co-60	5.3	4.02E+09
Eu-152	13.5	7.16E+08
Ni-63	100	5.83E+08
Ca-41	100,000	1.40E+08
C-14	5,730	6.20E+07
Cl-36	300,000	4.20E+03
subtotal		**5.52+09**

Data Source: WLDP-26000-REPT-006, EcoMetrix Ref:16-2292.3 August 2017

The main reason for these surprisingly large amounts at the Whiteshell site is that "there were approximately 150 documented fuel failures in the reactor between 1966 and 1983."[105] These fuel failures heavily contaminated the reactor and its component structures (the nuclear fuel was removed in the 1990s). Even though more than 30 years have elapsed since the closure of WR-1 in 1985, the site remains highly contaminated due to the longevity of these radionuclides.

[104] However, CNL's Safety Analysis Report para 4.3.3.1.2 on Systems and Components states "the total radionuclide inventory inside the process equipment is estimated at 1.3E+13 Bq, decay corrected to 2012" ie about 10 times more. The reason for this discrepancy is unknown.

[105] See para 5.3.1.1.1 of Safety Analysis Report. CNL (2017a).

1.4 The radioactive wastes at Whiteshell constitute Intermediate-Level Waste (ILW)

Intermediate-Level Waste **(**ILW) is defined by CNSC as waste "that contains long-lived radionuclides in concentrations that require isolation and containment for periods beyond several hundred years."[106]

The Canadian Standards Association (CSA, 2014) standard N292.0-14 contains an approximate boundary for radioactivity concentrations in ILW and LLW. Its Annex 5 recommends limiting the amount of long-lived beta and/or gamma-emitting radionuclides (specifically including C-14, Cl-36, Ni-63, Zr-93, and Nb-94) in LLW to "an average of up to tens of kBq/g". In other words, concentrations above this level (~E+04 Bq/g) constitute ILW.

In more detail, Annex 5 of the CSA's standard N292.0-14 provides that the numerical limits for LLW and ILW are for orientation purposes and not rigid limits, as acceptable concentrations will differ between individual radionuclides or groups of radionuclides. However, as Table 2 below illustrates, individual concentrations of radionuclides (ie. not an average in a mixture) in nearly every case (except one, Cl-36) exceed this CSA standard. Accordingly, they are considered to constitute ILW. As such, these radionuclides require a more rigorous containment and isolation than provided in near-surface facilities, such as that proposed for the ISD at Whiteshell.

Recently CNL was required by CNSC to stipulate that ILW would not be disposed of in its proposed near-surface facility at Chalk River. Exactly the same logic applies to these proposals at Whiteshell. In other words, the high concentrations of long-lived nuclides at Whiteshell constitute ILW and should not be disposed of in the proposed entombment which is also a near-surface facility.

1.5 Failure to meet CNSC Unconditional Clearance Criteria

Section 26 of the *Nuclear Safety and Control Act* provides no person shall "decommission or abandon a nuclear facility" except in accordance with a licence. CNL could presumably seek a licence to decommission or abandon the Whiteshell nuclear facility at the end of its proposed "active institutional control period" (ie. 100 years from now). The draft EIS states that CNL "plans to turn over the WR site to institutional control in 2024, and this is control is assumed to last for 300 years, with active controls (eg, groundwater monitoring and site inspection) only required for the first 100 years."[107] Despite the ambiguous wording, it appears that CNL is

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[106] CNSC, "Low- and intermediate-level radioactive waste," online: http://nuclearsafety.gc.ca/eng/waste/low-and-intermediate-waste/index.cfm#intermediate-level

[107] Draft EIS, *supra* note 1, p 1-11.

proposing that active institutional control will end in 100 years' time, ie. in 2124.

CNSC Guide G-320 contains provisions which apply to such future time frames.[108] The regulatory guide states "the predicted impact on the health and safety of persons and the environment from the management of radioactive waste {must be} no greater than the impacts that are permissible in Canada at the time of the regulatory decision" [emphases added].[109]

This means that at the time of the granting of any licence for the decommissioning or abandonment of a nuclear facility, the CNSC must consider whether the predicted (future) residual radioactivity in the grouted reactor site would meet the CNSC's current Unconditional Clearance Criteria for radionuclides, as set out in the CNSC's "Radionuclide Information Booklet."[110]

Therefore, the predicted nuclide concentrations in 100 years' time (ie. as reduced via decay) should have been calculated by CNL, but as far as can be ascertained, this has not occurred. These calculations have instead been carried out by CELA and provided in Table 2, below.

Table 2: Radioactivity Remaining after 100 years (end of active Institutional Control)
As estimated by Dr I. Fairlie

Radionuclide	Half-life (Years)	Current Activity (Bq)	Activity Remaining after 100y (Bq)	Concentration after 100 y (Bq/g) *	CNSC Unconditional Clearance Level (Bq/g)	in excess
H-3	12.3	5.54E+17	2.00E+15	2.27E+06	100	✘
Ni-63	100	9.58E+14	4.79E+14	0.54E+06	100	✘
Co-60	5.27	1.39E+14	2.70E-04	0.61E-12	0.1	
Fe-55	2.73	1.77E+13	0.164	1.8E-10	1	
Ni-59	76,000	8.30E+12	8.29E+12	9.4E+03	100	✘
C-14	5,730	3.00 E+12	2.96E+12	3.36E+03	1	✘
Nb-94	20,300	3.00E+12	2.99E+12	3.37E+03	0.1	✘
Pu-239	24,400	6.36E+09	6.34E+09	7.2	0.1	✘
Ca-41	103,000	1.40E+08	1.40E+08	0.16	1	

[108] 2007 Ref CNSC (2006) Regulatory Guide G–320. Assessing The Long Term Safety Of Radioactive Waste Management
[109] *Ibid*, Section 7.4, Assessment Time Frames, CNSC Regulatory Guide, G-320, page 24.
[110] Canadian Nuclear Safety Commission, "Radionuclide Information Booklet" (February 2017), online: http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/Radionuclide-Information-Booklet-2016-eng.pdf

Tc-99	211,000	1.30E+08	1.30E+08	0.15	1	
U-238	4.5E+09	1.22E+07	1.22E+07	0.013	1	
U-234	245,000	1.22E+07	1.22E+07	0.013	1	
Np-237	2,140,000	6.70E+06	6.70E+06	7.6E-03	1	
U-235	703,000,000	1.60E+06	1.60E+06	1.8E-03	1	
I-129	15,700,000	2.80E+05	2.80E+05	3.2E-04	0.01	
Cl-36	301,000	4.20E+03	4.20E+03	4.8E-06	1	

*****mass of WR-1 unit = 8.80E+08 g

NB: Calculations in the shaded columns were calculated by Dr. Ian Fairlie

Data Source: WLDP-26000-REPT-006, EcoMetrix Ref:16-2292.3 August 2017; CNSC, Radionuclide Information Booklet (2016)

Table 2 illustrates that in six instances (H-3, Ni-63, Ni-59, C-14, Nb-94 and Pu-239) the future predicted nuclide concentrations still exceed CNSC's current unconditional clearance criteria. This exceedance results from the very long half-lives of these nuclides. Thus, they will undergo little decay in 100 years, or even 300 years, before abandonment. Based on the current data, we do not recommend advancing the proposed abandonment/ decommissioning of the nuclear facility.

1.6 Tritium is the most significant radionuclide at Whiteshell

The above information has largely excluded discussion of tritium, ^{3}H, the radioactive isotope of hydrogen. But tritium is, by some margin, the most significant nuclide at WR-1. This is due to its remaining very large inventory, its high current annual releases, and its high estimated release rates during the proposed entombment.

As far as can be ascertained, tritium's inventory at the Whiteshell site is not disclosed in any of the CNL documents. However, an estimate can be derived from information contained in its reports. Para 5.3.1.1.3 of CNL's Safety Assessment Report (CNL, 2017a) states that a tritium concentration of "630 GBq/kg now remains in the WR-1 Building". This tritium concentration appears to be derived by dividing the tritium Bq inventory in the unit by the mass of the unit. CNL has stated (CNL, 2017a) that although much tritium is expected to reside within the unit's helium and heavy water system, it also remains widely distributed throughout the reactor and all component systems, including its steel and concrete structures.

With a reported total mass of 880,000 kg in the WR-1 unit (CNL, 2017a) it can be simply calculated that 554,000,000,000,000,000 becquerels (5.54E+17 Bq) of tritium remains in the unit, ie. an extremely large quantity of tritium. In fact, the amount of tritium in WR-1 is about 500 times greater than all other radionuclides in the unit added together (see Table 3 below).

Table 3: Tritium Inventory 30 years after shutdown in 1985 (Bq**)**
As estimated by Dr I. Fairlie

Radionuclide	**Bq**	**Factor**
H-3	5.54E+17	490
All other radionuclides summed	1.13E+15	1

This high estimated concentration for tritium is consistent with, and indeed explains, the unusually high amount of 61 GBq of tritium still released annually from Whiteshell, even 30 years after shutdown (see Table 4 below).

1.7 Continued Tritium Releases

Indeed, it is a matter of concern that more than 30 years after the WR-1 reactor stopped operating, significant tritium releases to air and water are still occurring. The EIS reports that 61 GBq of tritium are still released annually from Whiteshell to air.[111]

These tritium releases are not declining, and if anything have been slightly increasing over the past 5 years. This remains unexplained in the draft EIS. It confirms the very large current inventory at Whiteshell of 5.54E+17 Bq which CELA's report has estimated.

1.8 Nuclide Release Rates during Proposed Entombment Activities

(a) Tritium

CNL has stated (CNL, 2017a) that tritium (HTO) will be released during the majority of the closure activities at a rate similar to the average tritium release rates from the WR-1 Building between 2011 and 2015. The five-year average release rate for tritium was 1.18E+09 Bq/week or 61.4 GBq per year.

The maximum weekly tritium release rate observed during "couponing" (thought to be steel cutting) activities was approximately 1.28E+10 Bq/week (66.6 GBq per year). CNL has stated (CNL, 2017a) it is appropriate to use this figure as an expected release rate during grouting activities in the closure period. This high rate is due to vibration and heating of the surfaces

[111] *See* Table 3-12: Summary of Atmospheric Tritium Release Rates from WR-1 from 2011 to 2015 in WLDP-26000-REPT-006

experienced during grouting. These estimates are shown in Table 4, below

Table 4: Predicted Average Tritium Release Rates During Demolition and Grouting

Closure Activity	Average Release Rate E+10 Bq/week	Average Release Rate GBq
Normal annual releases	0.118*	61.4 over 12 months
Demolition prior to grouting	0.115**	59.8 for 6 months
During grouting	1.28**	666 over 12 months
Totals	1.513	787 over 18 months

NB: Calculations in the shaded columns were calculated by Dr. I Fairlie

* CNl stated that normal (ie. as in the past) releases will continue during closure

** CNL estimate - CNL estimates demolition will take only 6 months

Data Source: Weekly data from EcoMetrix (2017)

(b) Other Radionuclides

Table 5 below indicates the Bq amounts of other radionuclides which will released to air during the six-month demolition and one-year grouting phase.

Table 5: Estimated Radionuclide Release Rate from Primary Heat Transport System during 6 month* Demolition

Nuclide	Average release rate Bq/sec (PM_{10})	Amount released in 6 months** GBq
Cs-137	46.8	0.74
Sr-90	30.2	0.48
Pu-241	19.5	0.32
Am-241	2.05	0.032
Pu-240	0.849	0.013
Pu-239	0.595	0.009
Pu-238	0.244	0.004
Totals	**100 Bq/sec**	**1.6 GBq**

*CNL estimate for time needed to demolish primary heat transport system

**CNL estimate for time needed to grout the unit

Estimated Radionuclide Release Rate from Reactor Core during One-Year's Grouting

Ni-63	1.4E+01	0.441
Co-60	2.0E+00	0.063
Fe-55	2.6E-01	0.0082

Ni-59	1.2E-01	0.0038
Nb-94	4.4E-02	0.0014
C-14	4.3E-02	0.0013
Totals	**1.64E+01**	**0.52 GBq**

Data Source: EcoMetrix (2017)

As previously indicated, Table 4 illustrates that 787 GBq of tritium will be released over the estimated 18 months of demolition and grouting. This is a very large tritium release similar in scale to the average annual amount released by US BWR nuclear reactors. Similarly, Table 5 indicates that an additional 2 GBq of radioactivity from other nuclides will also be released during demolition and grouting. This is a very large release similar in scale to the average annual amounts of these nuclides released by US BWR nuclear reactors.

Recommendation No. 6

These high emissions to air (about 800 GBq) mean that radiation exposures to workers and farmers living nearby will be increased during entombment activities, with approximately 10 years' worth of normal tritium emissions would be emitted in an 18-month period. CELA recommends that the tritium emissions from the alternative scenarios should have been estimated and compared.

1.9 Drinking Water Limits for Tritium

At various points, the draft EIS refers to Health Canada's "safety" limit for tritium in drinking water of 7,000 Bq per litre. This limit which was set in 1994 is outdated compared with the safer limits now used by other agencies (see Table 6 below).

Table 6: Tritium Limits in drinking water

Agency	**Tritium Limit in drinking water** Bq per litre
Canada Health	7,000
US EPA*	740
European Union**	100
Ontario Government's ODWAC in 2009	20
Ontario Government's ACES in 1994	20
US State of Colorado (recommendation)	18
US State of California (advisory)	15

*EPA (1999) **European Commission (1998)

Canada's current federal limit for tritium in drinking water is 7,000 Bq//L. This is out of date and unsafe when compared to the limits set by the European Commission and the US EPA. The current US limit[112] is 740 Bq/l, based on a maximum dose to the public of 40 µSv per year from drinking water. The European Commission's limit is 100 Bq per litre.

The State of Colorado in the US has set a stricter standard for tritium in surface water of 18.5 Bq/l. [113] For example, the US Department of Energy specified the Colorado state action level for tritium in surface water in its clean-up program at the Rocky Flats plutonium plant in Colorado. The US state of California uses a limit of 15 Bq/L. [114] Both of these limits are based on a one-in-a-million lifetime risk of a fatal cancer, which is the cleanup goal under the US Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as the 'Superfund.'

On the other hand, the Health Canada limit for tritium corresponds to a risk of 350 excess fatal cancers per million people. Indeed, Health Canada's drinking water objective for **chemicals** also only allow a lifetime risk of 1 excess fatal cancer per million people. The primary reason for the difference is that the excess cancers predicted from radiation exposure are calculated assuming only *one year's* consumption of drinking water: the lifetime risk is calculated as if that year were the only consumption. With chemicals, it is assumed that people consume drinking water for their whole lifetime—commonly set at 70-years.

1.10 Problems with Tritium's Dosimetry

Many scientists have expressed concern about tritium's low dose factors and its radiotoxicity: indeed, demurring views about tritium's official doses have existed for decades.[115]

Official dose models for tritium are deficient, for the following reasons:

1. Tritium's unusual properties of extreme mobility, exchangeability, and binding with organic matter are not recognised.
2. Because of the short range of tritium's beta particle, tritium's damage depends on its location in the body. At present, it is not possible to model where tritium goes in the body with accuracy. Official models assume that tritium (HTO) is equally distributed throughout the whole body, thus lowering its concentration and dangers, but this is a

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[112] 20,000 picocuries per litre.
[113] 500 picocuries per litre.
[114] 400 picocuries per liter.
[115] *See* Fairlie, 2007; AGIR, 2007, Makhijani et al, 2006, and CERRIE, 2004

profoundly unconservative assumption.

3. Tritium is often described as a “weak” beta-emitter, but in radiation biology, so-called “weak” beta particles are more effective (ie. dangerous) than energetic ones. This is especially the case with tritium, but this is not acknowledged in setting its dose factor. In fact, much evidence indicates that tritium’s RBE (in radiation biology experiments comparing tritium with gamma rays) is two or three times that recognised by the ICRP (Fairlie, 2007).
4. Little official recognition is given to tritium’s ability to incorporate in organic molecules to high levels as a result of chronic environmental exposures. Official dose models for OBT therefore significantly underestimate its doses.

None of these concerns are acknowledged in CNL’s draft EIS. Instead, para 5.3.1.1.3 of the Safety Assessment Report incorrectly states “Tritium …delivers a whole body dose because it will get distributed throughout the whole body”.[116] A significant fraction of tritium intake in fact is metabolised to organically bound tritium and thus is heterogeneously distributed. Tritium ingested as OBT is not homogenously distributed throughout the entire body.

2. Hydrogeology

2.1 Hydrogeological Considerations

The location of the Whiteshell facilities was originally chosen for reasons other than its suitability as a waste disposal site. Ground conditions at the WL site are highly inappropriate for ILW radwaste disposal. All shallow groundwater in the vicinity of Whiteshell Laboratories flows directly or indirectly towards the Winnipeg River, located only 400 m from the site. In deeper zones, downward movement from recharge (from rainfall), seepage (from leaks) or from contamination will either travel laterally towards the Winnipeg River, or, if this flux penetrates to the bedrock/overburden interface, will preferentially migrate along that interface to the Winnipeg River.

Permeabilities of surficial matter and bedrock are highly variable across the site (AECL, 1996; AECL, 2001) but the overwhelming scale of the Winnipeg River dominates all shallow drainage. A Basal Sandy Drift deposit has been recorded extending from the WN-1 Reactor foundations westward, towards the Winnipeg River (AECL, 2001).

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[116] In Situ Decommissioning of Whiteshell Reactor 1 Project, “Decommissioning Safety Assessment Report” Whiteshell Laboratories Decommissioning Project WLDP-26000-SAR-001 Revision 2 2017

2.2 Geotechnical Considerations

The foundations of the WR-1 unit extend below grade into bedrock but the exact depth is not reported (Klukas-CNL, 2016). Many services, including pipes, cables and a discharge pipeline for cooling water enter below ground sections of the WN-1 site. These service pipes etc., extend to the Winnipeg River and provide additional pathways for nuclide travel.

2.3 Grouting

The precise physical and chemical properties of the proposed grout are not discussed (Klukas-CNL, 2016). Simple internal gravity placement of grout would not penetrate all void spaces in the below-ground structures forming the remaining component parts of WN-1. Nor would it guarantee long-term stabilisation and isolation of radionuclides within the required timescales of thousands of years.

2.4 Engineered Containment

Other approaches for the isolation of radioactive wastes are available, for instance Flexible Concrete Membranes, ICOS congruent secant pile walls, etc (Reeves et al, 2006). None of these options are discussed by the proponent (Klukas-CNL, 2016).

Conclusion

Our review of the human health and safety effects of the draft EIS demonstrate that the site should not be licensed for in-situ decommissioning as (1) there is far too much ILW at Whiteshell for a near-surface facility, and (2) the CNSC's unconditional clearance levels for radionuclides will still be exceeded after active institutional controls are ended in 100 years' or even 300 years' time.

Additionally, as demonstrated by our analysis, CNL's proposals for the entombment of the WN-1 reactor at Whiteshell Laboratories are technically and environmentally unsustainable due to the hydrogeological and geotechnical complexities and difficulties with the Whiteshell site.

Table 7: Other Related Information Requests

IR#	Information Request
#11	Regarding institutional control, the 2nd paragraph on page 7–2 of the Project Description (CNL, 2016) states the WR -1 Reactor site will be returned to AECL for institutional control. With the proposed entombment, CNL appears to be making commitments on the part of AECL and by extension the Government of Canada that could last for hundreds of years. The proponent must be accountable for the entire life of the project, i.e. design, construction, commissioning, operations up to and including final abandonment. Thus, as CNL's contract with AECL is for a maximum of 10 years from 2014, it is questionable whether CNL should be the proponent. We request a response from the CNSC on this issue.
#12	In 1998, AECL made a decision to decommission the Whiteshell Laboratories site. The current approved decommissioning strategy for WR-1 includes complete removal of the facility. This is described in the Comprehensive Study Report (herein "2001 Comprehensive Study Report").[117] This report was commissioned under CEAA 2012's predecessor legislation[118], with the Canadian Nuclear Safety Commission (CNSC) and Department of Fisheries and Oceans as the Responsible Authorities on EA. This Report remains in force. In the draft EIS, CNL acknowledges that entombment is "a departure from the end-state defined in the 2001 Comprehensive Study Report". However, the draft EIS argues that the proposal qualifies "as a designated project under Section 37(b) of the Regulations Designating Physical Activities of the Canadian Environmental Assessment Act 2012 as a project related to "the long term management or disposal of irradiated fuel or nuclear waste." Theforefore, as CNL is proposing to change the Report's decommissioning strategy from complete removal to entombment, CELA submits the 2001 Comprehensive Study Report should be reopened, because (1) of the magnitude of modification proposed and (2) the need to bring the revised undertaking in line with current environmental assessment law, CEAA 2012.
#13	The original 1960s (WNRE) and 1970s (WNRE and the URL site) agreements between AECL and the Manitoba Government stipulated that both locations would be returned to "green-field conditions" on their abandonment by AECL (AECL, 1994). It is questionable whether CNL's flawed proposals for containment, timeless

[117] Whiteshell Laboratories Decommissioning Project, Comprehensive Study Report, Volume 1: Main Report, Rev 2, 2001 March, AECL 2001

[118] *Canadian Environmental Assessment Act,* SC 1992, c 37

	institution control and surveillance will be considered as "green-field conditions" by the Manitoba Provincial Government.
#14	Several CNL documents are not yet available for public examination, including: • A Health and Safety Plan (HASP) which will identify workplace hazards associated with the closure period activities, specifically addressing all non-radiological COPCs. • A detailed safety analysis for the ISD of the WMA trenches. The absence of these documents impairs our review and also, is a deficiency of the data provided by CNL in the draft EIS.
#15	The following omissions/errors in the draft documents require rectifying: • Ag-108m and Sn-121m are absent from the nuclide inventory • No definition of couponing activities • No technical description of the engineered cover system • No technical description of the proposed grout and its properties • No discussion of hydrogen releases from grout-aluminum reactions • No discussion of collective doses • No discussion of organically bound tritium • Table 2.6.3-1 of the draft EIS omits "$ millions" in the legend • Para 6.3.1 of the Technical Document WR-1 Reactor Radiological Characterization Summary - WLDP-26100-041-000-0001 Rev. 0 states "Heavy Water and Tritium Inventory" but contains no Bq inventory for tritium • Table 3-6: Estimated Radionuclide Inventory in Primary Heat Transport System Following Shutdown (Bq) in WLDP-26000-REPT-006, EcoMetrix Ref:16-2292.3 contains incorrect half-lives

CONCLUSION

CELA has sought to identify the gaps in the existing draft EIS, its consideration of international guidance and alignment with the purposes of *CEAA, 2012,* and the project's impacts on human health and safety (see pages 32, 40 and 56).

CELA requests that all recommendations (see pages 1-2) and information requests (see pages 3-5) be provided before the EIS proceeds for further review.

As it stands, Canada lacks acceptable policies and strategies for managing radioactive wastes that is reflective of international best practices and standards. This should be a prerequisite to any consultation on proposed decommissioning strategies. We therefore submit that given this omission and the proven lack of technology, and real risks posed to people and the environment, the project should not proceed and the Whiteshell site should instead remain under active management.

All of which is respectfully submitted this 19th day of December, 2017:

CANADIAN ENVIRONMENTAL LAW ASSOCIATION
Per

<Signature Redacted>

Theresa A. McClenaghan
Executive Director and Counsel

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