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Oral presentation

Written submission from Northwatch

Exposé oral

Mémoire de Northwatch

In the Matter of the

À l'égard des

Canadian Nuclear Laboratories (CNL)

Laboratoires Nucléaires Canadiens (LNC)

Application from the CNL to amend its Chalk River Laboratories site licence to authorize the construction of a near surface disposal facility

Demande des LNC visant à modifier le permis du site des Laboratoires de Chalk River pour autoriser la construction d'une installation de gestion des déchets près de la surface

Commission Public Hearing Part 2

Audience publique de la Commission Partie 2

May and June 2022

Mai et juin 2022

Canada

NEAR SURFACE DISPOSAL FACILITY (NSDF)

IAA REF# 80122

CNSC REF# 2022-H-07

COMMENT ON CNL'S PROPOSED NEAR SURFACE DISPOSAL FACILITY

NORTHWATCH

1. Introduction

On October28, 2021 the Canadian Nuclear Safety Commission issued a public notice that it would hold a two-part public hearing on Canadian Nuclear Laboratories' application to amend its Chalk River Laboratories site licence to authorize the construction of a "near surface disposal facility".[1] Part 1 was announced for February 2022 and Part 2 to commence May 31, 2022.

According to the notice, the current license authorizes CNL to operate the CNL site, composed of a range of nuclear facilities, radioisotope labs, waste management facilities and other supporting facilities. In its license amendment request, CNL is seeking approval to add the construction of the NSDF, a proposed "engineered containment mound for low-level radioactive waste along with supporting facilities" to the CRL licensing basis. CNL proposed to construct the facility within the next three years and operate the facility (i.e. emplace the waste) over a 50 year period. This would be followed by a 30-year decommissioning phase including capping and closure of the mound by the hearing 2100.

Environmental Assessment Process

In May 2016, CNSC staff determined that the proposed NSDF was subject to the Canadian Environmental Assessment Act under CEAA 2012. Prior to making a licensing decision, the Commission must make an EA decision to determine whether the proposed activities are likely to cause significant adverse environmental effects.

An environmental assessment (EA) conducted under the Canadian Environmental Assessment Act, 2012 is required. Notice of the commencement of the environmental assessment was

[1] Notice of Public Hearing, dated October 28, 2021, Ref. 2022-H-07, as posted at https://nuclearsafety.gc.ca/eng/the-commission/pdf/Notice-PublicHearing-CNL-NSDF-22-H7-e.pdf

issued in May 2016, and public comments were invited on a 31page project description in May 2016 and on a revised project description in October 2016.

Public comments were invited on the draft environmental impact statement (EIS) for the Near Surface Disposal Facility Project in March 2017, and an initial deadline of May 17th was extended to August 16th to allow time for the proponent to provide and the public to consider a French language version of the EIS. A final EIS and an environmental assessment report to be prepared by CNSC staff was initially expected to be released in January 2018. In November 2017 the Commission issued a public notice that the timeline for release of the revised EIS was being delayed and an announcement would be forthcoming.[2]

In November 2019 CNSC staff advised CNL that they had reviewed CNL's revised EIS (there was no public comment on Revision 1 of the EIS) and the information provided by CNL continued to be deficient.

In January 2020 CNSC issued a notice that a review was underway of review of CNL's most recent (at that time) revised draft environmental impact statement (EIS) for the proposed Near Surface Disposal Facility. There was no public comment period for this revision of the draft EIS.

In May 2021 a document was posted titled "Final Environmental Impact Statement for the Near Surface Disposal Facility Project" in the review registry

Throughout the period between 2017 and 2022 Canadian Nuclear Laboratories' released various iterations of a number of technical documents related to or supporting the Environmental Impact Statement or the license application

[2] https://iaac-aeic.gc.ca/050/evaluations/document/121140

2. Northwatch's Interest

Northwatch is a public interest organization concerned with environmental protection and social development in northeastern Ontario. Founded in 1988 to provide a representative regional voice in environmental decision-making and to address regional concerns with respect to energy, waste, mining and forestry related activities and initiatives, we have a long term and consistent interest in the nuclear chain, and its serial effects and potential effects with respect to northeastern Ontario, including issues related to uranium mining, refining, nuclear power generation, and various nuclear waste management initiatives and proposals as they may relate or have the potential to affect the lands, waters and/or people of northern Ontario.

The NSDF project is outside Northwatch's geographic area, which is comprised of the six federal districts of northeastern Ontario, albeit in an immediately neighbouring county. Northwatch's direct interest is in the potential for decisions related to the NSDF project to be precedent-setting, including for a "mound" currently proposed by Cameco for decommissioning wastes from Port Hope, which the company has signaled they intend to construct in Blind River, in Algoma District of northeastern Ontario on the north shore of Lake Huron.

CNSC decisions on many of the issues associated with Canadian Nuclear Laboratories proposed Near Surface Disposal Facility have potential implications for northern Ontario in the event that practices, policies and / or regulatory decision-making with respect to the management of radioactive wastes become precedent-setting or normative in Canada.

In particular, the waste management approach of "surface disposal" may be similar to that being proposed by Cameco for northeastern Ontario, and CNL's stated intention to open the facility proposed for Chalk River to commercialization and traffic and disposal of radioactive wastes from undisclosed sources could be of consequence in other projects or regions in which Northwatch has a direct interest.

3.0 Environmental Assessment Review

3.1 Focus of Northwatch Review

During review of the project description and the draft Environmental Impact Statement Northwatch focused our review primarily in two key areas: CNL's presentation and technical evidence with respect to their proposed Waste Acceptance Criteria, and CNL's selection and presentation of international examples in support of their proposed engineered mound. General comments of the project description and the draft Environmental Impact Statement are also provided.

Northwatch has continued with these same areas of focus during this review period for the final Environmental Impact Statement and the CNSC commission member documents, as outlined below.

3.2 Waste Acceptance Criteria

The draft Environmental Impact Statement persistently coupled the Waste Acceptance Criteria (WAC) with operational performance and safety, but by Northwath's assessment failed to provide sufficient information about the Waste Acceptance Criteria and its application to assess its adequacy.

The "Waste Acceptance Criteria Variance Process" outlined in Section 3.2.3 of the draft EIS lacked clarity, definition and rigour. While having failed to present actual Waste Acceptance Criteria in the draft EIS, with the "Waste Acceptance Criteria Variance Process" the proponent outlined a process which would have effectively voided any Waste Acceptance Criteria that might have been put in place as part of or prior to project approval.

In our comments on the draft Environmental Impact Statement we noted that the draft EIS was made available in March 2017 for public comment[3], and did not include Waste Acceptance Criteria. In June 2017, a "Waste Acceptance Criteria" was presented to the CNL's

[3] CEAR #28, March 17, 2017, Public Comments Invited on the Draft Environmental Impact Statement for the Near Surface Disposal Facility Project

Stewardship Advisory Committee, and it is now posted on the CNL web site.[4] The document, titled "*Waste Acceptance Criteria 232-508600-WAC-002, Deliverable 1.1, Revision 2*" is dated June 21, 2017, but according to the record of revisions it was delivered to CNL as a "Final Deliverable" on March 31, 2017. Given its exclusion from the draft EIS, Northwatch provided no comment on *Waste Acceptance Criteria document 232-508600-WAC-002*.

The final EIS opens with an assurance that "the NSDF WAC ensures CNL meets its responsibility as the licensee; that all waste received for disposal is in compliance with the design and licensing basis for the facility (CNL 2020c)" and references various documents were specific safety criteria are provided (in addition to the EIS, it references *Design Description* (AECOM 2019), the *Post-Closure Safety Assessment* (Arcadis and Quintessa 2020) and the *Safety Analysis Report* (CNL 2020b)). Purportedly, compliance with the NSDF safety criteria <u>ensures</u> the short-term and long-term protection of the public, the environment and workers (emphasis added).

The EIS includes a brief description of the physical, radiological and chemical characteristics of the acceptable waste, stating that:

- The NSDF will accept only solid wastes with no <u>free</u> liquid, but may accept wastes that have been solidified or packaged
- LLW <u>mostly</u> contains short-lived radioactivity
- The radionuclide concentration limits for waste are provided in an included table for a single radionuclide.
- The vast <u>majority</u> of the fissionable material projected for placement in ECM is natural uranium
- small amounts of other fissionable material will exist in residual, unrecoverable amounts
- the <u>majority</u> of LLW accepted in the ECM will be on-site building waste, soil and soil-like wastes

[4] http://www.cnl.ca/site/media/Parent/WAC-232-508600-WAC-002-R2.pdf

- LLW may also contain chemical constituents of potential concern (COPCs), as residual contamination.[5]

Northwatch retained Hutchinson Environmental Sciences Ltd (HESL) to undertake a review of the Waste Acceptance Criteria as presented by Canadian Nuclear Laboratories and is providing this report to the Commission under separate cover.

The findings of the WAC review include the following; note that in the review provided by HESL each of these findings has a corresponding recommended action or remedy, and these findings should be read in the context of the HESL report for a fuller understanding:

- There is some ambiguity regarding the types and quantities of intermediate-level radioactive waste that are acceptable in the NSDF.
- There is some confusion if the Post-Closure Safety Assessment (PCSA) was included in the NSDF licensing agreement
- In the terms of the licence, a description of the disposal facility design itself, potential pathways from the facility to the environment, and potential impacts and/or mitigation measures were not well described.
- It is unclear whether decomposition of organic material and dewatering of soils have been accounted for in the design of the NSDF.
- Landfill gas capture is mentioned in this licensing document, although it is not clear how methane gas production will be mitigated
- Exposure of the ECM cells to weather events prior to closure and sealing remains uncertain, as the potential for runoff and increased leachate production during precipitation events may cause unpredictable treatment volumes.
- Groundwater monitoring across the site and in potential stratified groundwater regimes was not well described in licensing documents The guidelines for the maximum acceptable concentrations of radionuclides in groundwater are derived from Heath Canada's

[5] EIS page 3-28 to 3-30

- Drinking Water Quality Guidelines, which are not appropriate for surface water discharges.
- The fate of the metals and radionuclides separated from the leachate during the water treatment process was not described in the background documents.
- CNSC stated that several radionuclides and non-radiological constituents may be present in the wastewater at concentrations exceeding discharge targets.
- There is some ambiguity surrounding the number and volume of long-lived radionuclides (half-life >30 years).
- The method by which tritium will be pre-screened before on-site acceptance as a pre-treatment precaution was not well described.
- The environmental impacts and framework for detecting project related effects are not well understood from this document.
- If unacceptable waste is found, adequate actions will be taken to halt work, remove contamination, clean the area and evaluate disposal options, although the specific actions are not clear from this document.
- "The waste acceptance criteria for the NSDF will limit the level of contamination, limiting the magnitude of surface water and groundwater quality changes," however no rationale was given for how this will protect surface water quality or what mitigation strategies will be implemented if a leak is detected.
- Waste that does not comply with the NSDF WAC will be temporarily stored in a separate controlled area, but details of the temporary storage area (i.e., containment protocols) were not included in this document.
- There is some ambiguity surrounding the proportions of waste included in the ECM, as it is stated in the WAC that ~90% of the waste in the ECM would contain contaminated soils and building materials.
- It is unclear whether maximum concentrations will remain below applicable environmental quality criteria, or if there will be radiological attenuation and site-specific criteria for groundwater at the site.
- Key information regarding the environmental context of this project is difficult to find in this document without a detailed review.

- The groundwater velocity at the Chalk River site was not clearly defined in the EIS or licensing documents.
- Considerations for particle and radionuclide resuspension (included in Nevada WAC) do not appear to be accounted for in NSDF WAC, which may be a concern for contaminated soil placement.
- Leak detection protocols (included in Paducah WAC) were not encountered in the NSDF WAC.

3.3 Comparative Sites

The draft EIS promoted an argument that the acceptability of the waste mound as currently proposed is demonstrated by performance of a number of other facilities, all of which CNL refers to as a "near surface disposal" facilities.
CNL introduced this notion in Section 2.4.2 "Design Principles from External Sources", with the very general suggestion that "*In addition to CNL design principles, the design and operation of the NSDF will also use Canadian and international best practices and safety fundamentals, including those from the International Atomic Energy Agency (IAEA) and the CNSC*." This argument was continued in Section 2.5.2.1.1 of the draft EIS, titled "Technical Feasibility", where CNL sets the claim out as follows:

> *A near surface disposal facility is a suitable and technically feasible means of disposing of LLW and ILW and the effectiveness of such facilities for disposal of LLW and ILW has been demonstrated as illustrated through the following near surface facilities currently in operation globally:*

- *LLW Repository near the Village of Drigg in Cumbria operated by United Kingdom (UK) Nuclear Waste Management Ltd (consisting of AECOM, Studsvik UK, and Areva) on behalf of the Nuclear Decommissioning Authority.*
- *Four commercial LLW disposal facilities in the United States, namely:*
    - *Waste Control Specialists in Andrews, Texas;*
    - *Energy Solutions facility in Barnwell, South Carolina;*
    - *Energy Solutions facility in Clive, Utah; and,*
    - *US Ecology Washington's site at Hanford, near Richland, Washington.*
- *United States Department of Energy Facilities and National Laboratories on-site disposal facilities:*
    - *Idaho CERCLA1 Disposal Facility at the Idaho National Laboratory, Idaho;*

- *Environmental Management Waste Management Facility at the Oak Tennessee;*
- *Fernald Environmental Management Project – On-Site Disposal Facility near Hamilton, Ohio; and,*
- *Environmental Restoration and Disposal Facility at Hanford Site, Washington.* [6]

Of the listed facilities, only one received later mention, and that was a mention only: Section 6.2, titled "General Approach" stated that a hazard identification involved a literature review of documents and guidance and listed "Some of the documents included as part of the literature review", and a Performance Assessment for the Idaho CERCLA NSDF (US DOE 2011) is listed. We emphasise that this was a listing only; there was no description of the document, and no discussion of how the Performance Assessment for the Idaho CERCLA NSDF informed the development of CNL's proposed waste mound.

In a section of the final EIS titled "Technical Feasibility", CNL promotes their proposed Near Surface Disposal facility as being consistent with both the IAEA definition of a near surface disposal facility IAEA guidelines and requirements.

The document also argues that "an NSDF is a suitable and technically feasible means of disposing of LLW and the effectiveness of such facilities for disposal of LLW has been demonstrated as illustrated through the following near surface facilities currently in operation North America", citing its own projects at Port Hope and Port Granby, and four nuclear weapons complex sites in the U.S: the Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility, the Portsmouth On-site Waste Disposal Facility, and the Fernald On-site Disposal Facility.[7]

[6] Draft EIS page 2-17
[7] Final EIS, pages 2-16 and 2-17

Northwatch retained Radioactive Waste Management Associated to undertake a review of the comparatives sites as presented by Canadian Nuclear Laboratories and is providing this report to the Commission under separate cover.

The findings of RWMA's review of comparative sites include the following; note that these findings should be read in the context of the RWMA report for a fuller understanding:

- The Oakridge National Laboratories Environmental Management Waste Management Facility does not provide an example of the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility. What it does provide is an example of how a lack of oversight and/or commitment to operational safety can result in violations of operating protocol and subsequently, environmental violations.
- The environmental violations at Oakridge EMWFM resulted from a combination of design and operational failures in that there was insufficient water storage capacity as part of the facility design and there were operational decisions made which resulted in environmental harm as a result of those design limitations. The responsibility chain went from site owner to contractor to sub-contractor and was broken.
- The Hanford Environmental Restoration Disposal Facility further demonstrates how irregularities in project delivery and the project evolution can emerge under the operating model.
- In the GOCO model in place at the Hanford Environmental Restoration Disposal Facility, a lack of oversight from both the contractor and the site owner was observed, which allowed key equipment failures to continue undetected for seven months and a falsification of documents to be carried out over a period of years.
- Government agency oversight reports failed to note even such significant failures in project delivery at Hanford. In addition, a form of "authorization creep" emerged, with the initial authorization for the facility changing significantly over even the first decade of operation, beginning with an expansion of the acceptable wastes in the first year after initial authorization and an expansion of the size of the facility the following year and multiple additional expansions to the authorization continuing throughout the operating period.

- The Fernald On-site Disposal Facility provides an example of several elements which do not appear to be in place in the case of CNL's proposed NSDF, but were important to the Fernald project.
- In particular, the degree to which the Fernald clean-up operations were successful relied on several critical factors, including and particularly that the remediation activities followed closure, rather than running concurrent with continued waste generating and contaminating activities co-located on the site.
- Citizen engagement was a priority for this disposal facility and citizens occupied a central role in decision-making, communicating with the public, and priority setting.
- Perpetual care was embedded as a project expectation in the Fernald project, and the oversight agencies have a known and seemingly reliable plan for long term record keeping and retention of institutional memory.

In conclusion, rather than providing examples of success, the observations from the Oakridge National Laboratories Environmental Management Waste Management Facility, Hanford Environmental Restoration Disposal Facility and Fernald On-site Disposal Facility operating experience provide caution warnings.

3.4 Additional Environmental Assessment Matters

Despite the expressed confidence of CNSC staff and CNL, there are many aspects of the project which remain uncertain, ill-defined, or over which there appear to be conflicting statements. Northwatch notes the following examples.

Groundwater Table

Contact between the low level waste and the radio-contaminants which CNL proposed to emplace in the "mound" and ground or surface water is a central concern with the NDSF project. Despite this, CNL's various statements about the groundwater table suggest there is uncertainty about this fundamental fact. For example, in the executive summary of the Environmental Impact Statement (EIS) groundwater table depth is describes as varying "significantly throughout the NSDF Project site and changes with the seasons. The average groundwater depths range from approximately 0.06 m in the vicinity of the wetlands to 15.95

m in the northern section of the study area, which corresponds to the thickest overburden” [8] A later section of the EIS describes “an advantage of this mound-type repository design is that the waste is placed above the groundwater table and the waste stays dry as long as the protective barriers are intact”[9] and later yet the EIS sets out that the “base of the ECM (i.e., top of the primary liner) shall be designed to maintain a minimum of 1.5 m above the seasonal high groundwater table.” [10]

The CNSC staff Commission Member Document (CMD) suggests that not only is the description of groundwater table depth widely variable, but the water table depths will be manipulated in the course of project implementation, as “rock blasting (depth ranges from 1 to 8 m) will be needed to drain groundwater within the rock mass and lower groundwater elevations beneath the ECM footprint”. [11] Perhaps on a related note, in a discussion of why the shallow caverns concept was eliminated from further consideration, the water table was described as “high”, which “increases the likelihood and risk of flooding”.[12]

These are significant variations, both the natural variations between the wetlands and “the northern edge”, but also it is significant that the water table is described as “high” and is going to be purposely lowered as part of the mound construction.

Given these variations and this seeming complexity, it is surprising that when President Velshi asked about the groundwater table compared to the planned/proposed NSDF the full response was simply that “the average groundwater table is about 4.5 metres below the surface”. [13]

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[8] EIS ES-9
[9] EIS 2-26
[10] EIS 2-74
[11] CNSC CMD 22-H7 Pg 8
[12] 22-H7 p 27
[13] Feb 22 Transcript page 119

Monitoring

Staff address the issue of monitoring in several different sections of the CMD, including in the "Environmental Assessment Report". Earlier references simply direct the reader to later sections. Descriptions are most detailed in section 6.4.1.3 of the CNSC staff CMD and followup monitoring is briefly discussed in the Environmental Assessment Report.

The substantive discussion of monitoring is in a stand-alone report referenced in the CMD and in the EA Report, titled "Draft Environmental Assessment Follow-Up Monitoring Program for the Near Surface Disposal Facility 232-509220-PLA-001" and dated February 2021.[14]

Generally, the monitoring program is described largely in terms of standard monitoring for a nuclear or other industrial operation, i.e. compliance and effluent monitoring. The approach is largely standard to all operations:

- CNSC staff would monitor CNL's performance during the operation period through routine compliance oversight activities, including inspections and reviews of documentation, and event reporting. (22-H7 p 29)
- CNL developed a monitoring and surveillance plan for the NSDF with the program objective of providing assurance that the NSDF is performing at the required level of safety during the pre-operational, operational, closure, institutional control and post closure phases (22-H7 p 46)

While we would expect that the monitoring program would include all of the standard activities, in the case of the NSDF the area of most interest in the followup and monitoring program is monitoring or evaluating the performance of the NSDF, including the components of the Engineered Containment Mound, the effluent collection and the waste water treatment.

There are several indications that – despite the lengthy "Draft Environmental Assessment Follow-Up Monitoring Program for the Near Surface Disposal Facility" document, that the program details are yet to be developed.

In Northwatch's view the key elements of the monitoring program relate to facility performance, and it must meet adhere to the guidance which requires that it:

▪ Verify that the disposal facility is performing as expected

[14] http://www.cnl.ca/wp-content/uploads/2021/07/Draft-Environmental-Assessment-Follow-Up-Monitoring-Program-for-the-Near-Surface-Disposal-Facility-Rev-0.pdf

▪ Verify that the key assumptions made and models used to assess safety continue to be consistent with actual conditions

▪ Maintain records of the disposal facility, the site and the environment

▪ Ensure the protection and preservation of passive safety features

The CMD indicates that "Should the Commission issue a positive EA decision, CNL will then be required to further design and implement an EA Follow-Up Monitoring Program", again indicating that this is at best a work in program or possible a work to come.

Having a detailed and comprehensive plan for monitoring system performance is essential, as is the need for a contingency plan. The monitoring program must include a solid plan to measure the performance of each of the NSDF design areas, have some clearly delineated thresholds which trigger action, and have contingency plans in place which can be operationalized on a timely basis.

Site Selection

In Northwatch's view, CNL did not employ a sufficiently robust process for site selection, and were particularly weak in terms of how the considered alterative means of meeting the project purpose and considering alternative sites.

An interesting observation from the U.S. program is the strong preference shown in the U.S. for dry and arid sites. Yet CNL chose a site with extremely varied topography, extremely close to both Perch Lake and the Otttawa River, and with no compelling feature other than that it was available.

Northatch strongly supports managing radioactive wastes as close to the source as possible, applying the "proximity principle" in order to avoid risks and impacts (carbon and other) of transportation, and as much as possible limiting the nuclear footprint. However, in Northwatch's view the site study process should not have been limited to the central area of the CNRL site, particularly given the proximity of a large adjacent land-holding which is also owned by the federal government.

Our impression both from the documentation and from a site visit with CNL several years ago, largely to discuss the site selection process, is that CNL took an attitude of two extremes: the options were either very very close, or very very far. Taking the "middle path" of exploring adjacent locations may well have yielded better results.

Alternative Design

CNL reports having evaluated three design concepts of near surface facilities to “dispose” of low-level radioactive waste, namely above ground concrete vaults, shallow caverns and an engineered containment mound. CNL assessed the three conceptual alternatives based on technical and economic feasibility.

The shallow caverns concept was eliminated from further consideration due to the CRL site characteristics (high water table which increases the likelihood and risk of flooding) and due to the large volume of waste inventory (1 million m3) which would require the design of multiple caverns.

Reportedly, the above ground concrete vault and the ECM options are both comparable and technically feasible. These two options were evaluated and compared based on technical and economic feasibility, environmental effects and societal considerations. CNL assessed that both alternatives can be constructed on the CRL site to meet the purpose of the NSDF Project, can accommodate the waste inventory and are technically feasible with proper engineering.[15] We found no evidence of CNL having given any weight – let alone sufficient weight – to the comparable feasibility of monitoring and measuring system performance and implementing course correction in one system – for example, an engineered mound – versus another system – for example, a series of above grade or at grade concrete vaults.

Northwatch’s primary criteria for comparing one waste management / waste containment system relative to another is to apply four very basic but essential questions: Does the system facilitate monitoring? Does the system support enable measuring the performance of system components and the system as a whole? Does the design support waste retrieval, should there system performance not meet expectations? Does the system accommodate replacement or re-encapsulation of waste and / or waste containers?

We suspect that the option of concrete vaults would rank higher than a massive landfill when those criteria are applied.

[15] 22-H7 p 26

Record Keeping

The staff CMD identifies issues around markers, memory retention and long term record-keeping as if the topic had just come upon them.

Interestingly, staff have worked out some specifics – such as directing CNL to install at least 4 permanent and durable markers on the final cover or at a specific/appropriate location – while keeping the larger issues at bay, simply saying that "planning and details of the facility closure plan may evolve during the lifecycle of the facility as CNSC guidance becomes available" and that "CNL and CNSC staff will revisit this matter to align with the most up-to-date information on international research with respect to archives and markers/monuments to provide passive warnings to future generations". CNSC's thinking appears to be very preliminary on this important matter, whereas their international counterparts are moving ahead with concrete plans being put in place as clean-up work progresses.[16]

[16] 22-H7 P 29

4.0 Decisions

4.1 The EA Decision

CNSC staff state that they have determined that "the proposed NSDF Project is not likely to cause significant adverse environmental effects, taking into account the implementation of all identified EA regulatory commitments"[17]

This conclusion was reached by staff without the benefit of public reviews of the last two iterations of the Environmental Impact Statement, and in advance of the public hearing which will be the first opportunity for members of the public to bring forward their critique of the project as it now stands (as compared to five years ago, which as the last opportunity to comment on the Environmental Impact Statement), and the first opportunity to question the evidence being put forward by the proponent.

A key purpose of the Canadian Environmental Assessment Act is public participation:

> *(e) to ensure that opportunities are provided for meaningful public participation during an environmental assessment*[18]

Northwatch is strongly of the view that CNSC staff should withdraw their recommendation, adopt the attitude of regulatory support staff rather than proponent's advocate, and focus on supporting the Commission in considering the Project, the evidence, and the concerns, interests and expertise of the intervenors prior to coming to an EA decisions.

4.2 The Licensing Decision

CNSC staff, in advance of the hearing and in the absence of any independent technical expertise of public scrutiny, have come to the conclusions based on their interactions with the proponent that the proponent's project should be approved:

> *Based on the licensing regulatory review and technical assessments, CNSC staff have determined that the proposed NSDF project is protective of people and the*

[17] 22-H7 p 19

[18] CEAA 2012, Section 4 (1) e

environment, taking into account the implementation of all identified EA regulatory commitments and licensing regulatory actions (for further details, please refer to section 1.2.3 and part two of this CMD). CNSC staff conclude that CNL's licence application to construct the NSDF at the CRL site complies with all applicable regulatory requirements.[19]

Northwatch will share their views with the Commission on EA approval for the project in the course of the hearing and in final comment, after having had the benefit of hearing from both the proponent and others with expertise and insights into the project. However, we do not believe at this point that there is sufficient evidence that the project can be carried out in a safe and predictable manner, and the uncertainties provide ample basis for rejecting the project.

Should an EA approval and a licence to construct be issued, a next license application would be expected within approximately three years:

The operation of the NSDF would be subject to a separate Commission approval. These activities would be governed by the CRL Operating Licence, the associated LCH licensing basis, the facility authorization (FA) (which sets the key requirements, conditions and limits for the safe operation of a given CRL facility), the CNL management system and quality program and the conduct of operation program. As has been mentioned earlier, international guidance and practices recommend that operational and post-closure safety assessments are sufficiently detailed and reviewed by the regulator to provide for the basis to proceed with construction. [20]

Should the project move to that stage, the Commission must ensure that the application for a licence to operate the Near Surface Disposal Facility is subject to a full public licensing process including a public hearing, and that all information related to the next stage application is made readily available in a timely manner and that the participation of the Canadian public and of Indigenous peoples is supported and encouraged.

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[19] 22-H7 p 19
[20] 22-H7 p 28

NEAR SURFACE DISPOSAL FACILITY (NSDF)

IAA REF# 80122

CNSC REF# 2022-H-07

Review of Canadian Nuclear Laboratories Waste Acceptance Criteria for a Near-SurfaceDisposal Facility

PREPARED ON BEHALF OF NORTHWATCH

Hutchinson Environmental Sciences Ltd.

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April 11, 2022 Project No. 220047

Brennain Lloyd
Project Co-ordinator
Northwatch
1450 Ski Club Rd, North Bay, ON
P1B 8E6

Dear Ms. Lloyd,

Re: Review of Canadian Nuclear Laboratories Waste Acceptance Criteria for a Near-Surface Disposal Facility

INTRODUCTION

Hutchinson Environmental Sciences Ltd. (HESL) reviewed four core documents related to licensing a proposed low- and intermediate-level nuclear-impacted waste Near Surface Disposal Facility (NSDF) at Chalk River Laboratories (CRL), near Deep River, Ontario. CRL is operated by Canadian Nuclear Laboratories (CNL). International cases for similar shallow waste disposal sites were also reviewed to provide a jurisdictional comparison for the licence. The core documents and international cases were provided by Northwatch, which was the organization that commissioned the review.

The NSDF project is presently under review by the Canadian Nuclear Safety Commission (CNSC), and a public hearing followed by a final decision by CNSC will be given in May, 2022. CNSC is currently accepting written feedback on the NSDF project from the public, Indigenous communities, and other stakeholders. Northwatch commissioned this review to identify key elements of the Waste Acceptance Criteria (WAC) that might have an uncertain impacts to environmental and human health, and to compare the NSDF Waste Acceptance Criteria to similar international facilities.

INFORMATION REVIEWED

The information provided by Northwatch was reviewed. CNL WAC for the proposed NSDF, was the primary document reviewed[1]. The other core documents regarding Waste Acceptance Criteria were reviewed to identify key elements and potential environmental concerns from the WAC:

- CNSC, 2022. Written submission from the Canadian Nuclear Laboratories, Commission Public Hearing Part 1, February 22, 2022 (CMD22-H7-1).
- CNSC, 2022. Licence Amendment, required approvals for the construction of the Near Surface Disposal Facility, Canadian Nuclear Laboratories Chalk River Laboratory, Commission Public Hearing Part 1, scheduled for February 22, 2022 (CMD22-H7).

[1] *Canadian Nuclear Laboratories (2020). Near Surface Disposal Facility Waste Acceptance Criteria. 232-508600-WAC-003. Revision 4.*

- NSDF Environmental Impact Statement 232-509220-REPT-004, Revision 3, 28 May 2021.

The review of documents pertaining to WAC internationally and in other jurisdictions, was limited to the following:

- National Nuclear Security Administration (2016). Nevada Security Site Waste Acceptance Criteria. U.S. Department of Energy.
- FCC Environment & Atkins. Lillyhall Landfill Site Waste Acceptance Criteria (WAC) – High Volume Very Low Level Waste (HV-VLLW) Disposal. Distington, Cumbria, UK.
- National Radioactive Waste Disposal Institute (NRWDI) Waste Acceptance Criteria South Africa.
- LATA Environmental Services of Kentucky (2013). Waste Acceptance Criteria for the Treatment, Storage, and Disposal Facilities at the Paducah U.S. Department of Energy Site. PAD-WD-0011/R1. U.S. Department of Energy, Office of Environmental Management.

These five documents were selected for review from the information sources provided by Northwatch, because they were for potentially similar facilities (i.e., shallow disposal sites) with low-level radiological waste.

BACKGROUND

Summary of CNL Near Surface Disposal Facility

The NSDF was proposed by CNL to house solid, low-level radioactive waste for permanent disposal. The NSDF is located within the bounds of the CRL site, approximately 300 km west-northwest of Ottawa. The shore of the Ottawa River is northwest of the site. The NSDF project will dispose of waste in an Engineered Containment Mound (ECM) including a multi-level base liner and cover system. The NSDF will hold up to 1,000,000 cubic metres of low-level waste, within 10 internal cells. The base liner and final cover systems are composed of a compact clay liner and high-density polyethylene geomembrane to encapsulate the waste and reduce or prevent water from leaching into or from the cell interiors, and reduce or prevent contaminant release to the environment.

The waste is proposed to be placed in each of the 10 cells, and each cell will be covered once it is full. A wastewater collection and treatment system is included in the NSDF design, to collect and pump leachate from the ECM to a wastewater treatment plant. Leachate will be treated to remove radiological and chemical contaminants (metals and radionuclides) and discharged to the ground via an exfiltration gallery. During high groundwater water levels (e.g., spring freshet), some wastewater effluent will be discharged to Perch Lake to accommodate the wastewater treatment plant discharge rate, which is higher than the soil infiltration capacity. Wetlands are adjacent to and downgradient of the NSDF and may receive groundwater from the facility. Shallow groundwater migrates towards the Ottawa River, and surface water ultimately flows to the Ottawa River via Perch Lake and Perch Creek. Perch Lake and Perch Creek may also receive groundwater that originates in the NSDF area.

The proposed NSDF is designed to contain low-level radioactive waste from previous (and future) operations at the Chalk River facility, as well as contaminated soils from environmental remediation and decommissioning of outdated infrastructure at the CRL site. Low-level radioactive waste is defined as waste containing short-lived radionuclides (half-life of <30 years), requiring containment for hundreds of years. A small amount of material from outside sources (hospitals, universities, and other facilities owned by Atomic Energy of Canada Limited) may also be included in the ECM.

The ECM has a design life of 550 years to comply with the necessary time for radiologic decay of the low-level radioactive waste. In the first 100 years, the radioactivity of the ECM contents will decrease by approximately 2000 times and then approach natural radioactivity.

Waste Acceptance Criteria Guidelines

According to the CSA N292.0 General Principles for Management of Radioactive Waste[2], Waste Acceptance Criteria (WAC) must be developed to consider:

- Radionuclide content and radiological properties;
- Waste form;
- Potential for criticality (i.e., accidental uncontrolled nuclear fission chain reaction);
- Chemical properties;
- Physical and mechanical properties;
- Biological properties;
- Period that the waste remains hazardous;
- Package design and properties (e.g., corrosion resistance, specific storage and handling considerations);
- Facility design, and
- Retrievability.

WAC for the NSDF was developed by CNL following CSA[2] and IAEA[3] guidelines. The review of core documents (below) highlights questions or uncertainties of the WAC for the NSDF, that could result in environmental impacts. Several positive elements related to the WAC were also identified, but for brevity, the review comments focussed on opportunities for improvement.

REVIEW FINDINGS

Document Review Findings

Canadian Nuclear Laboratories (2020). *Near Surface Disposal Facility Waste Acceptance Criteria. 232-508600-WAC-003. Revision 4.*

Summary of pertinent information:

CNL (2020) is a licensing document prepared to meet Ontario requirements for regulating radioactive waste for acceptance in the proposed NSDF. The document was organized into four sections pertaining to criteria

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[2] *CSA N292.0 General Principles for the Management of Radioactive Waste and Irradiated Fuel.*
[3] *IAEA GSG-1 (International Atomic Energy Agency). Classification of Radioactive Waste.*

for physical, chemical, and radiological properties of accepted waste, and quality assurance controls to ensure waste placed in the NSDF complies with WAC. This complies with CSA requirements[2], which state that WACs must be developed with well-characterized physical, chemical, and radiological properties of waste. Section 3 pertained to the physical properties of accepted waste. Six physical types of waste were proposed to be included in the NSDF, defined by material type:

- Type 1 Waste: Soil and soil-like wastes;
- Type 2 Waste: Co-mingled radioactive waste, debris, refuse, soil, and soil-like waste (at least 50% soil or soil-like in nature);
- Type 3 Waste: Non-soil like waste (process wastes, organic wastes, highly compressible wastes);
- Type 4 Waste: Decommissioning and demolition waste (concrete, asphalt, brick, lumber, structural steel, process equipment, wood, and other building materials);
- Type 5 Waste: Packaged waste (non-leachate controlled and leachate-controlled waste packages); and,
- Type 6 Waste: Oversize debris (waste that does not fall within Types 1 through 5 in terms of size or shape).

In Section 3.3.1 of the document, non-leachate-controlled waste packages were defined as "waste packages that must be able to contain the waste until placement in the NSDF." These may include drums, steel waste boxes, or intermodal waste containers. Leachate-controlled waste packages were defined as "waste packages that are able to provide containment of the waste during the time the disposal cell is not covered with the final cover (approximately 5-10 years)." The packaging must prevent water infiltration when subjected to pressure, the packaging exterior must be able to withstand the chemical disposal environment of the NSDF, and must include gas venting if applicable.

Section 4 of the document included the limits and controls for the chemical properties of accepted waste. Hazardous waste is not permitted for NSDF disposal. Key Constituents of Potential Concern (COPC) were identified in Section 4.2 for NSDF leachate modeling, and it was stated that if COPCs are present in a waste container, the concentration/quantity and uncertainty shall be reported. Key COPCs were presented in Table 3 of the WAC and include metals (i.e., copper, cadmium, mercury, lead, silver), dioxins, furans, PCBs, and other chemical constituents that may be found in the leachate.

Section 5 of the document included the radiological properties of waste for inclusion in the NSDF. According to the WAC, "The activity and identity of the significant radionuclides that contribute to 95% of the total activity and the uncertainty of those radionuclides" must be reported to CNL prior to disposal. The radionuclide activity for radionuclides with half-lives greater than five years must be reported (particularly for radionuclides that decay to more significant radionuclides).

Questions and Comments:

Under Scope and Applicability of the document, it was stated that "the NSDF will not contain high-level radioactive wastes such as used nuclear fuels nor intermediate waste such as irradiated reactor core components". Other regulatory documents pertaining to the NSDF asserted that some intermediate-level radioactive waste may be included in the NSDF if CRL legacy waste contains some longer-lived radionuclides that are not practical to separate from lower-level waste, and it is interpreted that the WAC has made provisions for low-level waste that has been contaminated by intermediate-level waste and cannot be reasonably separated. The extent of allowable contamination and content of intermediate-level waste should be further defined to prevent unacceptable quantities or types of intermediate-level waste from being deposited into the NSDF.

There is some ambiguity surrounding what documents are included in the licensing agreement at this stage, in addition to the WAC document. If not part of the current licensing stage, the Post-Closure Safety Agreement (referenced in the WAC document) should be reviewed in the early stages of the facility operation to inform proper post-closure planning and licensing. If the Post-Closure Safety Agreement currently forms part of the licensing agreement, it should be reviewed prior to the licence approval.

This WAC prepared by CNL included a thorough disposal framework for low-level (and mixed) radioactive waste, and inventory and quality control protocols appear to be sufficiently described to have accepted waste meet CSA and IAEA guidelines, providing the proposed rigorous waste certification, verification, and reporting protocols are maintained. The types of materials to be included in the NSDF were clear in the WAC document, although some uncertainty surrounding radioactivity levels of materials permitted in the NSDF (i.e., intermediate-level radioactive waste allowances) may need further explanation.

The terms of the licence, including the disposal facility design itself, potential pathways from the facility to the environment, and potential impacts and/or mitigation measures were not well described in the document. These aspects were well documented in the Commission Public Hearing Documents, however, but a summary of the design, potential COPC pathways to the environment and mitigation in the WAC document would provide a useful context and be helpful for individuals reviewing the document. More information on the wastewater treatment system and leachate collection would be particularly helpful.

Canadian Nuclear Safety Commission (2022). *Written submission from the Canadian Nuclear Laboratories, Commission Public Hearing Part 1, February 22, 2022 (CMD22-H7.1)*

Summary of pertinent information:

This document is a Commission Member Document presented to the Commission Registry for an amendment of the Nuclear Research and Test Establishment Operating Licence for CRL and provided evidence to show that the NSDF meets the requirements of the Nuclear Safety and Control Act. It stated that the NSDF will only house low-level radioactive waste (contaminated soils, building materials, and general items such as mops, protective clothing, and rags), and ~10% of waste volume will come from other labs and commercial sources (hospitals and universities).

The document presented the alternatives that were considered for storage of legacy waste from the CRL site, and that the NSDF was the preferred alternative due to technical and economic feasibility. The document provided environmental context to the NSDF project (description of the wastewater treatment system, some potential pathways from the facility to potential receivers), such that the possible environmental risks are better understood.

The NSDF leachate wastewater treatment process will include chemical precipitation to separate out metals and radionuclides, and treated effluent will be discharged to an exfiltration gallery, providing a longer migration time to the Ottawa River instead of directly discharging to Perch Lake (although water will be discharged directly to Perch Lake under high water table conditions). The wastewater treatment plant effluent discharge targets for radionuclides are the maximum acceptable concentrations for drinking water (derived from Health Canada Guidelines for Drinking Water Quality). Tritium is unable to be removed from wastewater, therefore strict tritium limits (10,000,000 Bq/g in leachate-controlled packaged waste) will be placed on the NSDF so that effluent discharges meet targets to remain below 7000 Bq/L, the Health Canada Guideline for tritium. The NSDF is surrounded by wetlands, and the NSDF is set back 30 metres from the wetland boundary.

Questions and Comments:

CNSC stated that internal void space in the NSDF will be limited, and high volumes of contaminated soils will help to fill in the void space. It is unclear whether degassing of organic material and dewatering of soils have been accounted for in the design of the NSDF. Since dewatering will lead to increased leachate production, it is assumed that the leachate control system will control and direct leachate to wastewater treatment, however, no infrastructure related to the control of landfill gases was encountered, although the WAC states that the mass of metal and organics received will be tracked.

More clarification should be given in this licensing document to describe the landfill gas capture and monitoring for radionuclides. The EIS mentioned that a landfill gas venting system will be included, and methane gas production will be mitigated, although it remains unclear in the Commission Member Document how this will be accomplished – for document completeness, a summary of the landfill gas management approach should be provided or a reference provided to the EIS.

CMD22-H7.1 stated that “waste placement in the ECM may cease during periods of inclement weather such as high winds, major precipitation, extreme cold, or inability to compact waste due to frozen conditions,” which is a good provision to maintain quality control under adverse conditions. Exposure of the ECM cells to weather events prior to closure and sealing of filled cells remains uncertain, as the potential for runoff and increased leachate production during precipitation events may cause unpredictable treatment volumes and loads to the leachate management and treatment system. Additional information should be provided on how precipitation treatment has been accounted for in the design of the ECM.

Groundwater monitoring will be conducted at 9 wells located along the wetland-NSDF boundary, but groundwater monitoring across the rest of the site and in potential stratified groundwater regimes was not well described, nor was the frequency of groundwater monitoring to assess impacts. Given the reported high level of groundwater fluctuation throughout the year, there may be a concern regarding the impacts on shallow vs. intermediate groundwater regimes, and/or contamination of the seasonally wetted zone. Clarification should be provided on the potential impacts to the different groundwater regimes and zone of water table fluctuation, and how impacts (if any) will be monitored and mitigated.

The guidelines for the maximum acceptable concentrations of radionuclides in groundwater are derived from Heath Canada's Drinking Water Quality Guidelines, which are not appropriate for surface water discharges: Drinking Water Quality Guidelines are less stringent than Provincial Water Quality Objectives (PWQO) which are intended to protect ecological receivers in the Province of Ontario. Clarification should be provided for why Drinking Water Quality Guidelines were proposed and why the guidelines will be protective of ecological receivers and the aquatic environment. If Drinking Water Guidelines are not sufficiently protective, alternative appropriate guidelines should be included in the licence.

The fate of the metals and radionuclides separated from the leachate during the water treatment process was not described in the background documents. Collection and disposal of the residuals, which may contain elevated concentrations of metals and radionuclides should be clarified. According to CNSC, "a comparison of projected leachate concentrations and effluent discharge targets show that several radionuclides and non-radiological constituents may be present in the wastewater at concentrations that exceed discharge targets, and treatment for these designated contaminants of potential concern will be required." Contingency plans for treating leachate if the water treatment system is not in operation were not provided and should be included in the licence.

The WAC restricts the number of long-lived radionuclides (half-life >30 years), but the volume of allowable longer-lived radionuclides is not clear and should be specified.

CNSC acknowledged that tritium is unable to be removed from wastewater and has considered this from the perspective of potential receivers, but the method by which tritium will be pre-screened before on-site acceptance as a pre-treatment precaution was not well described and should be clarified to confirm that appropriate tritium pre-screening occurs.

This CNSC Commission Member Document gave a better framework of the environmental context and fills in many contextual gaps not addressed in the WAC, including describing the receivers (Perch Lake, Ottawa River) and possible risks from the facility (which are further addressed in detail in the Environmental Impact Statement). The Environmental Impact Statement document provided additional information on guideline applicability, and a framework for detecting project-related effects. A summary of or reference to these guidelines and mitigation strategies should be readily available in the CNSC Commission Member Document for ease of review and public confidence in the project.

Canadian Nuclear Safety Commission (2022). *Licence Amendment, required approvals for the construction of the Near Surface Disposal Facility, Canadian Nuclear Laboratories Chalk River Laboratory, Commission Public Hearing Part 1, scheduled for February 22, 2022 (CMD22-H7).*

Summary of pertinent information:

This document is a review by CNSC of regulatory concerns surrounding the proposed NSDF and includes recommended amendments to CNL's operating licence for Chalk River Laboratories and the NSDF project. CNSC recommended that the NSDF is not likely to cause significant adverse environmental effects, that it is qualified to carry out the activities authorized by the licence and will make adequate provisions for the protection of the environment and health and safety. CNSC recommended approving CNL's application to construct the NSDF.

This document stated that the Post-closure Safety Agreement (PCSA) document, which is a part of the licensing agreement, was used to adjust the NSDF waste inventory and develop the WAC, to ensure that the final inventory at closure will result in predicted doses during the post-closure period, demonstrating good long-term forethought. CNSC asserted that waste types identified for disposal in the NSDF meet the definition of low-level radioactive waste as stated in CSA N292.0-19 and IAEA GSG-1 radioactive waste management guidelines. Should radioactive or hazardous wastes be identified, CNL will remove the contamination, clean the area, and evaluate management/disposal options. CNSC also conducted a waste characterization compliance inspection and found that for all waste intended to be placed in the NSDF, CNL has to recharacterize the waste for which the collected characterization data is not sufficient to ensure compliance with the WAC.

Questions and Comments:

This Commission Member Document stated that "in case radioactive, mixed, or hazardous wastes are found, CNL will, in accordance with the existing program and procedures, take adequate actions to halt the work, remove the contamination, address the situation, clean the area and evaluate management/disposal options." Clarification within the document, or reference to protocols for the "adequate actions" should be provided for transparency and to ensure that unacceptable waste is handled appropriately by the licensee. There are multiple occurrences of the phrase "The waste acceptance criteria for the NSDF will limit the level of contamination, limiting the magnitude of surface water and groundwater quality changes," however, no rationale is given for how this will protect surface water quality or what mitigation strategies will be implemented if a leak is detected. Details on the response framework for detecting project-related effects should be provided, or a reference provided for response protocols in another document, if water quality changes are detected. This information may be included in the Environmental Impact Statement, but this was not clear in the Commission Member Document.

The Commission Member Document stated that "waste that does not comply with the NSDF WAC will be temporarily stored in a separate and controlled area for management and dispositioning." It would be beneficial for the containment protocols for the temporary storage area, including a description of appropriate controls and monitoring, to be provided in the licensing documents for clarity and to ensure that ancillary temporary storage areas are adequately regulated by the licence.

Golder & Canadian Nuclear Laboratories (May 2021). *NSDF Environmental Impact Statement 232-509220-REPT-004. Revision 3.*

Summary of pertinent information:

The EIS was prepared for CNL by Golder. It states that an NSDF facility would substantially reduce the risks of CNL legacy wastes on-site since the current CRL waste management practice is to store radioactive waste on-site in individual facilities and temporary storage systems (which is not sustainable). The EIS for the NSDF project does not predict any significant adverse impacts on humans or the environment.

More guidance is given in this document on the filling and placement of waste in the ECM, which will be completed in a staged approach. During stage 1, 525,000 cubic metres of waste (including waste currently in storage and waste expected to be generated over the next 20-25 years) will be placed in the ECM, enabling remediation of existing contaminated areas of CRL property. During stage 2, the design fill capacity will expand to 1 million cubic metres, for waste expected to be generated up to the year 2070 (including waste from future operations, decommissioning, and remediation).

Golder asserted that changes in groundwater quality and quantity are not expected to result in significant adverse effects on the aquatic environment or human health. On page E-10 of the executive summary, a list of mitigation measures was included to prevent the impact of effluent discharge, surface water runoff, and leakages. A Surface Water Management Plan was developed for the NSDF and includes stormwater management ponds, erosion and sediment control practices, and sampling of treated effluent before release, although a detailed review of the Surface Water Management Plan was not conducted by HESL due to time constraints.

Questions and Comments:

In Section 3.3.3.1 of the EIS, it stated that the majority of waste (~87%) to be accepted in the ECM will be bulk materials (physical waste types 1, 2, 3, 4, and 6), while packaged waste (Type 5) will make up approximately 13% of the total waste volume. As found in the CNSC documents, there is some ambiguity surrounding the proportions of waste included in the ECM, as it is stated in the WAC that ~90% of the waste in the ECM would contain contaminated soils and building materials. Details on the proportion of wastes that will be accepted in the ECM should be consistent between the core documents.

The EIS stated that significant adverse effects on groundwater are not expected. It is unclear whether maximum concentrations will remain below applicable environmental quality criteria, or if there will be radiological attenuation and site-specific criteria for groundwater at the site. The expected spatial and temporal groundwater quality should be clearly defined so that potential environmental impacts can be accurately assessed, planned for, and approved.

The EIS is a substantive document that provided the environmental context of the NSDF project in detail. It filled several information gaps from previous documents, such as landfill gas monitoring considerations (Section 3.4.1.9.4), in which gas monitoring probes will be installed around the perimeter of the landfill, and exceedance levels for wastewater and special radionuclides, which will inform mitigation strategies and response frameworks. However, this document was not able to be reviewed in its entirety due to time constraints, and thus only sections pertaining to waste acceptance were reviewed. It is possible that many of the contextual shortcomings identified in the previous core documents are addressed in the EIS, although the key information is difficult to find without a detailed review. An overarching recommendation of the NSDF licensing is that key environmental impact monitoring and response frameworks should be summarized and made readily available in the core licensing documents.

Part 2: International Waste Acceptance Criteria

A cursory review of international documents pertaining to Waste Acceptance Criteria at other radioactive waste disposal facilities was conducted. Three facilities were identified in the international documents provided by Northwatch that were sufficiently similar to the CRL NSDF facility to warrant comparison (i.e., all have a shallow landfill-like ECM design). The Waste Acceptance Criteria were reviewed for the following three facilities: Lillyhall Landfill in Cumbria, UK; National Nuclear Security Site in Nevada, USA; and the Vaalputs facility in South Africa. The Paducah gaseous diffusion plant in Kentucky, USA, was also reviewed to compare landfill gas management strategies. Other facility WAC were not reviewed due to differing facility types (e.g., deep geological depositories).

National Nuclear Security Site, Nevada, USA

The National Nuclear Security Site in Nevada, USA is a multi-layer lined landfill system with leachate collection, conceptually similar in design to the CRL NSDF. The primary liner is composed of geocomposite and high-density polyethylene, and the secondary layer is composed of geocomposite mesh and synthetic clay liner. Low-level radioactive waste is stored in packages and stacked four feet below grade, covered with 8 feet of cover soil, and vegetated with native plants[4]. A water-permeable cap was not specified, but may be included or may not be needed for the low precipitation in Nevada.

The Waste Acceptance Criteria for the Nevada site included guidelines for waste in particulate form, stating that "waste known to be in fine particulate form or in a form that could mechanically or chemically be transformed to a particulate during handling and interim storage should be immobilized." Considerations for particle and radionuclide resuspension do not appear to be accounted for in NSDF WAC, which may be a particular concern for contaminated soil placement. Clarification should be provided for how particulate matter will be safely contained within the NSDF.

Only low-level radioactive waste is accepted at the Nevada site, and no provisions appear to be made for intermediate-level waste. Building materials, waste packages, mixed low-level waste (low-level radioactive waste mixed with hazardous waste), and contaminated media including groundwater, surface waters, sediments, and soils are accepted for disposal in the facility. Contaminated liquid waste must be converted to a form containing limited free-standing and non-corrosive liquids.

For packaged waste, packages with an activity of 3.7 MBq or greater are segregated from other waste and profiled as a separate waste stream. The NSDF limits activity levels up to 4000 Bq/g for individual waste packages, but it is not clear whether higher-activity packages are segregated from other waste streams during placement in the ECM. Similar guidelines for void space allowances are given in the Nevada WAC, stating that containers must be 90% full when placed in the landfill.

Screening of waste prior to disposal in the Nevada landfill differs from NSDF guidelines. Only 5% of waste containers must be physically inspected and screened (although all accepted waste is documented prior to acceptance), and 10% of visually inspected waste is then chemically screened. It is understood from the

[4] *Nevada National Security Site (2016). U.S. Department of Energy Public Meeting. Poster Presentation.*

NSDF WAC that all waste received on-site is physically characterized, which is an improvement over Nevada.

The Nevada site WAC contained limited environmental context. The design and leachate management were not well defined, nor were potential receivers and environmental risks. The Nevada National Security website states that three groundwater wells around the site are sampled semi-annually, and that horizontal groundwater velocity is 10 cm/year. The groundwater velocity at the Chalk River site was not clearly defined in the EIS or licensing documents and should be described to evaluate whether an appropriate groundwater monitoring program will be conducted.

Lillyhall Landfill; Cumbria, UK

The Lillyhall Landfill WAC document is shorter than other reviewed WAC documents. The landfill limits accepted waste to only high volume, very low-level radioactive waste. Hazardous waste, chelating agents, and free liquids are not accepted in the landfill, which differs from NSDF WAC, where chelating agents and free liquids are accepted for disposal. Total activity concentrations at the Lillyhall landfill must not exceed 4 Bq/g (but exceptions are made for tritium, which must not exceed 40 Bq/g), whereas the CRL NSDF has a limit of 400 Bq/g for long-lived alpha-emitting radionuclides and 4000 Bq/g for individual waste packages.

No framework was given in this document regarding environmental risks, potential pathways to receivers, or the infrastructure and design of the landfill, and therefore, limited comparisons can be made to NSDF.

Vaalputs facility, South Africa

The Waste Acceptance Criteria document for the Vaalputs facility was unable to be located, although the National Radioactive Waste Disposal Institute (NRWDI) of South Africa has included an overview of the facility design. Low-level waste is disposed of in trenches, which are backfilled and clay capped once filled, covered with 50 m of topsoil, and replanted with shallow-rooted vegetation. This facility appears to be much less robust than the multi-layered NSDF facility, which is likely why only low-level waste is accepted. Very little information was given on the types of low-level radioactive waste permitted at this facility.

Paducah Gaseous Diffusion Plant, Kentucky, USA

The Paducah Plant is a disposal facility for the decommissioning of a former uranium enrichment plant, environmental remediation, and nuclear waste disposal. According to the Paducah WAC, the facility accepts hazardous wastes (not permitted in the NSDF), regulated toxic wastes, LLW, mixed waste, transuranic wastes (having a half-life greater than 20 years and over 3700 Bq/g of alpha-emitting transuranic isotopes), and sanitary solid wastes. For transuranic wastes, more stringent protocols appear to be in place for reporting before disposal, including the estimated percent of combustible material, handling requirements, thermal power, and the number/type of sealed layers of packaging.

Leak detection protocols at the Paducah facility are provided, stating that “any leak test that shows 0.005 µCi or more of removable contamination will be considered evidence that the sealed source is leaking its radioactive contents. If a leak test cannot be performed because of handling or measurement limitations, the source will be assumed to be leaking." Leak detection protocols were not encountered in the NSDF WAC, and more clarification should be given regarding CNL's policies for detecting and responding to leaks in packaging before it is sealed in its respective cell.

General

The reviewed international WAC documents included very little environmental context, facility design information, or leachate management practices, and therefore the potential pathways from each facility and potential receivers have not been compared to the NSDF facility. As none of the above facilities appear to have made provisions for intermediate-level waste, it is possible that the NSDF facility has a more robust construction to facilitate the inclusion of legacy waste where intermediate-level radioactive waste cannot be feasibly separated.

SUMMARY

For ease of reference, the findings and recommendations from the NSDF review are provided in the table below.

Source Document	Summary of Potential Concern	Recommended Follow-up
Canadian Nuclear Laboratories (2020). Near Surface Disposal Facility Waste Acceptance Criteria. 232-508600-WAC-003. Revision 4.	There is some ambiguity regarding the types and quantities of intermediate-level radioactive waste that are acceptable in the NSDF.	The extent of allowable contamination and content of intermediate-level waste should be further defined by the proponent to prevent unacceptable quantities or types of intermediate-level waste from being deposited in the NSDF.
	There is some confusion if the PCSA was included in the NSDF licensing agreement.	If the PCSA is not included in the licence terms, once the NSDF is in the early stages of operation, a review should be conducted on long-term post-closure planning documents.
	In the terms of the licence, a description of the disposal facility design itself, potential pathways from the facility to the environment, and potential impacts and/or mitigation measures were not well described.	A summary of the design, potential contaminant pathways, mitigation strategies, wastewater treatment, and leachate collection would be useful in the WAC document to provide licence condition context, and should be included.

Canadian Nuclear Safety Commission (2022). Written submission from the Canadian Nuclear Laboratories, Commission Public Hearing Part 1, February 22, 2022 (CMD22-H7.1)	It is unclear whether decomposition of organic material and dewatering of soils have been accounted for in the design of the NSDF.	Further clarification should be given by the proponent regarding whether considerations have been made regarding leachate production from organics decomposition and soil dewatering.
	Landfill gas capture is mentioned in this licensing document, although it is not clear how methane gas production will be mitigated.	More clarification should be given in the licensing document to describe the landfill gas capture and gas monitoring for radionuclides.
	Exposure of the ECM cells to weather events prior to closure and sealing remains uncertain, as the potential for runoff and increased leachate production during precipitation events may cause unpredictable treatment volumes.	Additional information should be provided in the licensing document on how open cell precipitation treatment has been accounted for in the design and operation of the ECM.
	Groundwater monitoring across the site and in potential stratified groundwater regimes was not well described in licensing documents.	Clarification should be provided for concerns regarding the impacts on shallow vs. intermediate groundwater regimes, and/or contamination in the seasonally wetted zone, and monitoring of those concerns (if any).
	The guidelines for the maximum acceptable concentrations of radionuclides in groundwater are derived from Heath Canada's Drinking Water Quality Guidelines, which are not appropriate for surface water discharges.	Clarification should be provided for why Drinking Water Quality Guidelines were proposed and why the guidelines will be protective of ecological receivers and the aquatic environment. If Drinking Water Guidelines are not sufficiently protective, alternative appropriate guidelines should be included in the licence.
	The fate of the metals and radionuclides separated from the leachate during the water treatment process was not described in the background documents.	Collection and disposal of the residuals, which may contain elevated concentrations of metals and radionuclides should be clarified.

	CNSC stated that several radionuclides and non-radiological constituents may be present in the wastewater at concentrations exceeding discharge targets.	Contingency plans for treating leachate if the water treatment system is not operational should be provided.
	There is some ambiguity surrounding the number and volume of long-lived radionuclides (half-life >30 years).	The volume of allowable longer-lived radionuclides is not clear and should be specified.
	The method by which tritium will be pre-screened before on-site acceptance as a pre-treatment precaution was not well described.	The method should be clarified by the proponent to confirm that appropriate tritium pre-screening occurs.
	The environmental impacts and framework for detecting project-related effects are not well understood from this document.	A summary of or reference to these guidelines and mitigation strategies should be readily available in the CNSC Commission Member Document for ease of review and public confidence in the project.
Canadian Nuclear Safety Commission (2022). Licence Amendment, required approvals for the construction of the Near Surface Disposal Facility, Canadian Nuclear Laboratories Chalk River Laboratory, Commission Public Hearing Part 1, scheduled for February 22, 2022 (CMD22-H7).	If unacceptable waste is found, adequate actions will be taken to halt work, remove contamination, clean the area and evaluate disposal options, although the specific actions are not clear from this document.	Reference to protocols for the "adequate actions" should be provided for transparency and to ensure that unacceptable waste is handled appropriately by the licensee.
	"The waste acceptance criteria for the NSDF will limit the level of contamination, limiting the magnitude of surface water and groundwater quality changes," however no rationale was given for how this will protect surface water quality or what mitigation strategies will be implemented if a leak is detected.	Details on the response framework for detecting project-related effects should be provided, or a reference provided for response protocols in another document if water quality changes are detected.

	Waste that does not comply with the NSDF WAC will be temporarily stored in a separate controlled area, but details of the temporary storage area (i.e., containment protocols) were not included in this document.	Containment protocols for the temporary storage area, including a description of appropriate controls and monitoring, could be provided in the licensing documents for clarity and to ensure that ancillary temporary storage areas are adequately regulated by the licence.
Golder & Canadian Nuclear Laboratories (May 2021). NSDF Environmental Impact Statement 232-509220-REPT-004. Revision 3.	There is some ambiguity surrounding the proportions of waste included in the ECM, as it is stated in the WAC that ~90% of the waste in the ECM would contain contaminated soils and building materials.	Details on the proportion of wastes that will be accepted in the ECM should be consistent between the core documents and should be addressed by the licensee.
	It is unclear whether maximum concentrations will remain below applicable environmental quality criteria, or if there will be radiological attenuation and site-specific criteria for groundwater at the site.	The expected spatial and temporal groundwater quality should be clearly defined, so that potential environmental impacts can be accurately assessed, planned for, and approved.
	Key information regarding the environmental context of this project is difficult to find in this document without a detailed review.	Key environmental impact monitoring and response frameworks should be summarized and made readily available in the core licensing documents, even if contextual shortcomings are addressed in the EIS.
	The groundwater velocity at the Chalk River site was not clearly defined in the EIS or licensing documents.	Groundwater velocity should be described in the EIS and licensing documents to evaluate whether an appropriate groundwater monitoring program will be conducted.
National Nuclear Security Administration (2016). Nevada Security Site Waste Acceptance Criteria. U.S. Department of Energy.	Considerations for particle and radionuclide resuspension (included in Nevada WAC) do not appear to be accounted for in NSDF WAC, which may be a	Clarification should be provided by the licensee for how particulate matter will be safely contained within the NSDF.

	concern for contaminated soil placement.	
LATA Environmental Services of Kentucky (2013). Waste Acceptance Criteria for the Treatment, Storage, and Disposal Facilities at the Paducah U.S. Department of Energy Site. PAD-WD-0011/R1. U.S. Department of Energy, Office of Environmental Management.	Leak detection protocols (included in Paducah WAC) were not encountered in the NSDF WAC.	More clarification should be given by the licensee regarding CNL's policies for detecting and responding to leaks in packaging before it is sealed in its respective cell.

CLOSING

Thank you for the opportunity to conduct this review for Northwatch. If you have any questions or concerns, please contact Emily Ham at your earliest convenience.

Sincerely,
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NEAR SURFACE DISPOSAL FACILITY (NSDF)

IAA REF# 80122

CNSC REF# 2022-H-07

Comparative Study of NSDF Reference Sites

PREPARED ON BEHALF OF NORTHWATCH

RADIOACTIVE WASTE MANAGEMENT ASSOCIATES

Section 1 - Introduction

Canadian Nuclear Laboratories is proposing to construct and operate what they have named a "Near Surface Disposal Facility (NSDF)" at the Chalk River Laboratories (CRL) site. [1]

The Chalk River Laboratories site is situated on the Ottawa River on unceded Algonquin territory approximately 200 km west of Ottawa, approximately equidistant between Ottawa, Ontario and North Bay, Ontario.

The Proponent

The proponent operates as Canadian Nuclear Laboratories and is described as a private-sector company that is contractually responsible for the management and operation of nuclear sites, facilities and assets owned by Atomic Energy of Canada Limited (AECL).[2]

Atomic Energy of Canada Limited (AECL) is a federal Crown corporation responsible for the long-term, contractual arrangement with Canadian National Energy Alliance (CNEA) for the management and operation of Canadian Nuclear Laboratories (CNL) under a "Government owned, Contractor operated (GoCo) model". This follows the announcement by the Government of Canada in June 2015 of the selection of CNEA through a competitive procurement process.[3]

Canadian Nuclear Energy Alliance is a "engineering and technology companies" consortium consisting of Jacobs, Fluor, and SNC-Lavalin Inc. CNEA was formed to respond to the Government of Canada's procurement for the"Management and Operation of Atomic Energy of Canada Limited's (AECL) Nuclear Laboratories."[4]

Project Summary

The stated purpose of the NSDF Project is to "provide the permanent disposal of current and future low-level waste at the CRL site, as well as a small percentage of waste volume from off-site locations, in a manner that is protective of both the public and the environment. The practice of continuing to build additional temporary storage systems at the CRL site for low-level waste is not consistent with modern waste management principles. Further, the NSDF Project would enable the remediation of historically contaminated lands and legacy waste

[1] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-1
[2] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-1
[3] AECL Web site printout, dated 2016-06-22
[4] Canadian Nuclear Energy Alliance as found at http://www.cnea.co/about-us/, 2022-03-03

management areas, as well as the decommissioning of outdated infrastructure to facilitate the CRL site revitalization".[5]

The NSDF Project is proposed as a waste disposal facility which will utilize an engineered containment mound design built at ground surface and intended to hold up to 1,000,000 cubic metres (m3) of low-level waste. According to the 2021 version of the Environmental Impact Statement, the facility will feature 10 waste disposal cells, built in two phases.

The engineered containment mound, if approved and constructed as proposed, would include a multilayer base liner and cover system, where waste will be placed in between. The waste in each cell would be covered after the cell is full.[6] Purportedly, the NSDF would include only "low-level waste which contains primarily short-lived radionuclides with a restriction on waste containing long-lived radionuclides" with the supposition that this material will require isolation and containment for only up to a few hundred years. The engineered containment mound design life of 550 years would allow for radiologic decay of the waste inventory.[7] The waste types include contaminated soils from remediation activities, demolition debris from decommissioning work and general waste such as used personal protection clothing or equipment. The May 2021 EIS states that "the NSDF will primarily contain waste currently in storage at the CRL site, waste generated during environmental remediation and decommissioning activities now underway, as well as future waste that is expected to be produced as a result of on-going nuclear science and technology activities. A small percent of the waste volume will come from other AECL-owned sites (e.g., Whiteshell Laboratories), or from sources such as hospitals and universities." [8]

The facility's long term safety performance relies on a series of engineered barriers, including a base liner system comprised of a primary and secondary liner, a final cover system, and a perimeter berm. The base liner and final cover systems are composed of a combination of natural materials (e.g., compact clay liner) and synthetic materials (e.g., high density polyethylene geomembranes). The perimeter berm is constructed exclusively from natural materials. The proposed project design includes leachate collection and treatment systems. After treatment, the effluent will be discharged to ground via an exfiltration gallery.[9] When that system lacks sufficient capacity (e.g., under spring conditions), treated effluent will be discharged untreated directly to Perch Lake.[10]

The CRL site is located within the Canadian Shield, with bedrock outcrops throughout the region. Groundwater table depth varies significantly throughout the NSDF Project site and changes with the seasons. The average groundwater depths range from approximately 0.06 m

[5] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-1
[6] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-2
[7] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-3
[8] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021 ES-4
[9] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-4
[10] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-5

in the vicinity of the wetlands to 15.95 m in the northern section of the study area, which corresponds to the thickest overburden. Groundwater flow from the NSDF Project site is to the adjacent wetlands, and ultimately discharges into the Ottawa River via Perch Lake and Perch Creek.[11] The NSDF Project will alter the local hydrogeology, and groundwater levels and flows will be changed due to the construction of the NSDF Project. [12]

[11] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-9
[12]NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004, Revision 3, May 2021, ES-10

Purpose of the Comparative Sites Study

In their May 2021 Environmental Impact Statement, CNL argued that "the preferred option for disposal of low-level waste (LLW) is near surface disposal facilities (IAEA 2001)" and positioned their proposed Near Surface Disposal Facility as one such facility.

CNL went on to opine that "the effectiveness of such facilities for disposal of LLW has been demonstrated as illustrated through the following near surface facilities currently in operation in North America" and went on to describe projects within Canada that CNL is in the process of implementing in Port Hope and Port Granby Projects, referencing selected examples of NSDFs for LLW as provided in Table 2.5.2-1 of the EIS.

The referenced table provides a summary of information about a short list of facilities. In addition to the Port Granby and Port Hope sites, the table lists the Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility, the Portsmouth On-site Waste Disposal Facility, and the Fernald On-site Disposal Facility.

The Canadian sites are owned by the federal government and are the responsibility of Atomic Energy of Canada Limited but managed by Canadian Nuclear Laboratories. The U.S. sites are also owned by the federal government and managed by the Department of Energy under a variety of contractual arrangements.

Table 2.5.2-1: Attributes of Selected Near Surface Facilities in Canada and USA for Long-Term Management of Low-Level Waste

Facility	Location	Built	Status	Capacity (m3)	Waste Type	Climate	Annual Precipitation	Terrain	Distance to Nearest Surface Water Body
Proposed CNL Near Surface Disposal Facility	Ontario, Canada	Proposed	Proposed	1,000,000	LLW from past operations, environmental remediation and decommissioning	Wet	87 cm	On a ridge	~0.35 km to Perch Creek, 1.2 km to Ottawa River
Port Granby Long-Term Waste Management Facility	Ontario, Canada	2017	In Operation	774, 000	LLW, hazardous and mixed waste from uranium processing and environmental remediation	Wet	83 cm	Flat	0.7 km Lake Ontario
Port Hope Long-Term Waste Management Facility	Ontario, Canada	2017	In Operation	1,200,000	LLW, hazardous and mixed waste from uranium processing and environmental remediation	Wet	83 cm	Flat	0.1 km to Brand Creek, 3 km to Lake Ontario
Oakridge National Laboratories, Environmental Management Waste Management Facility	Tennessee, USA	2002	In Operation	1,300,000	LLW, hazardous waste from environmental remediation and decommissioning	Wet	140 cm	On a ridge	0.5 km to Bear Creek & Clinch River
Hanford Environmental Restoration Disposal Facility	Washington, USA	1996	In Operation	16,800,000	LLW, hazardous and mixed waste from environmental remediation and decommissioning	Arid	16 cm	Flat	12 km to Columbia River
Portsmouth On-site Waste Disposal Facility	Ohio, USA	Under Construction	Under Construction	1,000,000	LLW, hazardous and mixed waste from uranium processing	Wet	102 cm	On a ridge	2.4 km to Sciota River
Fernald On-site Disposal Facility	Ohio, USA	1996	Closed	2,250,000	LLW and mixed waste from uranium processing	Wet	105 cm	Flat	~1 km to Great Miami River

Similarly, in their 2016 Project Description,[13] CNL had stated that "the design of the NSDF is currently under development. It will be designed as an engineered mound, built at near-surface level on the CRL property, and resembling the plan for the Port Granby Project and licensed waste landfills established on many US Department of Energy sites; e.g., Idaho CERCLA Disposal Facility, Fernald On Site Disposal Facility and the Oak Ridge Environmental Management Waste Management Facility."

Northwatch's comment on the 2016 Project Description included the observation that while the project description referenced one Canadian project and three American projects stating that they "resemble" the not yet developed design of the NSDF, it provided no description of those projects, no analysis of similarities or differences in terms of waste volumes and characteristics and/or physical settings and did not even include references to these projects or source materials.

The purpose of this comparative sites study undertaken for Northwatch is to examine the validity of the statements made by CNL with respect to a) the effectiveness of the referenced facilities in isolating radionuclides from the environment, b) the relevance of the example facilities for review and consideration of the Near Surface Disposal Facility as an option for the long term management of radioactive wastes at the Chalk River site, and c) the alignment of this project with IAEA guidelines, as referenced by CNL.

[13] NSDF Project Description, 2016, as found at https://www.ceaa-acee.gc.ca/050/documents/p80122/114475E.pdf

Section 2 – Comparative Study

Section 2.1 Overview

As noted in the previous section of this report, in their May 2021 Environmental Impact Statement, CNL stated that the effectiveness of a facility such as the Near Surface Disposal Facility proposed for the Chalk River site has been illustrated by facilities currently in operation, including the Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility, the Portsmouth On-site Waste Disposal Facility, and the Fernald On-site Disposal Facility.

The four U.S. sites referenced - Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility, the Portsmouth On-site Waste Disposal Facility, and the Fernald On-site Disposal Facility – are all part of the the legacy of the U.S. nuclear weapons program, but each addresses only a portion of the contamination issues at its respective host site.

The nuclear weapons production complex is vast and includes 13 nuclear weapons sites located in 10 states. These sites include hundreds of factories, very large acreages, and are highly contaminated. They were created as the production sites for the uranium, plutonium and tritium used in atomic bombs, but they also produced a wide range of dangerous contaminants, including poisonous radionuclides and toxic chemicals which contaminated surface and subsurface water in the nuclear weapons complex and in many if not most cases the contamination migrated, moving off site. The contamination has threatened important municipal and agricultural water supplies and has placed major rivers at risk as well as being potentially hazardous to the water supply of several large cities.

Cleanup has been underway at the 13 nuclear weapons factories run by the Department of Energy (DOE) over the last few decades, and the four facilities cited by CNL in the 2021 EIS for the proposed Near Surface Disposal Facility are part of this cleanup effort.[14]

Nuclear Weapons States - the Challenge of Cleanup

The prestigious National Academy of Sciences in a 1999 report, *Groundwater and Soil Cleanup*, warns, "The Department of Energy faces monumental challenges in restoring the environment at installations that were part of the U.S. nuclear weapons production complex." The National Academy adds, "Despite the large amount invested in DOE environmental management, progress on groundwater and soil remediation has been slow."[15]

[14] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003

[15] National Research Council, *Groundwater and Soil Cleanup: Improving Management of Persistent Contaminants,* National Academy Press, Washington, D.C. 1999.

Eight years earlier, in 1991 the respected US Office of Technology Assessment also sounded an alarm about contamination levels in the nation's nuclear weapons production complex. In their detailed report, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production,* the agency says: "Contamination of soil, sediments, surface water, and groundwater throughout the weapons complex is widespread."

The report goes on to say: "Almost every facility has confirmed groundwater contamination with radionuclides or hazardous chemicals."[16]

History of the Nuclear Weapons Complex

In the early 1940s, the Atomic Energy Commission (AEC), later known as the Department of Energy, opened factories across the nation to design, construct and test nuclear bombs for use in World War II. The Manhattan Project, as this project was initially called, was run as a top-secret operation. The factories were typically sited near a river or lake or directly above ground water. At the time a water-rich location was seen as a plus because the nuclear reactors and other processes required large amounts of water. This plus has now become a terrible detriment as pollutants have migrated to these bodies of water and contaminated them, making cleanup exceptionally difficult.

On August 6, 1945 the US dropped an atomic bomb on Hiroshima, Japan, followed by another bomb dropped on Nagasaki three days later. Nuclear weapons production continued even after the war to build a stockpile of weapons as a part of the United States' military policies. By 1967 this arsenal totaled 32,000 nuclear weapons. Since then the arsenal has been reduced to approximately 10,000 long-range nuclear weapons.

In the 1980's the US stopped producing plutonium and tritium and started to shut down some of the nuclear weapons factories. This change was a result of the Cold War's end, new disarmament treaties and a shift towards recycling plutonium out of old, dismantled weapons.[17]

Spreading Contamination

Both surface and subsurface water systems are at risk from the DOE nuclear weapons factories. Some of the major rivers at risk include the Columbia River in Washington, the Clinch River in Tennessee, the Savannah River in South Carolina and Ohio's Great Miami River. Other smaller rivers are also impacted. Pollutants have been detected in several important aquifers, including, but not limited to, the Snake River Aquifer in Idaho, the Tuscaloosa Aquifer in South

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[16] US Congress, Office of Technology Assessment, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production*, 1991, p.23.
[17] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003

Carolina, Ogallala Aquifer in Texas and the Great Miami Aquifer in Ohio. (An aquifer is a permeable, water-bearing unit of rock or sediment that yields water in a usable quantity to a well or spring.) The contamination in these vital water systems includes dangerous long-lived radioactive pollutants and toxic chemicals. Among the affected cities, cities whose municipal water supplies are dependent on at-risk rivers and aquifers for all or portions of their municipal water supply, are Richland, Washington, Cincinnati, Ohio and Kingston, Tennessee.

Contamination has traveled from the DOE sites to the groundwater via many different routes. Precipitation and surface water are methods of recharge for aquifers. As precipitation encounters surface contamination it can percolate through the soil, carrying the pollutants down towards the aquifers. And as surface water flows, it carries contaminants from the surface further from their source and may spread the contamination into nearby streams and rivers, municipal reservoirs, as well as further offsite. Injection techniques, unlined landfills, trenches and pits, degrading waste containers, breaks in pipelines, or deliberate dumping also cause the spread of contaminants into the subsurface as well.[18]

Health Hazards

The health impact of radiation was poorly understood at the time of the construction of the weapons complex. Indeed, the use of radiation detectors and the idea of health physics were in their infancy when the weapons complex was built. The International Commission on Radiological Protection was officially formed in 1950, several years after Los Alamos and Oak Ridge were built; this commission is the international body that recommends radiation standards. As more information from Japanese bomb survivor data and other sources became available, it was apparent that no radiation dose was too small to cause cancer, that is, no threshold existed. Also, increasing the dose increased the likelihood of developing cancer.

Reckless Waste Management Policies

At the nuclear weapons factories immense quantities of radioactive and toxic chemicals were poured *directly* into the ground. Unbelievable as it seems today, millions of curies of radioactive materials and tons of toxic chemicals were poured into drainage ditches, seepage and evaporation ponds, and unlined burial grounds. From these unstable disposal sites, contaminants have quickly migrated to surface and subsurface water systems. Sometimes these contaminants were even directly poured or injected into underground bodies of water.

From the beginning, dilution was the DOE's method for solving many waste problems. Often concentrations of contaminants in groundwater at the site perimeter are reduced due to dilution. Thus, it appears as if the area is not heavily contaminated and makes it easier for a nuclear factory to meet regulatory guidelines regarding off-site emissions. From a public relations standpoint, out-of-sight-out-of-mind is certainly attractive. However, as

[18] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003

contamination spreads, more people are affected. According to prevailing scientific opinion, the total dose to the population is the important parameter. The linear no-threshold hypothesis holds that a dose of 100 rems to 100 people (1 rem per person to 100 people) or to 1000 people (0.1 rem per person to 1000 people) produces the same number of fatal cancers. Thus, dilution does not necessarily lead to fewer occurrences of cancer.

Furthermore, dilution does not take into account the fact that diluted radionuclides will travel long distances downstream from the point of release and reconcentrate in mollusks, fish, bird and other creatures that could be subsequently eaten by unsuspecting humans. For example, radioactively contaminated mussels have been found in Oregon, near where the Columbia River empties into the Pacific Ocean, over 200 miles downstream from the Hanford complex. Neither does dilution address the problem of radionuclides adhering to sediments along waterways such as riverbanks and streams. Subsequently, when water levels drop (for example during a drought) dangerous contaminants can be resuspended and travel in the direction of the prevailing wind.

Perhaps nowhere has DOE's dilution policy been more alarming than in the contamination of underground water. This is contamination that is almost impossible to map accurately and for which current technology does not allow for the complete cleanup.[19]

The Chalk River Connection

The Chalk River nuclear laboratories site shares this regrettable legacy of atomic weapons program with its American counterpart sites.

The British government began to plan a nuclear weapons research project in 1940, and in 1942 Canada accepted a British request to relocate the research project, first to the "Montreal Laboratory" based at McGill University and the Université de Montréal, and relocated to Chalk River just a few years later.

In 1943 Britain and the United States merged their nuclear weapons research program and the joint effort - agreed to at a Quebec conference - would later become the notorious Manhattan Project, to which Canada made three main contributions: Canada supplied and processed the uranium that the Americans used to research and then develop atomic bombs; Canada played a major role in researching the extraction and production of plutonium; and Canada provided many researchers and scientists, as well as key facilities for research and production, including and in particular the research facilities established in Chalk River in 1944.[20]

[19] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003
[20] "Canada and the Manhattan Project", by Taylor C. Noakes, Published Online August 21, 2020, Last Edited October 29, 2020 by the Canadian Encyclopedia, as found at

The ZEEP, housed in Chalk River, Ontario, was a small prototype reactor constructed to prove that natural uranium and heavy water could be used to create and sustain nuclear fission (also known as achieving “criticality"). The reactor was also used to demonstrate the design's potential to generate plutonium – an artificially created fissile material that can be extracted chemically from irradiated uranium fuel – for the Allies' military programs. The first reactor to achieve criticality outside the U.S. (in September 1945), the ZEEP served as the basis for the design of the NRX (National Research Experimental) reactor.

After the Manhattan Project was terminated in 1946, Chalk River Laboratories focused its efforts on medical and industrial applications of nuclear technology. A laboratory to extract plutonium from irradiated fuel rods from the NRX was developed and operated until 1954.

Between 1959 and 1964, about 252 kg of plutonium contained in used nuclear fuel was exported to the U.S. The material was transferred from Chalk River Laboratories to the Savannah River Site in South Carolina, where it was processed and blended with the remaining U.S. nuclear weapons program inventories.[21]

Chalk River was the site of two nuclear accidents in the 1950s. The first incident occurred on December 12, 1952, when there was a power excursion and partial loss of coolant in the NRX reactor, which resulted in significant damage to the core. The control rods could not be lowered into the core because of mechanical problems and human errors. Three rods did not reach their destination and were taken out again by accident. The fuel rods were overheated, resulting in a meltdown. The reactor and the reactor building were seriously damaged by hydrogen explosions. The seal of the reactor vessel was blown up four feet, and 4,500 cubic metres (1,200,000 US gal) of radioactive water were found in the cellar of the building. This water was dumped in ditches around 1,600 metres from the Ottawa River and an estimated 10 kilocuries (400 TBq) of radioactive material was released.[22]

A flatbed truck used to haul the intensely radioactive core to a nearby burial site was manned by a relay team of drivers, each spending just a few minutes behind the wheel before running away to limit their exposure to lethal radiation. A portion of the road was buried as radioactive waste. Thousands of litres of radiotoxic water and other contaminated reactor wreckage were put in sandy trenches. Radioactive wastes from the NRX accident remain a significant contributor to the immense toxic and radioactive legacy handed down from decades of nuclear research and nuclear materials production at the Chalk River Laboratories.[23]

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https://www.thecanadianencyclopedia.ca/en/article/canada-and-the-manhattan-project#:~:text=In%201943%2C%20the%20British%20nuclear,became%20the%20Chalk%20River%20Laboratory.

[21] Canada's historical role in developing nuclear weapons, May 28, 2012, Canadian Nuclear Safety Commission, as found at https://nuclearsafety.gc.ca/eng/resources/fact-sheets/Canadas-contribution-to-nuclear-weapons-development.cfm

[22] Jedicke, Peter (1989). "The NRX Incident". Canadian Nuclear Society. Retrieved 19 December 2021.

[23] Chalk Rivers toxic legacy, by Ian MacLeod, published by the Ottawa Citizen, Friday, December 16, 2011

The second accident, in 1958, involved a fuel rupture and fire in the National Research Universal (NRU) reactor building. Some fuel rods were overheated. With a robotic crane, one of the rods with metallic uranium was pulled out of the reactor vessel. When the arm of the crane moved away from the vessel, the uranium caught fire and the rod broke. The largest part of the rod fell down into the containment vessel, still burning. The whole building was contaminated. The valves of the ventilation system were opened, and a large area outside the building was contaminated. The fire was extinguished by scientists and maintenance men in protective clothing running along the hole in the containment vessel with buckets of wet sand, throwing the sand down at the moment they passed the smoking entrance.[24]

Both accidents required a major cleanup effort involving many civilian and military personnel and contributed significantly to the contamination at the Chalk River site. The 37-square-kilometre site along the Ottawa River harbors 70 per cent of all the radioactive waste ever produced by Atomic Energy of Canada Ltd. (AECL) and its predecessor, the National Research Council of Canada.

Like its DOE counterparts struggling to clean up U.S. nuclear weapons complex sites, Atomic Energy of Canada launched a multi-billion dollar multi-decade federal cleanup effort of its "legacy" wastes in 2004. More than half of the federal nuclear legacy liabilities are the result of Cold War activities in the 1940s, '50s and '60s, when the risks of atomic waste were not well known, and regulations were less stringent. The rest is from research and development for nuclear reactor technology, medical isotope production and national science programs.

The cleanup includes: the Chalk River Laboratories, the former Whiteshell Laboratories (and nearby Underground Research Laboratory) in Manitoba, two closed heavy water plants and three partially decommissioned prototype power reactors at Rolphton located 30 kilometres northwest of Chalk River, Douglas Point on the eastern shore of Lake Huron in Bruce County, and the WR1 reactor on the Winnipeg River in Manitoba. As Canada's primary nuclear science establishment since the 1940s, Chalk River poses the most complex cleanup.[25]

Just as the four U.S. sites referenced - Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility, the Portsmouth On-site Waste Disposal Facility, and the Fernald On-site Disposal Facility – will address only a portion of the contamination issues at each respective host site, CNL’s proposed Near Surface Disposal Facility will address only a portion of the contamination issues at the Chalk River Site.

[24] The Canadian Nuclear FAQ What are the details of the accident at Chalk River's NRU reactor in 1958? Archived 2009-01-30 at the Wayback Machine
[25] Chalk Rivers toxic legacy, by Ian MacLeod, published by the Ottawa Citizen, Friday, December 16, 2011

Section 2.2.1

Oakridge National Laboratories Environmental Management Waste Management Facility

The Oakridge National Laboratories Environmental Management Waste Management Facility was one of four U.S. nuclear waste management facilities identified in CNL's May 2021 Environmental Impact Statement as examples of the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility.

As outlined in the previous section of this report Oakridge National Laboratories Environmental Management Waste Management Facility is part of the the legacy of the U.S. nuclear weapons program – in this case, the Oak Ridge Reservation – but the facility addresses only a portion of the contamination issues at its host site.

The Oak Ridge Reservation is located in eastern Tennessee. The site is comprised of three major industrial complexes: Oak Ridge National Laboratory, Oak Ridge East Tennessee Technology Park, and the Nuclear Weapons Components. Weapons production activities at this site have included enriching uranium at the gaseous diffusion plant and producing machined components for nuclear weapons assembly.

The Knox Aquifer is the main aquifer located beneath the site and it has been contaminated with mercury, strontium, and thorium. There is an abundance of surface water onsite and contamination has traveled into the aquifer via surface water. Cs-137 and Hg were released from the White Oak Dam and are present in sediments in the downstream Watts Bar reservoir. The causes of the pollution have also included deep injection, unlined pits, deliberate releases into onsite streams, leaking waste burial grounds, waste storage tanks, spill sites, seepage ponds, contaminated inactive facilities, and hydrofracturing. Hydrofracturing is a waste disposal "technique" through which fractures are made by pumping fluids under great pressure into boreholes, after which wastes encased in cement are placed in the enlarged fractures.

At Oak Ridge, some landfills were placed directly in aquifer discharge areas. The US Southern Regional Burial Ground, sometimes called Burial Ground 4, placed waste, including significant amounts of strontium-90, in continuous contact with groundwater.[26]

Environmental Management Waste Management Facility

In May 2002, the Department of Energy (DOE) opened the Environmental Management Waste Management Facility (EMWMF), a multi-celled, above grade disposal facility located on the Oak Ridge National Laboratory Reservation (ORNL) near the Y-12 facility in Oak Ridge, Tennessee. The facility was

[26] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003

part of an accelerated cleanup program to provide disposal of waste from DOE burial sites at the Oak Ridge Reservation, which includes multiple facilities and waste areas.

The Environmental Management Waste Management Facility was constructed as a series of waste disposal cells. The design included stormwater being diverted around the disposal cells, and rainwater that fell on the cells being pumped to one of four contact water ponds. The contact water ponds were expected to be tested to assure the level of contaminants met the release levels outlined in protocols and, when full, would be pumped to a sediment basin where it would be held allowing the suspended solids to settle out before being released into Bear Creek.

Each contact water pond could hold 350,000 - 400,000 gallons of water and all were synthetically lined to prevent seepage. This water was to be managed for both radioactive contaminants and chemical constituents for the known waste streams accepted.

DOE contracted with Bechtel-Jacobs Company (BJC) to operate the facility. Bechtel Jacobs Company LLC is a limited liability company owned by Bechtel and Jacobs Engineering Group that served as the primary contractor to the U.S. Department of Energy (DOE) for waste management and environmental remediation activities on DOE-managed federal government properties in Oak Ridge, Tennessee.

While Bechtel-Jacobs Company held the contract with DOE, BJC subcontracted actual landfill operations and management to Duratek Federal Services (DFS), the company that was later charged with environmental violations at the EMWMF.

Bechtel Jacobs was established as the environmental management contractor for DOE's Oak Ridge operations (including sites in Paducah, Kentucky and Piketon, Ohio, in addition to Oak Ridge) in 1997, when a $2.5 billion management and integration contract was issued to the company. In 2003, Bechtel Jacobs was awarded a new 5-year cost-plus-incentive-fee contract with an estimated value of $1.8 billion.[27] Bechtel Jacobs was replaced as the environmental remediation contractor for the Portsmouth Gaseous Diffusion Plant site in Piketon in 2005,[28] and their involvement at the Paducah Gaseous Diffusion Plant site ended in 2006[29] after DOE entered into contracts with other service providers. Bechtel Jacobs' role in Oak Ridge ended in 2011 after the environmental management contract for DOE properties there was awarded to a different company.[30]

Jacobs, a partner in Bechtel Jacobs, is also one of three corporations that comprise Canadian Nuclear Energy Alliance; as previously noted in this report, CNEA is the operator of Canadian Nuclear Laboratories under a Government-owned / contractor-operated business arrangement between AECL and CNEA.

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[27] U.S. Department of Energy Awards Portsmouth Remediation Contract To LATA/Parallax; $141 Million Small Business Contract Runs Through September, 2009 Archived 2009-04-12 at the Wayback Machine, U.S. Department of Energy press release, January 10, 2005

[28] LATA/Parallax Portsmouth, LLC website Archived 2008-07-04 at the Wayback Machine

[29] Joe Walker, DOE plant site gets new cleanup firm; Shaw Environmental and Infrastructure and Portage Environmental will replace Bechtel Jacobs at the Paducah Gaseous Diffusion Plant, Paducah Sun, December 28, 2005

[30] Frank Munger (May 23, 2011). "The UCOR era begins in Oak Ridge". Atomic City Underground. Knoxville News Sentinel. Archived from the original on February 16, 2013.

Environmental Concerns

The Southern Environmental Law Center, acting on behalf of several public interest groups in the area, has set out a list of environmental concerns related to the EMWMF to the U.S. Environmental Protection Agency in several communications, including:

- Water pollution is occurring as a result of the operations at the Environmental Management Waste Management Facility.
- he EMWMF has been discharging radionuclide pollution into Bear Creek for many years.
- There are no real limits on the discharges of radionuclide pollution into Bear Creek
- the radionuclide pollutants include chemicals that are known to cause cancer and are bio-accumulative, meaning they will continue to build up in waterways, fish and other wildlife over time.
- The contamination will have a major impact on communities that fish and enjoy Bear Creek and the Clinch River; signs installed in 2016 told people not to eat the fish in an area downstream from the EMWMF.
- The contact water holding ponds at the existing EMWMF have come close to failing in the past during heavy rain events, and as a result, thousands of gallons of untreated wastewater containing radionuclides and other hazardous pollutants have been discharged from EMWMF into Bear Creek.[31]
- Contact water holding ponds at the existing EMWMF have come close to failing in the past during heavy rain events, and as a result, thousands of gallons of untreated wastewater containing radionuclides and other hazardous pollutants have been discharged from EMWMF into Bear Creek.[32]
- The EMWMF was not always operated consistently with federal law; for example, there is no authorization for discharge of landfill wastewater to surface water, but an EMWMF contractor had an unauthorized release of landfill wastewater containing radionuclides to Bear Creek during 2002 to avert a pond failure (see next section on Environmental Violations).
- EMWMF wastewater has been discharged to Bear Creek surface water for over 18 years without the necessary authorization to discharge landfill wastewater with radionuclides in the absence of legally compliant and protective discharge criteria.
- The EMWMF WAC included a limited set of radionuclides and are likely not protective of human health associated with future groundwater use.

[31] "Environmental group has concerns for future landfill", by Benjamin Pounds, Oakridger dated as found at https://www.oakridger.com/story/news/2022/03/02/environmental-group-has-concerns-future-landfill/9047743002/

[32] *See, e.g.,*Att. 2, Plea Agreement, *United States v. Duratek Federal Services*, No. 3:06-cr-00172-CCS (E.D. Tenn. 2006); Att. 3, Factual Basis at 2–3, *United States v. Duratek Federal Services*, No. 3:06-cr-00172-CCS (E.D. Tenn. 2006).

- Unlimited amounts of radionuclides without WAC may be disposed and those radionuclides are not tracked and used to determine if the landfill is in overall compliance with waste acceptance criteria.
- Even though EMWMF has released contact water to Bear Creek since 2003, fish samples from Bear Creek and lower East Fork Poplar Creek were not being analyzed to evaluate levels of radionuclides in fish that people may eat from 2003 through 2019, and the frequency of radionuclide analysis and radionuclides to be analyzed in future fish sampling remains unclear.[33]

As of July 2021 the EMWMF was at 78% capacity. A second similar facility, the Environmental Management Disposal Facility (EMDF) is being proposed for a nearby and similar location. The second facility will be for similar waste types, described by the Department of Energy (DOE) as "soil and soil-like materials" and demolition debris from ongoing clean-up efforts at Y-12 and ORNL (both are part of the Oak Ridge Reservation). Local conservation groups are opposing the construction of the next landfill, arguing for alternate proposals which would see the waste managed in a different and drier location. [34]

Environmental Violations

The following statements are excerpts directly from the Agreed Factual Basis in the case of the United States District Court Eastern District of Tennessee versus Duratek Federal Services:

- Samples of the contact water in the ponds was expected to be collected by DFS and sent to a designated lab for analysis.
- Prior to water being released from the ponds the water must meet DOE Order 5400.5 and Tennessee Department of Environment and Conservation (TDEC) Rule 1200-4-3 Water Quality Criteria.
- The procedure (DFS-OP-009) in place at the time of discharge did not allow the use of annual averaging of the concentration of radiological constituents.
- Once water is ready for release it was to be pumped into the east/west diversion ditch to a sediment basin that holds up to 1.5 million gallons and then to the north tributary (nt 5) that empties into Bear Creek.
- If the analysis exceeded release criteria, the water in the contact water ponds was supposed to be pumped to a Leachate Tank and shipped to the ORNL Waste Water Treatment Plant, treated and then released at ORNL.
- In mid-August 2002, STL Richland Lab, Richland, Washington, received water samples from DFS which were analyzed and found to contain radiological constituents.
- DFS was notified the results were above release criteria for one of the ponds. The ponds were full due to heavy rains in the area that had occurred in July that year.

[33] Southern Environmental Law Center, Attachment to 11/4/2021 Letter to EPA Administrator Michael S. Regan
[34] "Environmental group has concerns for future landfill", by Benjamin Pounds, Oakridger dated as found at https://www.oakridger.com/story/news/2022/03/02/environmental-group-has-concerns-future-landfill/9047743002/

- On September 22 and 23, 2002, heavy rains from the remnants of Hurricane Isadore filled the waste cells and the contact water ponds.
- The storm caused the cell walls to breach allowing cell one storm water to commingle with cell two.
- On September 23, 2002, the landfill manager, David Williams, learned from weather reports that another heavy rainfall was imminent. The landfill manager determined that if the water in the cells was not pumped off the cells, it would breach causing a complete failure of the disposal cells which would destroy the disposal cells, damage downgradient features, and allow the buried waste to be exposed and wash into waters of the United States.
- The landfill manager determined that the leachate tanks would not contain the amount of water from the cells and contact ponds.
- To avert this potential disaster, the landfill manager met with BJC officials on September 24, 2002, to discuss measures that could be employed to address the water in the cells and the ponds.
- The landfill manager was aware that one of the two ponds exceeded release criteria as set out in the protocols existing at that time. Because there was nowhere for the water in the cells to be pumped, the contact water ponds needed to be emptied to accommodate the anticipated volumes of water from the cells. As such, the landfill manager began pumping the ponds to the sediment pond.
- During the night of September 24, 2002, the landfill manager became concerned that the water in the contact ponds was not being pumped rapidly enough to beat the impending storm. In order to speed up the process, the landfill manager, without notification to or consultation with any Duratek management, decided on his own to use a portable pump to pump the water in one of the ponds into a drainage ditch which ran directly into Bear Creek, bypassing the sediment basin and the established treatment procedure and protocols.
- As a result, the landfill manager allowed 350,000-400,000 gallons of contact water containing radionuclides to bypass the sediment basin and the water was discharged directly into Bear Creek.[35]

A Plea Agreement was reached between the U.S. Attorney for the Eastern District of Tennessee and the defendant Durateck Federal Services, and the defendant agreed to plead guilty to the misdemeanor violation outlined in the agreed upon facts and to pay a combination of fines and fees amounting to $300,000. [36]

Three observations directly relevant to the CNL claim that the Oakridge National Laboratories Environmental Management Waste Management Facility provides an example of the

[35] Agreed Factual Basis in the case of the United States District Court Eastern District of Tennessee versus Duratek Federal Services

[36] U.S. Attorney for the Eastern District of Tennessee v. Durateck Federal Services, Case 3:06-cr-00172-CCS Document 2 Filed 12/14/06

effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility can be drawn from this violation, including the related Agreed Factual Basis and the resultant settlement:

- The operation of the EMWMF does not demonstrate the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility.
- The contractor Bechtel Jacobs Limited was made aware of the situation and the associated risks to the environment prior to the events.
- The environmental violations resulted from a combination of design and operational failures: There was insufficient water storage capacity as part of the facility design and there were operational decisions made which resulted in environmental harm as a result of those design limitations

Section 2.2.2 Hanford Environmental Restoration Disposal Facility

The Hanford Environmental Restoration Disposal Facility was one of four U.S. nuclear waste management facilities identified in CNL's May 2021 Environmental Impact Statement as examples of the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility.

As outlined in the previous section of this report the Hanford Environmental Restoration Disposal Facility is part of the the legacy of the U.S. nuclear weapons program, but the facility addresses only a portion of the contamination issues at the larger host site.

The Hanford Nuclear Reservation is the most contaminated site in the United States. The site includes 56 million gallons of radioactive waste being stored in old, leaky underground tanks just a few miles from the Columbia River. There is a plan to clean up this 56 million gallons of waste, at a cost of $2.4 billion per year, but after more than 20 years, none of the worst waste has been cleaned up.

Hanford is located in Southeastern Washington state and is 586 square miles. The Department of Energy owns the Hanford Site and controls major cleanup decisions and priorities, but contracts private sector operators —like Bechtel, AECOM, and CH2MHill—to do the actual cleanup.
Along the river, there are nine old nuclear reactors. The Central Plateau, located in the center of the site, is where the tank farms, the worst of the waste is located, along with a Waste Treatment Plant designed to turn the liquid waste in the tanks into a solid glass (a process called vitrification), with a longer-term intention to bury the vitrified waste in a hypothetical deep geological repository.[37]

The site was originally established as part of the Manhattan Project to support the nuclear weapons program with missions that included reactor operations, chemical separations,

[37] "What is Handford?", produced by Hanfordchallenge.org as found March 2022 at https://www.hanfordchallenge.org/whatishanford

fabrication, and research. It was this mission that left a legacy of contaminated sites along a major waterway, the Columbia River.[38]

At this site in south-central Washington, nearly two-thirds of the nation's inventory of high-level waste is stored in massive tanks, 68 of which are known or suspected to have leaked over a million gallons. Hanford reprocessed nuclear fuel and produced plutonium. Carbon tetrachloride, chromium (vi), nitrates, tritium, iodine-129, uranium, strontium-90 and plutonium-239 and 240 are some of the identified pollutants in groundwater at Hanford. Cesium-137 and technetium-99 have been found deep underground beneath the high-level waste tanks and are moving towards the Columbia River.[39]

During production years, more than 100 billion gallons of waste water were discharged to the ground, contaminating it, the groundwater below, and often reaching the Columbia River. The most hazardous and radioactive waste, 56 million gallons, was stored in 177 underground tanks. Boxes and barrels containing chemical and radioactive waste were dumped in unlined trenches. Large pieces of contaminated equipment were buried underground in rail cars. Items dumped in unlined trenches included lab materials, liquids, solids, office waste, etc., and were radioactive or hazardous.[40]

An underground mound of contaminated groundwater formed has been spreading and migrating out into the environment since reprocessing operations ceased. Over 200 square miles of groundwater beneath Hanford are contaminated. The 200-Area, where reprocessing and waste disposal took place, will be restricted forever.[41]

Hanford Environmental Restoration Disposal Facility

ERDF accepts only Hanford waste including low-level radioactive, hazardous, and mixed wastes. Today the landfill has taken in more than 18 million tons of waste and has a capacity of about 20 million tons.

The Environmental Restoration Disposal Facility (ERDF) is a waste disposal facility located in Area 200 at the Hanford Nuclear Reservation. ERDF is a large, multi-cell CERCLA waste disposal facility located just southeast of the 200 West Area on the Central Plateau. ERDF was

[38] HANFORD ENVIRONMENTAL RESTORATION DISPOSAL FACILITY: AN OPERATION AND PRIVATIZATION SUCCESS Joel A. Eacker, Waste Management Federal Services, Inc, as found March 2022 at http://archive.wmsym.org/1998/html/sess19/19-06/19-06.htm

[39] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003

[40] Hanford Overview, Department of Ecology, State of Washington, as posted March 2022 at https://ecology.wa.gov/Waste-Toxics/Nuclear-waste/Hanford-cleanup/Hanford-Overview

[41] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003

constructed using a double liner and a leachate collection system and is used to dispose of hazardous and dangerous waste, low-level radioactive waste, as well as mixed waste that meets, or has been treated to meet, land disposal restrictions, and ERDF waste acceptance criteria.[42]

Built in 1996, ERDF accepts low-level radioactive waste, mixed waste, and other hazardous materials that are generated at Hanford. The main storage facilities consist of single layer tanks that hold in all more than 17 million tons of nuclear waste. As of 2011, two new "super tanks" which hold double the amount of the single layer tanks were installed. Liners were previously installed to collect liquid released by the tanks or rain water that may seep in. The ERDF does not accept liquid waste, but water that seeps into the landfill is treated to keep the surrounding environment safe.[43]

The Hanford Site's Environmental Restoration Disposal Facility (ERDF), operated by contractor CH2M HILL Plateau Remediation Company, receives low-level radioactive, hazardous, and mixed wastes that are generated during cleanup activities at Hanford.[44]

Wastes at the ERDF vary dramatically in quantities, characteristics and contaminants of concern. Generating sites include reactor complex areas, chemical treatment facilities, liquid waste disposal sites, solid waste disposal sites, research facilities, and various miscellaneous clean-up efforts. A reactor complex, as an example, produces a large variety of wastes from the actual reactor structure, primary coolant systems and piping, secondary systems and piping, fuel storage basins, laboratories, and ancillary equipment needed to operate the reactor. Wastes produced at such a site include bulk soils, demolition debris, contaminated equipment, stabilized/treated sludge, irradiated hardware, and numerous types of scrap steel, piping, and other miscellaneous materials. [45]

Contaminants of concern also vary greatly based upon the original function of the generating site. Radioactive isotopes include alpha, beta, and gamma emitting isotopes from nuisance levels to contamination and direct radiation levels that require special handling and protective equipment. Hazardous constituents include RCRA listed wastes, RCRA characteristic wastes, toxic substances, and mixed wastes. This wide spectrum of anticipated contaminants was a significant factor in developing the facility design and providing the appropriate operational controls to ensure worker safety.

[42] Hanford Site Third CERCLA Five-Year Review Report, page 83-84, DOE/RL-2011-56, Rev. 1, Date Published March 2012 Prepared for the U.S. Department of Energy Assistant Secretary for Environmental Management

[43] "Environmental Restoration Disposal Facility - Hanford Site". hanford.gov. Retrieved 2016-11-01.

[44] https://www.facebook.com/HanfordSite/photos/the-hanford-sites-environmental-restoration-disposal-facility-erdf-operated-by-c/10156491574171330/

[45] HANFORD ENVIRONMENTAL RESTORATION DISPOSAL FACILITY: AN OPERATION AND PRIVATIZATION SUCCESS Joel A. Eacker, Waste Management Federal Services, Inc, as found March 2022 at http://archive.wmsym.org/1998/html/sess19/19-06/19-06.htm

Bulk soils represent the vast majority of the waste forms and are handled through dumping, placement by bulldozers, and compaction in place to meet structural requirements. Water or recycled leachate is used for both compaction purposes and dust control. The arid Hanford environment has made optimum water moisture in materials critical in achieving design compaction.

Special wastes at ERDF are those that require handling by other equipment and/or special procedures to ensure worker safety or prevent release of contamination to the environment. Large equipment including fans, piping, tanks, and other miscellaneous hardware have required some form of stabilization to ensure compaction in the landfill. A common waste from the decontamination and decommissioning efforts at the site have led to the use of grout, contaminated fill, or sand to prevent differences in subsidence in the landfill. [46]

Since beginning operation on July 1, 1996, more than 10.2 million tons (9.25 million metric tons) of remediation waste has been disposed of at ERDF. Approximately 12.6 million gallons (47.7 million liters) of ERDF leachate have been treated or recycled, and approximately 82.45 tons (74.8 metric tons) of waste has been treated at ERDF prior to disposal. The two initial disposal cells reached their operational capacity in August 2000 and an interim cover was installed. In 2009, the initial interim cover was extended 500 feet (152.4 meters) to the east. Six additional disposal cells have been constructed, all of which have been placed into operation.[47]

The Facility is one of 45 different projects, project areas or defined waste areas delineated within the Hanford Nuclear Reservation.[48]

Project Irregularities

Project activities at Hanford have received media attention because of the high costs, missed deadlines, and design flaws. For example, a vitrification plant was originally supposed to cost a little over $4 billion dollars and start making glass in 2008, but the latest estimate for treating dangerous waste is 2036 and will cost more than $16.8 billion dollars.[49]

An independent technical review investigated operational irregularities at the Environmental Restoration Disposal Facility (ERDF) and found the irregularities included (i) failure to recognize that pumps for the leachate collection system were not functioning for an extended period and (ii) falsification of compaction data by a technician responsible for monitoring waste placement

[46] HANFORD ENVIRONMENTAL RESTORATION DISPOSAL FACILITY: AN OPERATION AND PRIVATIZATION SUCCESS Joel A. Eacker, Waste Management Federal Services, Inc, as found March 2022 at http://archive.wmsym.org/1998/html/sess19/19-06/19-06.htm

[47] Hanford Site Third CERCLA Five-Year Review Report, page 83-84, DOE/RL-2011-56, Rev. 1, Date Published March 2012 Prepared for the U.S. Department of Energy Assistant Secretary for Environmental Management

[48] https://www.hanford.gov/page.cfm/ERDF

[49] "What is Handford?", produced by Hanfordchallenge.org as found March 2022 at https://www.hanfordchallenge.org/whatishanford

in the ERDF. Other issues related to compaction of the waste were also considered during the independent technical review.[50] A number of important lessons were learned as part of this review. These lessons are summarized below.

In May 2006 an incident affected the pumps that are designed to operate automatically when the level of leachate exceeds prescribed settings. The contractor did not discover the inoperable leachate pumps until December 2006 – a full seven months later - although technicians were aware of the lack of flow from the pumps and have even documented it.

This circumstance sparked an investigation which revealed another irregularity: some of the waste compaction test data did not correspond to the Radiological Control Technician records of entry into the contaminated area where compaction tests are performed. Upon investigation, it was discovered that the technician who was responsible for taking the compaction tests had not performed the tests and had been fabricating the test data since June 2005.

The response from DOE and the US Environmental Protection Agency (EPA) upon being notified of the operational breaches was to place the ERDF in standby mode from January 12th until EPA issued a consent to resume waste placements a week later in an area that had not yet been used.

An independent technical review team to assess the impacts of these operational irregularities was established, carried out a site visit in March 2007, met with EPA staff involved with oversight of the ERDF and received a detailed briefing from the ERDF operations staff, and reviewed extensive technical documentation regarding the design and operation of the ERDF after the site visit and facility tour. The review team pursued seven different lines of inquiry; their review generated the following findings:

- Root cause analysis of why the falsification of compaction data went undetected for several months included shortcomings in past procedures, a lack of accountability of the subcontractor and lack of visual verification of testing.
- The root cause analysis did not address factors contributing to failure of the leachate pumping system or the contractor's inability to identify that pumping was not occurring for an extended period; the reason for the pump failure remains unknown.
- Analyses indicated that the problem would have been noticed had the pumping rate been regularly compared to historical pumping rates.
- Analysis of the impacts of the excessive leachate level did not assess the most significant impact associated with the elevated leachate level, i.e., whether the excessive leachate level cause additional leakage from the ERDF.
- The most significant issue regarding waste compaction is whether the compacted waste fill in the ERDF will provide adequate support for the final cover. The analysis conducted by the contractor indicated that results of waste compaction testing between January

[50] C.H. Benson, Wisconsin Distinguished Professor, et al, "Evaluating Operational Irregularities at Hanford's Environmental Restoration Disposal Facility", WM2008 Conference, February 24-28, 2008, Phoenix, AZ

2002 and January 2007 were questionable given that a considerable portion of the data was falsified, and in many cases where measurements were made, the technician was re-doing tests to find an area that met the compaction criteria and both of these actions cast considerable doubt on the reliability of the density testing during this period.

- The ITR team concluded that the density methodology that has been used to evaluate compaction at the ERDF has many technical flaws and is of questionable value.
- Documentation was not available to confirm that the 3:1 ratio (soil to debris), or the number of containers over which this ratio can be averaged (24), was adequate to support the final cover for the ERDF.
- The ITR team concluded that additional information or demonstrations are needed to verify that the compaction criterion is adequate.
- The team determined that the soil pressure requirement has not been directly related to the compaction criterion.
- The ITR team also concluded that the information currently available is insufficient to confirm that the existing compaction specification and compaction methods are adequate to ensure that the waste will provide a stable foundation for the final cover to be placed on the ERDF.[51]

Interestingly, despite these project irregularities, the CERCLA 5 Year Report for the period of 2005 to 2011 simply reported the ERDF as "operating as required to meet the objectives outlined in the ROD for disposing of waste from all Hanford CERCLA activities".[52]

Project Evolution

Hanford's massive landfill, known as the Environmental Restoration Disposal Facility (ERDF), is located in Hanford's 200 area and was originally constructed in 1996. Since being built, ERDF has seen four major expansions.[53]

The Environmental Restoration Disposal Facility was authorized in January 1995 to provide waste disposal capacity for cleanup of contaminated areas on the Hanford Site. The first ERDF Record of Decision provided the overall plan for construction of the facility and disposal of remediation waste from the Hanford Site.

Since that initial approval, there have been multiple amendments to the project authorization, and so to the project itself. These include but are not limited to:

- allows for the disposal of investigation-derived waste; D&D waste; waste from RCRA past-practice OUs and closures; and non-RCRA waste from inactive TSD units

[51] C.H. Benson, Wisconsin Distinguished Professor, et al, "Evaluating Operational Irregularities at Hanford's Environmental Restoration Disposal Facility", WM2008 Conference, February 24-28, 2008, Phoenix, AZ
[52] Hanford Site Third CERCLA Five-Year Review Report, Executive Summary Page iii and
[53] Hanford Overview, Department of Ecology, State of Washington, as posted March 2022 at https://ecology.wa.gov/Waste-Toxics/Nuclear-waste/Hanford-cleanup/Hanford-Overview

- authorizing the conditional use of ERDF leachate for dust suppression and waste compaction
- authorizing expansion of the facility by constructing two new disposal cells and to allow for limited waste treatment at ERDF
- authorizing the delisting of ERDF leachate; this was done to "allow for implementation of more cost-effective and appropriate leachate handling techniques".
- authorizing the second ERDF expansion to disposal cells 5 through 8, and allowed the staging of remediation waste at ERDF while awaiting treatment
- authorizing disposal of certain Hanford Site waste in storage and created a 'plug-in' approach of Hanford-only generated waste in storage for ERDF disposal Hanford Site
- authorizing super cells 9 and 10, including modification of the cell design to allow a single 'super cell' to be used in place of the double cell side-by-side configuration described in the initial ROD
- authorizing the addition of future ERDF cells upon EPA approval through the issuance of a fact sheet by DOE, rather than using the ROD amendment process required by the original ERDF ROD[54]
- authorizing ERDF leachate to be transferred to either the ETF located in the 200 East Area or the 200 West Area P&T for treatment; previously, excess leachate from ERDF operations was collected and transferred by pipeline to the ETF.
- authorizing placement of certain long, large, and/or heavy hazardous waste items in an ERDF trench prior to completing the required land disposal restriction treatment because treatment prior to placement results in greater risk to human health and the environment.[55]

Observations

Three observations directly relevant to the CNL claim that the Hanford Environmental Restoration Disposal Facility provides an example of the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility can be drawn from the irregularities and the project evolution observed at the ERDF:

- In the GOCO model in place at the Hanford Environmental Restoration Disposal Facility, a lack of oversight from both the contractor and the site owner was observed, which allowed key equipment failures to continue undetected for seven months and a falsification of documents to be carried out over a period of years.
- Government agency oversight reports failed to note even such significant failures as those noted immediately above.

[54] Hanford Site Third CERCLA Five-Year Review Report, page 83-84, DOE/RL-2011-56, Rev. 1, Date Published March 2012 Prepared for the U.S. Department of Energy Assistant Secretary for Environmental Management
[55] Hanford Site Fourth CERCLA Five-Year Review Report, page 3-39, Date Published March 2017, Prepared for the U.S. Department of Energy Assistant Secretary for Environmental Management

- The initial authorization for the facility changed significantly even in the first decade of operation. It began with an expansion of the acceptable wastes in the first year after initial authorization and an expansion of the size of the facility the following year; multiple additional expansions to the authorization have continued throughout the operating period.

Section 2.2.3 Fernald On-site Disposal Facility

The Fernald On-site Disposal Facility was one of four U.S. nuclear waste management facilities identified in CNL's May 2021 Environmental Impact Statement as examples of the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility.

As outlined in the previous section of this report cleanup work at the Fernald On-site Disposal Facility is part of the the legacy of the U.S. nuclear weapons program – in this case, the former Fernald Feed Materials Production Center – but the facility addresses only a portion of the contamination issues at the larger host site, with some wastes shipped off site as part of the site closure and remediation program.

The former Fernald Feed Materials Production Center, now named the Fernald Preserve, is a 1,050-acre site located near Cincinnati in southwest Ohio. It is a former uranium foundry that produced high-quality uranium metals for the nuclear weapons complex.[56]
Titled the Feed Materials Production Center, it was situated on 1050 acres and near the community of Fernald. It employed 2800 individuals and produced most of the uranium used in US Nuclear Weapons production. [57]

Over a period of nearly 37 years, from 1952 to 1989, the Fernald Feed Materials Production Center produced over 500 million pounds of high-purity uranium metal products for the U.S. nuclear weapons program. These operations generated over 6 million tons of liquid and solid wastes and emitted over 1 million pounds of uranium into the atmosphere. [58] When operations ceased in 1989, they left a legacy of radioactive and hazardous wastes, nuclear product, aging facilities and site infrastructure, contaminated soil and a uranium-contaminated groundwater plume.[59]

Controversy struck the site when, in 1984, a faulty dust collector at one of the plants released nearly 300 pounds of enriched uranium oxide into the environment. It was also revealed at that time that uranium had contaminated three off-site wells just three years earlier (nearby wells contained uranium at levels 180 times the federal safety standard [60]). Since the community sits above the Great Miami Aquiver, one of the largest drinking water aquifers in the country, these revelations caused great concern and anger. The community filed a class action lawsuit against the Department of Energy (DOE, previously known as the AEC) and five years later received

[56] https://www.nga.org/wp-content/uploads/2021/03/2019_FFTF_Ohio.pdf
[57] https://participedia.net/organization/4852
[58] https://www.fluor.com/projects/fernald-environmental-remediation
[59] https://www.fluor.com/projects/fernald-environmental-remediation
[60] "Toxic legacy of the Cold War", Ralph Vartabedian, published Oct. 20, 2009 in the Los Angeles Times at https://www.latimes.com/archives/la-xpm-2009-oct-20-na-radiation-fernald20-story.html

compensation of $73 million[61] to local residents and to the state of Ohio and agreed to allow the state to oversee its waste disposal activities. [62]

During site investigations prior to and during the cleanup operations, uranium was found to be the principal contaminant in Ohio's Great Miami Aquifer. This aquifer is located directly underneath the Fernald plant and provides water to the city of Cincinnati. Uranium is one of the radionuclides that can be removed by pump-and-treat, but the fact that the contaminated groundwater is moving off-site is of serious concern.

The aquifer is also contaminated with radium and thorium. A local stream, Paddy's Creek, served as a recharge area for the Great Miami Aquifer and carried uranium below ground to the aquifer. In 2003, uranium concentrations in groundwater ranged from 500 to 800 ppb, well above the 30 ppb required to meet EPA regulations. Major municipal water intakes from the Great Miami Aquifer are located just ¾ mile from the site's east boundary.[63]

Fernald On-Site Disposal Facility

The clean-up strategy for the Fernald site included small volumes of more-radioactive waste material being shipped to licensed offsite disposal facilities; the more highly radioactive material, consisting of high-purity former Belgian Congo uranium ore and tailings, was hauled away. It was deemed too dangerous to leave in the rainy Ohio climate. Ultimately, it was mixed with cement and cast in 3,776 steel containers that were sent to a privately owned dump in west Texas. [64] The much larger volumes of low-level radioactive materials remain at Fernald, encapsulated in the On-Site Disposal Facility (OSDF).

The OSDF was completed in 2006 and contains nearly 3-million cubic yards of low-level waste consisting of 85 percent soil and 15 percent building debris. The facility is 800-feet wide, 3,700-feet long, and 65-feet high.

It has a multilayer cap-and-liner system that encapsulates waste material and an engineered system that collects liquid that drains from the waste and conveys it to the Fernald wastewater treatment facility.

[61] https://participedia.net/organization/4852
[62] https://participedia.net/organization/4852
[63] *Danger Lurks Beneath*, prepared for the Alliance for Nuclear Accountability (ANA) by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, 2003
[64] "Toxic legacy of the Cold War", Ralph Vartabedian, published Oct. 20, 2009 in the Los Angles Times at https://www.latimes.com/archives/la-xpm-2009-oct-20-na-radiation-fernald20-story.html

The OSDF is covered with a prairie grass mix that serves the dual purpose of controlling erosion and providing habitat for a variety of grassland birds and raptors. DOE monitors the performance of the OSDF and performance reports are provided each year in the Site Environmental Report. More detailed information, including a cross-sectional model of the OSDF, is available for viewing at the Fernald Preserve Visitors Center. [65] The large mound sits on the eastern edge of the Fernald Preserve.[66]

Engineered as above-grade waste disposal facility for low level radioactive waste (LLRW) and treated mixed LLRW generated during Decommissioning and Demolition (D and D) and soil remediation, the OSDF is engineered to store 2.93 million cubic yards of waste derived from the remediation activities. The OSDF is intended to isolate its LLRW from the environment for at least 200 years and for up to 1,000 years to the extent practicable and achievable. Construction of the OSDF started in 1997 and waste placement activities were completed and the final cover (cap) placement over the last open cell was in place in Spring 2006.[67]

Ongoing activities at the site include continuing groundwater remediation, surveillance and monitoring of the on-site disposal facility, institutional controls implementation and other aspects of the remedy. Ohio settled litigation regarding natural resource damage that focuses primarily on contamination and lost use of a portion of the Great Miami Buried Valley Aquifer.[68] Original projections estimated the Fernald cleanup would take 30 years and cost $12 billion.

The $4.4-billion cleanup transformed Fernald from a dangerously contaminated factory complex into what many would consider to be an environmental showcase. However, the site is "clean" only by the terms of a legal agreement. Its soils contain many times the natural amounts of radioactivity, and a plume of tainted water extends underground about a mile. Federal scientists say that no one could ever safely live on the site, and the site will have to be closely monitored essentially forever.[69]

Although the cleanup officially ended at Fernald in 2006, long-term groundwater testing will continue at this site "probably into the late 2030s, and there might always be some level of water treatment needed at the site." The "plume" - the area of affected groundwater, or the sphere of contamination - is down to about 100 acres now.[70]

[65] https://www.energy.gov/sites/prod/files/2020/04/f74/Fernald%20Preserve%2C%20Ohio%20On-Site%20Disposal%20Facility.pdf
[66] https://www.energy.gov/sites/prod/files/2020/04/f74/Fernald%20Preserve%2C%20Ohio%20On-Site%20Disposal%20Facility.pdf
[67] Lessons Learned from the On-Site Disposal Facility at Fernald Closure Project, Kumthekar, U A; Chiou, J D, as found at https://www.osti.gov/biblio/21210731-lessons-learned-from-site-disposal-facility-fernald-closure-project
[68] https://www.nga.org/wp-content/uploads/2021/03/2019_FFTF_Ohio.pdf
[69] "Toxic legacy of the Cold War", Ralph Vartabedian, published Oct. 20, 2009 in the Los Angles Times at https://www.latimes.com/archives/la-xpm-2009-oct-20-na-radiation-fernald20-story.html
[70] "What Lies Beneath the Fernald Preserve", Jenny Wohlfarth, as published in the Cincinnati Magazine on June 7th, 2019, as posted at https://www.cincinnatimagazine.com/citywiseblog/what-lies-beneath-the-fernald-preserve/

An Energy Department agency, the Office of Legacy Management, has been created to monitor the weapon sites after closure and decommissioning. A warehouse in West Virginia will hold millions of records in perpetuity, detailing how the cleanups were conducted and where the toxins are buried. In the case of Fernald, the records will note the location of the radioactive mound, and will show how the basements of the former manufacturing buildings became storage ponds and how for hundreds and possibly thousands of years workers will have to trap groundhogs so they don't burrow through the barriers keeping radioactive waste from leaching into groundwater. [71]

Citizen Engagement

While the DOE communicated with the local community according to the minimum regulatory requirements during the initial period of closure planning, the residents insisted on having a much greater involvement in the project.

In response, the Environmental Protection Agency (EPA) established a forum called the Federal Facilities Environmental Restoration Dialogue Committee (FFERDC), which would provide a blueprint for stakeholders engagement. DOE managers at the Fernald site decided to implement this approach, which led to the establishment of the Fernald Citizens Task Force in 1993 (which became the Fernald Citizens Advisory Board in 1997). It met over a 13-year period in order to provide recommendations for the better management of the remediation process.[72]

Conclusions and demands of local citizen groups, the US and Ohio EPA and the DOE managers at Fernald, all of whom were concerned about reducing the human health risk and environmental damage in the area, led to the creation of the Fernald Citizens Advisory Board (FCAB) in 1993.
FCAB was established in order to provide policy and technical advice regarding important clean-up decisions to the regulated and regulating agencies. In 1995, it was deemed that over 3 million cubic yards of waste and contaminated material would need to be removed from the site. [73]

The Department of Energy estimated that the Fernald Citizens Advisory Board (FCAB) recommendations saved the taxpayers more than $2 billion over the lifetime of the project. This substantial savings is partly due to FCAB's call for the acceleration of cleanup efforts (to be completed by 2006 instead of the DOE's original 2020 goal). The amended cleanup estimate of $2.9 billion – $4.3 billion, billions less than the original $7.2 billion estimate resulted from years of savings in building maintenance expenses, salaries for workers and a number of other expenses. FCAB also saved a significant amount by recommending that 80% of the FEMP site's

[71] "Toxic legacy of the Cold War", Ralph Vartabedian, published Oct. 20, 2009 in the Los Angles Times at https://www.latimes.com/archives/la-xpm-2009-oct-20-na-radiation-fernald20-story.html
[72] https://participedia.net/organization/4852
[73] https://participedia.net/organization/4852

waste remain on-site, and that off-site disposal be limited to 20% of the waste. Since it would have cost three times more to ship the waste than to construct the on-site disposal facility, an additional $700 million was saved[74]

Observations

Three observations directly relevant to the CNL claim that the Fernald On-site Disposal Facility provides an example of the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility can be drawn from even the summary account provided above. Those observations are:

- The degree to which the Fernald clean-up operations were successful relied on several critical factors, including and particularly that the remediation activities followed closure, rather than running concurrent with continued waste generating and contaminating activities co-located on the site.
- Citizen engagement was a priority, and citizens occupied a central role in decision-making, communicating with the public, priority setting.
- Perpetual care was embedded as a project expectation, and the oversight agencies have a known and seemingly reliable plan for long term record keeping and retention of institutional memory.

[74] https://participedia.net/organization/4852

Section 2.2.4. Referenced Sites Not Included in this Comparative Study

In their May 2021, Environmental Impact Statement CNL referenced “selected examples of NSDFs for LLW” including the Port Granby and Port Hope sites, the Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility, the Portsmouth On-site Waste Disposal Facility, and the Fernald On-site Disposal Facility.

This study of comparative sites examined the Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility and the Fernald On-site Disposal Facility.

This study did not examine the Port Granby and Port Hope sites or the Portsmouth On-site Waste Disposal Facility as these projects are still in the early implementation stages and provided insufficient operational experience or observation of outcomes for this studies purpose.

Section 2.2.5 Alignment of the Project with IAEA Guidelines

In their 2021, Environmental Impact Statement CNL makes the claim that the NSDF Project has been specifically designed as a permanent solution to reduce environmental risk and achieve isolation and containment of the sources of contamination for a sufficiently long period, and that this is in accordance with the requirements set out in the International Atomic Energy Agency (IAEA) Disposal of Radioactive Waste Specific Safety Requirements No. SSR-5 (SSR-5; IAEA 2011).[75]

CNL further claims that "the IAEA definition of a near surface disposal is the placement of solid, or solidified, radioactive waste in a disposal facility located at or near the land surface (IAEA 2014). The preferred option for disposal of LLW is in near surface disposal facilities (IAEA 2001). [76]

In their 2017 review of International Atomic Energy Agency guidance relevant to the Near Surface Disposal Facility, Concerned Citizens of Renfrew County and Area concluded that the NSDF proposal advanced by Canadian Nuclear Laboratories (CNL) would not meet IAEA guidance on several counts, including:

- The approach would place large quantities of radioactive waste with longer lived hazards in in a landfill-type facility suitable only for very low level waste.
- Long-lived radionuclides in the NSDF would be highly vulnerable to human intrusion in the post-closure period.
- Radioactive exposures to humans as a result of intrusion would exceed currently allowed limits by a large margin.
- Acceptance of the proposed NSDF project by Canadian regulatory authorities would violate international safety standards for radioactive waste disposal.[77]

The 2021 EIS states that, "To meet the requirements of IAEA's SSR-5, CNL has defined the near surface disposal within its Integrated Waste Strategy as the primary disposal path for LLW that meet the Waste Acceptance Criteria."[78] However, a fundamental issue with the NSDF is continued uncertainties with respect to the radioactive waste inventory and the characterization of the radioactive wastes which CNL may deposit in the NSDF. Until such issues are resolved, there can be no reliable determination made as to whether the wastes being placed in the NSDF meet IAEA guidance.

Further, the IAEA guidelines set out that a near surface disposal facility is not appropriate for Very-low-level waste. But CNL has determined that "the development of a VLLW disposal facility does not meet the NSDF Project purpose which recognizes the need for an LLW disposal

[75] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004 Revision 3, 2021, Page 2-7
[76] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004 Revision 3, 2021, Page 2-16
[77] "International Atomic Energy Agency guidance relevant to the Near Surface Disposal Facility", Concerned Citizens of Renfrew County and Area, July 2017, as found at https://www.ceaa.gc.ca/050/documents/p80122/119397E.pdf
[78] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004 Revision 3, 2021, Page 2-15

facility and a VLLW disposal facility is not considered technically feasible"[79] and therefore intends to utilize NSDF capacity for the disposition of VLLW.

Disposal of Radioactive Waste

The International Atomic Energy Agency says that the "specific aims of disposal" are to:
(a) contain the waste;
(b) isolate the waste from the accessible biosphere and to reduce substantially the likelihood of, and all possible consequences of, inadvertent human intrusion into the waste;
(c) inhibit, reduce and delay the migration of radionuclides at any time from the waste to the accessible biosphere;
(d) ensure that the amounts of radionuclides reaching the accessible biosphere due to any migration from the disposal facility are such that possible radiological consequences are acceptably low at all times.[80]

The NSDF has not demonstrated as being capable of meeting these "specific aims".

Near Surface Disposal Facilities for Radioactive Waste

The International Atomic Energy Agency assumes that member states intending to pursue an option of near-surface disposal of radioactive waste will do this in accordance with national policy. It says:

> *"Within the framework set by the national policy for near surface disposal of radioactive waste, the operator, in consultation with the regulatory body, should set out elements of the national policy in a formal safety strategy document that is produced as early as possible in the disposal program and is updated periodically. The safety strategy is the high level integrated approach adopted for achieving safe disposal. It should include strategies to select a site and to design, construct, operate and close a disposal facility. In addition, it should include recommendations for the preparation and maintenance of the safety case for use in decision making and procedures for regulatory approval for the assumed duration of the period of institutional control."*[81]

Canada's current radioactive waste policy, the 1996 Radioactive Waste Policy Framework, does not provide this policy direction. Nor does the draft policy released by Natural Resources Canada on February 1, 2022 for public comment.

[79] NSDF ENVIRONMENTAL IMPACT STATEMENT 232-509220-REPT-004 Revision 3, 2021, Page 2-21
[80] IAEA 2010. Disposal of Radioactive Waste. Specific Safety Requirements No. SSR-5, p. 3
[81] IAEA 2014. Near surface disposal facilities for radioactive waste. Specific Safety Guide No. SSG-29., p. 16

Section 3.0 Conclusions

The purpose of this study of comparative sites undertaken for Northwatch is to examine the validity of the statements made by CNL with respect to a) the effectiveness of the referenced facilities in isolating radionuclides from the environment, b) the relevance of the example facilities to the review and consideration of the Near Surface Disposal Facility as an option for the long term management of radioactive wastes at the Chalk River site, and c) the alignment of this project with IAEA guidelines, as referenced by CNL.

In carrying out the study, the report authors examined the three examples sites which have sufficient operational experience that are far enough along in implementation to provide a basis for consideration, i.e. the Oakridge National Laboratories Environmental Management Waste Management Facility, the Hanford Environmental Restoration Disposal Facility and the Fernald On-site Disposal Facility.

Each of these facilities and their operating experience was unique, but each provided insights and observations which were relevant to CNL's proposed Near Surface Disposal Facility at Chalk River. Some experiences were common across the three, which are directly relevant. In particular, all three operate under the GOCO model, and two of the three have contractors which are partners in the Canadian Nuclear Energy Alliance (operator of CNL). All three examples appear to be effectively reducing the footprint or the extent of radio-contaminants but none are successfully isolating the radio-contaminants from the environment. And, all three are facilities whose operations were part of the nuclear weapons complex; similarly, the origins of the Chalk River nuclear laboratory site are with the Canadian contribution to nuclear weapons development.

The Oakridge National Laboratories Environmental Management Waste Management Facility does not provide an example of the effectiveness of a facility such as CNL's proposed Near Surface Disposal Facility. What it does provide is an example of how a lack of oversight and/or commitment to operational safety can result in violations of operating protocol and subsequently, environmental violations. The environmental violations resulted from a combination of design and operational failures in that there was insufficient water storage capacity as part of the facility design and there were operational decisions made which resulted in environmental harm as a result of those design limitations. The responsibility chain went from site owner to contractor to sub-contractor and was broken.

The Hanford Environmental Restoration Disposal Facility further demonstrates how irregularities in project delivery and the project evolution can emerge under the operating model. In the GOCO model in place at the Hanford Environmental Restoration Disposal Facility, a lack of oversight from both the contractor and the site owner was observed, which allowed key equipment failures to continue undetected for seven months and a falsification of documents to be carried out over a period of years. Government agency oversight reports failed to note even such significant failures as those noted immediately above. In addition, a form of “ authorization creep” emerged, with the initial authorization for the facility changing significantly over even the first decade of operation, beginning with an expansion of the acceptable wastes in the first year after initial authorization and an expansion of the size of the facility the following year and multiple additional expansions to the authorization continuing throughout the operating period.

The Fernald On-site Disposal Facility provides an example of several elements which do not appear to be in place in the case of CNL’s proposed NSDF, but were important to the Fernald project. In particular, the degree to which the Fernald clean-up operations were successful relied on several critical factors, including and particularly that the remediation activities followed closure, rather than running concurrent with continued waste generating and contaminating activities co-located on the site. Citizen engagement was a priority, and citizens occupied a central role in decision-making, communicating with the public, and priority setting. Finally, perpetual care was embedded as a project expectation, and the oversight agencies have a known and seemingly reliable plan for long term record keeping and retention of institutional memory.

In conclusion, rather than providing examples of success, the observations from the Oakridge National Laboratories Environmental Management Waste Management Facility, Hanford Environmental Restoration Disposal Facility and Fernald On-site Disposal Facility operating experience provide caution warnings.

Appendix A – Report Authors

Dr. Marvin Resnikoff is an international consultant on radioactive waste issues.
A nuclear physicist and a graduate of the University of Michigan, Dr. Resnikoff has worked on radioactive issues since his first project at West Valley, New York in 1974. Throughout his career, he has assisted public interest groups and state and local governments across the US, Canada and England.

His recent research focus has been on the risk of transporting and storing radioactive nuclear reactor fuel, decommissioning nuclear facilities and the health impact of radioactive waste from oil and uranium production.

This report relied extensively on research completed by RWMA over a number of decades, which integrated studies prepared by contractors managing the US weapons complex, research reports and books written by independent engineers, scientists, and epidemiologists, and research information developed by public interest groups. Finally, the full text and individual chapters were painstakingly reviewed by an extensive list of public interest groups located in the vicinity of each of the nuclear weapons factories

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