Speaking Notes
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Radioactive Waste Management Associated
Comparative Study of NSDF Reference Sites
CNSC REF# 2022-H-07

SLIDE 1 – Project 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.
- 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 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.
- When that system lacks sufficient capacity (e.g., under spring conditions), treated effluent will be discharged untreated directly to Perch Lake.

SLIDE 2 - 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.

- According to CNL "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"

- CNL identified a short list of sites, including CNL managed sites in Port Granby and Port Hope sites, and 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, all located in the U.S. and owned by the federal government and managed by the Department of Energy under a variety of contractual arrangements.

- this comparative sites study examined 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 and c) the alignment of this project with IAEA guidelines, as referenced by CNL.

Slide 3 – Comparative Sites Study Overview

- 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 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

Slide 4 - Nuclear Weapons States - the Challenge of Cleanup

"The Department of Energy faces monumental challenges in restoring the environment at installations that were part of the U.S. nuclear weapons production complex… Despite the large amount invested in DOE environmental management, progress on groundwater and soil remediation has been slow."

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

Slide 5 - Oakridge National Laboratories Environmental Management Waste Management Facility

- 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 (K-25), and the Nuclear Weapons Components (Y-12).
- The K-25 plant is the original gaseous diffusion plant, used to enrich uranium. K-25 is situated on 1,500 acres bordered by the Clinch River, zs shown in Fig. 3.
- Weapons production activities at this site have included enriching uranium at the gaseous diffusion plant and producing machined components for nuclear weapons assembly.
- The Y-12 Plant occupies 811 acres. All storage facilities of radioactive and hazardous materials including settlement ponds, seepage pits and trenches, inactive tanks, abandoned underground pipelines, and surplus facilities have contributed to the contamination of the environment site-wide.
- As reported by the site operator, almost 540,000 cubic feet of this waste and contaminated soil will require remediation

- 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.
- East Fork Poplar Creek originates at Y-12 and travels offsite through the city of Oak Ridge emptying into the Clinch River and Watts Bar Lake in the northwest section of ORR. Figure 4 shows the volatile organics at the Y-12 site.
- 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.

Slide 6 – Oak Ridge 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 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 200629 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

Slide 7 - Environmental Concerns at Oak Ridge EMWMF

- The EMWMF has been discharging radionuclide pollution into Bear Creek for many years, and 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; 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
- 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.
- 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.
- 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.

Slide 7 - Environmental Violations at Oak Ridge EMWMF

- 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.
- 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.
- 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.

Slide 8 – Observations on the Oak Ridge EMWMF

Three observations 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

Slide 9 - Hanford Environmental Restoration Disposal Facility – Context

- 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 Columbia 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.
- 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, fabrication, and research. It was this mission that left a legacy of contaminated sites along a major waterway, the Columbia River.
- At this site in south-central Washington, nearly two-thirds of the nation's volume 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 (See Fig. 2.)
- 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.
- An underground mound of contaminated groundwater 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.

SLIDE 10 - Hanford Environmental Restoration Disposal Facility – Facility

- 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.
- 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.
- 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.
- 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.
- Contaminants of concern also vary greatly based upon the original function of the generating site. Radioactive isotopes include alpha, beta, and gamma emitting
- 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.
- 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.
- The Facility is one of 45 different projects, project areas or defined waste areas delineated within the Hanford Nuclear Reservation.

Slide 11 - Project Irregularities

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

Slide 11 - Project Evolution

- Since being built, Environmental Restoration Disposal Facility has seen four major expansions.
- 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
  - 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
  - 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.

Slide 12 - Observations at the Hanford Environmental Restoration Disposal Facility

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.
- 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.

Slide 13 - Fernald On-site Disposal Facility - Context

- The former Fernald Feed Materials Production Center, now named the Fernald Preserve, is a 1,050-acre site located near Cincinnati in southwest Ohio.
- Within 3 miles of the site are the towns of Fernald, Ross, New Baltimore, and New Haven, Ohio. (See Figure 1). FEMP is approximately 17 miles northwest of Cincinnati. It is a former uranium foundry that produced high-quality uranium metals for the nuclear weapons complex.
- 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.
- 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 a uranium-contaminated groundwater plume, shown in Fig. 3.
- 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).
- 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 compensation of $73 million to local residents and to the state of Ohio and agreed to allow the state to oversee its waste disposal activities.
- 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.

Slide 13 - 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.
- 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.
- 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.
- 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. 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.
- 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.
- 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.

Slide 14 - Citizen Engagement at Fernald

- 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.
- 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.
- 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 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

Slide 15 - 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.

Slide 16 - Alignment of the NSDF 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).
- 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).
- 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.

- 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."
- 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.

Slide 17 - Conclusions of the Comparative Sites Study

- 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 observations were common across the three sites:

- All three sites 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.
- 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.

Slide 18 – Observations Unique to Each Site -

The Oakridge National Laboratories Environmental Management Waste Management Facility illustrated:

- 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.

Slide 19 – Observations Unique to Each Site - Hanford

The Hanford Environmental Restoration Disposal Facility demonstrated:

- In the GOCO model a lack of oversight from both the contractor and the site 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.
- A form of " authorization creep" emerged, with the initial authorization for the facility changing significantly over even the first decade of operation, including broadening the categories of waste and the size of the facility

Slide 20 – Observations Unique to Each Site - Fernald

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, including:

- 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.
- 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.

Slide 19- Overall 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.