THE NIAGARA FALLS STORAGE SITE REMEDIAL ACTION PROJECT

STATUS UPDATE AND SUMMARY OF SPECIAL FEATURES

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ABSTRACT

The U.S. Department of Energy (DOE) and its Project Management Contractor, Bechtel National, Inc. are conducting remedial action at the Niagara Falls Storage Site (NFSS) near Lewiston, New York to stabilize low-level radioactive wastes stored at the site and to decontaminate over two dozen contaminated vicinity properties. Over the past 4 years a 10-acre interim waste containment facility has been developed at the site to hold the approximately 250,000 yd^3 of contaminated soil and rubble from the cleanup operations. Several existing buildings were demolished or modified for burial inside the containment area. In addition, residues inside a 165-ft-high concrete tower were transferred to one of the buildings inside the containment area using hydraulic mining techniques. The residues were dewatered and covered with clay to minimize radom emanation; the tower was demolished and the rubble disposed of in the containment area. Environmental monitoring will continue throughout the interim storage period. In addition, the surface and subsurface condition of the containment structure will be monitored to ensure that undesirable trends are detected in time for corrective action to be taken. The DOE Record of Decision on the long-term disposition of the NFSS is expected to be made by the end of April 1986.

INTRODUCTION

The Niagara Falls Storage Site (NFSS) is a U.S. Department of Energy (DOE) surplus facility located approximately 10 mi north of the city of Niagara Falls and within the town of Lewiston, New York (Fig. 1). The site covers approximately 191 acres and is used for the interim storage of radioactive residues and contaminated soils and rubble.

The NFSS is a remnant of the U.S. Army's original Lake Ontario Ordnance Works (LOOW), portions of which were used by the Manhattan Engineer District (MED) for the storage and transshipment of radioactive materials. As a result of these operations, some portions of the former LOOW other than the present NFSS were also contaminated. In addition, some of the radioactive materials stored at the NFSS over the years were subject to water and wind erosion. As a result, radioactive materials migrated off-site, chiefly through drainage ditches onto vicinity properties.

DOE established the Surplus Facilities Management Program (SFMP) to manage and plan the ultimate disposition of surplus DOE-owned facilities such as the NFSS. The contaminated material on vicinity properties is the responsibility of the Formerly Utilized Sites Remedial Action Program (FUSRAP), another DOE program.

HISTORY OF SITE OWNERSHIP

The U.S. Army's 7,500-acre LOOW was used for TNT production early in World War II. When those operations ceased, the Army assigned the site to the War Assets Administration, which transferred a portion of the property to the MED. When the MED became the Atomic Energy Commission (AEC) in 1947, AEC-owned property totaled approximately 1,500 acres.

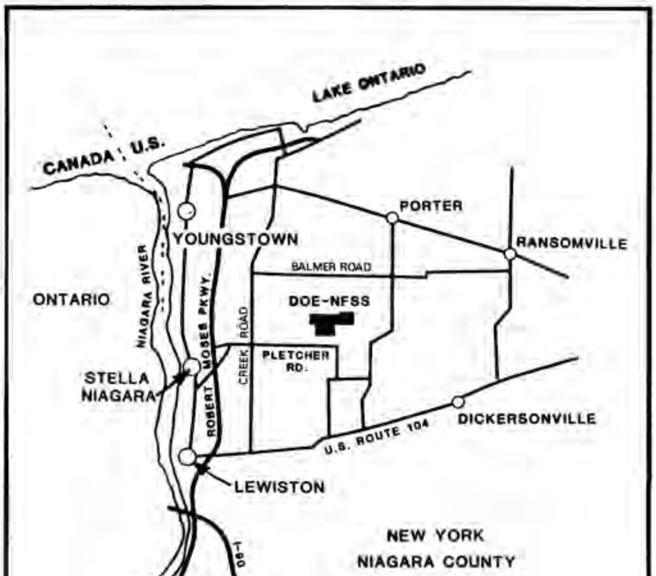

Fig. 1. The Regional Setting of the NFSS.

During 1944, the MED began to use the property for the storage of pitchblende (uranium ore) processing residues. Between 1949 and 1952, the AEC property was used as a temporary storage location for uranium and thorium ore residues from processing facilities located in New York State and elsewhere. The site's original steam plant was modified and used for boron-10 production between 1953 and 1959, and again between 1965 and 1971. During the first period of operation, a major site cleanup occurred that included consolidation and removal of surface debris, packaging of waste for shipment to Oak Ridge, Tennessee, and sale of bulk metallic scrap. After 1971, when the boron-10 operations ceased, most of the AEC-owned property was transferred or sold. Only 191 acres remained, comprising the NFSS. Site operations were put on standby in 1971, and National Lead Company of Ohio designated caretaker for the site.

Responsibility for the NFSS passed from the AEC to the Energy Research and Development Administration, and then to DOE. In 1981, DOE chose Bechtel National, Inc. (BNI) as the Project Management Contractor (PMC) for remedial action at the NFSS. Interim remedial actions began in 1982[1].

THE NFSS PRIOR TO INTERIM REMEDIAL ACTIONS

The radiological status of the NFSS prior to the beginning of interim remedial actions is illustrated in Fig. 2. The primary radiological features of the site were: radioactive residues stored in various locations on the site; widespread areas of contaminated soil on the site; and on-site and off-site drainage areas contaminated as a result of the migration of radioactive materials. In addition, several vicinity properties located adjacent to or near the NFSS had not been characterized, but were thought to be contaminated in excess of DOE remedial action guidelines. These properties have since been characterized, and remedial action has been performed on several of them. Each of the radiological features of the site is covered in the following subsections.

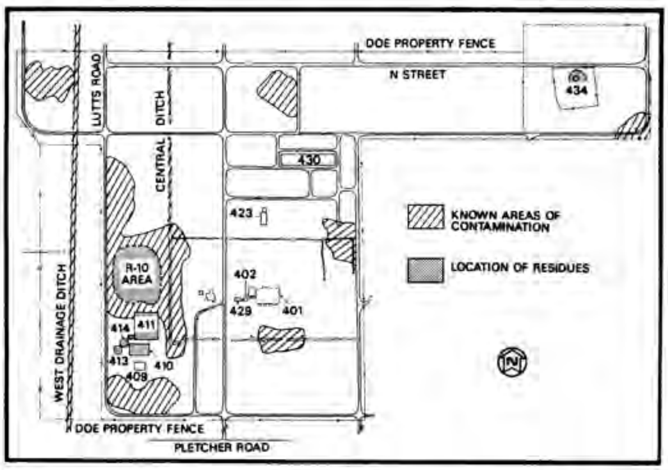

Fig. 2. The NFSS Prior to Interim Remedial Action.

Residues

Six different types of residues and sands totalling about 23,400 yd^3 were stored in various locations at the NFSS. Although they represented only 6 percent of the volume of contaminated materials there, they accounted for 99 percent of the activity. Most of the activity was thorium-230 and its daughters. The residues were code-named K-65, L-30, L-50, F-32, and R-10 during wartime activities.

The K-65 residues have the highest specific activity (200,000-300,000 pCi/g) and represented the biggest challenge in the remedial action process because of their storage location and high specific activity. These residues resulted from the processing of high-grade pitchblende ore (containing 35-60 percent uranium oxide) by a St. Louis processing plant. In 1949 they were brought to the NFSS where they were stored in drums outdoors and in Building 410 (Fig. 2). From 1950 to 1952, the K-65 residues were transferrred to Building 434, a renovated concrete water tower.

The L-30, L-50, F-32, and R-10 residues originated from various processing and extraction operations at the nearby Linde Ceramics Plant in Tonawanda, New York. Material known as the Middlesex sands resulted from sandblasting activities at the Middlesex Sampling Plant in Middlesex, New Jersey. All of these materials were stored in various buildings and on the ground at the NFSS.

Contaminated On-site Areas

Several distinct areas of contaminated soil were present on the site (Fig. 2). The R-10 storage area covered over 37,000 yd^2 and the other areas shown in Fig. 2 covered approximately 165,000 yd^2.

On-Site and Off-Site Drainage Ditches

Surface erosion from contaminated areas on the NFSS, in particular the R-10 area, resulted in contamination of the two major drainage ditches that flowed onto and off of the site. The larger Central Ditch begins on-site and flows north approximately 3-1/2 mi to its confluence with Fourmile Creek northwest of the site; the West Ditch begins at a point west and south of the site and flows northward for approximately 4,500 ft, intersecting with the Central Ditch north of the site.

Vicinity Properties

Since the NFSS now covers only 191 acres of the approximately 1,500 acres originally utilized for shipment, storage, and burial of radioactive materials and wastes, several contaminated properties once part of the federally owned land are now privately owned. The locations of the vicinity properties are shown in Fig. 3. Cleanup of these properties began in 1984.

PROJECT OBJECTIVES

DOE's objectives for the NFSS are to:

- Provide surveillance and maintenance of the site as necessary to maintain public safety and reduce impact on the public, the environment, and on-site personnel to as low as reasonably achievable
- Perform interim remedial actions to clean up contaminated areas on-site, the off-site ditches, and the vicinity properties and to develop an interim waste containment facility for the contaminated materials
- Perform the necessary environmental, geological, engineering, and other studies as required to support the decision-making process for eventual long-term disposition of the site

- o Select, in accordance with the National Environmental Policy Act (NEPA) process, a preferred alternative for long-range disposition of the wastes and residues at the site and implement the remedial action program required to accomplish the selected alternative

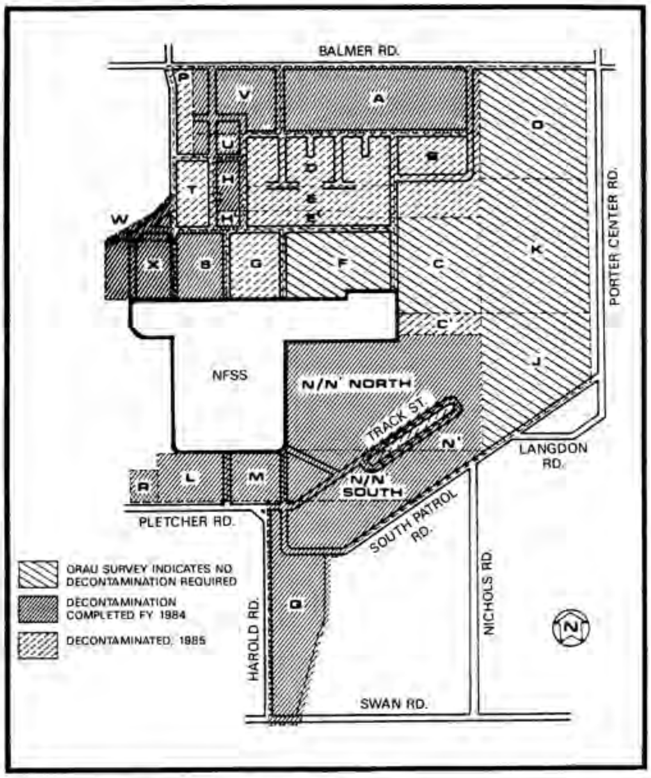

Fig. 3. Status of NFSS Vicinity Property Cleanup-1985.

MANAGEMENT ORGANIZATION AND RESPONSIBILITIES

DOE Headquarters

DOE Headquarters (DOE-HQ) has the responsibility for the development of overall policy necessary to accomplish NFSS project objectives. Through its Division of Facility and Site Decommissioning Projects, DOE-HQ provides broad guidance, establishes program budgets, and acts as a liaison with other government agencies in implementing SFMP or FUSRAP projects.

Surplus Facilities Management Program Office

The DOE Operations Office in Richland (RL), Washington is the Lead Field Office for the SFMP. The RL Surplus Facilities Management Program Office (SFMPO) manages SFMP and oversees individual projects, such as the NFSS.

Oak Ridge Operations Office

SFMPO assigned the SFMP portion of the NFSS project to the DOE Oak Ridge Operations Office (OR), which is the DOE Lead Field Office for FUSRAP. Therefore, the two portions of the NFSS project, SFMP and FUSRAP, are united under DOE-OR, which provides technical, administrative, and financial management of the NFSS project on a day-to-day basis. In this capacity, DOE-OR oversees the work of BNI, the PMC that implements project activities, and Argonne National Laboratory (ANL), the National Environmental Policy Act (NEPA) activities contractor.

Project Management Contractor

As PMC, BNI is responsible for overall management of the project including analyzing site conditions, and evaluating, recommending, planning, and engineering interim remedial actions, and for management of subcontracts implementing the remedial actions.

BNI also is responsible for maintaining a program for maintenance and surveillance of the NFSS, including environmental monitoring, health and safety, and radiological protection programs.

NEPA Activities Contractor

ANL is responsible for ensuring NFSS project compliance with NEPA requirements. As part of its responsibilities, ANL performs environmental assessments necessary to support interim activities. ANL is presently preparing the Environmental Impact Statement (EIS) for the NFSS, which is scheduled for publication in February 1986. The Record of Decision on long-term disposition of the site is expected to be made at the end of April 1986.

INTERIM REMEDIAL ACTIONS - PROGRESS TO DATE

Disposal Alternatives Studied

The remedial action that has been performed at the NFSS is interim remedial action, because no official decision has been made regarding the ultimate disposition of the site. That decision will be made by DOE in accordance with the NEPA process and after all technical, environmental, safety, and other impacts of the reasonable alternatives have been evaluated in the EIS. The decision-making process provides opportunities for members of the public and local communities to become informed about the alternatives and to contribute to the DOE decision.

As part of the documentation necessary for the EIS, BNI published, in January 1984, the Engineering Evaluation of Alternatives for the Disposition of Niagara Falls Storage Site, Its Residues and Wastes.[2] The document presented the conceptual engineering, occupational radiation exposure, construction schedule, maintenance and surveillance, and cost details related to four basic scenarios for the long-term management of the existing radioactive wastes and residues stored at the NFSS. The scenarios ranged from "No Action", through several "Long-Term Management at NFSS" alternatives, to moving all or some of the contaminants to other disposal sites.

The subsequent public scoping process for the EIS resulted in the detailed study of several variations of the basic scenarios. State and federal comments and questions led to additional studies, which will also be presented in the EIS.

Remedial Actions - 1982

Interim remedial actions began in 1982. The first orders of priority were to stabilize the R-10 residues to prevent further off-site migration and to upgrade and seal two buildings to reduce emissions of radon gas from the residues stored in them. An area around the R-10 pile was cleared and grubbed, approximately 16,000 yds^3 of contaminated soil were moved onto the cleared area, and a clay dike and cutoff wall were constructed around the pile. The top of the pile was covered with a synthetic liner. The upgrading and sealing of Buildings 413 and 414 reduced radon emissions to essentially background level.

Remedial Actions - 1983

The continued development of the waste containment area was the primary activity during 1983. The dike and cutoff wall surrounding the R-10 pile were extended southward to enclose Buildings 410, 411, 413, and 414, although a portion of the west and south walls was left open to allow for clean water drainage and as future access for placing contaminated materials inside the containment area. Like the section constructed in 1982, the extended dike/cutoff wall was keyed into underlying clay to prevent lateral migration of contamination.

Preparations were also made for the transfer, dewatering, and consolidation of residues stored in Building 411. Openings and pipes into Building 410 were sealed to prepare the building for water storage during residue transfer operations in Building 411.

Several on-site contaminated areas were decontaminated, as well as approximately 4,800 ft of the West Ditch and approximately 6,900 ft of the Central Ditch. Roughly 54,000 yd^3 of contaminated material were excavated and placed in the waste containment area.

Remedial Actions - 1984

In 1984 the south dike of the waste containment facility was completed, forming the final segment of the cutoff wall; Building 410 and the upper portion of Building 415 were demolished, clearing the way for final development of the southern portion of the containment area. The interim cap was placed over the northern portion, or about 40 percent, of the waste containment area (Fig. 4).

Fig. 4. Aerial View of the NFSS Waste Containment Area Showing the Partially Completed Interim Cap and Building 411.

In addition, Building 411 was transformed into a storage facility for the L-30, F-32, and K-65 residues. The former were relocated between bays in the building and were dewatered to make room for the K-65 residues that were transferred from Building 434 (the renovated water tower) using hydraulic mining. Figure 5 shows the tower during the transfer operation. About 90 percent of the K-65 residues were transfered in 1984.

Fig. 5. View of Building 434 During the Residue Transfer Operation.

Decontamination was performed on several vicinity properties, some contaminated on-site areas, and another portion of the Central Ditch. The contaminated soil from these areas totaled approximately 27,900 yd^3.

Remedial Actions - 1985

In 1985 a major milestone was reached when the last of the K-65 residues were removed from Building 434 by mechanical means and the building was demolished. Its rubble and the contaminated soil surrounding the building were moved to the waste containment area. The major portion of the interim cap over the containment area was completed, leaving only the section over Building 411 to be completed in 1986 after transfers of contaminated soil to the containment area are complete.

The 10 remaining contaminated vicinity properties were decontaminated, producing 6,300 yd^3 of soil that were disposed of in the waste containment area. Cleanup of on-site areas produced 11,000 yd^3.

Water treatment was a major concern during 1985. Approximately 4 million gallons of highly contaminated water had been generated, mainly as a result of the hydraulic mining activity. In 1984 and through the first half of 1985 the Oak Ridge National Laboratory worked to develop a treatment process that would meet the stringent State of New York Department of Environmental Conservation criteria governing release of the water to uncontrolled areas. By the end of 1985 approximately 3 million gallons had been released in accordance with these criteria.

1986 Plans

The few remaining contaminated areas on-site and off-site will be cleaned up by the end of 1986 and the contaminated materials placed in the waste containment facility. The final portion of the interim cap will then be completed. Geotechnical instrumentation will be installed in the containment area and monitoring wells developed around it to verify the effectiveness of the containment system. Another 2.5 million gallons of contaminated water will be treated and released. These activities will complete the interim remedial actions at the NFSS; from the beginning of fiscal year 1987 cap surveillance, maintenance, and environmental monitoring will be the only activities at the site until the final disposition of the site is determined.

SPECIAL FEATURES

There are several rather unique features of the remedial action at the NFSS that are worthy of special note. These include the waste containment facility, the residue dewatering system, the hydraulic mining and transfer of highly contaminated residues, the environmental monitoring program during remedial action, and the monitoring program to be implemented following site closure.

Interim Waste Containment Facility

The main product of the interim remedial actions at the NFSS is the disposal facility, which has a 25-year design life, but which could be upgraded to a design life of 200 to 1000 years.

The facility utilizes an underlying clay stratum as its bottom; the sides are formed by cutoff walls keyed into this stratum and topped with clay dikes. The dike and cutoff wall function as a continuous barrier to radionuclide migration in both groundwater and surface water. Both consist of clay compacted to achieve a permeability of 10^{-7} cm/s.

The containment facility is being covered with a cap designed to minimize water infiltration, radon emanation, erosion, and frost heave damage. A 3-ft-thick layer of clay is the main component of the cap. Eighteen inches of topsoil will cover the clay layer and a turf cover will minimize erosion and frost heave damage to the clay. The cap is sloped to enhance natural drainage away from the storage facility.

Waste stabilization is the cornerstone to successful construction of such a facility. Soil wastes are spread in thin layers and compacted to 90 percent maximum dry density; moisture conditioning is achieved by air drying or wetting as required; rubble is placed in thin layers and voids are filled with lean concrete; organic materials are not stored in the facility. Thus a stable waste form is produced that is not susceptible to subsidence or to the generation of leachates. Water infiltration and resultant leaching is minimized because the stabilized waste form has a low permeability.

If the interim cap is upgraded to a design life of 200 to 1000 years, a thicker clay layer will be used and a layer of crushed stone will be added to serve as a barrier to intrusion into the waste by plant roots, animals, or humans.

Dewatering and Stabilization of Residues

At the start of remedial action, most of the residues at the NFSS were saturated and unconsolidated. Consequently, stabilization -- i.e., dewatering and consolidation -- was necessary in preparation for storage.

The dewatering system utilized in Building 411 is a vacuum system, designed to minimize worker exposure and maximize waste stability. No fixing compounds (e.g., cement or fly ash) were used, thereby allowing for the possible future recovery of the residues. Volume constraints were another factor eliminating the use of additives: Building 411 is approximately 200 ft long by 180 ft wide and is 20 ft deep.

The dewatering system consists of several components: vacuum system, sand and geotextile drainage layer, drainage wicks, residues, clay seal, and cover. The vacuum system and clay surcharge apply the force necessary to draw water out of the residues and through the wicks and piping system. The water is removed through the drainage layer with eductor pumps operating within the closed vacuum system. The drainage layer filters the water from the residues and prevents the slotted PVC vacuum piping from becoming clogged. Wick drains are used to decrease the dewatering time by acting as water conduits through the highly impermeable residues.

The piping and drainage layers were placed in the bottom of the residue storage area before the residues were transferred to that area. This permitted the majority of the work to be performed without the constraint of working in a highly radioactive environment. Placing the drainage layer below the residues has the added benefit of gravity assistance to remove the water from the residues. The residues were then transferred onto the prepared drainage layer by the hydraulic mining process and by clamshell. Thereafter, the wicks were installed and a dry, clay seal was placed over the residues to improve the vacuum system operation and reduce radon emissions.

The dewatering process will reduce the residues to approximately two thirds their original volume. Once consolidation is complete in the next several months, the dewatered residues will be covered with clay before the interim cap is extended over Building 411.

Hydraulic Mining of Residues

By far the most physically difficult activity undertaken at the NFSS was the removal of the K-65 residues from Building 434 and their transfer to the waste containment area. The silo-shaped Building 434 was 165 ft tall and 38 ft in diameter. In addition to the top or outer dome, a convex inner dome had been constructed 40 ft above the bottom of the original water tank.

In the early 1950s, between 3,000 and 4,000 yd^3 of K-65 residues were placed in this tower for safe keeping. Most of the residue was placed in the bottom of the tower, but some (perhaps 400 yd^3) was placed in the upper section. The residues in the tower were inaccessible and generated large quantities of radon gas, requiring anyone within a few feet of the tower to be dressed in respirator-equipped protective clothing.

The residues were removed using a hydraulic mining unit that caused them to form a slurry mixture with water and then be pumped through a 4-in. steel pipeline to Building 411, approximately 1 mi away. The mining unit was suspended in the center of the tower by a crane and lowered as the mining operation progressed. A remote control TV camera was installed inside the tower and proved to be invaluable in guiding operations. While many difficulties were encountered, the mining operation did succeed in getting about 90 percent of the residues out of the tower. The biggest problem was that the residues were harder and more cohesive than expected, and consequently were much more difficult to get into a slurry form. Once this was recognized, a high pressure spray manifold was added to the bottom of the mining unit increasing the spraying pressure from about 150 psi to 2,000 psi. This "super charged" mining unit worked quite well.

Environmental Monitoring

The NFSS environmental monitoring program was designed to measure radon gas concentrations in air, radium and uranium concentrations in surface water and groundwater, and external gamma radiation levels. Thirty-four monitoring stations located on-site and at the site boundaries are equipped with both radon and external radiation detectors.

Radon levels are measured by Terradex Track-Etch detectors evaluated each month. External radiation levels are measured on a quarterly basis by lithium flouride thermoluminescent dosimeters. Supplemental radon monitoring is performed by Mound Laboratories using passive environmental radon monitors at 12 locations on the site perimeter, 2 locations along the West Ditch, and 30 off-site locations. Groundwater samples are collected quarterly from 16 locations and annually from 3 off-site locations. Surface water samples are also collected on- and off-site. All water samples are analyzed for radium-226 and uranium.

BNI summarizes the above data and prepares an annual environmental monitoring report for the NFSS. The report for 1984 demonstrated that the site is in compliance with all DOE concentration guidelines and radiation protection standards[3].

Monitoring After Closure

After the containment area is closed, both surface and subsurface monitoring will be performed in an attempt to ensure that undesirable trends in the physical condition or performance of the facility are detected early so that timely corrective actions can be taken.

Surface monitoring will consist of topographic surveys, walkover surveys, and aerial photography. For the topographic survey, a grid will be established on the cap and evaluations made twice each year for the life of the interim cap. Walkover surveys will be conducted to detect settlement, cracking, or other undesirable conditions. Aerial mapping will document changes in the surface contours of the waste containment facility; infrared photography will be used to identify stressed areas of the vegetal cover as well as surficial moisture differentials, thereby permitting location and delineation of saturated areas indicative of localized subsidence and ponding.

Subsurface monitoring will be done by means of a series of monitoring wells installed around the containment area and by a system of vibrating wire pressure transducers (VWPTs) and pneumatic pressure transducers (PPTs) installed in the containment area. Experience with these instruments in dam and tunnel construction indicated that they were well suited to this application. A pressure increase measured by these instruments can be translated into an increase in the height of saturation above them. The rate at which the pressure changes will be indicative of the location of entry of the water: pressure increases that occur rapidly within the first year after closure will be indicative of a permeable condition nearby, whereas a slow increase in pressure at one or more stations with a steady decrease in pressure at others will indicate equalization of the water contained within the facility at closure. The instruments are expected to stabilize within a year after closure. The differences in pressure between the instruments across the facility 4 to 5 years after closure will permit production of equipotential contours and sections. In addition to pressure changes, the VWPTs will measure temperature to monitor potential changes in the form of the wastes.

Any evidence of an apparent breach in the containment facility will be documented and remedial action developed if necessary. The use of external and internal monitoring techniques will make possible the documentation and evalution of potential or actual migration of radionuclides from the facility in time for repairs to the facility to be accomplished and waste to be reconfined before contamination reaches the site boundary. It will also document the adequacy of the design and construction of the facility.

SUMMARY

The current total estimated cost to complete the NFSS project through the installation of the interim cap is approximately $40 million. If the decision is made to permanently store material at the site, the final cap will cost $4 to $5 million more. Through installation of the interim cap, the project will have taken about 5 years during which more than 250,000 yd^3 of contaminated material will have been cleaned up and stored in the waste containment area, making the NFSS the largest completed decontamination project of its type in the U.S.

REFERENCES

1. U.S. Department of Energy. Niagara Falls Storage Site Project Management Plan, ORO-845, Rev. 1, Oak Ridge, TN, October 1985.

2. Bechtel National, Inc. Engineering Evaluation of Alternatives for the Disposition of Niagara Falls Storage Site, Its Residues and Wastes, DOE/OR/20722-1, Oak Ridge, TN, January 1984.

3. Bechtel National, Inc. Niagara Falls Storage Site Environmental Monitoring Report, Calendar Year 1984, DOE/OR/20722-55, Oak Ridge, TN, July 1985.