EFFECTIVENESS OF INTERIM REMEDIAL ACTIONS AT THE NIAGARA FALLS STORAGE SITE

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ABSTRACT

There are 190,000 m^3 of contaminated soils, wastes, and residues stored at the Niagara Falls Storage Site (NFSS). The residues have a volume of 18,000 m^3 and contain about 1930 Ci of ^{226}Ra, which accounts for most of the radioactivity. Since 1980, actions have been taken to minimize potential radiological risks and prevent radionuclide migration. Interim actions included capping vents, sealing pipes, relocating the perimeter fence (to limit radon risk), transferring and consolidating wastes, upgrading storage buildings, constructing a clay cutoff wall (to limit potential ground-water transport of contaminants), treating and releasing contaminated water, using a synthetic liner, and using an interim clay cap. An interim waste containment facility was completed in 1986.

Environmental monitoring showed a decrease in radon concentrations and in external gamma radiation from 1982 to 1986; levels have been stable since 1986. Uranium and radium concentrations in surface water have decreased; very low concentrations have been detected in stream sediments, and concentrations in ground water have remained stable. Recent monitoring showed that NFSS is in compliance with the U.S. Department of Energy's (DOE's) radiation protection standards.

SITE BACKGROUND

The Niagara Falls Storage Site (NFSS) is located in northwestern New York in Lewiston Township, Niagara County, approximately 6.4 km south of Lake Ontario and 16 km north of Niagara Falls. The site occupies approximately 77.4 ha in a generally rural setting and is bordered by a hazardous-waste disposal site, a sanitary landfill, and vacant land. Figure 1 shows the key features of the site, including the numbers and locations of various old buildings that are no longer in existence. The nearest permanent residence is 1.1 km to the southwest.

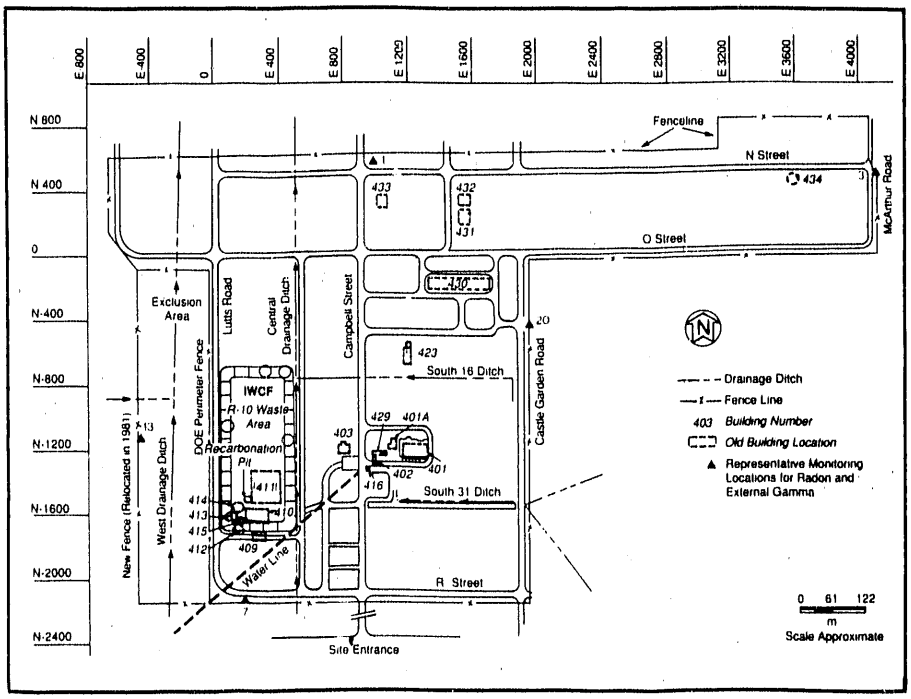

Figure 1. Niagara Falls storage site (NFSS).

The climate of the area is classified as humid continental; normal yearly temperatures range from -3.9 to 24.4°C; mean annual precipitation is 80 cm. Wind is predominantly from the southwest, with an average monthly wind speed ranging from 15.9 to 23 km/h. The site is generally level, sloping gently to the northwest. Soils are predominantly silty loams underlaid by clayey glacial till and lacustrine clay. Surface water from the site discharges via the Central Drainage Ditch and its tributary ditches into Four Mile Creek, located northwest of the site (BNI, 1989).

NFSS is a remnant of the original 612-ha site used during World War II by the Manhattan Engineer District (MED) project and was part of the U.S. Department of the Army's Lake Ontario Ordnance Works (LOOW). The site's major use since 1944 has been for storage and transitory storage of radioactive residues from uranium processing during the MED and subsequent Atomic Energy Commission projects. The site is currently managed by the DOE under its Formerly Utilized Site Remedial Action Program (previously under Surplus Facilities Management Program).

Composition of residues and waste materials at NFSS is given in DOE (1986); primary radionuclides are ^{238}U, ^{226}Ra, and associated radioactive decay products. The major contaminant is ^{226}Ra. Materials stored at the site consist of low-grade residues and by-products from the Linde Air Products Division, Union Carbide Corporation, Tonawanda, New York (L-300, L-50, and R-10 residues) and from the sampling plant in Middlesex, New Jersey (F-32 residues). The L-30 and L-50 residues were stored in Buildings 411, 413, and 414; F-32 residues were stored in the recarbonation pit directly west of Building 411. R-10 residues and associated iron cake were stored in the open, north of Building 411. The small quantity of Middlesex sands resulting from decontamination activities at the sampling plant was stored in Building 410. In 1949, pitchblende (K-65) residues from uranium extraction at a St. Louis, Missouri, plant were transported to the LOOW in drums; some were stored outdoors along existing roads and rail lines; others were stored in Building 410. From 1950 to 1952, the K-65 residues were transferred to a renovated concrete water tower (Building 434).

About 190,000 m^3 of contaminated soils, wastes, and residues are stored at NFSS. The residue inventory includes: 3891 short tons (tn) K-65, 8227 tn L-30, 1878 tn L-50, 138 tn F-32, and 8235 tn R-10 (BCL, 1981). About 2 tn of Middlesex sands are also stored at the site. The residues, about 18,000 m^3, account for most of the radioactivity, primarily from ^{226}Ra. The K-65 residues, which account for about 95% of the ^{226}Ra content, are estimated to contain about 1830 Ci of ^{226}Ra (Letter from G. P. Turi, U.S. Department of Energy, Washington, D.C. to R. Hargrove, U.S. Environmental Protection Agency, New York, NY, March 13, 1987). The amount of uranium remaining in residues and wastes after extraction from the ores is low: <30 Ci in residues and <1 Ci in wastes (DOE, 1986).

INTERIM REMEDIAL ACTIONS AND THEIR EFFECTIVENESS

Over the past 8 yr, several interim actions were taken at NFSS. Overall, these actions reduced radon release levels from above DOE guidelines to near background. Beginning in 1984, wastes were consolidated; following this action, gamma exposure rates declined to stable, low levels when the Interim Waste Containment Facility (IWCF) was completed in 1986.

Inhalation of radon and gamma irradiation are the only significant exposure pathways at or near NFSS. Figures 2 and 3 show declines in radon and gamma exposure rates during the years when interim remedial actions were taken, eventually culminating in waste consolidation in the IWCF. Radon levels, including background, which has ranged from 0.3 to 1 pCi/L over the past several years, are shown in Figure 2. Gamma exposure rates that can be attributed to radioactive materials at NFSS are shown in Figure 3. The background levels, 64 to 91 mR/yr, were subtracted from the readings.

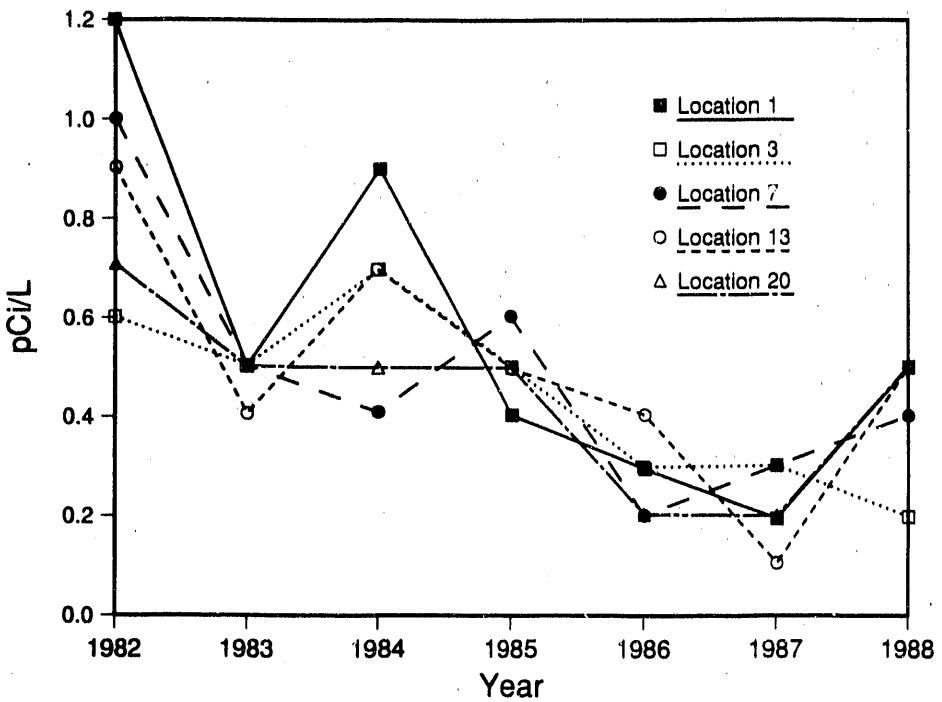

Figure 2. Radon levels (annual averages) at representative NFSS boundary locations.

The current monitoring network includes 35 radon detectors and 33 thermoluminescent dosimeters to measure gamma radiation. Average annual concentrations of total uranium in surface water where the Central Drainage Ditch exits NFSS have decreased from 108 pCi/L in 1982 to 10 pCi/L in 1988. Radium concentrations at the same location have remained low, ranging from 1.5 pCi/L in 1982 to 1.0 pCi/L in 1988. Average concentrations in sediments were 2 pCi/g (dry) for uranium and 0.9 pCi/g for radium in 1988; these are near-background

levels. Total uranium and radium in ground water have generally remained stable. For example, along the eastern and western edges of the northern NFSS boundary, uranium concentration is about 4 pCi/L and that for radium is about 0.4 pCi/L. Only one well on the western perimeter of IWCF has shown elevated uranium (about 55 pCi/L). The well is located in a sand lens (a small deposit of sand of finite extent in a formation of clay or other geologic stratum); radioactive contamination may reflect contaminated solids in or near the well (BNI, 1989). The current ground water monitoring network consists of 48 onsite wells.

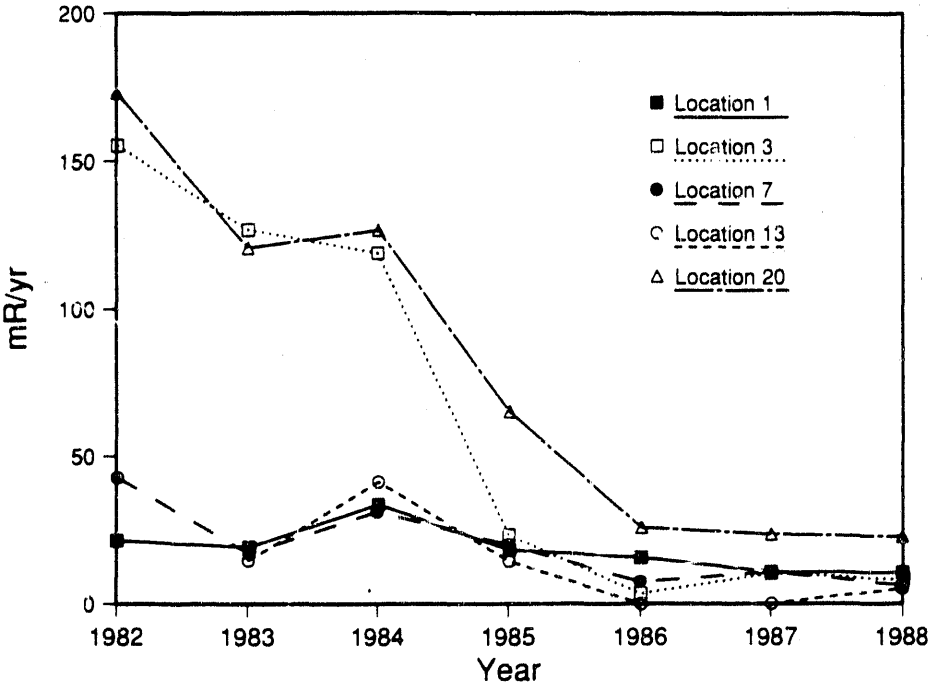

Figure 3. Gamma exposure rates (annual averages) at representative NFSS boundary locations.

A radiological survey of NFSS conducted in 1979 served as the basis for initial interim remedial action planning (BCL, 1981). Bechtel National, Inc., DOE's project management contractor, has implemented interim remedial actions since 1981 and currently maintains the site and conducts environmental monitoring (BNI, 1989).

Since 1980, actions have been taken at the NFSS to minimize radiological risks and prevent migration of residues. For example, the vent on top

of Building 434 (the former water tower where K-65 residues were stored) was capped to reduce radon emissions, and pipes penetrating the walls of residue storage buildings were sealed or resealed to prevent radionuclide migration. Because radon levels (5 to 7 pCi/L; NLO, 1981) exceeded the DOE limit (3 pCi/L; DOE, 1987), the site fence was relocated, in 1981, 152.4 m to the west, to create an exclusion area and protect the public. Radon levels at the new boundary were below applicable guidelines. Also in 1981, 342 m^3 of excavated material, contaminated with ^{238}U and decay products, from a triangle-shaped property adjacent to NFSS, was placed in storage at the site.

To further reduce radon levels, Buildings 413 and 414 (used to store L-50 residues) were upgraded and sealed in 1982. To prevent further migration of residues, contaminated soil near the R-10 pile was moved onto the pile, and a dike and cutoff wall were constructed around the R-10 area. The R-10 pile was then covered with an ethylene propylene diene monomer (EPDM) liner. This action effectively reduced radon concentrations at the old site boundary (along Lutts Road, Figure 1) to below DOE guidelines.

In 1983 and 1984, the EPDM liner was removed, additional contaminated soils and rubble from on and off site were placed on the pile, and the pile was covered with the first layer of an interim clay cap. These actions constituted the origin of the IWCF. In 1984, 93% of K-65 residues were transferred from Building 434 to Building 411 inside the IWCF.

Transfer of K-65 residues from Building 434 to the IWCF was completed in 1985. Other actions included demolition of Building 434, completion of remedial action on properties near the site, and continued installation of the cap over waste in the IWCF. These actions involved excavating 10,640 m^3 of contaminated materials from on and off site, transferring 1,102 m^3 of building rubble to the IWCF, and discharging 12 million L of treated, impounded water in accordance with New York State Department of Environmental Conservation (NYSDEC) permit requirements. In 1986, another 25.8 million L of contaminated water were treated and released; four of six water treatment ponds were reclaimed and reduced to grade.

The cap over the IWCF was completed in 1986. The facility covers 4 ha and is enclosed within a dike and cutoff wall, each constructed of compacted clay. The cutoff wall extends a minimum of 45 cm into an underlying clay unit. The dike and cutoff wall, in conjunction with the engineered earthen cap, enclose waste in a clay envelope that prevents migration of contaminants. Pollution control measures used

during construction of the IWCF included sedimentation barriers in excavation areas and batch discharges of treated, impounded surface water in accordance with NYSDEC requirements. In 1987, impounded water in the remaining two ponds (38.8 million L) was treated and released; the ponds were reclaimed and reduced to grade; and the NFSS was closed. The site is currently inactive except for environmental monitoring, and surveillance and maintenance of the IWCF.

In 1988, several isolated areas of residual radioactivity were excavated and placed in temporary storage until the IWCF is reopened so that additional material can be added. At present, all the residual radioactivity on site has been remediated except for one localized area, which will be remediated in the future (BNI, 1989).

CONCLUSIONS

Interim remedial actions over the past 8 yr at NFSS have reduced radon and gamma exposure. Since the IWCF was completed in 1986, exposure levels have remained stable and close to background. Remedial actions have also limited migration of radionuclides via water. Environmental monitoring shows the site is in compliance with DOE's radiation protection standards.

ACKNOWLEDGMENT

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