NF-125

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

For the Niagara Falls Site, New York

U.S. Department of Energy

0489-0613.1

200-1e

NFSS_01.06_1051_a

NOTES TO REVIEWERS:

1. All final data and discussion is included in this Tech Memo with the exception of external gamma exposure results and the maximally exposed individual discussion. The revised tables and text will be provided to you before you are asked to sign off on comment resolution.

2. We have negotiated with FSRD to make the tech memo preparation process more cost-effective and efficient. During your review, please adhere to the following guidelines to help us achieve these objectives:

   - To simplify report generation, DOE has concurred that the ESTM organizational format will be the same as that which has been used the past two years. Please refrain from making comments on report organization or format.

   - The review board for this document is streamlined to make the review process more efficient, and tech memo budgeting and planning reflects this decision. Please contact me immediately if you believe another discipline should also review the document.

The charge number for this task is 14501-700-158-L030. We have budgeted 3 hours for each of you for a thorough review of this document. Please let me know if you think it will take substantially longer than that.

Your contributions to this document are much appreciated. Feel free to contact me at 6-0410 if you have any questions.

150463

FUSRAP Project
Job 14501

No. 158-97-XXX Rev. 0
Date: February 26, 1997

FUSRAP TECHNICAL MEMORANDUM

To: Jason Darby, Environmental Scientist - FSRD
From: James C. McCague, Project Engineering Manager - FUSRAP
Subject: Environmental Surveillance Results for 1996 for the Niagara Falls Storage Site

Prepared By	ES Team Lead	Project Engineer	Project Manager
Paula Bond	Angela K Jot		

SUMMARY

This memorandum presents and interprets analytical results and measurements obtained as part of the 1996 environmental surveillance program for the Niagara Falls Storage Site (NFSS) under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The discussion provides a comparative analysis of local background conditions and applicable regulatory criteria to results reported for external gamma radiation and for samples from the media investigated (air, surface water, streambed sediment, and groundwater). Results from the 1996 surveillance program at NFSS indicate that applicable U.S. Department of Energy (DOE) guidelines were not exceeded for any measured parameter or for any dose calculated for potentially exposed members of the general public.

1.0 INTRODUCTION

NFSS is located in the Town of Lewiston in northwest New York state, northeast of Niagara Falls and south of Lake Ontario (Figure 1). Presently, the 77 ha site includes one former process building (401), two office buildings, a small equipment shed, and a 4 ha waste containment structure (WCS). The property is entirely fenced, and public access is restricted.

Land use in the region is predominantly rural; however, the site is bordered by a chemical waste disposal facility (ChemWaste Management Chemical Services, Inc.) on the north, a solid waste disposal facility (Modern Disposal, Inc.) on the east and south, and a Niagara Mohawk Power Corporation right-of-way on the west. The nearest residential areas are approximately 1.1 km southwest of the site; the residences are primarily single-family dwellings.

Beginning in 1944 NFSS was used as a storage facility for low-level radioactive residues and wastes. The residues and wastes are the process by-products of uranium extraction from pitchblende (uranium ore). The residues originated at sites other than NFSS and were transferred there for storage. The residues were stored in buildings and onsite pits and surface piles. From 1953 to 1959 and 1965 to 1971, building 401 was used as a boron-10 isotope separation plant.

From 1971 to present, activities at NFSS have been confined to residue and waste storage and remediation. All onsite and offsite areas of residual radioactivity above current DOE guidelines were remediated between 1955 and 1992; materials generated during remedial actions (approximately 195,000m^3) are encapsulated within the WCS, specifically designed to provide long-term storage of the material. During 1996, remedial activities included the partial decontamination of building 401 and the delineation of contamination in one office building (BNI, 1996a). Appendix A contains a summary of 1996 remedial activities, non-routine environmental monitoring, and the results and conclusions for these activities.

1.1 Monitored Constituents

The key elements of the 1996 environmental surveillance program at NFSS were as follows:

- measurement of external gamma radiation;
- measurement of radon gas concentrations in air (combined contributions from radon-220 and radon-222);
- monitoring of radon-222 flux (rate of radon-222 emission from the storage piles);
- sampling and analysis of surface water for total uranium, thorium-232, and radium-226 (hereafter referred to collectively as radioactive constituents);
- sampling and analysis of streambed sediments for radioactive constituents:
- sampling and analysis of groundwater for radioactive constituents, metals, and water quality parameters.

1.2 Unit Conversions

The following tables provide the units of measurement and appropriate abbreviations used in this document. Conventional units for radioactivity are used in this document because the applicable regulatory guidelines are generally provided in these terms; Système Internationale (SI) units of measurement are used in the discussion of all other parameters. Unit conversions will be provided in the text only for water level information.

Units of Measurement and Conversion Factors - Radioactivity

Parameter	Conventional Units	SI Units	Conversion Factor
Dose	millirem (mrem)	milliSievert (mSv)	1 mrem = 0.01 mSv
Activity	picocurie (pCi)	becquerel (Bq)	1 pCi = 0.037 Bq

Units of Measurement and Conversion Factors - Mass, Length, Area, and Volume

Parameter	SI Units	English Units	Conversion Factor
Mass	gram (g)	ounce (oz)	1 g = 0.035 oz
	kilogram (kg)	pound (lb)	1 kg = 2.2046 lb
Length	centimeter (cm)	inch (in)	1 cm = 0.394 in
	meter (m)	foot (ft)	1 m = 3.281 ft
	kilometer (km)	mile (mi)	1 km = 0.621 mi
Area	hectare (ha)	acre	1 ha = 2.47 acres
Volume	milliliter (mL)	fluid ounce (fl. oz.)	1 mL = 0.0338 fl. oz.
	liter (L)	gallon (gal)	1 L = 0.264 gal
	cubic meter (m^3)	cubic yard (yd^3)	1 m^3 = 1.307 yd^3

2.0 REGULATORY GUIDELINES

The primary regulatory guidelines that affect activities at FUSRAP sites are found in DOE Orders, federal statutes, and federal regulations as identified in the FUSRAP Standards/Requirements Identification Document (S/RID) (DOE, 1996), and state and local regulations. S/RID requirements are generally applicable to all sites, while the applicability of other regulations varies from site to site. Regulatory criteria that were used to evaluate the results of the 1996 environmental surveillance program at NFSS are summarized below, categorized by applicable medium and parameter.

<u>External Gamma Radiation and Air (Radon Gas and Airborne Particulates)</u>

Applicable regulatory criteria for evaluating the calculated maximum doses from external gamma radiation and inhalation of radioactive particulates, and the measured concentrations of radon gas are as follows:

- DOE Order 5400.5

  Dose limits for members of the public are presented in this DOE Order. The primary dose limit is expressed as an effective dose equivalent. The limit of 100 mrem effective dose equivalent above background in a year from all sources is specified in this Order; external gamma radiation dose and the calculated doses from airborne particulate releases are included in the calculation of the effective dose equivalent total. DOE limits for radon concentrations in air are also presented in this Order. The limits for radon-220 and radon-222 concentrations in air are both 3.0 pCi/L above background concentrations. If both isotopes are present, the sum of the ratios of the concentration of each isotope to the allowable limit must be less than one. Based on the radioactive constituents in the wastes contained in the WCS, it is unlikely that radon-220 would be emitted from the WCS; it is, however, possible that radon-222 would be emitted.

- Clean Air Act

  Section 112 of the Clean Air Act authorized the Environmental Protection Agency (EPA) to promulgate the National Emission Standards for Hazardous Air Pollutants (NESHAPs), which is applicable at NFSS. Compliance with Subpart H (for nonradon, radioactive constituents) is verified by applying the EPA-approved CAP88-PC model (EPA 1992a). Compliance with Subpart Q is verified by annual monitoring of the piles for radon-222 flux.

Summary of Radiological Standards and Guidelines
- External Gamma Radiation and Air -

Radioactive Parameter	DOE Order 5400.5 [a]	Federal Standard or Guideline
Radon-222 flux	---	20 $pCi/m^2/s$ [b]
Radon-222	3.0 pCi/L	4 pCi/L [c]
Radionuclide Emissions (airborne particulates and radioactive gases excluding radon-220 and radon-222)	10 mrem/yr	10 mrem/yr [b]
Effective Dose Equivalent (total contribution from all sources [d])	100 mrem/yr	---

[a] *Guidelines provided in the DOE Order are above background concentrations or exposure rates.*
[b] *Federal (EPA) Standard from 40 CFR, Part 61.*
[c] *EPA action level for radon concentration in homes (reference EPA 400-R-92-011).*
[d] *Contributing sources at NFSS consist of external gamma radiation exposure, radionuclide emissions listed above, and ingested radionuclides in water and soil/sediment (listed in the following table).*
-- *No existing standard.*

<u>Sediment, Surface Water, and Groundwater - Radioactive Parameters</u>

Applicable regulatory criteria for evaluating the measured concentrations of radionuclides in sediment, surface water, and groundwater at NFSS are as follows:

- DOE Order 5400.5

  The environmental surveillance program does not include analysis of onsite soils; however, because there are no standards for sediment, the residual soil cleanup criteria specified in DOE Order 5400.5 are used to provide a basis for evaluation of the analytical results in sediment. The soil guidelines are health-based values that are established based on future use scenarios, such as farming and grazing livestock.

  DOE Order 5400.5 states that the guideline for residual concentrations of radium-226 and thorium-232 in soil is 5 pCi/g above background, based on an average of the first 15 cm of soil below the surface. The NFSS proposed site-specific DOE soil cleanup criterion for total uranium is 90 pCi/g above background. For mixtures of radionuclides, the Order prescribes that the data be evaluated by the sum-of-the-ratios. By this method, the above-background concentration of each of the radioisotopes is divided by the respective criterion, and the ratios are summed. If the result is greater than 1, the mixture of radionuclides fails the sum-of-the-ratios test and is considered to exceed the soil guidelines.

DOE derived concentration guides (DCGs) for water, which are also presented in this Order, are used to evaluate analytical data for surface water and groundwater at NFSS, and are called out in the appropriate data tables within this report.. The DCG for each radionuclide represents the concentration that would result in a dose of 100 mrem during a year, conservatively calculated for continuous exposure conditions.

Summary of Radiological Standards and Guidelines - Water and Sediment

Radioactive Parameter	DOE DCG [a] for Water [b]	DOE Soil Cleanup Criterion [c,d]
Total Uranium	600 pCi/L [e]	90 pCi/g
Thorium-232	50 pCi/L	5 pCi/g
Radium-226	100 pCi/L	5 pCi/g

[a] *DOE Derived Concentration Guide (DOE Order 5400.5)*

[b] *Surface water and groundwater (non-drinking water values); represent concentrations above background.*

[c] *Above background concentration in soil, averaged over the topmost 15 cm of soil.*

[d] *There are no standards for sediment; therefore, the DOE residual (radium and thorium) and proposed site-specific (uranium) soil cleanup criteria are used to provide a basis for evaluation of analytical results for sediment. If a mixture of the radionuclides is present, then the sum of the ratios of the concentration of each isotope to the allowable limit must be less than one.*

[e] *This guideline applies for total uranium in natural isotopic abundance.*

Groundwater - Chemical Parameters

Although the groundwater at NFSS does not provide a public drinking water supply, state and Federal standards for drinking water are used in this document (as detailed below) to provide a conservative basis for comparison of chemical analytical results.

- SDWA

  SDWA is the primary Federal regulation applicable to the operation of a public water system and the development of drinking water quality standards [*EPA Drinking Water Regulations and Health Advisories* (EPA, 1996)]. These regulations, found in 40 Code of Federal Regulations (CFR) Part 141, set maximum permissible levels of organic, inorganic, and microbial contaminants in drinking water by specifying the maximum contaminant level (MCL) for each. In some cases, secondary maximum contaminant levels (SMCLs), which are not federally enforceable (40 CFR 143.1), are provided as guidelines for the states.

- New York State Department of Environmental Conservation (NYSDEC) Water Quality Criteria for groundwater

NYSDEC has adopted the Federal SDWA standards into its own regulations in Title 6 New York Codes, Rules, and Regulations (NYCRR) Parts 700-705, "Water Quality Regulations for Surface and Groundwater" (NYSDEC, 1996). In addition, NYSDEC has independently established standards for some constituents.

The State of New York categorizes groundwater resources by groundwater quality and use in order to apply established standards. At NFSS, because of uniformly poor groundwater quality and availability in the general region, the shallow groundwater resources are of little consequence. Regional studies and studies conducted near the site (La Sala, 1968; Wehran, 1977; Acres American, 1981) conclude that groundwater quality is poor in the vicinity of the site because of high mineralization. Additionally, local studies (Wehran, 1977 and Acres American, 1981) indicate that the permeabilities of the shallow groundwater systems are sufficiently low that it is not practical to obtain groundwater from these systems for water supply. Onsite permeability testing at NFSS confirms the low permeabilities.

Well surveys conducted in 1988 and 1995 identified eight private wells within a 4.8-km radius of the site; these wells further confirm the impracticability of using the shallow groundwater system for obtaining water in appreciable quantities. Of the eight wells identified during the survey, only one [2 km north of the site] is downgradient of the site. None of the wells identified in the well survey is reportedly used for drinking water supply; most are used for irrigation (DOE, 1994). In light of these findings, the NYSDEC Class GA (water supply) groundwater standards represent a conservative basis for comparing analytical results because the groundwater at NFSS does not meet the criteria for Class GA groundwater.

However, to establish a basis for comparison of analytical results, Class GA (groundwater) water quality standards for some constituents were obtained from the above-referenced NYSDEC document.

- NYSDEC Technical and Administrative Guidance Memorandum (January 24, 1994)
  This Technical and Administrative Guidance Memorandum (TAGM) specifically addresses soil cleanup objectives (NYSDEC, 1994). However, since the method for determining these objectives is partly based on protection of the groundwater, groundwater standards for some constituents were included in this TAGM. These standards have been used to establish additional Class GA (related, conservative case) state water quality standards for comparison of analytical results.

3.0 SAMPLING LOCATIONS AND RATIONALE

Radioactive materials that exceed guidelines at NFSS are stored in the WCS. Exposure of members of the public to radioactivity at NFSS is unlikely due to site access restrictions (e.g., fences) and engineering controls; however, potential pathways include direct exposure to external gamma radiation; inhalation of air containing radon or radioactively contaminated particulates; and contact with, or ingestion of, contaminated surface water, streambed sediments, or groundwater. The environmental surveillance program at NFSS has been developed to provide surveillance of these exposure routes through periodic sampling and analysis for radioactive and chemical constituents. Figures 2 and 3 present the environmental surveillance program at NFSS and indicate sampling locations and media. Table 1 summarizes the environmental surveillance program at NFSS for external gamma radiation, radon-222/radon-220, surface water, sediment, and groundwater.

External gamma radiation monitoring and radon gas measurement occur at fenceline locations surrounding NFSS and the WCS to assess the potential exposures to the public and site workers (Figure 2) . Measurement of radon-222 flux is periodically conducted at discrete grid intersections on the WCS (Figure 3).

Groundwater monitoring wells have been selected to assess background, downgradient, and source-area (near the WCS) groundwater quality conditions in the upper groundwater system (Figure 2). The upper groundwater system would provide the earliest indication in the unlikely event of a breach of the WCS. The lower groundwater system is not monitored because past analytical results from the upper groundwater system have not indicated migration of radioactive material from the WCS. Groundwater monitoring includes analysis for radioactive constituents, water quality parameters, and metals.

Surface water and streambed sediment sampling is conducted along the drainage ditch system to assess upstream, onsite, and downstream concentrations of radioactive constituents (Figure 2). Surface water and sediment sampling locations were selected to assess the migration of constituents in these media should any be apparent. Surface water and streambed sediment samples are analyzed for radioactive constituents.

4.0 SURVEILLANCE METHODOLOGY

Under the NFSS environmental surveillance program, standard analytical methods approved and published by EPA and the American Society for Testing and Materials (ASTM) are used for chemical (i.e., all nonradiological) analyses. The laboratories conducting the radiological analyses adhere to EPA-approved methods and to procedures developed by the Environmental Measurements Laboratory

(EML) and ASTM. A detailed listing of the specific procedures and the data quality objectives for the surveillance program is provided in the FUSRAP *Environmental Surveillance Plan* (BNI, 1996a).

All 1996 environmental surveillance activities at NFSS were conducted in accordance with the *Environmental Surveillance Plan* (BNI, 1996a) and the instruction guides (IGs) listed in the following table. The IGs are based on guidelines provided in *RCRA Ground Water Monitoring: Draft Technical Guidance* (EPA, 1992b), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846; EPA, 1992c), and *A Compendium of Superfund Field Operations Methods* (EPA, 1987).

FUSRAP Instruction Guides Used for Environmental Surveillance Activities

Document Number	Document Title
191-IG-007	Groundwater Level and Meteorological Measurements (BNI, 1996b)
191-IG-011	Decontamination of Field Sampling Equipment at FUSRAP Sites (BNI, 1996c)
191-IG-028	Surface Water and Sediment Sampling Activities (BNI, 1993a)
191-IG-029	Radon/Thoron and TETLD Exchange (BNI, 1993b)
191-IG-033	Groundwater Sampling Activities (BNI, 1996d)

5.0 ANALYTICAL DATA AND INTERPRETATION OF RESULTS

This section presents the data and interpretation of results for the environmental surveillance program at NFSS. Data for 1996 are presented in Tables 2 through 11.

Note that in data tables containing analyses for radioactive constituents, some results may be expressed as negative numbers. This phenomenon occurs if the average background activity of the laboratory counting instrument exceeds the measured sample activity. In such cases, when this instrument background activity is subtracted from the sample activity, a negative number results. For the purposes of interpretation, all values below the baseline minimum detectable activity (MDA) are interpreted as having an unknown value between zero and the MDA. Such a value will be referred to as a nondetect in the text discussion.

For direct comparison of analytical results to the DOE DCGs, average background radioactivity in surface water, sediment, and groundwater is subtracted from the 1996 results The reported results and the background corrected results are both provided in the data tables; but for simplicity, discussions in the text present only the actual analytical results (background not subtracted) because none of the measured concentrations is near the DCG. All figures displaying results present actual analytical data.

Average historical background concentration for each sampled analyte is determined from background sampling results from 1992 to 1996, unless otherwise noted. Subtracting the calculated average background from the sampling results for 1996 then gives an estimate of the above-background concentration of the measured constituent at each location. When background is subtracted from the sampling result, it is possible that a negative number will be obtained, much the same as a negative value may be obtained when the laboratory subtracts instrument background from a sample measurement. A negative number will be considered indistinguishable from background.

The most precise analytical method for analysis of total uranium yields results in µg/L and µg/g for water and sediment samples, respectively. To allow direct comparison of results to the DCGs and soil guidelines, the data must be converted to pCi/L and pCi/g, as appropriate. The specific activity for total uranium in its natural isotopic abundance (uranium that is neither depleted nor enriched) is 0.677 pCi/µg (BNI. 1995a), which is used as the conversion factor to convert the data to pCi/L or pCi/g, as appropriate. Only the converted data are provided in the tables and text of this document.

5.1 External Gamma Radiation

External gamma radiation dose rates are measured using tissue-equivalent thermoluminescent dosimeters (TETLDs) in place at NFSS continuously throughout the year. Each TETLD measures a cumulative dose, which, when divided by the period of exposure (one year), yields the external gamma radiation dose rate at that location. TETLD results for external gamma radiation dose rate in 1996 (both raw data and data corrected for shelter/absorption and background) are summarized in Table 2. TETLD surveillance locations are shown in Figures 2.

All 1996 external gamma radiation results at NFSS were indistinguishable from background. Based on these data, the dose rate from direct gamma exposure at NFSS is essentially 0 mrem/yr above background. This value is well within compliance with the DOE guideline of 100 mrem/yr above background.

5.2 Radon Gas

Based on the radioactive constituents in the wastes contained in the WCS, it is unlikely that radon-220 would be emitted from the WCS; however, it is possible that radon-222 would be emitted. Air surveillance is conducted to determine the concentration of radon gas at NFSS using RadTrack® detectors that are designed to measure alpha particle emissions from both isotopes of radon (radon-220 and radon-222) and to collect passive, integrated data throughout the period of exposure. Because radon-220 is not a contaminant of concern at NFSS, all concentrations are assumed to be radon-222. Results of semiannual monitoring in 1996 are presented in Table 3; the corresponding surveillance locations are shown in Figure 2.

Consistent with results for 1995 (BNI, 1996e), the majority of the radon-222 results from the 1996 environmental surveillance program are at or below the detection limit (0.20 pCi/L). All 1996 concentrations are below the DOE limit of 3.0 pCi/L for radon-222. One apparent anomaly (1.90 pCi/L) was measured at location 1 during the last six months of 1996, at the north end of the site on the fenceline just east of Campbell Street. The radon-222 concentration at this location during the first six months of 1996 and throughout 1995 (BNI, 1996e) was less than the detection limit. No site disturbances occurred in the vicinity of this monitoring location.

5.3 Radon-222 Flux

Measurement of radon-222 flux provides an indication of the rate of radon-222 emission from a surface. Radon-222 flux is measured with activated charcoal canisters placed at 15-m intervals across the surface of the WCS for a 24-hr exposure period. Measurements for 1996 are presented in Table 4; measurement locations are shown in Figure 3. Measured results for 1996 ranged from nondetect to 0.26 $pCi/m^2/s$. As in previous years (BNI, 1996e), these results are well below the 20 $pCi/m^2/s$ standard specified in 40 CFR Part 61, Subpart Q, and strongly demonstrate the effectiveness of the containment cell design and construction in mitigating radon-222 migration.

5.4 Airborne Particulate Dose

To determine the dose from airborne particulates, airborne particulate release rates are calculated using historical data for site soil contamination and a limited reservoir surface wind erosion model (EPA, 1985). Airborne particulate release rates are then entered into the CAP88-PC computer model (EPA, 1992a) to perform two calculations. The first calculation estimates the resultant hypothetical doses from airborne particulates to individuals at the distances to the nearest residence (1,100 m southwest of the site) and to the nearest commercial/industrial facility (510 m east of the site) measured from a central location onsite. Hypothetical doses are then corrected for the occupancy of the nearest residence (24 hour/day) and the nearest commercial/industrial facility (40 hour/week for 50 weeks/year). The higher of these hypothetical doses then becomes the hypothetical airborne particulate dose to the maximally exposed individual for the site. The second calculation estimates the hypothetical airborne particulate collective dose to the population within 80 km of the site. The second calculation also uses a population file (generated from county population densities) to determine numbers of people in circular grid sections fanning out to 80 km from the center of the site.

The first of the calculations indicates that the 1996 hypothetical airborne particulate dose to the maximally exposed individual, an occupant at the nearest residence 1,100 m southwest of the site, was essentially zero (0.000000005 mrem/yr, or 5×10^{-9} mrem/yr). This value is well below the 10 mrem/yr standard specified in 40 CFR, Part 61, Subpart H. The second calculation indicates that the hypothetical airborne particulate collective dose to the population within 80 km of the site was 5×10^{-8} person-rem/yr (equivalent to 0.00000005 person-mrem/yr).

5.5 Surface Water and Sediment

In 1996, annual surface water and sediment samples were collected at five locations: SWSD009 and SWSD021 at the upstream fenceline; SWSD010 and SWSD022 onsite along the central drainage ditch; and SWSD011, downstream along the central drainage ditch. Surface water and sediment sampling location SWSD009 was selected as a background location because it is at the upstream boundary of the South 31 drainage ditch, a drainage which eventually joins the central drainage ditch. Surface water and sediment sampling SWSD021 was selected because it is located upstream, along the NFSS fenceline, where the central drainage ditch first enters the property. Sampling locations are presented in Figure 2.

Surface water and sediment samples were analyzed for radium-226, thorium-232, and total uranium. The 1996 environmental surveillance analytical results for surface water and sediment samples are presented in Tables 5 and 6, respectively. Analytical results for surface water in 1996 are compared to the DOE DCGs for radium-226, thorium-232, and total uranium. Because there are no established standards for sediments, the residual soil cleanup criterion of 5 pCi/g is used to provide a basis for comparison of radium-226 and thorium-232 analytical results. The NFSS DOE site-specific soil cleanup criterion of 90 pCi/g is used as a basis for comparison of total uranium analytical results.

Background concentrations were determined by averaging historical analytical results for the appropriate constituents at surface water/sediment sampling locations SWSD009 and SWSD021. For total uranium and radium-226, background concentrations include data from 1992 through 1996 for surface water and sediment. Since thorium-232 analysis first began in 1995 for sediment and 1996 for surface water, background concentrations for thorium-232 in sediment were determined from 1995 and/or 1996 analytical results as applicable.

<u>Surface Water</u>
In 1996 as in previous years (BNI, 1996e), surface water analytical results were consistently less than the DOE DCGs and were generally indistinguishable from the historical background (upstream) concentrations. Measured results (background not subtracted) are discussed below:

- The 1996 analytical results for radium-226 concentrations onsite, ranging from nondetect to 1.08 pCi/L, are consistent with historical results and are indistinguishable from background. The average historical background concentration for radium-226 is 0.65 pCi/L, and 1996 background ranged from 0.19 to 1.81 pCi/L. The radium-226 DOE DCG is 100 pCi/L.

- In 1996, thorium-232 was detected only at SWSD022 at a trace concentration of 0.49 pCi/L, which is statistically indistinguishable from background. The DOE DCG for thorium-232 is 50 pCi/L.

- The 1996 analytical results for total uranium in onsite surface water (7.03 to 9.57 pCi/L) are consistent with historical results and are indistinguishable from background. Background for 1996 ranged from 3.47 to 15.33 pCi/L, and the average historical background concentration is 7.34 pCi/L. The DOE DCG for total uranium is 600 pCi/L.

Sediment

Sediment concentrations of radium-226, thorium-232, and total uranium were less than the DOE soil guidelines and were generally indistinguishable from upstream (background) conditions. At all sampled locations, results were less than the DOE guideline for mixtures of radionuclides (sum of the ratios). Measured results are presented below (background not subtracted).

- The 1996 analytical results for radium-226 are consistent with historical analytical results. Radium-226 results from upstream locations SWSD009 and SWSD021 were 1.27 and 1.63 pCi/g, respectively, comparing favorably with the calculated historical background of 1.56 pCi/L. The 1996 results of analysis for radium-226 in samples collected at downstream locations SWSD010, SWSD011, and SWSD022 ranged from 0.71 to 1.92 pCi/g. All radium-226 concentrations in sediment were less than the DOE soil cleanup criterion of 5 pCi/g above background.

- Downstream thorium-232 results ranged from 0.75 to 1.11 pCi/g, and upstream results from SWSD009 and SWSD021 were 1.22 and 1.60 pCi/g, respectively. All 1996 analytical results for thorium-232 samples were comparable to the historical average background concentration of 1.33 pCi/L; therefore, none of the thorium-232 concentrations in sediment exceeded the DOE soil cleanup criterion of 5 pCi/g above background.

- The 1996 analytical results for total uranium at upstream sampling locations SWSD009 and SWSD021 were 2.60 and 2.14 pCi/g, respectively, comparing favorably with the historical upstream average of 3.32 pCi/g. The 1996 analytical results for total uranium at downstream sampling locations SWSD010, SWSD011, and SWSD022 ranged from 1.39 to 2.25 pCi/g, consistent with historical analytical results and comparable to upstream results. The DOE-established site-specific standard for total uranium is 90 pCi/g above background; the historical and 1996 analytical results are well below this standard.

5.6 Groundwater

The locations of environmental surveillance groundwater monitoring wells at NFSS are shown in Figure 2. Background information, descriptions of activities performed under the groundwater surveillance program, and surveillance results are discussed below.

5.6.1 Groundwater Flow System

Natural System

Four unconsolidated units and one bedrock unit are readily identified in the subsurface at the site. The uppermost unit is composed of a low-permeability silty clay till. Discontinuous sand lenses have been identified and mapped within this clay till. The clay till is underlain by a very low permeability glaciolacustrine clay that is present at varying thickness across the entire site. The glaciolacustrine clay is underlain by a second glaciolacustrine unit, which consists of sand and gravel; this unit exhibits the highest permeability identified in the shallow unconsolidated subsurface materials at the site. This unit is underlain by a dense, silty, glacial till that exhibits very low permeability. Beneath this till is the shale bedrock.

Groundwater at NFSS occurs in both the unconsolidated deposits and the shale bedrock. In the unconsolidated deposits, two distinct groundwater systems are present: the upper groundwater system, which occurs within the uppermost clay unit, and the lower groundwater system, which occurs within the sand and gravel unit, the underlying till unit, and the weathered portion of the bedrock shale. The bedrock groundwater system occurs within the unweathered portion of the bedrock shale. Regionally, groundwater in both the upper and lower groundwater systems and the bedrock system flows northwestward toward Lake Ontario.

Surface drainage from the site originally entered Fourmile, Sixmile, and Twelvemile Creeks, which all flow northward to Lake Ontario. In the 1940s, a system of drainage ditches was installed to drain surface water to a central drainage ditch. The largest of these drainage ditches, the central drainage ditch, significantly influences groundwater flow in the upper groundwater system near the WCS and ditch.

Historical analytical results from groundwater wells completed in the lower groundwater system and the low concentration levels of constituents monitored in the upper groundwater system indicate that annual monitoring of the lower groundwater system is not presently necessary. Because the monitoring wells completed in the upper groundwater system provide an effective early warning network by which to monitor the performance of the WCS, the lower groundwater system is not routinely monitored as part of the environmental surveillance program. Special groundwater studies that are conducted periodically at NFSS typically include sampling and analysis of groundwater samples from the lower groundwater system. These studies help to verify the effectiveness of the upper groundwater system monitoring well network for monitoring WCS performance.

Background concentrations for the upper groundwater system were determined by averaging 1992 through 1996 analytical results for the appropriate constituents at the background monitoring well B02W20S. This well was selected as the background well because it is distant and is not downgradient from the WCS.

Water Level Measurements

Sixty-three groundwater monitoring wells are used to monitor groundwater levels in both the upper and lower groundwater systems. Water level measurements are obtained using an electronic depth-to-water meter. Of these wells, 25 are screened in the upper groundwater system. The screened intervals for wells completed in the upper groundwater zone range from 1.7 to 8.4 m (5.5 to 27.6 ft) below ground surface. Thirty-eight of these wells are screened in the lower groundwater system. The screened intervals for wells completed in the lower groundwater zone range from 7.7 to 14.0 m (25.2 to 46.0 ft) below ground surface. Groundwater monitoring wells are located primarily on the perimeter of the WCS and along the northern property fenceline (Figure 2).

In most monitoring well pairs, groundwater elevations of the upper groundwater system are greater than those of the lower groundwater zone, indicating a downward, vertical hydraulic gradient. In some monitoring well pairs near the central drainage ditch, groundwater elevations of the upper groundwater system are less than those of the lower groundwater system, indicating an upward, vertical hydraulic gradient.

In the upper groundwater system, the depth to water ranged from about 0.030 m to 3.39 m (0.10 to 11.12 ft) below ground surface during the year. Water level fluctuations in the upper groundwater system in 1996 were on the order of 1.2 m (3.9 ft). In the lower groundwater system, the depth to water ranged from about 0.15 to 4.27 m (0.48 to 14.01 ft) below ground surface during the year. Water level fluctuations in the lower groundwater system in 1996 were on the order of 0.94 m (3.1 ft). Current and historical results indicate that the upper groundwater system responds more rapidly than the lower groundwater system to seasonal fluctuations in groundwater recharge and the effects of watering the WCS to maintain the appropriate soil-moisture content in the capping material. Groundwater level fluctuations in the lower groundwater system occur over a significantly longer period than in the upper groundwater system, indicating that the glaciolacustrine clay aquitard slows and dampens recharge to the lower groundwater system.

Figures 4 (upper groundwater system) and 5 (lower groundwater system) present piezometric surfaces and groundwater flow directions representative of high condition in the upper groundwater system. Figures 6 (upper groundwater system) and 7 (lower groundwater system) present piezometric surfaces and groundwater flow directions representative of low condition in the upper groundwater system.

Groundwater Flow

Groundwater occurs in near-surface alluvial sediments consisting mostly of horizontal layers of unconsolidated sand, silt, and clay. Two groundwater systems monitored at the site are associated with the uppermost clay unit and the sand and gravel unit, corresponding to the upper and lower groundwater systems, respectively. Hydrologic data indicate that the upper clay unit and the lower sand and gravel unit are hydraulically isolated by the glaciolacustrine clay unit, which is present across the entire site.

Generally, groundwater flows northwestward across the site at a gradient of about 0.006 to 0.008 in the upper groundwater system. In the lower groundwater system, groundwater flow in the northern portion of the site is generally north to northwestward. An area of elevated groundwater elevations located in the vicinity of the western boundary of the WCS existed throughout 1996 during low groundwater elevation conditions. Additionally, groundwater flow in the eastern portion of the site in the lower groundwater system is influenced by dewatering activities on the adjacent property (Modern Landfill). In this portion of the site, groundwater flow is toward the east and southeast in the lower groundwater system.

The flow in the upper groundwater system is strongly influenced by the central drainage. As indicated in Figure 7, during periods of low groundwater levels, the frequent watering of the WCS creates a groundwater mound along the western boundary of the WCS and consequently induces radial flow in this area. This is a localized effect and only temporarily affects the overall northwest regional flow. A groundwater flow velocity of 38 cm/yr (15 in./yr) has previously been estimated at NFSS (DOE, 1994). This velocity does not necessarily represent the rate at which a contaminant could migrate, because contaminant-dependent transport factors such as retardation (caused by phenomena such as binding to clay particles) can significantly slow the rate of transport.

Groundwater elevations during the seasonal high condition (April 22, 1996) ranged from 94.48 m (309.97 ft) above mean sea level at B02W19D to 97.28 m (319.15 ft) above mean sea level at B02W20S. Groundwater elevations during the seasonal low condition (August 22, 1996) ranged from 93.10 m (305.43 ft) above mean sea level at B02W19D to 96.17 m (315.52 ft) above mean sea level at OW02B during the year.

5.6.2 Groundwater Quality

Field Parameters

Table 7 summarizes field measurements for 1996 environmental surveillance sampling.

Water Quality Parameters

At NFSS, the upper groundwater system water quality indicates relatively recently recharged groundwater. The lower groundwater system water quality parameters indicate longer residence times or distance traveled. It is likely that the primary recharge of the lower groundwater system occurs at the base of the Niagara Escarpment, situated approximately 3.2 km south of the site (DOE, 1994). Water quality parameter data for 1996 are provided in Table 8.

TDS results in all wells including background (ranging from 770 to 1,840 mg/L) are above the NYSDEC water quality standard (500 mg/L). Sodium was detected in all wells, including background, at concentrations ranging from 40,800 µg/L (B02W20S) to 72,000 µg/L (OW17B), indicating that groundwater is naturally slightly saline in the region. The results are consistently greater than the NYSDEC groundwater quality standard for sodium (20,000 µg/L). Sulfate was also detected in all wells at concentrations ranging from 316,000 µg/L (B02W20S) to 775,000 µg/L (OW07B), greater than the NYSDEC groundwater quality standard for sulfate (250,000 µg/L). There are no Federal standards for sodium, sulfate, or TDS.

5.6.3 Groundwater - Radioactive Constituents

In 1996, groundwater samples collected from 8 groundwater monitoring wells completed in the upper groundwater system were analyzed for radium-226, thorium-232, and total uranium. Environmental surveillance analytical results for radioactive constituents in groundwater are presented in Table 9. Only results for detected analytes are discussed. Historical and current analytical results for total uranium (background not subtracted) in groundwater is summarized in Figure 8.

<u>Upper Groundwater Zone Results</u>

All analytical results for radium-226, thorium-232, and total uranium in groundwater were well below the DOE DCGs. Consistent with previous years (BNI, 1996c), radium-226 concentrations were indistinguishable from background.

- Radium-226 results in groundwater in 1996 ranged from nondetect to 0.25 pCi/L and were comparable to the average historical background concentration (sampling location B02W20S) of 0.19 pCi/L. The DOE DCG for radium-226 is 100 pCi/L above background. As shown in Figure 8, radium-226 concentrations in groundwater at NFSS have been consistently low, with all measured concentrations (background not subtracted) less than 1 pCi/L.
- A trace concentration of thorium-232 was detected in groundwater from well OW04B (0.31 pCi/L); but no thorium-232 was detected in the field duplicate collected at the same time and location. Thorium-232 concentrations were not measured during the current period of record used for comparing analytical results (1992 through 1995); therefore, the 1996 background concentration (sampling location B02W20S) result was nondetect. The DOE DCG for thorium-232 is 50 pCi/L above background.

- The average historical background concentration (sampling location B02W20S) of total uranium in groundwater was determined to be 7.59 pCi/L. Uranium was detected in all sampled wells with results ranging from 3.39 to 31.51 pCi/L. None of the 1996 analytical results exceeded the DOE DCG for uranium of 600 pCi/L above background, consistent with the historical results presented in Figure 8 (measured results, background not subtracted). Since 1992, total uranium concentrations in all sampled wells have been less than 60 pCi/L.

5.6.4 Groundwater - Chemical Constituents

Metals

The 1996 environmental surveillance analytical results for metals in groundwater are presented in Table 10. Only results for detected analytes are presented below.

Groundwater at NFSS is not used as a public drinking water supply; however, to provide a conservative basis for comparison of analytical results, SDWA MCLs and New York State Water Quality Regulation Class GA standards were used. Although copper and lead are present in some groundwater monitoring wells at NFSS, the 1996 analytical results indicate that neither the SDWA MCLs nor the New York State Water Quality Regulation Class GA standards for these metals were exceeded at any of the wells. Vanadium was not detected in any of the eight wells sampled in 1996. The 1996 metals results show a decline in overall concentrations from prior years (BNI, 1996c).

- In those wells where copper was detected in 1996, the results ranged from 6.8 (OW17B) to 13.5 μg/L (OW15B), which is well below the SDWA MCL of 1300 μg/L and the New York State Water Quality Regulation Class GA standard of 200 μg/L.

- In 1996, one well (A45) indicated the presence of lead at a concentration of 6.1 μg/L, which is well below the SDWA MCL of 15 μg/L and the New York State Water Quality Regulation Class GA standard of 25 μg/L for lead.

- In 1996, all vanadium results were nondetect. In 1994, the maximum concentration of vanadium was 53.4 μg/L in well A45, and in 1995 the maximum vanadium concentration detected was 7.1 μg/L. Both the number of wells in which vanadium was detected and the concentration detected has decreased steadily (BNI, 1996e). Neither a SDWA MCL nor a New York State Water Quality Regulation Class GA standard has been established for vanadium.

6.0 CONCLUSIONS

A. External Gamma Radiation

The 1996 dose to a hypothetical maximally exposed individual has been calculated at 0 mrem/yr above background.

B. Radon Gas

Results of the 1996 radon gas surveillance program indicate that the radon gas concentrations at the site were consistently low (nondetect to 1.90 pCi/L, including background) and in many cases were at or below the detection limit. All radon gas concentrations at NFSS were well below the DOE limit for radon-222 of 3.0 pCi/L above background.

C. Radon-222 flux

The 1996 radon-222 flux measurements at NFSS were less than 1.3 percent of the standard of 20 pCi/m^2/s specified in 40 CFR Part 61, Subpart Q of the National Emission Standards for Hazardous Air Pollutants (NESHAPs). Radon-222 flux measurements ranged from nondetect to 0.26 pCi/ m^2/s, strongly demonstrating the effectiveness of the containment cell design and construction in mitigating radon-222 migration.

D. Airborne Particulate Dose

The 1996 hypothetical airborne particulate dose from the wind erosion of soil to an individual 1,100 m southwest of the site is 5×10^{-9} mrem/yr. The 1996 hypothetical airborne particulate collective dose to the population within a 80-km radius of the site has been calculated at 5×10^{-8} person-rem/yr. The hypothetical dose to an individual is essentially zero relative to the 10 mrem/yr standard in 40 CFR Part 61, Subpart H of NESHAPs.

E. Cumulative Dose from External Gamma Radiation and Airborne Particulates

The 1996 cumulative external gamma radiation and airborne particulate dose to an individual is 1.5×10^{-6} mrem/yr. This value is essentially zero when compared to the DOE DCG of 100 mrem/yr.

F. Surface Water

In 1996, onsite radium-226 (nondetect to 1.08 pCi/L), thorium-232 (nondetect to 0.49 pCi/L), and total uranium (7.03 to 9.57 pCi/L) concentrations in surface water samples were indistinguishable from background concentrations.

G. Sediment

Onsite concentrations of radium-226 (0.71 to 1.92 pCi/g), thorium-232 (0.75 to 1.11 pCi/g), and total uranium (1.39 to 2.25 pCi/g) in sediment samples were indistinguishable from background.

H. Groundwater

Radium-226 concentrations (nondetect to 0.25 pCi/L) in groundwater samples were indistinguishable from background.

Thorium-232 was detected only in one well at a trace concentration of 0.31 pCi/L, which is less than 0.6 percent of the DOE DCG (50 pCi/L)

Onsite total uranium concentrations (3.39 to 31.51 pCi/L) in groundwater samples were less than 8 percent of the DOE DCG (600 pCi/L).

Although drinking water standards are not directly applicable to the groundwater systems at NFSS, copper and lead concentrations in groundwater samples were all well below the established Federal primary and secondary SDWA MCLs and the NYSDEC Class GA groundwater standards. There are no standards for vanadium provided in these regulations. Results for TDS, sulfate, and sodium were greater than state standards in all sampled wells.

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Environmental Surveillance Results for 1996
Niagara Falls Storage Site

List of Tables

Table 1
Environmental Surveillance Summary
External Gamma Radiation and Radon-222 / Radon-220
Niagara Falls Storage Site

Measured Parameter	Station Identification	Number of Analyses or Measurements																								
		No. of Sample Locations				Sample Duplicate				Ship Blank				Contingency Sample				Matrix Spike				Matrix Spike Duplicate				Total Analyses per Year
		CY Quarter				CY Quarter				CY Quarter				CY Quarter				CY Quarter				CY Quarter				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
LABORATORY MEASUREMENTS																										
External gamma radiation (TETLDs)[a]	1, 7, 8, 10, 11, 12, 13, 15, 18, 21, 23, 24, 28, 29, 36, 105, 112, 116, 120, 121, 122, 123	22		22						1		1		23		23										92
Radon-222 / Radon-220		22		22		1		1																		46
Radon-222 flux				180																						180

a. TETLD = Tissue equivalent thermoluminescent dosimeter

Table 1
Environmental Surveillance Summary
Groundwater
Niagara Falls Storage Site

Measured Parameter	Station Identification	Number of Analyses or Measurements																								Total Analyses per Year
		No. of Sample Locations				Rinsate Blank[b]				Trip Blank[b]				Sample Duplicate				Matrix Spike				Matrix Spike Duplicate				
		CY Quarter				CY Quarter				CY Quarter				CY Quarter				CY Quarter				CY Quarter				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
FIELD MEASUREMENTS																										
Chemical/Physical																										
Dissolved oxygen	A45, A50, OW04B, OW06B, OW07B, OW15B, OW17B, B02W20S		8																							8
Eh			8																							8
Turbidity			8																							8
Temperature			8																							8
Specific conductivity			8																							8
pH			8																							8
LABORATORY MEASUREMENTS																										
Radiological																										
Total uranium	A45, A50, OW04B, OW06B, OW07B, OW15B, OW17B, B02W20S		8												1											9
Radium-226			8												1											9
Thorium-232			8												1											9
Chemical																										
ICPAES Metals[c]			8												1				1				1			11
GFAA Metals[c]			8												1				1				1			11
Water Quality[d]			8												1				1				1			11

b. Estimated number.
c. See Tale 11 for a comprehensive list of analytes for metals.
d. See Table 8 for a comprehensive list of analytes for water quality.

Table 1
Environmental Surveillance Summary
Surface Water and Sediment
Niagara Falls Storage Site

Measured Parameter	Station Identification	Number of Analyses or Measurements: No. of Sample Locations				Rinsate Blank [e]				Trip Blank[e]				Sample Duplicate				Matrix Spike				Matrix Spike Duplicate				Total Analyses per Year
		CY Quarter				CY Quarter				CY Quarter				CY Quarter				CY Quarter				CY Quarter				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
FIELD MEASUREMENTS																										
Chemical/Physical																										
Dissolved oxygen	SWSD009		5																							5
Eh	SWSD010		5																							5
Turbidity	SWSD011		5																							5
Temperature	SWSD021		5																							5
Specific conductivity	SWSD022		5																							5
pH			5																							5
LABORATORY MEASUREMENTS																										
Radiological																										
Surface Water																										
Total uranium	SWSD009		5												1											6
Radium-226	SWSD010		5												1											6
Thorium-232	SWSD011		5												1											6
Sediment	SWSD021																									
Total uranium	SWSD022		5				1								1											7
Radium-226			5				1								1											7
Thorium-232			5				1								1											7

e. Estimated number

Table 2
1996 External Gamma Radiation Dose Rates
Niagara Falls Storage Site

Monitoring Location [c]		TETLD [a] Readings (mrem/yr)	TETLD [a] Corrected [b] (mrem/yr)	Monitoring Location		TETLD [a] Readings (mrem/yr)	TETLD [a] Corrected [b] (mrem/yr)
NFSS	1			WCS [d]	8		
Perimeter	1			Perimeter	8		
	7				10		
	7				10		
	11				18		
	11				18		
	12				21		
	12				21		
	13				23		
	13				23		
	15				24		
	15				24		
	28			Background	105		
	28				105		
	29				112		
	29				112		
	36				116		
	36				116		
	122				120		
	122				120		
	123				121		
	123				121		

TETLDs ~~have not been collected.~~ - data processing/calc in progress.

Notes will be changed to reflect 1996

TETLD Exposed Days..
Calculated values:
Average Background [e]..
Corrected Background / year [f]...
1 mrem = 0.01mSv

a. TETLD = Tissue-equivalent thermoluminescent dosimeter. There are two TETLDs per station, each containing five chips. Reported values are an average chip reading per TETLD.

b. TETLD readings are corrected for shelter/absorption factor (s/a = 1.075), normalized to a one-year exposure, and corrected for corrected background/year.
Corrected exposure = (reading * 1.075 * days per year/exposed days) - (corrected background/year)
Example (Location 1): (xx.x*1.075*366/nnn) - (xx.x) = xx.x mrem/yr

c. Monitoring locations are shown on Figures

d. Monitoring locations are along the perimeter of the waste containment structure (WCS).

e. Average background is the average of reported values at locations 105, 112, 116, 120, and 121.

f. Corrected background/year = (days per year/exposed days)*(average background)*1.075
Example: 366/nnn* xx.x * 1.075 = xx.x mrem/yr

Table 3
1996 Radon Gas [a] Concentrations
Niagara Falls Storage Site

Monitoring Location [b]		Average Daily Concentration (pCi/L) Start Date 01/30/96 [c] End Date 07/24/96	Start Date 07/24/96 End Date 01/16/97
NFSS	1	0.20 *	1.90
Perimeter	7	0.20 *	0.20
	11	0.20 *	0.20 *
	12	0.20 *	0.20 *
Duplicate [d]	12	0.20 *	0.20
	13	0.20	0.20 *
	15	0.20	0.30
	28	0.20	0.20
	29	0.20 *	0.20 *
	36	0.20 *	0.20
	122	0.20	0.20 *
	123	0.40	0.20
WCS [e]	8	0.20	0.20
Perimeter	10	0.20 *	0.20 *
	18	0.20 *	0.20 *
	21	0.20	0.20
	23	0.20 *	0.30
	24	0.20	0.30
Background	105	0.20 *	0.20 *
	112	0.20 *	0.20 *
	116	0.20 *	0.20 *
	120	0.20 *	0.30
	121	0.20 *	0.20

a. 1996 radon gas concentrations were measured with RadTrack® detectors. These detectors measure the combined concentration of radon-220 and radon-222 in air. Historically, radon-220 has not been detected at NFSS.
b. Monitoring locations are shown on Figure 2.
c. Detectors were installed and removed on the dates listed.
d. A quality control duplicate is collected at the same time and location and is analyzed by the same method for use in evaluation of precision in sampling and analysis.
e. Monitoring locations are located at the perimeter of the waste containment structure (WCS).

Note: The DOE limit for radon is 3.00 pCi/L.
(*) Indicates result is less than the quantitaion limit of the method; detection limit is reported. Actual result is less than this value.
1 pCi = 0.037 becquerel

Table 4
1996 Radon-222 Flux Monitoring Results [a]
Niagara Falls Storage Site

Sample ID	Radon-222 Flux ($pCi/m^2/s$)	Sample ID	Radon-222 Flux ($pCi/m^2/s$)	Sample ID	Radon-222 Flux ($pCi/m^2/s$)
202-001	0.02 ± 0.02	202-045	0.08 ± 0.02	202-089	0.07 ± 0.02
202-002	0.08 ± 0.02	202-046	0.08 ± 0.02	202-090	0.10 ± 0.02
202-003	-0.13 ± 0.01	202-047	0.10 ± 0.02	202-091	0.08 ± 0.02
202-004	0.03 ± 0.02	202-048	0.03 ± 0.02	202-092	0.04 ± 0.02
202-005	0.02 ± 0.02	202-049	0.13 ± 0.02	202-093	0.11 ± 0.02
202-006	0.04 ± 0.02	202-050	0.11 ± 0.02	202-094	0.02 ± 0.02
202-007	0.07 ± 0.02	202-051	0.10 ± 0.02	202-095	0.07 ± 0.02
202-008	0.00 ± 0.02	202-052	0.05 ± 0.02	202-096	0.00 ± 0.02
202-009	0.05 ± 0.02	202-053	0.14 ± 0.02	202-097	0.04 ± 0.02
202-010	0.05 ± 0.02	202-054	0.11 ± 0.02	202-098	0.04 ± 0.02
202-011	0.06 ± 0.02	202-055	0.12 ± 0.02	202-099	0.16 ± 0.02
202-012	0.05 ± 0.02	202-056	0.08 ± 0.02	202-100	0.04 ± 0.02
202-013	0.04 ± 0.02	202-057	0.13 ± 0.02	202-101	0.02 ± 0.02
202-014	0.12 ± 0.02	202-058	0.11 ± 0.02	202-102	0.06 ± 0.02
202-015	0.06 ± 0.02	202-059	0.10 ± 0.02	202-103	0.00 ± 0.02
202-016	0.02 ± 0.02	202-060	0.03 ± 0.01	202-104	0.00 ± 0.02
202-017	0.06 ± 0.02	202-061	0.05 ± 0.02	202-105	0.06 ± 0.02
202-018	0.06 ± 0.02	202-062	0.05 ± 0.02	202-106	0.05 ± 0.02
202-019	0.07 ± 0.02	202-063	0.04 ± 0.02	202-107	0.11 ± 0.02
202-020	0.14 ± 0.02	202-064	0.05 ± 0.02	202-108	0.07 ± 0.02
202-021	0.17 ± 0.02	202-065	0.11 ± 0.02	202-109	0.11 ± 0.02
202-022	0.23 ± 0.02	202-066	0.06 ± 0.02	202-110	0.03 ± 0.02
202-023	0.12 ± 0.02	202-067	0.03 ± 0.02	202-111	0.02 ± 0.02
202-024	0.04 ± 0.02	202-068	0.07 ± 0.02	202-112	0.03 ± 0.02
202-025	0.02 ± 0.02	202-069	0.03 ± 0.02	202-113	0.04 ± 0.02
202-026	0.03 ± 0.02	202-070	0.07 ± 0.02	202-114	0.05 ± 0.03
202-027	0.13 ± 0.02	202-071	0.16 ± 0.02	202-115	0.01 ± 0.03
202-028	0.06 ± 0.02	202-072	0.08 ± 0.02	202-116	0.06 ± 0.03
202-029	0.04 ± 0.02	202-073	0.21 ± 0.02	202-117	0.10 ± 0.03
202-030	0.04 ± 0.02	202-074	0.20 ± 0.02	202-118	0.05 ± 0.03
202-031	0.01 ± 0.02	202-075	0.06 ± 0.02	202-119	0.02 ± 0.03
202-032	-0.01 ± 0.02	202-076	0.12 ± 0.02	202-120	0.07 ± 0.03
202-033	0.26 ± 0.02	202-077	0.06 ± 0.02	202-121	0.04 ± 0.03
202-034	0.03 ± 0.02	202-078	-0.29 ± 0.02	202-122	0.04 ± 0.03
202-035	0.04 ± 0.02	202-079	0.12 ± 0.02	202-123	0.02 ± 0.03
202-036	0.10 ± 0.02	202-080	0.04 ± 0.02	202-124	0.04 ± 0.03
202-037	0.06 ± 0.02	202-081	0.03 ± 0.02	202-125	0.02 ± 0.03
202-038	0.06 ± 0.02	202-082	0.13 ± 0.02	202-126	0.02 ± 0.03
202-039	0.13 ± 0.02	202-083	0.07 ± 0.02	202-127	0.18 ± 0.03
202-040	0.04 ± 0.02	202-084	-0.01 ± 0.02	202-128	0.06 ± 0.03
202-041	-0.01 ± 0.02	202-085	-0.28 ± 0.02	202-129	0.06 ± 0.03
202-042	0.00 ± 0.02	202-086	0.02 ± 0.02	202-130	0.04 ± 0.03
202-043	0.11 ± 0.02	202-087	0.03 ± 0.02	202-131	0.03 ± 0.03
202-044	0.08 ± 0.02	202-088	-0.31 ± 0.02	202-132	0.04 ± 0.03

Table 4
1996 Radon-222 Flux Monitoring Results [a]
Niagara Falls Storage Site

Sample ID	Radon-222 Flux (pCi/m²/s)	Sample ID	Radon-222 Flux (pCi/m²/s)
202-133	0.06 ± 0.03	202-166	0.13 ± 0.03
202-134	0.02 ± 0.03	202-167	0.04 ± 0.03
202-135	0.16 ± 0.03	202-168	0.12 ± 0.03
202-136	0.01 ± 0.03	202-169	0.09 ± 0.03
202-137	0.07 ± 0.03	202-170	0.09 ± 0.03
202-138	0.02 ± 0.03	202-171	0.06 ± 0.03
202-139	0.00 ± 0.03	202-172	0.10 ± 0.03
202-140	0.13 ± 0.03	202-173	0.06 ± 0.03
202-141	0.05 ± 0.03	202-174	0.11 ± 0.03
202-142	0.07 ± 0.03	202-175	0.15 ± 0.03
202-143	0.09 ± 0.03	202-176	0.01 ± 0.03
202-144	0.13 ± 0.03	202-177	0.04 ± 0.03
202-145	0.09 ± 0.03	202-178	0.10 ± 0.03
202-146	0.07 ± 0.03	202-179	0.04 ± 0.03
202-147	0.16 ± 0.03	202-180	0.06 ± 0.03
202-148	0.03 ± 0.03		
202-149	0.07 ± 0.03	QC duplicates [b]	
202-150	0.04 ± 0.03	202-030 dup	0.04 ± 0.02
202-151	0.00 ± 0.03	202-040 dup	0.03 ± 0.02
202-152	0.07 ± 0.03	202-050 dup	0.10 ± 0.02
202-153	0.04 ± 0.03	202-060 dup	0.03 ± 0.01
202-154	0.08 ± 0.03	202-070 dup	0.06 ± 0.02
202-155	0.10 ± 0.03	202-080 dup	0.03 ± 0.02
202-156	0.02 ± 0.03	202-090 dup	-0.33 ± 0.02
202-157	0.07 ± 0.03	202-100 dup	0.04 ± 0.02
202-158	0.21 ± 0.03	202-110 dup	0.02 ± 0.02
202-159	0.15 ± 0.03	202-120 dup	0.08 ± 0.03
202-160	-0.01 ± 0.03	202-130 dup	0.02 ± 0.03
202-161	0.03 ± 0.03	202-140 dup	0.13 ± 0.03
202-162	0.00 ± 0.03	202-150 dup	0.02 ± 0.03
202-163	0.03 ± 0.03	202-160 dup	-0.03 ± 0.03
202-164	0.09 ± 0.03	202-170 dup	0.09 ± 0.03
202-165	0.26 ± 0.03	202-180 dup	0.09 ± 0.03

Note: The EPA standard for radon-222 flux is 20 pCi/m²/s.

a. Radon-222 flux measurements were taken during the third quarter in September 1996.

b. The canisters are counted twice in the laboratory as quality control (QC) duplicates in order to evaluate analytical precision.

Table 5
1996 Surface Water Analytical Results - Radioactive Constituents
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result [a] (pCi/L)	BNI Flag [b]	MDA [c] (pCi/L)	Result Above Background [d] (pCi/L)	DCG [e] (pCi/L)
SWSD009	05/02/96	Radium-226	0.19 ± 0.13		0.13	-0.46 ± 0.20	100
Background	05/02/96	Thorium-232	0.18 ± 0.19	UJ	0.25	0.02 ± 0.22	50
	05/02/96	Total uranium	3.47 ± 0.07		0.02	-3.87 ± 0.30	600
SWSD021	05/02/96	Radium-226	1.81 ± 0.56		0.27	1.16 ± 0.58	100
Background	05/02/96	Thorium-232	0.14 ± 0.15	UJ	0.10	-0.02 ± 0.19	50
	05/02/96	Total uranium	15.33 ± 0.96		0.02	7.99 ± 1.00	600
SWSD010	05/02/96	Radium-226	0.37 ± 0.28		0.29	-0.28 ± 0.32	100
	05/02/96	Thorium-232	0.16 ± 0.17	UJ	0.11	0.00 ± 0.21	50
	05/02/96	Total uranium	7.03 ± 0.16		0.02	-0.31 ± 0.33	600
SWSD011	05/02/96	Radium-226	1.08 ± 0.48		0.36	0.43 ± 0.50	100
	05/02/96	Thorium-232	0.09 ± 0.13	UJ	0.21	-0.07 ± 0.18	50
	05/02/96	Total uranium	8.92 ± 0.58		0.02	1.58 ± 0.65	600
SWSD022	05/02/96	Radium-226	0.27 ± 0.22	U	0.27	-0.38 ± 0.27	100
	05/02/96	Thorium-232	0.49 ± 0.28		0.29	0.33 ± 0.30	50
	05/02/96	Total uranium	9.57 ± 0.61		0.02	2.23 ± 0.68	600
Duplicate [f]	05/02/96	Radium-226	0.30 ± 0.24	UJ	0.50	-0.35 ± 0.28	100
	05/02/96	Thorium-232	0.40 ± 0.28		0.24	0.24 ± 0.30	50
	05/02/96	Total uranium	9.02 ± 0.60		0.02	1.68 ± 0.67	600

a. Results reported with (±) radiological error quoted at 2-sigma (95 percent confidence level).

b. Bechtel National, Inc. data qualifier flags:

U = The analyte was not detected.

UJ = Analyte was undetected; estimated value reported. The result is below the MDA or less than the associated error.

c. Minimum detectable activity

d. Historical (1992-1996) average background for surface water is 0.65±0.15 and 7.34±0.29 pCi/L for radium-226 and total uranium, respectively. Background (1996 only) for thorium-232 is 0.16±0.12 pCi/L. Associated error term for result above background was calculated: $(\text{error}^2_{\text{result}} + \text{error}^2_{\text{background}})^{1/2}$

e. DOE derived concentration guide for water.

f. A quality control duplicate is collected at the same time and location and is analyzed by the same method for use in evaluation of precision in sampling and analysis.

Table 6
1996 Sediment Analytical Results - Radioactive Constituents
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result[a] (pCi/G)	BNI Flag[b]	MDA[c] (pCi/G)	Result Above Background[d] (pCi/G)	Cleanup Criteria[e] (pCi/G)
SWSD009	05/02/96	Radium-226	1.27 ± 0.33		0.11	-0.29 ± 0.36	5
Background	05/02/96	Thorium-232	1.22 ± 0.52	J	0.19	-0.11 ± 0.57	5
	05/02/96	Total uranium	2.60 ± 0.13		0.07	-0.72 ± 0.18	90[f]
SWSD021	05/02/96	Radium-226	1.63 ± 0.36		0.14	0.07 ± 0.39	5
Background	05/02/96	Thorium-232	1.60 ± 0.60	J	0.21	0.27 ± 0.65	5
	05/02/96	Total uranium	2.14 ± 0.07		0.07	-1.18 ± 0.15	90[f]
SWSD010	05/02/96	Radium-226	0.87 ± 0.26		0.12	-0.69 ± 0.30	5
	05/02/96	Thorium-232	0.80 ± 0.30		0.14	-0.53 ± 0.38	5
	05/02/96	Total uranium	2.25 ± 0.10		0.07	-1.07 ± 0.16	90[f]
SWSD011	05/02/96	Radium-226	0.71 ± 0.23		0.10	-0.85 ± 0.27	5
	05/02/96	Thorium-232	1.11 ± 0.45	J	0.22	-0.22 ± 0.51	5
	05/02/96	Total uranium	1.83 ± 0.07		0.07	-1.49 ± 0.15	90[f]
SWSD022	05/02/96	Radium-226	1.92 ± 0.41		0.10	0.36 ± 0.43	5
	05/02/96	Thorium-232	0.75 ± 0.28		0.14	-0.58 ± 0.37	5
	05/02/96	Total uranium	1.39 ± 0.08		0.07	-1.93 ± 0.15	90[f]
Duplicate[g]	05/02/96	Radium-226	1.23 ± 0.34		0.22	-0.33 ± 0.37	5
	05/02/96	Thorium-232	0.95 ± 0.38	J	0.16	-0.38 ± 0.45	5
	05/02/96	Total uranium	1.54 ± 0.08		0.07	-1.78 ± 0.15	90[f]

a. Results reported with (±) radiological error quoted at 2-sigma (95 percent confidence level).

b. Bechtel National, Inc. data qualifier flags:
J = Reported as an estimated value.

c. Minimum detectable activity

d. Historical (1992-1996) average background for sediment is 1.56±0.14 and 3.32±0.13 pCi/g for radium-226 and total uranium, respectively. Background (1995-1996) for thorium-232 is 1.33±0.24 pCi/g. Associated error term for result above background was calculated: $(error^2_{result} + error^2_{background})^{1/2}$

e. DOE soil cleanup criteria, averaged over topmost 6 in. (15 cm) of soil. Because there are no standards for radioactive constituents in sediment, these soil values are used to provide a basis for camparison of sediment results.

f. NFSS proposed site-specific cleanup criterion for total uranium.

g. A quality control duplicate is collected at the same time and location and is analyzed by the same method for use in evaluation of precision in sampling and analysis.

Table 7
1996 Field Parameter Summary
Niagara Falls Storage Site

Sampling Location	Date	Temperature (C)	pH	Spec. Cond.[a] (mS/cm)	DO[b] (mg/L	Eh (mV)[c]	Turbidity (NTU)[d]	Volume Purged (gal)[e]	Discharge (GPM)[f]
GROUNDWATER									
A45	05/01/96	9.5	6.76	2.080	0.51	66	13	4.0	0.08
A50	04/30/96	7.5	7.22	1.690	3.56	223	5	2.0	0.06
OW04B	05/01/96	7.3	7.04	1.742	1.03	169	17	4.5	0.08
OW06B	05/01/96	7.3	7.12	1.934	4.38	214	2	2.25	0.06
OW07B	05/01/96	7.0	7.37	1.838	4.72	253	9	1.5	0.04
OW15B	04/30/96	7.1	7.25	1.624	4.62	279	12	2.25	0.06
OW17B	04/30/96	7.6	7.94	1.420	4.31	253	3	2.25	0.06
B02W20S	04/30/96	8.0	7.57	1.158	1.80	258	2	3.25	0.08
SURFACE WATER									
SWSD009	05/02/96	6.4	6.41	0.996	8.28	281	52	--[g]	--
SWSD010	05/02/96	8.0	6.97	1.026	8.20	274	24	--	--
SWSD011	05/02/96	7.9	7.81	0.874	12.38	274	27	--	--
SWSD021	05/02/96	7.2	7.75	0.954	10.28	271	59	--	--
SWSD022	05/02/96	8.8	7.62	0.746	11.07	272	70	--	--

a. Specific conductance, measured in milliSiemens/centimeter (mS/cm)

b. Dissolved oxygen

c. Oxidation/reduction potential, measured in milliVolts (mV)

d. Nephelometric turbidity units

e. Volume purged measured in gallons (gal)

f. Gallons per minute

g. -- Parameter not applicable

Table 8
1996 Groundwater Quality Results
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result	Data Qualifiers[a] BNI	Data Qualifiers[a] Lab	Detection Limit	Related Regulations[b] Federal[c]	Related Regulations[b] State[d]
B02W20S	04/30/96	Alkalinity	406 mg/L			4	NE	NE
Background	04/30/96	Bicarbonate	406 mg/L			4	NE	NE
	04/30/96	Calcium	69300 μg/L			17.7	NE	NE
	04/30/96	Carbonate	4 mg/L		U	4	NE	NE
	04/30/96	Chloride	6.3 mg/L			0.25	250	250
	04/30/96	Magnesium	109000 μg/L			27.8	NE	NE
	04/30/96	Nitrate, As N	0.02 mg/L		U	0.02	10	10
	04/30/96	Phosphate	0.05 mg/L		U	0.05	NE	NE
	04/30/96	Potassium	1420 μg/L			446	NE	NE
	04/30/96	Sodium	40800 μg/L			54.5	NE	20000
	04/30/96	Sulfate	316 mg/L			50	NE	250
	04/30/96	Total dissolved solids	770 mg/L			10	500	500
A45	05/01/96	Alkalinity	454 mg/L			4	NE	NE
	05/01/96	Bicarbonate	454 mg/L			4	NE	NE
	05/01/96	Calcium	259000 μg/L			17.7	NE	NE
	05/01/96	Carbonate	4 mg/L		U	4	NE	NE
	05/01/96	Chloride	52.1 mg/L			2.5	250	250
	05/01/96	Magnesium	134000 μg/L			27.8	NE	NE
	05/01/96	Nitrate, As N	0.11 mg/L			0.02	10	10
	05/01/96	Phosphate	10 mg/L			0.05	NE	NE
	05/01/96	Potassium	6190 μg/L			446	NE	NE
	05/01/96	Sodium	46600 μg/L			54.5	NE	20000
	05/01/96	Sulfate	749 mg/L			50	NE	250
	05/01/96	Total dissolved solids	1800 mg/L			5	500	500
A50	04/30/96	Alkalinity	413 mg/L			4	NE	NE
	04/30/96	Bicarbonate	413 mg/L			4	NE	NE
	04/30/96	Calcium	122000 μg/L			17.7	NE	NE
	04/30/96	Carbonate	4 mg/L		U	4	NE	NE
	04/30/96	Chloride	22.4 mg/L			1.2	250	250
	04/30/96	Magnesium	138000 μg/L			27.8	NE	NE
	04/30/96	Nitrate, As N	0.03 mg/L			0.02	10	10
	04/30/96	Phosphate	0.05 mg/L		U	0.05	NE	NE
	04/30/96	Potassium	1460 μg/L			446	NE	NE
	04/30/96	Sodium	71600 μg/L			54.5	NE	20000
	04/30/96	Sulfate	596 mg/L			50	NE	250
	04/30/96	Total dissolved solids	1300 mg/L			10	500	500
OW04B	05/01/96	Alkalinity	335 mg/L			4	NE	NE
	05/01/96	Bicarbonate	335 mg/L			4	NE	NE
	05/01/96	Calcium	148000 μg/L			17.7	NE	NE
	05/01/96	Carbonate	4 mg/L		U	4	NE	NE

Table 8
1996 Groundwater Quality Results
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result	Data Qualifiers[a] BNI	Data Qualifiers[a] Lab	Detection Limit	Related Regulations[b] Federal[c]	Related Regulations[b] State[d]
OW04B	05/01/96	Chloride	92.1 mg/L			6.2	250	250
continued	05/01/96	Magnesium	121000 µg/L			27.8	NE	NE
	05/01/96	Nitrate, As N	0.05 mg/L			0.02	10	10
	05/01/96	Phosphate	0.05 mg/L		U	0.05	NE	NE
	05/01/96	Potassium	2020 µg/L			446	NE	NE
	05/01/96	Sodium	51500 µg/L			54.5	NE	20000
	05/01/96	Sulfate	527 mg/L			50	NE	250
	05/01/96	Total dissolved solids	1390 mg/L			5	500	500
duplicate[e]	05/01/96	Alkalinity	336 mg/L			4	NE	NE
	05/01/96	Bicarbonate	336 mg/L			4	NE	NE
	05/01/96	Calcium	155000 µg/L			17.7	NE	NE
	05/01/96	Carbonate	4 mg/L		U	4	NE	NE
	05/01/96	Chloride	95.6 mg/L			2.5	250	250
	05/01/96	Magnesium	124000 µg/L			27.8	NE	NE
	05/01/96	Nitrate, As N	0.08 mg/L			0.02	10	10
	05/01/96	Phosphate	0.05 mg/L		U	0.05	NE	NE
	05/01/96	Potassium	1800 µg/L			446	NE	NE
	05/01/96	Sodium	54200 µg/L			54.5	NE	20000
	05/01/96	Sulfate	525 mg/L			50	NE	250
	05/01/96	Total dissolved solids	1360 mg/L			5	500	500
OW06B	05/01/96	Alkalinity	675 mg/L			4	NE	NE
	05/01/96	Bicarbonate	675 mg/L			4	NE	NE
	05/01/96	Calcium	110000 µg/L			17.7	NE	NE
	05/01/96	Carbonate	4 mg/L		U	4	NE	NE
	05/01/96	Chloride	32.2 mg/L			1.2	250	250
	05/01/96	Magnesium	214000 µg/L			27.8	NE	NE
	05/01/96	Nitrate, As N	0.05 mg/L			0.02	10	10
	05/01/96	Phosphate	0.05 mg/L		U	0.05	NE	NE
	05/01/96	Potassium	3040 µg/L			446	NE	NE
	05/01/96	Sodium	62800 µg/L			54.5	NE	20000
	05/01/96	Sulfate	622 mg/L			50	NE	250
	05/01/96	Total dissolved solids	1840 mg/L			5	500	500
OW07B	05/01/96	Alkalinity	410 mg/L			4	NE	NE
	05/01/96	Bicarbonate	410 mg/L			4	NE	NE
	05/01/96	Calcium	111000 µg/L			17.7	NE	NE
	05/01/96	Carbonate	4 mg/L		U	4	NE	NE
	05/01/96	Chloride	17.2 mg/L			1.2	250	250
	05/01/96	Magnesium	175000 µg/L			27.8	NE	NE
	05/01/96	Nitrate, As N	0.09 mg/L			0.02	10	10
	05/01/96	Phosphate	0.05 mg/L		U	0.05	NE	NE

Table 8
1996 Groundwater Quality Results
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result	Data Qualifiers[a] BNI	Data Qualifiers[a] Lab	Detection Limit	Related Regulations[b] Federal[c]	Related Regulations[b] State[d]
OW07B	05/01/96	Potassium	2810 µg/L			446	NE	NE
continued	05/01/96	Sodium	64700 µg/L			54.5	NE	20000
	05/01/96	Sulfate	775 mg/L			50	NE	250
	05/01/96	Total dissolved solids	1610 mg/L			5	500	500
OW15B	04/30/96	Alkalinity	499 mg/L			4	NE	NE
	04/30/96	Bicarbonate	499 mg/L			4	NE	NE
	04/30/96	Calcium	94600 µg/L			17.7	NE	NE
	04/30/96	Carbonate	4 mg/L		U	4	NE	NE
	04/30/96	Chloride	13.5 mg/L			0.5	250	250
	04/30/96	Magnesium	151000 µg/L			27.8	NE	NE
	04/30/96	Nitrate, As N	0.02 mg/L			0.02	10	10
	04/30/96	Phosphate	0.05 mg/L		U	0.05	NE	NE
	04/30/96	Potassium	1950 µg/L			446	NE	NE
	04/30/96	Sodium	67200 µg/L			54.5	NE	20000
	04/30/96	Sulfate	574 mg/L			50	NE	250
	04/30/96	Total dissolved solids	1320 mg/L			10	500	500
OW17B	04/30/96	Alkalinity	423 mg/L			4	NE	NE
	04/30/96	Bicarbonate	423 mg/L			4	NE	NE
	04/30/96	Calcium	60300 µg/L			17.7	NE	NE
	04/30/96	Carbonate	4 mg/L		U	4	NE	NE
	04/30/96	Chloride	14.8 mg/L			0.5	250	250
	04/30/96	Magnesium	144000 µg/L			27.8	NE	NE
	04/30/96	Nitrate, As N	0.03 mg/L			0.02	10	10
	04/30/96	Phosphate	0.05 mg/L		U	0.05	NE	NE
	04/30/96	Potassium	2250 µg/L			446	NE	NE
	04/30/96	Sodium	72000 µg/L			54.5	NE	20000
	04/30/96	Sulfate	505 mg/L			50	NE	250
	04/30/96	Total dissolved solids	1100 mg/L			10	500	500

a. Bechtel National, Inc. (BNI) and laboratory data qualifier flags:
U = The analyte was not detected. The detection limit is reported.

b. Regulations presented pertain to drinking water quality and are listed for comparison only.
No drinking water supply is obtained from groundwater at NFSS. NE = Not established.

c. Federal Safe Drinking Water Act maximum contaminant levels from EPA Drinking Water Regulations and Health Advisories (November 1994).

d. Water Quality Criteria (class GA) per 6 NYCRR, Chapter X, Subchapter A.

e. A quality control (QC) duplicate is collected at the same time and location and is analyzed by the same method for use in evaluation of precision in sampling and analysis.

Table 9
1996 Groundwater Analytical Results - Radioactive Constituents
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result [a] (pCi/L)	BNI Flag [b]	MDA [c] (pCi/L)	Result Above Background [d] (pCi/L)	DCG [e] (pCi/L)
B02W20S	04/30/96	Radium-226	0.07 ± 0.08	UJ	0.24	-0.12 ± 0.11	100
Background	04/30/96	Thorium-232	0.07 ± 0.10	UJ	0.36	0.00 ± 0.14	50
	04/30/96	Total uranium	7.01 ± 0.15		0.02	-0.58 ± 0.39	600
A45	05/01/96	Radium-226	0.25 ± 0.19		0.17	0.06 ± 0.20	100
	05/01/96	Thorium-232	0.12 ± 0.17	UJ	0.38	0.05 ± 0.20	50
	05/01/96	Total uranium	31.51 ± 1.96		0.02	23.92 ± 1.99	600
A50	04/30/96	Radium-226	0.13 ± 0.11	UJ	0.14	-0.06 ± 0.13	100
	04/30/96	Thorium-232	0.04 ± 0.07	UJ	0.20	-0.03 ± 0.12	50
	04/30/96	Total uranium	11.28 ± 0.71		0.02	3.69 ± 0.80	600
OW04B	05/01/96	Radium-226	0.10 ± 0.10	UJ	0.14	-0.09 ± 0.12	100
	05/01/96	Thorium-232	0.31 ± 0.21	J	0.16	0.24 ± 0.23	50
	05/01/96	Total uranium	21.73 ± 1.36		0.02	14.14 ± 1.41	600
duplicate [f]	05/01/96	Radium-226	0.08 ± 0.09	UJ	0.16	-0.11 ± 0.11	100
	05/01/96	Thorium-232	0.07 ± 0.10	UJ	0.21	0.00 ± 0.14	50
	05/01/96	Total uranium	21.08 ± 1.31		0.02	13.49 ± 1.36	600
OW06B	05/01/96	Radium-226	0.08 ± 0.09	UJ	0.17	-0.11 ± 0.11	100
	05/01/96	Thorium-232	0.27 ± 0.00	UJ	0.27	0.20 ± 0.10	50
	05/01/96	Total uranium	18.39 ± 1.16		0.02	10.80 ± 1.21	600
OW07B	05/01/96	Radium-226	0.14 ± 0.12	UJ	0.16	-0.05 ± 0.14	100
	05/01/96	Thorium-232	0.03 ± 0.07	UJ	0.17	-0.04 ± 0.12	50
	05/01/96	Total uranium	9.92 ± 0.64		0.02	2.33 ± 0.73	600
OW15B	04/30/96	Radium-226	0.12 ± 0.12	UJ	0.18	-0.07 ± 0.14	100
	04/30/96	Thorium-232	0.06 ± 0.13	UJ	0.29	-0.01 ± 0.16	50
	04/30/96	Total uranium	8.05 ± 0.51		0.02	0.46 ± 0.62	600
OW17B	04/30/96	Radium-226	0.17 ± 0.12		0.11	-0.02 ± 0.14	100
	04/30/96	Thorium-232	0.09 ± 0.00	UJ	0.09	0.02 ± 0.10	50
	04/30/96	Total uranium	3.39 ± 0.07		0.02	-4.20 ± 0.37	600

a. Results reported with (±) radiological error quoted at 2-sigma (95 percent confidence level).

b. Bechtel National, Inc. data qualifier flags:
J = Reported as an estimated value.
UJ = Analyte was undetected; estimated value reported. The result is below the MDA or less than the associated error.

c. Minimum detectable activity

d. Historical (1992-1996) average background for surface water is 0.19±0.07 and 7.59±0.36 pCi/L for radium-226 and total uranium, respectively. Background (1996 only) for thorium-232 is 0.07±0.10 pCi/L. Associated error term for result above background was calculated: $(error^2_{result} + error^2_{background})^{½}$

e. DOE derived concentration guide for water.

f. A quality control duplicate is collected at the same time and location and is analyzed by the same method for use in evaluation of precision in sampling and analysis.

Table 10
1996 Groundwater Analytical Results - Detected Metals[a]
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result (µg/L)	Data Qualifiers[b] BNI	Data Qualifiers[b] Lab	Detection Limit	Related Regulations[c] Federal[d]	Related Regulations[c] State[e]
B02W20S[f] Background								
A45	05/01/96	Lead	6.1			0.8	15	25
A50								
OW04B	05/01/96	Copper	10.8			5.1	1300	200
duplicate[f,g]								
OW06B	05/01/96	Copper	7.1			5.1	1300	200
OW07B	05/01/96	Copper	10.3			5.1	1300	200
OW15B	04/30/96	Copper	13.5			5.1	1300	200
OW17B	04/30/96	Copper	6.8			5.1	1300	200

a. Only the analytes that were detected are reported. See Table 11 for a comprehensive listing of requested analyses and associated detection limits.
b. Bechtel National, Inc. (BNI) and laboratory data qualifier flags:
c. Regulations presented pertain to drinking water quality and are listed for comparison only. No drinking water supply is obtained from groundwater at NFSS. NE = Not established.
d. Federal Safe Drinking Water Act maximum contaminant levels from EPA Drinking Water Regulations and Health Advisories (November 1994).
e. Water Quality Criteria (class GA) per 6 NYCRR, Chapter X, Subchapter A.
f. No metals (see Table 11) were detected at this location in 1996.
g. A quality control duplicate is collected at the same time and location and is analyzed by the same method for use in evaluation of precision in sampling and analysis.

Table 11
1996 Comprehensive List of Analytes and Detection Limits for Metals Analyses
Niagara Falls Storage Site

Groundwater Metals	Detection Limit (µg/L) [a]
Metlas list 1, by ICPAES [b]	
Copper	5.1
Vanadium	4.7
Metals list 2, by GFAA [b]	
Lead	0.8

a. The detection limit listed for each analyte is the maximum detection limit taken from all non-detect results (i.e., results that were U qualified by either BNI or the laboratory) for the same analyte.

b. Analyses performed by:
ICPAES = inductively coupled plasma atomic emission spectrophotometry
GFAA = graphite furnice atomic absorption

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Environmental Surveillance Results for 1996
Niagara Falls Storage Site

List of Figures

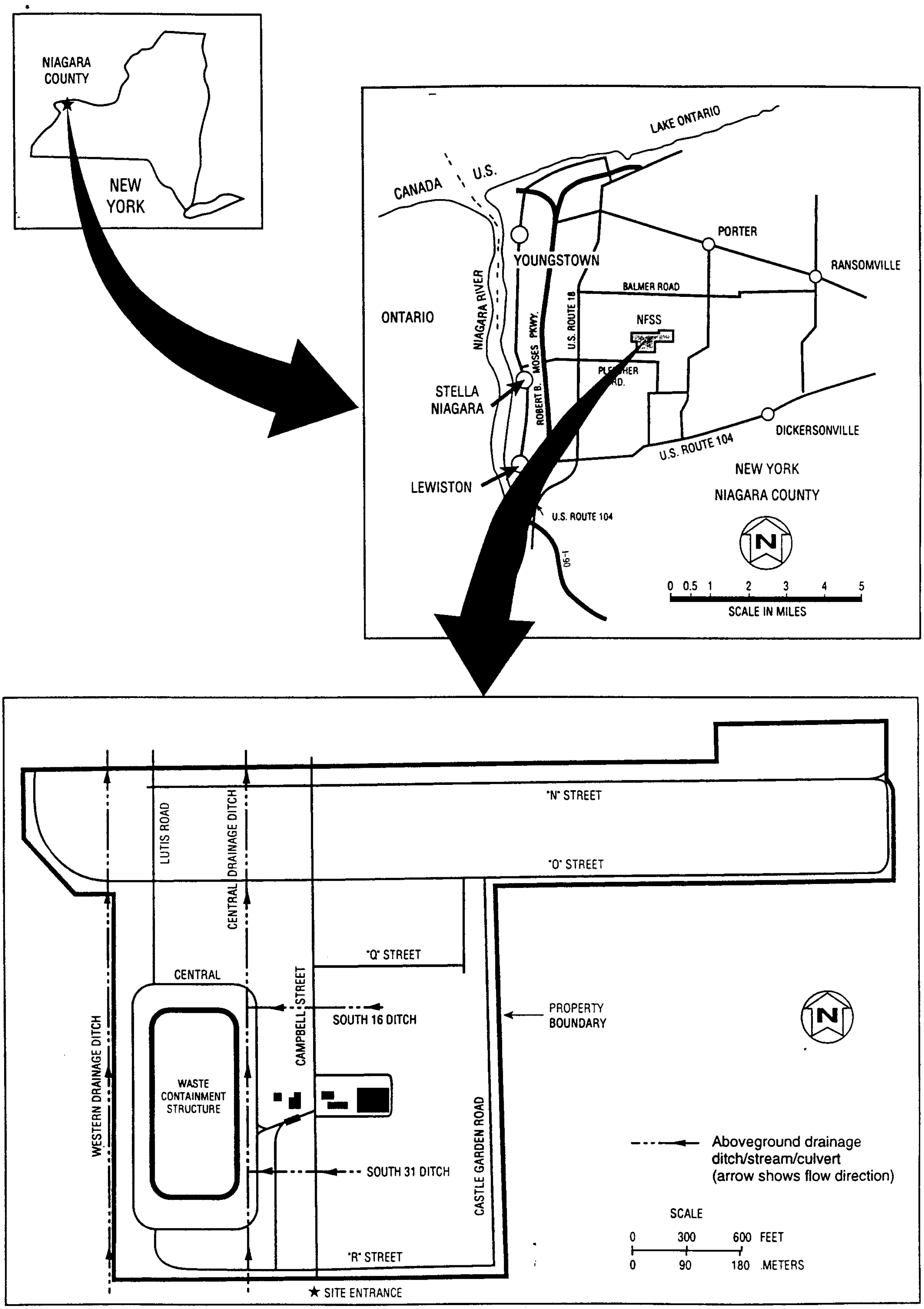

Figure 1
Niagara Falls Storage Site, Site Location and Site Map

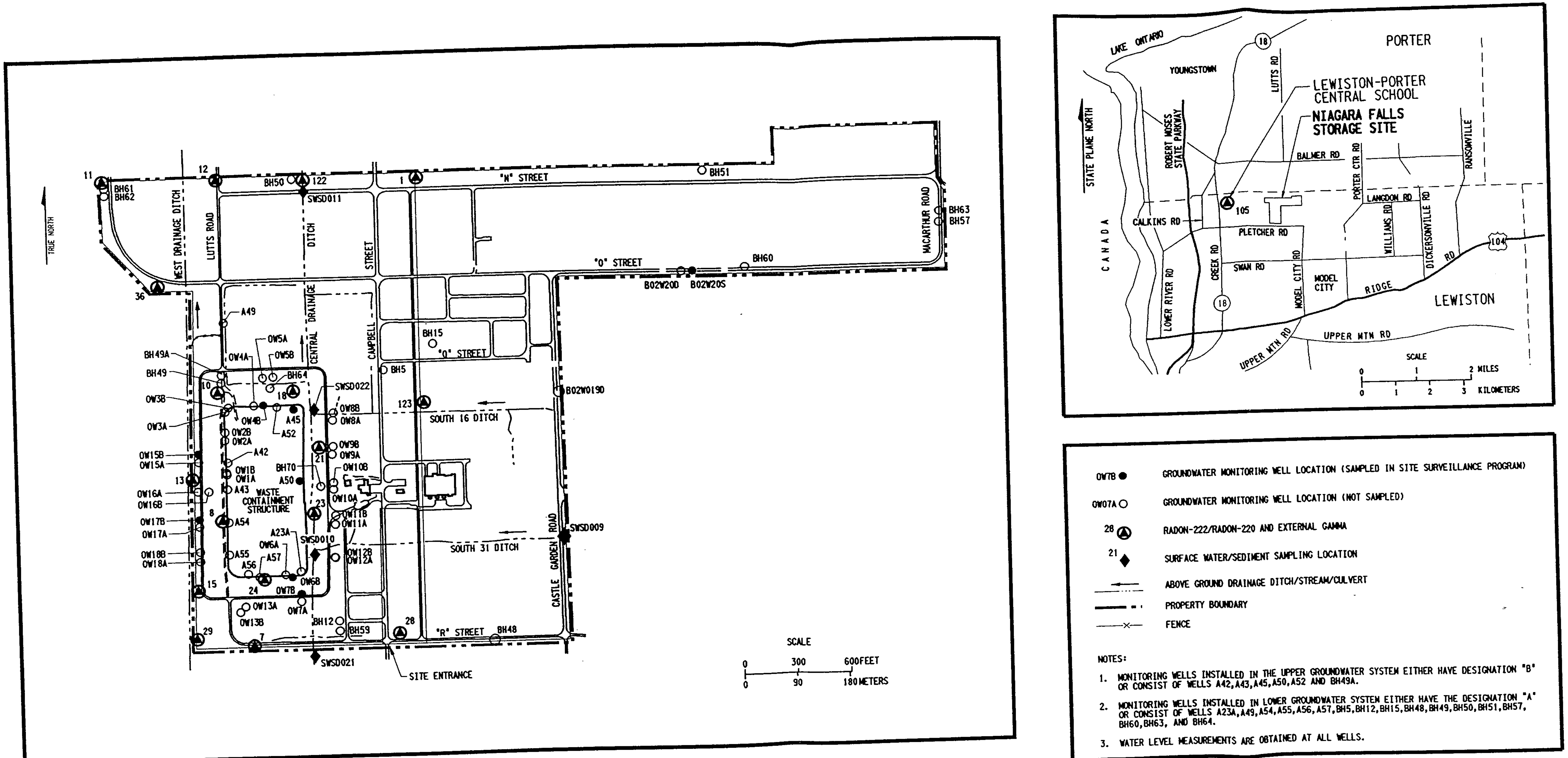

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Figure 2
Niagara Falls Storage Site Environmental Surveillance Sampling Locations:
External Gamma Radiation, Radon-222/Radon-220, Groundwater, and Surface Water and Sediment

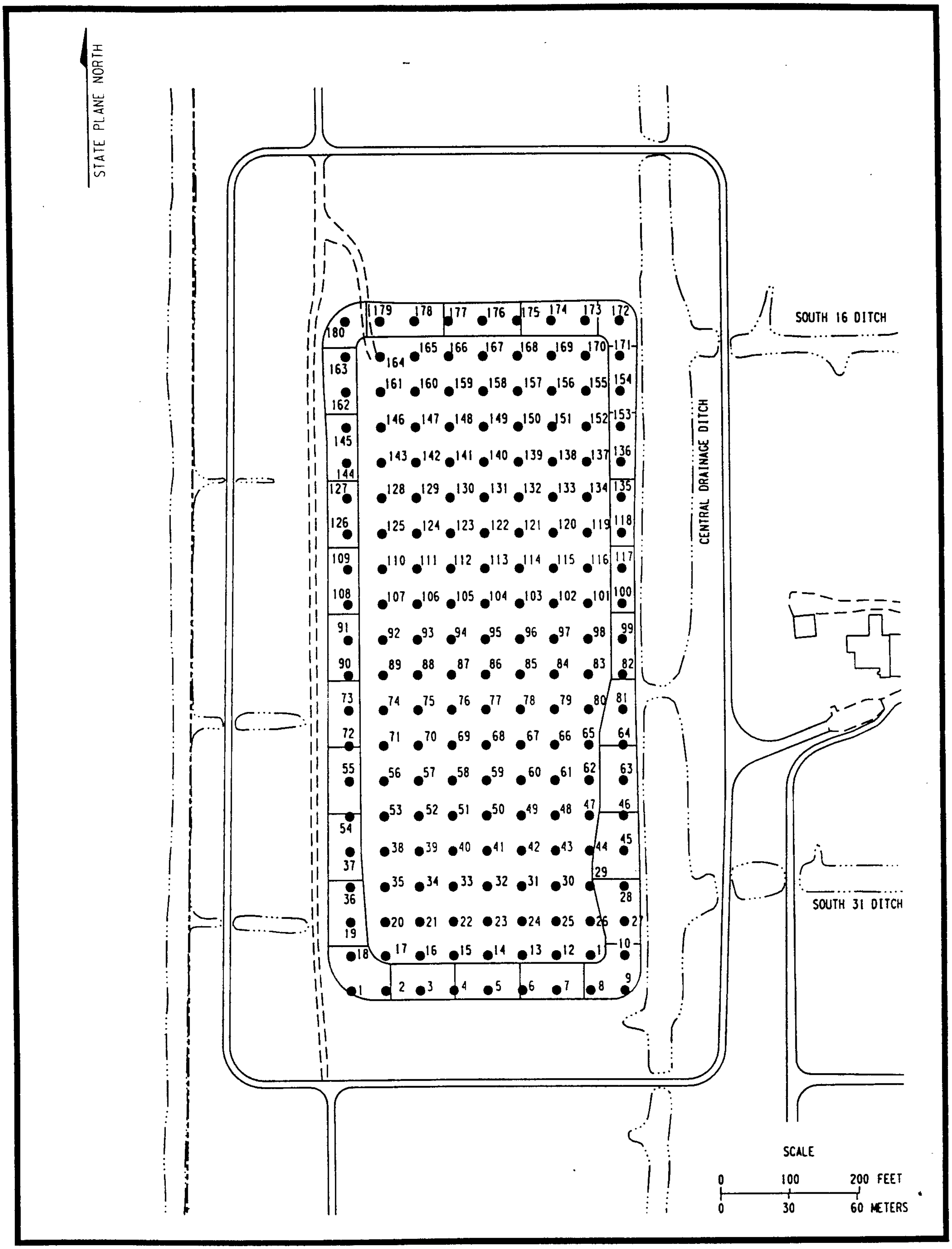

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Figure 3
Niagara Falls Storage Site
Approximate Radon Flux Monitoring Locations
for the Waste Containment Structure

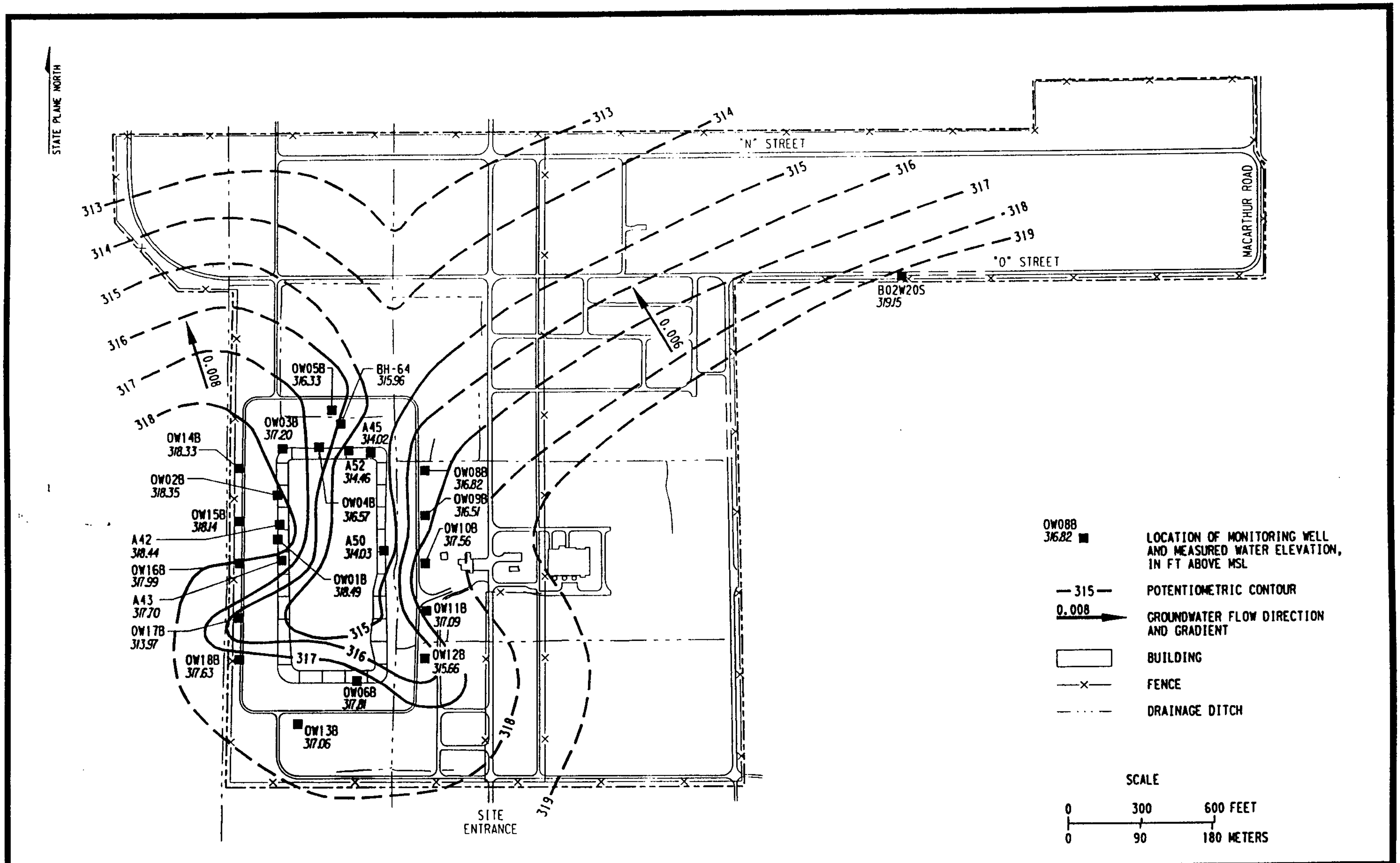

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Figure 4
Potentiometric Surface Map (April 22, 1996)
Upper Groundwater System

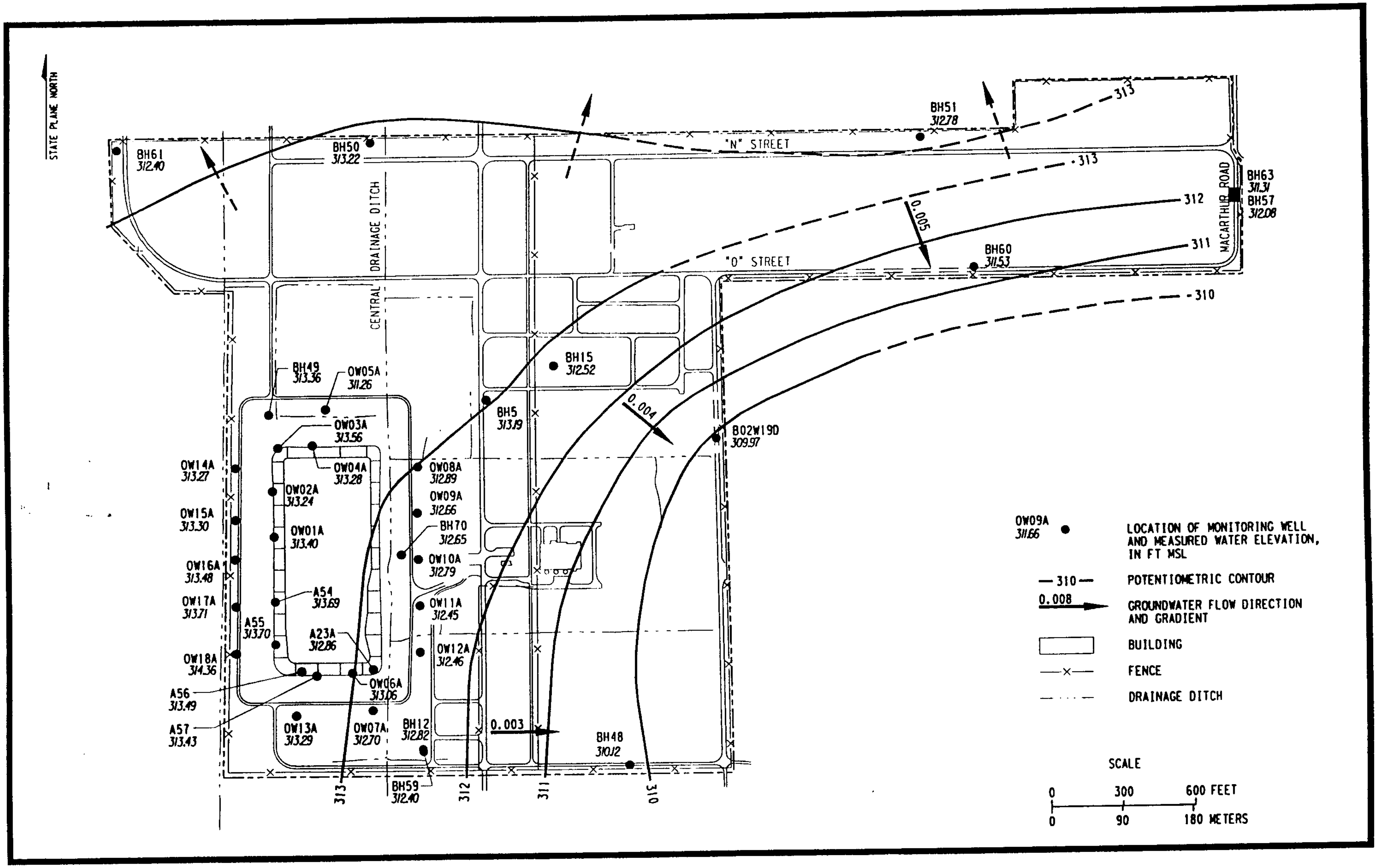

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Figure 5
Potentiometric Surface Map (April 22, 1996)
Lower Groundwater System

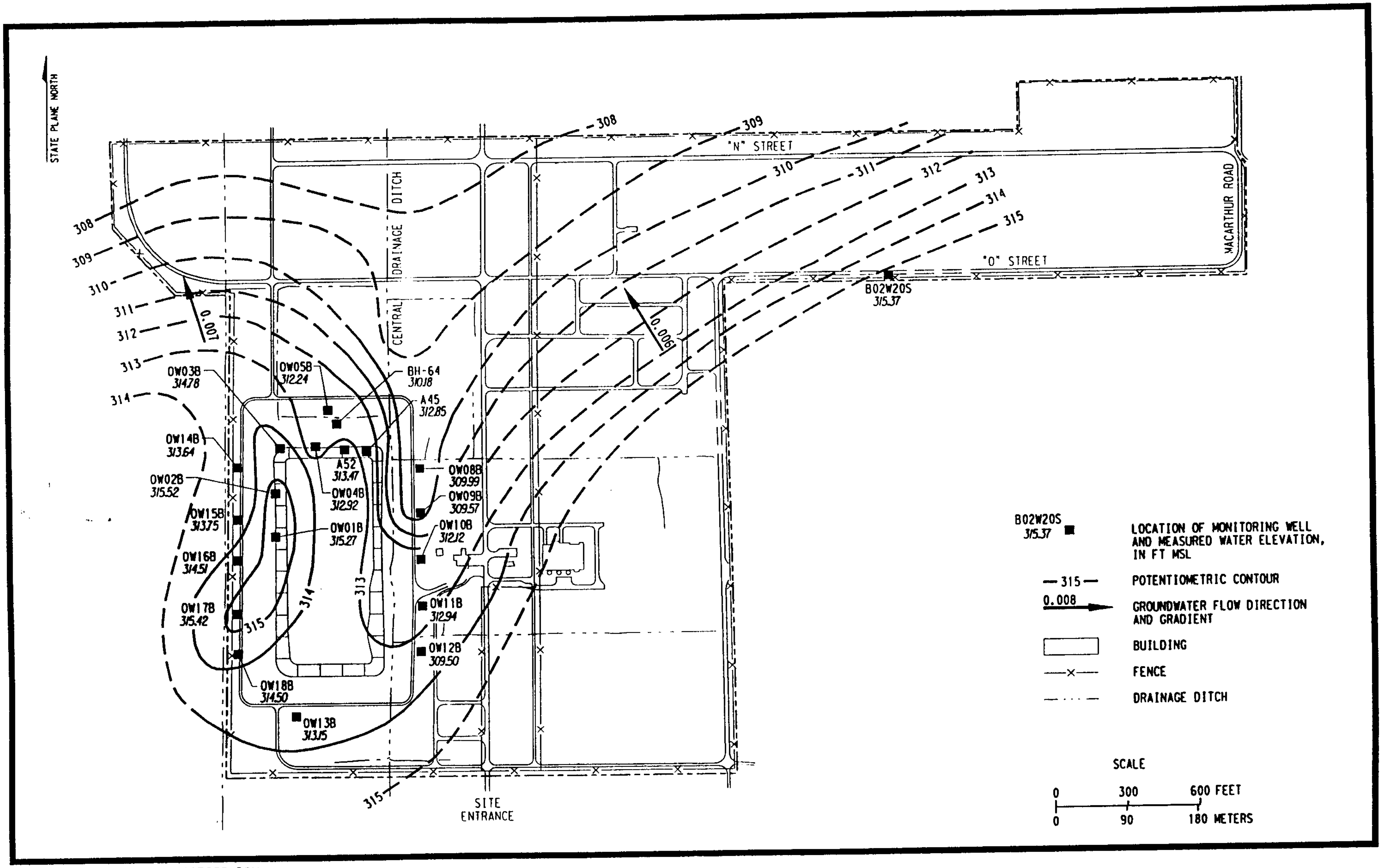

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Figure 6
Potentiometric Surface Map (August 22, 1996)
Upper Groundwater System

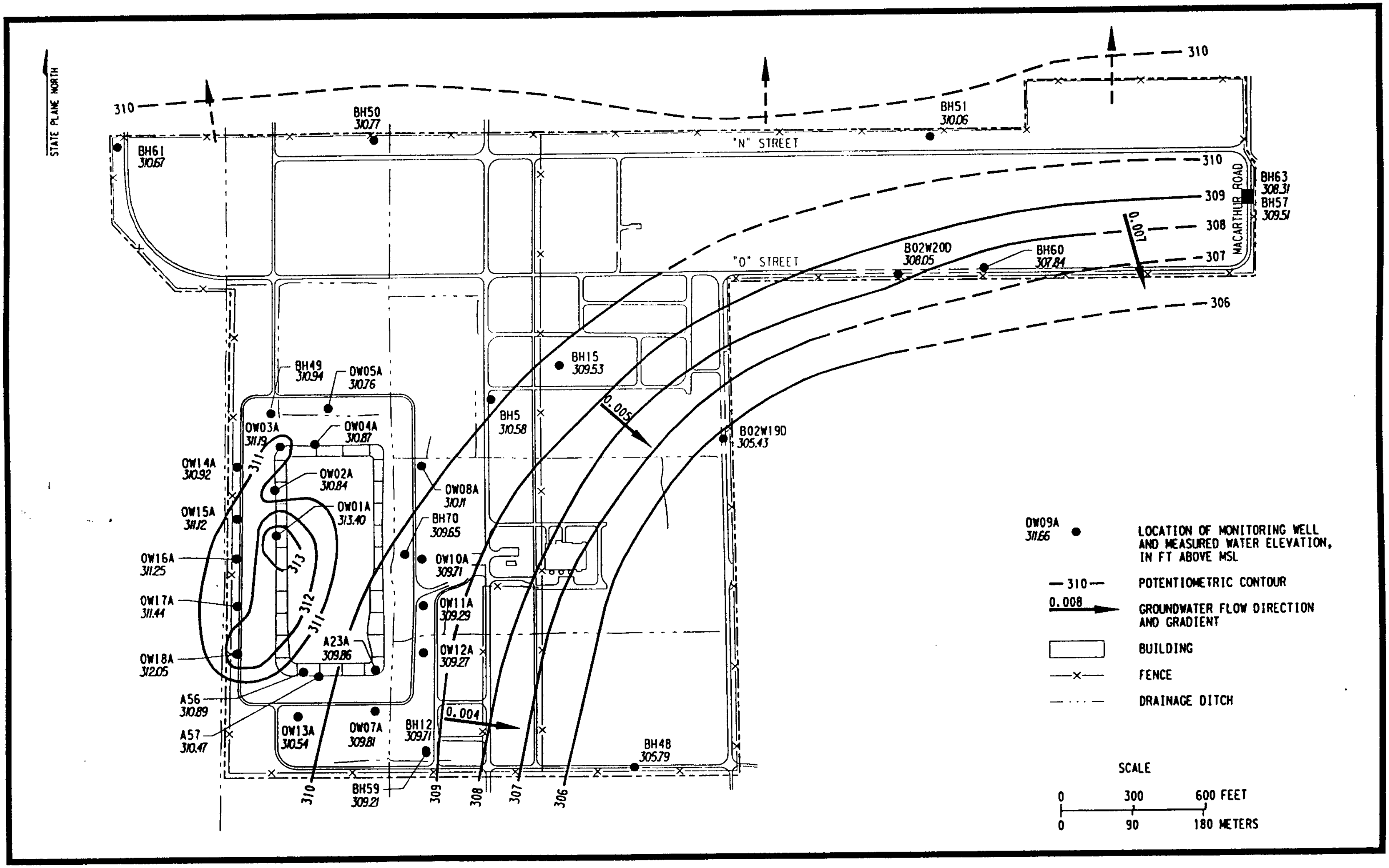

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Figure 7
Potentiometric Surface Map (August 22, 1996)
Lower Groundwater System

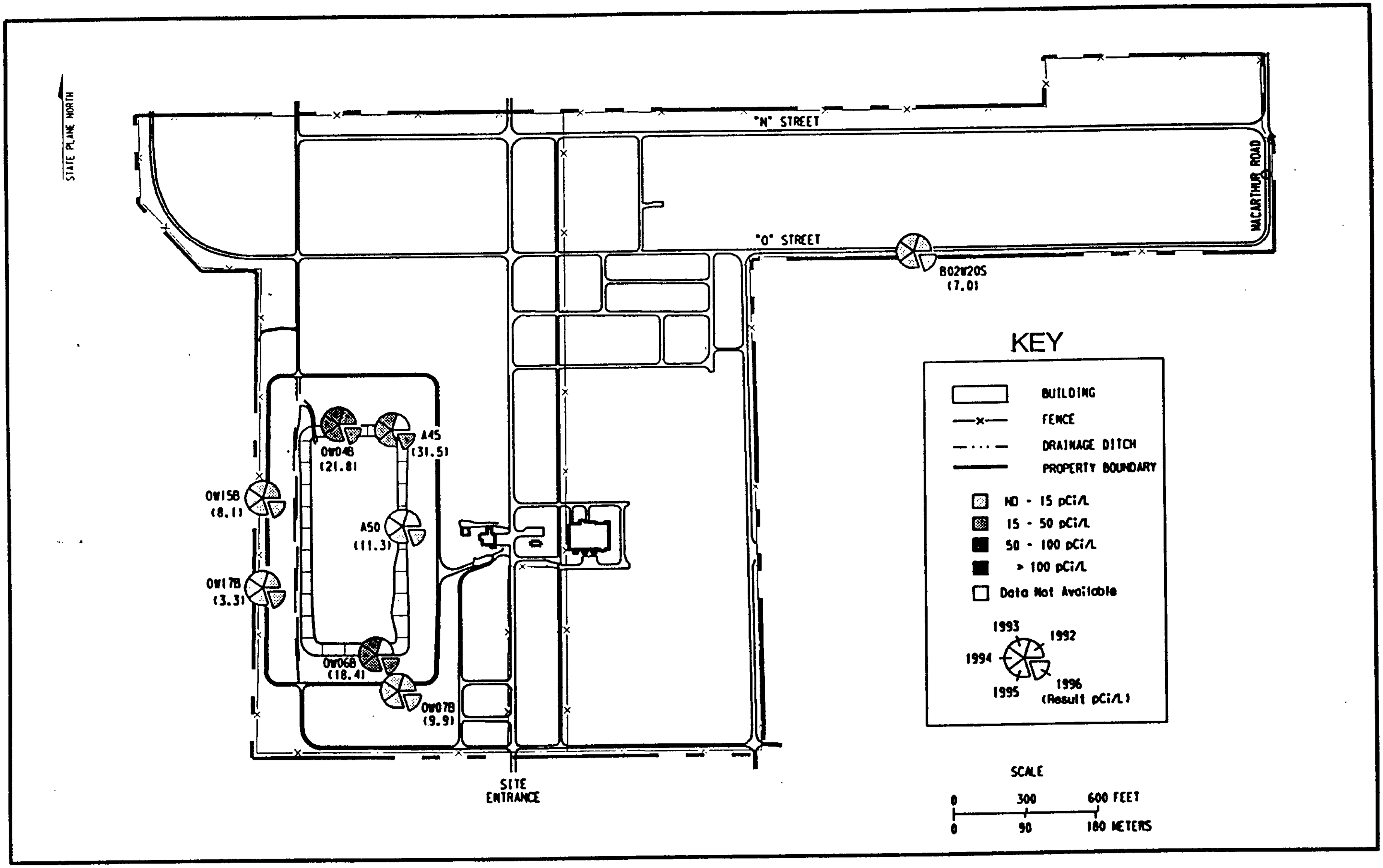

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Figure 8
Niagara Falls Storage Site Environmental Surveillance
Total Uranium Trend Results in Groundwater

APPENDIX A
Environmental Monitoring at NFSS

This appendix documents the results of non-routine environmental monitoring activities conducted in 1996 and is provided as a supplement to the environmental surveillance information included in the body of this technical memorandum. These activities are described here in order to present a more complete picture of the site activities during the year and to provide technical reviewers with sufficient information to determine to what extent these activities influenced site conditions and ultimately the environmental surveillance program.

At FUSRAP sites included in the environmental surveillance program, environmental sampling is typically conducted either as a part of the monitoring program or as a special study. Two distinct activities comprise the FUSRAP monitoring program: environmental monitoring and environmental surveillance. Environmental monitoring consists of measuring the quantities and concentrations of pollutants in solid wastes, liquid effluents, and air that discharge directly to the environment from onsite activities. Environmental surveillance documents the effects, if any, of DOE activities on onsite and offsite environmental and natural resources. At FUSRAP sites, because there are no onsite waste treatment facilities with point discharges, the monitoring program consists primarily of environmental surveillance (BNI, 1996). The Environmental Surveillance Technical Memorandum specifically reports the results of routine environmental surveillance sampling and, at applicable sites, includes information for routine environmental monitoring (stormwater discharges and radon flux measurement). The main text of the technical memorandum does not, however, discuss results of non-routine site sampling conducted as special studies or environmental monitoring.

The following section documents environmental monitoring, which is typically conducted in conjunction with field activities (e.g., excavation, decontamination, or waste treatment) that may generate an effluent (e.g., airborne release). In 1996, concurrent with ongoing remedial action in building 401, personnel air monitoring was conducted. There were no special studies conducted at NFSS in 1996.

A.1 Environmental Monitoring

Partial remediation of the interior of building 401 at NFSS was conducted from July to September of 1996 and included removal of surface contamination from building surfaces such as pipes, floors, drains, walls, and lockers. Surface contamination was removed using sponge blasting equipment, air-hammers, grinders, and wire brushes, according to the type of surface and level of abrasion necessary. Because these activities had the potential to generate contaminated dust, which could be inhaled or could cross contaminate other surfaces, engineering controls were implemented, including enclosing work areas using plastic partitions and covering the floors with plastic. Local area HEPA units and vacuums were also used.

All work was interior, and therefore site perimeter monitoring was not applicable. To confirm that work practices and engineering controls are adequate to protect the workers performing the decontamination work, personnel monitoring was conducted using low volume pumps with inline air filter cartridges. The duration of exposure for each cartridge and the pump rate were both recorded such that the air sample volume for a given cartridge could be calculated. The cartridges were then counted onsite for gross alpha radioactivity, and the results were converted into equivalent concentrations of radium-226. All results were well below applicable limits for occupational exposures as specified in DOE Order 5480.11 (DOE, 1988), confirming that engineering controls and work practices were effective in minimizing exposure to airborne contamination.

References:

Bechtel National, Inc. (BNI), 1996. *Environmental Surveillance Plan, Appendix C2,* 191-ESP, rev.0 (March 7).

Department of Energy (DOE), 1988. "Radiation Protection for Occupational Workers." DOE Order 5480.11 (December 21).