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MESSAGE: Annual Environmental Surveillance Report for NFSS for 1997

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Bechtel

70 Pearce Avenue
Tonawanda, NY 14150
Telephone: (716) 447-9380
Facsimilie: (716) 871-1192

Job No. 14501, FUSRAP Project
USACE Contract No. DACW45-98-D-0028
Code: 7430 /WBS: 158

USACE
Buffalo District
1776 Niagara Street
Buffalo, NY 14207-3199

Attention: Judith S. Leithner, Ph.D.
Project Engineer

Subject: Niagara Falls Storage Site (NFSS)-
1998 Environmental Surveillance Report for NFSS

Dear Dr. Leithner:

As part of the Bechtel National, Inc. (BNI) Scope of Work for FY 1998 and the USACE Delivery Order 0002, we are transmitting Technical Memorandum 158-98-005. This technical memorandum reports the environmental monitoring results for 1997 at the Niagara Falls Storage Site.

If you have any questions, please call me at (716) 447-9380, ext. 310 or Robert Gibbs at (716) 447-9380, ext. 332.

Sincerely,

David L. Schlick

David Schlick
Project Manager - FUSRAP

Enclosure

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Concurrence: R.J. Gibbs @ R.J.G.
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FUSRAP TECHNICAL MEMORANDUM

To: Judy Leitner, Site Manager - USACE
From: David L. Schlick, Project Manager, Buffalo District FUSRAP
Subject: Environmental Surveillance Results for 1997 for the Niagara Falls Storage Site

Prepared By	ET Team Lead	Project Engineer	Project Manager

SUMMARY

In 1974, the Atomic Energy Commission (AEC), a predecessor to the U.S. Department of Energy (DOE), instituted the Formerly Utilized Sites Remedial Action Program (FUSRAP). This program is now managed by United States Army Corps of Engineers (USACE) to identify and clean up, or otherwise control sites where residual radioactivity remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized USACE to remedy under FUSRAP.

This memorandum presents and interprets analytical results and measurements obtained as part of the 1997 environmental surveillance program for the Niagara Falls Storage Site (NFSS) under the Formerly Utilized Sites Remedial Action Program (FUSRAP). In October 1997, Congress transfered the responsibility for FUSRAP from the United States Department of Energy (DOE) to the United States Army Corps of Engineers (USACE). Because low-level radioactive wastes and residues are stored in the waste containment structure (WCS) at NFSS, the environmental surveillance program at the site includes sampling of air, water, and streambed sediment to aid in evaluating potential effects on the offsite population. The discussion below provides a comparative analysis of local background conditions and regulatory criteria to results reported for external gamma radiation and for samples from the media investigated. Data tables and figures referenced in the text are included at the end of this document.

Results from the 1997 surveillance program at NFSS indicate that no measured parameter exceeded DOE guidelines, and no dose calculated for potentially exposed members of the general public exceeded DOE limits. Please note that the DOE guidelines presented throughout this report will continue to be followed until the USACE establishes limits in their transition to managing FUSRAP.

1.0 INTRODUCTION

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

Land use in the region is primarily 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 other sites and were transferred to NFSS for storage 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.

Since 1971, activities at NFSS have been confined to residue and waste storage and remediation. All onsite and offsite areas with residual radioactivity exceeding current DOE guidelines were remediated between 1955 and 1992; materials generated during remedial actions (approximately 195,000 m^3) are encapsulated in the WCS, which is specifically designed to provide long-term storage of the material. During 1997, there were no remedial activities performed.

1.1 Measured Parameters

The key elements of the 1997 environmental surveillance program at NFSS were

- 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 pile);
- sampling and analysis of surface water for total uranium, thorium-232, and radium-226 (referred to collectively as radioactive constituents);
- sampling and analysis of streambed sediments for radioactive constituents; and
- sampling and analysis of groundwater for radioactive constituents, metals, and water quality parameters.

1.2 Unit Conversions

The following tables list the units of measurement and appropriate abbreviations used in this document. Conventional units for radioactivity are used because the 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 for water level information only.

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 federal statutes and in federal, state, and local regulations. DOE Orders will also affect activities at FUSRAP until the USACE establishes limits in their transition to managing FUSRAP. Regulatory criteria that were used to evaluate the results of the 1997 environmental surveillance program at NFSS are summarized below, categorized by media and parameters.

External Gamma Radiation and Air (Radon Gas and Airborne Particulates)

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 (excluding radon) 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 of the two isotopes to the allowable limit must be less than one. Based on the relative abundance of 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

  Since 1992, radon flux monitoring results at NFSS have consistently been less than 20 pCi/m^2-s, successfully demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) Subpart Q standard. The final Memorandum of Understanding between the EPA and DOE (DOE, 1996) concerning the Clean Air Act Emission Standards for Radionuclides, 40 Part 61 including subparts H, I, Q, and T (signed April 1995), makes the following statement:

  > "Where flux measurements demonstrate compliance with the $20pCi/m^2$-s standard, no further measurements are required so long as the storage or disposal site remains in the condition for which compliance was demonstrated."

  Consistent with the language in the Memorandum of Understanding, based on successful demonstration of compliance with the standard, it is technically justifiable to discontinue monitoring until alterations of site conditions necessitate reassessment of radon flux at the site. Nevertheless, radon flux monitoring continues at NFSS on an annual basis as part of performance monitoring of the clay pile cover.

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

Parameter	DOE Order 5400.5 [a]	Other Federal Standard or Guideline
Radon-222 flux	20 pCi/m^2/s	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	100 mrem/yr [e]

[a] *Guidelines provided in the DOE Order are above background concentrations or exposure rates.*

[b] *Federal (EPA) Standard from 40 CFR, Part 61, subparts H (radionuclide emissions) and Q (radon-222 flux).*

[c] *EPA action level for radon concentration in homes (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).*

[e] *Federal (Nuclear Regulatory Commission) Standard 10 CFR 20 and proposed (EPA) Radiation Protection Guidance for Exposure of the General Public (FR 59:66414, December 23, 1994).*

Sediment, Surface Water, and Groundwater - Radioactive Constituents

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

- DOE Order 5400.5

  This Order provides applicable limits for radioactive constituents in water and soil at some government operated facilities.

  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 as a basis for evaluating the analytical results in sediment.

  DOE Order 5400.5 states that the guideline for residual concentrations of radium-226 and thorium-232 in surface soil is 5 pCi/g above background, based on an average of the first 15 cm of soil below the surface. For subsequent 15-cm depth intervals (subsurface soils), the specified limit is 15 pCi/g above background. Because surveillance sediment samples are collected from the first 15 cm of sediment, only the surface soil criteria are used. The NFSS 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 method. By this method, the above-background concentration of each of the radioisotopes is divided by its 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 radionuclides in water, which are also presented in this Order, are used to evaluate analytical data for surface water and groundwater at NFSS and are cited in the appropriate data tables in 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. For mixtures of radionuclides in water, the sum of the ratios of each concentration to the DCG must not exceed 1.

- Safe Drinking Water Act (SDWA)

  SDWA is the primary federal law 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)]. The regulations in 40 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. MCLs have been established (promulgated) for combined concentrations of radium-226 and radium-228. Although groundwater at NFSS is not a public drinking water supply, the MCLs for drinking water are considered relevant and appropriate and are therefore used in this document as a conservative basis for evaluation of analytical results.

Summary of Radiological Standards and Guidelines - Water and Sediment

Parameter	DOE DCG [a] for Water [b]	Other Federal Standards	DOE Authorized Limit for Residual Radioactivity in Surface Soil [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/L [f]	5 pCi/g

[a] *DOE derived concentration guide (DOE Order 5400.5)*

[b] *Surface water and groundwater (non-drinking water values); criteria represent concentrations above background. If a mixture of radionuclides is present, the sum of the ratios of each isotope to its respective DCG must be less than one.*

[c] *Above-background concentrations 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 site-specific (uranium) surface soil cleanup criteria are used as a basis for evaluating analytical results for sediment. If a mixture of the radionuclides is present in soil, 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.*

[f] *Current SDWA MCL for the combined concentration of radium-226 and radium-228 in drinking water. Radium-228 has not been routinely detected at NFSS and is not sampled in the surveillance program. Groundwater at NFSS is not a drinking water source.*

– *No existing (promulgated) standard.*

Groundwater - Chemical Parameters

As noted above, although the groundwater at NFSS is not a public drinking water supply, state and federal standards for drinking water are used as a conservative basis for comparison of chemical analytical results.

- SDWA

  As indicated previously, SDWA is the primary federal law applicable to the operation of a public water system and the development of drinking water quality standards (EPA 1996). The regulations set MCLs for organic, inorganic, and microbial contaminants in drinking water. 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 of 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.

  To apply established standards, the State of New York categorizes groundwater resources by groundwater quality and use. 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 near 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 practicable 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 is downgradient of the site (2 km north). None of the wells identified in the well survey is reportedly used for drinking water; most are used for irrigation (DOE 1994b). 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 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, because 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 this radioactively contaminated material at NFSS is unlikely because of site access restrictions (e.g., fences) and engineering controls (e.g., pile covers); 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. Figure 2 presents 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 gas, 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. Measurement of radon-222 flux is conducted annually at discrete grid intersections on the WCS (Figure 2).

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). Groundwater monitoring includes analysis for radioactive constituents, water quality parameters, and metals. 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.

Surface water and streambed sediment sampling of radioactive constituents is conducted along the drainage ditch system in upstream, onsite, and downstream locations (Figure 2) to assess the migration of constituents in these media should any occur.

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 1997 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 1997 are presented in Tables 2 through 10.

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 is referred to as a nondetect in the text discussion.

For direct comparison of analytical results to the DOE soil authorized limits and the DCGs, average background radioactivity in surface water, sediment, and groundwater is subtracted from the 1997 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 are near the DCG. All figures displaying results present actual analytical data only.

The average historical background concentration for each radioactive analyte is determined from background sampling results from 1992 to 1997, unless otherwise noted (BNI 1997a). Subtracting the calculated average background from the sampling results for 1997 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 is 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 the factor used 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 over the period of exposure (approximately one year). When corrected for shelter/absorption and background and normalized to exactly one year's exposure, these detectors provide a measurement of the annual external gamma radiation dose at that location. TETLD results for the 1997 external gamma radiation dose (both raw and corrected data) are summarized in Table 2. TETLD surveillance locations are shown in Figure 2.

The corrected data are no longer used to calculate the external gamma radiation dose rate to a hypothetical maximally exposed individual. The final Memorandum of Understanding between EPA and DOE Concerning the Clean Air Emission Standards for Radionuclides (40 CFR Part 61 subparts H, I, Q, and T) states that based on successful demonstration of compliance with the standard, no further measurements are required so long as the storage or disposal site remains in the

condition for which compliance was demonstrated. Based on 1996 external gamma radiation results, the dose to a hypothetical maximally exposed individual (resident) 2,800 m from the west fence line would be 0.00005 mrem/yr (BNI 1997b), well below the DOE guideline of 100 mrem/yr (for all pathways, excluding radon). It is the intent to continue radon flux monitoring at the site, however, in order to evaluate the performance of the clay pile cover and because of the presence of the K-65 residues which are a strong radon source.

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 1997 are presented in Table 3; the corresponding surveillance locations are shown in Figure 2.

At location 1 during the last 6 months of 1996 at the northern end of the site on the fenceline just east of Campbell Street, the radon-222 concentration was 1.90 pCi/L. This appears to have been an anomaly because results from the first 6 months of 1996 and those for all of 1997 were at or below the detection limit of 0.2 pCi/L. Except for location 1, the results from 1997 are consistent with results for 1996 (BNI 1996e). Furthermore, all 1997 concentrations are below the DOE limit of 3.0 pCi/L for radon-222.

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-h exposure period. Measurements for 1997 are presented in Table 4; measurement locations are shown in Figure 2. Measured results for 1997 ranged from nondetect to 2.47 $pCi/m^2/s$. 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

The final Memorandum of Understanding between EPA and DOE Concerning the Clean Air Emission Standards for Radionuclides (40 CFR Part 61 subparts H, I, Q, and T) states that based on successful demonstration of compliance with the standard, no further measurements are required so

long as the storage or disposal site remains in the condition for which compliance was demonstrated. Thus, airborne particulate dose is not calculated for 1997. The calculated 1996 airborne particulate dose to the hypothetical 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 was well below the 10 mrem/yr standard specified in 40 CFR, Part 61, Subpart H. The hypothetical airborne particulate collective dose to the population within 80 km of the site was 5×10^{-8} person-rem/yr (BNI 1997c).

5.5 Surface Water and Sediment

In 1997, 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 location 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, radium-228, thorium-230, thorium-232, and total uranium. The 1997 environmental surveillance analytical results for surface water and sediment samples are presented in Tables 5 and 6, respectively. Analytical results for surface water in 1997 are compared with the DOE DCGs for radium-226, thorium-232, and total uranium. Because there are no established standards for sediments, the surface soil criterion of 5 pCi/g is used as a basis for comparison of radium-226 and thorium-232 analytical results. The NFSS DOE site-specific soil cleanup criterion of 90 pCi/g (above background) 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 1997 for surface water and sediment. Because analysis for thorium-232 first began in 1995 in sediment and 1996 in surface water, background concentrations for thorium-232 were determined from analytical results from 1995 and/or 1996 through 1997, as appropriate.

Surface Water

In 1997 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 (with background not subtracted) are provided in Table 5 and discussed below:

- The 1997 on-site analytical results for radium-226 and radium-228 concentrations ranged from nondetect to 0.33 pCi/L and from nondetect to 0.27 pCi/L, respectively. These values are consistent with historical results and are indistinguishable from background. Historically, the concentration of radium-226 has ranged from nondetect to 2.38 pCi/L. The background analytical results for radium-226 and radium-228 concentrations, ranged from 0.10 to 0.15 pCi/L and from nondetect to 0.14 pCi/L, respectively. The average historical background concentration for radium-226 is 0.53 pCi/L. The radium-226 DOE DCG is 100 pCi/L.

- The 1997 on-site analytical results for thorium-230 and thorium-232 concentrations, ranged from 0.29 to 0.35 pCi/L and from nondetect to 0.38 pCi/L, respectively. The 1997 on-site concentrations are consistent with historical results and are indistinguishable from background. The background analytical results for thorium-230 and thorium-232 concentrations, ranged from 0.19 to 0.22 pCi/L and from nondetect to 0.12 pCi/L, respectively. The DOE DCG for thorium-232 is 50 pCi/L.

- The 1997 analytical results for total uranium in onsite surface water (5.45 to 8.04 pCi/L) are consistent with historical results and are indistinguishable from background. Background for 1997 ranged from 2.77 to 10.50 pCi/L, and the average historical background concentration is 7.18 pCi/L. The DOE DCG for total uranium is 600 pCi/L.

Sediment

Concentrations of radium-226, thorium-232, and total uranium in shallow sediment were less than the DOE surface 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 (using the sum-of-the-ratios method; BNI 1997d). Measured results (with background not subtracted) are presented in Table 6 and discussed below.

- The 1997 analytical results for radium-226 are consistent with historical analytical results. Radium-226 results from upstream locations SWSD009 and SWSD021 were 0.41 and 0.34 pCi/g, respectively, comparing favorably with the calculated historical background of 1.29 pCi/L. The 1997 results of analysis for radium-226 in samples collected at downstream locations SWSD010, SWSD011, and SWSD022 ranged from 0.17 to 0.44 pCi/g. Historically, the concentration of radium-226 has ranged from 0.71 pCi/g to 2.9 pCi/g. All radium-226 concentrations in sediment were less than the DOE surface soil cleanup criterion of 5 pCi/g above background.

- The 1997 downstream thorium-232 results ranged from 1.18 to 1.57 pCi/g, and upstream results from SWSD009 and SWSD021 were 1.39 and 1.27 pCi/g, respectively. All 1997

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 surface soil cleanup criterion of 5 pCi/g above background.

- The 1997 analytical results for total uranium at upstream sampling locations SWSD009 and SWSD021 were 2.27 and 2.23 pCi/g, respectively, which are lower than the historical upstream average of 3.08 pCi/g. The 1997 analytical results for total uranium at downstream sampling locations SWSD010, SWSD011, and SWSD022 ranged from 1.75 to 2.39 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 1997 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. 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.

Historically low concentrations of constituents in groundwater wells completed in the lower groundwater system and the continuously low concentrations of constituents monitored in the upper groundwater system indicate that annual monitoring of the lower groundwater system is not currently necessary. Because the monitoring wells completed in the upper groundwater system provide an early detection 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 1997 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

Water level measurements are obtained using an electronic depth-to-water meter. Sixty-three groundwater monitoring wells are used to monitor groundwater levels in both the upper and lower groundwater systems. 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. While groundwater flow is primarily horizontal, this vertical hydraulic gradient indicates that the flow is also slightly downward. However, 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. The upward hydraulic gradient near the central drainage ditch provides an upward component to groundwater flow, thereby preventing downward migration of dissolved contaminants.

In the upper groundwater system, the depth to water ranged from about 0.60 m to 3.01 m (1.98 to 9.86 ft) below ground surface during 1997. Water level fluctuations in the upper groundwater system in 1997 were on the order of 1.3 m (4.2 ft). In the lower groundwater system, the depth to water ranged from about 1.98 to 4.47 m (6.51 to 14.66 ft) below ground surface during the year. Water level fluctuations in the lower groundwater system were on the order of 0.22 m (0.73 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 5 (upper groundwater system) and 6 (lower groundwater system) present piezometric surfaces and groundwater flow directions representative of the high condition in the upper groundwater system. Figures 3 (upper groundwater system) and 4 (lower groundwater system) present piezometric surfaces and groundwater flow directions representative of the 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 0.004 to 0.019 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 1997 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 3, 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 1994b). This velocity does not necessarily represent the rate at which a contaminant could migrate, because contaminant-dependent transport factors such as retardation (caused by physical interactions such as contaminants binding to clay particles) can significantly slow the rate of transport.
Groundwater elevations during the seasonal high condition (February 25, 1998) ranged from 94.48 m (309.97 ft) above mean sea level to 97.28 m (319.15 ft) above mean sea level. Groundwater elevations during the seasonal low condition (July 17, 1997) ranged from 94 m (308 ft) above mean sea level to 95.5 m (314 ft) above mean sea level at OW02B during the year.

5.6.2 Groundwater Quality

Field Parameters

Table 7 summarizes field measurements (temperature, pH, specific conductance, oxidation-reduction potential, and turbidity) for 1997 environmental surveillance sampling. These measurements represent water conditions at the time of 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 1994b). Water quality parameter data for 1997 are provided in Table 8.

Total dissolved solids (TDS), sulfate, and sodium were present onsite and upgradient (background) in concentrations exceeding NYSDEC water quality standards; there are no federal standards for these water quality parameters. TDS results in all wells including the background well (ranging from 791 to 1,760 mg/L) exceed the NYSDEC water quality standard (500 mg/L). Sodium was detected in all wells, including the background well, at concentrations ranging from 40.4 mg/L (B02W20S) to 71.9 mg/L (A50), indicating that groundwater is naturally slightly saline in the region. The results are consistently greater than the NYSDEC groundwater quality standard for sodium (20 mg/L). Sulfate was also detected in all wells at concentrations ranging from 135 mg/L (OW15B) to 817 mg/L (A45). All wells except one had sulfate concentrations greater than the NYSDEC groundwater quality standard for sulfate (250 mg/L).

5.6.3 Groundwater - Radioactive Constituents

In 1997, groundwater samples collected from eight 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 (with background not subtracted) in groundwater are summarized in Figure 7.

Upper Groundwater Zone Results

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

- Radium-226 results in groundwater in 1997 ranged from nondetect to 0.14 pCi/L and were comparable to the average historical background concentration (sampling location B02W20S) of 0.17 pCi/L. The DOE DCG for radium-226 is 100 pCi/L above background. Radium-226 concentrations in groundwater at NFSS have been consistently low, with all measured concentrations (background not subtracted) less than 1 pCi/L. Radium-228 is present at negligible concentrations nondetect to 0.26 pCi/L. Combined concentrations of radium-226 and radium-228 at NFSS would be well below the SDWA MCL.

- A trace concentration of thorium-232 was detected in groundwater from well A45 (0.30 pCi/L), with lesser concentrations of thorium-232 being detected in the remaining monitoring wells. The maximum concentration detected in 1996 was 0.21 pCi/L. The historical background concentration for thorium-232 is 0.11 pCi/L however concentrations were not measured prior to 1996. 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 7.60 pCi/L. Uranium was detected in all sampled wells with results ranging from 3.03 to 32.67 pCi/L. None of the 1997 analytical results exceeded the DOE DCG for uranium of 600 pCi/L above background, consistent with the historical results presented in Figure 7 (measured results, with 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 1997 environmental surveillance analytical results for metals in groundwater are presented in Table 9 and discussed below.

Groundwater at NFSS is not used as a public drinking water supply; however, as a conservative basis for comparison of analytical results, SDWA MCLs and New York State Water Quality Regulation Class GA standards were used. Although copper was present in some groundwater monitoring wells at NFSS, the 1997 analytical results indicate that neither the SDWA MCLs nor the New York State Water Quality Regulation Class GA standards for this metal was exceeded at any of the wells. Vanadium was detected in all of the eight wells sampled in 1997.

- In 1997 copper results ranged from 0.91 µg/L (OW06B) to 13.7 µg/L (OW04B), which is well below the SDWA MCL of 1,300 µg/L and the New York State Water Quality Regulation Class GA standard of 200 µg/L. The 1996 concentration ranged from nondetect

to 13.5 µg/L. Historically, the concentration of copper has ranged from nondetect to 41.1 µg/L.

- In 1997, all lead results were nondetect. In 1996 lead was detected in only one well (A45) at a concentration of 6.8 µg/L. Historically, the concentration of lead has ranged from nondetect to 6.8 µg/L. The SDWA MCL is 15 µg/L and the New York State Water Quality Regulation Class GA standard is 25 µg/L.

- In 1997, vanadium results ranged from 6.8 µg/L (OW17B) to 23.7 µg/L (A45). In 1996 vanadium was not detected in any well. Historically, the concentration of vanadium has ranged from nondetect to 53.4 µg/L. Neither an 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 external gamma radiation dose rate to a hypothetical maximally exposed individual is no longer calculated. The final Memorandum of Understanding between EPA and DOE Concerning the Clean Air Emission Standards for Radionuclides (40 CFR Part 61 subparts H, I, Q, and T) states that based on successful demonstration of compliance with the standard, no further measurements are required so long as the storage or disposal site remains in the condition for which compliance was demonstrated.

B. Radon Gas

Results of the 1997 radon gas surveillance program indicate that the radon gas concentrations at the site were consistently low (nondetect to 0.20 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 1997 radon-222 flux measurements at NFSS were approximately 8 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 2.47 $pCi/ m^2/s$, strongly demonstrating the effectiveness of the containment cell design and construction in mitigating radon-222 migration.

D. Airborne Particulate Dose

As per the final Memorandum of Understanding between EPA and DOE Concerning the Clean Air Act Emission Standards for Radionuclides (40 CFR Part 61, subparts H, I, Q,

and T) based on successful demonstration of compliance with the standard, airborne particulate dose will no longer be calculated.

E. Cumulative Dose from External Gamma Radiation and Airborne Particulates

As per the final "Memorandum of Understanding between EPA and DOE Concerning the Clean Air Act Emission Standards for Radionuclides (40 CFR Part 61)" based on successful demonstration of compliance with the standard, cumulative dose from external gamma radiation and airborne particulates will no longer be calculated.

F. Surface Water

In 1997, onsite radium-226 (nondetect to 0.33 pCi/L), thorium-232 (nondetect to 0.38 pCi/L), and total uranium (5.45 to 8.04 pCi/L) concentrations in surface water samples were indistinguishable from background concentrations.

G. Sediment

Onsite concentrations of radium-226 (0.17 to 0.44 pCi/g), thorium-232 (1.18 to 1.57 pCi/g), and total uranium (1.75 to 2.39 pCi/g) in sediment samples were indistinguishable from background.

H. Groundwater

Radium-226 concentrations (nondetect to 0.14 pCi/L) in groundwater samples were comparable to background (0.17 pCi/L).

Thorium-232 was detected in only one well at a trace concentration of 0.30 pCi/L, which is less than 0.6 percent of the DOE DCG (50 pCi/L).

Onsite total uranium concentrations (3.03 to 32.67 pCi/L) in groundwater samples were less than 8 percent of the DOE DCG (600 pCi/L).

Although groundwater systems at NFSS do not provide drinking water copper and lead concentrations in groundwater samples were all well below the established federal primary and SDWA MCLs and the NYSDEC Class GA groundwater standards. Results for TDS, sulfate, and sodium were greater than state standards in all sampled wells, including the background well.

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Environmental Surveillance Results for 1997
Niagara Falls Storage Site

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Environmental Surveillance Results for 1997
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APPENDIX A
Environmental Monitoring at NFSS

This appendix documents the results of non-routine environmental monitoring activities conducted in 1997 and supplements the environmental surveillance information included in the body of this technical memorandum. These activities are described to present a more complete picture of the site activities during the year and to provide technical reviewers with sufficient information to determine how much 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 compose 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 are discharged 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 typically no onsite waste treatment facilities with routine 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 about routine environmental monitoring (stormwater discharges and radon flux measurement).

There were no remedial activities conducted at NFSS in 1997 and thus no related environmental monitoring. There were no special studies conducted at NFSS in 1997.

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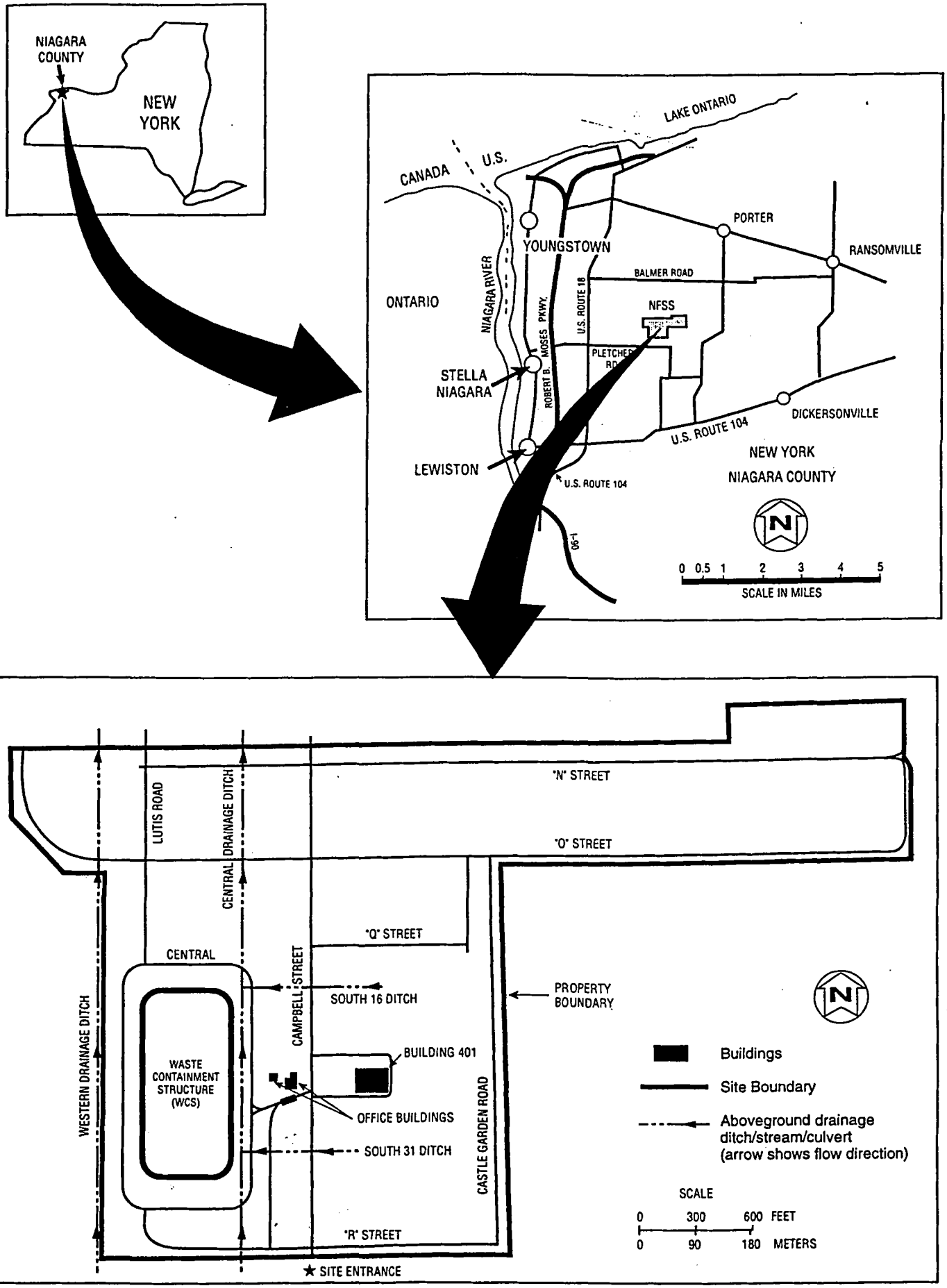
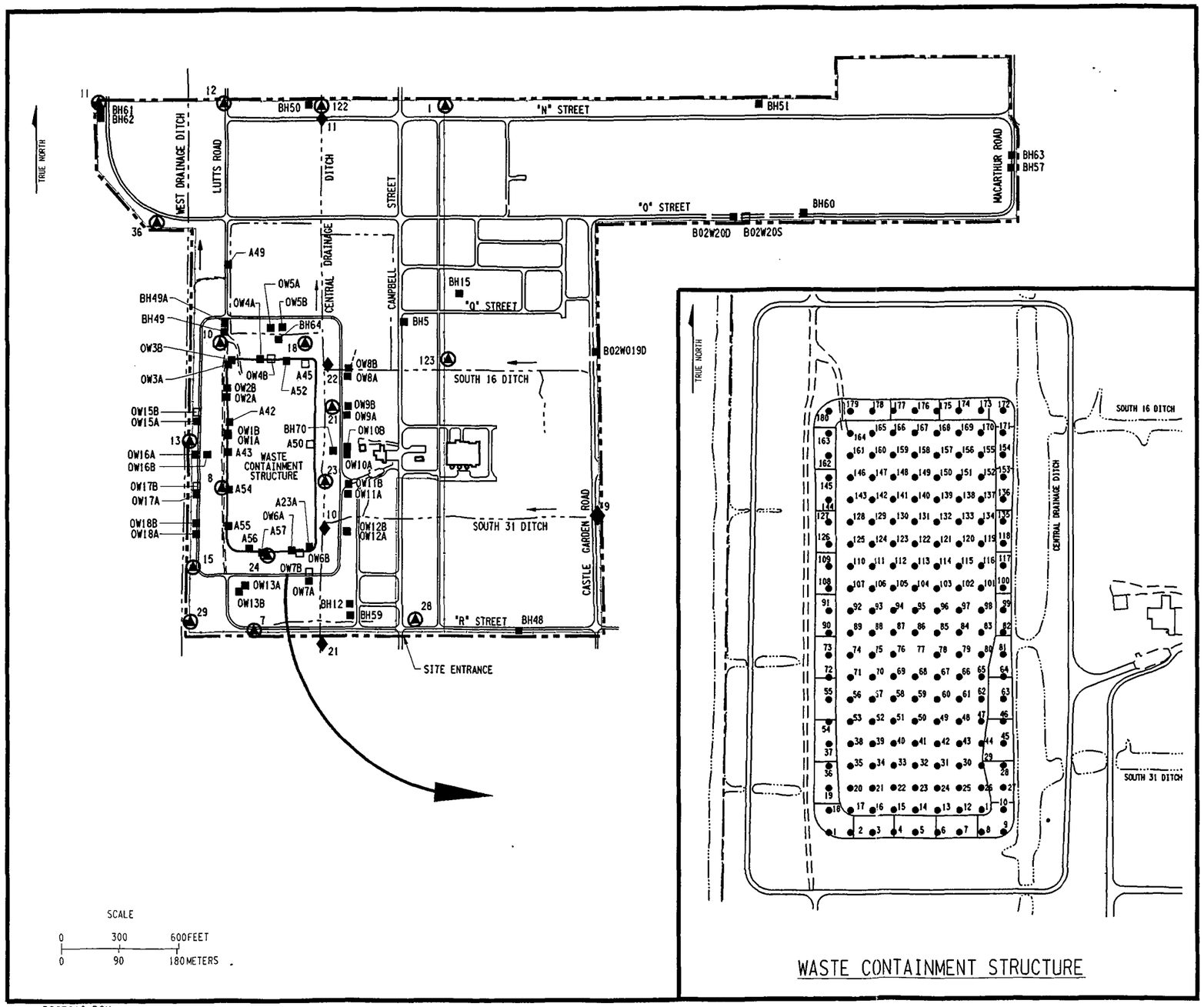


Figure 1
Niagara Falls Storage Site, Site Location and Site Map

Z4.24 0804.4



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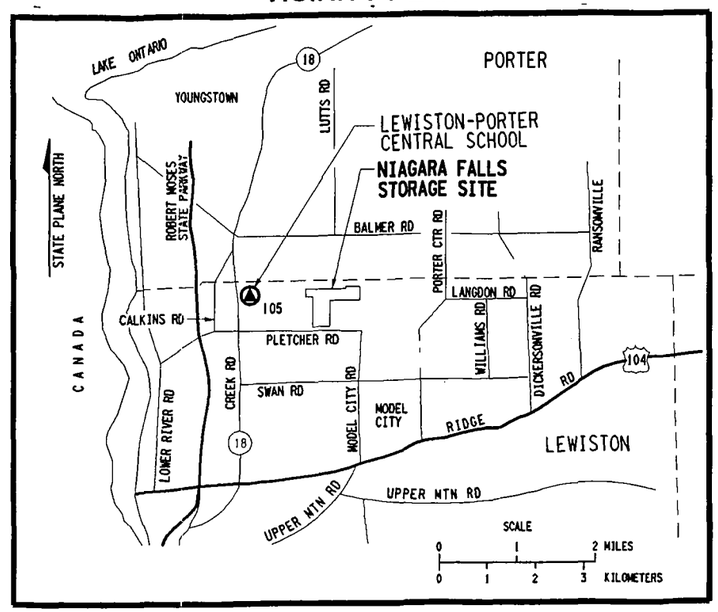
VICINITY PLAN



LEGEND

OW7B ☐	GROUNDWATER MONITORING WELL LOCATION (SAMPLED IN SITE SURVEILLANCE PROGRAM)
OW07A ■	GROUNDWATER MONITORING WELL LOCATION (NOT SAMPLED)
28 ◬	RADON-220/RADON-222 AVERAGE CONCENTRATION MONITORING AND EXTERNAL GAMMA
21 ◆	SURFACE WATER/SEDIMENT SAMPLING LOCATION
●	RADON FLUX MONITORING LOCATION
⟵	ABOVE GROUND DRAINAGE DITCH/STREAM/CULVERT
	PROPERTY BOUNDARY
	FENCE

NOTES:

1. MONITORING WELLS INSTALLED IN THE UPPER GROUNDWATER SYSTEM EITHER HAVE DESIGNATION "B" OR CONSIST OF WELLS A42,A43,A45,A50,A52 AND BH49A.
2. MONITORING WELLS INSTALLED IN LOWER GROUNDWATER SYSTEM EITHER HAVE THE DESIGNATION "A" OR CONSIST OF WELLS A23A,A49,A54,A55,A56,A57,BH5,BH12,BH15,BH48,BH49,BH50,BH51,BH57, BH60,BH63, AND BH64.
3. WATER LEVEL MEASUREMENTS ARE OBTAINED AT ALL WELLS.

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

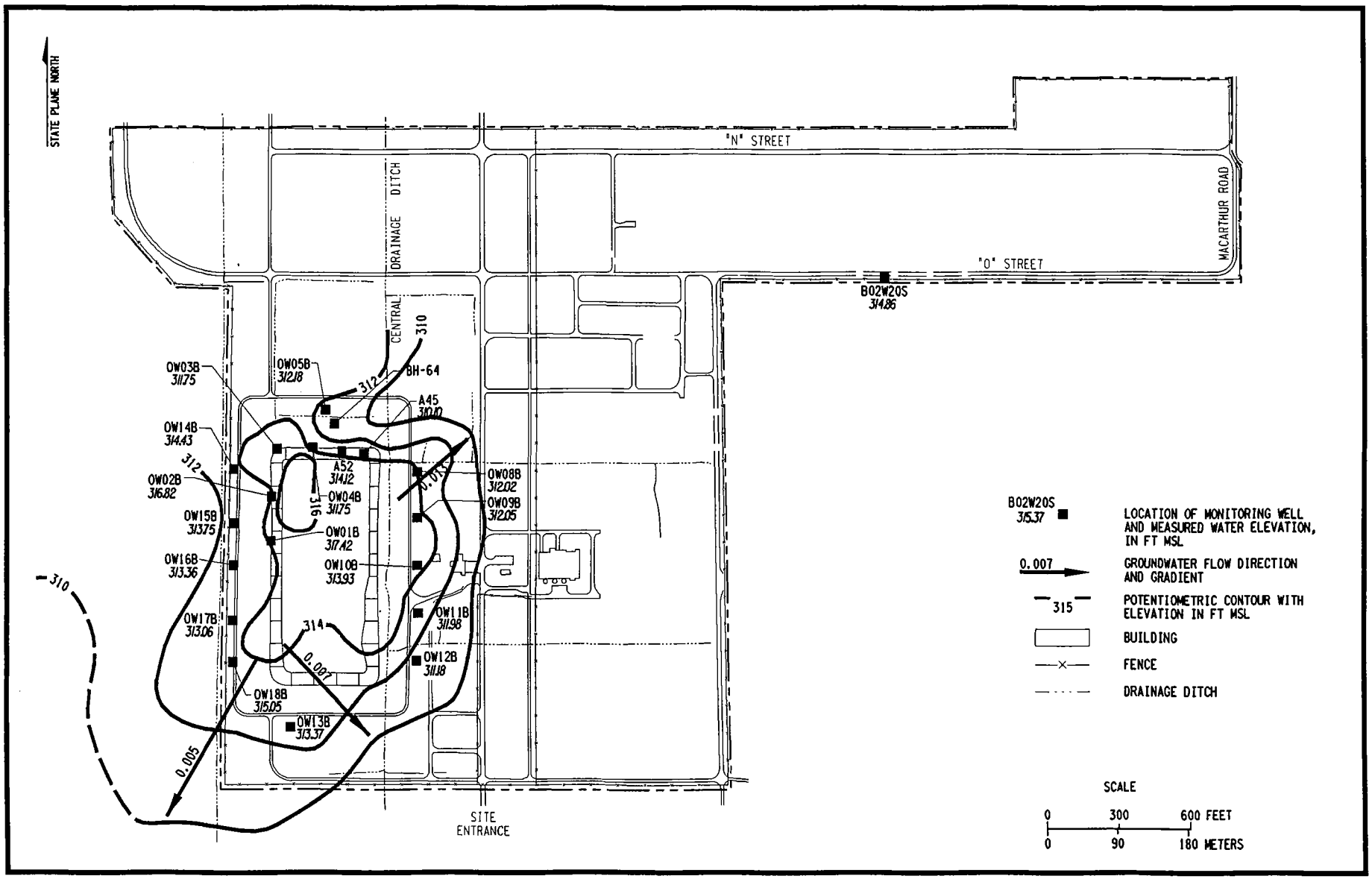


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Figure 3
Potentiometric Surface Map (July 17,1997)
Upper Groundwater System

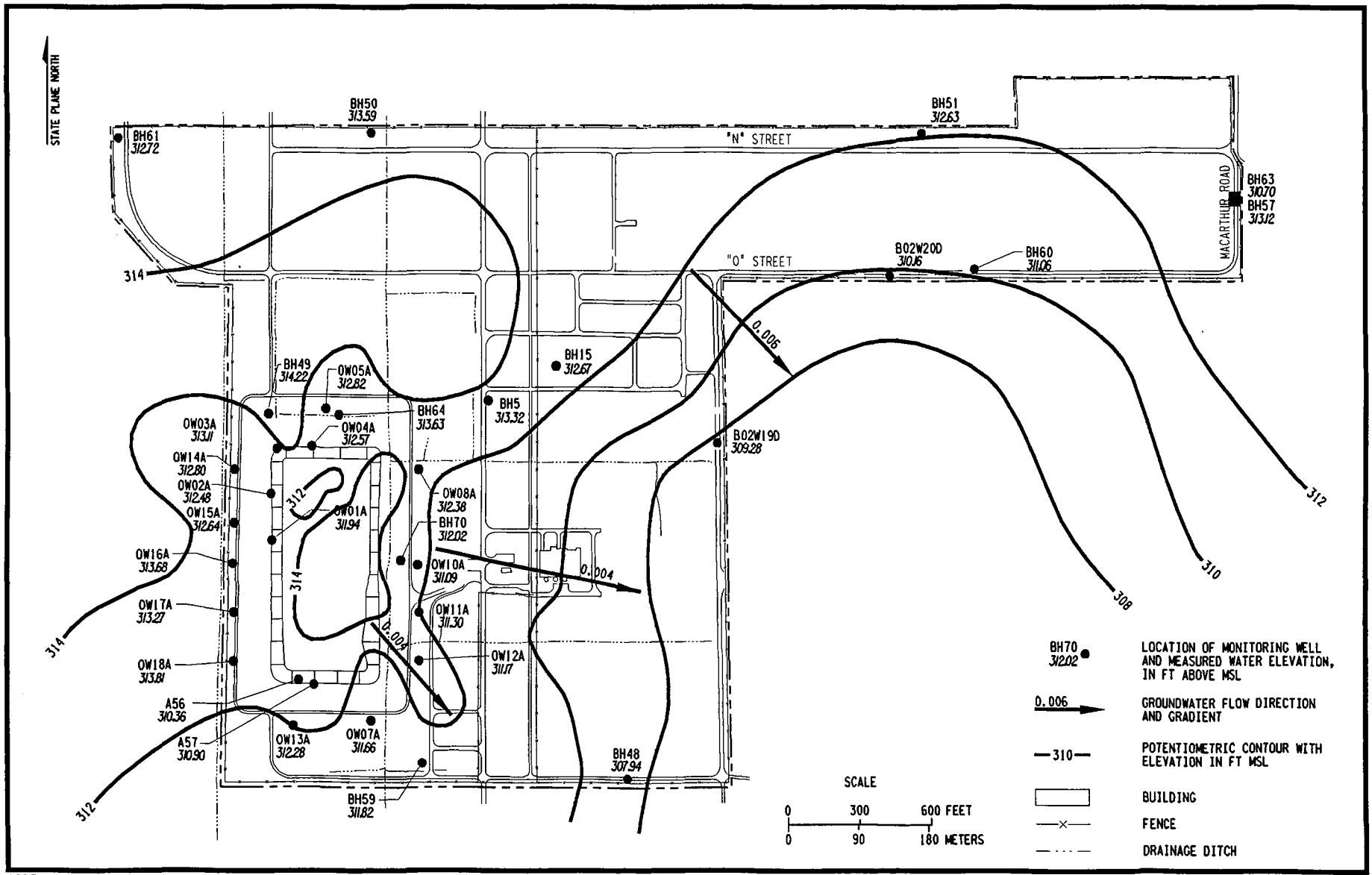

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Figure 4
Potentiometric Surface Map (July 17, 1997)
Lower Groundwater System

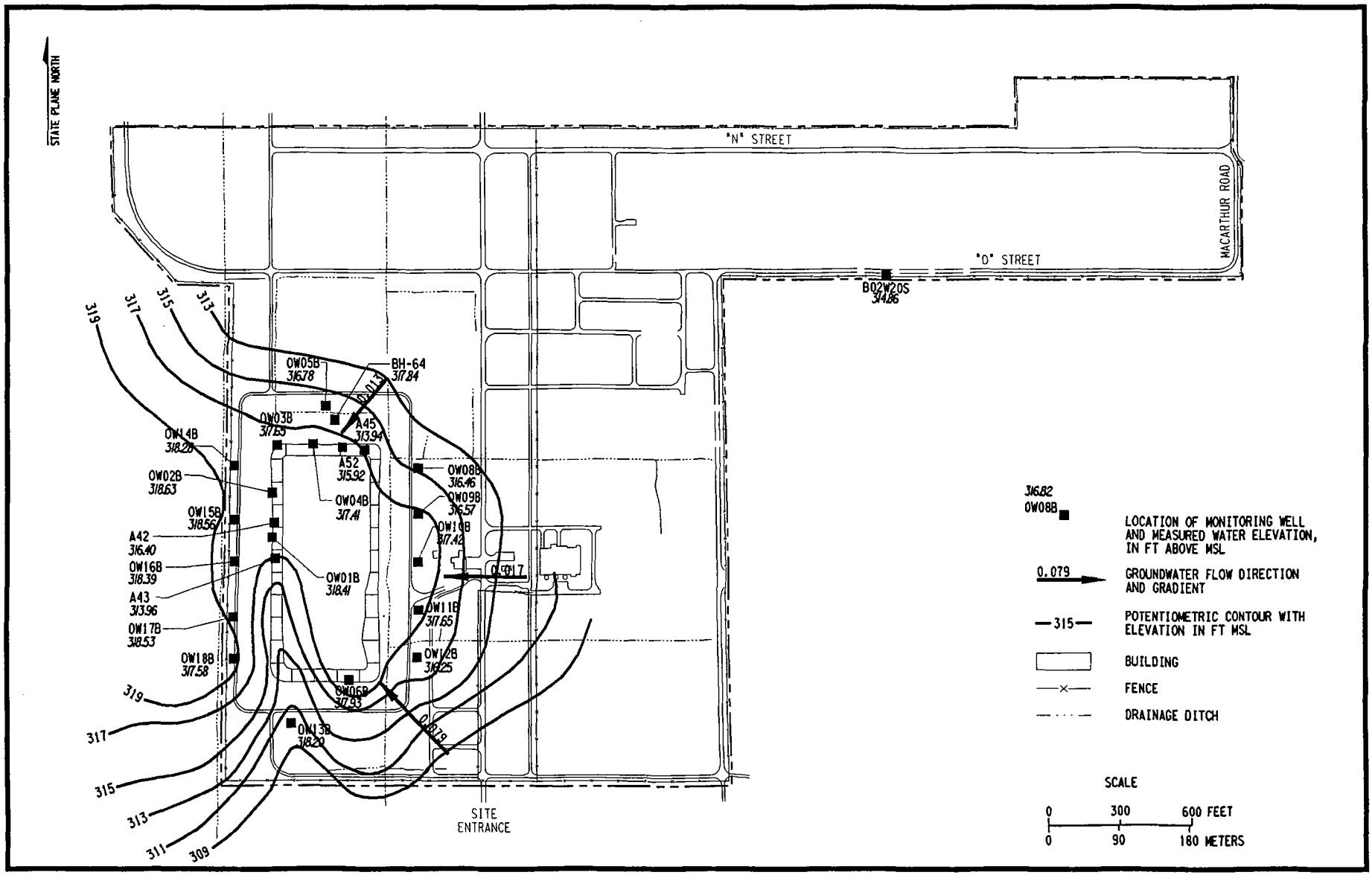

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Figure 5
Potentiometric Surface Map (February 25, 1998)
Upper Groundwater System

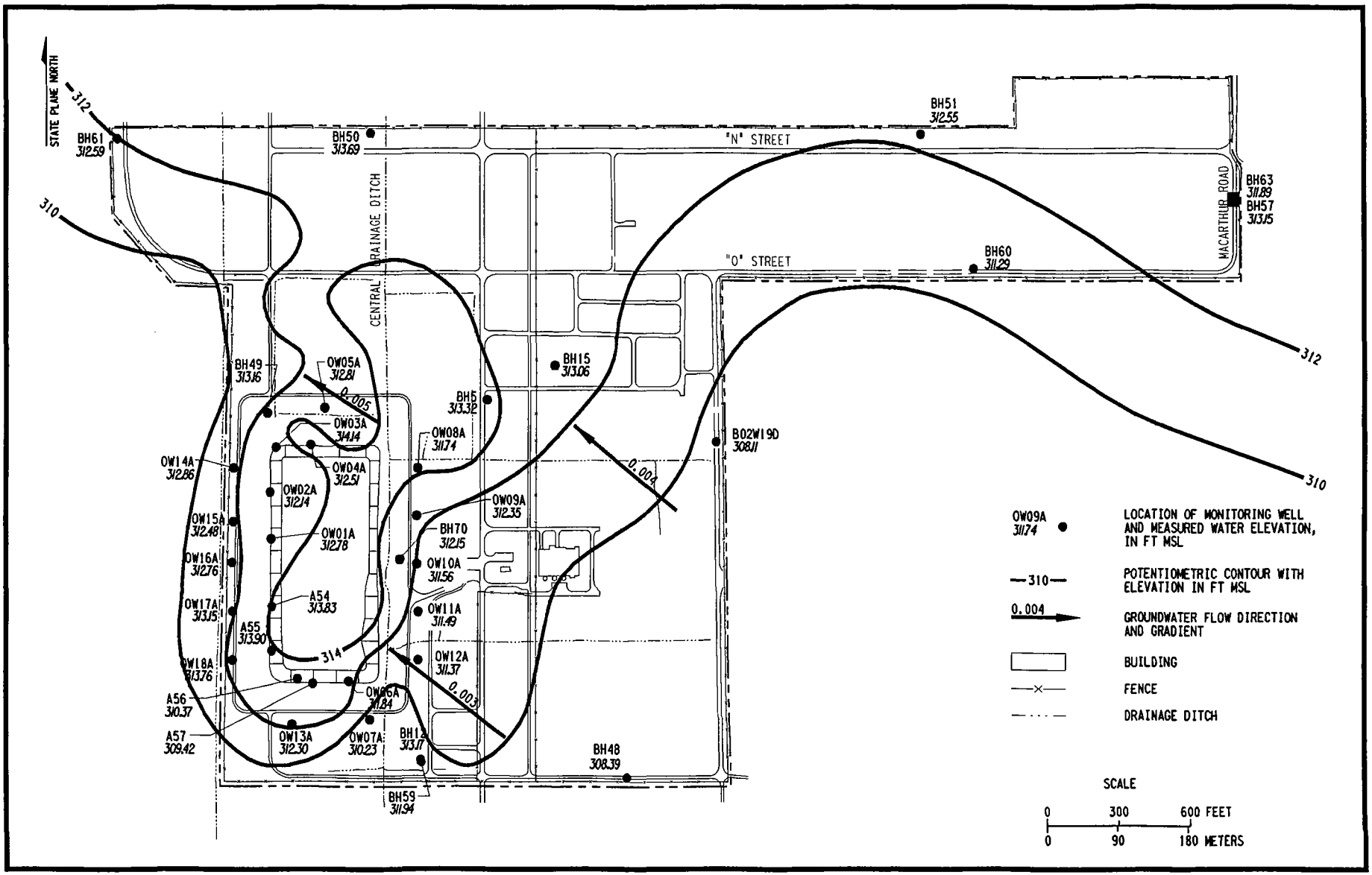

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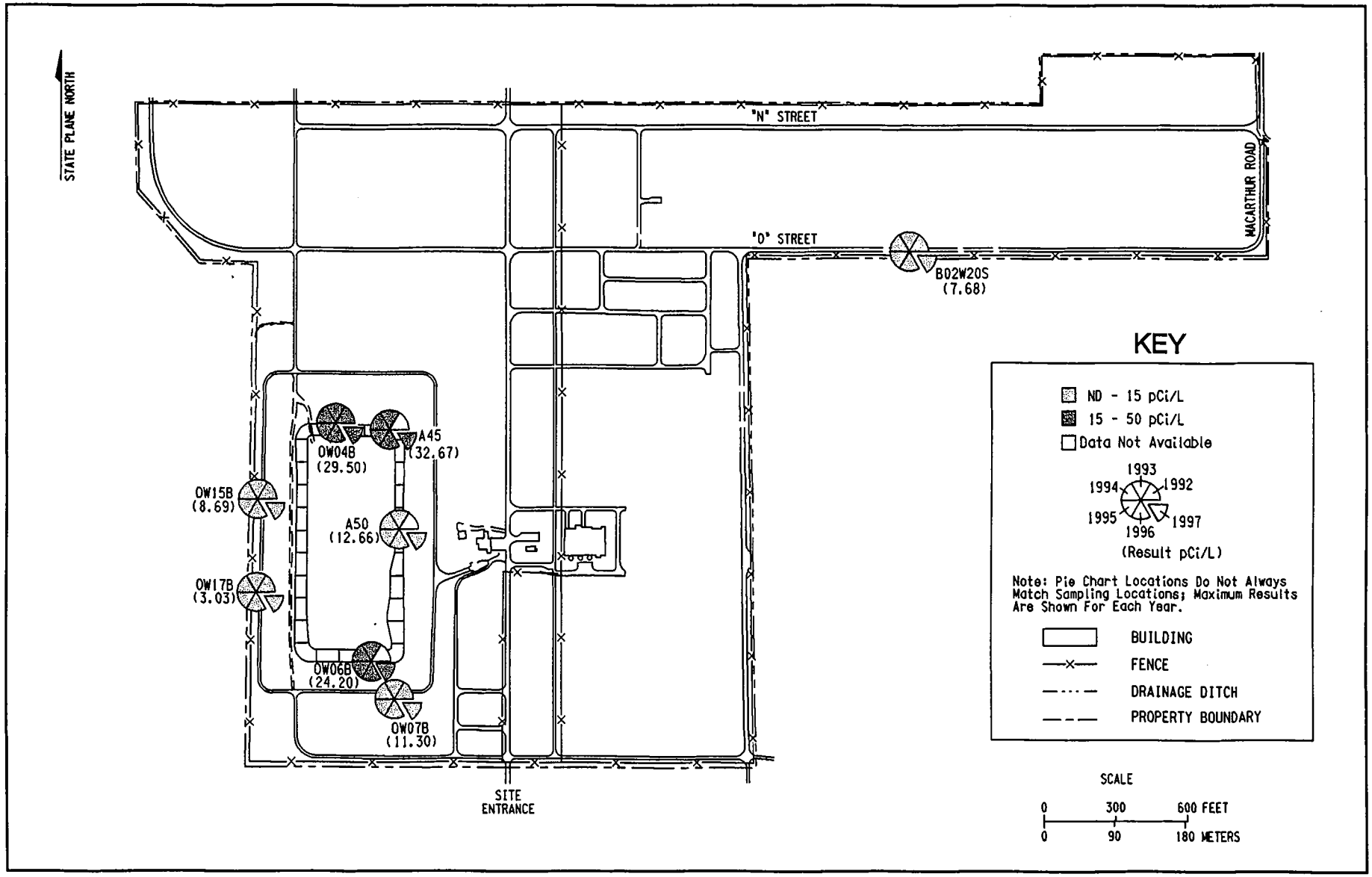
Figure 6
Potentiometric Surface Map (February 25,1998)
Lower Groundwater System



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2/27/97

Figure 7
Niagara Falls Storage Site Environmental Surveillance
Total Uranium Trend Results in Groundwater

Table 1
Environmental Surveillance Summary
External Gamma Radiation, Radon Gas, and Radon-222 Flux
Niagara Falls Storage Site

Measured Parameter	Station Identification	Number of Analyses or Measurements																								Total Analyses per Year
		No. of Sample Locations				Sample Duplicate				Ship Blank				Contingency Sample				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	
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 gas		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				Trip Blank				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																										
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 (List 1) [b]			8												1				1				1			11
GFAA Metals (List 2) [b]			8												1				1				1			11
Water Quality [b]			8												1				1				1			11

b. Table 11 includes analytical parameters for metals list 1 and 2. Table 8 lists water quality parameters.

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

Measured Parameter	Station Identification	Number of Analyses or Measurements																								Total Analyses per Year
		No. of Sample Locations				Rinsate Blank				Trip Blank				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																										
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

Table 2
1997 External Gamma Radiation Dose Rates
Niagara Falls Storage Site

Monitoring Location [b]		TETLD [a] Readings (mrem)	TETLD [a] Corrected [c] (mrem/yr)
NFSS	1	74.9	7.7
Perimeter	1	74.1	6.9
	7	59.7	-7.5
	7	65.4	-1.8
	11	66.8	-0.4
	11	66.5	-0.7
	12	76.3	9.1
	12	73.6	6.4
	13	70.7	3.5
	13	69.9	2.7
	15	78.9	11.7
	15	73.2	6.0
	28	77.6	10.4
	28	77.8	10.6
	29	69.0	1.8
	29	77.8	10.6
	36	73.8	6.6
	36	74.9	7.7
	122	75.8	8.6
	122	76.5	9.3
	123	72.9	5.7
	123	72.1	4.9
WCS [d]	8	73.6	6.4
Perimeter	8	75.2	8.0
	10	74.9	7.7
	10	76.7	9.5
	18	83.8	16.6
	18	78.5	11.3
	21	84.4	17.2
	21	70.5	3.3
	23	73.4	6.2
	23	72.3	5.1
	24	59.5	-7.7
	24	60.8	-6.4
Background [e]	105	65.2	
	105	69.2	
	Avg	*67.2*	

a. TETLD = Tissue-equivalent thermoluminescent dosimeter. There are two TETLDs per station, each containing five chips. Reported readings are the average chip reading per TETLD for the exposure period (355 days, from January 16 to January 6, 1998).
b. Monitoring locations are shown in Figure 2.
c. All TETLD readings are corrected for shelter/absorption factor (s/a = 1.075) and are normalized to exactly one year's exposure. Average corrected background is then subtracted from all other corrected readings
d. Monitoring locations along the perimeter of the waste containment structure (WCS).
e. To reduce redundancy, four of the original five background monitoring locations were deleted from the 1997 surveillance program.

Table 3
1997 Radon Gas [a] Concentrations
Niagara Falls Storage Site

Monitoring Location [b]		Average Daily Concentration (pCi/L) Start Date / End Date	01/16/97 [c] 07/07/97	07/07/97 [c] 01/6/98
NFSS	1		0.2*	0.2*
Perimeter	7		0.2*	0.2*
	11		0.2*	0.2*
	12		0.2*	0.2*
Duplicate [d]	12		0.2*	0.2*
	13		0.2*	0.2*
	15		0.2*	0.2*
	28		0.2*	0.2*
	29		0.2*	0.2*
	36		0.2*	0.2*
	122		0.2*	0.2*
	123		0.2*	0.2*
WCS [e]	8		0.2*	0.2*
Perimeter	10		0.2*	0.2*
	18		0.2*	0.2*
	21		0.2*	0.2*
	23		0.2*	0.2*
	24		0.2*	0.2*
Background [f]	105		0.2*	0.2*

a. Radon gas concentrations in 1997 were measured with RadTrack® detectors. These detectors measure the combined concentration of radon-220 and radon-222 in air.
b. Monitoring locations are shown in 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 evaluating precision in sampling and analysis.
e. Monitoring locations are at the perimeter of the waste containment structure (WCS).
f. To reduce redundancy, four of the original five background monitoring locations were deleted from the 1997 surveillance program.

Note: The DOE limit for radon-222 is 3.00 pCi/L.
(*) Indicates detection limit is reported. Actual result is less than this value.
1 pCi = 0.037 becquerel

Table 4
1997 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	0.09 ± 0.05	202-031	0.16 ± 0.04	202-061	0.03 ± 0.03
202-002	0.05 ± 0.05	202-032	0.43 ± 0.06	202-062	0.10 ± 0.05
202-003	0.05 ± 0.03	202-033	0.30 ± 0.06	202-063	0.09 ± 0.04
202-004	0.02 ± 0.03	202-034	0.06 ± 0.04	202-064	0.09 ± 0.05
202-005	0.01 ± 0.03	202-035	0.19 ± 0.04	202-065	0.41 ± 0.06
202-006	0.07 ± 0.05	202-036	0.06 ● 0.05	202-066	0.06 ± 0.04
202-007	0.06 ± 0.04	202-037	0.12 ± 0.03	202-067	0.07 ± 0.04
202-008	0.07 ± 0.06	202-038	0.24 ± 0.07	202-068	0.06 ± 0.04
202-009	0.04 ± 0.03	202-039	0.12 ± 0.03	202-069	0.10 ± 0.05
202-010	0.00 ± 0.03	202-040	0.05 ± 0.03	202-070	0.10 ± 0.03
Duplicate [b]	0.04 ± 0.03	Duplicate [b]	0.05 ± 0.04	Duplicate [b]	0.08 ± 0.05
202-011	0.03 ± 0.04	202-041	0.19 ± 0.04	202-071	0.17 ± 0.07
202-012	0.06 ± 0.04	202-042	0.08 ± 0.02	202-072	0.09 ± 0.05
202-013	0.08 ● 0.05	202-043	0.07 ± 0.04	202-073	0.00 ± 0.03
202-014	0.01 ± 0.03	202-044	0.14 ● 0.06	202-074	0.06 ± 0.04
202-015	0.11 ± 0.05	202-045	0.20 ± 0.04	202-075	0.02 ± 0.04
202-016	0.08 ± 0.04	202-046	0.08 ± 0.03	202-076	0.10 ± 0.03
202-017	0.20 ± 0.05	202-047	0.07 ± 0.04	202-077	0.02 ± 0.03
202-018	0.03 ± 0.03	202-048	0.42 ± 0.06	202-078	0.06 ± 0.04
202-019	0.06 ± 0.04	202-049	0.08 ± 0.04	202-079	0.05 ± 0.04
202-020	2.47 ± 0.15	202-050	0.08 ± 0.04	202-080	0.13 ± 0.06
Duplicate [b]	2.32 ± 0.14	Duplicate [b]	0.07 ± 0.04	Duplicate [b]	0.16 ± 0.07
202-021	0.08 ± 0.06	202-051	0.10 ± 0.03	202-081	0.14 ± 0.06
202-022	0.06 ± 0.03	202-052	0.06 ± 0.03	202-082	0.43 ± 0.06
202-023	0.13 ± 0.06	202-053	0.09 ± 0.06	202-083	0.14 ± 0.03
202-024	0.15 ± 0.04	202-054	0.11 ± 0.03	202-084	0.11 ± 0.05
202-025	0.07 ± 0.05	202-055	0.09 ± 0.05	202-085	0.08 ± 0.06
202-026	0.30 ± 0.05	202-056	0.12 ± 0.05	202-086	0.20 ± 0.07
202-027	0.03 ± 0.04	202-057	0.08 ± 0.05	202-087	0.07 ± 0.05
202-028	0.00 ± 0.03	202-058	0.03 ± 0.05	202-088	0.00 ± 0.03
202-029	0.08 ± 0.05	202-059	0.09 ± 0.06	202-089	0.03 ± 0.03
202-030	0.32 ± 0.05	202-060	0.02 ± 0.03	202-090	0.09 ● 0.06
Duplicate [b]	0.35 ± 0.05	Duplicate [b]	0.05 ± 0.03	Duplicate [b]	0.06 ± 0.05

Table 4
1997 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 ($pCi/m^2/s$)
202-091	0.04 ± 0.04	202-121	0.12 ± 0.03	202-151	0.16 ± 0.06
202-092	0.22 ± 0.05	202-122	0.02 ± 0.03	202-152	0.10 ± 0.07
202-093	0.02 ± 0.03	202-123	0.23 ± 0.04	202-153	0.30 ± 0.06
202-094	0.09 ± 0.08	202-124	0.11 ± 0.05	202-154	0.04 ± 0.04
202-095	0.07 ± 0.05	202-125	0.13 ± 0.04	202-155	0.01 ± 0.04
202-096	0.08 ± 0.05	202-126	0.14 ± 0.07	202-156	0.01 ± 0.02
202-097	0.05 ± 0.04	202-127	0.09 ± 0.03	202-157	0.11 ± 0.05
202-098	0.18 ± 0.05	202-128	0.00 ± 0.03	202-158	0.09 ± 0.04
202-099	0.67 ± 0.07	202-129	0.07 ± 0.05	202-159	0.05 ± 0.04
202-100	0.81 ± 0.09	202-130	0.07 ± 0.04	202-160	0.05 ± 0.04
Duplicate [b]	0.75 ± 0.09	Duplicate [b]	0.08 ± 0.05	Duplicate [b]	0.05 ± 0.05
202-101	0.11 ± 0.05	202-131	0.01 ± 0.05	202-161	0.10 ± 0.04
202-102	0.09 ± 0.07	202-132	0.07 ± 0.05	202-162	0.15 ± 0.04
202-103	0.13 ± 0.06	202-133	0.10 ± 0.05	202-163	0.11 ± 0.04
202-104	0.13 ± 0.06	202-134	0.09 ± 0.05	202-164	0.10 ± 0.04
202-105	0.01 ± 0.02	202-135	0.13 ± 0.06	202-165	0.15 ± 0.06
202-106	0.11 ± 0.06	202-136	0.24 ± 0.08	202-166	0.05 ± 0.04
202-107	0.24 ± 0.05	202-137	0.08 ± 0.05	202-167	0.09 ± 0.05
202-108	0.12 ± 0.03	202-138	0.09 ± 0.05	202-168	0.12 ± 0.06
202-109	0.04 ± 0.04	202-139	0.21 ● 0.05	202-169	0.10 ± 0.05
202-110	0.17 ± 0.05	202-140	0.00 ± 0.03	202-170	0.07 ± 0.04
Duplicate [b]	0.19 ± 0.07	Duplicate [b]	0.01 ± 0.03	Duplicate [b]	0.00 ± 0.02
202-111	0.09 ± 0.06	202-141	0.05 ± 0.04	202-171	0.10 ± 0.08
202-112	0.07 ± 0.05	202-142	0.12 ± 0.06	202-172	0.37 ± 0.06
202-113	0.05 ± 0.05	202-143	0.10 ± 0.06	202-173	0.22 ± 0.05
202-114	0.15 ± 0.07	202-144	0.26 ± 0.05	202-174	0.34 ± 0.06
202-115	0.06 ± 0.04	202-145	0.15 ± 0.06	202-175	0.28 ± 0.05
202-116	0.20 ● 0.04	202-146	0.03 ± 0.04	202-176	0.23 ± 0.05
202-117	0.33 ± 0.06	202-147	0.00 ± 0.04	202-177	0.30 ± 0.06
202-118	0.35 ± 0.06	202-148	0.08 ± 0.05	202-178	0.25 ± 0.05
202-119	0.23 ± 0.05	202-149	0.11 ± 0.05	202-179	0.13 ± 0.06
202-120	0.07 ± 0.05	202-150	0.07 ± 0.06	202-180	0.09 ± 0.05
Duplicate [b]	0.08 ± 0.05	Duplicate [b]	0.08 ± 0.05	Duplicate [b]	0.11 ± 0.08

Note: The EPA standard for radon-222 flux is 20 $pCi/m^2/s$.

a. Radon-222 flux monitoring was performed from September 24 and 25, 1997.

b. Every tenth canister is counted twice in the laboratory as a quality control (QC) duplicate to evaluate analytical precision.

Table 5
1997 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)	DCG [d] (pCi/L)
SWSD009	04/30/97	Radium-226	0.10 ± 0.12		0.50	100
Background	04/30/97	Radium-228	0.04 ± 0.09		0.50	100
	04/30/97	Thorium-230	0.22 ± 0.20		0.50	300
	04/30/97	Thorium-232	0.12 ± 0.00		0.50	50
	04/30/97	Total uranium	2.77 ± 0.06		0.03	600
SWSD021	04/30/97	Radium-226	0.15 ± 0.13		0.50	100
Background	04/30/97	Radium-228	0.14 ± 0.13		0.50	100
	04/30/97	Thorium-230	0.19 ± 0.15		0.50	300
	04/30/97	Thorium-232	0.06 ± 0.08		0.50	50
	04/30/97	Total uranium	10.50 ± 0.68		0.03	600
SWSD010	04/30/97	Radium-226	0.15 ± 0.15		0.50	100
	04/30/97	Radium-228	0.10 ± 0.12		0.50	100
	04/30/97	Thorium-230	0.34 ± 0.22		0.50	300
	04/30/97	Thorium-232	0.10 ± 0.12		0.50	50
	04/30/97	Total uranium	5.45 ± 0.12		0.03	600
SWSD011	04/30/97	Radium-226	0.08 ± 0.11		0.50	100
	04/30/97	Radium-228	0.27 ± 0.21		0.50	100
	04/30/97	Thorium-230	0.35 ± 0.24		0.50	300
	04/30/97	Thorium-232	0.04 ± 0.08		0.50	50
	04/30/97	Total uranium	8.04 ± 0.51		0.03	600
SWSD022	04/30/97	Radium-226	0.17 ± 0.14		0.50	100
	04/30/97	Radium-228	0.18 ± 0.21		0.50	100
	04/30/97	Thorium-230	0.29 ± 0.27		0.50	300
	04/30/97	Thorium-232	0.38 ± 0.00		0.50	50
	04/30/97	Total uranium	7.47 ± 0.16		0.03	600
Duplicate [e]	04/30/97	Radium-226	0.33 ± 0.22		0.50	100
	04/30/97	Radium-228	0.04 ± 0.08		0.50	100
	04/30/97	Thorium-230	0.04 ± 0.08		0.50	300
	04/30/97	Thorium-232	0.04 ± 0.08		0.50	50
	04/30/97	Total uranium	7.14 ± 0.16		0.03	600

a. Results reported with (±) radiological error quoted at 2 sigma (95 percent confidence level).
b. Bechtel National, Inc. data qualifier flags: None.
c. Minimum detectable activity.
d. DOE derived concentration guide for water.
e. A quality control duplicate is collected at the same time and location and is analyzed by the same method for evaluating precision in sampling and analysis.

Table 6
1997 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)	Cleanup Criteria [d] (pCi/G)
SWSD009	04/30/97	Radium-226	0.41 ± 0.17		0.50	5
Background	04/30/97	Radium-228	1.13 ± 0.48		0.50	5
	04/30/97	Thorium-230	1.75 ± 0.62		0.50	5
	04/30/97	Thorium-232	1.39 ± 0.54		0.50	5
	04/30/97	Total uranium	2.27 ± 0.08		0.10	90 [e]
SWSD021	04/30/97	Radium-226	0.34 ± 0.16		0.50	5
Background	04/30/97	Radium-228	1.30 ± 0.44		0.50	5
	04/30/97	Thorium-230	1.86 ± 0.56		0.50	5
	04/30/97	Thorium-232	1.27 ± 0.43		0.50	5
	04/30/97	Total uranium	2.23 ± 0.07		0.10	90 [e]
SWSD010	04/30/97	Radium-226	0.17 ± 0.10		0.50	5
	04/30/97	Radium-228	1.39 ± 0.47		0.50	5
	04/30/97	Thorium-230	2.30 ± 0.66		0.50	5
	04/30/97	Thorium-232	1.57 ± 0.51		0.50	5
	04/30/97	Total uranium	1.89 ± 0.06		0.10	90 [e]
SWSD011	04/30/97	Radium-226	0.44 ± 0.22		0.50	5
	04/30/97	Radium-228	1.34 ± 0.40		0.50	5
	04/30/97	Thorium-230	2.17 ± 0.56		0.50	5
	04/30/97	Thorium-232	1.22 ± 0.38		0.50	5
	04/30/97	Total uranium	2.39 ± 0.09		0.10	90 [e]
SWSD022	04/30/97	Radium-226	0.39 ± 0.21		0.50	5
	04/30/97	Radium-228	1.10 ± 0.36		0.50	5
	04/30/97	Thorium-230	1.53 ± 0.44		0.50	5
	04/30/97	Thorium-232	1.34 ± 0.40		0.50	5
	04/30/97	Total uranium	1.85 ± 0.07		0.10	90 [e]
Duplicate [f]	04/30/97	Radium-226	0.42 ± 0.18		0.50	5
	04/30/97	Radium-228	1.05 ± 0.32		0.50	5
	04/30/97	Thorium-230	1.59 ± 0.42		0.50	5
	04/30/97	Thorium-232	1.18 ± 0.35		0.50	5
	04/30/97	Total uranium	1.75 ± 0.08		0.10	90 [e]

a. Results reported with (±) radiological error quoted at 2 sigma (95 percent confidence level).
b. Bechtel National, Inc. data qualifier flags: None.
c. Minimum detectable activity.
d. DOE surface 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 as a basis for camparison of sediment results.
e. NFSS site-specific cleanup criterion for total uranium.
f. A quality control duplicate is collected at the same time and location and is analyzed by the same method for evaluating precision in sampling and analysis.

Table 7
1997 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	04/29/97	9.65	6.82	1.745	2.86	237	7.1	2.0	0.08
A50	04/28/97	9.27	7.15	1.749	4.40	257	14.4	2.0	0.08
OW04B	04/29/97	8.10	7.11	1.346	1.59	266	273	2.25	0.08
OW06B	04/29/97	12.34	6.86	0.909	2.44	235	20.2	3.0	0.12
OW07B	04/28/97	7.36	7.12	1.981	4.97	353	19.4	1.60	0.15
OW15B	04/29/97	8.33	7.18	1.241	4.41	266	13.8	2.50	0.06
OW17B	04/29/97	9.10	7.90	1.466	2.64	265	16.7	1.75	0.05
B02W20S	04/30/97	8.91	7.43	1.077	2.20	323	---[g]	2.75	0.06
SURFACE WATER									
SWSD009	04/30/97	12.29	8.20	1.047	7.83	435	63	--[h]	--
SWSD010	04/30/97	11.86	7.70	1.273	7.52	422	74	--	--
SWSD011	04/30/97	9.70	7.88	1.651	9.61	371	4.4	--	--
SWSD021	04/30/97	13.53	7.69	1.036	10.51	429	50	--	--
SWSD022	04/30/97	12.21	7.89	414	---[g]	414	5.2	--	--

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. --- Measurement not valid.

h. -- Parameter not applicable.

Table 8
1997 Groundwater Quality Results
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result (mg/L)	Data Qualifiers [a] BNI	Data Qualifiers [a] Lab	Reporting Limit (mg/L)	Related Regulations [b] Federal [c] (mg/L)	Related Regulations [b] State [d] (mg/L)
B02W20S	04/30/97	Alkalinity	398			4	NE	NE
Background	04/30/97	Bicarbonate	398			4	NE	NE
	04/30/97	Calcium	71.2			0.021	NE	NE
	04/30/97	Carbonate	4		U	4	NE	NE
	04/30/97	Chloride	5.8			0.25	250	250
	04/30/97	Magnesium	115			0.0096	NE	NE
	04/30/97	Nitrate, as N	0.08			0.02	10	10
	04/30/97	Nitrite	0.02		U	0.02	1	10
	04/30/97	Phosphate	0.052			0.050	NE	NE
	04/30/97	Potassium	1.67			0.024	NE	NE
	04/30/97	Sodium	40.4			0.005	NE	20
	04/30/97	Sulfate	258			50	NE	250
	04/30/97	Total dissolved solids	791			5	500	500
A45	04/29/97	Alkalinity	439			4	NE	NE
	04/29/97	Bicarbonate	439			4	NE	NE
	04/29/97	Calcium	269			0.021	NE	NE
	04/29/97	Carbonate	4		U	4	NE	NE
	04/29/97	Chloride	69.6			5	250	250
	04/29/97	Magnesium	149			0.0096	NE	NE
	04/29/97	Nitrate, as N	0.06			0.02	10	10
	04/29/97	Nitrite	0.02		U	0.02	1	10
	04/29/97	Phosphate	0.05		U	0.05	NE	NE
	04/29/97	Potassium	5.69			0.024	NE	NE
	04/29/97	Sodium	48.8			0.005	NE	20
	04/29/97	Sulfate	817			125	NE	250
	04/29/97	Total dissolved solids	1700			5	500	500
Duplicate [e]	04/29/97	Alkalinity	412			4	NE	NE
	04/29/97	Bicarbonate	412			4	NE	NE
	04/29/97	Calcium	265			0.021	NE	NE
	04/29/97	Carbonate	4		U	4	NE	NE
	04/29/97	Chloride	82.3			5	250	250
	04/29/97	Magnesium	147			0.0096	NE	NE
	04/29/97	Nitrate, as N	0.05			0.02	10	10
	04/29/97	Nitrite	0.02		U	0.02	1	10
	04/29/97	Phosphate	0.05		U	0.05	NE	NE
	04/29/97	Potassium	6.05			0.024	NE	NE
	04/29/97	Sodium	48.1			0.005	NE	20
	04/29/97	Sulfate	801			125	NE	250
	04/29/97	Total dissolved solids	1760			5	500	500

Table 8
1997 Groundwater Quality Results
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result (mg/L)	Data Qualifiers[a] BNI	Data Qualifiers[a] Lab	Reporting Limit (mg/L)	Related Regulations[b] Federal[c] (mg/L)	Related Regulations[b] State[d] (mg/L)
A50	04/29/97	Calcium	121			0.021	NE	NE
	04/29/97	Magnesium	148			0.0096	NE	NE
	04/29/97	Potassium	1.85			0.024	NE	NE
	04/29/97	Sodium	71.9			0.005	NE	20
OW04B	04/29/97	Calcium	175			0.021	NE	NE
	04/29/97	Magnesium	139			0.0096	NE	NE
	04/29/97	Potassium	4.26			0.024	NE	NE
	04/29/97	Sodium	56.3			0.005	NE	20
OW06B	04/29/97	Alkalinity	685			4	NE	NE
	04/29/97	Bicarbonate	685			4	NE	NE
	04/29/97	Calcium	144			0.021	NE	NE
	04/29/97	Carbonate	4		U	4	NE	NE
	04/29/97	Chloride	50.5			5	250	250
	04/29/97	Magnesium	227			0.0096	NE	NE
	04/29/97	Nitrate, as N	0.13			0.02	10	10
	04/29/97	Nitrite	0.02		U	0.02	1	10
	04/29/97	Phosphate	0.05		U	0.05	NE	NE
	04/29/97	Potassium	3.95			0.024	NE	NE
	04/29/97	Sodium	64.4			0.005	NE	20
	04/29/97	Sulfate	614			125	NE	250
	04/29/97	Total dissolved solids	1560			5	500	500
OW07B	04/29/97	Calcium	118			0.021	NE	NE
	04/29/97	Magnesium	185			0.0096	NE	NE
	04/29/97	Potassium	3.57			0.024	NE	NE
	04/29/97	Sodium	63.7			0.005	NE	20
OW15B	04/29/97	Alkalinity	447			4	NE	NE
	04/29/97	Bicarbonate	447			4	NE	NE
	04/29/97	Calcium	96.9			0.021	NE	NE
	04/29/97	Carbonate	4		U	4	NE	NE
	04/29/97	Chloride	10			5	250	250
	04/29/97	Magnesium	154			0.0096	NE	NE
	04/29/97	Nitrate, as N	0.02		U	0.02	10	10
	04/29/97	Nitrite	0.02		U	0.02	1	10
	04/29/97	Phosphate	0.092			0.05	NE	NE
	04/29/97	Potassium	1.47			0.024	NE	NE
	04/29/97	Sodium	67			0.005	NE	20
	04/29/97	Sulfate	135			125	NE	250
	04/29/97	Total dissolved solids	1250			5	500	500

Table 8
1997 Groundwater Quality Results
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result (mg/L)	Data Qualifiers [a] BNI	Data Qualifiers [a] Lab	Reporting Limit (mg/L)	Related Regulations [b] Federal [c] (mg/L)	Related Regulations [b] State [d] (mg/L)
OW17B	04/29/97	Calcium	43.8			0.021	NE	NE
	04/29/97	Magnesium	147			0.0096	NE	NE
	04/29/97	Potassium	2.37			0.024	NE	NE
	04/29/97	Sodium	67			0.005	NE	20

a. Bechtel National, Inc. (BNI) and laboratory data qualifier flags:
U = The analyte was not detected. The sample quantitation 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 (February 1996).

d. Water Quality Criteria (class GA) per 6 NYCRR, Part 703.

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

Table 9
1997 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)	DCG [d] (pCi/L)
B02W20S	04/30/97	Radium-226	0.03 ± 0.05		0.50	100
Background	04/30/97	Radium-228	0.09 ± 0.11		0.50	100
	04/30/97	Thorium-230	0.37 ± 0.22		0.50	300
	04/30/97	Thorium-232	0.14 ± 0.00		0.50	50
	04/30/97	Total uranium	7.68 ± 0.51		0.02	600
A45	04/29/97	Radium-226	0.08 ± 0.07		0.50	100
	04/29/97	Radium-228	0.06 ± 0.11		0.50	100
	04/29/97	Thorium-230	0.28 ± 0.26		0.50	300
	04/29/97	Thorium-232	0.30 ± 0.00		0.50	50
	04/29/97	Total uranium	32.67 ± 2.09		0.02	600
Duplicate [e]	04/29/97	Radium-226	0.14 ± 0.10		0.50	100
	04/29/97	Radium-228	0.09 ± 0.10		0.50	100
	04/29/97	Thorium-230	0.17 ± 0.14		0.50	300
	04/29/97	Thorium-232	0.08 ± 0.00		0.50	50
	04/29/97	Total uranium	31.03 ± 1.97		0.02	600
A50	04/29/97	Radium-226	0.07 ± 0.07		0.50	100
	04/29/97	Radium-228	0.03 ± 0.06		0.50	100
	04/29/97	Thorium-230	0.31 ± 0.20		0.50	300
	04/29/97	Thorium-232	0.18 ± 0.00		0.50	50
	04/29/97	Total uranium	12.66 ± 0.82		0.02	600
OW04B	04/29/97	Radium-226	0.14 ± 0.10		0.50	100
	04/29/97	Radium-228	0.05 ± 0.07		0.50	100
	04/29/97	Thorium-230	0.34 ± 0.20		0.50	300
	04/29/97	Thorium-232	0.03 ± 0.05		0.50	50
	04/29/97	Total uranium	29.50 ± 1.89		0.02	600
OW06B	04/29/97	Radium-226	0.09 ± 0.08		0.50	100
	04/29/97	Radium-228	0.12 ± 0.17		0.50	100
	04/29/97	Thorium-230	0.27 ± 0.00		0.50	300
	04/29/97	Thorium-232	0.06 ± 0.12		0.50	50
	04/29/97	Total uranium	24.20 ± 1.54		0.02	600
OW07B	04/29/97	Radium-226	0.05 ± 0.06		0.50	100
	04/29/97	Radium-228	0.11 ± 0.11		0.50	100
	04/29/97	Thorium-230	0.24 ± 0.16		0.50	300
	04/29/97	Thorium-232	0.05 ± 0.08		0.50	50
	04/29/97	Total uranium	11.30 ± 0.73		0.02	600

Table 9
1997 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)	DCG [d] (pCi/L)
OW15B	04/29/97	Radium-226	0.08 ± 0.07		0.50	100
	04/29/97	Radium-228	0.26 ± 0.22		0.50	100
	04/29/97	Thorium-230	0.64 ± 0.35		0.50	300
	04/29/97	Thorium-232	0.12 ± 0.00		0.50	50
	04/29/97	Total uranium	8.69 ± 0.58		0.02	600
OW17B	04/29/97	Radium-226	0.11 ± 0.08		0.50	100
	04/29/97	Radium-228	0.08 ± 0.09		0.50	100
	04/29/97	Thorium-230	0.34 ± 0.20		0.50	300
	04/29/97	Thorium-232	0.07 ± 0.00		0.50	50
	04/29/97	Total uranium	3.03 ± 0.07		0.02	600

a. Results reported with (±) radiological error quoted at 2-sigma (95 percent confidence level).
b. Bechtel National, Inc. (BNI) data qualifier flags: None.
c. Minimum detectable activity.
d. DOE derived concentration guide for water.
e. A quality control duplicate is collected at the same time and location and is analyzed by the same method for evaluating precision of sampling and analysis.

Table 10
1997 Groundwater Analytical Results - Metals [a]
Niagara Falls Storage Site

Sampling Location	Date Collected	Analyte	Result (µg/L)	Data Qualifiers [a] BNI	Data Qualifiers [a] Lab	Reporting Limit (µg/L)	Related Regulations [b] Federal [c] (µg/L)	Related Regulations [b] State [d] (µg/L)
B02W20S	04/30/97	Copper	2.7			0.9	1300	200
Background	04/30/97	Lead	1.2	U		0.9	15	25
	04/30/97	Vanadium	8.8			4.9	NE	NE
A45	04/29/97	Copper	1.8			0.9	1300	200
	04/29/97	Lead	0.9		U	0.9	15	25
	04/29/97	Vanadium	21.2			4.9	NE	NE
Duplicate [e]	04/29/97	Copper	0.91			0.9	1300	200
	04/29/97	Lead	1.1	U		0.9	15	25
	04/29/97	Vanadium	23.7			4.9	NE	NE
A50	04/29/97	Copper	3.3			0.9	1300	200
	04/29/97	Lead	0.9		U	0.9	15	25
	04/29/97	Vanadium	11.8			4.9	NE	NE
OW04B	04/29/97	Copper	13.7			0.9	1300	200
	04/29/97	Lead	2	U		0.9	15	25
	04/29/97	Vanadium	22.7			4.9	NE	NE
OW06B	04/29/97	Copper	1.8			0.9	1300	200
	04/29/97	Lead	0.9		U	0.9	15	25
	04/29/97	Vanadium	10.9			4.9	NE	NE
OW07B	04/29/97	Copper	11.7			0.9	1300	200
	04/29/97	Lead	1.9	U		0.9	15	25
	04/29/97	Vanadium	12.3			4.9	NE	NE
OW15B	04/29/97	Copper	8.7			0.9	1300	200
	04/29/97	Lead	1.2	U		0.9	15	25
	04/29/97	Vanadium	11.4			4.9	NE	NE
OW17B	04/29/97	Copper	3.9			0.9	1300	200
	04/29/97	Lead	0.9		U	0.9	15	25
	04/29/97	Vanadium	6.8			4.9	NE	NE

a. Bechtel National, Inc. (BNI) and laboratory data qualifier flags:
U = The analyte was not detected. If flagged by the laboratory, the sample quantitation limit is reported. If flagged by BNI, the measured concentration in the sample was less than two times the concentration detected in the associated laboratory blank.

b. Regulations presented pertain to drinking water quality and are listed for comparison only. No drinking water supply is obtained from groundwater at NFSS.

c. Federal Safe Drinking Water Act maximum contaminant levels from EPA Drinking Water Regulations and Health Advisories (February 1996).

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

e. A quality control duplicate is collected at the same time and location and is analyzed by the same method for evaluating precision in sampling and analysis.