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COLONIE INTERIM STORAGE SITE
ENVIRONMENTAL REPORT FOR
CALENDAR YEAR 1989

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SUMMARY ASSESSMENT
ENVIRONMENTAL COMPLIANCE ACTIVITY
U.S. DEPARTMENT OF ENERGY
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM
COLONIE INTERIM STORAGE SITE

BACKGROUND AND OVERVIEW

To evaluate the environmental compliance record of the Colonie Interim Storage Site (CISS), managed as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), it is necessary to describe the history of the site relative to existing environmental regulations and programs.

The site was used by a manufacturer of wood products and as a brass foundry before National Lead (NL) Industries converted the plant to produce uranium products. This occurred in 1958 under a license issued by the U.S. Atomic Energy Commission, a predecessor of the Department of Energy (DOE). The plant produced shielding components, counterweights, and projectiles from depleted uranium. During its processing history the plant utilized depleted and enriched uranium and natural thorium. Several of these operations required electroplating, which was conducted using materials regulated under the Resource Conservation and Recovery Act (RCRA). In 1980 NL Industries obtained a RCRA Part A permit.

On February 15, 1980, the New York State Supreme Court issued a temporary order restraining NL Industries from operating because the facility emitted uranium compounds in airborne releases. The temporary restraining order was amended on May 12, 1980, to allow NL Industries to continue limited operation. The amended order also required the company to initiate an independent investigation to assess all adverse environmental effects to surrounding properties that could have resulted from airborne discharges of radioactive material from the plant.

The Colonie site was assigned to DOE as part of the decontamination research and development project authorized by Congress under the 1984 Energy and Water Appropriations Act. DOE placed responsibility for the site under its existing FUSRAP program.

In February 1984, the Secretary of Energy accepted an NL Industries offer to donate the land, buildings, and equipment at the Colonie site to DOE, including the radioactively contaminated wastes and residues on the property. The U.S. Army Corps of Engineers accepted the property on behalf of DOE on February 29, 1984, at which time the title was transferred to DOE. In 1985 DOE also acquired a portion of the Niagara Mohawk Power Corporation property that borders CISS on the north and northwest. Since 1984, CISS has been used for interim storage of waste materials removed by DOE from the vicinity properties because they were contaminated with low-level radioactivity.

During its history, the Colonie site has been subject to evolving federal and state environmental regulations. The following summary describes compliance requirements as they currently exist.

Clean Air Act (CAA) and National Emission Standards for Hazardous Air Pollutants (NESHAPs)

CISS does not have any state or federal air permits. As a non-operating facility, only Subpart H of NESHAPs is applicable. Subpart Q of NESHAPs does not apply to CISS, because calculations show that the waste does not contain radium-226 of sufficient concentration to emit radon-222 in excess of the standard. Compliance with the non-radon radionuclide standard in Subpart H will be determined by evaluating the site using a computer model (e.g., AIRDOS-PC) approved by the Environmental Protection Agency (EPA).

DOE Orders for Radionuclide Releases

Site releases must comply with specific DOE orders that place quantitative limits, called derived concentration guides (DCGs), and dose limits for radiological releases from DOE facilities. Results of environmental monitoring conducted in 1989 show that CISS is in compliance with DOE orders.

Clean Water Act (CWA)

CISS does not have any state or federal water permits and has only stormwater discharge. An environmental compliance assessment conducted by Oak Ridge National Laboratory (ORNL) in July 1989 found the site to be in compliance with the CWA. The amendments to the CWA in 1987 required EPA to promulgate regulations requiring permits for stormwater discharges from industrial facilities; therefore, a stormwater discharge permit may be required in the future.

RCRA

CISS has a RCRA Part A interim status permit for containment storage of hazardous electroplating wastes (F006 - F009) and characteristic hazardous wastes that are the result of past NL operations. An EPA inspection on December 29, 1988, did not result in any violations. However, an environmental compliance assessment conducted by ORNL in July 1989 found 12 Best Management Practice deficiencies. All but one of the deficiencies have been resolved; the remaining deficiency involves revision of the RCRA closure plan for the site.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CISS is not on the National Priorities List. Remediation of this site will be managed under the authority of CERCLA because of

the presence of radionuclides. RCRA does not have the authority to direct corrective action for low-level radioactive material.

Toxic Substances Control Act (TSCA)

Polychlorinated biphenyl (PCB) capacitors and PCB-contaminated waste are present on the site as the result of past plant operations. The environmental compliance assessment of the site by ORNL revealed five deficiencies. All but one of the deficiencies have been resolved. The remaining deficiency involves the storage of these materials for longer than one year.

National Environmental Policy Act (NEPA)

In the past, compliance with NEPA has been accomplished through use of memoranda-to-file and an environmental assessment (EA). To date, 53 vicinity property removal actions have been determined to have had no significant impacts on the environment and have been documented by memoranda-to-file. Compliance with NEPA for site remedial actions is being accomplished by incorporating those elements required by an EA into the format of the CERCLA remedial investigation/feasibility study.

CURRENT ISSUES

A number of specific compliance issues have been identified as a result of the environmental compliance assessment conducted in July 1989. The significant issues are discussed below.

RCRA Closure Plan

Because the closure of the site cannot be fully addressed under RCRA, the need for revisions to the RCRA closure plan is unclear. Discussions with EPA and the New York State Department of Environmental Conservation (NYSDEC) regarding RCRA closure of the site will occur, and the issue will be resolved by October 1990.

Storage of PCBs for More Than One Year

The site is currently in compliance with TSCA, with one exception. TSCA-regulated materials have been stored for greater than one year. A limited amount of this waste is present on site, as a result of NL operations. Upon review of the analytical results from characterization of this material, appropriate disposal or management will be implemented by October 1990. Some of the material is radioactively contaminated and PCB-contaminated waste for which treatment and/or disposal options may be nonexistent and, therefore, may remain on site past October 1990.

ABSTRACT

During 1989, the fifth year of the environmental monitoring program was conducted at the Colonie Interim Storage Site (CISS), a U.S. Department of Energy (DOE) facility located in Colonie, New York. CISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to decontaminate or otherwise control sites where residual radioactive materials remain from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy. As part of the decontamination research and development project authorized by Congress under the 1984 Energy and Water Appropriations Act, remedial action is being conducted at the site and at vicinity properties by DOE through Bechtel National, Inc. (BNI), project management contractor for FUSRAP. The environmental monitoring program is also carried out by BNI.

The monitoring program at CISS measures external gamma radiation levels, total uranium, and radium-226 concentrations in surface water, groundwater, and sediment. Additionally, several nonradiological parameters are measured in groundwater. To verify that the site is in compliance with the DOE radiation protection standard (100 mrem/yr) and to assess the potential effect of the site on public health, the potential radiation dose was calculated for a hypothetical maximally exposed individual. Based on the conservative scenario described in the report, this hypothetical individual would receive an annual external exposure approximately equivalent to 2 percent of the DOE radiation protection standard. This is less than the exposure a person would receive during a round-trip flight from New York to Los Angeles (because of the greater amounts of cosmic radiation present at higher altitudes). The cumulative dose to the population within an 80-km (50-mi) radius of CISS that results from radioactive materials present at the site is indistinguishable from the dose the same population receives from naturally occurring radioactive sources.

Activities at CISS are controlled in part by an interim status permit issued pursuant to the Resource Conservation and Recovery Act (RCRA) for the management of a hazardous waste storage facility. The permit, Environmental Protection Agency (EPA) ID Number NYD002084721, was issued in 1980 to National Lead Industries for wastes generated from their electroplating operations. The RCRA program is implemented by EPA and the New York State Department of Environmental Conservation.

There are no radioactive airborne effluents resulting from ongoing commercial, industrial, or remedial activities at CISS that exceed DOE-derived concentration guidelines. Results of 1989 monitoring show that CISS is in compliance with the DOE radiation protection standard of 100 mrem/yr.

With completion of a series of on-site and off-site monitoring wells in 1988, the groundwater monitoring program was upgraded to include chemical sampling beginning in January 1989. Because this program has been in operation only one year, the information is considered baseline data.

Very few differences between contaminant concentrations in upgradient versus downgradient wells were noted. The data suggest that the site is not adding contamination to groundwater. Although well B39W019S (inside Bay 5) does exhibit a high concentration of zinc, the metal does not occur in similar concentration in either upgradient or downgradient wells, suggesting that the metal is not moving in groundwater.

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1.0 INTRODUCTION

In 1984, Congress assigned the cleanup of the National Lead (NL) Industries site in Colonie, New York, to the Department of Energy (DOE) as part of a decontamination research and development project under the 1984 Energy and Water Appropriations Act. DOE then included the site in the Formerly Utilized Sites Remedial Action Program (FUSRAP), an existing DOE program to decontaminate or otherwise control sites where residual radioactive materials remain from the early years of the nation's atomic energy program. DOE instituted an environmental monitoring program at the site in 1984. Results are presented annually in reports such as this. Under FUSRAP, the first environmental monitoring report for this site presented data for calendar year 1984. This report presents the findings of the environmental monitoring program conducted during calendar year 1989.

1.1 LOCATION AND DESCRIPTION

The former NL property, now known as the Colonie Interim Storage Site (CISS), is located at 1130 Central Avenue in the Town of Colonie, New York. It is approximately 6.4 km (4 mi) northwest of downtown Albany and about 4.8 km (3 mi) southeast of the Village of Colonie, as shown in Figure 1-1. CISS covers 4.5 ha (11.2 acres); it consists of the NL property and buildings where that company manufactured a variety of products using uranium, and approximately 0.8 ha (2 acres) of land northwest of the original property that was acquired by DOE from the Niagara Mohawk Power Corporation. Several vicinity properties were radioactively contaminated as a result of airborne releases of uranium compounds produced during operations at the plant. All vicinity properties except those adjacent to the site have been remediated. Although depleted uranium was used for most plant operations, small quantities of natural and enriched uranium and natural thorium were also used in selected manufacturing processes. The CISS property is shown in Figure 1-2. Figure 1-3 is an aerial photograph of the site.

FIGURE 1-1 LOCATION OF CISS

FIGURE 1-2 MAP OF CISS SHOWING INTERIM STORAGE AREA

FIGURE 1-3 AERIAL VIEW OF CISS

CISS is located within the Patroon Creek drainage basin, about 2.6 km (1.6 mi) east of Rensselaer Lake (Figure 1-4). Patroon Creek lies approximately 0.4 km (0.25 mi) south of the site. A small, unnamed stream enters the site from the northwest through a culvert and exits through another culvert on the south side of the site. After it passes under the Penn Central Railroad tracks, the stream reappears and empties into Patroon Creek.

The site is underlain by Ordovician-age shale of the Normanskill formation at a depth of about 45.7 to 60.9 m (150 to 200 ft). The bedrock is overlain by unconsolidated deposits of clay and silt (Ref. 1).

Groundwater in the vicinity of the site is available in small quantities from the bedrock aquifer and in moderate to large quantities from the unconsolidated deposits (Ref. 2). The groundwater table around the site ranged from about 0.6 to 4.9 m (2 to 16 ft) below the ground surface during borehole drilling in March 1981 (Ref. 3). Depths to water measured in wells installed during November 1984 ranged from 1.1 to 5.5 m (3.5 to 18 ft) below the ground surface (Ref. 4). Groundwater flows to the south in the CISS vicinity (Refs. 4 and 5).

The average annual daily maximum temperature for the Albany area is 14.2°C (57.6°F), and the average daily minimum is 2.7°C (36.8°F). The highest average monthly temperature is 28.4°C (83.2°F) (July), and the lowest is -11.2°C (11.9°F) (January). Average annual precipitation is 90.68 cm (35.7 in.), with average annual snowfall of 146.1 cm (57.5 in.). As shown in Figure 1-5, winds in the area blow predominantly from the south at a mean speed of 16 km/h (10 mph) (Ref. 6).

The residential population of the Town of Colonie is approximately 74,600. The 1980 population of the City of Albany was 101,727; that of Albany County was 285,909 (Ref. 7).

As shown in Figure 1-6, land use in the vicinity of CISS is primarily industrial and residential. The site and adjacent area are currently zoned as industrial by the Town of Colonie; the site and the Yardboro Avenue area are zoned for light industry by Albany County. Central Avenue is lined by numerous small

FIGURE 1-4 SURFACE WATER DRAINAGE IN THE CISS AREA

BASED ON AERIAL PHOTOGRAPHS, SITE VISITS AND USGS TOPOGRAPHIC MAP 1:24000 SCALE.
ALBANY NY QUADRANGLE (PHOTO REVISED 1982)

C	COMMERCIAL	G	GOVERNMENT
C/I	MIXED COMMERCIAL AND INDUSTRIAL	R	RESIDENTIAL
C/R	MIXED COMMERCIAL AND RESIDENTIAL	V	VACANT
E	EDUCATIONAL		

0 ————— 0.5 MI
0 ————— 0.8 KM

FIGURE 1-6 GENERALIZED LAND USE IN THE VICINITY OF CISS

businesses, but the area across Central Avenue from CISS is primarily residential and is zoned residential by the Town of Colonie (Ref. 7). To the northwest and west, the site is bordered by open land and an electrical substation owned by Niagara Mohawk Power Corporation. The southeastern and eastern boundaries adjoin various commercial properties. To the southwest and south, the facility is abutted by the Penn Central Railroad right-of-way.

1.2 SITE HISTORY

The NL Industries plant began producing uranium products in 1958 under a license issued by the U.S. Atomic Energy Commission (AEC), a predecessor of DOE. After the contract was terminated in 1968, plant production was limited to fabrication of shielding components, counterweights, and projectiles from depleted uranium. During its processing history the plant utilized depleted and enriched uranium and natural thorium.

On February 15, 1980, the New York State Supreme Court issued a temporary order restraining NL Industries from operating because the facility emitted uranium compounds in airborne releases. The temporary restraining order was amended on May 12, 1980, to allow NL Industries to continue limited operation. The amended order also required the company to initiate an independent investigation to assess all adverse environmental effects to surrounding properties that could have resulted from airborne discharges of radioactive materials from the plant. In 1980, Teledyne Isotopes was contracted by NL Industries to survey the radioactivity in the environs of the facility (Refs. 3 and 8).

The Colonie site was assigned to DOE as part of the decontamination research and development project authorized by Congress under the 1984 Energy and Water Appropriations Act. DOE placed responsibility for the site under its existing FUSRAP project.

In February 1984, the Secretary of Energy accepted an NL Industries offer to donate to DOE the land, buildings, and

equipment at the Colonie site, including the radioactively contaminated wastes and residues on the property. The U.S. Army Corps of Engineers accepted the property on behalf of DOE on February 29, 1984, at which time the title was transferred to DOE. In 1985 DOE also acquired a portion of the Niagara Mohawk Power Corporation property that borders CISS to the north and northwest.

Since 1984 CISS has been used for interim storage of waste materials contaminated with low-level radioactivity that were removed by DOE from the vicinity properties. The contaminated waste materials removed in 1984 include rocks and dirt, tar paper roofing material, grass and sod, surface material removed during the scabbling of asphalt, and crushed stone. Contaminated materials removed from vicinity properties during 1985 include gutters, topsoil and sod, crushed stone, and asphalt dust from scabbling operations. In 1988, work on removing contamination from off-site properties except those adjacent to the site and repairing the CISS building roof was completed. In total, 53 properties have been cleaned. The material removed from the properties remediated in 1988 consisted mainly of topsoil and sod. The excavated contaminated materials are stored temporarily in the former NL building until a permanent remedial action alternative is selected. Three properties adjacent to the CISS property will be cleaned when the site is remediated. Waste volume projections for Colonie are presented in Ref. 9.

Investigations of on-site contamination were conducted in 1988. This work consisted of drilling boreholes both inside and outside the building to determine the extent of vertical and horizontal contamination, walkover surveys to locate surface contamination, and installation of new monitoring wells to aid in determining the potential for contaminant migration. On-site investigations were completed in 1989. With the addition of new wells (1988), the 1989 monitoring program was revised to take advantage of the best available data. These revisions included removing some of the older wells from the program when adding a new one would provide better data. Chemical screening was also performed in all of the wells included in the 1989 program.

There are no continuing commercial, industrial, or remedial activities at CISS; therefore, there are no airborne radioactive effluents from the site, and waterborne radioactive effluents are limited to extremely low concentrations in surface drainage.

1.3 HYDROGEOLOGICAL CHARACTERISTICS OF THE SITE

CISS groundwater characteristics did not change in 1989 compared with those observed in previous monitoring years. New subsurface and water level data demonstrated that the upper sand is an unconfined aquifer, the lower sand is a semiconfined aquifer, and the two systems are connected.

The statistical data and interpretations presented here are based primarily on groundwater levels measured in calendar year 1989. The two groundwater systems monitored are designated "upper sand" and "lower sand" (Ref. 4). Groundwater monitoring wells (Figure 1-7) were installed at CISS by Bechtel National, Inc. (BNI) in late 1984 and in 1988 to supplement existing wells installed by NL (wells B-1, B-2, B-3, and B-4; (Ref. 4). Beginning in 1989, the NL wells were dropped from the monitoring program because the newly installed BNI wells provided the necessary coverage and their construction is better documented. In addition, the 1984 well numbering format was changed to be consistent with that of the 1988 wells and the wells at other FUSRAP sites (see Table 1-2). In addition to sequencing the wells, the new format identifies the drilling company, the site, the ultimate use intended for the well, and the relative depth. Site geology, hydrogeology, and well installation methods are documented in Ref. 4. A summary of well construction information is shown in Table 1-3. An example of well construction details is included in Appendix E.

Groundwater levels at the CISS site were measured with an electric downhole probe water level indicator. Water level measurements were taken for all wells at weekly intervals in 1989.

FIGURE 1-7 MONITORING WELL LOCATIONS

TABLE 1-1
NEW DESIGNATIONS FOR RENUMBERED CISS MONITORING WELLS

1984 Designation	New Designation
CISS-1	B39W08S
CISS-3	B39W08M
CISS-4	B39W01M
CISS-5	B30W01S
CISS-6	B39W05S
CISS-7	B39W18S
CISS-11	B39W15S

TABLE 1-2
MONITORING WELL CONSTRUCTION SUMMARY

Well Number	Completion Date	Total Depth [m (ft)]	Screened Interval Below Ground [m-m (ft-ft)]	Construction Material ^a
<u>Upper Sand</u>				
B39W01S	11/16/84	6.71 (22.0)	3.51-5.03 (11.5-16.5)	Schedule 40 PVC
B39W02S	7/28/88	7.62 (25.0)	5.49-7.01 (18.0-23.0)	316L SS flush-threaded
B39W05S	11/16/84	6.71 (22.0)	3.99-5.52 (13.1-18.1)	Schedule 40 PVC
B39W06S	8/22/88	3.87 (12.7)	2.1-3.63 (6.9-11.9)	316L SS flush-threaded
B39W07S	8/12/88	4.88 (16.0)	3.14-4.66 (10.3-15.3)	316L SS flush-threaded
B39W08S	11/07/84	4.27 (14.0)	1.8-3.35 (6.0-11.0)	Schedule 40 PVC
B39W09S	7/27/88	5.18 (17.0)	3.44-4.97 (11.3-16.3)	316L SS flush-threaded
B39W10S	8/15/88	4.88 (16.0)	2.2-3.69 (7.1-12.1)	316L SS flush-threaded
B39W14S	8/24/88	3.05 (10.0)	1.2-2.7 (4.0- 9.0)	316L SS flush-threaded
B39W15S	11/27/84	6.07 (19.9)	3.87-5.40 (12.7-17.7)	Schedule 40 PVC
B39W18S	11/19/84	6.10 (20.0)	3.72-5.24 (12.2-17.2)	Schedule 40 PVC
B39W19S	12/15/88	7.92 (26.0)	4.21-7.44 (13.8-24.4)	316L SS flush-threaded
<u>Lower Sand</u>				
B39W01M	11/15/84	14.3 (47.0)	10.5-12.0 (34.4-39.4)	Schedule 40 PVC
B39W02M	8/30/88	14.9 (49.0)	12.7-14.2 (41.7-46.7)	316L SS flush-threaded
B39W08M	11/13/84	13.0 (42.7)	10.9-12.4 (35.6-40.6)	Schedule 40 PVC
B39W10M	8/16/88	9.14 (30.0)	7.50-9.02 (24.6-29.6)	316L SS flush-threaded
B39W14M	8/23/88	8.33 (27.5)	6.15-7.68 (20.2-25.2)	316L SS flush-threaded
B39W18M	8/18/88	11.9 (39.0)	8.96-10.5 (29.4-34.4)	316L SS flush-threaded

^apvc - polyvinyl chloride; SS - stainless steel.

1.3.1 Upper Sand Groundwater System

The upper sand is an unconfined groundwater system with the exception of the area around well B39W14S, which is confined. The water table surface for the upper sand occurs in a zone 1.5 to 4.3 m (5 to 14 ft) below ground surface. (The water table--or potentiometric surface--is defined as the highest elevation to which water will rise in tightly cased wells. Delineation of the potentiometric surface of an aquifer indicates groundwater table slope and flow direction in homogeneous materials.) Upper sand wells are screened in unconsolidated sands at depths of 1.2 to 7.44 m (4 to 24.4 ft). Elevations of groundwater levels measured for each well (except B39W14S, which has artesian flow) are displayed as hydrographs (Figures 1-8 and 1-9). Precipitation records for CISS are presented graphically beneath the hydrographs.

Slope and flow direction for the upper sand groundwater system follow topography from north to south, draining toward Patroon Creek. The slope of the potentiometric surface is on the order of 0.02, essentially unchanged from the previous year. The contours shown in Figures 1-10 and 1-11 were derived from water levels measured during the seasonal high and low water table periods.

1.3.2 Lower Sand Groundwater System

The potentiometric surface of the semiconfined lower sand groundwater system is 1.8 to 5.5 m (6 to 18 ft) below ground surface. The BNI lower sand wells are screened at depths of 6.15 to 14.2 m (20.2 to 46.7 ft). Hydrographs of the lower sand groundwater system (Figure 1-12) show the same seasonal variation as water levels in the upper sand system. (No hydrograph is presented for B39W14M, which has artesian flow.) Precipitation records for CISS are shown graphically in Figure 1-12.

Slope and flow direction for the lower sand groundwater system, like those of the upper sand, follow topography and flow north to

FIGURE 1-8 HYDROGRAPHS OF WELLS B39W01S, B39W02S, B39W05S, B39W06S, B39W07S, AND B39W08S, UPPER SAND GROUNDWATER SYSTEM

FIGURE 1-9 HYDROGRAPHS OF WELLS B39W09S, B39W10S, B39W15S, B39W18S, AND B39W19S, UPPER SAND GROUNDWATER SYSTEM

FIGURE 1-10 UPPER SAND POTENTIOMETRIC SURFACE MAP (4/28/89)

FIGURE 1-11 UPPER SAND POTENTIOMETRIC SURFACE MAP (9/29/89)

139F 032, DCN 5

FIGURE 1-12 HYDROGRAPHS OF WELLS B39W01M, B39W02M, B39W08M, B39W10M, AND B39W18M, LOWER SAND GROUNDWATER SYSTEM

south with a slope on the order of 0.02. The slope and flow direction of the lower sand system were calculated using two potentiometric surface maps (Figures 1-13 and 1-14). Because of the similarity in water levels of the upper and lower sand systems during seasonal high and low periods, the same dates were used for both systems in preparing potentiometric surface maps. The apparent similarity between these two systems is discussed in Subsection 1.3.3.

1.3.3 Discussion of Data

Groundwater levels for both systems seem to be affected only slightly by site precipitation. The wells in the eastern part of the site are installed in grassy areas that experience surface recharge; those to the west are installed in concrete or asphalt and there is no surface recharge. This does not seem to make a difference in groundwater response to precipitation events, indicating that the groundwater systems reach equilibrium rapidly.

As reported in Ref. 10, the lower sand potentiometric surface is again 0.6 to 1.2 m (2 to 4 ft) below and generally parallel to the upper sand potentiometric surface. It was suggested that the upper clay layer that separates these systems is probably leaky (Refs. 4 and 10). This condition is clarified by borehole B39G12, drilled in 1988, where the upper clay layer is missing and the upper and lower sands are in direct contact (see cross section A-A', Figure 1-15). As of 1988, subsurface investigations had penetrated to 50.0 m (164 ft); a deeper groundwater system has not been identified.

1.3.4 Conclusions

CISS groundwater characteristics did not change in 1989 compared with those observed in previous monitoring years. New subsurface and water level data demonstrated that the upper sand is an unconfined aquifer, the lower sand is a semiconfined aquifer, and the two systems are connected.

FIGURE 1-15 SUBSURFACE PROFILE A - A'

2.0 SUMMARY OF MONITORING RESULTS

The environmental monitoring program consists of collecting and analyzing groundwater, surface water, and sediment samples and measuring external gamma radiation levels to verify compliance with the DOE radiation protection standard of 100 mrem/yr (Ref. 11). Based on these measurements, the external radiation dose was calculated to determine the degree of compliance with the radiation protection standard.

During 1989, average annual external radiation levels at the CISS property boundary ranged from background to 22 mrem/yr above background. The average background for the CISS area was 61 mrem/yr. External radiation levels are discussed in Subsection 3.1. There has been no overall trend in external gamma radiation levels measured since 1984 (see Subsection 3.6.1) (Refs. 12-15).

In surface water, the highest average concentrations of uranium and radium-226 were 1.35×10^{-7} $\mu\text{Ci/ml}$ (135 pCi/L) and 7×10^{-10} $\mu\text{Ci/ml}$ (0.7 pCi/L), respectively (see Subsection 3.2).

In groundwater (see Subsection 3.3), the highest average concentration of uranium was 5.5×10^{-9} $\mu\text{Ci/ml}$ (5.5 pCi/L). For radium-226, the highest average concentration was 1.6×10^{-9} $\mu\text{Ci/ml}$ (1.6 pCi/L). There has been no detectable trend in the concentrations of radionuclides in groundwater since 1985 (see Subsection 3.6.3) (Refs. 10 and 13-15). Concentrations of uranium and radium-226 measured in surface water and groundwater are below DOE-derived concentration guidelines.

Chemical analyses of well water detected a total of 14 organic pollutants and 13 metals at relatively low concentrations. Eleven of the organic pollutants and twelve of the metals were detected in upgradient wells reflecting the poor groundwater quality typical of regions with a long history of industrial activity.

In stream sediments, the highest average concentrations of total uranium and radium-226 were 9.1 and 0.6 pCi/g, respectively (see Subsection 3.4). Although DOE currently does not have

concentration guidelines for sediments, these concentrations are within DOE-derived concentration guidelines for soil.

Calculations were made of the potential radiation doses received by a hypothetical maximally exposed individual. This individual is one who is assumed, when all potential routes of exposure are considered, to receive the greatest dose. Review of potential exposure pathways indicates that the only plausibly significant pathway involves exposure to external gamma radiation at the CISS boundary. Other potential pathways of exposure were not factored into the calculations because monitoring data indicate that contributions from them would be negligible. The calculated exposure to the maximally exposed individual at CISS from this pathway was 2 mrem/yr above background. This exposure is approximately equivalent to 2 percent of the DOE radiation protection standard. The cumulative dose to the population within an 80-km (50-mi) radius of CISS that would result from radioactive materials present at the site would be indistinguishable from the dose the same population would receive from naturally occurring radioactive sources (see Subsection 3.5.2). Results of 1989 monitoring show that CISS is in compliance with the DOE radiation protection standard.

3.0 DATA COLLECTION, ANALYSIS, AND EVALUATION

This section provides a description of the sampling, monitoring, and analytical procedures used and the results of environmental monitoring activities at CISS during 1989. Calculations were made to determine the estimated maximum possible radiation dose based on environmental conditions, measurements recorded, and evaluation of potential exposure pathways.

Data are presented in summary tables that include number of data points collected, and minimum, maximum, and average values.

Individual sources of error (e.g., analytical error or sampling error) were not estimated. The "less than" notation (<) is used to denote specific sample analysis results that are below the limit of sensitivity of the analytical method, based on a statistical analysis of parameters. When computing annual averages, quarterly values reported as less than a given limit of sensitivity (detection limit) are considered equal to that limit of sensitivity. In previous environmental monitoring reports, when two or more such values were involved in calculating an annual average, the reported value carried the "less than" notation. This year, because limits of sensitivity varied from quarter to quarter, an increasing number of results are at or below the limit of sensitivity, and because data error terms are not reported, a more conservative method of computing annual averages is being employed. Annual averages carry the "less than" notation only if all of the quarterly values involved in the calculation were less than the limit of sensitivity.

During 1989, the routine environmental monitoring program for CISS included external gamma radiation measurements and measurement of radionuclide concentrations in surface water, sediment, and groundwater.

Tables are provided in Subsection 3.6 to show trends in external gamma radiation levels as well as in radionuclide concentrations in surface water and groundwater at CISS. These tables list annual averages for each monitoring location for 1985

through 1989 to allow for comparisons of data and identification of trends in monitoring results.

3.1 EXTERNAL GAMMA RADIATION

Before 1988, external gamma radiation levels were measured at 11 on-site monitoring stations and 1 off-site station. Three additional off-site stations were added to the program in March 1988. Ten of the 11 on-site stations are spaced at approximately equal intervals along the site boundary, and the eleventh is within the site (Figure 3-1). The other four are background monitoring stations whose locations are identified in Table 3-1.

External gamma radiation levels are measured using lithium fluoride thermoluminescent dosimeters (TLDs). Since 1988, the system of measurement for external gamma radiation has utilized tissue-equivalent dosimeters to provide values that are more realistic in terms of radiation dose to tissues of the body at a depth of 1 cm. Each monitoring station contains a minimum of four dosimeters, which are exchanged after approximately one year of accumulated exposure. For example, a dosimeter placed in the station in October 1988 would be removed in October 1989 and replaced with a new dosimeter. Each dosimeter contains five individual lithium fluoride chips (each group of five chips is preselected on the basis of having a reproducibility of ± 3 percent across a series of laboratory exposures), the responses of which are averaged. Analysis is performed by Thermo Analytical/Eberline (TMA/E). The average value is then corrected for the shielding effect of the shelter housing (approximately 8 percent). The corrected value is then converted to millirem per year by dividing by the number of days of exposure and subsequently multiplying by 365 days.

Because the current measurement system allows for dosimeter detection intervals of approximately a year versus the 3-month interval previously used, the current system is more sensitive to

FIGURE 3-1 ON-SITE EXTERNAL GAMMA RADIATION MONITORING STATIONS AT CISS

low radiation levels. Although the tissue-equivalent TLDs used are "state-of-the-art," one should keep in mind when examining the external gamma radiation results that the dosimeter accuracy is approximately ± 10 percent at levels from 100 mrem/yr to 1 rem/yr and ± 25 percent at radiation levels around 70 mrem/yr.

The results of external gamma radiation monitoring are presented in Table 3-1. For each quarter, an average of the background levels measured was subtracted from the site boundary station measurements to provide an estimate of radiation levels resulting from residual materials at the site. The highest annual average external gamma radiation level at CISS in 1989 was 22 mrem/yr above background at station 12, inside the CISS enclosure. The highest annual average external gamma radiation level at the boundary was 21 mrem/yr above background at station 4. The reading at station 4 was used for calculation of dose to the maximally exposed individual because it is a boundary reading. Because the area adjacent to the site is occupied by a railroad line, a highly conservative occupancy factor of 14 h/week, 52 weeks/yr was used to estimate the impact of this exposure rate. On this basis, the exposure to an individual on this property would be approximately 2 mrem/yr.

The background external gamma radiation value for a given station is not constant. Because the background value is a combination of both natural terrestrial sources and cosmic radiation sources, factors such as the location of the detector in relation to surface rock outcrops, stone or concrete structures, or highly mineralized soil can affect the value measured. Independent of the placement of the detector are the factors of site altitude, annual barometric pressure cycles, and the occurrence and frequency of solar flare activity (Ref. 16).

Because of these factors, the background radiation level is not constant from one location to another even over a short time. Thus it is not abnormal for some stations at the boundary of a site to have an external gamma radiation value less than the background level measured some distance from the site.

TABLE 3-1
EXTERNAL GAMMA RADIATION LEVELS AT CISS, 1989

Sampling Station ^a	Number of Measurements	Radiation Level (mrem/yr) ^b		
		Minimum	Maximum	Average
1	4	- ^c	8	4
2	4	- ^c	7	2
3	4	5	13	9
4	4	16	24	21
5	4	15	26	19
6	4	- ^c	<1	- ^c
7	4	- ^c	12	5
8	4	3	11	8
9	4	- ^c	3	1
10	4	- ^c	5	1
12	4	12	28	22
<u>Background</u>				
11 ^d	4	50	62	56
13 ^e	4	59	80	71
14 ^f	4	55	72	64
15 ^g	3 ^h	47	57	52

^aLocations of sampling stations are shown in Figure 3-1.

^bMeasured background has been subtracted.

^cMeasurement was less than or equal to the measured background level.

^dStation 11 is at Fuller Place, Albany, NY, approximately 9.7 km (6 mi) northwest of CISS.

^eStation 13 is at the Colonie Town Hall, approximately 4.8 km (3 mi) north-northwest of CISS.

^fStation 14 is at the Albany County Airport, approximately 8 km (5 mi) north of CISS.

^gStation 15 is at the Colonie Fire Station, approximately 6 km (3.75 mi) north-northwest of CISS.

^hNo data available from this station for the first quarter of the year.

In April 1988, additional background monitoring stations were established at the Albany County Airport, the Colonie Town Hall, and the Colonie Fire Station. Because of the measurement system operating parameters, the 6 months of exposure time on the TLDs was not representative of yearly fluctuations in background that occur because of seasonal weather variations. Data from these locations, therefore, could not be presented in the 1988 environmental report but are presented here.

For comparisons of external gamma radiation levels measured from 1985 through 1989, see Subsection 3.6.1.

3.2 SURFACE WATER SAMPLING

During 1989, quarterly sampling was performed to determine the concentrations of total uranium and radium-226 in surface water at both on-site and off-site locations.

Surface water samples were collected quarterly from four off-site and two on-site locations (Figure 3-2). Two of these sampling locations (2 and 3) are downstream of the CISS to enable the effect of runoff from the site on surface waters in the vicinity to be determined. Location 4 is upstream.

Nominal 1-L (0.26-gal) grab samples were collected to fill a 3.8-L (1.0-gal) container and were analyzed by TMA/E. The concentration of total uranium was determined by a fluorometric method. Radium-226 concentrations in water were determined by radon emanation. (The method for detecting radon consists of precipitating radium-226 as sulfate and transferring the treated sulfate to a radon bubbler, where the radon-222 is allowed to come to equilibrium with its radium-226 parent. The radon-222 is then withdrawn into a scintillation cell and counted by the gross alpha technique. The quantity of radon-222 detected in this manner is directly proportional to the quantity of radium-226 originally present in the sample.)

FIGURE 3-2 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS AT CISS

Analytical results for surface water samples are presented in Table 3-2. The annual average concentrations of total uranium ranged from $<5 \times 10^{-9}$ to 1.35×10^{-7} $\mu\text{Ci/ml}$ (<5 to 135 pCi/L). The annual average concentrations of radium-226 ranged from 5 to 7×10^{-10} $\mu\text{Ci/ml}$ (0.5 to 0.7 pCi/L). The highest annual averages for both analytes came from sampling location 1, which is in an area of known contamination. There is no evidence that the contamination is migrating, and the area will be remediated in the near future. Except for location 1, uranium concentrations are close to background levels and radium-226 concentrations are essentially equal to background levels. Maximum annual average concentrations of both analytes are less than DOE-derived concentration guidelines.

For comparisons of radionuclide concentrations measured in surface water from 1985 through 1989, see Subsection 3.5.2.

3.3 GROUNDWATER SAMPLING

In 1989, groundwater samples were collected quarterly from 10 on-site and off-site wells installed as part of hydrogeologic investigations conducted at the site in 1984 and 1988 (Ref. 4). Descriptions of these wells appear in Subsection 1.3.1. Wells B39W08S, B39W08M, B39W14S, and B39W14M are the upgradient wells for the site. The locations of these wells are shown in Figure 1-7. Samples were collected with a hand bailer after the wells had been bailed dry and allowed to recover or three well casing volumes had been removed. Nominal 1-L (0.26-gal) grab samples were collected to fill a 3.8-L (1.0-gal) container. Using the analysis methods described for surface water, TMA/E analyzed the samples for dissolved total uranium and radium-226 and Weston Analytical Laboratory analyzed samples for several chemical parameters.

TABLE 3-2
CONCENTRATIONS OF TOTAL URANIUM AND
RADIUM-226 IN SURFACE WATER AT CISS, 1989

Sampling Location ^a	Number of Samples	Concentration (10 ⁻⁹ μCi/ml) ^b		
		Minimum	Maximum	Average
<u>Total Uranium</u>				
1	4	10	314	135
2	4	6	9	8
3	4	8	10	9
4 ^c	4	5	9	7
5	4	<5	<5	<5
<u>Background</u>				
10 ^d	4	2	3	2
<u>Radium-226</u>				
1	4	0.3	0.9	0.7
2	4	0.4	0.8	0.6
3	4	0.5	0.7	0.6
4 ^c	4	0.4	0.6	0.5
5	4	0.3	0.6	0.5
<u>Background</u>				
10 ^d	4	0.5	1.1	0.8

^aSampling locations are shown in Figure 3-2. Locations 1 and 5 are on site and represent northern boundary conditions.

^b 1×10^{-9} $\mu\text{Ci/ml}$ is equivalent to 1 pCi/L.

^cLocation 4 is upstream.

^dLocated at the Town Hall Lake, Newtonville, NY, approximately 5 km (3 mi) north-northwest of CISS. Established in October 1988 to represent background. Background has not been subtracted.

3.3.1 Radiological

Radiological analytical results for groundwater samples are presented in Table 3-3. The highest annual average concentration of total uranium for all samples was 5.5×10^{-9} $\mu\text{Ci/ml}$ (5.5 pCi/L). The highest annual average radium-226 concentration was 1.6×10^{-9} $\mu\text{Ci/ml}$ (1.6 pCi/L). Few differences exist between upgradient and downgradient wells at CISS; these results are well below DOE-derived concentration guidelines.

For a discussion of the comparisons of radionuclide concentrations measured in groundwater from 1985 through 1989, see Subsection 3.6.3.

3.3.2 Chemical

In January 1989, monitoring wells at CISS were sampled for baseline chemical monitoring pursuant to 40 CFR 261, Appendix IX, for indicator parameters, and for selected metals.

The Appendix IX (baseline) monitoring program analyses were performed only for the initial sampling (January 1989). This program includes analysis for 51 volatile organic compounds (VOCs); 116 base/neutral and acid extractable compounds (BNAEs); 28 pesticides and PCBs; 10 organophosphate pesticides; 3 herbicides; 17 toxic or potentially toxic metals; and sulfides, fluorides, and cyanides. Chemical analyses for subsequent quarters were performed in accordance with the Hazardous Substances List (HSL). The HSL and the Appendix IX list do not include identical compounds.

Concentrations of many of these compounds were below the limit of detection of the analytical method used. Tables 3-4 through 3-6 list parameters for which analysis was conducted but for which contaminants were not detected.

Fourteen chemical contaminants were detected (Table 3-7). Eleven of these can be found in upgradient wells, which indicates the generally low quality of groundwater in the vicinity.

TABLE 3-3
CONCENTRATIONS OF TOTAL URANIUM AND
RADIUM-226 IN GROUNDWATER AT CISS, 1989

Sampling Location ^a	Number of Samples	Concentration (10 ⁻⁹ μ Ci/ml) ^b		
		Minimum	Maximum	Average
<u>Total Uranium</u>				
B39W01M	4	2	2.6	2.2
B39W01S	4	<2	3.4	2.4
B39W07S	4	<2	4.3	2.6
B39W10S	4	<2	2.2	2.1
B39W10M	4	<2	3.9	2.5
B39W19S ^c	2	4.7	10.3	5.5
<u>Background</u>				
B39W08S ^d	4	<2	2.6	2.2
B39W08M ^d	4	<2	2.6	2.2
B39W14S ^d	4	<2	2.2	2.1
B39W14M ^d	4	<2	2.6	2.2
<u>Radium-226</u>				
B39W01M	4	0.2	0.8	0.5
B39W01S	4	0.1	5.4	1.6
B39W07S	4	0.3	1.8	0.7
B39W10S	4	0.1	1.4	0.5
B39W10M	4	0.2	2.6	0.8
B39W19S ^c	2	0.2	0.3	0.3
<u>Background</u>				
B39W08S ^d	4	0.2	2.0	1.6
B39W08M ^d	4	0.2	0.6	0.4
B39W14S ^d	4	<0.1	1.5	0.6
B39W14M ^d	4	0.1	0.6	0.4

^aSampling locations are shown in Figure 1-7.

^b 1×10^{-9} $\mu\text{Ci/ml}$ is equivalent to 1 pCi/L.

^cSampled only the last two quarters.

^dUpgradient well, considered to be the background well.
Background has not been subtracted.

TABLE 3-4
METALS NOT DETECTED IN GROUNDWATER AT CISS, 1989

<u>Appendix IX Metals</u>	<u>ICPAES Metals^a</u>
Silver	Silver
Barium	Barium
Beryllium	Beryllium
Cadmium	Cadmium
Cobalt	Cobalt
Mercury	Molybdenum
Nickel	Nickel
Antimony	Antimony
Selenium	Selenium
Tin	Thallium
Thallium	Vanadium
Vanadium	

^aICPAES - inductively coupled plasma atomic emission spectrophotometry.

TABLE 3-5
PESTICIDES, PCBs, AND HERBICIDES NOT DETECTED
IN GROUNDWATER AT CISS, 1989

<u>PESTICIDES</u>	<u>PCBs</u>
Alpha-BHC	Aroclor-1016
Beta-BHC	Aroclor-1221
Delta-BHC	Aroclor-1232
Gamma-BHC	Aroclor-1242
Heptachlor	Aroclor-1248
Aldrin	Aroclor-1254
Heptachlor epoxide	Aroclor-1260
Endosulfan I	
Dieldrin	
4,4'-DDE	2,4-D
Endrin	2,4,5-TP
4,4'-DDD	2,4,5-T
Endosulfan sulfate	
4,4'-DDT	
Methoxychlor	
Endrin aldehyde	
Alpha chlordane	
Gamma chlordane	
Toxaphene	
Phorate	
Dimethoate	
Diazinon	
Methyl parathion	
Ethyl parathion	
Ethyl phosphorothioate	
Thionazin (zinophos)	
Sulfotepp	
Disulfoton	
Famphur (famophos)	

TABLE 3-6
VOLATILE AND EXTRACTABLE CHEMICALS NOT DETECTED
IN GROUNDWATER AT CISS, 1989

Chloromethane	Ethylbenzene
Bromomethane	Styrene
Vinyl chloride	Xylene (total)
Chloroethane	Acrolein
Methylene chloride	Acrylonitrile
Acetone	Trichlorofluoromethane
Carbon disulfide	Dichlorodifluoromethane
1,1-dichloroethene	Acetonitrile
1,1-dichloroethane	Iodomethane
1,2-dichloroethene (total)	Propionitrile (ethyl cyanide)
Chloroform	3-chloropropene
1,2-dichloroethane	Methacrylonitrile
2-butanone	Dibromomethane
Carbon tetrachloride	Isobutyl alcohol
Vinyl acetate	1,2-dibromoethane
Bromodichloromethane	1,1,1,2-tetrachloroethane
1,2-dichloropropane	1,2,3-trichloropropane
cis-1,3-dichloropropene	trans-1,4-dichloro-2-butene
Dibromochloromethane	1,2-dibromo-3-chloropropane
1,1,2-trichloroethane	2-chloro-1,3-butadiene
Trans-1,3-dichloropropene	2-chloroethyl vinyl ether
Bromoform	1,2-dichlorobenzene
4-methyl-2-pentanone	1,3-dichlorobenzene
2-hexanone	1,4-dichlorobenzene
1,1,2,2-tetrachloroethane	Pentachlorophenol
Phenol	Phenanthrene
bis(2-chloroethyl) ether	Anthracene
2-chlorophenol	Di-n-butylphthalate
1,3-dichlorobenzene	Fluoranthene
1,4-dichlorobenzene	Pyrene
Benzyl alcohol	Butylbenzylphthalate
1,2-dichlorobenzene	3,3'-dichlorobenzidine
2-methylphenol	Benzo(a)anthracene
bis(2-chloroisopropyl) ether	Chrysene
4-methylphenol	bis(2-ethylhexyl)phthalate
N-nitroso-di-n-propylamine	Di-n-octyl phthalate
Hexachloroethane	Benzo(b)fluoranthene
Nitrobenzene	Benzo(k)fluoranthene
Isophorone	Benzo(a)pyrene
2-nitrophenol	Indeno(1,2,3-cd)pyrene
2,4-dimethylphenol	Dibenzo(a,h)anthracene
Benzoic acid	Benzo(g,h,i)perylene
bis(2-chloroethoxy)methane	1,4-dioxane
2,4-dichlorophenol	Methyl methacrylate
1,2,4-trichlorobenzene	Pyridine
4-chloroaniline	Naphthalene

TABLE 3-6
(continued)

Hexachlorobutadiene	N-nitrosodimethylamine
4-chloro-3-methylphenol	Ethyl methacrylate
Hexachlorocyclopentadiene	2-picoline
2,4,6-trichlorophenol	N-nitrosomethylethylamine
2,4,5-trichlorophenol	Methyl methanesulfonate
2-chloronaphthalene	N-nitrosodiethylamine
2-nitroaniline	Methyl methanesulfonate
Dimethylphthalate	Aniline
Acenaphthylene	N-nitrosodiethylamine
2,6-dinitrotoluene	Ethyl methanesulfonate
3-nitroaniline	Pentachloroethane
Acenaphthene	3-methylphenol
2,4-dinitrophenol	N-nitrosopyrrolidine
4-nitrophenol	Acetophenone
Dibenzofuran	N-nitrosomorpholine
2,4-dinitrotoluene	o-toluidine
Diethylphthalate	N-nitrosopiperidine
4-chlorophenyl-phenylether	a,a-dimethylphenethylamine
Fluorene	2,6-dichlorophenol
4-nitroaniline	Hexachloropropene
4,6-dinitro-2-methylphenol	p-phenylenediamine
N-nitrosodiphenylamine	N-nitroso-di-n-butylamine
4-bromophenyl-phenylether	Safrole
Hexachlorobenzene	1,2,4,5-tetrachlorobenzene
2-naphthylamine	Isosafrole
1,3,5-trinitrobenzene	1,4-naphthoquinone
Phenacetin	1,3-dinitrobenzene
5-nitro-o-toluidine	Pentachlorobenzene
Pronamide	1-naphthylamine
Pentachloronitrobenzene	2,3,4,6-tetrachlorophenol
Methapyrilene	Diallate
Chlorobenzilate	Diphenylamine
3,3'-dimethylbenzidine	4-aminobiphenyl
7,12-dimethylbenz(a)anthracene	2-sec-butyl-4,6-dinitrophenol
3-methylcholanthrene	4-nitroquinoline-1-oxide
Aramite	2-acetylaminofluorene
p-dimethylaminoazobenzene	Hexachlorophene

Indicator parameters monitored at CISS include pH, specific conductance, total organic carbon (TOC), and total organic halides (TOX). These parameters indicate changes in the inorganic and organic composition of the groundwater.

Specific conductance and pH measure changes in the inorganic composition of the groundwater. Acidity or basicity of water is expressed as pH. A change in pH affects the solubility and mobility of chemical contaminants in groundwater. Specific conductance measures the capacity of water to conduct an electrical current. Generally, conductivity increases with an elevated concentration of dissolved solids. Waters with high salinities or high total dissolved solids exhibit high conductivities.

Groundwater is analyzed for TOC and TOX to determine organic content. TOC measures the total organic carbon content of water but is not specific to a given contaminant. TOX measures organic compounds containing halogens; many pollutants contain halogenated hydrocarbons, which are organic compounds containing fluorine, chlorine, bromine, and iodine.

As shown in Table 3-7, TOC levels across the site varied from 1.0 to 467 mg/L, and TOX levels ranged from below detection limits to 99 µg/L. TOX and TOC levels in the upgradient wells are similar to those measured in the other monitoring wells. Specific conductance and pH measurements were fairly consistent across the site, with the exception of one high pH measurement from upgradient well B39W08M. The analytical results for chemical indicator parameters indicate that the groundwater at CISS is generally of poor quality, which is typical of groundwater in industrial/urban areas.

As a part of the CISS monitoring program, quarterly analysis for dissolved metals in groundwater was initiated in 1989. Metal ions are normal constituents of groundwater; however, the presence of very high concentrations of toxic heavy metals associated with the materials stored at CISS could indicate an impact resulting from site activities. The monitoring well system is designed to provide sufficient coverage of both upgradient and downgradient conditions.

TABLE 3-7

ANALYTICAL RESULTS FOR INDICATOR PARAMETERS AND CHEMICAL
CONTAMINANTS IN GROUNDWATER AT CISS, 1989^a

Sampling Location (Monitoring Well Number)										
Parameter	B39W08S	B39W08M	B39W01N	B39W01S	B39W07S	B39W10S	B39W10M	B39W14S	B39W14M	B39W19S ^b
pH (standard units)	6.7-7.0	8.5-11.0	8.1-8.7	6.8-7.2	7.0-7.1	6.8-8.0	8.2-8.8	7.1-7.4	7.2-8.6	7.0-7.1
Total organic carbon (mg/L)	4.0-467	1.2-33.4	1.0-190	1.4-34	6.3-10.5	2.4-37.3	1.5-18.2	0.96-129	1.4-10.8	6.1-11.3
Total organic halides (µg/L)	ND-40 ^c	ND-44	ND-30	ND-64	ND-99	ND-24	ND-48	ND-43	ND-43	ND
Specific conductance (µmhos/cm)	431-508	187-349	188-198	354-434	596-778	254-262	245-283	661-802	203-229	810-816
Bis(2-ethylhexyl)phthalate (µg/L)	ND	ND	ND	ND	ND-270	ND-910	ND	ND	ND-5200	310-349
Benzene (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND-60	ND	ND
Tetrachloroethane (µg/L)	ND	ND	ND	ND	ND-360	ND	ND	ND	ND	ND
1,1,1-trichloroethane (µg/L)	ND-8	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethylene (µg/L)	ND	ND	ND	ND	ND-14	ND	ND	ND-55	ND	ND
1,1-dichloroethylene (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND-72	ND	ND
Toluene (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND-56	ND	ND
Chlorobenzene (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND-61	ND	ND
Tetrachloroethylene (µg/L)	ND	ND	ND	ND	ND-450	ND	ND	ND-61	ND	ND
Trichloroethene (µg/L)	ND	ND	ND	ND	ND-35	ND	ND	ND-61	ND	ND
Fluoride (mg/L)	0.11-0.21	0.12-0.22	0.14-0.18	0.097-0.12	ND-0.16	ND	0.61-0.76	ND-0.10	0.26-0.31	0.25-0.30
Cyanide (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-18.1
2-methylnaphthalene (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-489
Kapone (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND-0.69	ND	ND

^a Does not include parameters for which concentrations were below the limit of sensitivity of the analytical method used.

^b Data for last two quarters of 1989 only.

^c ND - no detectable concentration.

Concentrations of detectable metals for January through October 1989 are given in Table 3-8. (Metal contaminants not present in detectable concentrations are listed in Table 3-4).

No definite conclusions regarding metal contaminants in groundwater at CISS may be drawn from the 1989 sampling and analyses. Of the Appendix IX metals, only arsenic, chromium, copper, and zinc were found, in limited amounts, usually for a single quarter. Because they were usually found in similar concentrations in both upgradient and downgradient wells, it can probably be concluded that the site is not contributing these metals to groundwater. The notable exception to the above is zinc, which was present at over 40 times the detection limit of 20 $\mu\text{g/L}$ in the on-site, downgradient well B39W19S. Since well B39W10S, which is downgradient of well B39W19S, exhibited zinc concentrations similar to upgradient wells, it can probably be concluded that the metal is not moving.

Of the ICPAES metals, the salts calcium and sodium were found in samples from all wells in all quarters analyzed. Calcium and sodium ranged in concentration from 6,000 to 92,000 and 7,000 to 65,000 $\mu\text{g/L}$, respectively. No correlation between well location or aquifer sampled and concentration was apparent, although the highest concentrations of both were noted in samples from well B39W19S. Manganese was found in water from all wells for at least one sampling period, ranging in concentrations from 15.0 to 2,400 $\mu\text{g/L}$. Magnesium was detected in water from all wells except B39W01M, B39W10M, and B39W14M, although not for every sampling period. Potassium was detected in relatively high concentrations (14,000 to 15,000 $\mu\text{g/L}$) in water from wells B39W08M and B39W01M, but only for a single quarter (not the same quarter). Aluminum was detected in water from three wells and iron in water from four wells, but represented a single quarter's sampling. Although concentrations of some of these common elements appear high, they do constitute a relatively large percentage of the Earth's composition and, therefore, are expected to be present in relatively large amounts in groundwater. Lead was detected in a single sample of water, from well B39W19S.

METALS DETECTED IN GROUNDWATER AT CISS, 1989^a

Sampling Location (Monitoring Well Number) (By Quarter)																				
Metal (µg/L)	B39W08S				B39W08M				B39W01M				B39W01S				B39W07S			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Aluminum	ND ^b	317	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	271	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Boron	-C	365	485	330	-C	ND	ND	ND	ND	-C	ND	ND	ND	581	697	594	-C	270	324	348
Calcium (X1000)	-C	68.1	71.2	68.9	-C	5.8	18.6	13	-C	19.8	19.8	7.6	-C	40.5	36	39.3	-C	75.6	53.8	51.7
Chromium	ND	ND	16.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	27.1	ND	ND	ND	ND	ND
Copper	ND	25.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	28.3	ND	ND	ND	ND	ND	ND
Iron	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	117	ND	ND	ND	4260	ND	ND
Magnesium (X1000)	-C	12.4	12.2	12.6	-C	ND	ND	5.8	-C	ND	ND	ND	ND	-C	5.4	ND	ND	-C	13.9	9.4
Manganese	-C	ND	118	33.8	-C	ND	21.5	ND	-C	26.2	22.7	ND	-C	17.6	15.2	ND	-C	2210	2200	2410
Potassium (X1000)	-C	ND	ND	ND	-C	15.5	ND	ND	-C	ND	ND	14	-C	ND	ND	ND	-C	ND	ND	ND
Sodium (X1000)	-C	13	13.7	17.1	-C	31.5	16.5	19.1	-C	17.9	15.3	31.4	-C	39.8	37.4	31.8	-C	63.6	53.1	42.2
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	47.9	100	169	ND	ND	ND	277	ND	ND	62.5	24.9	ND	50.5	201	62.8	ND	29.1	95.6	120	57

TABLE 3-8
(continued)

Sampling Location (Monitoring Well Number) (By Quarter)

Metal (µg/L)	B39W10S				B39W10M				B39W14S				B39W14M				B39W19S			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Aluminum	ND	ND	ND	ND	ND	685	225	254	ND	ND	ND	ND	ND	ND	ND	ND	-d	-d	ND	ND
Arsenic	ND	ND	ND	ND	ND	172	ND	ND	ND	ND	ND	ND	11.9	ND	ND	ND	-d	-d	ND	ND
Boron	-c	ND	ND	ND	-c	151	109	120	-c	ND	ND	ND	-c	ND	ND	ND	-d	-d	405	474
Calcium (X1000)	-c	36.7	35.9	35.8	-c	10.8	12.6	10	-c	75.4	77.5	78	-c	19	20.7	18.5	-d	-d	91.1	92.1
Chromium	ND	ND	28.3	ND	ND	ND	20	ND	ND	ND	ND	ND	ND	ND	21.5	ND	-d	-d	15.6	ND
Copper	ND	ND	ND	ND	ND	59.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-d	-d	117	25
Iron	ND	ND	ND	ND	ND	344	200	179	ND	408	118	ND	ND	ND	ND	ND	-d	-d	ND	ND
Magnesium (X1000)	-c	7.4	7.1	7.3	-c	ND	ND	ND	-c	11.5	11.7	12.3	-c	ND	ND	ND	-d	-d	17.7	17.1
Manganese	-c	25.7	63.3	66.8	-c	28.9	50.9	20.5	-c	480	463	502	-c	23.5	45	23.8	-d	-d	788	857
Potassium (X1000)	-c	ND	ND	ND	-c	ND	ND	ND	-c	ND	ND	ND	-c	ND	ND	ND	-d	-d	ND	ND
Sodium (X1000)	-c	8.4	7	11.7	-c	50.1	44.6	55.6	-c	51.7	49.9	58.3	-c	21.3	17.6	21.3	-d	-d	60.4	64.8
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-d	-d	ND	246
Zinc	ND	ND	52.3	58.4	52.9	288	ND	21.8	60.5	101	31	44.3	28.9	32.7	27	26.9	-d	-d	845	938

^aAnalysis by quarterly sampling period.

^bND - no detectable concentration.

^cAnalysis for these metals not included for this period (not included on Appendix IX list).

^dNot sampled first two quarters.

3.4 SEDIMENT SAMPLING

Sediment samples consisting of composites weighing approximately 0.5 kg (1 lb) were collected quarterly at three of the sampling locations established for sediment and surface water (Figure 3-2, locations 1, 2, and 3). A strong current at location 4 prevents sampling. Location 5 will be sampled for sediments in 1990. Location 1 is in an area of known contamination on the site. Locations 2 and 3 measure the potential for migration of contaminated sediments to off-site areas. TMA/E analyzed the samples for isotopic uranium and radium-226. Total uranium concentration was determined by summing the results of analyses for isotopic uranium. Isotopic uranium concentrations were determined by alpha spectrometry, in which uranium is leached, organically extracted, and electroplated on a metal substrate. Radium-226 concentrations were determined by the radon emanation method described for surface water analysis. Results of the analyses, based on dry weight, are presented in Table 3-9.

The average annual concentration of total uranium in sediment measured at location 2 was 7.7 pCi/g, and the average annual radium-226 concentration was 0.6 pCi/g. Location 3 exhibited a slightly higher average concentration of total uranium (9.1 pCi/g) than location 2, but the radium-226 average was identical (0.6 pCi/g). Although DOE does not have guidelines specifically for sediments, the uranium and radium-226 concentrations found in sediments at CISS are below DOE-derived concentration guidelines for soil.

As mentioned earlier, location 1 is in an area of known contamination, and the high uranium levels measured there reflect this. The contamination seems to be stationary, as evidenced by levels measured at locations 2 and 3. The contaminated area is completely fenced in, and it will be remediated in the near future.

TABLE 3-9
CONCENTRATIONS OF TOTAL URANIUM AND RADIUM-226
IN SEDIMENT AT CISS, 1989

Sampling Location ^{a, b}	Number of Samples	Concentration [pCi/g (dry)]		
		Minimum	Maximum	Average
<u>Total Uranium^c</u>				
1	4	19	673	278
2	4	5.1	11.5	7.7
3	4	4.9	15.2	9.1
<u>Radium-226</u>				
1	4	0.7	1.1	1.0
2	4	0.6	0.7	0.6
3	4	0.5	0.7	0.6

^aSampling locations are shown in Figure 3-2.

^bNo background location was established for 1989 reporting.

^cTotal uranium concentration was calculated by summing the concentrations of all three isotopes.

3.5 RADIATION DOSE

To assess the impact of the radioactive materials stored at CISS, radiological exposure pathways were evaluated to calculate the potential dose to a hypothetical maximally exposed individual. This individual is one who is assumed, when all potential routes of exposure are considered, to receive the greatest dose. An appraisal of potential pathways (ingestion of water or exposure to external gamma radiation) suggested that external gamma radiation was the only plausibly significant exposure pathway.

The dose from ingesting groundwater or surface water from sources on the CISS property was not calculated because it was considered unrealistic to assume that ingestion of this water would occur. CISS is fenced and locked, and security is well maintained; thus a member of the public could only consume water on the site by trespassing on the property. To consume groundwater from a well at the site, a member of the public would have to be equipped with a means of removing the well cap (which is locked) and extracting the groundwater by such means as a bailer or pump. Furthermore, because the quality of the groundwater at the site approximates background values (Table 3-3), the potential impact due to off-site exposure to contaminated groundwater migrating from the CISS property is insignificant.

3.5.1 Dose to the Maximally Exposed Individual

To identify the individual in the vicinity of CISS who would receive the highest dose from on-site radioactive materials, the dose from exposure to external gamma radiation was calculated for various monitoring locations that could be accessible to the public. This dose was then reviewed with regard to land use and occupancy factors for areas adjacent to the monitoring points. For the properties surrounding CISS, the highest overall dose would be received by an individual directly to the south of the site.

The average annual external gamma radiation level at monitoring location 12 (Figure 3-1) was 22 mrem/yr above background. Because

gamma radiation levels decrease rapidly with distance, it would be expected that at the nearest occupied residence external gamma radiation would not exceed the background level. However, because locations 3, 4, and 5 are next to the Penn Central Railroad right-of-way, exposure to the hypothetical maximally exposed individual was calculated assuming that an individual walked through this right-of-way area at the site fence for 2 h/day, 7 days/week, 52 weeks/yr. Under these assumptions, the annual exposure to this individual would be 2 mrem. This scenario is, however, highly conservative because it is unlikely that any individual would spend so much time at this location. By this conservative scenario the dose is approximately equivalent to 2 percent of the DOE radiation protection standard of 100 mrem/yr. This is also less than the exposure a person would receive during a flight from Los Angeles to New York (because of the greater amounts of cosmic radiation at higher altitudes) (see Appendix D).

3.5.2 Dose to the Population in the Vicinity of CISS

The dose to the population represents the conceptual cumulative radiation dose to all residents within an 80-km (50-mi) radius of a given site. This dose includes contributions from all significant potential pathways.

The contribution to the population dose made by gamma radiation from on-site radioactive materials is too small to be measured because gamma radiation levels decrease rapidly as distance from the source of contamination increases. For example, if the gamma exposure rate at a distance of 0.9 m (3 ft) from a small-area radioactive source were 100 mrem/yr, the exposure rate at a distance of 6.4 m (21 ft) from the source would be indistinguishable from naturally occurring background radiation.

On the basis of radionuclide concentrations measured in water leaving the site, it also appears that there is no predictable pathway by which ingestion of water could result in a significant

dose to the population. As water migrates farther from the source, radionuclide concentrations are further reduced, thereby lowering potential doses to the public. Because the contributions to population dose from both potential exposure pathways are inconsequential, calculation of the dose to the population is not warranted. The cumulative dose to the population within an 80-km (50-mi) radius of CISS that would result from radioactive materials present at the site would be indistinguishable from the dose that the same population would receive from naturally occurring radioactive sources.

3.6 TRENDS

The environmental monitoring program at CISS was established to allow an annual assessment of the environmental conditions at the site, provide a historical record for comparisons from year to year, and permit detection of trends over time. In the following subsections, 1989 annual averages for each monitoring location for external gamma radiation and for total uranium and radium-226 in surface water are compared with results for 1985 through 1989. (Groundwater data for 1984 can be found in Ref. 12). As the environmental monitoring program continues at CISS and more data are collected, comparisons will become more valid and identification of trends will be facilitated.

3.6.1 External Gamma Radiation

As shown in Table 3-10, there has not been an identifiable overall trend in external gamma radiation levels measured at CISS since 1985. Given the accuracy limitations of low-level dosimetry (see Subsection 3.1), the slight yearly fluctuations shown in Table 3-10 cannot be interpreted as meaningful. The data do suggest that gamma radiation levels measured at all on-site stations are low and the stored waste at the site contributes little to background levels.

TABLE 3-10
ANNUAL AVERAGE EXTERNAL GAMMA RADIATION LEVELS
AT CISS, 1985-1989^a

Sampling Station	Radiation Level (mrem/yr) ^c				
	1985	1986	1987	1988 ^d	1989
1	1	1	<1	13	4
2	27	36	5	10	<1
3	56	51	21	21	9
4	71	58	26	28	21
5	9	7	15	34	19
6	5	25	<1	4	-e
7	66	61	25	8	5
8	60	27	7	20	8
9	1	4	1	7	-e
10	1	3	<1	5	-e
12	36	36	17	26	22
<u>Background</u>					
11 ^f	87	78	63	70	56
13 ^g	--	--	--	--	74
14 ^h	--	--	--	--	64
15 ⁱ	--	--	--	--	52

^a Sources for 1985-1988 data are the annual site environmental reports for those years (Refs. 10, 13-15).

^b Locations of sampling stations are shown in Figure 3-1.

^c Measured background has been subtracted from readings obtained at on-site stations.

^d The TLD program was modified in 1988 to use a more sensitive monitoring system.

^e Measured value was equal to or less than background.

^f Station 11 is at Fuller Place, Albany, NY, approximately 10 km (6 mi) northwest of CISS.

^g Station 13 is at the Colonie Town Hall, approximately 5 km (3 mi) north-northwest of CISS. Established March 31, 1988.

^h Station 14 is at the Albany County Airport, approximately 8 km (5 mi), north of CISS. Established March 31, 1988.

ⁱ Station 15 is at the Colonie Fire Station, approximately 6 km (4 mi) north-northwest of CISS. Established March 31, 1988.

3.6.2 Surface Water

As shown in Table 3-11, concentrations of radium-226 in surface water at CISS have remained basically stable since 1985. Location 1 is in an area of known contamination; however, the data show that contamination is not migrating to other areas. The area will be remediated in the near future. In 1989, measured concentrations of total uranium and radium-226 in surface water increased as compared with 1988 levels. Climatic factors such as the quantity and frequency of rainfall runoff from the site affect contaminant concentrations found in surface water samples.

3.6.3 Groundwater

In 1984, the groundwater monitoring program at CISS was based on four monitoring wells that existed at the site before the property was acquired by DOE. Additional monitoring wells were installed in 1985 and 1988 to upgrade the monitoring program.

As shown in Table 3-12, concentrations of uranium in groundwater at CISS in 1989 did not change much from those in 1988 and were comparable to those measured in 1985. Radium-226 concentrations have remained within the range of values naturally found in groundwater. Although concentrations of both radionuclides have fluctuated from year to year, neither has exhibited an identifiable trend. Concentrations of both total uranium and radium-226 in groundwater at CISS in 1989 were similar to those upgradient of the site.

TABLE 3-11
ANNUAL AVERAGE CONCENTRATIONS OF TOTAL URANIUM
AND RADIUM-226 IN SURFACE WATER
AT CISS, 1985-1989^a

Sampling Location ^b	Concentration (10^{-9} $\mu\text{Ci/ml}$) ^c				
	1985	1986	1987	1988	1989
<u>Total Uranium</u>					
1	34	60	73	39	135
2	16.0	13.8	9.3	7.0	8
3	8.0	13.2	7.1	6.0	9
4	4.0	5.0	2.2	5.0	7
5	3.4	3.4	5.2	2	<5
<u>Background</u>					
10 ^d	--	--	--	2.0	2
<u>Radium-226</u>					
1 ^e	--	--	--	0.4	0.7
2	0.1	0.4	0.2	0.3	0.6
3	0.3	0.3	0.1	0.4	0.5
4	0.1	0.2	0.2	0.4	0.5
5 ^e	--	--	--	0.2	0.5
<u>Background</u>					
10	--	--	--	0.4	0.8

^a Sources for 1985-1988 data are the annual site environmental reports for those years (Refs. 10, 13-15).

^b Sampling locations are shown in Figure 3-2.

^c 1×10^{-9} $\mu\text{Ci/ml}$ is equivalent to 1 pCi/L.

^d Background location established in 1988. Located at Town Hall Lake, Newtonville, NY, approximately 5 km (3 mi) north-northwest of CISS. Background has not been subtracted.

^e Surface waters were not sampled for radium-226 before 1988.

TABLE 3-12
ANNUAL AVERAGE CONCENTRATIONS OF TOTAL
URANIUM AND RADIUM-226 IN GROUNDWATER
AT CISS, 1985-1989^a

Sampling Location ^b	Concentration (10^{-9} $\mu\text{Ci/ml}$) ^c				
	1985	1986	1987	1988	1989
<u>Total Uranium</u>					
B39W08S ^d	<3.0	5.0	<2.2	3.0	2.2
B39W08M ^d	<3.0	6.2	2.8	3.0	2.2
B39W01M	<3.0	6.7	3.9	4.0	2.2
B39W01S	<3.0	3.8	2.5	2.0	2.4
B39W05S ^e	<3.0	4.3	2.5	3.0	- ^e
B39W18S ^e	<3.0	5.0	<2.2	3.0	- ^e
B39W15S ^e	<3.0	4.5	2.4	3.0	- ^e
B39W07S ^f	--	--	--	--	2.6
B39W10S ^f	--	--	--	--	2.1
B39W10M ^f	--	--	--	--	2.5
B39W14S ^{d, f}	--	--	--	--	2.1
B39W14M ^{d, f}	--	--	--	--	2.2
B39W19S ^f	--	--	--	--	5.5 ^g
<u>Radium-226</u>					
B39W08S ^d	0.2	0.3	0.3	0.4	1.6
B39W08M ^d	0.2	0.3	0.4	2.1	0.4
B39W01M	0.1	0.4	0.7	0.5	0.6
B39W01S	0.1	0.3	0.2	0.5	1.6
B39W05S ^e	0.4	0.5	0.6	0.8	- ^e
B39W18S ^e	0.2	0.3	0.3	0.2	- ^e
B39W15S ^e	0.2	0.3	0.3	0.5	- ^e
B39W07S ^f	--	--	--	--	0.7
B39W10S ^f	--	--	--	--	0.5
B39W10M ^f	--	--	--	--	0.8
B39W14S ^{d, f}	--	--	--	--	0.6
B39W14M ^{d, f}	--	--	--	--	0.4
B39W19S ^f	--	--	--	--	0.3 ^g

^a Sources for 1985-1988 data are the annual site environmental reports for those years (Refs. 10, 13-15).

^b Sampling locations are shown in Figure 1-7.

^c 1×10^{-9} $\mu\text{Ci/ml}$ is equivalent to 1 pCi/L.

^d Upgradient well, considered to represent background. Background has not been subtracted.

^e Dropped from the monitoring program in 1989 because new wells were added.

^f New monitoring well; sampling initiated in 1989.

^g Includes samples only from the last two quarters of 1989.

4.0 RELATED ACTIVITIES AND SPECIAL STUDIES

4.1 RELATED ACTIVITIES

No vicinity properties were remediated in 1989. Site maintenance and security continued.

4.2 SPECIAL STUDIES

No special studies were performed at CISS in 1989.

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APPENDIX A
QUALITY ASSURANCE

QUALITY ASSURANCE

A comprehensive quality assurance (QA) program involving sampling, data management, and analysis was maintained to ensure that the data reported were representative of actual concentrations in the environment. The QA program meets the requirements of DOE Order 5700.6B and ANSI/ASME NQA-1.

QA sampling requirements were ensured through the following:

- Samples at all locations collected using established procedures
- Sampling program design provided for spikes, trip blanks, field blanks, and quality control (QC) duplicate sampling
- Chain-of-custody procedures implemented to maintain traceability of samples and corresponding analytical results

Data management QA was achieved through:

- Completion and recording of parameter-specific data review checklists for each analysis report
- Use of calculation sheets for constructing data tables and documenting computations
- Double-checking and concurrence on calculations
 - By the originator
 - By an independent, equally qualified second party

System QA audits are conducted by BNI FUSRAP QA personnel to verify adherence with laboratory procedures and to evaluate the appropriateness and effectiveness of the procedures. Audit team leaders and auditors are trained and certified in accordance with project procedures. Technical specialists participate as auditors under the direction of the audit team leader when warranted by the nature of the activities being audited. Audit reports are prepared for each audit conducted. Audit findings that require corrective action and followup are documented, tracked, and resolved, as verified by the project QA supervisor.

Routine radioanalyses for the FUSRAP Environmental Monitoring Program were performed under subcontract by TMA/E, Albuquerque, New Mexico. This laboratory maintained an internal quality assurance program that involved routine calibration of counting instruments, source and background counts, routine yield determinations of radiochemical procedures, and replicate analyses to check precision. The accuracy of radionuclide determination was determined through the use of standards traceable to the National Institute of Standards and Technology (NIST), when available. When NIST standards were not available, standards from the New Brunswick Laboratory were used. The laboratory also participated in the Environmental Protection Agency's (EPA) Laboratory Intercomparison Studies Program. In this program, samples of different environmental media (water, milk, air filters, soil, foodstuffs, and tissue ash) containing one or more radionuclides in known amounts were prepared and distributed to the participating laboratories. After the samples were analyzed, the results were forwarded to EPA for comparison with known values and with the results from other laboratories. This program enabled the laboratory to regularly evaluate the accuracy of its analyses and take corrective action if needed. Table A-1 summarizes results of the EPA comparison studies for water samples. TMA/E has applied and been accepted for readmission into the DOE Laboratory Quality Assessment Program for Radioactive Materials, coordinated by the DOE Environmental Laboratory, New York, New York.

Interlaboratory comparison of the tissue-equivalent TLD results was provided by participation in the International Environmental Dosimeter Project sponsored jointly by DOE, NRC, and EPA.

Chemical analyses were performed under subcontract by Weston Analytical Laboratory, Lionsville, Pennsylvania. Weston's standard practices manual was reviewed and accepted by BNI. The laboratory maintains an internal QA program that involves the following.

For inorganic analyses, the program includes:

- Initial calibration and calibration verification
- Continuing calibration verification

TABLE A-1
SUMMARY COMPARISON OF WATER SAMPLE RESULTS
(EPA and TMA/E)

Analysis and Sample Date	Value (pCi/L)		Ratio (TMA/E:EPA) a
	EPA	TMA/E	
<u>Alpha</u>			
1/89	41.0 ± 10.0	49.0 ± 1.0	1.20
4/89	8.0 ± 5.0	13.0 ± 1.0	1.63
6/89	30.0 ± 8.0	33.0 ± 2.7	1.10
7/89	29.0 ± 7.0	30.3 ± 2.1	1.04
11/89	4.0 ± 5.0	4.3 ± 0.6	1.08
<u>Beta</u>			
1/89	54.0 ± 5.0	53.0 ± 1.7	0.98
4/89	4.0 ± 5.0	5.3 ± 0.6	1.33
6/89	50.0 ± 5.0	58.3 ± 1.5	1.17
7/89	57.0 ± 5.0	51.0 ± 3.0	0.89
11/89	6.0 ± 5.0	6.7 ± 0.6	1.12
<u>Ra-226</u>			
1/89	5.0 ± 0.8	5.5 ± 0.3	1.10
3/89	3.50 ± 0.50	3.67 ± 0.06	1.05
5/89	4.90 ± 0.7	4.03 ± 0.25	0.82
7/89	3.50 ± 0.50	3.87 ± 0.15	1.11
10/89	17.7 ± 2.7	17.2 ± 0.5	0.97
<u>Ra-228</u>			
1/89	5.2 ± 0.8	6.1 ± 0.2	1.17
3/89	10.3 ± 1.5	11.3 ± 0.7	1.10
5/89	1.70 ± 0.30	1.77 ± 0.30	1.04
7/89	3.60 ± 0.50	5.20 ± 1.04	1.44
10/89	18.3 ± 2.7	24.8 ± 0.3	1.36
<u>U (Natural)</u>			
1/89	5.0 ± 6.0	5.3 ± 0.6	1.06
5/89	5.0 ± 6.0	5.0 ± 0.0	1.00
7/89	3.00 ± 6.00	3.00 ± 0.00	1.00
9/89	41.0 ± 6.0	39.7 ± 1.2	0.97

^aThis ratio can be used to determine the accuracy of TMA/E's analytical procedures.

- Reagent blank analyses
- Matrix spike analyses
- Duplicate sample analyses
- Laboratory control sample analyses
- Interlaboratory QA/QC

For organic analyses, the program includes:

- Gas chromatography/mass spectrometry instrumentation for both volatile and semivolatile compound analysis
- Initial multilevel calibration for each Hazardous Substances List (HSL) compound
- Matrix spike analyses
- Reagent blank analyses
- Interlaboratory QA/QC
- Continuing calibration for each HSL compound
- Addition of surrogate compounds to each sample and blanks for determining percent recovery information

Weston is currently an EPA-designated Contract Laboratory Program (CLP) laboratory for both organic and inorganic analyses. This requires passing EPA's blind performance evaluation testing each quarter. The technical specifications in BNI's subcontract with Weston specify QA/QC at, and in some cases beyond, the CLP level.

Currently, Weston participates in drinking water, wastewater, and/or hazardous waste certification programs. They are certified (or pending) in 35 such state programs (including New York). Continued certification hinges upon Weston's ability to pass regular performance evaluation testing.

Weston's QA program also includes an independent overview by their project QA coordinator and a corporate vice president who audits their program activities quarterly.

APPENDIX B
ENVIRONMENTAL STANDARDS AND CONVERSION FACTORS

ENVIRONMENTAL STANDARDS

The DOE long-term radiation protection standard of 100 mrem/yr above background level includes exposure from all pathways except medical treatments (Ref. 11). Evaluation of exposure pathways and resulting dose calculations is based on assumptions such as occupancy factors in determining the dose from external gamma radiation; subtraction of background concentrations of radionuclides in air, water, and soil before calculating dose; closer review of water use, using the data that most closely represent actual exposure conditions rather than maximum values as applicable; and using average consumption rates of food and water per individual rather than maximums. Use of such assumptions will result in calculated doses that more accurately reflect the exposure potential from site activities.

TABLE B-1
CONVERSION FACTORS

1 gal	=	3.785 L
1 yd ³	=	0.765 m ³
1 ft	=	0.3048 m
1 year	=	8,760 hours
1 liter	=	1,000 ml
1 μ Ci	=	1,000,000 pCi
1 pCi	=	0.000001 μ Ci
1 pCi/L	=	10^{-9} μ Ci/ml
1 pCi/L	=	0.000000001 μ Ci/ml
1 μ Ci/ml	=	1,000,000,000 pCi/L
10^{-6}	=	0.000001
10^{-7}	=	0.0000001
10^{-8}	=	0.00000001
10^{-9}	=	0.000000001
10^{-10}	=	0.0000000001
7×10^{-10}	=	0.0000000007

APPENDIX C
ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS

cm	centimeter
cm/s	centimeters per second
ft	foot
ft msl	feet above mean sea level
g	gram
gal	gallon
h	hour
ha	hectare
in.	inch
km	kilometer
km/h	kilometers per hour
L	liter
lb	pound
m	meter
m ³	cubic meter
mg	milligram
mg/L	milligrams per liter
mi	mile
ml	milliliter
mph	miles per hour
mrem	millirem
mrem/yr	millirem per year
μCi/ml	microcuries per milliliter
pCi	picrocurie
pCi/g	picrocuries per gram
pCi/L	picrocuries per liter
yd ³	cubic yard
yr	year

ACRONYMS

AEC	Atomic Energy Commission
BNAE	base/neutral and acid extractable
BNI	Bechtel National, Inc.
CISS	Colonie Interim Storage Site
DOE	Department of Energy
EPA	Environmental Protection Agency
FUSRAP	Formerly Utilized Sites Remedial Action Program
HSL	Hazardous Substances List
ICPAES	inductively coupled plasma atomic emission spectrophotometry
NBL	New Brunswick Laboratory
NBS	National Bureau of Standards
NL	National Lead
PCB	polychlorinated biphenyl
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
TLD	thermoluminescent dosimeter
TMA/E	Thermo Analytical/Eherline
VOC	volatile organic compound

APPENDIX D
RADIATION IN THE ENVIRONMENT

Radiation is a natural part of our environment. When our planet was formed, radiation was present—and radiation surrounds it still. Natural radiation showers down from the distant reaches of the cosmos and continuously radiates from the rocks, soil, and water on the Earth itself.

During the last century, mankind has discovered radiation, how to use it, and how to control it. As a result, some manmade radiation has been added to the natural amounts present in our environment.

Many materials—both natural and manmade—that we come into contact with in our everyday lives are radioactive. These materials are composed of atoms that release energetic particles or waves as they change into more stable forms. These particles and waves are referred to as *radiation*, and their emission as *radioactivity*.

As the chart on the left shows, most environmental radiation (82%) is from natural sources. By far the largest source is radon, an odorless, colorless gas given off by natural radium in the Earth's crust. While radon has always been present in the environment, its significance is better understood today. Manmade radiation—mostly from medical uses and consumer products—adds about eighteen percent to our total exposure.

TYPES OF IONIZING RADIATION

Radiation that has enough energy to disturb the electrical balance in the atoms of substances it passes through is called *ionizing radiation*. There are three basic forms of ionizing radiation.

Alpha

Alpha particles are the largest and slowest moving type of radiation. They are easily stopped by a sheet of paper or the skin. Alpha particles can move through the air only a few inches before being stopped by air molecules. However, alpha radiation is dangerous to sensitive tissue inside the body.

Beta

Beta particles are much smaller and faster moving than alpha particles. Beta particles pass through paper and can travel in the air for about 10 feet. However, they can be stopped by thin shielding such as a sheet of aluminum foil.

Gamma

Gamma radiation is a type of electromagnetic wave that travels at the speed of light. It takes a thick shield of steel, lead, or concrete to stop gamma rays. X rays and cosmic rays are similar to gamma radiation. X rays are produced by manmade devices; cosmic rays reach Earth from outer space.

Units of Measure

Radiation can be measured in a variety of ways. Typically, units of measure show either 1) the total amount of radioactivity present in a substance, or 2) the level of radiation being given off.

The radioactivity of a substance is measured in terms of the number of transformations (changes into more stable forms) per unit of time. The *curie* is the standard unit for this measurement and is based on the amount of radioactivity contained in 1 gram of radium. Numerically, 1 curie is equal to 37 billion transformations per second. The amounts of radioactivity that people normally work with are in the millicurie (one-thousandth of a curie) or microcurie (one-millionth of a curie) range. Levels of radioactivity in the environment are in the picocurie, or pCi (one-trillionth of a curie) range.

Levels of radiation are measured in various units. The level of gamma radiation in the air is measured by the *roentgen*. This is a relatively large unit, so measurements are often calculated in milliroentgens. Radiation absorbed by humans is measured in either *rad* or *rem*. The rem is the most descriptive because it measures the ability of the specific type of radiation to do damage to biological tissue. Again, typical measurements will often be in the millirem (mrem), or one-thousandth of a rem, range. In the international scientific community, absorbed dose and biological exposure are expressed in *grays* and *sieverts*. 1 gray (Gy) equals 100 rad. 1 sievert (Sv) equals 100 rem. On the average, Americans receive about 360 mrem of radiation a year. Most of this (97%) is from natural radiation and medical exposure. Specific examples of common sources of radiation are shown in the chart below.

Cosmic Radiation

Cosmic radiation is high-energy gamma radiation that originates in outer space and filters through our atmosphere.

Sea Level	26 mrem/year
(increases about 1/2 mrem for each additional 100 feet in elevation)	
Atlanta, Georgia (1,050 feet)	31 mrem/year
Denver, Colorado (5,300 feet)	50 mrem/year
Minneapolis, Minnesota (815 feet)	30 mrem/year
Salt Lake City, Utah (4,400 feet)	46 mrem/year

Terrestrial Radiation

Terrestrial sources are naturally radioactive elements in the soil and water such as uranium, radium, and thorium. Average levels of these elements are 1 pCi/gram of soil.

United States (average)	26 mrem/year
Denver, Colorado	63 mrem/year
Nile Delta, Egypt	350 mrem/year
Paris, France	350 mrem/year
Coast of Kerala, India	400 mrem/year
McAlpe, Brazil	2,558 mrem/year
Pocos De Caldas, Brazil	7,000 mrem/year

Buildings

Many building materials, especially granite, contain naturally radioactive elements.

U.S. Capitol Building	85 mrem/year
Base of Statue of Liberty	325 mrem/year
Grand Central Station	525 mrem/year
The Vatican	800 mrem/year

Radon

Radon levels in buildings vary, depending on geographic location, from 0.1 to 200 pCi/liter. Average Indoor Radon Level 1.5 pCi/liter
Occupational Working Limit 100.0 pCi/liter

RADIATION IN THE ENVIRONMENT

Because the radioactivity of individual samples varies, the numbers given here are approximate or represent an average. They are shown to provide a perspective for concentrations and levels of radioactivity rather than dose.

mrem = millirem
pCi = picocurie

Food

Food contributes an average of 20 mrem/year, mostly from potassium-40, carbon-14, hydrogen-3, radium-226, and thorium-232.

Beer	390 pCi/liter
Tap Water	20 pCi/liter
Milk	1,400 pCi/liter
Salad Oil	4,900 pCi/liter
Whiskey	1,200 pCi/liter
Brazil Nuts	14 pCi/g
Bananas	3 pCi/g
Flour	0.14 pCi/g
Peanuts & Peanut Butter	0.12 pCi/g
Tea	0.40 pCi/g

Medical Treatment

The exposures from medical diagnosis vary widely according to the required procedure, the equipment and film used for x rays, and the skill of the operator.

Chest X Ray	10 mrem
Dental X Ray, Each	100 mrem

Consumer Goods

Cigarettes—two packs/day (polonium-210)	8,000 mrem/year
Color Television	<1 mrem/year
Gas Lantern Mantle (thorium-232)	2 mrem/year
Highway Construction	4 mrem/year
Airplane Travel at 39,000 feet (cosmic)	0.5 mrem/hour
Natural Gas Heating and Cooking (radon-222)	2 mrem/year
Phosphate Fertilizers	4 mrem/year

Natural Radioactivity in Florida Phosphate Fertilizers (in pCi/gram)

	Normal Superphosphate	Concentrated Superphosphate	Gypsum
Ra-226	21.3	21.0	33.0
U-238	20.1	58.0	6.0
Th-230	18.9	48.0	13.0
Th-232	0.6	1.3	0.3

Porcelain Dentures

(uranium)	1,500 mrem/year
Radioluminescent Clock (promethium-147)	<1 mrem/year
Smoke Detector (americium-241)	0.01 mrem/year

International Nuclear Weapons Test Fallout from pre-1980 atmospheric tests

(average for a U.S. citizen) 1 mrem/year

References

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- Radiation in Medicine and Industry. A.P. Jacobson and G.P. Sokolovsky, 1980.
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PERSPECTIVE: How Big is a Picocurie?

The *curie* is a standard measure for the intensity of radioactivity contained in a sample of radioactive material. It was named after French scientists Marie and Pierre Curie for their landmark research into the nature of radioactivity.

The basis for the curie is the radioactivity of one gram of radium. Radium decays at a rate of about 2.2 trillion disintegrations (2.2×10^{12}) per minute. A *picocurie* is one trillionth of a curie. Thus, a picocurie represents 2.2 disintegrations per minute.

To put the relative size of one *trillionth* into perspective, consider that if the Earth were reduced to one trillionth of its diameter, the "pico earth" would be smaller in diameter than a speck of dust. In fact, it would be six times smaller than the thickness of a human hair.

The difference between the curie and the picocurie is so vast that other metric units are used between them. These are as follows:

Millicurie =	$\frac{1}{1,000}$ (one thousandth) of a curie
Microcurie =	$\frac{1}{1,000,000}$ (one millionth) of a curie
Nanocurie =	$\frac{1}{1,000,000,000}$ (one billionth) of a curie
Picocurie =	$\frac{1}{1,000,000,000,000}$ (one trillionth) of a curie

The following chart shows the relative differences between the units and gives analogies in dollars. It also gives examples of where these various amounts of radioactivity could typically be found. The number of disintegrations per minute has been rounded off for the chart.

UNIT OF RADIOACTIVITY	SYMBOL	DISINTEGRATIONS PER MINUTE	DOLLAR ANALOGY	EXAMPLES OF RADIOACTIVE MATERIALS
1 Curie	CI	2×10^{12} or 2 Trillion	2 Times the Annual Federal Budget	Nuclear Medicine Generator
1 Millicurie	mCI	2×10^9 or 2 Billion	Cost of a New Interstate Highway from Atlanta to San Francisco	Amount Used for a Brain or Liver Scan
1 Microcurie	μ CI	2×10^6 or 2 Million	All-Star Baseball Player's Salary	Amount Used in Thyroid Tests
1 Nanocurie	nCI	2×10^3 or 2 Thousand	Annual Home Energy Costs	Consumer Products
1 Picocurie	pCI	2	Cost of a Hamburger and Coke	Background Environmental Levels

PERSPECTIVE: Radioactivity in Gas Lantern Mantles

Around the House

Many household products contain a small amount of radioactivity. Examples include gas lantern mantles, smoke detectors, dentures, camera lenses, and anti-static brushes.

The radioactivity is added to the products either specifically to make them work, or as a result of using compounds of elements like thorium and uranium in producing them. The amount of radiation the products gives off is not considered significant. But with today's sensitive equipment, it can be detected.

Lanterns: In a New Light

About 20 million gas lantern mantles are used by campers each year in the United States.

Under today's standards, the amount of natural radioactivity found in a lantern mantle would require precautions in handling it at many Government or industry sites. The radioactivity present would contaminate 15 pounds of dirt to above allowable levels. This is because the average mantle contains 1/3 of a gram of thorium oxide, which has a specific activity (a measure of radioactivity) of approximately 100,000 picocuries per gram. The approximately 35,000 picocuries of radioactivity in the mantle would, if thrown onto the ground, be considered low-level radioactive contamination.

APPENDIX E
WELL CONSTRUCTION LOG

OBSERVATION WELL		PROJECT	FUSRAP		WELL NO.	CISS- 1	
JOB NO. 14501	SITE COLONIE I.S.S.		COORDINATES N 980829 E 642361				
BEGUN 11/7/84	COMPLETED 11/7/84	PREPARED BY E. W. LUNDEEN	REFERENCE POINT FOR MEASUREMENTS TOP OF SURFACE CASING				

	DEPTH (FT)	ELEV. (FT)
GROUND SURFACE	0.0	228.90
ELEV. - TOP OF SURFACE CASING		231.45
ELEV. - TOP OF RISER CASING		230.91
BOTTOM OF SURFACE CASING	3.20	225.70
TOP OF SEAL	3.30	225.60
TOP OF FILTER PACK	3.97	224.93
TOP OF SCREEN	5.97	222.93
BOTTOM OF SCREEN	10.97	217.93
BOTTOM OF SLUMP	12.97	215.93
BOTTOM OF HOLE	14.00	214.90

GENERALIZED GEOLOGIC LOG

0.0 - 10.80 FEET
DUNE SAND:
LIGHT BROWN, FINE-
TO-MEDIUM GRAINED,
LOOSE.

10.80 - 14.00 FEET
UPPER SAND:
SILTY SAND AND SILT,
GRAY BROWN, SOME
CLAYEY SILT.

SURFACE CASING
DIA: 6 INCHES
TYPE: STEEL, 1/8 IN. GAUGE

BACKFILL MATERIAL
TYPE: CEMENT GROUT: 1:1
WITH 2.5% BENTONITE BY WT.

RISER CASING
DIA: 2 INCHES
TYPE: SCHEDULE 40 PVC

ANNULAR SEAL
TYPE: BENTONITE PELLETS

FILTER PACK
TYPE: SAND (40 ROCK)

SCREEN:
DIA: 2 INCHES
TYPE: SCHEDULE 40
PVC
OPENINGS: WIDTH: 0.01 INCH
TYPE: MACHINE SLOTTED

HOLE DIA: 7.5 INCHES

END

DATE FILMED

12 / 17 / 90