DOE/OR/21949-365

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-91OR21949

WAYNE INTERIM STORAGE SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1992

868 Black Oak Ridge Road
Wayne, New Jersey

May 1993

4.120 1104.5

DOE/OR/21949-365

WAYNE INTERIM STORAGE SITE

ENVIRONMENTAL REPORT

FOR CALENDAR YEAR 1992

868 BLACK OAK RIDGE ROAD

WAYNE, NEW JERSEY

MAY 1993

Prepared for

United States Department of Energy

Oak Ridge Operations Office

Under Contract No. DE-AC05-91OR21949

By

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

EXECUTIVE SUMMARY

This report describes the environmental surveillance program at the Wayne Interim Storage Site (WISS) and provides the results for 1992. The fenced, 2.6-ha (6.5-acre) site, 32 km (20 mi) northwest of Newark, New Jersey, was used between 1948 and 1971 for commercial processing of monazite sand to separate natural radioisotopes— predominantly thorium.

Environmental surveillance of WISS began in 1984 in accordance with Department of Energy (DOE) Order 5400.1 when Congress added the site to DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP). FUSRAP was established to identify and 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. WISS is part of a National Priorities List (NPL) site.

The environmental surveillance program at WISS includes sampling networks for radon and thoron in air; external gamma radiation exposure; radium-226, radium-228, thorium-230, thorium-232, total uranium, and several chemicals in surface water and sediment; and total uranium, radium-226, radium-228, thorium-230, thorium-232, and organic and inorganic chemicals in groundwater.

Monitoring results are compared with applicable Environmental Protection Agency (EPA) and state standards, DOE derived concentration guides (DCGs), dose limits, and other DOE requirements. This monitoring program assists in fulfilling the DOE policy of measuring and monitoring effluents from DOE activities and calculating hypothetical doses.

Results for environmental surveillance in 1992 show that the concentrations of all radioactive and most chemical contaminants were below applicable standards. In groundwater, four metals were detected at concentrations above New Jersey Groundwater Quality Standards (NJGQS): aluminum, iron, and manganese in samples from three wells and lead in a sample from one well. The hypothetical radiation dose calculated for a

maximally exposed individual and for the population within an 80-km (50-mi) radius was not distinguishable from natural background.

During 1992 site activities included routine maintenance, environmental surveillance, and onsite sampling in support of the Wayne site remedial investigation. The only potential for release from the site is through contaminant migration. There were no specific releases from the site. Based on the present knowledge of site conditions, WISS was in compliance with applicable federal and state regulations, except for the aluminum, iron, manganese, and lead in groundwater that exceeded NJGQS. Groundwater contamination will be discussed in the feasibility study-environmental impact statement (FS-EIS) being prepared for site remediation. A permit application has been submitted to the State of New Jersey to address the discharge of stormwater from WISS.

The complete environmental report is routinely distributed to representatives of federal, state, and local agencies and to individuals who have requested copies. The report is also available to the media and is part of the site's administrative record file located at the Wayne Public Library and in the public information office.

COMPLIANCE SUMMARY

The primary regulatory guidelines, limits, and DOE requirements for environmental monitoring originate in the following federal acts: the Clean Air Act (CAA); the Clean Water Act (CWA); the Safe Drinking Water Act (SDWA); the Resource Conservation and Recovery Act (RCRA); the Toxic Substances Control Act (TSCA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the National Environmental Policy Act (NEPA); and the National Historic Preservation Act.

Environmental remediation of WISS is being conducted in accordance with CERCLA, the protocol for remediating low-level radioactive contamination at FUSRAP sites, and applicable DOE requirements authorized by the Atomic Energy Act. The following summaries identify applicable or relevant and appropriate requirements (ARARs) as they existed in 1992 and the first quarter of 1993, define the status of compliance with the referenced requirements, and forecast the regulatory changes that may affect the site in the near future.

PRIMARY REGULATORY GUIDELINES

DOE Requirements for Radionuclide Releases

Site releases must comply with specific DOE requirements that establish quantitative limits, DCGs, and dose limits for radiological releases from DOE facilities. A review of environmental monitoring results for 1992 shows that WISS was in compliance with all applicable DOE radionuclide release standards.

Clean Air Act and National Emission Standards for Hazardous Air Pollutants

The primary federal statute governing air emissions is the CAA. The only potential source of air emissions from WISS is radionuclide emissions from contaminated soil. WISS is not required to have any state or federal air permits, pursuant to the authority of CERCLA Section 121. Although WISS is a nonoperating DOE facility, Subpart H ("National Emission

Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities") and Subpart Q ("National Emission Standards for Radon Emissions from Department of Energy Facilities") of the National Emission Standards for Hazardous Air Pollutants are potentially applicable. However, Subpart Q was determined to not apply to the WISS interim storage pile because calculations show that the waste does not contain radium-226 of sufficient concentration to emit radon-222 in excess of the applicable standards established in this regulation.

In 1992 compliance with the emission standard for other radionuclides under Subpart H was evaluated using the EPA Clean Air Act Assessment Package-1988 (CAP-88) PC computer model. An annual report is due to EPA on June 30, 1993. Calculations indicate that the site is in compliance with Subpart H.

Clean Water Act

Pollutants discharged to waters of the United States are regulated under the CWA as promulgated and implemented by the State of New Jersey. Stormwater and shallow groundwater are the primary pathways for discharges to surface water. Compliance activities in progress include the submittal of an application for a stormwater permit to the New Jersey Department of Environmental Protection and Energy (NJDEPE) on September 30, 1992. Additional sampling is planned to further characterize stormwater flow onto the site.

Safe Drinking Water Act

The SDWA was enacted by Congress in 1974 to regulate drinking water systems, provide for the protection of aquifers, and require EPA to establish primary drinking water regulations for contaminants that can cause adverse public health effects. The regulations established by EPA for drinking water systems include both mandatory levels [maximum contaminant levels (MCLs)] and nonenforceable health goals [maximum contaminant level goals (MCLGs)] for regulated contaminants in drinking water.

Under the 1986 Superfund Amendments and Reauthorization Act, drinking water MCLs and MCLGs for regulated contaminants are ARARs that CERCLA cleanups must meet for groundwater or surface water that is a current or potential source of drinking water. New Jersey is responsible for primary enforcement of federal drinking water regulations, and federal and state standards for regulated radionuclides in groundwater and surface water are identical.

In addition, New Jersey, unlike EPA, has established standards for contaminants in groundwater. These standards, revised in February 1993, also establish numerical criteria for regulated radionuclides in groundwater that are the same as federal and state SDWA standards. Under CERCLA, state groundwater standards that are more stringent than federal standards are ARARs to be attained during site remediation.

Chemical data for groundwater monitoring have been evaluated to determine whether cleanup levels are meeting the newly revised standards. Lead concentrations in two wells exceeded the standards. Groundwater contamination will be discussed in the CERCLA FS-EIS being prepared for site remediation.

Resource Conservation and Recovery Act

RCRA is the principal federal statute governing the management of hazardous waste. In 1991 approximately 40 soil samples were taken from the interim storage pile at WISS for analysis using the toxicity characteristic leaching procedure (TCLP). Based on an evaluation of the sample data, the soil in the pile does not meet the criteria for classification as "hazardous waste." Samples were also collected from onsite soils outside of the pile and analyzed using the TCLP. These soil samples also did not meet the hazardous waste classification criteria.

Toxic Substances Control Act

The most common toxic substances regulated by TSCA are polychlorinated biphenyls and asbestos. TSCA-regulated waste has not been detected at WISS.

Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan are the primary sources of federal regulatory authority at WISS.

Because WISS is on the NPL, a federal facilities agreement between EPA Region II and DOE was established on April 22, 1991, for site remedial action. The agreement defines the roles and responsibilities of the respective agencies and provides a schedule for the completion of a remedial investigation/FS for the site. A record of decision, which documents the remedial action alternative selected for the site, is scheduled for 1993.

DOE's policy is to integrate NEPA documentation requirements with the procedural and documentation requirements of CERCLA. The two laws have significant similarities in content; however, they have differences in scope, specific procedures, and definition of terms. DOE integrates CERCLA and NEPA to avoid the duplication of effort and the larger commitment of resources needed to implement both statutes separately.

National Environmental Policy Act

NEPA requires an analysis of potential environmental impacts from proposed federal projects including the cleanup of the Wayne site. This analysis will be contained in an EIS, which will be combined with the FS, as required by CERCLA.

Categorical exclusions for routine maintenance and environmental monitoring activities were approved in 1992. A categorical exclusion is a category of actions, defined by 40 CFR 1508, that would not normally require an environmental assessment or EIS.

National Historic Preservation Act

The Office of New Jersey Heritage is evaluating WISS to determine whether historic and archeological resources are present. Any information required by this office will be submitted accordingly. FUSRAP is actively committed to its responsibilities for managing

cultural resources that may be affected by environmental restoration activities. The FUSRAP cultural resource management program ensures that the early stages of project planning provide for a thorough consideration of the areas of potential effects of environmental restoration activities on any cultural resources that may be located on FUSRAP sites. Consultation with state historical preservation officers, Native American groups, and local historians is ongoing to identify cultural resources that may be eligible for nomination to the National Register of Historic Places in accordance with requirements of Section 106 of the National Historic Preservation Act.

To date, the FUSRAP cultural resource management program has not identified any historic properties, such as districts, sites, buildings, and structures, at any of the FUSRAP sites that are currently undergoing environmental restoration.

Other Major Environmental Statutes and Executive Orders

In addition to DOE requirements and statutes, several other major environmental statutes have been reviewed for applicability. For example, the Federal Insecticide, Fungicide, and Rodenticide Act and the Endangered Species Act have been found to impose no current requirements on WISS. In addition, Executive Orders 11988 ("Floodplain Management") and 11990 ("Protection of Wetlands") and state laws and regulations have been reviewed for applicability. WISS is in compliance with all applicable federal and state environmental statutes, regulations, and executive orders other than those specifically noted in previous subsections. These statutes, regulations, and executive orders are reviewed regularly to maintain continual regulatory compliance at WISS.

APPLICABLE ENVIRONMENTAL PERMITS

As stated previously in the CWA section, a stormwater discharge permit application was submitted to NJDEPE pursuant to National Pollutant Discharge Elimination System regulations before the regulatory deadline of October 1, 1992.

SUMMARY OF REGULATORY COMPLIANCE IN CALENDAR YEAR 1993 (FIRST QUARTER)

During the first quarter of 1993, environmental monitoring continued, as did review of potentially applicable regulations for their impact on the site. Compliance issues currently being addressed include lead that was detected in excess of NJGQS.

CONTENTS

CONTENTS

(continued)

FIGURES

TABLES

TABLES

(continued)

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
BNI	Bechtel National, Inc.
CAA	Clean Air Act
CAP88	Clean Air Act Assessment Package-1988
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPRB	Central Passaic River Basin
CWA	Clean Water Act
DCG	derived concentration guide
DOE	Department of Energy
DQO	data quality objective
EIS	environmental impact statement
EPA	Environmental Protection Agency
FS	feasibility study
FUSRAP	Formerly Utilized Sites Remedial Action Program
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
NEPA	National Environmental Policy Act
NJDEPE	New Jersey Department of Environmental Protection and Energy

ACRONYMS

(continued)

NJGQS	New Jersey Groundwater Quality Standards
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyl
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI/FS-EIS	remedial investigation/feasibility study - environmental impact statement
RPD	relative percent difference
SDWA	Safe Drinking Water Act
TCLP	toxicity characteristic leaching procedure
TETLD	tissue-equivalent thermoluminescent dosimeter
TOC	total organic carbon
TOX	total organic halides
TPH	total petroleum hydrocarbon
TSCA	Toxic Substances Control Act
WISS	Wayne Interim Storage Site

UNITS OF MEASURE

Bq	becquerel
C	Celsius
cm	centimeter
F	Fahrenheit
ft	foot
ft msl	feet above mean sea level
g	gram
gpm	gallons per minute
h	hour
ha	hectare
km	kilometer
L	liter
m	meter
μCi	microcurie
μg	microgram
mi	mile
min	minute
ml	milliliter
mph	miles per hour
mR	milliroentgen
mrem	millirem
mSv	millisievert
pCi	picocurie
rem	roentgen equivalent man
s	second
Sv	sievert
yd	yard
yr	year

1.0 INTRODUCTION

Environmental monitoring of the U.S. Department of Energy's (DOE) Wayne Interim Storage Site (WISS) began in 1984. This document describes the environmental surveillance program, the results for 1992, and the regulatory compliance status of the site.

Environmental monitoring of WISS is managed under DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP). FUSRAP was established to identify and 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. A concerted effort is made to minimize waste and prevent further pollution.

1.1 SITE DESCRIPTION

WISS occupies approximately 2.6 ha (6.5 acres) in the Piedmont Plateau of north-central New Jersey within Wayne Township, Passaic County, approximately 32 km (20 mi) northwest of Newark, New Jersey, and 60 km (37 mi) northwest of New York City (Figure 1-1). WISS, Pompton Plains Railroad Spur, and vicinity properties compose the Wayne site. The WISS property is fenced and includes a two-story masonry building and a 1.1-ha (2.7-acre) interim storage pile. No processing activities are conducted, and no process effluents are generated at WISS. The pile contains low-level radioactively contaminated waste and covers approximately 1 ha (2.5 acres) in the center of the property. The storage pile is approximately 122 m (400 ft) long, 80 m (262 ft) wide, and a maximum of 5.5 m (18 ft) high; contains about 29,400 m^3 (38,500 yd^3) of waste; and is covered with a high-density polyethylene pile cover. The portion of the property outside the security fence consists of a small asphalt parking lot approximately 40 by 40 m (130 by 130 ft) in the northwestern corner and undeveloped wooded terrain along the eastern boundary (Figure 1-2). A leachate collection system within the pile and a liner system beneath the pile intercept any seepage that may occur.

The topography at WISS slopes gently and ranges in elevation from 60 to 69 m (197 to 226 ft) above mean sea level (MSL). The highest elevations are in the eastern portion of the property adjacent to the base of a ridge trending northwest to southeast. A drainage ditch traverses the eastern part of the property from south to north, turning west along the northern side of the site. The drainage ditch exits the site to the west through a manhole in the parking area and is considered the primary potential surface water pathway for contaminant migration. The area along the western side of the site is generally flat and slopes gently toward the Pompton River.

From 1948 through 1971, Rare Earths, Inc., and, later, W.R. Grace & Co., processed monazite sand to extract thorium and rare earth elements. Rare Earths received a license from the Atomic Energy Commission to conduct the operations in 1954, after passage of the Atomic Energy Act. In 1957 W.R. Grace (Davison Chemical Division) purchased the facility and continued production until July 1971. During the years of operation, some of the thorium process waste was buried onsite, and some was spread to low-lying properties by erosion and through storm drains and storm sewers. Process waste and residues included ore tailings, yttrium sludges, and sulfate precipitates.

After processing ceased in 1971, the facility was licensed only for storage. In 1974 W.R. Grace performed a partial decontamination during which some buildings were razed, and the rubble and equipment were buried onsite; the remaining buildings were decontaminated. In 1975 the facility was decommissioned, and W.R. Grace's license was terminated.

In 1980 the New Jersey Department of Environmental Protection and Energy (NJDEPE) conducted a radiological survey of the area and identified areas of elevated contamination. In September 1984 the Environmental Protection Agency (EPA) added the Wayne site to the National Priorities List. Since 1984, when the site was assigned to DOE by Congress through the Energy and Water Development Appropriations Act, WISS has served as an interim storage area. Contaminated materials removed from WISS and vicinity properties during 1985 through 1987 were consolidated onsite in an interim storage pile.

1.2 REGIONAL DEMOGRAPHY

Land use in the vicinity of WISS is predominantly residential and commercial (Figure 1-3). The site is bordered by residential property to the north and east, commercial property to the south and west, and agricultural property to the northwest. Figure 1-4 is an aerial photograph of WISS and its vicinity.

The population of Passaic County is about 450,000; the populations of Wayne and Pequannock townships are about 50,000 and 13,000, respectively. The nearest residential areas, primarily a mixture of single- and multiple-family dwellings, are less than 0.2 km (0.1 mi) from the site. The total population of the area within an 80-km (50-mi) radius is over 10 million.

1.3 HYDROGEOLOGIC SETTING

The most prominent site surface feature is the interim storage pile. About half of the fenced site is covered by a mound of mildly radioactively contaminated soil materials. The site slopes gently northwest toward the street. A drainage ditch along the eastern and northern sides exits to Sheffield Brook and the Pompton River about 0.8 km (0.5 mi) west.

1.3.1 Geology

The Wayne site lies within the geologic structure known as the Newark Basin, which extends from the Hudson River Valley of New York to southeastern Pennsylvania. The Newark Basin formed at the end of the Paleozoic epoch along the eastern portion of the North American continental margin. The basin was filled with clastic sediments (sand, silt, and clay) derived from the highlands to the west. These sediments are interbedded with igneous flow basalts that were deposited during the formation of the basin. Late structural deformation resulted in shallow, open folds and high-angle faulting along the basin margin. The high-angle faults bound en-echelon tilted blocks of sediment that step down to the east and tilt to the west and south. A thin veneer of glacial, fluvial (stream) deposits and lacustrine (lake) sediments covers the bedrock erosional surface. WISS is located in the

physiographic province known as the Central Passaic River Basin (CPRB), which corresponds to one of the aforementioned structural blocks. This feature is bordered on the west by the Ramapo Fault and on the east by a pronounced topographic ridge of Hook Mountain Basalt. This physiographic province contains isolated, sole-source aquifers in the glacial sediments and in the fractured bedrock units.

The bedrock underlying the site consists of lower Jurassic sedimentary and igneous rocks of the Brunswick Group, Newark Supergroup. Lithologies identified in geologic boreholes include conglomerates, sandstones, and siltstones of the Boonton Formation. The Hook Mountain Basalt underlies the site at an estimated depth of 107 m (350 ft) and outcrops along the ridge to the east. The bedrock units are fractured and tilt to the west-southwest at approximately 13 to 17 degrees. The bedrock surface was extensively eroded during the late Mesozoic and early Tertiary period. An erosional low area in the bedrock surface, probably produced by a dip-slope drainage stream, is present under the center of the Wayne site. Stream deposits composed of poorly sorted sand, gravel, fine-grained silt, and clay fill the erosional low in the area of WISS. These stream sediments and the upper weathered portion of the bedrock constitute the lower aquifer at WISS and are overlain by clay deposited in a glaciolacustrine environment. The clay unit confines the lower aquifer over most of the site and separates the lower stream sediments from the shallow deposits. The near-surface sediments are similar to the lower section below the lake clays. The shallow sediments, also deposited by stream processes, are composed of poorly sorted sand, gravel, silt, and clay. These shallow sediments constitute the upper aquifer in the WISS area. The stream, which deposited the shallow sediments and downcut into the lake clays and in the northeastern portion of the site, has completely removed the lake beds.

1.3.2 Surface Water

WISS has an average slope of 10.3 percent toward the west. Elevations range from 60 to 69 m (197 to 226 ft) above MSL. Approximately 60 percent of the site is covered with grass and trees, and the remainder is covered with impervious materials (asphalt parking areas and buildings). WISS is drained by a stormwater drainage system of open ditches and underground conduits that discharges through a single manhole in the parking area. The

outflow from the manhole enters the city storm sewer system that discharges to Sheffield Brook. Surface water samples were collected at locations both onsite and offsite.

1.3.3 Groundwater

The CPRB, the physiographic region in which WISS is located, contains two primary aquifer systems: a bedrock system composed of Jurassic sedimentary and igneous rocks, and a shallow system (Buried-Valley aquifer) in the unconsolidated fluvial/glacial sediments. Groundwater flow in the bedrock aquifer is primarily internal to the CPRB. Recharge occurs along the highlands surrounding the basin, with flow toward the center of the CPRB and discharge upward into the overlying, unconsolidated sediments. Groundwater in the Buried-Valley aquifer is toward surface wetlands and down the basin, following low areas in the bedrock surface toward Hobart Gap. EPA has designated the bedrock and the Buried-Valley as sole-source aquifers. EPA Region II classifies all water in sole-source aquifers as Class-IIA, which is defined as a current supply for drinking water or other beneficial use. The bedrock aquifer has reported yields ranging from 1 to 32 L/s (20 to 510 gpm) with an average of 8 L/s (130 gpm). Yields from the Buried-Valley aquifer range from 0.25 to 58 L/s (4 to 920 gpm). In areas where the unconsolidated sediments are more extensive, well yields average 13 L/s (200 gpm).

Groundwater at WISS occurs in two aquifers. The lower zone aquifer includes the weathered upper portion of the Boonton Formation (bedrock) and the lower unconsolidated sediments, which are below the lake clay deposits. The lower aquifer typically exhibits flowing artesian conditions. The shallow aquifer exists in the surficial, coarse, clastic sediments of the unconsolidated sediments, which are above the lake clays. Groundwater is unconfined in this unit; depth to water ranges from the surface to 2.1 m (7 ft). Water levels in the upper aquifer fluctuate seasonally from 0.3 to 1.4 m (1 to 4.5 ft). The upper aquifer has an average hydraulic conductivity of 3×10^{-4} cm/s (310 ft/yr), an average gradient of 0.065 toward the west, and a computed linear flow velocity of 21 m/yr (70 ft/yr). The lower aquifer system has an average hydraulic gradient of 1×10^{-4} cm/s (104 ft/yr), an average gradient of 0.04 toward the west, and a computed flow velocity of 24 to 126 m/yr

(80 to 415 ft/yr). Hydrographs of groundwater level fluctuations are included in Appendix A.

Water Supply

Drinking water is supplied to Passaic and Morris counties from surface water and groundwater sources. In 1975, 93.5 percent of the public drinking water in Passaic County was derived from surface water sources; however, in Morris County, 89.9 percent of the public drinking water was supplied by groundwater sources (Hoffman 1989). A search of NJDEPE records identified 89 water wells drilled between 1940 and 1988 within a 1.6-km (1-mi) radius of WISS. Depths range from 9 to 150 m (30 to 493 ft) with reported yields of 1.9 to 3,236 L/min (0.5 to 855 gpm). The number and reported uses of the wells are: 56 for domestic use, 3 for industrial use, 5 for irrigation, and 4 for public supply. Information regarding use of the remaining 21 wells was not available. Five high-yield wells are located within 1.6 km (1 mi) of the site. Four of these are municipal supply wells; three are owned by the Wayne Township, and one is owned by Pompton Lakes Borough. The remaining well provides irrigation to a farm located approximately 300 m (1,000 ft) west of the site. The municipal supply wells closest to the site are upgradient of the site and located approximately 0.8 km (0.5 mi) northeast and approximately 1.1 km (0.7 mi) southeast of the site.

1.4 CLIMATE

Climatological data from the National Oceanic and Atmospheric Administration (NOAA) for the Newark vicinity for 1992 show that temperature extremes ranged from -12° to 36°C (10° to 97°F). Average wind speeds ranged from 14 to 18.4 km/h (8.7 to 11.4 mph), and the predominant resultant wind direction was from the west (NOAA 1993). The minimum monthly precipitation [1.85 cm (0.73 in.)] occurred in October 1992, the maximum [12.8 cm (5.02 in.)] occurred in November 1992, and the average for 1992 was 7.77 cm (3.06 in.).

FIGURES FOR SECTION 1.0

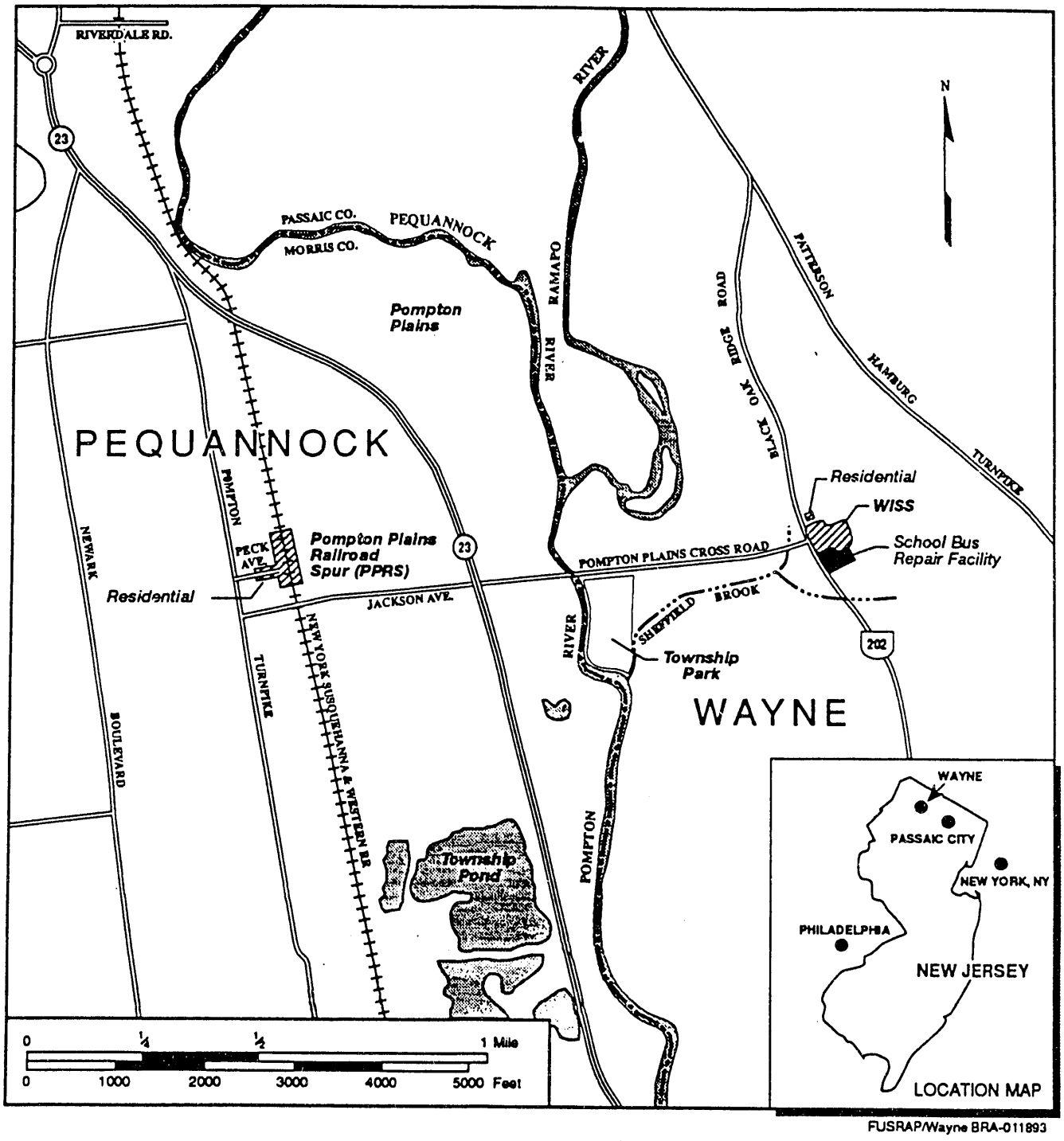
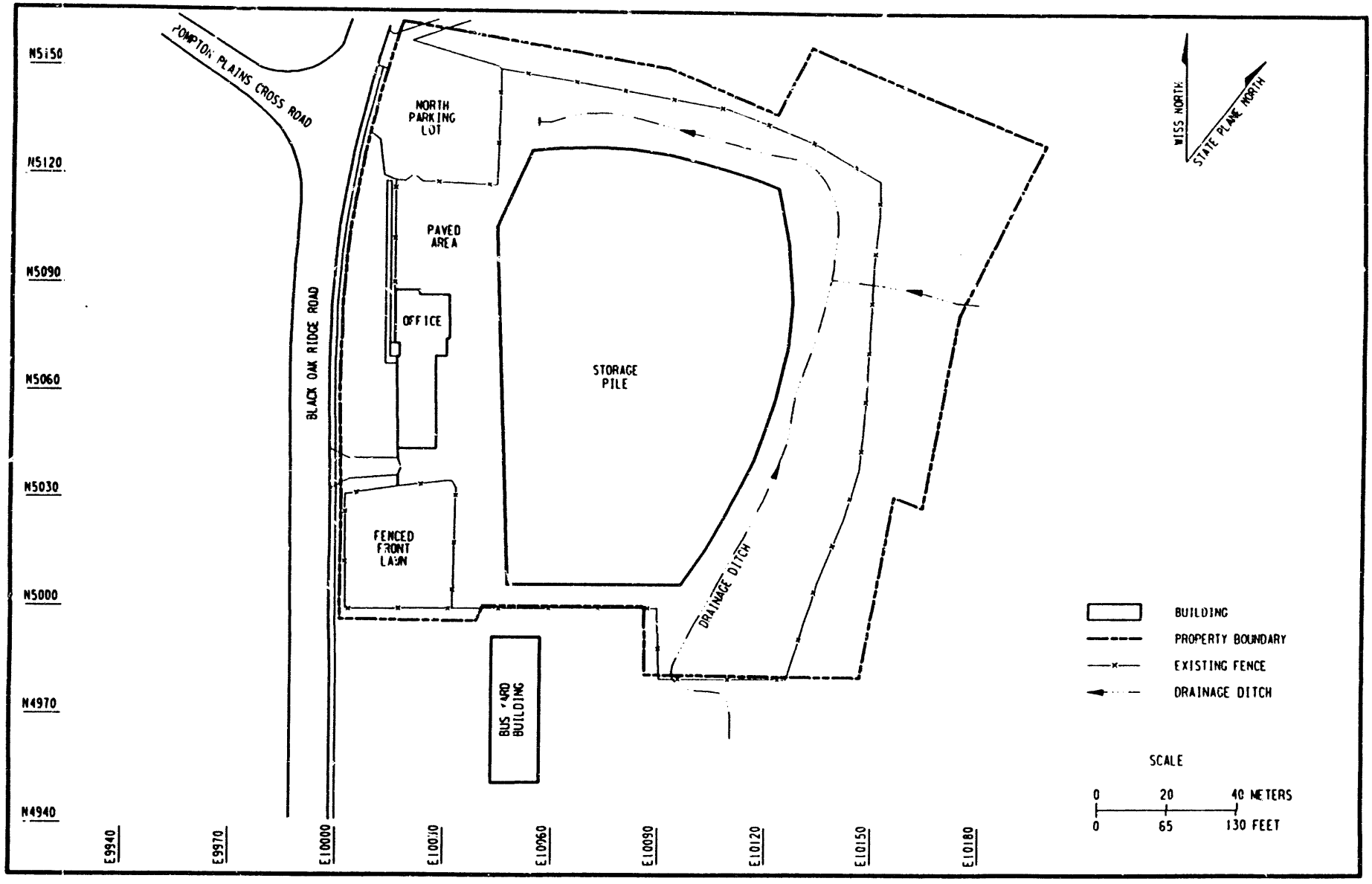
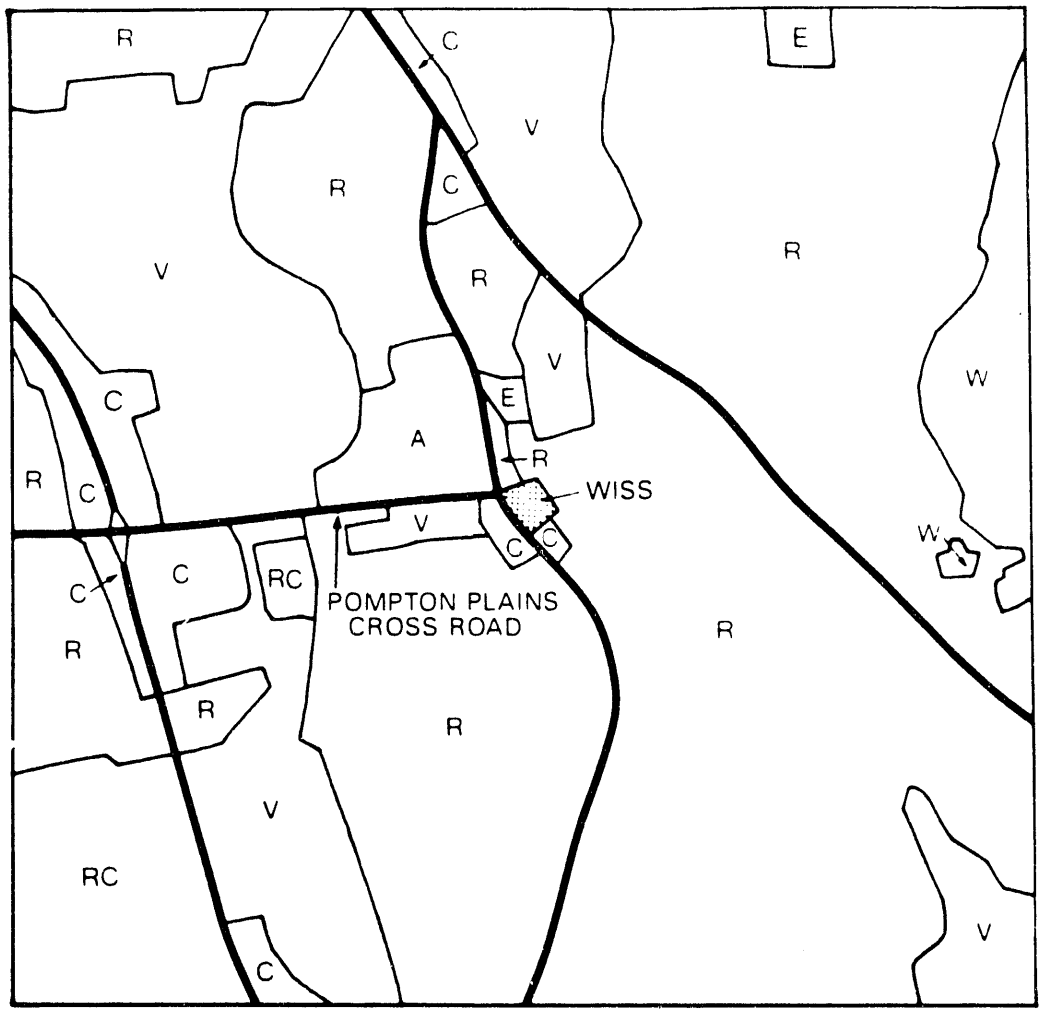


Figure 1-1
Wayne Site Location Map



137 R38F007.DGN

Figure 1-2
Site Plan of WISS



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

A	AGRICULTURAL	RC	RECREATIONAL
C	COMMERCIAL	V	VACANT
E	EDUCATIONAL	W	RESERVOIR
R	RESIDENTIAL		

0 0.5 MI
0 0.8 KM

N

Figure 1-3
Generalized Land Use in the Vicinity of WISS

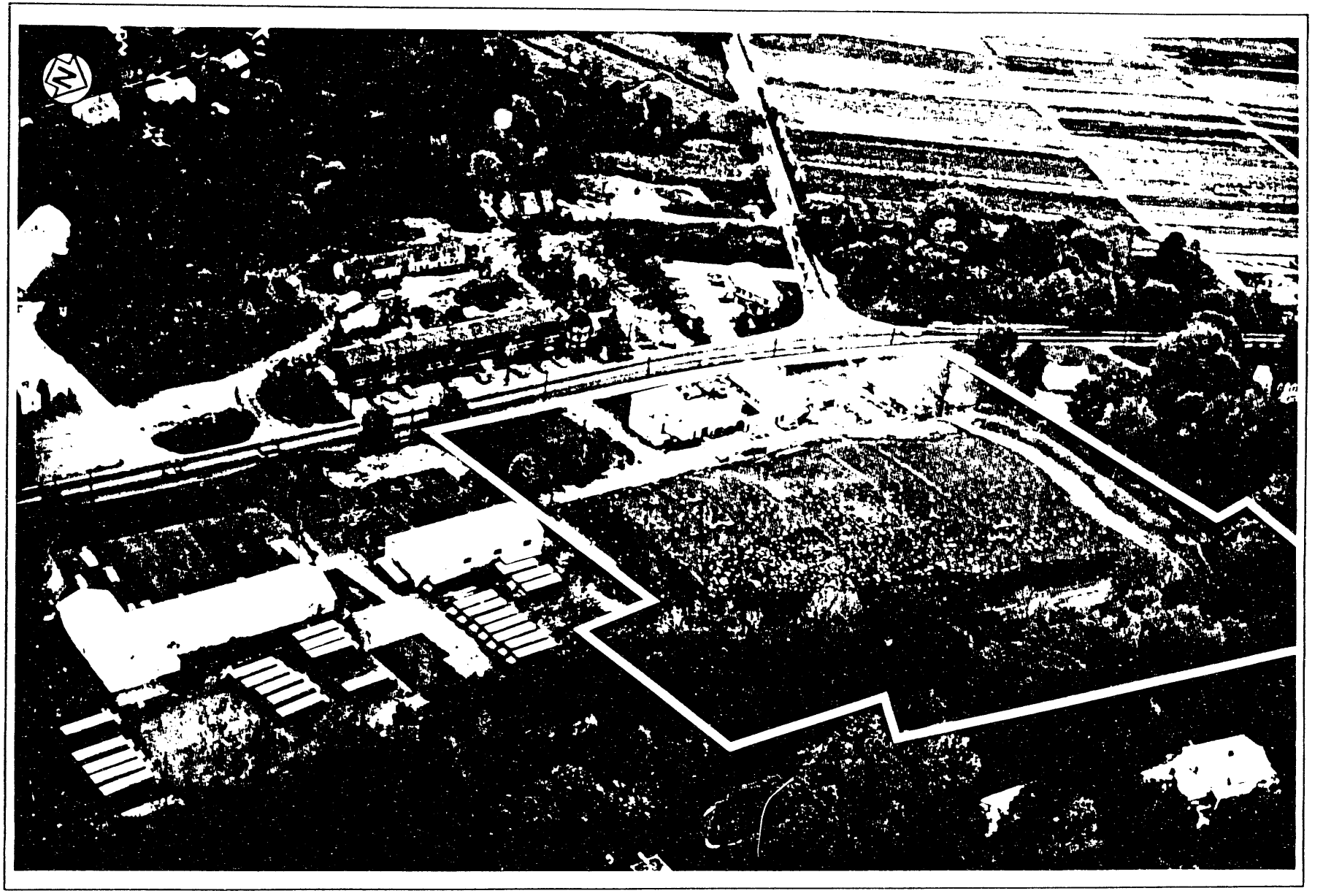


Figure 1-4
Aerial View of WISS

2.0 ENVIRONMENTAL PROGRAM INFORMATION

This section describes programmatic activities conducted at WISS other than those conducted as part of routine environmental monitoring. Environmental program information discussed in this section includes descriptions of the following:

- Emissions monitoring
- Environmental documentation activities
- Significant environmental activities at the site
- Environmental awareness activities such as employee education programs to help promote waste minimization at the site, site safety inspections, and employee training programs
- Self-assessment activities

Information regarding routine environmental surveillance at the site is provided in Section 3.0.

2.1 PERMIT ACTIVITIES

An application for a stormwater permit was submitted to NJDEPE on September 30, 1992 (DOE 1992a). Based on the present knowledge of site conditions and the onsite permitting exemption accorded under the Comprehensive Environmental Response, Compensation, and Liability Act to sites being remediated, no other permits are required.

2.2 EMISSIONS MONITORING

There were no environmental occurrences or unplanned releases during 1992. No reports under Section 313 of the Emergency Preparedness and Community Right-to-Know Act were required. FUSRAP sites were not subject to toxic chemical release reporting provisions under 40 CFR 372.22 in 1992.

However, FUSRAP evaluates and inventories chemicals used onsite. Small quantities of chemicals such as nitric acid, isopropyl alcohol, and fuels for maintenance activities are used at FUSRAP sites for sampling and other purposes. An active material safety data sheet log and a chemical inventory are maintained onsite.

2.3 ENVIRONMENTAL DOCUMENTATION

A remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS) is being prepared, and completion is scheduled for 1994. Categorical exclusions under the National Environmental Policy Act for routine site maintenance and environmental monitoring were issued (DOE 1992b,c).

2.4 SIGNIFICANT ENVIRONMENTAL ACTIVITIES

2.4.1 Special Studies

All remaining field work for the WISS RI has been completed, and the RI report is being prepared along with the FS and baseline risk assessment. These documents will be used for developing a proposed plan and record of decision for cleanup of the Wayne site.

2.4.2 Environmental Monitoring Changes

The environmental surveillance programs at FUSRAP sites are periodically evaluated and revised based on individual site conditions, program objectives, and monitoring results. Revisions can consist of the number of sample collection points, frequency of sample collection, and parameters analyzed. This section summarizes changes in the WISS environmental program from 1991 to 1992 (BNI 1991b).

Surface Water and Sediment

The sampling location in the drainage ditch upstream was deleted because it was often dry. Two sampling locations remain: one upstream and one downstream in Sheffield Brook

(locations are shown in Section 3.0). The quarterly sampling frequency was reduced to semiannual sampling, and the number of analytical parameters was reduced because the concentrations detected were essentially at background levels during the past five years (BNI 1991).

Groundwater

The scope of the groundwater sampling program was reduced in 1992; the revised scope included collection of samples from fewer wells (five overburden wells) and reduction in sampling frequency from quarterly to annually. The samples were analyzed for concentrations of radionuclides, total metals, volatile and semivolatile organic compounds, pesticides, and polychlorinated biphenyls (PCBs).

All wells completed in bedrock and four wells completed in the overburden were deleted from the program. This reduction was based on the following considerations:

- The wells completed in bedrock exhibit artesian conditions. The potentiometric heads in these wells are above ground surface and are higher than measured water levels in the unconfined water table. Therefore, vertical gradients are upward from the bedrock to the upper unconsolidated sediments, which precludes the downward migration of contaminants to the lower aquifer.

- Based on the groundwater data collected at the site from 1985 through 1990, annual sample collection from one upgradient well and four downgradient wells completed in the overburden should provide sufficient coverage of the site for detection monitoring.

External Gamma Radiation

Only minor changes were made in the sampling locations, which are shown in Section 3.0. Because of the completeness of existing data, the low contaminant levels found, and the site inactivity, sampling locations were adjusted (BNI 1991). These changes provide

for less redundancy in the data collected from these locations and more complete coverage of the site boundaries.

Radon/Thoron

The sampling locations were changed commensurate with the external gamma radiation monitoring locations, and the sampling frequency remained quarterly (BNI 1991).

2.4.3 Remedial Actions

No remedial actions were conducted at WISS in 1992, but site characterization activities were performed to support development of the RI/FS-EIS, which is scheduled for completion in 1994.

2.5 ENVIRONMENTAL AWARENESS ACTIVITIES

FUSRAP is committed to minimizing the generation of waste at FUSRAP sites and uses methods for waste minimization including source reduction, material substitution, and recycling. The development of waste minimization goals, waste generation information, and a process for continual evaluation of the program are primary elements of this philosophy.

Pollution prevention awareness is promoted and various waste minimization techniques are implemented as part of continuing employee training and awareness programs to reduce waste and meet the requirements for quality, safety, and environmental compliance. No hazardous waste minimization certifications or waste reduction reports for waste generators were required during this reporting period.

Site workers must complete a 40-h hazardous waste training program before beginning work and an 8-h refresher program annually thereafter to comply with Occupational Safety and Health Administration requirements in 29 CFR 1910.120. During their first three days onsite, workers also attend site-specific training sessions. Additional training includes, but is

not limited to, fire extinguisher training, respirator training, self-contained breathing apparatus training, and weekly safety meetings.

Routine safety and security inspections are conducted at the site to ensure that the site is in good repair and is safe for site workers and the public.

2.6 SELF-ASSESSMENTS

A formalized self-assessment approach for all FUSRAP sites was approved on April 22, 1993, specifically addressing self-assessment activities for the program during the remainder of fiscal year 1993 and in fiscal year 1994. A self-assessment was conducted in late December 1992 for WISS. The final report is scheduled for completion in June 1993.

3.0 MONITORING NETWORKS AND RESULTS

WISS is not an active site and produces no processing effluents. The only possibility for contamination to be released from the site is through natural migration. The adequacy of existing monitoring activities is assessed annually, and the results are used to identify any changes necessary in the program. These may result from changing site conditions, changing regulatory requirements, or newly identified data needs to support the remedy selection process being conducted for the site. Additionally, as monitoring data are accumulated, decisions may be made to adjust monitoring requirements. Future site environmental reports will reflect these changes.

Environmental monitoring at WISS in 1992 included sampling for:

- Radon and thoron concentrations in air
- External gamma radiation exposure
- Selected inorganic and organic parameters and radium-226, radium-228, thorium-230, thorium-232, and total uranium concentrations in surface water and sediment
- Selected inorganic and organic parameters and total uranium, radium-226, and thorium-232 in groundwater

Readers not familiar with radiation units may benefit from reviewing Appendix B before proceeding.

The monitoring systems included onsite, site boundary, and offsite stations to provide sufficient information on the potential effects of the site on human health and the environment. The sampling was conducted in accordance with EPA protocols and NJDEPE field sampling procedures. The analytical methods performed on the parameters in each matrix are identified in Appendix C.

This section (3.0) contains the results for each sampling point, annual averages, and trend information where applicable. The methodology for evaluating the results is provided in Appendix D. The results are compared with the standards listed in Appendix E.

3.1 AIR MONITORING

3.1.1 Radon/Thoron

One of the potential pathways of radiation exposure from the uranium-238 decay series is the inhalation of the radioactive gas radon-222 and its associated decay products. Radon-222 has a short half-life (3.8 days), which is the time it takes for half of the activity to decay. When the gaseous radon decays, it forms a radioactive particulate (solid) that attaches itself to very small dust particles that can also be inhaled. Similarly, in the thorium-232 decay series, inhalation of the radioactive gas radon-220 (or thoron) and its associated decay products is a potential pathway for radiation exposure. The half-life of thoron is very short (55 seconds), and the associated decay products are also radioactive solids that attach themselves to particles. Both radon and thoron decay by the emission of alpha particles that travel only a very short distance in air (about an inch) before losing their energy and ability to contribute a radiation dose to an individual.

Because radon and thoron are gaseous and subsequently decay to products that attach themselves to very small, easily dispersible particles, they are very mobile in air and are diluted and dissipated very quickly in the environment.

Radon and thoron are monitored quarterly at WISS to evaluate compliance with environmental regulations and to aid in the determination of the potential dose to the maximally exposed member of the general public. Some locations were changed in 1992 to provide for more complete coverage of the site boundary; 1991 and 1992 monitoring locations are shown in Figures 3-1 and 3-2, respectively.

As shown in Tables 3-1 and 3-2, all monitoring locations yielded annual average results that were essentially the same as background levels. The trends observed for 1992 and the preceding five years indicate that none of the average radon boundary levels exceeded the highest average background level and that thoron levels remained similarly low.

3.1.2 External Gamma Radiation

External gamma radiation exposure rates are measured as part of the routine environmental surveillance program to confirm that direct radiation from WISS is not significantly increasing radiation levels above natural background and to ensure compliance with environmental regulations.

Although the tissue-equivalent thermoluminescent dosimeters (TETLDs) used for monitoring are state-of-the-art, the dosimeter accuracy is approximately ± 10 percent at exposure rates between 100 and 1,000 mR/yr (1 and 10 mSv/yr) and ± 25 percent at rates between 0 and 100 mR/yr (1 mSv/yr).

The external gamma radiation background value is not constant for a given location or from one location to another, even over a short time, because the value is affected by a combination of both natural terrestrial and cosmic radiation sources and factors such as the location of the dosimeter in relation to surface rock outcrops, stone or concrete structures, and highly mineralized soil. Dosimeters are also influenced by site altitude, annual barometric pressure cycles, and the occurrence and frequency of solar flare activity (Eisenbud 1987). Thus, external gamma radiation exposure rates at the boundary could be less than the background rates measured some distance from the site, or rates onsite could be lower than at the boundary.

The annual average external gamma radiation exposure rates at WISS in 1992 listed in Table 3-3 were 170 mR/yr (1.7 mSv/yr) onsite and 13 mR/yr (0.13 mSv/yr) at the fenceline, not including an average background value of 82 mR/yr (0.82 mSv/yr). The highest reading, which was at location 12 [170 mR/yr (1.7 mSv/yr)], was approximately twice last year's result. Redistribution of drummed waste material that is stored in the building near this

location may have been a contributing factor. This location will be observed closely during the next year for a further rate increase. Information on public exposure is discussed in Section 4.0. Locations 11 and 16 are in an area with subsurface contamination (Figure 3-2).

For comparison, Table 3-4 shows the annual average external gamma radiation exposure rates at the site boundary, in the vicinity of the site, and across the nation. Based on these data, the thorium-contaminated soil stored at WISS does not present a threat to the public from external gamma radiation exposure because the rates are so low. In addition, access to the material is restricted.

3.2 SURFACE WATER AND SEDIMENT

3.2.1 Monitoring Network

Beginning in 1992, surface water and sediment samples were collected semiannually at locations 5 and 6 (Figure 3-3) and analyzed for radium-226, radium-228, thorium-230, thorium-232, and total uranium. Surface water samples were also collected and analyzed annually for the indicator parameters pH, specific conductance, total organic halides (TOX), and total organic carbon (TOC). Surface water and sediment samples were collected and analyzed annually for total petroleum hydrocarbons (TPH) and for the 25 metals listed in Appendix C, Tables C-1 and C-2.

3.2.2 Surface Water Results

The results for the radiological analysis of surface water in 1992 and the previous five years are essentially the same as background levels (Table 3-5). The naturally occurring elements boron, calcium, iron, magnesium, manganese, and sodium were found in surface water, but there were no unusual findings from the chemical analyses. All results except for iron were below SDWA MCLs, MCLGs, and New Jersey surface water quality criteria.

3.2.3 Sediment Results

A trend analysis of data from 1992 and the previous five years (Table 3-6) indicates that concentrations of radionuclides in sediment have remained stable and are comparable to background. The TPH concentration was above the detection limit, but this is not unusual because of the proximity of the sampling location to two heavily traveled roads.

3.3 GROUNDWATER MONITORING

Groundwater monitoring was conducted to detect potential contaminants in the shallow groundwater and to ensure compliance with environmental regulations. Groundwater monitoring well locations are shown in Figure 3-4.

3.3.1 Monitoring Well Network

The existing groundwater monitoring network consists of 17 wells. Six well pairs (WISS-1 through WISS-6) were installed in 1984 and 1985 as part of the DOE environmental surveillance program; these wells are located along the perimeter of the site and were first sampled in 1985. Two well pairs and one single well (B37W07, B37W08, and B37W09) were installed in 1989; these wells, also located along the site perimeter, were initially sampled in October 1991. Each well pair consists of one well completed in the upper unit of the unconsolidated sediments and one well completed in the shallow bedrock [upper 12 m (40 ft)]. The single well (B37W07S) is completed in the lower unit of the overburden. Wells WISS-1A and WISS-1B (located along the southeastern perimeter) and B37W09S and B37W09D (located along the eastern perimeter) are on the upgradient side of WISS, and the concentrations of the constituents found in these wells are considered baseline for the property. Depths of wells completed in the overburden range from 4.3 to 9.8 m (14 to 32 ft), and depths of wells completed in the bedrock range from 17 to 24.7 m (56 to 81 ft).

Data for 1985 to 1992 are available from DOE's ongoing environmental surveillance program. The standard analyses for the program from 1985 through 1991 included quarterly analyses for radium-226, radium-228, thorium-232, and total uranium and annual analyses for organic chemicals. Additional data (including total and dissolved metals and a more comprehensive suite of radionuclides) were collected from October 1990 through July 1991 as part of the expanded well sampling and analysis for the RI. Based on the results from past monitoring activities, the scope of the surveillance program was reduced in 1992; samples were collected from fewer wells annually (rather than quarterly). In June 1992, samples were collected from five wells completed in the overburden: background well B37W09S and downgradient wells WISS-3A, WISS-4A, B37W07S, and B37W08S. The samples were analyzed for radionuclides, total metals, volatile and semivolatile organic compounds, pesticides, and PCBs.

The groundwater radiological and chemical data in this section are interpreted through comparative analysis. Radionuclide concentrations are compared with background concentrations in upgradient wells, with existing EPA Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) (40 CFR 141.15, 16), and with DOE derived concentration guides (DCGs). A DCG is defined as the concentration of a radionuclide in air or water that, under continuous exposure for one year by one exposure mode (e.g., ingestion of water or inhalation), would result in an effective dose equivalent of 100 mrem. Chemical concentrations are compared with the background concentrations in the upgradient wells, New Jersey Groundwater Quality Standards (NJGQS) for Class II-A groundwater, existing SDWA MCLs, and SDWA non-zero maximum contaminant level goals (MCLGs).

3.3.2 Results

Table 3-7 presents the 1992 results for total uranium, radium-226, and thorium-232, along with the annual average concentrations of these parameters from 1986 through 1991. Additional radiological data are presented in Appendix A. These data include concentration ranges for radium-226, radium-228, total uranium, and thorium-232 from 1985 through 1991 (Table A-1) and the quarterly results from October (fourth quarter) 1990 through June 1992 (Table A-2).

As shown in Table 3-7, the radiological results for 1992 are low and approximate background conditions. Historic site data (1985-1991) have shown average annual upgradient concentrations of radiological constituents to be 0.2×10^{-9} to 3×10^{-9} μCi/ml (7.4×10^{-3} to 1.11×10^{-1} Bq/L) for total uranium, 0.2×10^{-9} to 1.2×10^{-9} μCi/ml (7.4×10^{-3} to 4.4×10^{-2} Bq/L) for radium-226, and 0.1×10^{-9} to 0.5×10^{-9} μCi/ml (3.7×10^{-3} to 1.8×10^{-2} Bq/L) for thorium-232. The data have consistently shown slightly elevated concentrations of total uranium [from approximately 4×10^{-9} to 11×10^{-9} μCi/ml (1.5×10^{-1} to 4.1×10^{-1} Bq/L)] in downgradient well WISS-4A. Average annual concentrations in samples from the remaining downgradient wells typically range from 0.2×10^{-9} to 3×10^{-9} μCi/ml (7.4×10^{-3} to 1.1×10^{-1} Bq/L) for total uranium, 0.1×10^{-9} to 1.7×10^{-9} μCi/ml (3.7×10^{-3} to 6.3×10^{-2} Bq/L) for radium-226, and 0.1×10^{-9} to 2×10^{-9} μCi/ml (3.7×10^{-3} to 7.4×10^{-2} Bq/L) for thorium-232. Elevated concentrations have been reported but are sporadic. For example, the data reported for October 1991 included slightly elevated concentrations of uranium [7.8×10^{-9} μCi/ml (2.9×10^{-1} Bq/L)] in upgradient well WISS-1A, but the average uranium concentration during 1991 (four quarters) was 3×10^{-9} μCi/ml (1.1×10^{-1} Bq/L). In addition, the October 1991 radium-226 results for samples from B37W07S and B37W08S exceeded the SDWA MCL of 5×10^{-9} μCi/ml (1.9×10^{-1} Bq/L) for total radium; the results from the 1992 analyses for radium-226 in B37W07S and B37W08S were substantially lower than the October 1991 results (Table 3-7). These elevated concentrations are sporadic and do not indicate any areas of significant groundwater contamination. Most analytical results were comparable to background and were below existing SDWA MCLs; all results were substantially below their respective DCGs.

The groundwater samples collected during 1992 were analyzed for 25 metals; 9 were detected (Appendix A, Table A-3). These included major ions (calcium, magnesium, sodium, and potassium) and commonly occurring metals (aluminum, boron, iron, manganese, and lead). The total concentrations of aluminum, iron, and manganese exceeded NJGQS in three wells (B37W07S, B37W08S, B37W09S), and the total concentration of lead exceeded the NJGQS in B37W07S in samples collected during 1992. The major ion and boron concentrations reflect baseline conditions of the groundwater in the overburden unit at the site. Concentrations of aluminum, iron, and manganese show a wide variation, especially

the higher concentrations in B37W08 and B37W09S. Previous results from the groundwater monitoring program at the site have shown a wide variation between sampling events in concentrations of total (unfiltered sample) aluminum, iron, and manganese; this variation probably reflects suspended sediment in the samples. Previous results have shown concentrations of these metals in the soluble fraction (filtered sample) to be very low or nondetectable.

Results of metals analyses conducted from October (fourth quarter) 1990 through June 1992 are presented in Appendix A, Table A-3. As shown, most of the total metal concentrations are low and less than the relevant standards. Dissolved metals concentrations are very low or nondetectable. However, elevated concentrations of total metals have been periodically reported. NJGQS, SDWA MCLs, and SDWA MCLGs for several heavy metals were exceeded in some samples (predominantly samples from an upgradient well pair) during the July 1991 sampling event, but concentrations detected in previous and subsequent samples were significantly lower. Statistical analysis using EPA guidance (EPA 1989) identified the data from the July 1991 sampling event as an outlier. In summary, the 1992 data are consistent with historic data and indicate that metals are not present in groundwater at levels of concern.

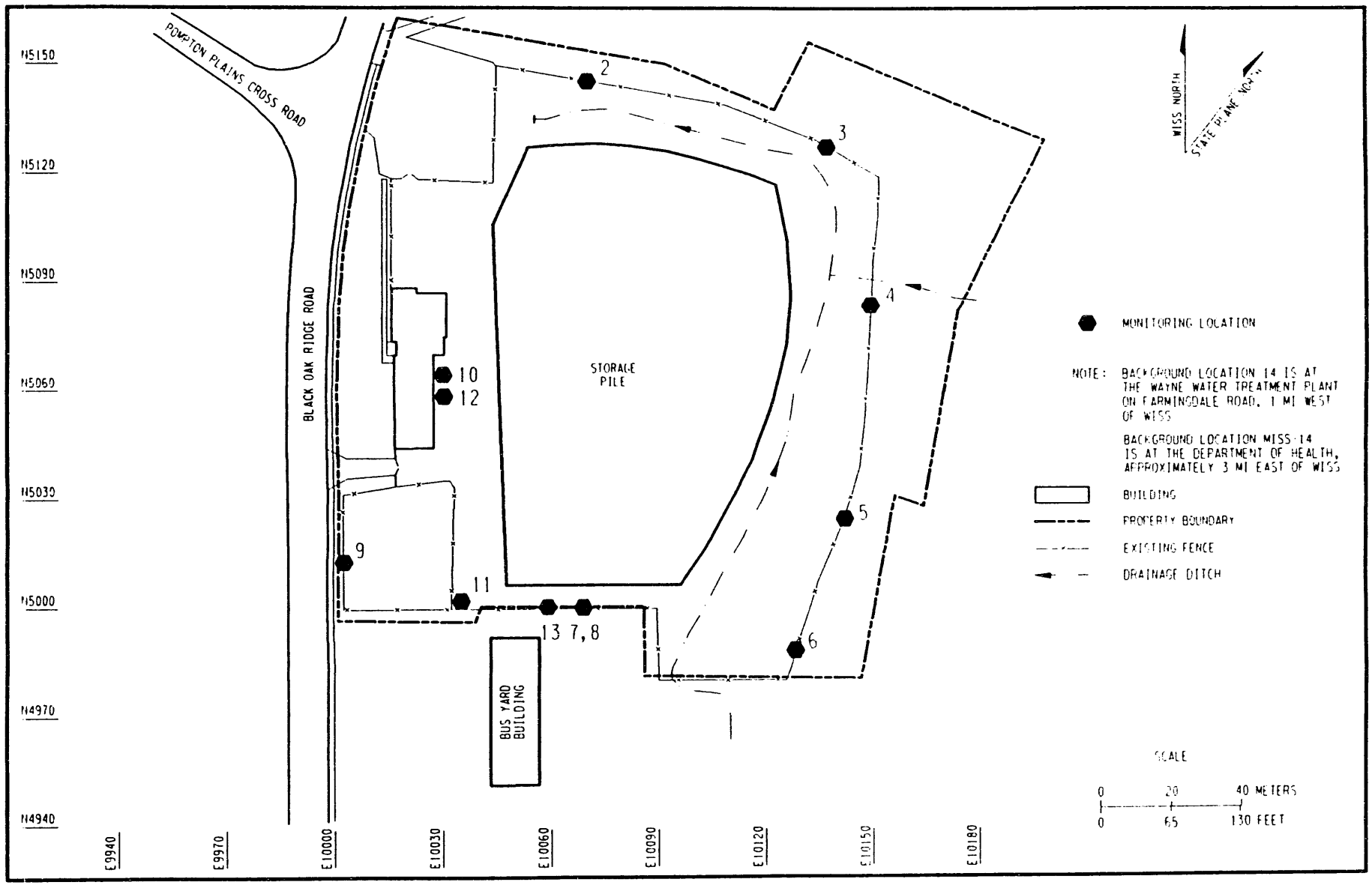
The 1992 organic results were consistent with historic results and showed methylene chloride and phthalates at low concentrations (3 to 18 μg/L). These compounds are typically associated with sample collection and laboratory analytical procedures and equipment. Trichloroethene in B37W08S was reported at an estimated concentration of 3 μg/L, which is below the SDWA MCL of 5 μg/L but above the NJGQS of 1 μg/L. No other volatile or semivolatile organic compounds were detected. Pesticides and PCBs were not detected. The results of these analyses do not indicate the presence of organic, pesticide, or PCB contamination in the groundwater.

Summary

Based on the analytical results from 1985 through 1992, there is no indication of significant levels of contaminants (radioactive, inorganic, or organic) in the groundwater at

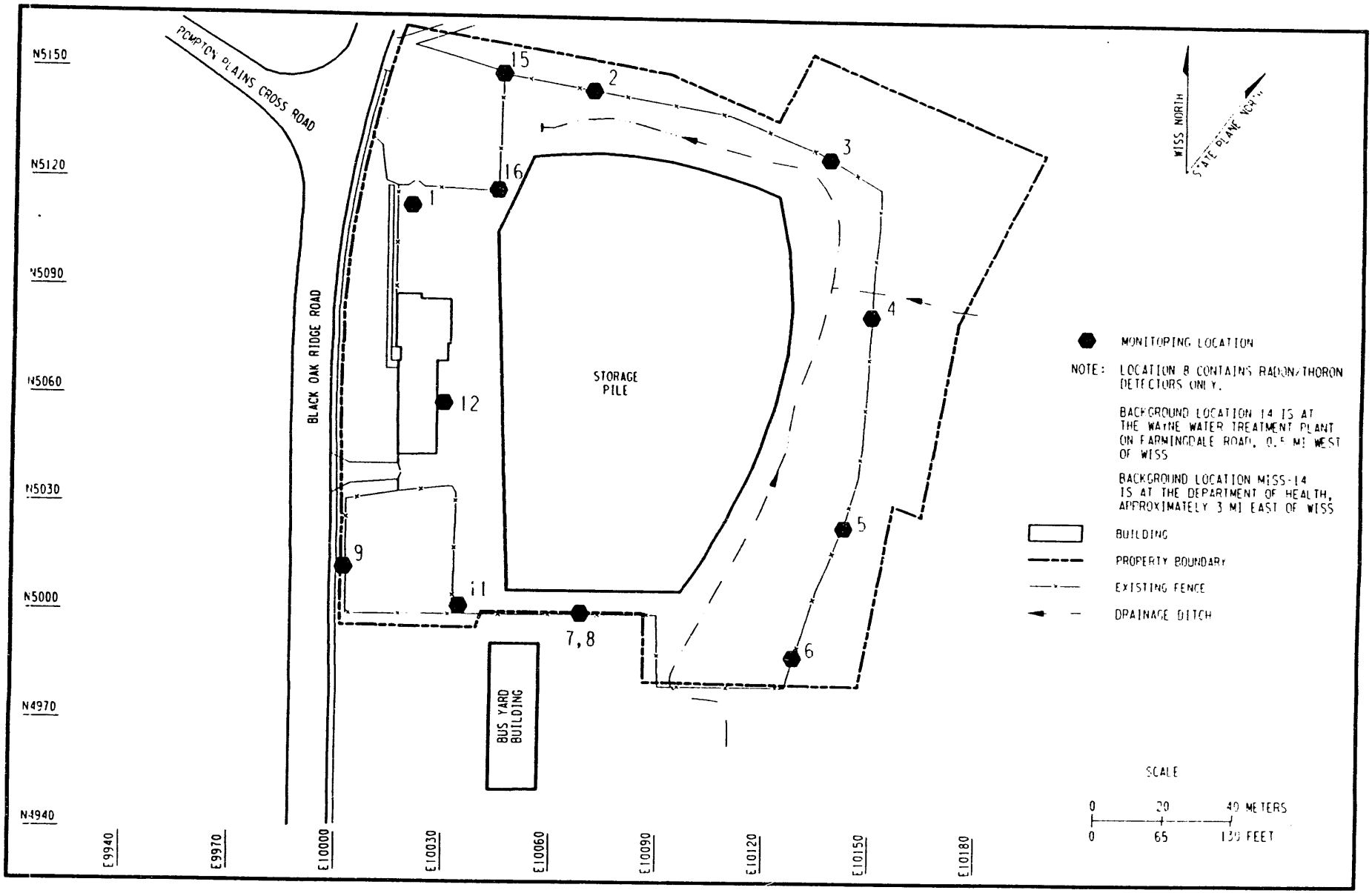
WISS. Analytical results for downgradient well WISS-4A have consistently shown slightly elevated concentrations of total uranium [from approximately 4×10^{-9} to 11×10^{-9} μCi/ml (1.5×10^{-1} to 4.1×10^{-1} Bq/L)]. Aluminum, iron, and manganese typically show a wide variation in concentrations; however, the concentrations do not indicate contamination and are not considered a result of previous or current site activities. Heavy metals concentrations are generally low or not detectable. Sporadic elevated concentrations of radionuclides and total metals have been reported, but there is no indication of extensive contamination. Results of organics, pesticides, and PCB analyses show no evidence of contamination in the groundwater by these compounds.

FIGURES FOR SECTION 3.0



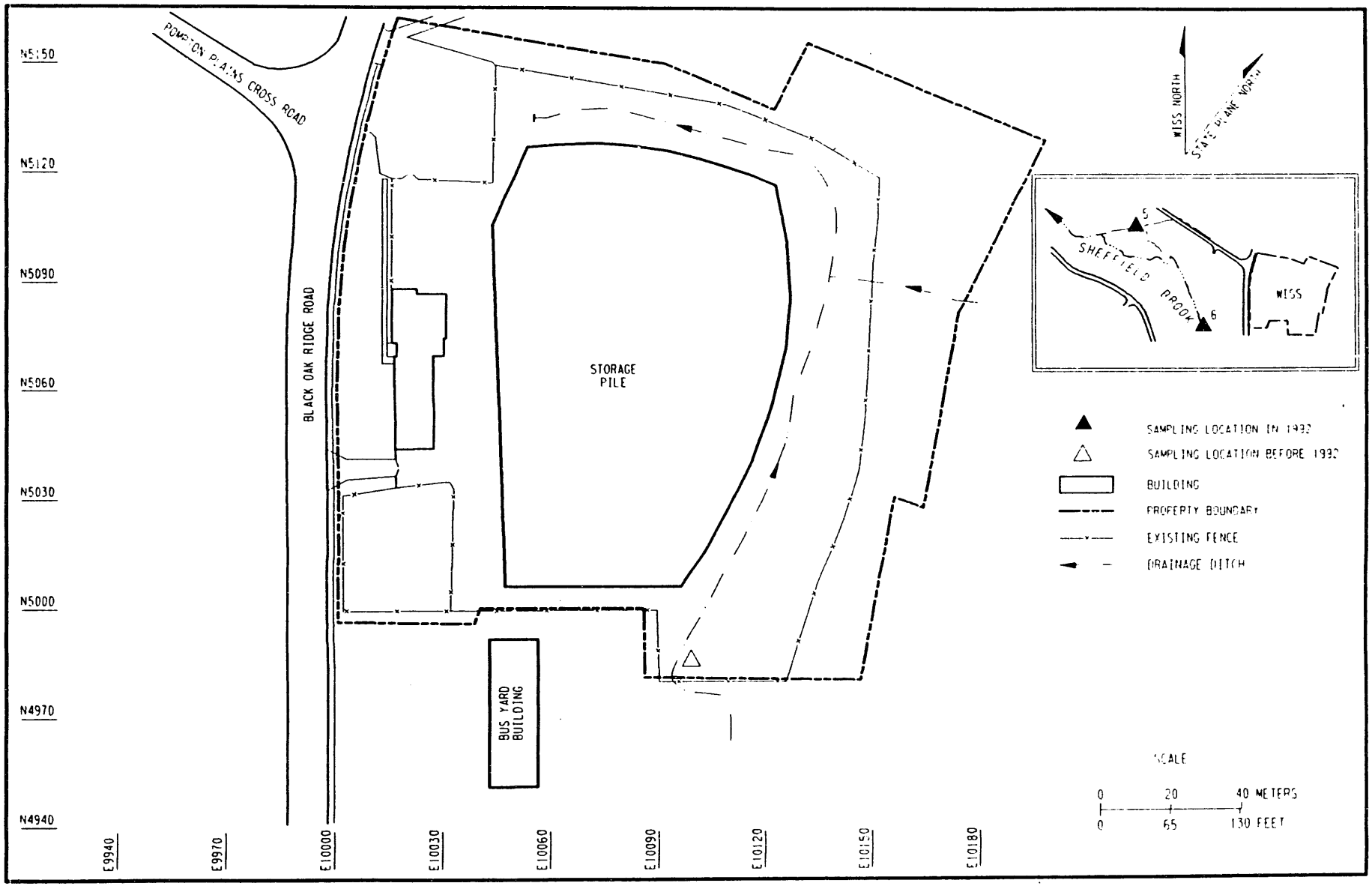
137 R38F009.DGN

Figure 3-1
Radon/Thoron and External Gamma Radiation Monitoring Locations at WISS (1991)



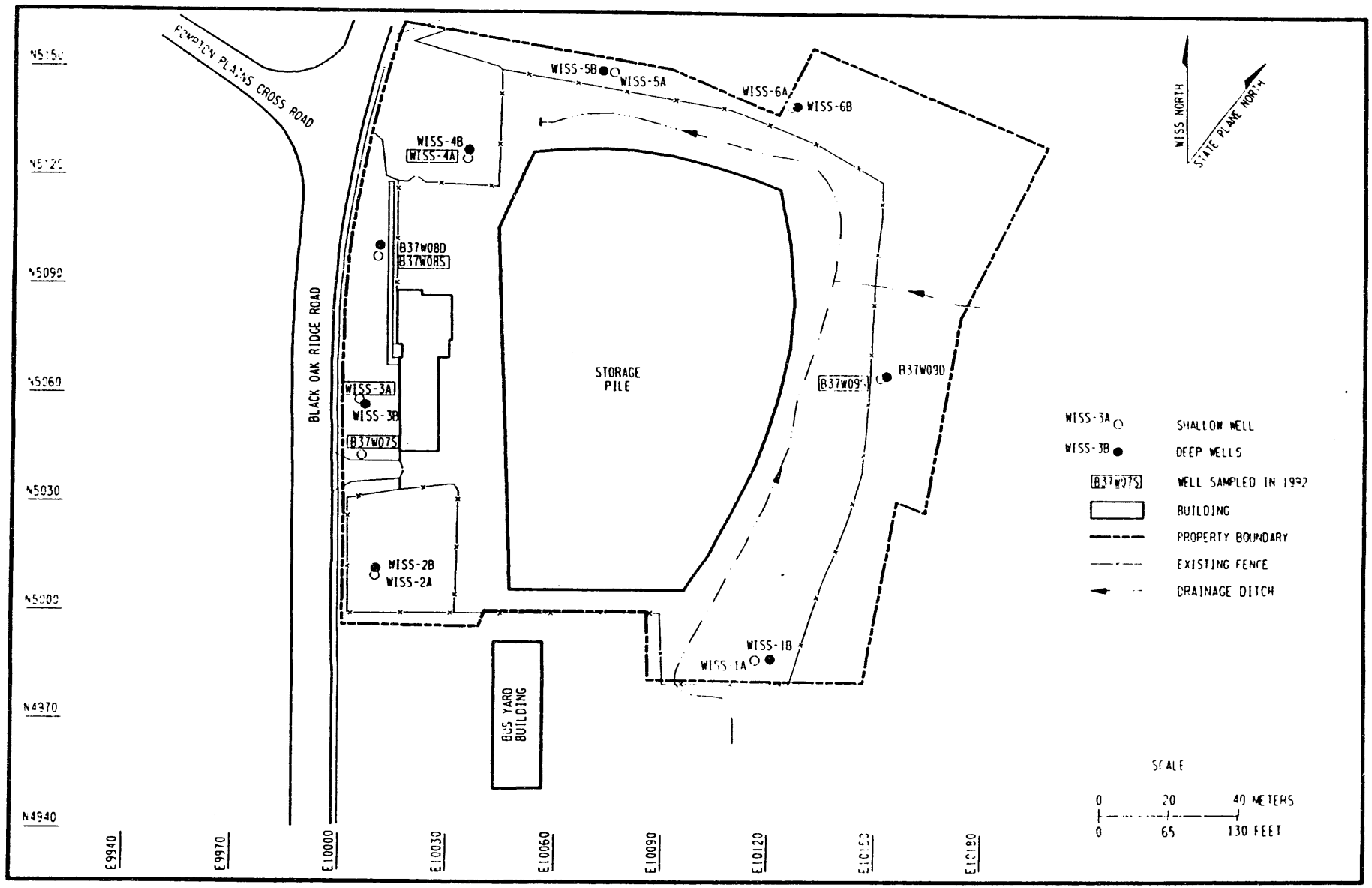
137 R38F008.DGN

Figure 3-2
Radon/Thoron and External Gamma Radiation
Monitoring Locations at WISS (1992)



137 R38F010.DGN

Figure 3-3
Surface Water and Sediment Sampling Locations at WISS



137 R38F006.DGN

Figure 3-4
Locations of Groundwater Wells Monitored for Radioactive

TABLES FOR SECTION 3.0

Table 3-1

Trend Analysis for Radon Concentrations[a,b] at WISS, 1987-1992

Sampling Location[c]	Average Annual Concentration 1987	1988	1989	1990	1991	Average Annual Concentration 1992
	(Concentrations are in 10^{-9} μCi/ml)					
Fenceline						
1	0.6	0.3	0.5	0.3	0.7	0.4
2	0.9	0.3	0.4	0.4	0.5	0.3
3	0.4	0.3	0.6	0.3	0.8	0.3
4	0.5	0.4	0.7	0.4	0.6	0.4
5	0.8	0.5	0.6	0.5	0.6	0.4
6	0.5	0.5	0.5	0.4	0.7	0.4
7	0.5	0.5	0.7	0.5	2	0.3
9	1.3	0.3	0.4	0.4	0.5	0.3
11[d]	--	--	--	0.7	0.7	0.3
15[e]	--	--	--	--	--	0.4
16[e]	--	--	--	--	--	0.3
Onsite						
12[d]	--	--	--	0.4	0.8	0.4
Quality Control						
8[f]	0.5	0.3	0.4	0.4	2	0.3
Background						
MISS-14[g]	1.8	0.3	0.6	0.3	0.4	--
14[h]	--	--	0.7	0.5	1.0	0.4
MISS-26[i]	--	--	--	--	--	0.3

Source for 1987-1991 data: BNI 1992b.

[a] 1×10^{-9} μCi/ml = 1 pCi/L = 0.037 Bq/L. The DOE DCG for radon-222 is 3.0×10^{-9} μCi/ml.

Table 3-1

(continued)

[b]Measured background has not been subtracted from the fenceline and onsite readings.

[c]Sampling locations are shown in Figures 3-1 and 3-2.

[d]Added to environmental surveillance program in 1990.

[e]Added to environmental surveillance program in 1992.

[f]Quality control for station 7.

[g]Located at the Department of Health in Paterson, N.J., approximately 4.8 km (3 mi) east of WISS; deleted from program on June 30, 1992.

[h]Located at Water Treatment Plant in Wayne, approximately 1.6 km (1 mi) west of WISS; established in January 1989.

[i]Located at 100 Fair Street, Paterson, N.J., approximately 8 km (5 mi) west of WISS; established on June 30, 1992. The average concentration is based on 6 months of monitoring.

Table 3-2

Average Thoron Concentrations[a,b] at WISS, 1991-1992

Sampling Location[c]	Average 1991	Average 1992
	(Concentrations are in 10^{-9} μCi/ml)	
Fenceline		
1	0.3	0.2
2	0.6	0.2
3	0.1	0.1
4	0.2	[d]
5	6	0.1
6	0.6	[d]
7	0.1	0.1
9	0.1	0.1
11	2	0.4
15[e]	-	0.5
16[e]	-	0.4
Onsite		
12	0.5	0.1
Quality Control		
8[f]	0.5	[d]
Background		
MISS-14[g]	[d]	[d]
14[h]	0.6	[d]
MISS-26[i]	-	[d]

Source for 1991 data: BNI 1992b.

Table 3-2

(continued)

[a] 1×10^{-9} μCi/ml = 1 pCi/L = 0.037 Bq/L. The DCG for thoron is being assessed by DOE; until this review has been completed and new guidelines have been issued, the DCG for radon (3.0×10^{-9} μCi/ml) can be used for comparison.

[b] Measured background has not been subtracted from the fenceline and onsite readings. 1991 was first full year for thoron monitoring.

[c] Sampling locations are shown in Figures 3-1 and 3-2.

[d] Thoron level was undetectable.

[e] Added to environmental surveillance program in 1992.

[f] Quality control for station 7.

[g] Located at the Department of Health in Paterson, N.J., approximately 4.8 km (3 mi) east of WISS; deleted from program on June 30, 1992.

[h] Located at the Water Treatment Plant in Wayne, approximately 1.6 km (1 mi) west of WISS.

[i] Located at 100 Fair Street, Paterson, N.J., approximately 8 km (5 mi) west of WISS; established on June 30, 1992.

Table 3-3

Trend Analysis for External Gamma Radiation Exposure Rates[a] at WISS, 1987-1992

Sampling Location[b]	Average Annual Rates 1987	1988	1989	1990	1991	Average Annual Rates 1992
			(Exposure rates are in mR/yr)			
Fenceline (measured background subtracted)[c]						
1	28	28	8	10	0	12
2	27	23	6	4	0	9
3	29	13	[d]	2	0	2
4	18	10	[d]	[d]	0	-5
5	18	5	[d]	1	0	-4
6	22	10	1	2	0	0
7	45	15	1	2	0	1
9	38	22	2	2	0	2
11[e]	--	--	--	67	47	62
15[f]	--	--	--	--	--	15
16[f]	--	--	--	--	--	51
Onsite (measured background subtracted)[c]						
10[e]	--	--	--	64	57	--
12[e]	--	--	--	69	84	170
Background						
MISS-14[g]	58	78	63	63	77	--
14[h]	--	--	94	95	109	82
MISS-26[i]	--	--	--	--	--	109[j]

Source for 1987-1991 data: BNI 1992b.

[a]The DOE guideline is 100 mrem/yr above background.
1 mR ≈ 1 mrem = 0.01 mSv.

[b]Sampling locations are shown in Figures 3-1 and 3-2.

Table 3-3

(continued)

[c]Measured background has been subtracted from fenceline and onsite readings.

[d]Measurement is not distinguishable from the average annual background rate.

[e]Added to environmental surveillance program in 1990.

[f]Added to environmental surveillance program in 1992.

[g]Located at the Department of Health in Paterson, N.J., approximately 4.8 km (3 mi) east of WISS; deleted from program on June 30, 1992.

[h]Located at the Water Treatment Plant in Wayne, approximately 1.6 km (1 mi) west of WISS; established in January 1989.

[i]Located at 100 Fair Street, Paterson, N.J., approximately 8 km (5 mi) west of WISS; established on June 30, 1992.

[j]Exposure rate is estimated based on six months of monitoring.

Table 3-4

External Gamma Radiation Exposure Rates for Comparison

Location	Average (mR/yr)
Site boundary (1992)	95
Site vicinity (i.e., background in the Wayne area) (1992)	82
U.S. background[a]	103
Grand Central Station[b]	525
Statue of Liberty base[b]	325

[a]Shleien 1989.

[b]Appendix B.

Table 3-5

Trend Analysis for Concentrations[a,b] of Total Uranium, Radium-226, Radium-228, Thorium-230, and Thorium-232 in Surface Water in the Vicinity of WISS, 1987-1992

Sampling Location[c]	Average Annual Concentration 1987	1988	1989	1990	1991	Annual Concentration 1992
	(Concentrations are in 10^{-9} µCi/ml)					
	Total Uranium[f]					
5	3.4	4	5	2.8	2	0.6
6[d]	3.4	5	5	2.7	2	0.2
	Radium-226					
5	0.2	0.3	0.4	0.1	0.2	0.3
6[d]	0.1	0.3	0.4	0.2	0.2	0.3
	Radium-228[e]					
5	-	-	-	-	2	0.6
6[d]	-	-	-	-	1	0.6
	Thorium-230[f,g]					
5	-	-	-	-	-	0.3
6[d]	-	-	-	-	-	0.2
	Thorium-232					
5	0.2	0.1	0.1	0.2	0.3	0.1
6[d]	0.1	0.1	0.1	0.1	0.3	0.1

Source for 1987-1991 data: BNI 1992b.

[a] 1×10^{-9} µCi/ml = 1 pCi/L = 0.037 Bq/L. The DCGs for total uranium, radium-226, radium-228, thorium-230, and thorium-232 are 600×10^{-9}, 100×10^{-9}, 100×10^{-9}, 300×10^{-9}, and 50×10^{-9} µCi/ml, respectively.

Table 3-5

(continued)

[b]Measured background has not been subtracted.

[c]Sampling locations are shown in Figure 3-3.

[d]Background sampling location in Sheffield Brook, upstream of the site drainage ditch discharge point.

[e]Analysis began in 1991.

[f]Total uranium concentrations were determined by fluorometric analysis during 1987 through 1990 and the first three quarters of 1991 and by kinetic phosphorescence analysis during the fourth quarter of 1991 and in 1992.

[g]Analysis began in 1992.

Table 3-6

Trend Analysis for Concentrations[a,b] of Total Uranium, Radium-226, Radium-228, Thorium-230, and Thorium-232 in Sediment in the Vicinity of WISS, 1987-1992

Sampling Location[c]	Average Annual Concentration 1987	1988	1989	1990	1991	Annual Concentration 1992
	(Concentrations are in pCi/g)					
	Total Uranium					
5	1.2	1	1.1	1	2.2	2.5
6[d]	1	0.9	1	1	2.9	2.4
	Radium-226					
5	0.5	0.4	0.6	0.6	0.7	0.5
6[d]	0.4	0.4	0.5	0.7	0.7	0.6
	Radium-228[e]					
5	-	-	-	-	2.4	0.9
6[d]	-	-	-	-	1.3	1.4
	Thorium-230[f]					
5	-	-	-	-	-	1.7
6[d]	-	-	-	-	-	0.7
	Thorium-232					
5	0.6	0.7	0.8	1	0.9	0.6
6[d]	0.3	0.5	0.4	0.8	0.9	1.1

Source for 1987-1991 data: BNI 1992b.

[a]1 pCi/g = 0.037 Bq/g. The FUSRAP soil concentration guideline for radium and thorium is 5 pCi/g above background. No guideline has been established for total uranium.

Table 3-6

(continued)

[b]Measured background has not been subtracted.

[c]Sampling locations are shown in Figure 3-3.

[d]Background sampling location in Sheffield Brook, upstream of the site drainage ditch discharge point.

[e]Analysis began in 1991.

[f]Analysis began in 1992.

Table 3-7

Trend Analysis for Concentrations[a,b] of Total Uranium, Radium-226, and Thorium-232 in Groundwater at WISS, 1986-1992

Sampling Location[c]	Average Annual Concentration						
	1986	1987	1988	1989	1990	1991[d]	1992[e]
(Concentrations are in 10^{-9} μCi/ml)							
Total Uranium[f]							
WISS-1A[g]	0.8	1.2	1.6	1.5	2	3	--[h]
WISS-1B[g]	0.2	0.5	1.1	1.0	2	2	--
WISS-2A	0.4	1.4	3.3	2.3	3	3	--
WISS-2B	0.6	1.1	2.0	1.8	3	3	--
WISS-3A	0.8	1.1	2.1	2.3	3	5	2.2
WISS-3B	0.2	0.7	1.7	1.9	3	3	--
WISS-4A	4.7	4.6	8.3	6.3	5	10.6	3.6
WISS-4B	0.4	0.9	1.0	1.4	2	3	--
WISS-5A	1.1	1.5	2.2	1.9	3	3	--
WISS-5B	0.5	1.2	1.5	1.2	3	3	--
WISS-6A	0.6	4.3	1.6	1.4	3	3	--
WISS-6B	0.7	1.2	2.0	1.8	3	5	--
B37W07S	--	--	--	--	--	1.8	0.8
B37W08S	--	--	--	--	--	3.1	0.8
B37W08D	--	--	--	--	--	0.8	--
B37W09S[g]	--	--	--	--	--	1.7	0.3
B37W09D[g]	--	--	--	--	--	0.5	--
Radium-226							
WISS-1A[g]	0.7	0.3	1.0	1.2	0.4	0.4	--
WISS-1B[g]	0.4	0.4	0.8	1.2	0.3	0.2	--
WISS-2A	0.1	0.4	1.3	1.7	0.6	1.5	--
WISS-2B	0.5	0.4	1.1	1.1	0.6	0.4	--
WISS-3A	0.4	0.4	0.9	1.0	0.5	0.3	0.2
WISS-3B	0.5	0.4	1.0	0.9	0.6	0.4	--
WISS-4A	0.4	0.2	0.8	0.9	0.4	0.4	0.8
WISS-4B	0.2	0.3	1.0	0.8	0.3	0.3	--
WISS-5A	0.4	0.3	1.0	0.8	0.4	0.2	--
WISS-5B	0.4	0.3	0.9	1.0	0.2	0.4	--
WISS-6A	0.3	0.4	1.0	0.9	0.6	0.4	--
WISS-6B	0.6	0.3	1.0	0.9	0.3	0.3	--
B37W07S	--	--	--	--	--	15.3	0.2
B37W08S	--	--	--	--	--	11.3	0.5

Table 3-7

(continued)

Sampling Location[c]	Average Annual Concentration 1986	1987	1988	1989	1990	1991[d]	1992[e]
B37W08D	--	--	--	--	--	0.7	--
B37W09S[g]	--	--	--	--	--	0.4	0.2
B37W09D[g]	--	--	--	--	--	0.1	--
Thorium-232							
WISS-1A[g]	0.1	0.1	0.4	0.2	0.1	0.5	--
WISS-1B[g]	0.1	0.1	0.2	0.2	0.1	0.3	--
WISS-2A	0.1	0.1	1	0.5	0.2	2	--
WISS-2B	0.1	0.1	0.2	0.2	0.1	0.3	--
WISS-3A	0.2	0.1	0.3	0.4	0.1	0.8	<0.10
WISS-3B	0.2	0.1	0.2	0.2	0.1	0.2	--
WISS-4A	0.1	0.1	0.3	0.2	0.1	0.3	0.2
WISS-4B	0.1	0.1	0.2	0.2	0.2	0.3	--
WISS-5A	0.1	0.1	0.2	0.2	0.1	0.1	--
WISS-5B	0.1	0.1	0.2	0.2	0.1	0.1	--
WISS-6A	0.1	0.3	0.3	0.2	0.2	0.2	--
WISS-6B	0.2	0.2	0.2	0.3	0.1	0.1	--
B37W07S	--	--	--	--	--	0.9	<0.3
B37W08S	--	--	--	--	--	<0.5	<0.1
B37W08D	--	--	--	--	--	<0.17	--
B37W09S[g]	--	--	--	--	--	<1.6	<0.3
B37W09D[g]	--	--	--	--	--	<0.1	--

Source for 1986-1991 data: BNI 1992b.

[a]1 × 10^{-9} μCi/ml = 1 pCi/L = 0.037 Bq/L. The DOE guidelines for total uranium, radium-226, and thorium-232 are 600 × 10^{-9}, 100 × 10^{-9}, and 50 × 10^{-9} μCi/ml, respectively.

[b]Measured background has not been subtracted.

[c]Sampling locations are shown in Figure 3-4.

[d]B37W series wells were sampled one time during 1991.

[e]1992 concentrations reflect results from one sampling event.

[f]Total uranium concentrations were determined by fluorometric analysis during 1986 through 1990 and the first three quarters of 1991 and by kinetic phosphorescence analysis during the fourth quarter of 1991 and in 1992.

[g]Upgradient, background well.

[h]-- = No sample collected.

4.0 ESTIMATED DOSE

The information in Section 3.0 was evaluated as described in Appendix F to estimate the hypothetical radiation doses to the general public and to a maximally exposed individual from the radioactive material at WISS. This material consists primarily of thorium-contaminated soil from commercial processing of monazite sand from 1948 to 1971. This sand is a naturally occurring material containing primarily isotopes of thorium, radium, and uranium.

To assess the potential health effects from the materials stored at WISS, internal and external radiation exposures were considered for the maximally exposed individual and the general public within 80 km (50 mi) of the site.

Doses can come from either external or internal exposures. Exposures to radiation from radionuclides outside the body are called external exposures; exposures to radiation from radionuclides deposited inside the body are called internal exposures. The distinction is important because external exposures occur only when a person is near the external radiation source, but internal exposures continue as long as the radionuclides reside in the body.

External exposure results from direct gamma radiation exposure from the radioactive materials in the storage pile and in surface and subsurface soils at the site. External exposure is determined by calculations performed on data obtained from the TETLD monitoring program.

To determine internal exposures to the maximally exposed individual and the general population within 80 km (50 mi), realistic and complete pathways by which radioactive materials could enter individuals must be identified. A complete internal exposure pathway must contain each of the following elements:

- A contaminant source and a mechanism by which the contaminant is released into the environment

- An environmental transport mechanism (i.e., a mechanism that disperses the contaminant into the surrounding environment)
- A location where human contact (a human receptor) with the contaminant is possible
- A route of entry that would enable the contaminant to enter the human receptor's body

If any of these four elements are not present, or could not conceivably be present in the future, the exposure pathway is not considered realistic, and no evaluation of exposure from this pathway is performed. Because of the inaccessibility of the contaminated material at the site and the lack of a drinking water well influenced by the site, the only complete exposure pathways would be from direct gamma radiation and from radon and thoron (and their associated decay products). These pathways would be the only contributors to the potential dose to the maximally exposed individual. All doses presented in this section are estimated and do not represent actual doses. A summary is provided in Table 4-1.

4.1 MAXIMALLY EXPOSED INDIVIDUAL

4.1.1 Direct Gamma Radiation Pathway

Monitoring data show that the highest external gamma radiation level at the site boundary is along the southern fence. The adjacent property is occupied by a school bus storage and maintenance facility. The nearest bus maintenance facility with any occupancy other than incidental is a shop about 91 m (300 ft) from the fence. The dose for a maximally exposed individual was calculated using a scenario that was chosen to illustrate the low risk. An individual working 40 h per week in the maintenance shop about 91 m (300 ft) from the fence for a year would receive no exposure attributable to WISS.

4.1.2 Drinking Water Pathway

Only one water pathway, either groundwater or surface water, is used to determine the committed dose to the maximally exposed individual. This individual would obtain

100 percent of his or her drinking water from either surface water or groundwater in the vicinity of the site. Concentrations of total uranium, radium-226, and thorium-232 in groundwater, Sheffield Brook, and Pompton River are compared with DOE standards (DCGs). These standards reflect the concentration of a radionuclide in water that, if ingested for one year, would result in an effective dose equivalent of 100 mrem (1 mSv). All of the radionuclides were well below these standards and comparable to normal background levels; therefore, the dose contribution of these radionuclides from these sources to the individual is negligible.

4.1.3 Air Pathway (Ingestion, Air Immersion, Inhalation)

A conservative dose to the maximally exposed individual was calculated using the assumption that the individual works within 91 m (300 ft) of the site. Air doses determined using EPA's Clean Air Act Assessment Package-1988 (CAP88) PC computer model were found to be negligible.

4.1.4 Total Dose

The total dose for the maximally exposed individual is the sum of the 50-year committed effective dose equivalent and the external effective dose equivalent, based on the total from all pathways. The data demonstrate that the total dose would not be different from natural background levels.

4.2 GENERAL POPULATION

The collective dose that the general population living within 80 km (50 mi) of the site would receive was considered as described in the following subsections.

4.2.1 Direct Gamma Radiation Pathway

Distance from the site to the nearest residential areas and the presence of intervening structures reduce direct gamma radiation exposure from WISS. Because of this additional

shielding and the low dose calculated for the maximally exposed individual, it is reasonable to assume that there is no detectable gamma radiation exposure to the general public above variations in the normal background levels.

4.2.2 Drinking Water Pathway

Because radionuclide concentrations in groundwater and surface water are essentially the same as background levels and because the maximally exposed individual would receive no significant dose commitment from radionuclides in drinking water, it is reasonable to assume that the general public would not receive a committed dose in drinking water.

4.2.3 Air Pathway

The CAP88-PC model provides an effective dose equivalent for contaminants transported via the atmospheric pathway at different distances from the site. Using these effective dose equivalents and the population density, the collective dose for the general population within 80 km (50 mi) of the site was calculated to be negligible compared with the dose from natural background.

4.2.4 Total Population Dose

The total population dose listed in Table 4-1 is the sum of the doses from all exposure pathways. The collective population dose calculated for WISS is negligible when compared with the collective population dose caused by natural background gamma radiation in the area [8.2×10^5 person-rem/yr (8.2×10^3 person-Sv/yr)] for the same population within 80 km (50 mi) of WISS.

TABLE FOR SECTION 4.0

Table 4-1

Summary of Calculated Doses[a] for WISS, 1992

Exposure Pathway	Dose for Maximally Exposed Individual (mrem/yr)[b]	Collective Dose for Population Within 80 km of Site (person-rem/yr)[b]
Direct gamma radiation[c]	--[d]	--[d]
Drinking water	--[e]	--[e]
Inhalation	1.03×10^{-3}	20
Total[f]	--[d]	--[d]
Background[g]	82	8.2×10^{5} [h]

[a]Does not include radon.

[b]1 mrem/yr = 0.01 mSv/yr; 1 person-rem/yr = 0.01 person-Sv/yr.

[c]Does not include contribution from natural background.

[d]Exposures from this pathway are negligible.

[e]No realistic pathway.

[f]The DOE guideline for total exposure to an individual is 100 mrem/yr above background (DOE 1990).

[g]Direct gamma radiation exposure only.

[h]Calculated by the following: (82 mrem/yr) (10×10^{6} people).

5.0 QUALITY ASSURANCE

5.1 INTRODUCTION

This section summarizes the quality assurance (QA) assessment of environmental activities, which were conducted to ensure that onsite contamination does not pose a threat to human health or the environment. Using this criterion, the overall project data quality objective (DQO) for the environmental surveillance program is to provide data of sufficient quality to allow reliable detection and quantitation of a potential release of contaminated material from the site. The DQO requirements are assessed annually during review of the environmental monitoring plan (BNI 1991) and are updated on the basis of historical information, trends identified, and changes in environmental regulations.

5.2 PROCEDURES

The *Quality Assurance Program Plan for the U.S. DOE FUSRAP* (BNI 1992a) addresses the quality requirements for work being performed under FUSRAP. This plan requires all subcontractors to implement a compatible plan for QA or use the DOE plan. This is done to ensure compatibility with all requirements to maintain protection of human health and the environment.

QA procedures are detailed in project procedures and project instructions and are implemented for all field activities. Sampling techniques are derived from several documents, including *A Compendium of Superfund Field Operations Methods* (EPA 1987) and the EPA Region II QA manual. Laboratory QA procedures are derived from applicable EPA methods to ensure compatibility of the results. Also, activities such as data reviews, calculation checks, and data evaluations are incorporated into procedures to monitor results and prevent or identify quality problems.

5.3 QUALITY ASSURANCE SUMMARY

QA/quality control (QC) activities are an integral part of all environmental monitoring activities at the site. The specific methods, definitions, and formulas used to evaluate the QA/QC program are described in the *Quality Assurance Document for Site Environmental Reports* (BNI 1993). This document also discusses, in detail, the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. For informational purposes, brief definitions or explanations will be given throughout this section for terms and processes used during the QA/QC evaluation.

The QA/QC program satisfies the requirements of DOE Orders 5400.1, 5400.5, and 5700.6C (DOE 1988, 1990, 1991). The programmatic controls in place for the environmental surveillance program are discussed in project instruction guides.

5.3.1 Data Usability

To determine data usability, a verification process is used that evaluates items such as holding times and results for method blanks, spike recoveries, and duplicates. This information is then used to verify whether the data are of sufficient quality to provide a basis for making decisions about the site. During this process, two qualifiers are used if there is any question concerning data usability: 1) "J" - the data result is estimated and should be used with discretion, and 2) "R" - the data result is rejected and should not be used.

The data are then evaluated using the PARCC parameters to determine whether there is enough information to make decisions concerning the site. Any major problems encountered are documented as nonconformances and are tracked to ensure correction.

The results of the PARCC evaluation are presented as a percentage that met requirements. The formula used is:

$$\frac{\text{number of results that met requirements}}{\text{total number of results}} \times 100 = \text{percent acceptable}$$

For Tables 5-1 and 5-2, a generic 80 percent was used as an acceptable level; evaluation criteria are discussed in Subsections 5.3.2 and 5.3.3. Representativeness and comparability cannot have a percentage applied; see Subsections 5.3.4 and 5.3.5 for definitions and discussions about the use of these two parameters.

5.3.2 Precision

Precision is defined as a measurement of the agreement of a set of replicate results among themselves without assumption of any prior information about the true result. Precision is assessed through the use of duplicate results or matrix spike (MS) and matrix spike duplicate (MSD) results. MSs and MSDs are usually used with organic analytes; inorganic analytes are generally run as a true duplicate and a single MS. Field duplicates are also used to assess field precision and are presented separately from the laboratory duplicates. EPA method limits are used to assess the results for both field and laboratory results. Table 5-1 shows the results of the laboratory precision evaluation. All results met the requirements for acceptability except for pesticides and PCBs. The recovery of MS sample results was at the bottom of the acceptable EPA range of limits, but the MSD results were at the upper end of the range. When the results were compared, the precision calculation failed the limits.

Table 5-2 provides results for field duplicates. Metals and TOX failed the acceptable levels. Precision for semivolatiles, volatiles, and pesticides and PCBs was not calculated because there were no positive values for the samples.

For TOX, there were two sets of duplicates. The first set failed the limits, and the second set passed the limits. Therefore, the final acceptable level was 50 percent. Many of the metals failed because of the nonhomogeneity of the sediment in the duplicates.

Table 5-3 gives the results for the laboratory radiochemical duplicates. Results for radium-226 failed the generic 80 percent level. EPA does not give a limit for radiochemical precision as it does for chemicals. However, because 75 percent of the precision results are acceptable, there should be no major impact on the data. The use of 20 percent relative percent difference (RPD) for radiochemical duplicates was derived from *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA 1988).

5.3.3 Accuracy

Accuracy is defined as the nearness of a result or the mean of a set of results to the true, known, or reference value. Accuracy can be determined through the use of standard reference materials, MSs, laboratory control samples, and surrogate spikes.

Table 5-4 gives the results for the chemical spikes; all categories were above the 80 percent level. Radiological spikes were all within criteria. Associated results are given in Table 5-5. The use of recovery windows of 75 to 125 percent for radiological spikes was derived from *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (EPA 1988).

5.3.4 Representativeness

Field sampling and laboratory analytical representativeness expresses the degree to which the data accurately and precisely represent the matrix from which the samples were obtained. Representativeness generally expresses the extent to which the data generated define an environmental condition.

To ensure field sampling representativeness, several controls were used during sampling, including the use of dedicated sampling equipment and trip blanks for volatiles. The dedicated equipment ensures that no cross-contamination occurs between sampling locations. The trip blank for volatiles monitors for contamination from the time of sampling through the time of analysis.

To ensure representativeness in the laboratory, constraints are placed on analytical methodology. Method blanks are prepared with each parameter analyzed, both organic and inorganic, with an associated frequency of 1 per batch of no more than 20 samples. The method (or preparation) blank is used to determine whether contaminants that could have an impact on the samples associated with that method blank are present in the laboratory. The presence of contaminants can indicate the possibility for false positive results.

False negative results can also be reduced through the use of sample preservatives and holding times. All samples were preserved at the time of sampling by adding required chemicals and/or by refrigeration. The use of preservation limits biological and chemical degradation that would bias sample results.

Tables 5-6 and 5-7 list the contaminants and concentrations for laboratory method blanks and trip blanks. The contamination detected was caused by common laboratory contaminants. EPA has recognized certain analytes as being present in the laboratory and expects some contamination. The rules governing these contaminants allow up to five times the quantitation limit of the analytes. The results were below this requirement and do not pose any problems.

5.3.5 Comparability

Comparability expresses the confidence with which data are compared with each other, taking into account the use of equivalent instrumentation and methodology. The laboratories follow approved procedures that are consistent with industry-accepted practices, and comparability is maintained.

5.3.6 Completeness

Completeness measures the usable data resulting from the data collection activities compared with the total data possible. For environmental monitoring, all samples were taken as required in the instruction guide for usability, giving a sampling completeness of 100 percent. As defined in Subsection 5.3.1, usable data are those that have no qualifiers

leading to rejection. Table 5-8 summarizes the usability rate for all analytes. All analytes, except for TOX, met the completeness goal. The failure of TOX results is considered borderline and should not affect the overall assessment of the data because no chemical analytical results for volatile organics (the analytes covered by the TOX analysis) were rejected.

5.3.7 Interlaboratory Programs

The radiochemistry laboratory participates in the Environmental Measurements Laboratory's Quality Assessment Program, EPA's Cross Check Program, and the Nuclear Fuel Services' Interlab Quality Control Comparison. The chemical laboratory participates in EPA's water supply and water pollution programs and analyzes quarterly single-blind samples submitted by FUSRAP. Results for these programs are submitted to FUSRAP. Repeated failure of an analyte for consecutive periods results in the suspension of that analyte until corrective actions have been taken. Table 5-9 provides the radiochemistry laboratory results from the DOE Quality Assessment Program. Table 5-10 gives the results from the EPA Intercomparison Program.

TABLES FOR SECTION 5.0

Table 5-1

Results for Chemical Laboratory Duplicates

Parameters	Percent Acceptable	Meets Established DQOs
Metals	95	Yes
TOX	100	Yes
TOC	100	Yes
TPH	100	Yes
Volatiles	100	Yes
Semivolatiles	82	Yes
Pesticides/PCBs	17	No

Table 5-2

Results for Field Duplicates[a]

Parameters	Percent Acceptable	Meets Established DQOs
Metals	69	No
Semivolatiles	NC[b]	NC
Volatiles	NC	NC
Pesticides	NC	NC
TOC	100	Yes
TOX	50	No
TPH	100	Yes
Radium-226	100	Yes
Radium-228	100	Yes
Thorium-230	80	Yes
Thorium-232	100	Yes
Total uranium	100	Yes

[a]Acceptability based on a 20 percent RPD for radiological analytes.

[b]NC = not calculated because all duplicate concentrations were nondetectable.

Table 5-3

Results for Radiochemical Laboratory Duplicates[a]

Parameters	Percent Acceptable	Meets Established DQOs
Radium-226	75	No
Radium-228	100	Yes
Thorium-230	100	Yes
Thorium-232	100	Yes
Total uranium	100	Yes

[a]Acceptability based on a 20 percent RPD.

Table 5-4

Results for Chemical Spike Recoveries

Parameters	Percent Acceptable	Meets Established DQOs
Metals	87	Yes
TOX	100	Yes
TOC	100	Yes
TPH	100	Yes
Volatiles	100	Yes
Semivolatiles	91	Yes
Pesticides/PCBs	92	Yes

Table 5-5

Results for Radiological Spike Recoveries[a]

Parameters	Percent Acceptable	Meets Established DQOs
Radium-226	100	Yes
Radium-228	100	Yes
Thorium-230	100	Yes
Thorium-232	100	Yes
Total uranium	100	Yes

[a]Acceptability based on a 75 to 125 percent recovery.

Table 5-6

Results for Laboratory Blanks

Analyte	Concentration
Acetone	2 μg/L
bis(2-Ethylhexyl)phthalate	31 μg/L
Di-n-butylphthalate	7 μg/L
Diethylphthalate	2 μg/L
Methylene chloride	7 μg/L

Table 5-7

Results for Trip Blanks

Analyte	Concentration
Methylene chloride	8 μg/L

Table 5-8

Usability Rates for Each Analyte

Parameters	Percent Acceptable	Meets Established DQOs
Metals		
Aluminum	100	Yes
Antimony	100	Yes
Arsenic	100	Yes
Barium	100	Yes
Beryllium	100	Yes
Boron	100	Yes
Cadmium	100	Yes
Calcium	100	Yes
Chromium	100	Yes
Cobalt	100	Yes
Copper	100	Yes
Iron	100	Yes
Mercury	100	Yes
Molybdenum	100	Yes
Lead	100	Yes
Magnesium	100	Yes
Manganese	100	Yes
Nickel	100	Yes
Potassium	100	Yes
Selenium	100	Yes
Silver	100	Yes
Sodium	100	Yes
Thallium	100	Yes
Vanadium	100	Yes
Zinc	100	Yes
TOX	78	No
TOC	100	Yes
TPH	100	Yes
Volatiles		
Chloromethane	100	Yes
Bromomethane	100	Yes
Vinyl chloride	100	Yes
Chloroethane	100	Yes
Methylene chloride	100	Yes
Acetone	100	Yes

Table 5-8

(continued)

Parameters	Percent Acceptable	Meets Established DQOs
Carbon disulfide	100	Yes
1,1-Dichloroethene	100	Yes
1,1-Dichloroethane	100	Yes
1,2-Dichloroethene (total)	100	Yes
Chloroform	100	Yes
1,2-Dichloroethane	100	Yes
2-Butanone	100	Yes
1,1,1-Trichloroethane	100	Yes
Carbon tetrachloride	100	Yes
Bromodichloromethane	100	Yes
1,2-Dichloropropane	100	Yes
cis-1,3-Dichloropropene	100	Yes
Trichloroethene	100	Yes
Dibromochloromethane	100	Yes
1,1,2-Trichloroethane	100	Yes
Benzene	100	Yes
trans-1,3-Dichloropropene	100	Yes
Bromoform	100	Yes
4-Methyl-2-pentanone	100	Yes
2-Hexanone	100	Yes
Tetrachloroethene	100	Yes
Toluene	100	Yes
1,1,2,2-Tetrachloroethane	100	Yes
Chlorobenzene	100	Yes
Ethyl benzene	100	Yes
Styrene	100	Yes
Xylenes (total)	100	Yes
2-Chloroethylvinylether	100	Yes
Acrolein	100	Yes
Acrylonitrile	100	Yes
Vinyl acetate	100	Yes
Semivolatiles		
Phenol	100	Yes
bis(2-Chloroethyl)ether	100	Yes
2-Chlorophenol	100	Yes
1,3-Dichlorobenzene	100	Yes
1,4-Dichlorobenzene	100	Yes

Table 5-8

(continued)

Parameters	Percent Acceptable	Meets Established DQOs
1,2-Dichlorobenzene	100	Yes
2-Methylphenol	100	Yes
bis(2-Chloroisopropyl)ether	100	Yes
4-Methylphenol	100	Yes
N-Nitroso-di-n-propylamine	100	Yes
Hexachloroethane	100	Yes
Nitrobenzene	100	Yes
Isophorone	100	Yes
2-Nitrophenol	100	Yes
2,4-Dimethylphenol	100	Yes
bis(2-Chloroethoxy)methane	100	Yes
2,4-Dichlorophenol	100	Yes
1,2,4-Trichlorobenzene	100	Yes
Naphthalene	100	Yes
4-Chloroaniline	100	Yes
Hexachlorobutadiene	100	Yes
4-Chloro-3-methylphenol	100	Yes
2-Methylnaphthalene	100	Yes
Hexachlorocyclopentadiene	100	Yes
2,4,6-Trichlorophenol	100	Yes
2,4,5-Trichlorophenol	100	Yes
2-Chloronaphthalene	100	Yes
2-Nitroaniline	100	Yes
Dimethylphthalate	100	Yes
Acenaphthylene	100	Yes
2,6-Dinitrotoluene	100	Yes
3-Nitroaniline	100	Yes
Acenaphthene	100	Yes
2,4-Dinitrophenol	100	Yes
4-Nitrophenol	100	Yes
Dibenzofuran	100	Yes
2,4-Dinitrotoluene	100	Yes
Diethylphthalate	100	Yes
4-Chlorophenyl-phenyl ether	100	Yes
Fluorene	100	Yes
4-Nitroaniline	100	Yes
4,6-Dinitro-2-methylphenol	100	Yes
N-nitrosodiphenylamine	100	Yes
4-Bromophenyl-phenyl ether	100	Yes

Table 5-8

(continued)

Parameters	Percent Acceptable	Meets Established DQOs
Hexachlorobenzene	100	Yes
Pentachlorophenol	100	Yes
Phenanthrene	100	Yes
Anthracene	100	Yes
Butylbenzylphthalate	100	Yes
3,3'-Dichlorobenzidine	100	Yes
Benzo(a)anthracene	100	Yes
Di-n-butylphthalate	100	Yes
Fluoranthene	100	Yes
Pyrene	100	Yes
Chrysene	100	Yes
bis(2-Ethylhexyl)phthalate	100	Yes
Di-n-octylphthalate	100	Yes
Benzo(b)fluoranthene	100	Yes
Benzo(k)fluoranthene	100	Yes
Benzo(a)pyrene	100	Yes
Indeno(1,2,3-cd)pyrene	100	Yes
Dibenz(a,h)anthracene	100	Yes
Benzo(g,h,i)perylene	100	Yes
1,2-Diphenylhydrazine	100	Yes
Benzidine	100	Yes
Benzoic acid	100	Yes
Benzyl alcohol	100	Yes
N-nitrosodimethylamine	100	Yes
Pesticides/PCBs		
Alpha-BHC	100	Yes
Beta-BHC	100	Yes
Delta-BHC	100	Yes
Gamma-BHC (Lindane)	100	Yes
Heptachlor	100	Yes
Aldrin	100	Yes
Heptachlor epoxide	100	Yes
Endosulfan I	100	Yes
Dieldrin	100	Yes
4,4'-DDE	100	Yes
Endrin	100	Yes
Endosulfan II	100	Yes

Table 5-8

(continued)

Parameters	Percent Acceptable	Meets Established DQOs
4,4'-DDD	100	Yes
Endosulfan sulfate	100	Yes
4,4'-DDT	100	Yes
Methoxychlor	100	Yes
Endrin ketone	100	Yes
Endrin aldehyde	100	Yes
Alpha chlordane	100	Yes
Gamma chlordane	100	Yes
Toxaphene	100	Yes
Aroclor 1016	100	Yes
Aroclor 1221	100	Yes
Aroclor 1232	100	Yes
Aroclor 1242	100	Yes
Aroclor 1248	100	Yes
Aroclor 1254	100	Yes
Aroclor 1260	100	Yes
Radiological		
Radium-226	100	Yes
Radium-228	100	Yes
Thorium-230	100	Yes
Thorium-232	100	Yes
Total uranium	100	Yes

Table 5-9

Radiochemistry Laboratory Performance on DOE Quality Assessment Program Samples, 1992

Sample Media	Radionuclides	Number of Results Reported	Number Within Control Limits
Air filters	Uranium (mass)	1	1
Soil	Potassium-40 Strontium-90 Cesium-137 Uranium (mass)	4	3
Vegetation	Potassium-40 Strontium-90 Cesium-137	3	3
Water	Tritium Manganese-54 Cobalt-60 Cesium-134 Cesium-137 Cerium-144 Plutonium-238 Plutonium-239 Americium-241 Uranium (mass)	10	9

Table 5-10

Radiochemistry Laboratory Performance on EPA Intercomparison Program Samples, 1992

Sample Media	Radionuclides	Number of Results Reported	Number Within Control Limits
Water	Alpha Beta Zinc-65 Cobalt-60 Ruthenium-106 Cesium-134 Cesium-137 Barium-133	26	24
Water	Radium-226 Radium-228 Plutonium-239 Uranium (natural)	16	16
Water	Strontium-89 Strontium-90	7	6
Water	Tritium	2	2
Air filters	Alpha Beta Strontium-90 Cesium-137	7	5

REFERENCES

Bechtel National, Inc. (BNI), 1991. *Environmental Monitoring Plan for the Wayne Interim Storage Site*, DOE/OR/21949-311, Oak Ridge, Tenn. (November).

BNI, 1992a. *Quality Assurance Program Plan for U.S. DOE FUSRAP*, Rev. 2, Oak Ridge, Tenn. (February).

BNI, 1992b. *Wayne Interim Storage Site Annual Environmental Report for Calendar Year 1991*, DOE/OR/21949-345, Oak Ridge, Tenn. (May).

BNI, 1993. *Quality Assurance Document for Site Environmental Reports*, DOE/OR/21949-362, Oak Ridge, Tenn. (January).

Cember, H., 1983. *Introduction to Health Physics*, Pergamon Press, Oxford.

Department of Energy (DOE), 1987. "Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Surplus Facilities Management Program Sites," Rev. 2 (March).

DOE, 1988. Order 5400.1, "General Environmental Protection Program" (January 9).

DOE, 1990. Order 5400.5, "Radiation Protection of the Public and the Environment" (February 5).

DOE, 1991. Order 5700.6C, "Quality Assurance" (August 21).

DOE, 1992a. Letter from Lester K. Price (Former Sites Restoration Division) to Debra Hammond (New Jersey Department of Environmental Protection and Energy), "New Jersey Stormwater Permit Determination," BNI CCN 095062 (September 30).

DOE, 1992b. Memorandum from Joe La Grone (Oak Ridge Field Office) to Carol M. Borgstrom (Office of NEPA Oversight), "Categorical Exclusion Determination - Routine Maintenance Activities at FUSRAP Sites," BNI CCN 091808 (July 9).

DOE, 1992c. Memorandum from Joe La Grone (Oak Ridge Field Office) to Carol M. Borgstrom (Office to NEPA Oversight), "Categorical Exclusion Determination - Routine Environmental Monitoring Activities for FUSRAP Sites," BNI CCN 091803 (July 9).

Department of Health, Education, and Welfare (HEW), 1970. *Radiological Health Handbook*, Rockville, Md. (January).

Eisenbud, M., 1987. *Environmental Radioactivity*, Viking Press, N.Y.

Environmental Protection Agency (EPA), 1987. *A Compendium of Superfund Field Operations Methods*, Vol. 2, EPA/540/P-87/001b (August).

EPA, 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (Draft) (July 1).

EPA, 1989. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Interim Final Guidance*, EPA/530/SW89/026, Office of Solid Waste, Waste Management Division, Washington, D.C. (February).

Hoffman, J. F., 1989. *Plan of Study for the Central Passaic River Basin Hydrogeologic Investigation*, New Jersey Geological Survey Open File Report 88-4.

National Oceanic and Atmospheric Administration (NOAA), 1993. Local Climatological Data, Newark Airport, Newark, N.J.

Shleien, B. 1989. *The Health Physics and Radiological Health Handbook*, Scinta, Inc., Silver Spring, Md.

APPENDIX A Hydrogeologic Details

HYDROGEOLOGIC DETAILS

The bedrock underlying the Wayne site is composed of lower Jurassic sedimentary and igneous rocks of the Brunswick Group, Newark Supergroup. Bedrock is overlain by unconsolidated Pleistocene glaciofluvial deposits and a thin veneer of Holocene sediments. Bedrock lithologies identified at the site include conglomerates, sandstones, and siltstones of the Boonton Formation (previously referred to as the Brunswick Formation). The surface of the Boonton sandstone was weathered and eroded by streams and glacial ice, and the configuration of this surface controlled the subsequent deposition and distribution of the overlying unconsolidated sediments. The unconsolidated sediments (overburden) are composed of channel fill deposits (poorly sorted clay, sand, and gravel) and lake clays. An erosional low in the bedrock surface, formed before the deposition of these deposits, had a direct influence on the type and distribution of sediments in the local area.

The shallow groundwater flow system at WISS occurs in the unconsolidated sediments (overburden) and the shallow Boonton Formation bedrock. Groundwater in the overburden occurs under unconfined and confined conditions, and groundwater in the bedrock occurs under confined conditions. Bedrock at the site is overlain by 7.6 to 15 m (25 to 50 ft) of unconsolidated sediments. In general, the overburden is composed of poorly sorted sand and gravel, and across most of the site, bedrock is directly overlain by sand and gravel. The overburden across most of the site is divided into upper and lower units separated by low-permeability silts and clays. The low-permeability sediments act as an aquitard, confining the groundwater in the lower overburden unit and the consolidated rock. The resulting confined conditions create an upward hydraulic gradient from the bedrock and lower overburden unit toward the upper overburden unit. Wells completed in the lower overburden unit and in bedrock generally exhibit flowing artesian conditions. Groundwater flow in both the bedrock and the unconsolidated sediments is to the west toward the Ramapo and Pompton rivers.

The groundwater monitoring network at the site consists of 17 wells. Eight of the overburden wells are completed in and/or above the confining unit, and one well is completed in the sands below the confining unit. The eight bedrock wells are completed in

the upper 9 to 12 m (30 to 40 ft) of bedrock. The wells are located along the perimeter of the site and, with one exception, are completed as well pairs to monitor groundwater in the upper unit of the overburden and in the bedrock. Well locations are shown in Figure A-1.

Overburden - Upper Unit

The thickness of unconsolidated sediments above the confining unit ranges from 1.8 m (6 ft) at location WISS-3 to 8.5 m (28 ft) at location B37W09. Potentiometric levels in the upper groundwater system generally range from 0.3 to 2.1 m (1 to 7 ft) below ground surface (BGS); however, levels in WISS-6A and B37W09S range from ground surface to 0.4 m (1.3 ft) above ground surface in the spring, indicating a groundwater discharge zone along the base of the hillside.

Water levels fluctuate seasonally in response to precipitation and evapotranspiration. Results of water level measurements over the past several years have shown that seasonal fluctuations typically range from 0.3 to 1.4 m (1 to 4.5 ft). Water levels are generally highest from February through June and lowest during October and November. Selected hydrographs reflecting typical seasonal fluctuations of groundwater levels in the overburden from January 1989 through December 1992 are presented in Figures A-2 through A-4. Potentiometric surface maps were constructed from groundwater data for June 9, 1992, and September 16, 1992 (Figures A-5 and A-6). These maps reflect annual high and low groundwater conditions. The potentiometric surface contours indicate horizontal hydraulic gradients ranging from 0.06 to 0.07, with average gradients slightly higher during the spring. Groundwater flow is toward the Pompton River and probably discharges in the wetlands area west of the site.

Overburden - Lower Unit

The lower overburden unit consists of the sediments between the confining layer and bedrock. Unit thickness ranges from 0.6 to 7.6 m (2 to 25 ft) and consists predominantly of sand and gravel. The maximum thickness of this unit occurs in the bedrock low through the central portion of site from B37W09 toward WISS-3. The unit thins to the south and north

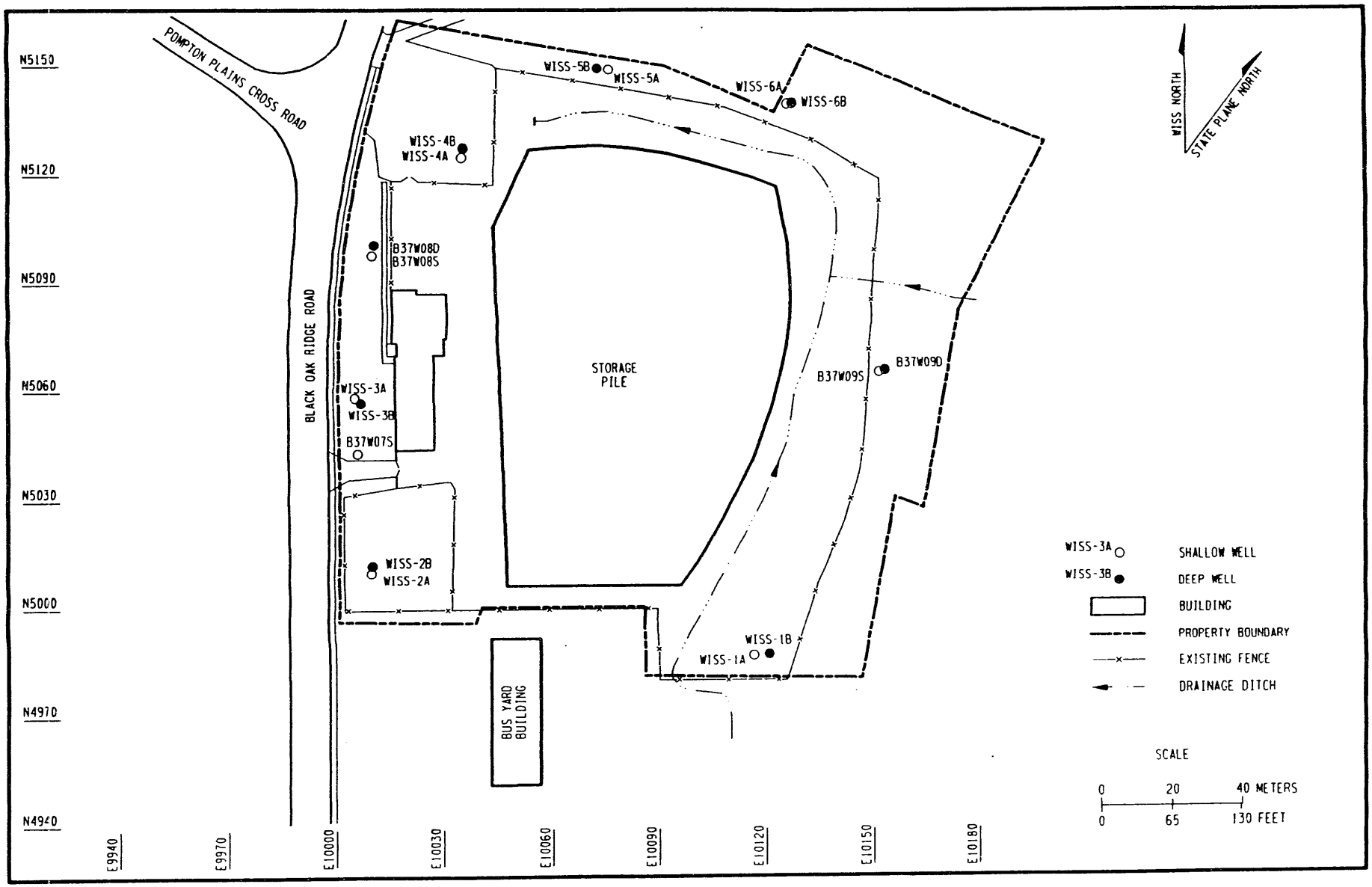
along higher bedrock elevations and is not present in the north-northeastern portion of the site (WISS-6). In this area, the upper and lower sand and gravel units of the overburden are in direct hydraulic connection. One monitoring well (B37W07S) is completed in the sand immediately below the clay unit and exhibits flowing artesian conditions.

Bedrock

Groundwater from wells completed in bedrock flows above ground surface in all wells except WISS-1B, which is located in a topographically higher area than the other wells. Potentiometric levels are above the top of the casing in all wells except WISS-1B and B37W09D, and as a result, these locations are the only bedrock wells where static water level measurements have been recorded over time. A potentiometric surface map generated from measurements taken in 1985 is presented in Figure A-7. As shown, from east to west, the levels ranged from approximately 69 to 63 m (226 to 208 ft) above MSL. Potentiometric levels measured in selected wells completed in the bedrock were periodically measured during the summer and fall of 1992. The levels ranged from approximately 70 m (231 ft) above MSL on the eastern portion of the site to 64 m (210 ft) above MSL on the western portion of the site (Figure A-8). These measurements are consistent with those taken in 1985. The hydrograph of potentiometric levels in WISS-1B indicates seasonal fluctuations from 0.6 to 1.2 m (2 to 4 ft). The general direction of groundwater flow in the bedrock is inferred to be toward the west at a gradient of approximately 0.04. Groundwater recharge occurs in the uplands area east of the site, and groundwater discharges in the valley fill deposits west of the site.

The upper aquifer has an average hydraulic conductivity of 3×10^{-4} cm/s (310 ft/yr), an average gradient of 0.065 toward the west, and a computed linear flow velocity of 21 m/yr (70 ft/yr). The bedrock aquifer system has an average hydraulic gradient of 1×10^{-4} cm/s (104 ft/yr), an average gradient of 0.04 toward the west, and a computed flow velocity of 24 to 126 m/yr (80 to 415 ft/yr).

FIGURES FOR APPENDIX A



137 R38F002.DGN

Figure A-1
Groundwater Monitoring Well Locations at WISS

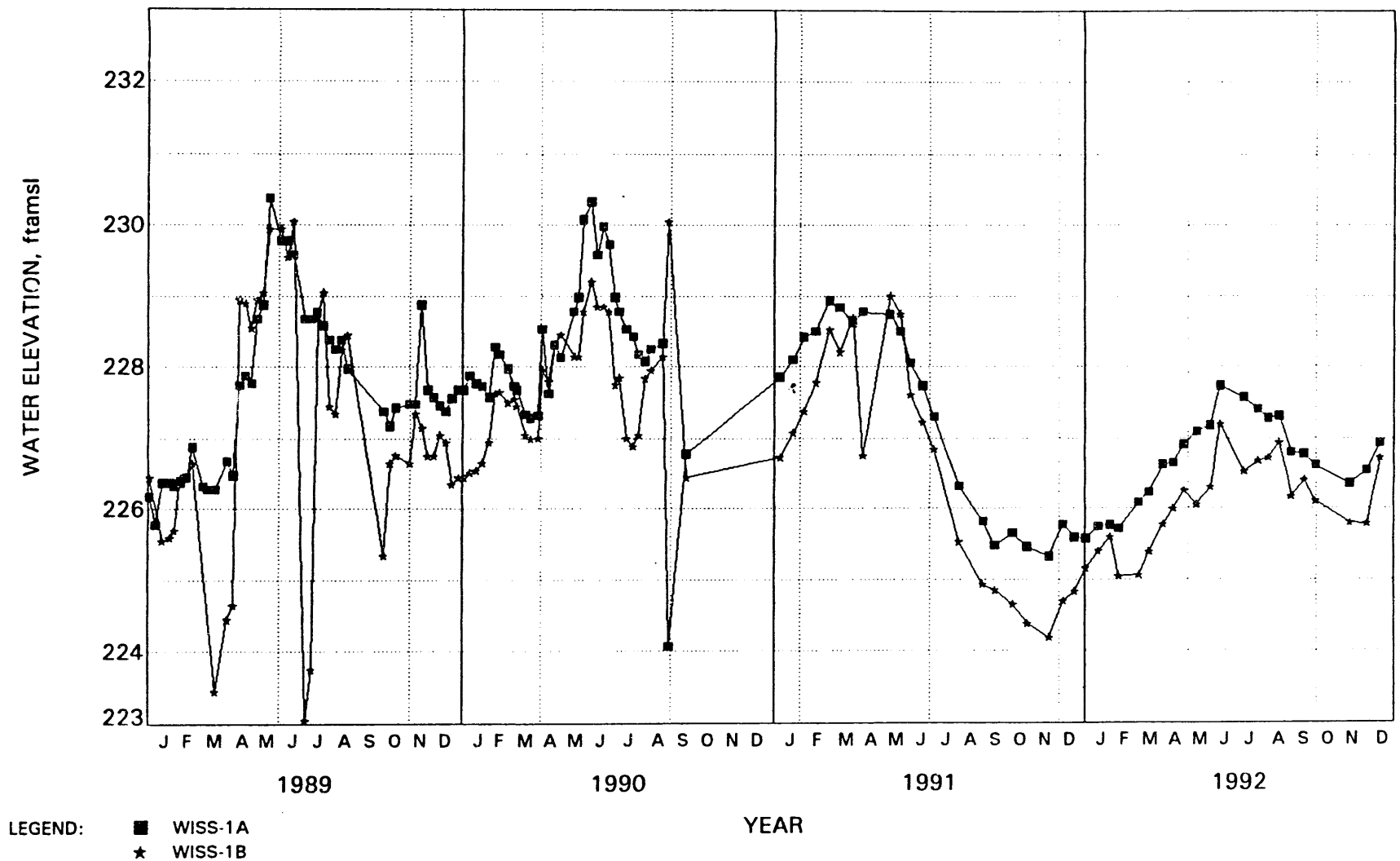


Figure A-2
Hydrograph for WISS-1A and WISS-1B

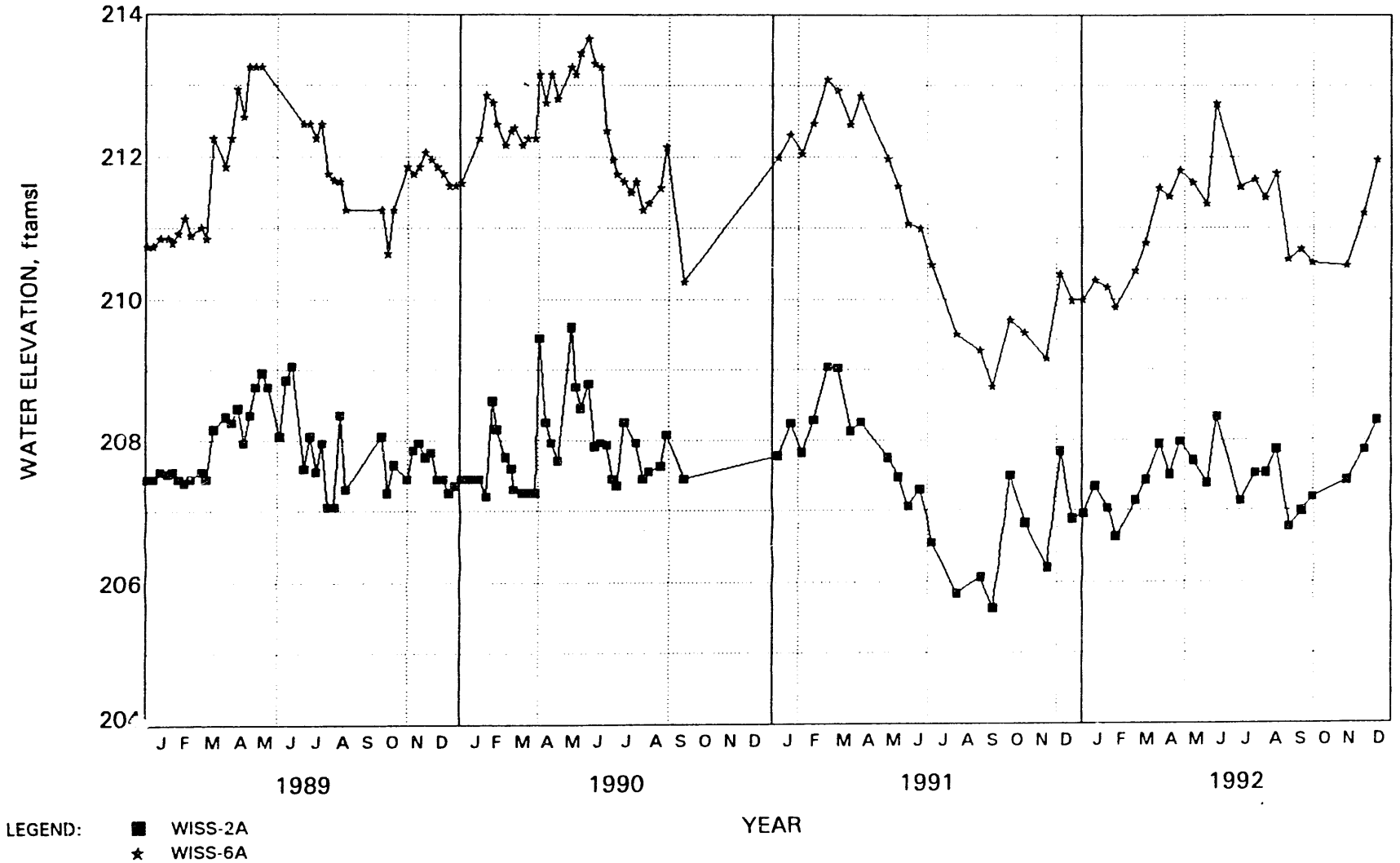


Figure A-3
Hydrograph for WISS-2A and WISS-6A

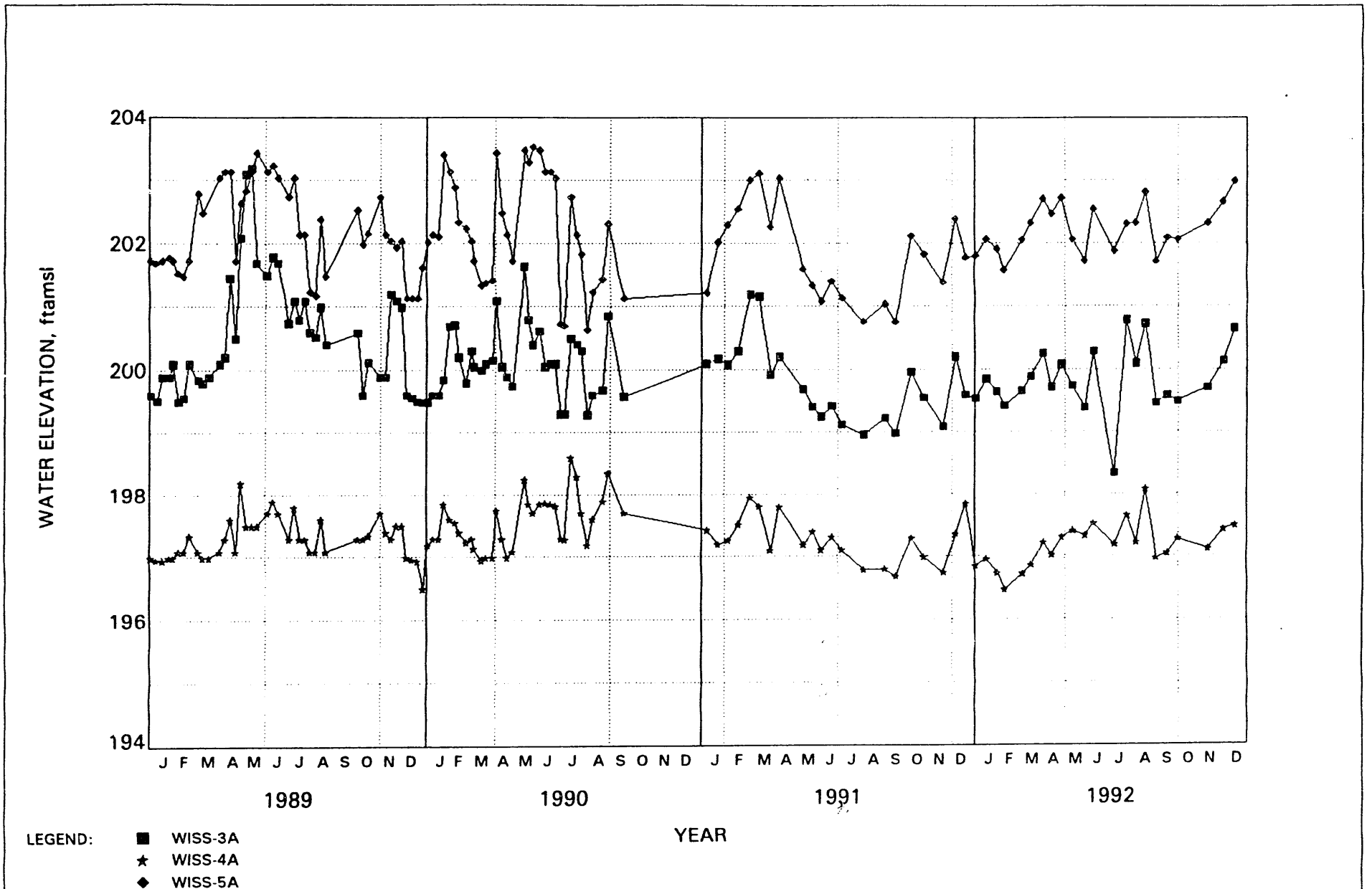
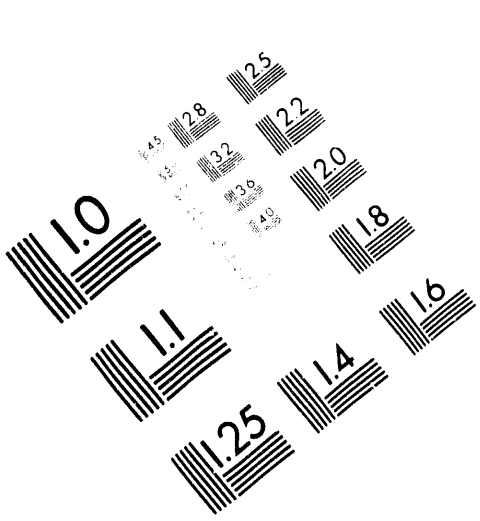
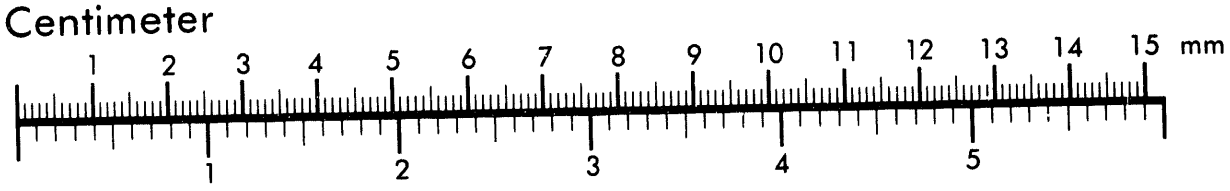
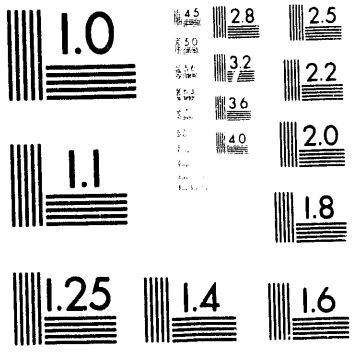
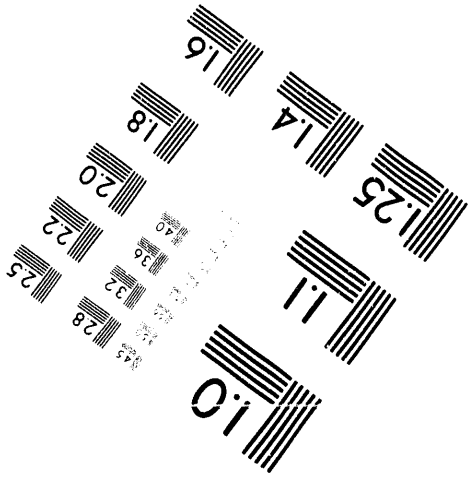


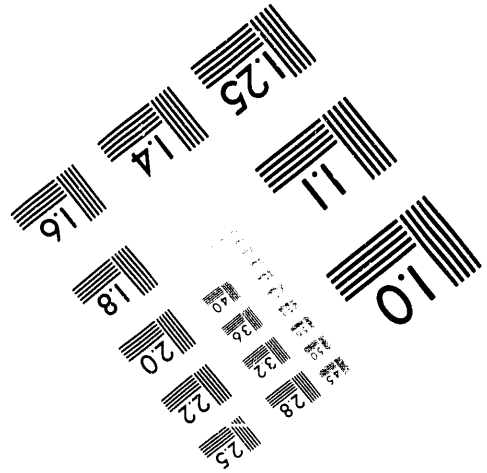
Figure A-4
Hydrograph for WISS-3A, WISS-4A, and WISS-5A



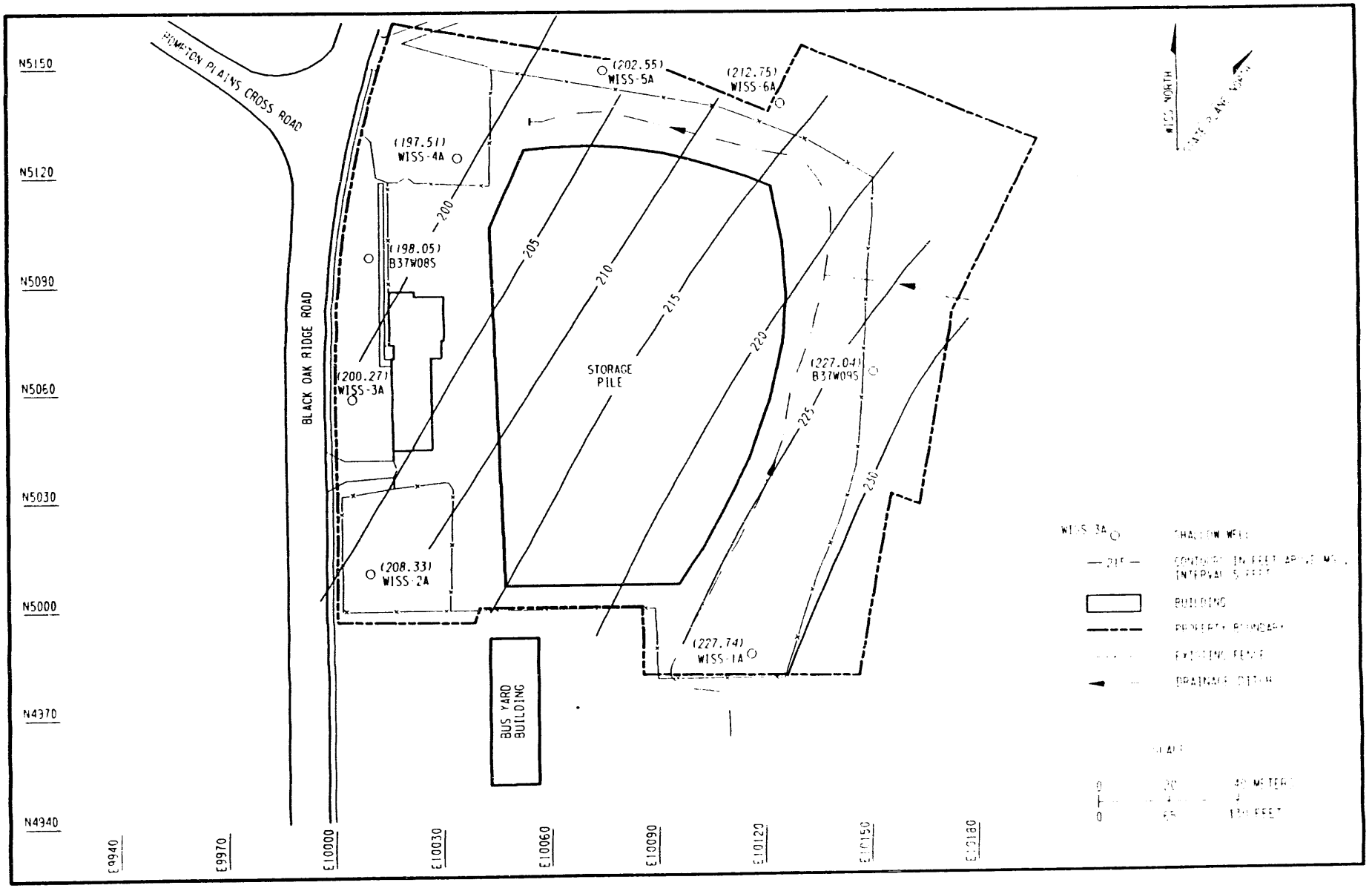






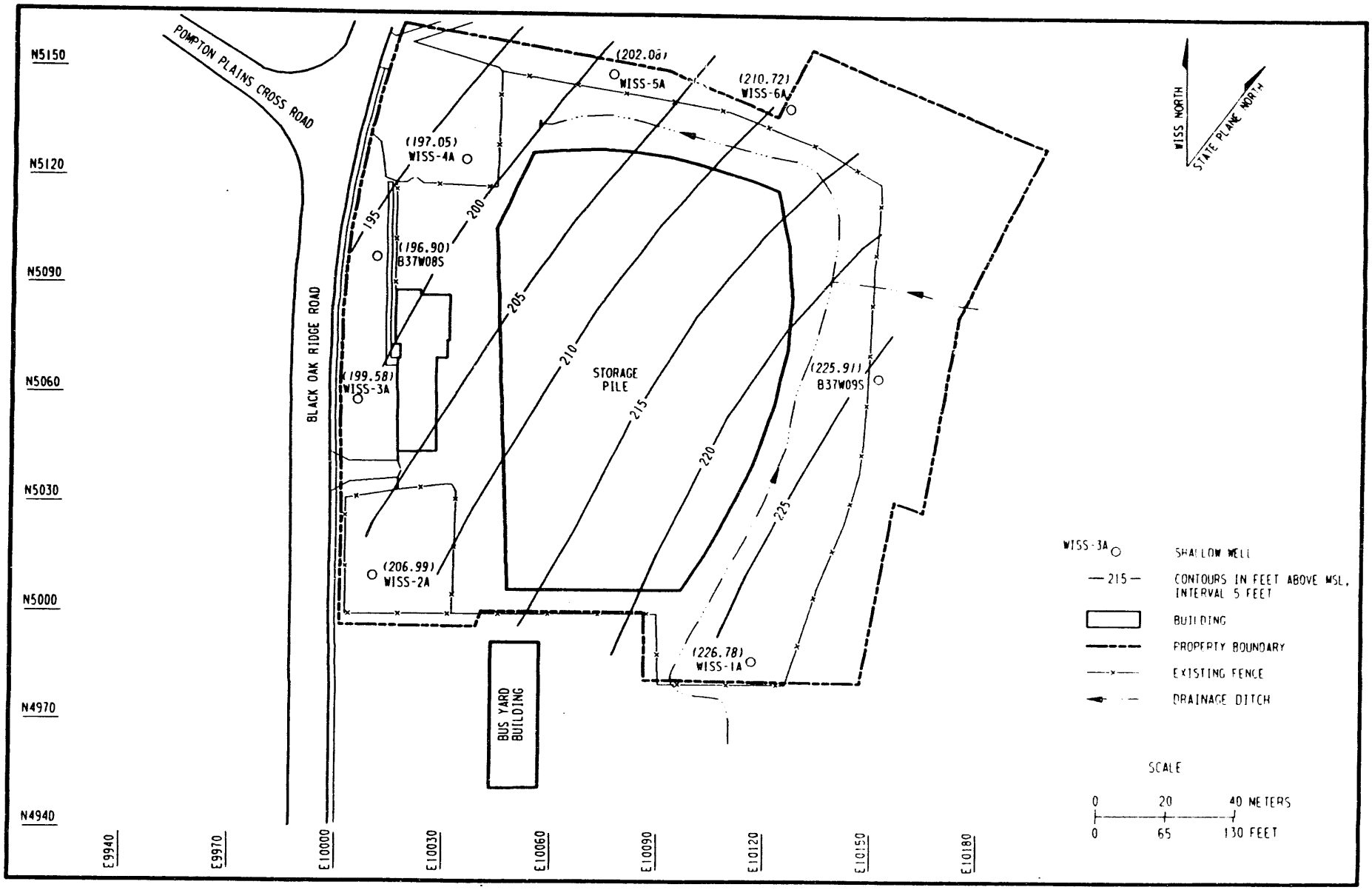


2 of 2



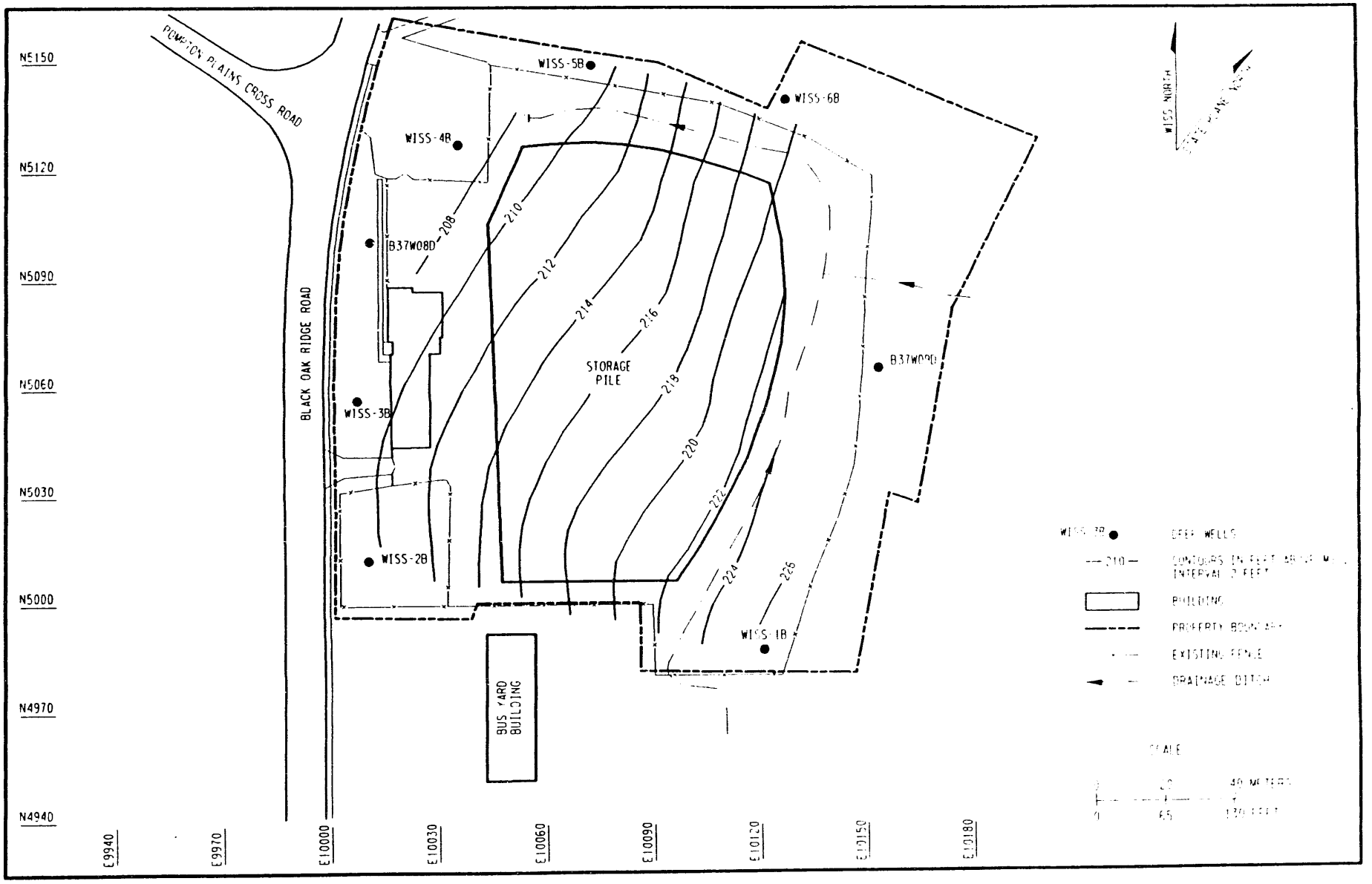
137 R38F001.DGN

Figure A-5
Piezometric Surface Map of the Upper Overburden Unit (June 9, 1992)



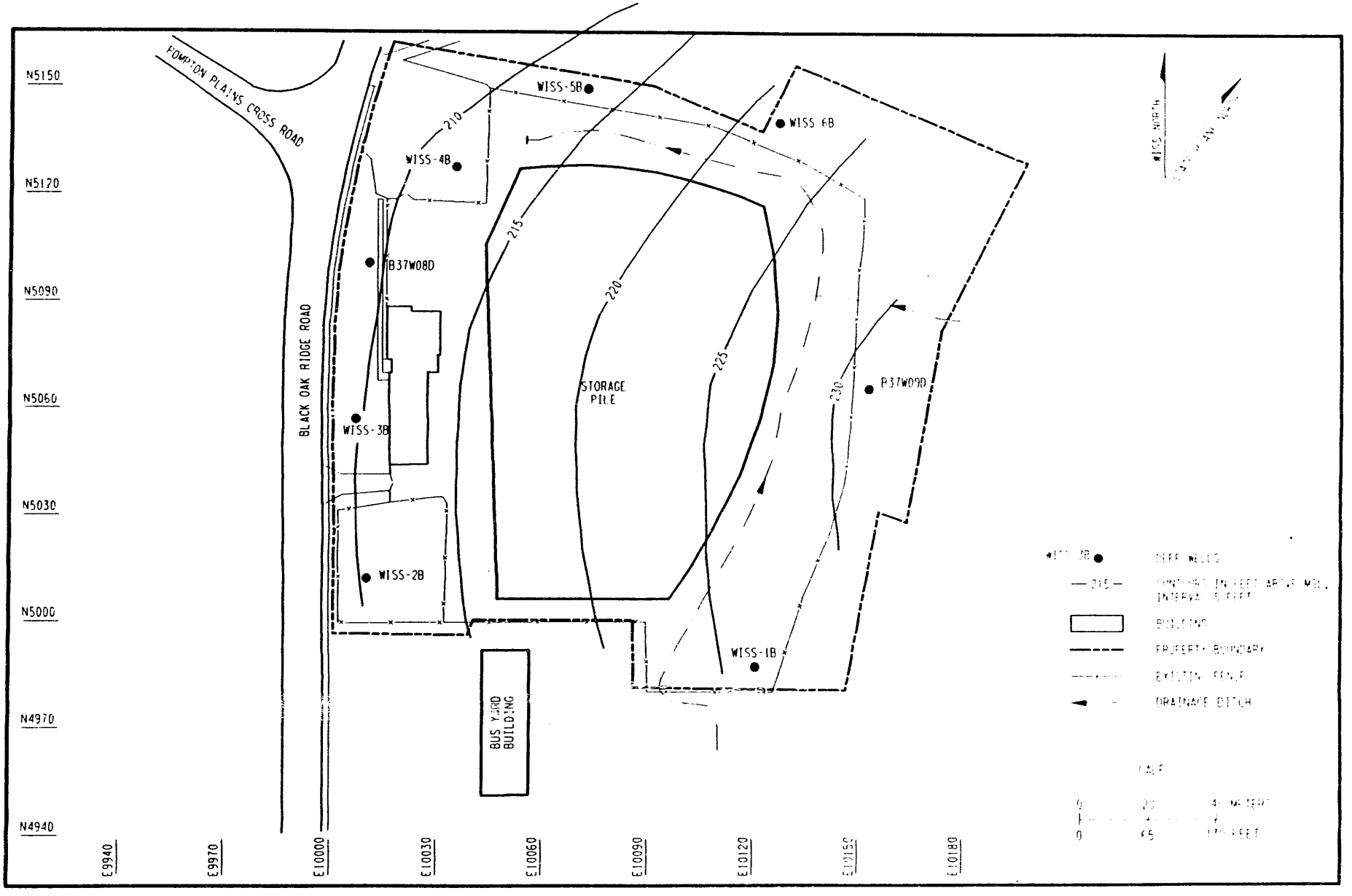
137 R38F005.DGN

Figure A-6
Piezometric Surface Map of the Upper Overburden Unit (September 16, 1992)



137 R20F004.DGN

Figure A-7
Potentiometric Surface Map of the Bedrock (February 27, 1985)



137 R38F003.DGN

Figure A-8
Potentiometric Surface Map of the Bedrock (September 16, 1992)

TABLES FOR APPENDIX A

Table A-1

Range of Radionuclide Concentrations in Groundwater, 1985-1992

Location	1985	1986	1987	1988	1989	1990	1991[a]	1992
				Radium-226 (pCi/L) (DCG = 100 pCi/L)				
Overburden								
WISS-1A	<0.1 - 0.4	0.2 - 2.1	<0.1 - 0.4	0.6 - 2.1	0.7 - 1.9	<0.1 - 1.0	<0.1 - 0.75	--[b]
WISS-2A	0.1 - 0.5	<0.1 - 0.2	0.3 - 0.5	0.9 - 1.9	0.7 - 3.1	0.1 - 1.3	0.4 - 3.3	--
WISS-3A	0.1 - 0.7	0.1 - 0.9	<0.1 - 0.6	0.5 - 1.7	0.7 - 1.3	0.2 - 0.8	0.07 - 0.7	0.21
WISS-4A	0.2 - 1.9	0.2 - 1.0	<0.1 - 0.3	0.5 - 1.7	0.6 - 1.4	0.1 - 0.9	<0.10 - 0.7	0.79
WISS-5A	<0.2 - 0.4	<0.1 - 1.1	0.1 - 0.6	0.5 - 2.1	0.5 - 1.5	0.1 - 0.5	<0.10 - 1.14	--
WISS-6A	<0.1 - 1.0	0.1 - 0.9	<0.1 - 1.0	0.6 - 1.7	0.4 - 1.5	0.1 - 1.0	0.1 - 0.8	--
B37W07S	--	--	--	--	--	--	15.3	0.21
B37W08S	--	--	--	--	--	--	11.3	0.48
B37W09S	--	--	--	--	--	--	0.4	0.19
Bedrock								
WISS-1B	<0.1 - 0.3	0.2 - 0.6	<0.1 - 0.8	0.4 - 1.5	0.7 - 1.9	0.1 - 0.6	<0.10 - 0.4	--
WISS-2B	0.1 - 0.5	0.2 - 1.1	<0.1 - 0.6	0.5 - 2.0	0.7 - 2.2	0.3 - 1.1	0.10 - 0.8	--
WISS-3B	<0.1 - 0.6	0.1 - 1.1	<0.1 - 0.7	0.7 - 1.7	0.5 - 1.7	0.2 - 0.9	0.10 - 0.8	--
WISS-4B	0.2 - 0.3	<0.1 - 0.5	<0.1 - 0.5	0.6 - 1.7	0.5 - 1.3	0.1 - 0.6	<0.10 - 0.6	--
WISS-5B	<0.1 - 0.8	0.2 - 0.8	<0.1 - 0.4	0.4 - 1.7	0.4 - 1.5	0.1 - 0.4	<0.10 - 0.94	--
WISS-6B	<0.1 - 0.4	0.4 - 1.3	<0.1 - 0.4	0.7 - 1.7	0.5 - 1.4	0.1 - 0.8	0.10 - 0.75	--
B37W08D	--	--	--	--	--	--	0.7	--
B37W09D	--	--	--	--	--	--	0.1	--
				Radium-228 (pCi/L) (DCG = 100 pCi/L)				
Overburden								
WISS-1A	<2.0 - <4.0	<0.1 - <5.0	<2.0 - <3.0	<4.0 - <6.0	<5.0 - <9.0	--	<0.30 - 24	--
WISS-2A	<0.4 - <4.0	<2.0 - <2.0	<2.0 - <3.0	<4.0 - <4.0	<4.0 - <10.0	--	<0.5 - <3.6	--
WISS-3A	<2.0 - <4.0	<2.0 - <4.0	<2.0 - <4.0	<4.0 - <6.0	<5.0 - <9.0	--	<0.5 - <4.9	1.56
WISS-4A	<2.0 - <4.0	<0.1 - <5.0	<2.0 - <4.0	<4.0 - <7.0	<5.0 - <8.0	--	0 - 2.16	0.60
WISS-5A	<2.0 - <4.0	<2.0 - <5.0	<2.0 - <4.0	<4.0 - <6.0	<4.0 - <8.0	--	<0.5 - <7.92	--
WISS-6A	<2.0 - <4.0	<2.0 - <5.0	<0.3 - <4.0	<4.0 - <8.0	<5.0 - <11.0	--	<1.96 - 4.8	--
B37W07S	--	--	--	--	--	--	<0.5	0.60
B37W08S	--	--	--	--	--	--	<0.5	0.90
B37W09S	--	--	--	--	--	--	<0.5	0.90

Table A-1

(continued)

Location	1985	1986	1987	1988	1989	1990	1991[a]	1992
Bedrock								
WISS-1B	<2.0 - <4.0	<2.0 - <5.0	<2.0 - <3.0	<4.0 - <5.0	<4.0 - <10.0	--	<0.31 - <6.1	--
WISS-2B	<0.6 - <4.0	<2.0 - <5.0	<2.0 - <3.0	<4.0 - <6.0	<5.0 - <9.0	--	<0.5 - <3.03	--
WISS-3B	<2.0 - <4.0	<2.0 - <5.0	<2.0 - <3.0	<4.0 - <7.0	<4.0 - <8.0	--	<0.5 - <5.26	--
WISS-4B	<2.0 - <4.0	<2.0 - <5.0	<2.0 - <5.0	<4.0 - <6.0	<4.0 - <8.0	--	0 - <2	--
WISS-5B	<2.0 - <4.0	<2.0 - <5.0	<2.0 - <5.0	<4.0 - <7.0	<4.0 - <9.0	--	<0.5 - <4.5	--
WISS-6B	<2.0 - <4.0	<2.0 - <5.0	<2.0 - <4.0	<4.0 - <8.0	<5.0 - <10.0	--	<0.5 - <4.2	--
B37W08D	--	--	--	--	--	--	<0.5	--
B37W09D	--	--	--	--	--	--	<0.5	--
			Total Uranium (pCi/L) (DCG = 600 pCi/L)					
Overburden								
WISS-1A	<3.0	0.4 - 1.2	0.7 - 1.8	1.3 - 1.8	0.9 - 2.5	0.7 - <3.4	0.3 - 7.8	--
WISS-2A	<3.0	0.2 - 0.6	0.8 - 1.9	2.1 - 5.5	1.6 - 3.2	2.1 - <3.4	1.7 - 4.0	--
WISS-3A	<3.0	0.5 - 1.0	0.7 - 1.6	1.3 - 3.2	2.1 - 2.9	1.2 - 4.0	1.7 - 10.0	2.2
WISS-4A	<3.0 - 29.3	1.1 - 9.4	4.2 - 5.4	5.4 - 10.6	4.3 - 10.0	<3.4 - 7.4	3.6 - 13.6	3.6
WISS-5A	<3.0	0.5 - 1.7	1.1 - 1.9	1.7 - 3.0	1.4 - 2.8	1.3 - <3.4	0.9 - 4.0	--
WISS-6A	<3.0	0.3 - 0.8	0.8 - 1.4	1.3 - 2.3	0.6 - 1.9	0.9 - <3.4	0.4 - 3.3	--
B37W07S	--	--	--	--	--	--	1.7	0.8
B37W08S	--	--	--	--	--	--	3.0	0.8
B37W09S	--	--	--	--	--	--	1.7	0.3
Bedrock								
WISS-1B	<3.0	0.4 - 1.2	0.2 - 0.2	0.9 - 1.2	0.4 - 1.4	0.6 - <3.4	0.3 - <3.3	--
WISS-2B	<3.0	0.3 - 1.0	0.5 - 1.8	1.7 - 2.4	0.6 - 2.7	1.5 - <3.4	1.5 - <3.3	--
WISS-3B	<3.0	0.1 - 0.5	0.3 - 1.6	0.9 - 3.3	0.9 - 3.5	0.9 - <3.4	1.4 - 4.0	--
WISS-4B	<3.0	0.2 - 0.8	0.3 - 2.1	0.9 - 1.4	0.6 - 2.9	<0.6 - <3.4	1.3 - 4.16	--
WISS-5B	<3.0	0.2 - 1.5	0.9 - 1.5	0.7 - 2.3	1.0 - 1.5	1.6 - <3.4	0.8 - 3.3	--
WISS-6B	<3.0	0.3 - 1.0	1.0 - 1.8	1.6 - 3.0	1.3 - 2.4	2.6 - <3.4	0.6 - 4.0	--
B37W08D	--	--	--	--	--	--	0.8	--
B37W09D	--	--	--	--	--	--	0.5	--

Table A-1

(continued)

Location	1985	1986	1987	1988	1989	1990	1991[a]	1992
				Thorium-232 (pCi/L) (DCG = 50 pCi/L)				
Overburden								
WISS-1A	<0.1 - <0.2	<0.1	<0.1	<0.2 - 0.7	<0.2 -<0.3	0.1 - 0.2	<0.1 - <0.78	--
WISS-2A	<0.1 - 1.8	<0.1	<0.1	<0.2 - 2.6	<0.2 - 1.1	<0.1 - <0.2	<0.04 - 4.6	--
WISS-3A	<0.1 - <0.2	<0.1 -<0.4	<0.1 - <0.2	<0.2 - 0.4	<0.2 - 0.6	0.1 - <0.2	<0.06 - 2.93	<0.10
WISS-4A	<0.1	<0.1	<0.1 - 0.2	<0.2 - 0.5	<0.2 - 0.2	<0.1 - 0.2	<0.01 - 2.02	0.22
WISS-5A	<0.1	<0.1 -<0.2	<0.1 - 0.2	<0.2 - 0.3	<0.2 - 0.3	<0.1 - <0.2	<0.04 - 1.05	--
WISS-6A	<0.1 - 0.8	<0.6 -<0.2	<0.1 - 0.9	<0.2 - 0.4	<0.2 - 0.3	<0.1 - 0.4	<0.1 - 0.24	--
B37W07S	--	--	--	--	--	--	0.9	<0.26
B37W08S	--	--	--	--	--	--	<0.5	<0.14
B37W09S	--	--	--	--	--	--	1.6	<0.29
Bedrock								
WISS-1B	<0.1 - <0.2	<0.04 -<0.1	<0.1	<0.2 -<0.3	<0.2	<0.1 - <0.2	<0.05 - <0.79	--
WISS-2B	<0.1 - 1.9	<0.1 -<0.2	<0.1	<0.2	<0.2	<0.1 - 0.2	<0.05 - 0.8	--
WISS-3B	<0.1 - <0.3	<0.1 -<0.4	<0.1	<0.2	<0.2 -<0.3	0.1 - <0.2	<0.02 - <0.19	--
WISS-4B	<0.1 - 0.3	<0.1 -<0.2	<0.1	<0.2	<0.2	0.1 - <0.3	<0.05 - <0.79	--
WISS-5B	<0.1 - <0.2	<0.1	<0.1	<0.2	<0.2	<0.1 - <0.2	<0.05 - 0.1	--
WISS-6B	<0.1 - <0.6	<0.1 -<0.5	<0.1 - <0.5	<0.2 -<0.3	<0.2 -<0.4	<0.1 - <0.2	<0.04 - <0.4	--
B37W08D	--	--	--	--	--	--	<0.17	--
B37W09D	--	--	--	--	--	--	<0.08	--

[a]B37W series wells sampled only one time during 1991.

[b]-- = No sample collected.

Table A-2

Summary of Total and Dissolved Radionuclide Concentrations in Groundwater, 1990-1992

Location	Sampling Date	Ra-226 (pCi/L)		Ra-228 (pCi/L)		Th-228 (pCi/L)		Th-230 (pCi/L)		Th-232 (pCi/L)		Uranium (µg/L)	
		Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss
OVERBURDEN - UPPER UNIT													
WISS-1A	10/26/90	<0.1	<0.1	<2	<2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	--
WISS-1A	01/07/91	0.4	0.1	<24	<3.3	<0.1	<0.1	0.1	0.1	<0.1	<0.1	--	--
WISS-1A	04/18/91	0.75	0.5	<2.9	<3.1	0.33	<0.08	0.09	<0.08	0.33	<0.08	--	--
WISS-1A	07/17/91	0.24	0.1	<2	<1.3	0.61	<0.07	0.45	0.44	0.61	<0.07	<5	<5
WISS-1A	10/29/91	<0.10	--	<0.30	--	<0.78	--	<0.78	--	<0.78	--	--	--
WISS-2A	01/07/91	0.4	0.4	--	--	--	--	--	--	4.6	<0.1	<5	<5
WISS-2A	04/18/91	0.55	<0.1	<3.6	<3.4	--	--	--	--	<0.04	<0.2	<5	<5
WISS-2A	07/17/91	1.68	<0.07	2.61	<1.5	1.43	<0.2	1	<0.12	1.43	<0.2	6	10
WISS-2A	10/24/91	3.3	--	<0.5	--	--	--	--	--	1.8	--	2.53	--
WISS-3A	10/26/90	0.7	0.5	--	--	--	--	--	--	<0.1	<0.1	6	6
WISS-3A	01/07/91	0.6	0.2	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-3A	04/17/91	0.17	0.2	<3.6	<3.2	--	--	--	--	<0.06	<0.09	<5	7
WISS-3A	07/17/91	0.07	<0.09	<4.9	<1.07	2.95	<0.04	1.73	<0.04	2.93	<0.04	15	<5
WISS-3A	10/23/91	0.20	--	<0.5	--	--	--	--	--	0.20	--	2.53	--
WISS-3A	06/23/92	0.21	--	1.56	--	--	--	0.19	--	<0.10	--	3.34	--
WISS-4A	10/24/90	0.4	0.3	<2	<2	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	--	--
WISS-4A	01/07/91	0.2	0.1	0	0	0.1	<0.1	0.1	0.1	0.1	<0.1	--	--
WISS-4A	04/16/91	0.7	0.7	<1.6	<1.7	0.19	<0.09	<0.09	<0.1	0.19	<0.09	--	--
WISS-4A	07/16/91	0.65	<0.07	2.16	<1.7	2.02	<0.04	0.31	<0.04	2.02	<0.04	18	10
WISS-4A	10/23/91	<0.10	--	<0.32	--	<0.78	--	<0.78	--	<0.78	--	--	--
WISS-4A	06/23/92	0.79	--	0.60	--	--	--	1.03	--	0.22	--	5.34	--
WISS-5A	10/25/90	0.5	0.8	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-5A	01/07/91	0.2	0.1	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-5A	04/16/91	0.4	<0.2	<4	<4.6	--	--	--	--	<0.04	<0.07	6	<5
WISS-5A	07/16/91	1.14	<0.09	<7.92	<1.6	1.05	<0.03	0.82	<0.05	1.05	<0.03	<5	5
WISS-5A	10/21/91	<0.10	--	<0.5	--	--	--	--	--	<0.24	--	1.3	--
WISS-6A	10/25/90	0.8	0.6	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-6A	01/07/91	0.2	0.2	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-6A	04/16/91	0.7	0.15	4.8	<4.2	--	--	--	--	<0.06	<0.07	5	6
WISS-6A	07/16/91	0.72	0.45	<1.96	<11.24	0.24	<0.03	0.31	<0.03	0.24	<0.03	<5	8
WISS-6A	10/21/91	0.1	--	<0.5	--	--	--	--	--	<0.18	--	0.56	--

Table A-2

(continued)

Location	Sampling Date	Ra-226 (pCi/L) Total	Ra-226 (pCi/L) Diss	Ra-228 (pCi/L) Total	Ra-228 (pCi/L) Diss	Th-228 (pCi/L) Total	Th-228 (pCi/L) Diss	Th-230 (pCi/L) Total	Th-230 (pCi/L) Diss	Th-232 (pCi/L) Total	Th-232 (pCi/L) Diss	Uranium (µg/L) Total	Uranium (µg/L) Diss
B37W08S	10/22/91	11.3	--	<0.5	--	--	--	--	--	<0.5	--	4.56	--
B37W08S	06/23/92	0.48	--	0.90	--	--	--	0.31	--	<0.14	--	1.28	--
B37W09S	10/29/91	0.4	--	<0.5	--	--	--	--	--	1.6	--	2.55	--
B37W09S	06/23/92	0.19	--	0.90	--	--	--	0.91	--	<0.29	--	0.51	--
OVERBURDEN - LOWER UNIT													
B37W07S	10/22/91	15.3	--	<0.5	--	--	--	--	--	0.9	--	2.67	--
B37W07S	06/23/92	0.21	--	0.60	--	--	--	0.27	--	<0.26	--	1.27	--
BEDROCK													
WISS-1B	10/26/90	0.3	0.6	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	--
WISS-1B	01/07/91	0.4	0.1	<6.1	<5.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	--
WISS-1B	04/18/91	<0.09	0.13	<3.2	<3.3	<0.05	<0.05	<0.05	<0.03	<0.05	<0.05	--	--
WISS-1B	07/17/91	0.17	<0.08	<2.42	<2.6	<0.07	<0.1	<0.03	<0.14	<0.07	<0.1	<5	5
WISS-1B	10/29/91	<0.10	--	<0.31	--	<0.79	--	<0.79	--	<0.79	--	--	--
WISS-2B	10/26/90	0.4	0.2	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-2B	01/07/91	0.4	0.2	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-2B	04/17/91	0.8	0.8	<1.6	<1.5	--	--	--	--	<0.05	0.09	--	<5
WISS-2B	07/17/91	0.11	<0.19	<3.03	<1.2	<0.09	<0.07	<0.09	<0.04	<0.09	<0.07	<5	<5
WISS-2B	10/25/91	0.10	--	<0.5	--	--	--	--	--	0.8	--	2.31	--
WISS-3B	10/26/90	0.8	0.7	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-3B	01/07/91	0.3	0.2	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-3B	04/17/91	0.74	0.07	<1.7	<1.7	--	--	--	--	<0.02	<0.02	6	5
WISS-3B	07/17/91	0.37	<0.09	<5.26	<1.13	<0.11	<0.03	<0.11	<0.03	<0.11	<0.03	<5	<5
WISS-3B	10/23/91	0.10	--	<0.5	--	--	--	--	--	<0.19	--	2.17	--
WISS-4B	10/24/90	0.1	0.1	<2	<2	<0.1	<0.1	0.1	<0.2	<0.1	<0.1	--	--
WISS-4B	01/07/91	0.4	0.3	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	--
WISS-4B	04/16/91	0.6	0.25	<1.4	<1.5	<0.1	<0.1	0.15	<0.09	<0.1	<0.1	--	--
WISS-4B	07/16/91	0.23	0.38	<1.91	<10.5	<0.05	<0.03	<0.04	<0.03	<0.05	<0.03	<5	6
WISS-4B	10/23/91	<0.10	--	<0.32	--	<0.79	--	<0.79	--	<0.79	--	--	--
WISS-5B	10/25/90	0.2	<0.1	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-5B	01/07/91	0.3	0.1	--	--	--	--	--	--	0.1	<0.1	<5	<5
WISS-5B	04/16/91	0.45	0.39	<4.5	<4.1	--	--	--	--	<0.07	<0.07	5	<5
WISS-5B	07/16/91	0.94	0.43	<3	<9.18	<0.05	<0.03	<0.07	<0.03	<0.05	<0.03	<5	9
WISS-5B	10/22/91	<0.10	--	<0.5	--	--	--	--	--	<0.1	--	1.26	--

Table A-2

(continued)

Location	Sampling Date	Ra-226 (pCi/L) Total	Ra-226 (pCi/L) Diss	Ra-228 (pCi/L) Total	Ra-228 (pCi/L) Diss	Th-228 (pCi/L) Total	Th-228 (pCi/L) Diss	Th-230 (pCi/L) Total	Th-230 (pCi/L) Diss	Th-232 (pCi/L) Total	Th-232 (pCi/L) Diss	Uranium (µg/L) Total	Uranium (µg/L) Diss
WISS-6B	10/24/90	0.2	0.1	--	--	--	--	--	--	<0.1	<0.1	<5	<5
WISS-6B	01/07/91	0.4	0.2	--	--	--	--	--	--	<0.2	<0.1	<5	<5
WISS-6B	04/16/91	0.4	0.63	<4.2	<3.8	--	--	--	--	<0.04	0.28	<5	<5
WISS-6B	07/16/91	0.75	0.22	<1.6	2.5	<0.4	<.06	<0.4	<.04	<0.4	<.06	6	--
WISS-6B	10/21/91	0.1	--	<0.50	--	--	--	--	--	<0.11	--	0.9	--
B37W08D	10/29/91	0.7	--	<0.5	--	--	--	--	--	<0.17	--	1.18	--
B37W09D	10/29/91	0.1	--	<0.5	--	--	--	--	--	<0.08	--	0.74	--

		U-233/4 (pCi/L) Total	U-233/4 (pCi/L) Diss	U-235 (pCi/L) Total	U-235 (pCi/L) Diss	U-238 (pCi/L) Total	U-238 (pCi/L) Diss
OVERBURDEN - UPPER UNIT							
WISS-1A	10/26/90	0.4	0.2	<0.1	<0.1	0.2	0.1
WISS-1A	01/07/91	0.1	0.3	<0.1	<0.1	0.1	0.2
WISS-1A	04/18/91	0.59	0.28	<0.3	<0.1	0.51	0.25
WISS-1A	07/17/91	--	--	--	--	--	--
WISS-1A	10/29/91	1.71	--	1.63	--	4.47	--
WISS-4A	10/24/90	3.8	3.7	0.2	0.2	3.4	3
WISS-4A	01/07/91	3.6	2.7	0.1	0.1	3.2	2.7
WISS-4A	04/16/91	4.95	3.84	0.22	0.13	4.51	3.66
WISS-4A	07/16/91	--	--	--	--	--	--
WISS-4A	10/23/91	7.0	--	1.94	--	4.67	--
WISS-4A	06/23/92	--	--	--	--	--	--
BEDROCK							
WISS-1B	10/26/90	0.4	0.1	<0.1	<0.1	0.2	0.1
WISS-1B	01/07/91	0.1	0.2	<0.1	0.1	<0.1	0.2
WISS-1B	04/18/91	0.32	0.09	<0.1	<0.08	0.27	<0.08
WISS-1B	07/17/91	--	--	--	--	--	--
WISS-1B	10/29/91	1.19	--	<0.15	--	0.59	--
WISS-4B	10/24/90	0.7	0.5	<0.1	<0.1	0.5	0.3
WISS-4B	01/07/91	1	0.3	0.3	<0.1	0.5	0.3
WISS-4B	04/16/91	1.31	1.14	<0.06	<0.05	0.68	0.59
WISS-4B	07/16/91	--	--	--	--	--	--
WISS-4B	10/23/91	1.69	--	0.60	--	1.87	--

Table A-3

Total and Dissolved Metal Concentrations in Groundwater, 1990-1992

Well	Sampling Date	Aluminum		Antimony		Arsenic		Barium		Beryllium		Boron		Cadmium	
		Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss
SDWA MCL[a]		-		6		50		2000		4		-		5	
SDWA MCLG[b]		-		6		-		2000		4		-		5	
NJGQS[c]		200		20		8		2000		20		-		4	
OVERBURDEN (UNITS = µg/L)															
WISS-1A	10/26/90	2470	113 U	22 UR	22 UR	2 U	2 U	32.4 B	15.6 B	1 U	1 U	147	124	4 U	4 U
WISS-1A	01/08/91	123 U	123 U	26.9 BR	28.2 BR	2 U	2 U	28.1 B	28.1 B	1 U	1 U	182	180	3 U	3 U
WISS-1A	04/18/91	3590	77 U	19 UJ	19 UJ	2 U	2 U	60.3 B	38.1 B	1 U	1 U	223	231	4 U	4 U
WISS-1A	07/17/91	3835.2	84 UJ	833.7 R	39 BJ	2 U	2 U	1205.2 R	40.5 B	62.5 R	1 U	1230 R	179	49.7 R	2 U
WISS-1A	10/29/91	149B		20 UJ		2UJ		149 B		1 UJ		100 U		3 U	
WISS-2A	01/08/91	16900	123 U	20 UR	20 UR	7.9 BJ	3.9 B	120 B	9.4 B	1.2 B	1 U	181	201	3 U	3 U
WISS-2A	04/18/91	14900	77 U	19 UJ	19 UJ	5 B	2.8 B	95.8 B	9.5 B	1.1 B	1 U	189	213	4 U	4 U
WISS-2A	07/17/91	38959.8	84 UJ	18.4 BJ	19.5 BJ	13.4	3.1 B	532.7	10.9 B	4.8 B	1 U	162	199	8.5	2 U
WISS-2A	10/24/91	12100		20 U		4.8 B		87.7 B		1 U		181		3 U	
WISS-3A	10/26/90	955	113 U	22 UR	22 UR	2 U	2.8 BJ	51.3 B	44 B	1 U	1 U	170	155	4 U	4 U
WISS-3A	01/08/91	123 U	123 U	20 UR	20 UR	2 B	3 B	20 B	19.1 B	1 U	1 U	123	148	3 U	3 U
WISS-3A	04/17/91	1550	77 U	19 U	38.3 BJ	3.1 BJ	2 BJ	41.9 B	26.2 B	1 U	1 U	100 U	100 U	4 U	4 U
WISS-3A	07/17/91	5473.8	84 UJ	18 UJ	27.3 BJ	5.1 B	2.8 B	75.9 B	29.2 B	1 U	1 U	145	148	2 U	2 U
WISS-3A	10/23/91	1510		20 U		2.3 B		45.5 B		1 U		139		3 U	
WISS-3A	06/23/92	200 U		60 U		10 U		200 U		5 U		135		5 U	
WISS-4A	10/24/90	113 U	113 U	22 UR	22 UR	2.8 B	2 U	136 B	105 B	1 U	1 U	101	112	4 U	4 U
WISS-4A	01/07/91	124 U	124 UJ	20.4 UR	20.4 UR	2.3 BJ	2 U	125 B	118 B	0.3 BJ	0.3 UJ	129	116	3.2 U	3.2 U
WISS-4A	04/16/91	78.9 BJ	77 UJ	19 UJ	36.3 BJ	2 U	2 U	109 B	98.4 B	1 U	1 U	129	105	4 U	4 U
WISS-4A	07/16/91	619.4 J	84 UJ	18 UJ	16 UJ	2.2 BJ	2 UJ	255.4 J	166 BJ	1 UJ	1 UJ	151	165	2 UJ	2 UJ
WISS-4A	10/23/91	9 U		20 U		2 U		112 B		1 U		100 U		3 U	
WISS-4A	06/23/92	200 U		60 U		10 U		200 U		5 U		122		5 U	
WISS-5A	10/25/90	602	113 U	22 UR	39.9 BR	3.6 BJ	2 U	34.6 B	21.6 B	1 U	1 U	176	164	4 U	4 U
WISS-5A	01/07/91	124 U	124 UJ	20.4 UR	20.4 UR	2.4 BJ	2 UJ	223	212	0.3 UJ	0.3 UJ	173	156	3.2 U	3.2 U
WISS-5A	04/16/91	913 J	77 UJ	25.1 BJ	23.4 BJ	2 U	5.4 BJ	19.6 B	19.9 B	1 U	1 U	100 U	159	4 U	4 U
WISS-5A	07/16/91	10931.2 J	84 UJ	18 UJ	18 UJ	3 BJ	2 UJ	95.5 BJ	26.2 BJ	1 UJ	1 UJ	200	199	2 UJ	2 UJ
WISS-5A	10/21/91	203		20 U		2.6 BJ		38.5 B		1 U		185		3 UJ	
WISS-6A	10/25/90	5560	113 U	22 UR	22 UR	4.5 BJ	2 U	177 B	108 B	1 U	1 U	173	182	4 U	4 U
WISS-6A	01/07/91	276	124 UJ	20.4 UR	26.6 BR	2 B	2.3 B	135 B	112 B	0.3 BJ	0.3 UJ	247	227	3.2 U	3.2 U
WISS-6A	04/16/91	3760 J	77 UJ	19 UJ	30.5 BJ	5.3 BJ	2.2 B	244	89.2 B	1 U	1 U	164	175	4 U	4 U
WISS-6A	07/16/91	2355.1 J	84 UJ	18 UJ	18 UJ	2 UJ	2 UJ	164 BJ	112.8 BJ	1 UJ	1 UJ	217	241	2 UJ	2 UJ
WISS-6A	10/21/91	170 B		20 U		2.1 BJ		108 B		1 U		172		3 UJ	
B37W07S	10/22/91	16800		20 U		5.3 B		133 B		1.2 B		108		3 U	
B37W07S	06/23/92	236		60 U		10 U		200 U		5 U		107		5 U	
B37W08S	10/22/91	14200		20 U		2.2 B		131 B		1 U		224		3 U	
B37W08S	06/23/92	2250		60 U		10 U		200 U		5 U		312		5 U	
B37W09S	10/29/91	19100		20 UJ		5.4 BJ		347		1.3 BJ		242		3 U	
B37W09S	06/23/92	859		60 U		10 U		200 U		5 U		158		5 U	

Table A-3
(continued)

Well	Sampling Date	Calcium Total	Calcium Diss	Chromium Total	Chromium Diss	Cobalt Total	Cobalt Diss	Copper Total	Copper Diss	Iron Total	Iron Diss	Lead Total	Lead Diss	Magnesium Total	Magnesium Diss
SDWA MCL[a]		-		100		-		1300		-		15		-	
SDWA MCLG[b]		-		100		-		1300						-	
NJGQS[c]		-		100		-		1000		300		10		-	
OVERBURDEN (UNITS = µg/L)															
WISS-1A	10/26/90	66200	66200	4 U	4 U	7 U	7 U	14.8 B	5 U	4560	51 U	6 UJ	3 UJ	19700	18900
WISS-1A	01/08/91	94000	108000	3 U	3 U	5 U	5 U	7.8 B	4 U	371	55 U	3 B	3 U	27300	30700
WISS-1A	04/18/91	116000	126000	3.7 B	3 U	4.3 B	4 U	12.9 B	7 U	6930	37 U	11.2 J	2 UJ	34300	35700
WISS-1A	07/17/91	75594	126448.1	130.3 R	3 UJ	589.2 R	3 UJ	294.4 R	5.1 BJ	4274.1	36 UJ	11.5 J	3 J	27030.6	34445.7
WISS-1A	10/29/91	119000		6 UJ		10 UJ		10 UJ		198		2 UJ		32700	
WISS-2A	01/08/91	49400	28900	9.7 B	3 U	17 B	5 U	47.1	4.2 B	31100	55 U	22.3	3 UJ	19600	7830
WISS-2A	04/18/91	39900	32400	10.4	3 U	12.1 B	4 U	26.7	7 U	26100	37 U	4.7 J	2.7 BJ	16100	8500
WISS-2A	07/17/91	154366.3	34073.5	62	3 UJ	50	3 UJ	171.5 R	2.7 BJ	71231.38	37.1 BJ	66.9 JR	2 UJ	48161.9	8588.7
WISS-2A	10/24/91	38100		15.9		10 U		26		21900		15		14100	
WISS-3A	10/26/90	112000	112000	4 U	4 U	7 U	7 U	10.7 B	5 U	2450	51 U	3 UJ	3 UJ	26600	26800
WISS-3A	01/08/91	46500	53300	3 U	3 U	5 U	5 U	4 U	4 U	1310	55 U	3 UJ	3 UJ	11600	13000
WISS-3A	04/17/91	77700 J	78800 J	3 U	3 U	4 U	4 U	7.7 B	7 U	5060	37 U	2 UJ	2 UJ	18700 J	18400 J
WISS-3A	07/17/91	91438.69	92749.81	11.6 J	3 UJ	6.7 BJ	3 UJ	18.4 BJ	2.4 BJ	12041.2	36 UJ	3.7 J	2 UJ	21676.6	19847.5
WISS-3A	10/23/91	89200		6 U		10 U		10 U		3370		3		20200	
WISS-3A	06/23/92	146000		10 U		50 U		25 U		195		3 U		36100	
WISS-4A	10/24/90	53400	48200	4 U	4 U	7 U	7 U	5 U	5 U	1940	51 U	3 UJ	3 UJ	16900	15200
WISS-4A	01/07/91	50900	57600	2.9 U	2.9 U	4.7 U	4.7 U	12 B	4.3 B	2560 J	54.8 UJ	9.2	3 UJ	16300	18400
WISS-4A	04/16/91	49300 J	51800 J	3 U	3 U	4 U	4 U	7 U	7 U	1690 J	37 UJ	2 U	2 U	16000 J	16600 J
WISS-4A	07/16/91	71078.88 J	71457 J	3 UJ	3 UJ	3.2 BJ	3 UJ	4 BJ	3.8 BJ	14803.9 J	42.1 BJ	2.5 BJ	2 UJ	22071.3 J	22328.1 J
WISS-4A	10/23/91	42000		6 U		10 U		10 U		994		2 U		13000	
WISS-4A	06/23/92	66100		10 U		50 U		25 U		114		3 U		22600	
WISS-5A	10/25/90	47400	47200	4 U	4 U	7 U	7 U	5 U	5 U	1150	51 U	3 UJ	3 U	16700	16600
WISS-5A	01/07/91	35400	35600	2.9 U	2.9 U	4.7 U	4.7 U	4.4 B	4.2 U	2400 J	54.8 UJ	3 U	3 U	15400	15500
WISS-5A	04/16/91	22800 J	47000 J	3 U	3 U	4 U	4 U	7 U	7 U	1580 J	37 UJ	2 U	17.2	8250 J	16500 J
WISS-5A	07/16/91	71994.81 J	48342.4 J	14.2 J	3 UJ	6.4 BJ	3 UJ	35 J	2 UJ	16967.6 J	36 UJ	5.7 J	2 UJ	25005.5 J	16831.5 J
WISS-5A	10/21/91	54100		6 R		10 U		11.10 B		396 J		42.2 R		18600	
WISS-6A	10/25/90	53700	52100	4 U	4 U	7 U	7 U	15.8 B	5 U	10100	51 U	8.8 B	3 U	19100	16700
WISS-6A	01/07/91	58700	56800	5.3 B	2.9 U	4.7 U	4.7 U	6.5 B	4.2 U	726 J	54.8 UJ	3 UJ	3 UJ	18600	17900
WISS-6A	04/16/91	49000 J	49600 J	4.5 B	3 U	6.2 B	4 U	19.2 B	7 U	7530 J	37 UJ	5.4	2 U	17000 J	15700 J
WISS-6A	07/16/91	56582.6 J	56180.9 J	7.9 BJ	3 UJ	3 UJ	3 UJ	9.2 BJ	2 UJ	4371.1 J	36 UJ	2.1 BJ	2 UJ	18655.8 J	17874.4 J
WISS-6A	10/21/91	46000		6 UR		10 U		10 U		334 J		16.1 R		14900	
B37W07S	10/22/91	54900		37.1		17.8 B		41		30200		13.5		21500	
B37W07S	06/23/92	40800		10 U		50 U		25 U		506		11.7		12600	
B37W08S	10/22/91	121000		27		12.9 B		40.7		24500		12.9		26200	
B37W08S	06/23/92	96800		10 U		50 U		25 U		4070		8.2		21900	
B37W09S	10/29/91	121000		44.8 J		26.5 BJ		83.7 J		39800		20 J		44500	
B37W09S	06/23/92	69200		10 U		50 U		25 U		1540		3 U		18000	

Table A-3
(continued)

Well	Sampling Date	Manganese Total	Manganese Diss	Mercury Total	Mercury Diss	Molybdenum Total	Molybdenum Diss	Nickel Total	Nickel Diss	Potassium Total	Potassium Diss	Selenium Total	Selenium Diss	Silver Total	Silver Diss
SDWA MCL[a]		-		2		-		100[d]		-		50		-	
SDWA MCLG[b]		-		2		-		100[d]		-		50		-	
NJGQS[c]		50		2		-		100		-		50		-	
OVERBURDEN (UNITS = µg/L)															
WISS-1A	10/26/90	176	2.5 B	0.2 U	0.2 U	100 U	100 U	10 U	10 U	2140 B	1380 B	2 UJ	2 UJ	4 UJ	4 UJ
WISS-1A	01/08/91	32.3	1.6 B	0.2 U	0.2 U	100 U	100 U	8 U	8 U	834 B	815 U	2 U	2 UJ	5 UJ	5 UJ
WISS-1A	04/18/91	228	4.6 B	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1050 B	1010 U	1 U	1 UJ	4 U	4 U
WISS-1A	07/17/91	308.5	2.6 BJ	0.1 UJ	0.1 UJ	1160 R	100 U	518.8 R	6 U	6174.8	1461.6 B	2 UJ	2 UJ	121.6 JR	4 UJ
WISS-1A	10/29/91	17.2		0.1 U		100 U		11 UJ		1030 B		2 UJ		10 UJ	
WISS-2A	01/08/91	1060	1 U	0.2 U	0.2 U	100 U	100 U	31.9 B	8 U	3480 B	815 U	2 UJ	2 U	5 UJ	5 UJ
WISS-2A	04/18/91	643	10.7 B	0.2 U	0.2 U	100 U	100 U	25.3 B	7 U	2990 B	1010 U	1 U	1 U	4 U	4 U
WISS-2A	07/17/91	4871.3	90.3	0.1 UJ	0.1 UJ	100 U	100 U	82.3	6 U	5941.6	955 U	20 UJ	2 UJ	4 UJ	4 UJ
WISS-2A	10/24/91	610		0.1 U		100 U		18.2 B		2390 B		2 UJ		10 U	
WISS-3A	10/26/90	441	277	0.2 U	0.2 U	100 U	100 U	10 U	10 U	2100 B	1580 B	2 UJ	2 UJ	4 UJ	4 UJ
WISS-3A	01/08/91	90.1	5.8 B	0.2 U	0.2 U	100 U	100 U	8 U	8 U	815 U	815 U	2 U	2 U	5 UJ	5 UJ
WISS-3A	04/17/91	731	118	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 U	1340 B	1 UJ	1 UJ	4 U	4 U
WISS-3A	07/17/91	967.7	158.6	0.1 UJ	0.1 UJ	100 U	100 U	13.7 B	6 U	1803.4 B	955 U	20 UJ	2 UJ	4 UJ	4 UJ
WISS-3A	10/23/91	358		0.1 U		100 U		11 U		987 B		2 U		10 U	
WISS-3A	06/23/92	27.2		0.2 U		100 U		40 U		5000 U		5 U		10 U	
WISS-4A	10/24/90	289	2 U	0.2 U	0.2 UJ	100 U	100 U	10 U	10 U	1340 B	925 B	2 UJ	2 UJ	4 UR	4 UJ
WISS-4A	01/07/91	228	1.8 B	0.2 U	0.2 U	100 U	100 U	7.7 U	7.7 U	1510 BR	991 BR	2 U	2 UJ	11.4 U	11.4 U
WISS-4A	04/16/91	162 J	2.1 BJ	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 UJ	1010 UJ	1.8 B	1 B	4 UJ	4 UJ
WISS-4A	07/16/91	1379 J	24.1 J	0.1 UJ	0.1 UJ	100 U	100 U	6 UJ	6.1 BJ	955 UJ	955 UJ	2 UJ	2 UJ	4 UJ	4 UJ
WISS-4A	10/23/91	121		0.1 U		100 U		11 U		862 U		2 UJ		10 U	
WISS-4A	06/23/92	18.7		0.2 U		100 U		40 U		5000 U		5 U		10 U	
WISS-5A	10/25/90	2090	89.8	0.2 UJ	0.2 UJ	100 U	100 U	10 U	10 U	1020 B	1690 B	2 UJ	2 UJ	4 UJ	4 UJ
WISS-5A	01/07/91	23.4	17.1	0.2 U	0.2 U	100 U	100 U	7.7 U	7.7 U	883 BR	1460 BR	2 UJ	2 UJ	11.4 U	11.4 U
WISS-5A	04/16/91	1420 J	33.3 J	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 UJ	1010 UJ	1 U	1.1 B	4 UJ	4 UJ
WISS-5A	07/16/91	978.5 J	100.6 J	0.1 UJ	0.1 UJ	100 U	100 U	16.6 BJ	6 UJ	1240.9 BJ	955 UJ	2 UJ	2 UJ	4 UJ	4 UJ
WISS-5A	10/21/91	1230		0.1 U		100 U		11 U		1400 B		2 UJ		10 U	
WISS-6A	10/25/90	884	93.6	0.2 UJ	0.2 UJ	100 U	100 U	10 U	10 U	1590 B	916 U	2 UJ	2 UJ	4 UJ	4 UJ
WISS-6A	01/07/91	345	3.6 B	0.2 U	0.2 U	100 U	100 U	18.3 B	7.7 U	1060 BR	905 BR	2 UJ	2 UJ	11.4 U	11.4 U
WISS-6A	04/16/91	2850 J	23.4 J	0.2 U	0.368	100 U	100 U	7 U	7 U	1020 BJ	1010 UJ	1 U	1 U	4 UJ	4 UJ
WISS-6A	07/16/91	745.5 J	72.9 J	0.1 UJ	0.1 UJ	100 U	100 U	6 UJ	6 UJ	955 UJ	955 UJ	2 UJ	2 UJ	4 UJ	4 UJ
WISS-6A	10/21/91	267		0.1 U		100 U		11 U		862 U		2 UJ		10 U	
B37W07S	10/22/91	860		0.1 U		100 U		41.4		2600 B		2 UJ		10 U	
B37W07S	06/23/92	71.6		0.2 U		100 U		40 U		5000 U		5 U		10 U	
B37W08S	10/22/91	857		0.1 U		100 U		29 B		8010		2.6 BJ		10 U	
B37W08S	06/23/92	142		0.2 U		100 U		40 U		6070		5 U		10 U	
B37W09S	10/29/91	2980		0.1 B		100 U		93.8 J		4250 B		20 UJ		10 UJ	
B37W09S	06/23/92	615		0.2 U		100 U		40 U		5000 U		5 U		10 U	

Table A-3
(continued)

Well	Sampling Date	Sodium		Thallium		Vanadium		Zinc		Lithium		Tellurium	
		Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss
SDWA MCL[a]		-		2[d]		-		-		-		-	
SDWA MCLG[b]		-		0.5[d]		-		-		-		-	
NJGQS[c]		5000		10		-		5000		-		-	
OVERBURDEN (UNITS = µg/L)													
WISS-1A	10/26/90	31200	31300	40 UR	40 UR	28.9 BJ	32.7 BJ	45.2	16.4 BJ				
WISS-1A	01/08/91	40900	44800	40 UR	40 UR	32.1 BJ	34.8 BJ	22.1	15.5 B	100 U	100 U	200 U	200 U
WISS-1A	04/18/91	49300	53500	5 UJ	5 UJ	22.4 BJ	20.1 BJ	45.2 J	11.5 BJ			200 U	200 U
WISS-1A	07/17/91	32080.4	54118.7	20 UJ	20 UJ	603.6 R	50.3 J	333.6 J	33.4 J			200 U	200 U
WISS-1A	10/29/91	54000		20 UJ		9.7 BJ		6 UJ				200 U	
WISS-2A	01/08/91	10700	9650	40 UR	4 UR	49 BJ	28.7 BJ	83	4.7 B	100 U	100 U	200 U	200 U
WISS-2A	04/18/91	11000	11000	5 UJ	5 UJ	31.8 BJ	12.6 BJ	77.5 J	4.4 BJ			200 U	200 U
WISS-2A	07/17/91	12169.5	11395.7	2 UJ	2 UJ	113.6 J	40.3 BJ	657.2 JR	8.1 BJ			200 U	200 U
WISS-2A	10/24/91	10600		2 UJ		15.1 B		68.3 J				200 U	
WISS-3A	10/26/90	19900	19900	4 UR	4 UR	39.7 BJ	42.1 BJ	38.3	7 BJ				
WISS-3A	01/08/91	12300	13700	4 UR	4 UR	27.5 BJ	26.7 BJ	14.3 B	12.1 B	100 U	100 U	200 U	200 U
WISS-3A	04/17/91	17300	17600	5 UJ	5 UJ	16.9 BJ	12.2 BJ	51.9 J	18.8 BJ			200 U	200 U
WISS-3A	07/17/91	21337.9	21318.2	2 UJ	2 UJ	53.7 J	48.9 BJ	419.2 JR	21.2 J			200 U	200 U
WISS-3A	10/23/91	19100		2 UJ		10.6 B		17.4 BJ				200 U	
WISS-3A	06/23/92	29600		10 U		50 U		20 U					
WISS-4A	10/24/90	14000	12300	4 UJ	4 UJ	6 U	6 U	8.8 BJ	10.3 BJ				
WISS-4A	01/07/91	12300 R	14200 R	4 UJ	4 UJ	10.2 B	5.4 B	28 J	22.1 J	100 U	100 U	200 U	200 U
WISS-4A	04/16/91	13700 J	14000 J	5 UJ	5 UJ	8 U	8 U	11.7 BJ	17.8 BJ			200 U	200 U
WISS-4A	07/16/91	22605.4 J	23924.4 J	2 UJ	2 UJ	38.9 BJ	39 BJ	144.5 J	22.6 J			200 U	200 U
WISS-4A	10/23/91	9560		2 UJ		8 U		120 J				200 U	
WISS-4A	06/23/92	28100		10 U		50 U		20 U					
WISS-5A	10/25/90	10500	11100	40 UR	4 UR	10.1 BJ	6.7 BJ	20.1 J	53.9				
WISS-5A	01/07/91	11100 R	11400 R	4 UJ	4 UJ	5 B	3.7 U	11.5 BJ	24 J	100 U	100 U	200 U	200 U
WISS-5A	04/16/91	4890 BJ	9950 J	5 UJ	5 UJ	8 U	8 U	12.3 BJ	12.2 BJ			200 U	200 U
WISS-5A	07/16/91	12508.7 J	11920 J	2 UJ	2 UJ	49.7 BJ	32.4 BJ	196.4 J	30.6 J			200 U	200 U
WISS-5A	10/21/91	11500		2 UJ		8.20 B		19.8 B				200 U	
WISS-6A	10/25/90	13400	14000	40 UR	4 UR	18.5 BJ	7.4 BJ	41.4	13.7 BJ				
WISS-6A	01/07/91	11700 R	11500 R	4 UJ	4 UJ	8.3 B	5.1 B	17.8 BJ	14.4 BJ	100 U	100 U	200 U	200 U
WISS-6A	04/16/91	10000 J	10600 J	50 UJ	5 UJ	9.6 B	8 U	30.6	16.3 BJ			200 U	200 U
WISS-6A	07/16/91	12760.4 J	12959.4 J	2 UJ	2 UJ	39.1 BJ	35.1 BJ	162.5 J	42.7 J			200 U	200 U
WISS-6A	10/21/91	14400		2 UJ		10.1 B		66 J				200 U	
B37W07S	10/22/91	9220		2 UJ		28.9 B		72.5				200 U	
B37W07S	06/23/92	8890		10 U		50 U		20 U					
B37W08S	10/22/91	31200		2 UJ		39.9 B		66.9				200 U	
B37W08S	06/23/92	34900		10 U		50 U		20 U					
B37W09S	10/29/91	20100		20 UJ		68.5 J		105 J				200 U	
B37W09S	06/23/92	13200		10 U		50 U		20 U					

Table A-3
(continued)

Well	Sampling Date	Aluminum Total	Aluminum Diss	Antimony Total	Antimony Diss	Arsenic Total	Arsenic Diss	Barium Total	Barium Diss	Beryllium Total	Beryllium Diss	Boron Total	Boron Diss	Cadmium Total	Cadmium Diss
SDWA MCL[a]		-		6		50		2000		4		-		5	
SDWA MCLG[b]		-		6		-		2000		4		-		5	
NJGQS[c]		-		20		8		2000		20		-		4	
BEDROCK (UNITS = µg/L)															
WISS-1B	10/26/90	113 U	113 U	22 UR	22 UR	2 U	2 U	57.3 B	49.4 B	1 U	1 U	179	182	4 U	4 U
WISS-1B	01/08/91	123 U	123 U	20 UR	20 UR	2 U	2 U	62 B	37.3 B	1 U	1 U	144	166	3 U	3 U
WISS-1B	04/18/91	77 U	77 U	19 UJ	19 UJ	3.9 B	2 U	59.8 B	37.4 B	1 U	1 U	151	175	4 U	4 U
WISS-1B	07/17/91	2564.1	84 UJ	701.5 R	25.4 BJ	2.8 B	2.2 B	963.5 R	80.8 B	49.9 R	1 U	995 R	131	47.5 R	2 U
WISS-1B	10/29/91	91 U		20 UJ		6.5 BJ		348		1 UJ		100 U		3 U	
WISS-2B	10/26/90	113 U	113 U	22 UR	22 UR	5.9 B	2 U	343	148 B	1 U	1 U	100 U	147	4 U	4 U
WISS-2B	01/08/91	123 U	123 U	20 UR	20 UR	2 U	2 U	267	110 B	1 U	1 U	106	128	3 U	3 U
WISS-2B	04/17/91	77 U	77 U	23 BJ	31.4 BJ	3.7 BJ	2 UJ	212	131 B	1 U	1 U	101	100 U	4 U	4 U
WISS-2B	07/17/91	84 UJ	84 UJ	19.4 BJ	25.3 BJ	4.5 B	2 U	246.1	90.8 B	1 U	1 U	100 U	101	2 U	2 U
WISS-2B	10/25/91	91 U		20 U		8.6 B		219		1 U		100 U		3 U	
WISS-3B	10/26/90	113 U	113 U	22 UR	22 UR	2 U	2 U	388	227	1 U	1 U	100 U	100 U	4 U	4 U
WISS-3B	01/08/91	123 U	123 U	20 UR	20 UR	2 U	2 U	536	176 B	1 U	1 U	100 U	100 U	3 U	3 U
WISS-3B	04/17/91	77 U	77 U	19 U	19 U	2 UJ	2 UJ	305	194 B	1 U	1 U	100 U	100 U	4 U	4 U
WISS-3B	07/17/91	84 UJ	84 UJ	18 UJ	37 BJ	2 U	2 U	388.7	211.8	1 U	1 U	100 U	100 U	2 U	2 U
WISS-3B	10/23/91	91 U		20 U		2 U		216		1 U		100 U		3 U	
WISS-4B	10/24/90	113 U	113 U	22 UR	31.8 BR	2 U	2 U	188 B	148 B	1 U	1 U	100 U	110	4 U	4 U
WISS-4B	01/07/91	124 U	124 UJ	20.4 UR	20.4 UR	2 UJ	2 U	147 B	144 B	0.3 BJ	0.3 UJ	122	121	3.2 U	3.2 U
WISS-4B	04/16/91	77 UJ	77 UJ	19 UJ	21.1 B	4.2 B	2 U	191 B	160 B	1 U	1 U	101	124	4 U	4 U
WISS-4B	07/16/91	84 UJ	84 UJ	18 UJ	18 UJ	2 UJ	2 UJ	271.5 J	177.2 BJ	1 UJ	1 UJ	119	150	2 UJ	2 UJ
WISS-4B	10/23/91	91 U		20 U		2 U		188 B		1 U		100 U		3 U	
WISS-5B	10/25/90	113 U	113 U	22 UR	22.4 BR	4.4 BJ	2 U	201	181 B	1 U	1 U	139	136	4 U	4 U
WISS-5B	01/07/91	567	124 UJ	20.4 UR	20.4 UR	2.4 BJ	2.8 B	44 B	23.7 B	0.3 UJ	0.3 UJ	179	189	3.2 U	3.2 U
WISS-5B	04/16/91	77 UJ	77 UJ	19 UJ	28.1 BJ	4.2 B	2 U	186 B	160 B	1 U	1 U	152	166	4 U	4 U
WISS-5B	07/16/91	298.1 J	84 UJ	18 UJ	29 BJ	54 JR	2 UJ	944.7 JR	153.9 BJ	1 UJ	1 UJ	100 U	188	2.1 BJ	2 UJ
WISS-5B	10/22/91	91 U		20 U		2.1 B		192 B		1 U		163		3 U	
WISS-6B	10/25/90	113 U	113 U	22 UR	22 UR	2.2 B	2 U	97 B	97.4 B	1 U	1 U	200	194	4 U	4 U
WISS-6B	01/07/91	124 U	124 UJ	20.4 UR	20.4 UR	2.1 B	2.4 B	89 B	105 B	0.3 UJ	0.3 UJ	197	241	3.2 U	3.2 U
WISS-6B	04/16/91	77 UJ	77 UJ	19 UJ	25.8 BJ	3.3 BJ	2 B	90.3 B	96.3 B	1 U	1 U	187	202	4 U	4 U
WISS-6B	07/16/91	84 UJ	84 UJ	18 UJ	18 UJ	2 UJ	2 UJ	111.6 BJ	105.1 BJ	1 UJ	1 UJ	270	253	2 UJ	2 UJ
WISS-6B	10/21/91	91 U		20 U		2 UJ		95.7 B		1 U		214		3 UJ	
B37W08D	10/24/91	91 U		20 U		2 U		281		1 U		100 U		3 U	
B37W09D	10/29/91	91 U		22.9BJ		2J		211		1 UJ		192		3 U	

Table A-3
(continued)

Well	Sampling Date	Calcium Total	Calcium Diss	Chromium Total	Chromium Diss	Cobalt Total	Cobalt Diss	Copper Total	Copper Diss	Iron Total	Iron Diss	Lead Total	Lead Diss	Magnesium Total	Magnesium Diss
SDWA MCL[a]		-		100		-		1300		-		15		-	
SDWA MCLG[b]		-		100		-		1300		-				-	
NJGQS[c]		-		100		-		1000		300		10		-	
BEDROCK (UNITS = µg/L)															
WISS-1B	10/26/90	10500	10900	4 U	4 U	7 U	7 U	5 U	5 U	7690	51 U	30 UJ	3 UJ	4610 B	4710 B
WISS-1B	01/08/91	9990	10300	3 U	3 U	5 U	5 U	7 U	4.2 B	12000	55 U	3 UJ	3 U	4330 B	4480 B
WISS-1B	04/18/91	13700	14000	3 U	3 U	4 U	4 U	7 U	7 U	8110	37 U	2 J	20 UJ	6180	6390
WISS-1B	07/17/91	24643.1	13037.4	111.1 R	3 UJ	496.9 R	3 UJ	231.2 R	3.4 BJ	2876.1	36 UJ	2.7 BJ	2 UJ	13047.4	8115.2
WISS-1B	10/29/91	46200		6 UJ		10 UJ		10 UJ		1510		2 UJ		18100	
WISS-2B	10/26/90	42100	43600	4 U	4 U	7 U	7 U	5 U	5 U	52100	51 U	7 BJ	3 UJ	14700	15600
WISS-2B	01/08/91	42000	40400	3 U	3 U	5 U	5 U	4 U	4 U	28200	55 U	5.1 J	3 U	14400	14300
WISS-2B	04/17/91	40100 J	43200 J	3 U	3 U	4 U	4 U	7 U	7 U	21000	37 U	2 UJ	2 UJ	13800 J	15100 J
WISS-2B	07/17/91	46607.3	41595.4	3.2 BJ	3 UJ	4.4 BJ	3 UJ	8.6 BJ	2 UJ	14949.2	36 UJ	2 UJ	2 UJ	15671.7	14284.5
WISS-2B	10/25/91	45800		6 U		10 U		10 U		5270		2 UJ		14500	
WISS-3B	10/26/90	15500	14600	4 U	4 U	7 U	7 U	5 U	5 U	37000	51 U	3 UJ	3 UJ	5930	5490
WISS-3B	01/08/91	21400	21200	3 U	3 U	6.3 B	5 U	7 B	4 U	123000	55 U	3 UJ	3 UJ	13700	13700
WISS-3B	04/17/91	24100 J	26400 J	3 U	3 U	4 U	4 U	7 U	7 U	65200	37 U	2 UJ	2 UJ	13000 J	13700 J
WISS-3B	07/17/91	51891.3	49064.8	8.9 BJ	3 UJ	6.7 BJ	3 UJ	8 BJ	2 UJ	113544	162 J	2 UJ	2 UJ	16415.1	15392.6
WISS-3B	10/23/91	51700		6 U		10 U		10 U		24300		2 U		14700	
WISS-4B	10/24/90	36500	35300	4 U	4 U	7 U	7 U	5 U	5 U	14100	51 U	3 UJ	3 UJ	14200	14000
WISS-4B	01/07/91	42300	44200	2.9 U	2.9 U	4.7 U	4.7 U	5.7 B	4.7 B	2770 J	54.8 UJ	3 UJ	3 U	14800	15500
WISS-4B	04/16/91	44100 J	46800 J	3 U	3 U	4 U	4 U	7 U	7 U	15500 J	37 UJ	2 U	2 U	14100 J	14800 J
WISS-4B	07/16/91	52699 J	50318.9 J	3 UJ	3 UJ	3 UJ	3 UJ	2 UJ	2 UJ	40101.9 J	46.9 BJ	2 UJ	2 UJ	16329.8 J	16210.9 J
WISS-4B	10/23/91	45300		6 U		10 U		10 U		8100		2 U		14100	
WISS-5B	10/25/90	33100	35700	4 U	4 U	7 U	7 U	5 U	5 U	6380	189	3 UJ	3 U	14400	15500
WISS-5B	01/07/91	50600	52600	2.9 U	2.9 U	4.7 U	4.7 U	6.9 B	4.2 U	940 J	54.8 UJ	3 UJ	3 U	17700	18400
WISS-5B	04/16/91	34300 J	35000 J	3 U	3 U	4 U	4 U	7 U	7 U	5000 J	37 UJ	2 U	2 U	14800 J	15100 J
WISS-5B	07/16/91	41597.4 J	36297 J	3 UJ	3 UJ	7.8 BJ	3 UJ	2 UJ	2 UJ	127492.4 J	41.7 BJ	2 UJ	2 UJ	16552.6 J	15925.3 J
WISS-5B	10/22/91	35100		6 U		10 U		10 U		1250		2 U		15100	
WISS-6B	10/25/90	52100	52700	4 U	4 U	7 U	7 U	5 U	5 U	464	51 U	3 U	3 UJ	16800	17000
WISS-6B	01/07/91	43100	53500	2.9 U	2.9 U	4.7 U	4.7 U	4.2 U	4.2 U	883 J	54.8 UJ	3 U	3 U	14700	18000
WISS-6B	04/16/91	46700 J	51800 J	3 U	3 U	4 U	4 U	7 U	7 U	579 J	37 UJ	2 U	2 U	15100 J	16700 J
WISS-6B	07/16/91	57761.7 J	55314.3 J	3 UJ	3 UJ	3 UJ	3 UJ	2 UJ	2 UJ	1041.4 J	39.9 BJ	2 UJ	2 UJ	18413.8 J	17769.9 J
WISS-6B	10/21/91	50500		6 UR		10 U		10 U		96.6 BJ		2 UR		16300	
B37W08D	10/24/91	54400		55.9		10 U		10 U		402		2 U		16000	
B37W09D	10/29/91	51500		100		10 UJ		10 UJ		1270		2 UJ		19400	

Table A-3
(continued)

Well	Sampling Date	Manganese Total	Manganese Diss	Mercury Total	Mercury Diss	Molybdenum Total	Molybdenum Diss	Nickel Total	Nickel Diss	Potassium Total	Potassium Diss	Selenium Total	Selenium Diss	Silver Total	Silver Diss
SDWA MCL[a]		-		2		-		100[d]		-		50		-	
SDWA MCLG[b]		-		2		-		100[d]		-		50		-	
NJGQS[c]		50		2		-		100		-		50		-	
BEDROCK (UNITS = µg/L)															
WISS-1B	10/26/90	87.9	7.1 B	0.2 U	0.21	100 U	100 U	10 U	10 U	2310 B	2160 B	2 UJ	2 UJ	4 UJ	4 UJ
WISS-1B	01/08/91	89.6	10.6 B	0.2 U	0.2 U	100 U	100 U	8 U	8 U	1780 B	1800 B	2 UJ	2 U	5 UJ	5 UJ
WISS-1B	04/18/91	72.9	3.4 B	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 U	1190 B	1 U	1 U	4 U	4 U
WISS-1B	07/17/91	187	3.8 BJ	0.1 UJ	0.1 UJ	973 R	100 U	434.5 R	6 U	4701.7 B	1685.5 B	20 UJ	2 UJ	101.5 JR	4 UJ
WISS-1B	10/29/91	22.8		0.1 U		100 U		11 UJ		862 U		2 UJ		10 UJ	
WISS-2B	10/26/90	231	21.1	0.2 U	0.2 U	100 U	100 U	10 U	10 U	1700 B	916 U	2 UJ	2.1 BJ	4 UJ	4 UJ
WISS-2B	01/08/91	118	18.1	0.2 U	0.2 U	100 U	100 U	8 U	8 U	815 U	1220 B	2 U	2 U	5 UJ	5 UJ
WISS-2B	04/17/91	72.4	6.4 B	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 U	1010 U	1.2 BJ	1 UJ	4 U	4 U
WISS-2B	07/17/91	99.5	58.7	0.1 UJ	0.1 UJ	100 U	100 U	6 U	6 U	955 U	955 U	20 UJ	2 UJ	4 UJ	4 UJ
WISS-2B	10/25/91	21.8		0.1 U		100 U		11 U		1080 B		2 U		10 U	
WISS-3B	10/26/90	89.3	2.5 B	0.2 U	0.2 U	100 U	100 U	10 U	10 U	916 U	1500 B	2 UJ	2 UJ	4 UJ	4 UJ
WISS-3B	01/08/91	269	5.1 B	0.2 U	0.2 U	100 U	100 U	8 U	8 U	815 U	815 U	2 UJ	2 U	13.3 J	5 UJ
WISS-3B	04/17/91	182	11.3 B	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 U	1170 B	1 UJ	1 U	4 U	4 U
WISS-3B	07/17/91	291.6	16.6	0.1 UJ	0.1 UJ	100 U	100 U	6 U	6 U	955 U	955 U	20 UJ	2 UJ	4 UJ	4 UJ
WISS-3B	10/23/91	59.5		0.1 U		100 U		11 U		862 U		2 UJ		10 U	
WISS-4B	10/24/90	58.9	28	0.2 U	0.2 UJ	100 U	100 U	10 U	10 U	916 U	916 U	2 UJ	2 UJ	4 UR	4 UJ
WISS-4B	01/07/91	43.5	40.3	0.2 U	0.2 U	100 U	100 U	7.7 U	7.7 U	815 UR	1250 BR	2 UJ	2 UJ	11.4 U	11.4 U
WISS-4B	04/16/91	40.1 J	4.3 BJ	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 UJ	1010 UJ	1 U	1.1 B	4 UJ	4 UJ
WISS-4B	07/16/91	115 J	8.5 BJ	0.1 UJ	0.1 UJ	100 U	100 U	6 UJ	6 UJ	955 UJ	955 UJ	2 UJ	2 UJ	4 UJ	4 UJ
WISS-4B	10/23/91	24.5		0.1 U		100 U		11 U		862 U		2 UJ		10 U	
WISS-5B	10/25/90	28.3	10.8 B	0.2 UJ	0.2 UJ	100 U	100 U	10 U	10 U	916 U	1090 B	2 U	2 U	4 UJ	4 UJ
WISS-5B	01/07/91	2040	33.2	0.2 U	0.2 U	100 U	100 U	7.7 U	7.7 U	926 BR	1250 BR	2 UJ	2.4 BJ	11.4 U	11.4 U
WISS-5B	04/16/91	27.3 J	10.4 BJ	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 UJ	1010 UJ	1.6 B	1 U	4 UJ	4 UJ
WISS-5B	07/16/91	289.4 J	16.3 J	0.1 UJ	0.1 UJ	100 U	100 U	14.7 BJ	6 UJ	955 UJ	955 UJ	2 UJ	2 UJ	7.6 BJ	4 UJ
WISS-5B	10/22/91	12 B		0.1 U		100 U		11 U		862 U		2		10 U	
WISS-6B	10/25/90	2.1 B	2 U	0.2 UJ	0.2 UJ	100 U	100 U	10 U	10 U	916 U	1120 B	2 UJ	4 U	4 UJ	4 UJ
WISS-6B	01/07/91	29.9	7.9 B	0.2 U	0.2 U	100 U	100 U	7.7 U	7.7 U	815 UR	815 UR	2 UJ	2 UJ	11.4 U	11.4 U
WISS-6B	04/16/91	3 BJ	2 UJ	0.2 U	0.2 U	100 U	100 U	7 U	7 U	1010 UJ	1010 UJ	1 U	1.1 B	4 UJ	4 UJ
WISS-6B	07/16/91	4.6 BJ	1.2 BJ	0.1 UJ	0.1 UJ	100 U	100 U	6.8 BJ	6 UJ	955 UJ	955 UJ	2 UJ	2 UJ	4 UJ	4 UJ
WISS-6B	10/21/91	2 U		0.1 U		100 U		11 U		862 U		2 UJ		10 U	
B37W08D	10/24/91	2 U		0.1 U		100 U		11 U		862 U		2 UJ		10 U	
B37W09D	10/29/91	29.4		0.1 U		100 U		75.1 J		862 U		2 UJ		10 UJ	

Table A-3
(continued)

Well	Sampling Date	Sodium Total	Sodium Diss	Thallium Total	Thallium Diss	Vanadium Total	Vanadium Diss	Zinc Total	Zinc Diss	Lithium Total	Lithium Diss	Tellurium Total	Tellurium Diss
SDWA MCL[a]		-		2[d]		-		-		-		-	
SDWA MCLG[b]		-		0.5[d]		-		-		-		-	
NJGQS[c]		50,000		10		-		5000		-		-	
BEDROCK (UNITS = µg/L)													
WISS-1B	10/26/90	16000	16600	4 UR	40 UR	16.1 BJ	25.9 BJ	7.1 BJ	14.3 BJ				
WISS-1B	01/08/91	13700	14000	40 UR	4 UR	17.3 BJ	29.8 BJ	15.6 B	3.8 B	100 U	100 U	200 U	200 U
WISS-1B	04/18/91	14900	15900	5 UJ	5 UJ	10.4 BJ	10.8 BJ	33.1 J	3 UJ			200 U	200 U
WISS-1B	07/17/91	12952.5	15136.5	2 UJ	2 UJ	512.2 R	34.4 BJ	269.6 J	37.8 J			200 U	200 U
WISS-1B	10/29/91	12000		2 UJ		8 UJ		7.7 BJ				200 U	
WISS-2B	10/26/90	8110	8600	40 UR	40 UR	6 U	28.7 BJ	19.7 BJ	5.3 BJ				
WISS-2B	01/08/91	7590	7790	40 UR	4 UR	20.9 BJ	46.2 BJ	5.7 B	7.2 B	100 U	100 U	200 U	200 U
WISS-2B	04/17/91	7380	7930	5 UJ	5 UJ	8 U	9.1 BJ	64.2 J	38.2 J			200 U	200 U
WISS-2B	07/17/91	9837.7	7440.8 J	20 UJ	2 UJ	29.6 BJ	50.3 J	144.3 J	10.3 BJ			200 U	200 U
WISS-2B	10/25/91	7300		2 UJ		8.9 B		9.3 B				200 U	
WISS-3B	10/26/90	8500	8620	40 UR	4 UR	13.2 BJ	27.8 BJ	10 BJ	5.9 BJ				
WISS-3B	01/08/91	7660	7940	40 UR	40 UR	4 U	29.3 BJ	3 U	3 U	100 U	100 U	200 U	200 U
WISS-3B	04/17/91	7530	7790	50 UJ	5 UJ	8 U	8.2 BJ	41.1 J	10.2 BJ			200 U	200 U
WISS-3B	07/17/91	8216.6 J	8081.9	20 UJ	2 UJ	4 UJ	43.8 BJ	82.7 J	13 BJ			200 U	200 U
WISS-3B	10/23/91	7480		2 UJ		8 U		6 U				200 U	
WISS-4B	10/24/90	7750	7590	4 UJ	4 UJ	6 U	6 U	19 BJ	5.2 BJ				
WISS-4B	01/07/91	7820 R	8380 R	4 UJ	4 UJ	6.6 B	3.8 B	17.7 BJ	24.4 J	100 U	100 U	200 U	2640
WISS-4B	04/16/91	7390 J	7630 J	50 UJ	5 UJ	8 U	8 U	8.2 BJ	13.9 BJ			200 U	200 U
WISS-4B	07/16/91	8876.5 J	8957.2 J	20 UJ	2 UJ	22.6 BJ	33.9 BJ	147.8 J	26 J			200 U	200 U
WISS-4B	10/23/91	7680		2 UJ		8 U		12.3 BJ				200 U	
WISS-5B	10/25/90	10300	11200	40 UR	4 UR	7.2 BJ	6.2 BJ	17.4 BJ	7.8 BJ				
WISS-5B	01/07/91	10900 R	11800 R	4 UJ	4 UJ	6.8 B	3.7 U	43.2 J	24.6 J	100 U	100 U	200 U	200 U
WISS-5B	04/16/91	10600 J	10900 J	5 UJ	5 UJ	8 U	8 U	9.5 BJ	12.8 BJ			200 U	200 U
WISS-5B	07/16/91	11968.3 J	12108.4 J	20 UJ	2 UJ	22.6 BJ	33.5 BJ	166.8 J	9.6 BJ			200 U	200 U
WISS-5B	10/22/91	10900		2 U		8 U		6.4 B				200 U	
WISS-6B	10/25/90	8490	8660	40 UR	40 UR	14.2 BJ	10.5 BJ	4 U	4 U				
WISS-6B	01/07/91	8140 R	10200 R	40 UJ	40 UJ	6.8 B	4.4 B	16.8 BJ	30.2 J	100 U	100 U	200 U	200 U
WISS-6B	04/16/91	7720 J	8410 J	5 UJ	5 UJ	8 U	8 U	8.3 BJ	18.9 B			200 U	200 U
WISS-6B	07/16/91	9523.2 J	9361.1 J	2 UJ	2 UJ	39 BJ	39 BJ	15.7 BJ	7.5 BJ			200 U	200 U
WISS-6B	10/21/91	8570		2 UJ		12 B		6 U				200 U	
B37W08D	10/24/91	7670		2 UJ		8 U		6 U				200 U	
B37W09D	10/29/91	9830		2 UJ		9.4 BJ		6.8 BJ				200 U	

U - The analyte was not detected. The detection limit is reported.
J - Analyte present; reported as an estimated value.
UJ - Analyte was analyzed for but not detected. It must be estimated because of quality control considerations.
B - Reported value was less than the contract-required detection limit (CRDL) but greater than or equal to the instrument detection limit (IDL).
BJ - Reported value was less than CRDL but greater than or equal to IDL; reported as an estimated value.
R - Result rejected based on quality control considerations; analyte may or may not be present in the sample.
BR - Reported value was less than CRDL but greater than or equal to IDL; result rejected based on quality control considerations.
UR - The analyte was not detected, but the result is rejected based on quality control considerations.

[a]Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs).

[b]Safe Drinking Water Act (SDWA) non-zero maximum contaminant level goals (MCLGs).

[c]New Jersey Class II-A Groundwater Quality Standards (February 1993).

[d]Effective 1994.

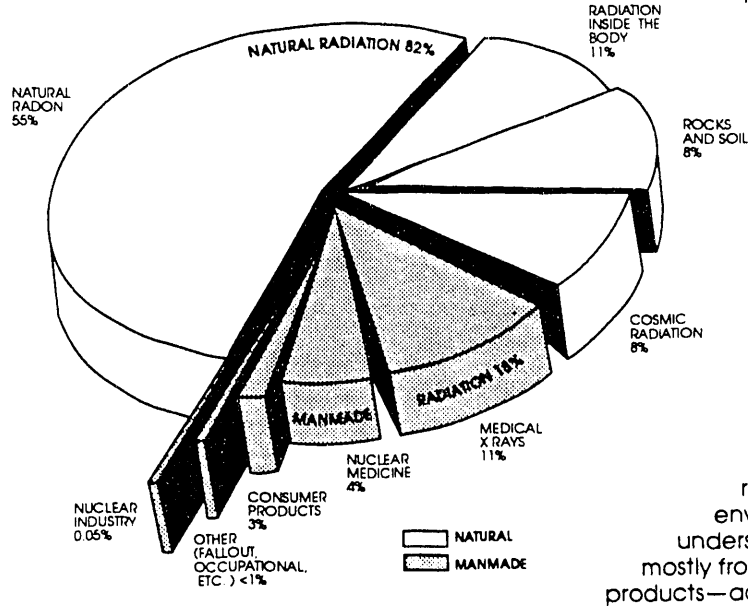
APPENDIX B Radiation in the Environment

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.

Sources of Radiation



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.

SAIC189

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 unit The level of gamma radiation in the air is measured t the *roentgen*. This is a relatively large unit, so measurements are often calculated in milliroentgen Radiation absorbed by humans is measured in eith *rad* or *rem*. The rem is the most descriptive becaus it measures the ability of the specific type of radiation to do damage to biological tissue. Agai typical measurements will often be in the millire (mrem), or one-thousandth of a rem, range. In the international scientific community, absorbe dose and biological exposure are expressed in *gra* and *seiverts*. 1 gray (Gy) equals 100 rad. 1 seivert (S equals 100 rem. On the average, Americans receive about 360 mrem of radiation a year. Mo of this (97%) is from natural radiation and medical exposure. Specific examples of common sources radiation are shown in the chart below.

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

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

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/yea
Color Television ..... <1 mrem/yea
Gas Lantern Mantle (thorium-232) ..... 2 mrem/yea
Highway Construction ..... 4 mrem/yea
Airplane Travel at 39,000 feet (cosmic) ..... 0.5 mrem/hou
Natural Gas Heating and Cooking (radon-222) ..... 2 mrem/ye
Phosphate Fertilizers ..... 4 mrem/ye

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

Effect of Ionizing Radiation on Human Health, The. Arthur C. Upton. New York University Medical Center. Atomic Industrial Forum, 1984.
Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980. Committee on the Biological Effects of Ionizing Radiation. National Academy Press, 1984.
Ionizing Radiation Exposure of the Population of the United States: Report Number 93. National Council on Radiation Protection and Measurements, 1987.
Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources: Report Number 95. National Council on Radiation Protection and Measurments, 1987.
Radiation in Medicine and Industry. A.P. Jacobson and G.P. Sakoolosky, 1980.
Radioactivity in Consumer Products. U.S. Nuclear Regulatory Commission, 1978.

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 ($2.2X10^{12}$) 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.

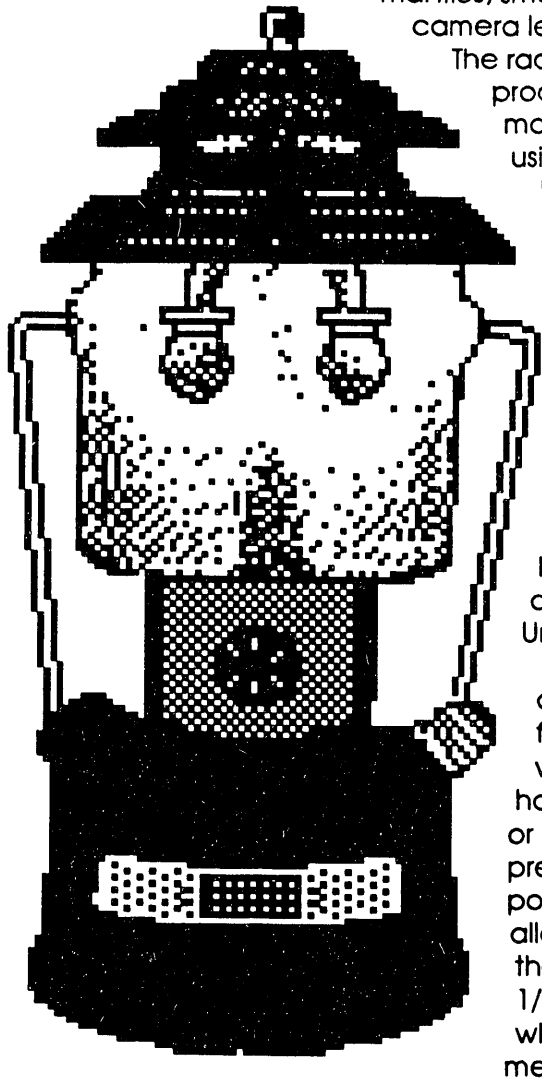
UNIT OF RADIOACTIVITY	SYMBOL	DISINTEGRATIONS PER MINUTE	DOLLAR ANALOGY	EXAMPLES OF RADIOACTIVE MATERIALS
1 Curie	Ci	$2x10^{12}$ or 2 Trillion	2 Times the Annual Federal Budget	Nuclear Medicine Generator
1 Millicurie	mCi	$2x10^{9}$ or 2 Billion	Cost of a New Interstate Highway from Atlanta to San Francisco	Amount Used for a Brain or Liver Scan
1 Microcurie	µCi	$2x10^{6}$ or 2 Million	All-Star Baseball Player's Salary	Amount Used in Thyroid Tests
1 Nanocurie	nCi	$2x10^{3}$ or 2 Thousand	Annual Home Energy Costs	Consumer Products
1 Picocurie	pCi	2	Cost of a Hamburger and Coke	Background Environmental Levels

Chart provided by W.L. Beck, Bechtel National, Inc.

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.

From information provided by W.L. Beck, Bechtel National, Inc.

SAIC189

APPENDIX C Parameters for Analysis

Table C-1

Parameters for Analysis at WISS, 1992

Medium	Parameter	Technique
Groundwater	Total uranium	Kinetic phosphorescence analyzer
	Radium-226	Alpha spectrometry
	Radium-228	Beta liquid scintillation
	Thorium-230	Alpha spectrometry
	Thorium-232	Alpha spectrometry
	Total organic halides	Microcoulimetry
	Total organic carbon	Wet ultraviolet-aided persulfate oxidation
	Mobile ions	Colorimetric determination
	Total metals: aluminum, antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lanthanides, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, zinc	Inductively coupled plasma atomic emission spectrophotometry (ICPAES)
	arsenic, lead, selenium, thallium	Atomic absorption (AA) spectrophotometry
	Specific conductivity	Electrometric
	pH	Electrometric
	Volatile compounds	Gas chromatography/mass spectrometry
	Semivolatile compounds	Gas chromatography/mass spectrometry
Air	Radon-222	Track-etch
	Radon-220	Track-etch
	External gamma radiation	Thermoluminescence

[a]Air samples are cumulative; all others are grab samples.

Sampling Methods and Detectors for Radon and Thoron

Radon and thoron concentrations are measured using an integrating alpha track-etch detector that contains a piece of alpha-sensitive film enclosed in a small two-piece cup. The radioactive gases diffuse through a membrane of the cup until the concentrations inside the cup are in equilibrium with atmospheric concentrations. Different types of membranes are used to distinguish between radon and thoron; one permits both radon and thoron to diffuse into the cup and one permits only radon to diffuse. Alpha particles from the radioactive decay of radon and thoron and their daughters create tiny tracks when they collide with the film. After they are collected, the films are placed in a caustic etching solution to enlarge the tracks; under strong magnification, the tracks are counted. The number of tracks per unit area is related through calibration to the radon concentration in air. For thoron measurements, both types of detectors are installed at the sampling location. The thoron level is then determined by subtracting the level measured by the radon detector from the level measured by the radon/thoron detector.

Table C-2

Laboratory Detection Limits for Organic Chemical Analyses of Groundwater at WISS During Third Quarter 1992

Compound	Laboratory Detection Limit[a] (μg/L)
Volatile Organic Compounds	
Chloromethane	10
Bromomethane	10
Vinyl chloride	10
Chloroethane	10
Methylene chloride	5
Acetone	10
Carbon disulfide	5
1,1-Dichloroethene	5
1,1-Dichloroethane	5
1,2-Dichloroethene (total)	5
Chloroform	5
1,2-Dichloroethane	5
2-Butanone	10
1,1,1-Trichloroethane	5
Carbon tetrachloride	5
Vinyl acetate	10
Bromodichloromethane	5
1,2-Dichloropropane	5
cis-1,3-Dichloropropene	5
Trichloroethylene	5
Dibromochloromethane	5
1,1,2-Trichloroethane	5
Benzene	5
trans-1,3-Dichloropropene	5
2-chloroethylvinylether	10
Bromoform	5
4-Methyl-1,2-pentanone	10
2-Hexanone	10
Tetrachloroethylene	5
1,1,2,2-Tetrachloroethane	5
Toluene	5
Chlorobenzene	5
Ethylbenzene	5

Table C-2

(continued)

Compound	Laboratory Detection Limit[a] (μg/L)
Semivolatile Organic Compounds	
Styrene	5
Xylene (total)	5
Acrolein	10
Acrylonitrile	10
Phenol	10
bis(2-Chloroethyl)ether	10
2-Chlorophenol	10
1,3-Dichlorobenzene	10
1,4-Dichlorobenzene	10
Benzyl alcohol	10
1,2-Dichlorobenzene	10
2-Methylphenol	10
bis(2-Chloroisopropyl)ether	10
4-Methylphenol	10
N-Nitroso-di-n-propylamine	10
Hexachloroethane	10
Nitrobenzene	10
Isophorone	10
2-Nitrophenol	10
2,4-Dimethylphenol	10
Benzoic acid	50
bis(2-Chloroethoxy)methane	10
2,4-Dichlorophenol	10
1,2,4-Trichlorobenzene	10
Naphthalene	10
4-Chloroaniline	10
Hexachlorobutadiene	10
4-Chloro-3-methylphenol	10
2-Methylnaphthalene	10
Hexachlorocyclopentadiene	10
2,4,6-Trichlorophenol	10
2,4,5-Trichlorophenol	50
2-Chloronaphthalene	10
2-Nitroaniline	50
Dimethylphthalate	10
Acenaphthylene	10
2,6-Dinitrotoluene	10

Table C-2

(continued)

Compound	Laboratory Detection Limit[a] (μg/L)
Semivolatile Organic Compounds (cont'd)	
3-Nitroaniline	50
Acenaphthene	10
2,4-Dinitrophenol	50
4-Nitrophenol	50
Dibenzofuran	10
2,4-Dinitrotoluene	10
Diethylphthalate	10
4-Chlorophenyl-phenylether	10
Fluorene	10
4-Nitroaniline	50
4,6-Dinitro-2-methylphenol	50
N-Nitrosodiphenylamine	10
4-Bromophenyl-phenylether	10
Hexachlorobenzene	10
Pentachlorophenol	50
Phenanthrene	10
Anthracene	10
Di-n-butylphthalate	10
Fluoranthene	10
Pyrene	10
Butylbenzylphthalate	10
3,3'-Dichlorobenzidine	20
Benzo(a)anthracene	10
Chrysene	10
bis(2-Ethylhexyl)phthalate	10
Di-n-octyl phthalate	10
Benzo(b)fluoranthene	10
Benzo(k)fluoranthene	10
Benzo(a)pyrene	10
Indeno(1,2,3-cd)pyrene	10
Dibenzo(a,h)anthracene	10
Benzo(g,h,i)perylene	10
N-nitrosodimethylamine	10
Benzidine	50
1,2-Diphenylhydrazine	10

Table C-2

(continued)

Compound	Laboratory Detection Limit[a] (μg/L)
PCBs	
Arochlor 1016	0.50
Arochlor 1221	0.50
Arochlor 1232	0.50
Arochlor 1242	0.50
Arochlor 1248	0.50
Arochlor 1254	1.00
Arochlor 1260	1.00
Pesticides	
Alpha-BHC	0.05
Beta-BHC	0.05
Delta-BHC	0.05
Gamma-BHC (Lindane)	0.05
Heptachlor	0.05
Aldrin	0.05
Heptachlor epoxide	0.05
Endosulfan I	0.05
Dieldrin	0.10
4,4'-DDE	0.10
Endrin	0.10
Endosulfan II	0.10
4,4'-DDD	0.10
Endosulfan sulfate	0.10
4,4'-DDT	0.10
Methoxychlor	0.50
Endrin ketone	0.10
Endrin aldehyde	0.10
Alpha chlordane	0.50
Gamma chlordane	0.50
Toxaphene	1.00

[a]Detection limits can vary because of dilution ratios.

APPENDIX D Methodology for Statistical Analysis of Data

METHODOLOGY FOR STATISTICAL ANALYSIS OF DATA

Treatment of "Less than Zero" Values

Occasionally a radiological analytical value may be reported as a negative number. This is not a mistake, and the value does not represent "negative radioactivity." Rather it is a result of the radiological measurement process produced by the subtraction of the background radiation measured by the instrument from the radiation measured in the sample. These results are essentially indistinguishable from zero.

Radioactive decay is a random phenomenon that can be described by a normal distribution (i.e., mean and standard deviation). When a sample contains radioactive elements at activities that are near instrument background, a single measurement of the sample can result in a negative value (when the instrument background is subtracted). If many measurements of the sample were taken and used to calculate the mean, this mean would be positive and would approximate the true radioactivity, however small, of the sample. In practice at FUSRAP sites, multiple measurements to calculate the mean activity of a sample near the instrument background are not necessary because the instrument background is typically several orders of magnitude less than any DCGs.

Beginning with third quarter 1992 environmental monitoring, less-than-zero radiological values have been reported when they occur. This practice will continue for all future environmental monitoring, which will result in more accurate statistical analysis. For 1992 both negative values and values reported as "less than" a detection limit are used in this report. The negative values are used as reported in the statistical calculations. For values reported as less than the detection limit, the limit is used in the statistical calculations. The use of the detection limit is a conservative practice because it results in a high bias for the calculated mean.

Treatment of Rounding and Significant Figures

When calculations are made, the result can be no more accurate than the least accurate number in the data (i.e., the number with the least number of significant digits). Regardless of whether a number contains a decimal, the number of significant digits is the total number of digits starting with the left-most, non-zero digit and ending with the right-most digit (even if it is a zero). For example, 231, 230, and 23.0 each have three significant digits, while 0.05 and 5 each have one significant digit. Rounding is performed on final calculation results only, not on interim results.

Treatment of Annual Average Concentrations

Annual average concentrations are calculated by adding the results for the year and dividing by the number of quarters for which data have been collected and reported (usually four). An example follows.

Thorium-230 Results (pCi/L)

Sampling Location	Quarter			
	1	2	3	4
1	13	7	12	5

First, results reported for the year are added.

$13 + 7 + 12 + 5 = 37$

Next, the sum of all results is divided by the number of quarters for which data were collected and reported. In this example there were data for all four quarters.

$37 \div 4 = 9.25$

Because there are two single-digit numbers (5 and 7) (the number of significant figures is 1), the result is rounded to 9. This value is entered into the average value column.

Thorium-230 Results (pCi/L)

Sampling Location	Quarter				Average Value
	1	2	3	4	
1	13	7	12	5	9

APPENDIX E Environmental Standards

ENVIRONMENTAL STANDARDS

The DOE long-term radiation protection standard of 100 mrem/yr (1 mSv/yr) in excess of the background level includes exposure from all pathways except medical treatments and exposures from radon (DOE 1990). Evaluation of exposure pathways and resulting dose calculations are based on assumptions such as the use of occupancy factors in determining dose from external gamma radiation; subtraction of background concentrations of radionuclides in air, water, and soil before calculating dose; closer review of water use; use of the data that most closely represent actual exposure conditions rather than maximum values as applicable; and use of average consumption rates of food and water per individual rather than maximums. Use of such assumptions results in calculated doses that more accurately reflect the exposure potential from site activities.

DERIVED CONCENTRATION GUIDES

DOE orders provide the standards for radionuclide emissions from DOE facilities. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," provides the procedures and requirements for radionuclide releases.

Applicable standards are found in Chapter III of DOE Order 5400.5 and are set as derived concentration guides (DCGs). A DCG is defined as the concentration of a radionuclide in air or water that, under conditions of continuous exposure to a single isotope for one year by one exposure mode (e.g., ingestion of water, inhalation), would result in an effective dose equivalent of 100 mrem. The following table provides reference values for conducting radiological environmental protection programs at operational DOE facilities and sites.

Radionuclide	F1 Value[a]	Ingested Water DCG (μCi/ml)[b]	Inhaled Air DCGs[c]		
			D	W	Y
Radium-226	2E-1	1E-7	--	1E-12	--
Thorium-230	2E-4	3E-7	--	4E-14	5E-14
Thorium-232	2E-4	5E-8	--	7E-15	1E-14
Uranium-234	2E-3	5E-6	--	--	9E-14
Uranium-235	2E-3	5E-6	--	--	1E-13
Uranium-238	2E-3	6E-6	--	--	1E-13
Radon-222[d]	3E-9	3E-9	--	--	3E-9
Radon-220[d]	3E-9	3E-9	--	--	3E-9

[a]F1 is defined as the gastrointestinal tract absorption factor, which measures the uptake fraction of ingestion of a radionuclide into the body.

[b]1E-9 μCi/ml = 0.037 Bq/L = 1 pCi/L.

[c]Inhaled air DCGs are expressed as a function of time. D, W, and Y represent a measure of the time required for contaminants to be removed from the system (D represents 0.5 day; W represents 50 days; and Y represents 500 days).

[d]DOE is reassessing the DCGs for radon. Until review is completed and new values issued, the values given in the chart above will be used.

SOIL GUIDELINES

Guidelines for residual radioactivity in soil established for FUSRAP are shown below.

Radionuclide	Soil Concentration (pCi/g) Above Background
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Other radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

Source: DOE 1987.

APPENDIX F Population Exposure Methodology

POPULATION EXPOSURE METHODOLOGY

DOE Order 5400.5 requires that the impacts of the site on both the hypothetical maximally exposed individual and the population within 80 km (50 mi) of the site be evaluated. For radioactive materials, this evaluation is usually conducted by calculating the dose received by the hypothetical individual and the general population and comparing this dose with DOE guidelines. This appendix describes the methodology used to calculate the doses discussed in Section 4.0.

PATHWAYS

The purpose of the dose calculation is to identify the potential routes or pathways that are available to transmit either radioactive material or ionizing radiation to the receptor. In general, the pathways are (1) direct exposure to gamma radiation, (2) atmospheric transport of radioactive material, (3) transport of radioactive material via surface water or groundwater, (4) bioaccumulation of radioactive materials in animals used as a food source, and (5) uptake of radioactive materials into plants used as a food source. For FUSRAP sites, the primary pathways may be direct gamma radiation and transport of radioactive materials by the atmosphere, groundwater, and surface water. The others are not considered primary pathways because FUSRAP sites are not located in areas where significant numbers of livestock are raised or foodstuffs are grown.

Gamma rays can travel until they expend all their energy in molecular or atomic interactions. In general, these distances are not very great, and the exposure pathway would affect only the hypothetical maximally exposed individual.

Contamination transported by the atmospheric pathway may take the form of contaminated particulates or dust and can provide a potential dose only when it is inhaled. Doses from radon are excluded in accordance with DOE Order 5400.5 II, 1.a(3) Application (02/08/90). Radon exposure is controlled through compliance with boundary concentration requirements.

Contamination can be transported in surface water when runoff from a rainfall event or some other source of overland flow carries contamination from the site to the surface water system. This contamination poses an exposure potential only when the surface water is used to provide municipal drinking water, to water livestock, and/or to irrigate crops. Contamination can be transported via groundwater if contaminants migrate into the groundwater system.

PRIMARY RADIONUCLIDES OF CONCERN

The primary radionuclides of concern for these calculations at most FUSRAP sites are uranium-238, uranium-235, uranium-234, thorium-232, radium-226, and the daughter products (excluding radon). For several of the dose conversion factors used in these calculations, the contributions of the daughters with half-lives of less than one year are included with the parent radionuclide. Table F-1 lists the pertinent radionuclides common among FUSRAP sites, their half-lives, and dose conversion factors for ingestion.

DOSE CALCULATION METHOD

Direct Gamma Radiation Exposure

As previously indicated, direct gamma radiation exposure is important in calculating the dose to the hypothetical maximally exposed individual. The dose from direct gamma radiation exposure is determined by using data collected through the tissue-equivalent thermoluminescent dosimeter (TETLD) program. These data provide a measure of the amount and energy (in units of mR/yr) of the ionizing radiation at 1 m (3 ft) above the ground. For the purposes of this report, two scenarios were considered:

- Realistic: A person working 40 hours per week for a year in a maintenance shop about 91 m (300 ft) from the fence would receive no exposure attributable to WISS.

Table F-1

Radionuclides of Interest

Radionuclide (mrem/pCi)	Half-life[a]	Dose Conversion Factor[b] for Ingestion
Uranium-238	4.51E+9 years	2.5E-4
Thorium-234	24.1 days	--[c]
Protactinium-234 m	1.17 minutes	--[c]
Protactinium-234	6.75 hours	--[c]
Uranium-234	2.47E+5 years	2.6E-4
Thorium-230	8.0E+4 years	5.3E-4
Radium-226	1602 years	1.1E-3
Uranium-235	7.1E+8 years	2.5E-4
Thorium-231	25.5 hours	--[d]
Protactinium-231	3.25E+4 years	1.1E-2
Actinium-227	21.6 years	1.5E-2
Thorium-227	18.2 days	--[e]
Radium-223	11.43 days	--[e]
Thorium-232	1.41E+10 years	2.8E-3
Radium-228	6.7 years	1.2E-3
Actinium-228	6.13 hours	--[f]
Thorium-228	1.91 years	7.5E-4

[a]Source: HEW 1970.

[b]Source: *Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation Submersion (EPA-520/1-88-020) and International Dose Conversion Factors for Calculation of Dose to the Public* (DOE/EH-0071).

[c]Included in the uranium-238 dose conversion factor.

[d]Included in the uranium-235 dose conversion factor.

[e]Included in the actinium-227 dose conversion factor.

[f]Included in the radium-228 dose conversion factor.

- Unrealistic: A hypothetical person assumed to work 40 hours per week for a year in an unheated bus garage about 9.1 m (30 ft) from the southern fenceline would receive a dose calculated to be 0.4 mrem/yr (0.004 mSv/yr).

The hypothetical dose to the maximally exposed individual can be determined by assuming that the individual is exposed to a line source located along a segment of the southeastern fenceline. Because the average exposure rate is known from the TETLD program for a distance of 1 m (3 ft) from the fenceline, the exposure at 9.1 m (30 ft) from the fenceline can be calculated by using the following equation (Cember 1983).

$$\text{Exposure at 9.1 m} = (\text{Exposure at 1 m}) \times \frac{h_1}{h_2} \times \frac{\tan^{-1}(L/h_2)}{\tan^{-1}(L/h_1)}$$

where: h_1 = TETLD distance from the fenceline [1 m (3 ft)]

h_2 = Maximally exposed individual's distance from the fenceline [9.1 m (30 ft)]

L = Half the length of the southeastern fenceline between stations 9, 11, 7, and 6 [60 m (195 ft)]

The exposure rate at 1 m (3 ft) can be calculated by taking the average of the results from the four detectors along this portion of the fenceline. The average exposure rate for these detectors was 16.3 mR/yr above background. Using the formula above, the exposure rate at 9.1 m (30 ft) is approximately 1.6 mR/yr. Because 1 mR/yr is approximately equal to 1 mrem/yr (1E-2 mSv/yr), the resulting dose would be 0.4 mrem/yr (0.004 mSv/yr) assuming exposure over a 40-hour work week. This exposure scenario does not account for shielding provided by the facility.

Surface Water Pathway

Exposures from contaminants in surface water can be important in calculating the dose to both the maximally exposed individual and the nearby population; however, surface water is not a factor for WISS because the radionuclide concentrations detected are so close to background levels.

Groundwater Pathway

Exposures from contaminants in groundwater that are part of a drinking water supply are important in calculating the dose to both the maximally exposed individual and the nearby population. The data used to support the groundwater dose calculations consist of measurements of the concentration of the contaminants in groundwater and an estimate of the dilution that occurs between the measurement location and the intake point; however, the onsite shallow wells yield very low or nondetectable levels of radioactivity, and the groundwater, therefore, is not a realistic pathway.

Air Pathway

The doses to the maximally exposed individual and the general public from particulate radionuclides transported via the air pathway are calculated using EPA's computer model CAP88-PC.

The release of particulates is normally calculated using a model for wind erosion because there are no other mechanisms for releasing particulates from the site; however, the storage pile has a sturdy geofabric cover, and the remainder of the site is either well-vegetated or covered with asphalt. These conditions preclude wind erosion from being a credible pathway.

APPENDIX G Distribution List for Wayne Interim Storage Site Environmental Report for Calendar Year 1992

The Department of Energy distributes this report to local, state, and federal agencies; U.S. Congress; the public, and the media (upon request).

DATE
FILMED
8/31/93
END