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Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for Maywood, New Jersey

U.S. Department of Energy

0489-0613.1

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Department of Energy
Oak Ridge Operations
P.O. Box 2001
Oak Ridge, Tennessee 37831— 8723

September 17, 1991

Distribution

ANNUAL SITE ENVIRONMENTAL REPORT - MAYWOOD INTERIM STORAGE SITE

Enclosed for your information is a copy of the 1990 Annual Site Environmental Report for the U.S. Department of Energy's Maywood Interim Storage Site located in your region. This report is prepared and published annually for distribution to interested local, state, and federal agencies; members of the public; and the press.

If you have any questions on the content of this report or desire additional information, please contact me either directly at (615) 576-1830, or you may call toll-free at (800) 253-9759.

Sincerely,

William M. Seay, Deputy Director
and Acting New Jersey Site Manager
Former Sites Restoration Division

Enclosure

DOE/OR/21949-287

08/037 01

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

MAYWOOD INTERIM STORAGE SITE ANNUAL ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1990

Maywood, New Jersey

September 1991

Bechtel National, Inc.

0189-0260.3

DOE/OR/21949-287

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

Maywood Interim Storage Site Annual Environmental Report for Calendar Year 1990

ERRATA

The following is a list of changes to this document. These changes are for technical correctness only; they do not in any way affect the results presented or conclusions made in the report.

Page 38

The second full paragraph should be replaced with the following text:

Thorium-232 is collected from surface water samples by precipitation with ammonium hydroxide. Separation from other ions in the water is accomplished by absorption of thorium on a cation exchanger from dilute hydrochloric acid, washing with water, and elution with dilute sulfuric acid. Final collection is accomplished by coprecipitation of lanthanum and thorium as hydroxides. The thorium is then electroplated on a stainless steel disk and counted by alpha spectrometry.

Page 42

The second sentence of the first full paragraph should be revised to state:

Radium-226 and thorium-232 were analyzed by gamma spectroscopy. Isotopic uranium was put into solution, ion-exchanged, eluted, electroplated to a stainless steel disk, and counted by alpha spectrometry.

Page D-1

The table titled "Parameters for Analysis at MISS, 1990" should be revised to reflect the following:

Medium	Parameter	Technique
Groundwater	Thorium-232	Alpha spectrometry
	Total organic halides	Coulometric determination
	Total organic carbon	Carbonaceous analyzer
Surface Water	Thorium-232	Alpha spectrometry
Sediment	Isotopic uranium	Alpha spectrometry

DOE/OR/21949-287

MAYWOOD INTERIM STORAGE SITE
ANNUAL ENVIRONMENTAL REPORT
FOR CALENDAR YEAR 1990

MAYWOOD, NEW JERSEY

SEPTEMBER 1991

Prepared for

United States Department of Energy
DOE Field Office, Oak Ridge
Under Contract No. DE-AC05-91OR21949

By

Bechtel National, Inc.
Oak Ridge, Tennessee

Bechtel Job No. 14501

EXECUTIVE SUMMARY

Environmental monitoring of the U.S. Department of Energy's (DOE) Maywood Interim Storage Site (MISS) and surrounding area began in 1984. MISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to decontaminate or otherwise control sites where residual radioactive materials remain from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy.

It is DOE policy to conduct its operations in an environmentally responsible manner that provides protection of human health and the environment. To that end, DOE is committed to incorporating national environmental protection and restoration programs, minimizing risks to the public and the environment, and addressing potential environmental hazards before they pose a threat to public welfare or environmental quality.

An environmental monitoring program has been established at MISS to confirm adherence to DOE environmental protection policies; to determine the effects of site operations on human health and the environment; and to ensure compliance with legal and regulatory requirements imposed by federal, state, and local agencies. Environmental monitoring programs are established on a site-specific basis to accommodate facility characteristics, applicable regulations, hazard potential, quantities and concentrations of materials released, extent and use of affected land and water, and local public interest or concern. The environmental monitoring program at MISS includes sampling networks for radon concentrations in air; external gamma radiation exposure; and total uranium, radium-226, and thorium-232 concentrations in surface water, sediment, and groundwater. Additionally, several nonradiological parameters are measured in surface water, sediment, and groundwater.

Monitoring results are compared with applicable Environmental Protection Agency (EPA) standards; federal, state, and local applicable or relevant and appropriate requirements (ARARs); and/or

DOE derived concentration guidelines (DCGs). Environmental standards, ARARs, and DCGs are established to protect public health and the environment (Appendix C).

Results from the 1990 environmental monitoring program show that concentrations of the contaminants of concern were all below applicable standards; a brief summary is provided below. Because the site is used only for interim storage and produces no processing effluents, all monitoring, except for radon and direct gamma radiation, was done on a quarterly basis.

During 1990, annual average radon concentrations for monitoring stations along the property boundary ranged from 0.3 to 2 pCi/L (0.01 to 0.07 Bq/L), well below the DOE guideline of 3.0 pCi/L (0.1 Bq/L). Additionally, radon flux measurements were collected to demonstrate that the site was in compliance with the radon flux limit of 20 $pCi/m^2/s$ (0.74 $Bq/m^2/s$) set forth in 40 Code of Federal Regulations (CFR) Part 61, Subpart Q. The average radon flux rate for the MISS waste pile was 0.02 $pCi/m^2/s$ (7E-4 $Bq/m^2/s$). (Note: 1E-n is equal to 1×10^{-n}.) Annual average external gamma radiation exposure levels averaged 58 mR/yr at the fenceline, excluding an annual average background level of 68 mR/yr. Annual average concentrations of radium-226 in surface water ranged from 0.3E-9 to 0.4E-9 μCi/ml (0.01 Bq/L); annual average concentrations of thorium-232 and total uranium were 0.1E-9 and 3E-9 μCi/ml (0.004 and 0.1 Bq/L), respectively. These concentrations are well below the DCGs for water of 100E-9, 50E-9, and 600E-9 μCi/ml (3.7, 1.9, and 22 Bq/L) for radium-226, thorium-232, and total uranium, respectively. Annual average concentrations of radium-226 and thorium-232 in sediment ranged from 0.4 to 0.5 and 0.3 to 0.7 pCi/g (0.01 to 0.02 and 0.01 to 0.03 Bq/g), respectively. The annual average concentration of total uranium in sediment was 1 pCi/g (0.04 Bq/g). Currently, no guidelines are in effect for radionuclides in sediment; however, radium-226 and thorium-232 concentrations in sediment were below the FUSRAP guideline of 5 pCi/g (0.19 Bq/g) in the top 15 cm (6 in.) of soil. There are also no uranium guidelines currently in effect for the Maywood area; however, uranium concentrations in sediment were near background levels. Annual average concentrations of radium-226, thorium-232, and total uranium in groundwater ranged from 0.4E-9 to 2E-9, 0.1E-9 to 2E-9, and 2E-9 to 6E-9 μCi/ml (0.02 to 0.07, 0.004 to 0.07, and 0.07 to 0.2 Bq/L), respectively. All measured values were below the DCG for water.

Analyses of nonradiological parameters were performed for surface water, sediments, and groundwater to determine basic water quality. Analyses were not performed to meet regulatory requirements; therefore, there are no comparative standards for these parameters.

Surface water samples were analyzed quarterly for pH, specific conductance, total organic carbon (TOC), total organic halides (TOX), and metals. Annual average pH values ranged from 7.4 to 8.0; annual average specific conductivity ranged from 486 to 681 μmhos/cm; annual average TOC concentrations ranged from 5 to 8 mg/L; and annual average TOX concentrations ranged from 91 to 320 μg/L. Boron, calcium, iron, magnesium, manganese, sodium, and zinc were regularly detected in surface water; similar concentrations of these metals were detected upstream and downstream of the site. In addition, third-quarter surface water samples were analyzed for semivolatile and volatile organic compounds. Four compounds (1,2-dichloroethene, trichloroethene, 1,1,2,2-tetrachloroethane, and chloroform) were detected at concentrations of less than 50 μg/L. Sediment samples were also analyzed for metals; the same metals detected in surface water were detected in sediments.

Groundwater samples were analyzed quarterly for pH, specific conductance, TOC, TOX, and metals. Annual average pH values ranged from 6.3 to 8.9; annual average specific conductance values ranged from 407 to 8810 μmhos/cm; annual average TOC concentrations ranged from 3 to 87 mg/L; and annual average TOX concentrations ranged from 20 to 240 μg/L. Aluminum, iron, lithium, boron, and zinc were regularly detected in groundwater; generally, similar concentrations of these metals were found in both upgradient and downgradient wells. In addition, third-quarter groundwater samples were analyzed for volatile and semivolatile organic compounds.

Eight volatile compounds (trichloroethene, 1,1-dichloroethene, toluene, 1,2-dichloroethene, tetrachloroethene, chloroform, 1,1,1-trichloroethane, and vinyl chloride) and three semivolatile compounds [bis(2-chloroethyl)ether, naphthalene, and phenol] were detected in offsite wells. However, only three volatile compounds and one semivolatile compound were detected in samples from onsite wells.

To verify that MISS was in compliance with the DOE public dose limit of 100 mrem/yr (1 mSv/yr) above background through all exposure modes from all DOE-controlled sources of radiation, the potential radiation dose was calculated for a hypothetical maximally exposed individual and for the population within 80 km (50 mi) of the site. Based on a conservative scenario, this hypothetical individual would receive an exposure of approximately 1.3 mrem/yr (0.013 mSv/yr) above background. The population within an 80-km (50-mi) radius of MISS would receive a collective population dose of 2.5 person-rem/yr (0.025 person-Sv/yr) above background.

To ensure that MISS was in compliance with 40 CFR Part 61, Subpart H, the EPA-approved AIRDOS computer model was used to calculate the dose to a hypothetical maximally exposed individual resulting from airborne radionuclides transported from the site. Meteorological data used to support the dose calculation were obtained from the National Oceanic and Atmospheric Administration. The calculated dose was 0.0083 mrem/yr (8.3E-5 mSv/yr), which is well below the 10 mrem/yr limit. The source term was calculated according to EPA procedures for hazardous waste sites.

During 1990, there were no nonroutine releases from the site; MISS was in compliance with applicable regulations for releases from the site, as has been the case since 1984, when the environmental monitoring program and remedial action began.

CONTENTS

CONTENTS
(continued)

FIGURES

TABLES

TABLES
(continued)

ACRONYMS

AEC	Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
BNI	Bechtel National, Inc.
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DCG	derived concentration guideline
DOE	Department of Energy
EE/CA	engineering evaluation/cost analysis
EIS	environmental impact statement
EPA	Environmental Protection Agency
FFA	federal facilities agreement
FR	Federal Register
FUSRAP	Formerly Utilized Sites Remedial Action Program
MISS	Maywood Interim Storage Site
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NJAC	New Jersey Administrative Code
NPL	National Priorities List
PCB	polychlorinated biphenyl
PERALS	photon/electron-rejecting alpha liquid scintillation
QA	quality assurance

ACRONYMS

(continued)

QC	quality control
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TETLD	tissue-equivalent thermoluminescent dosimeter
TMA/E	Thermo Analytical/Eberline
TOC	total organic carbon
TOX	total organic halides
TSCA	Toxic Substances Control Act
USC	United States Code

UNITS OF MEASURE

Bq	becquerel
C	Celsius
Ci	curie
cm	centimeter
F	Fahrenheit
ft	foot
ft MSL	feet above mean sea level
g	gram
h	hour
ha	hectare
in.	inch
km	kilometer
L	liter
m	meter
mg	milligram
mi	mile
μCi	microcurie
μg	microgram
μmhos	micromhos
ml	milliliter
mm	millimeter
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) Maywood Interim Storage Site (MISS) and surrounding area began in 1984. This document describes the environmental monitoring program, the program's implementation, and the monitoring results for 1990.

1.1 DOE INVOLVEMENT

MISS is part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE program to decontaminate or otherwise control sites where residual radioactive materials remain from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy.

1.2 SITE HISTORY

From 1916 until 1956, Maywood Chemical Works extracted thorium from monazite sands for making mantles used in gas lanterns. During this time, a thorium-contaminated slurry produced as a by-product was pumped to diked areas west of the plant. Some of this contaminated material was used by local property owners as fill or mulch, and some migrated offsite via natural mechanisms. The company continued to manufacture, process, distribute, and possess radioactive material until the facility was sold to the Stepan Company in 1959.

In 1961, based on an Atomic Energy Commission (AEC) inspection and other information, the Stepan Company was issued an AEC radioactive materials license to allow remediation of the facility. Actual cleanup began in 1963. From 1966 to 1968, approximately 14,600 m^3 (18,100 yd^3) of contaminated soil was removed.

In 1980, the Nuclear Regulatory Commission was notified of elevated readings from the present site and in 1983, the

Environmental Protection Agency (EPA) added the Maywood site to the National Priorities List (NPL). In 1984, the Maywood site was assigned to DOE.

1.3 SITE DESCRIPTION

MISS occupies approximately 4.73 ha (11.7 acres) in north-central New Jersey in the Borough of Maywood and the Township of Rochelle Park (Bergen County) (Figure 1-1). The MISS property includes an interim storage pile, two railroad spurs, a wooden warehouse, and a circular concrete reservoir (Figure 1-2). A decontamination pad, two trailers, a storage van, and a 5000-gal storage tank are inside the controlled area but not on DOE property. The area currently used for storage of approximately 26,700 m^3 (34,900 yd^3) of radioactively contaminated soil is entirely fenced and access is restricted. Figure 1-3 is an aerial photograph of the site.

1.4 LAND USE

As illustrated in Figure 1-4, land use in the vicinity of MISS is a mixture of residential, commercial, and industrial. The site is bordered by a railroad line to the northeast, commercial and industrial property to the south and east, and New Jersey State Highway 17 to the west.

Westerly Brook, which flows under the northern edge of MISS via a concrete pipe, empties into Saddle River, a tributary of the Passaic River; these waters are not used as drinking water sources. Almost all of the Borough of Maywood and the Township of Rochelle Park are served by a municipal water system supplied by bedrock aquifer wells.

The nearest residential area is approximately 46 m (150 ft) northeast of the site; the residences are a mixture of multiple- and single-family dwellings. The total population of the area within an 80-km (50-mi) radius of MISS is over 10 million.

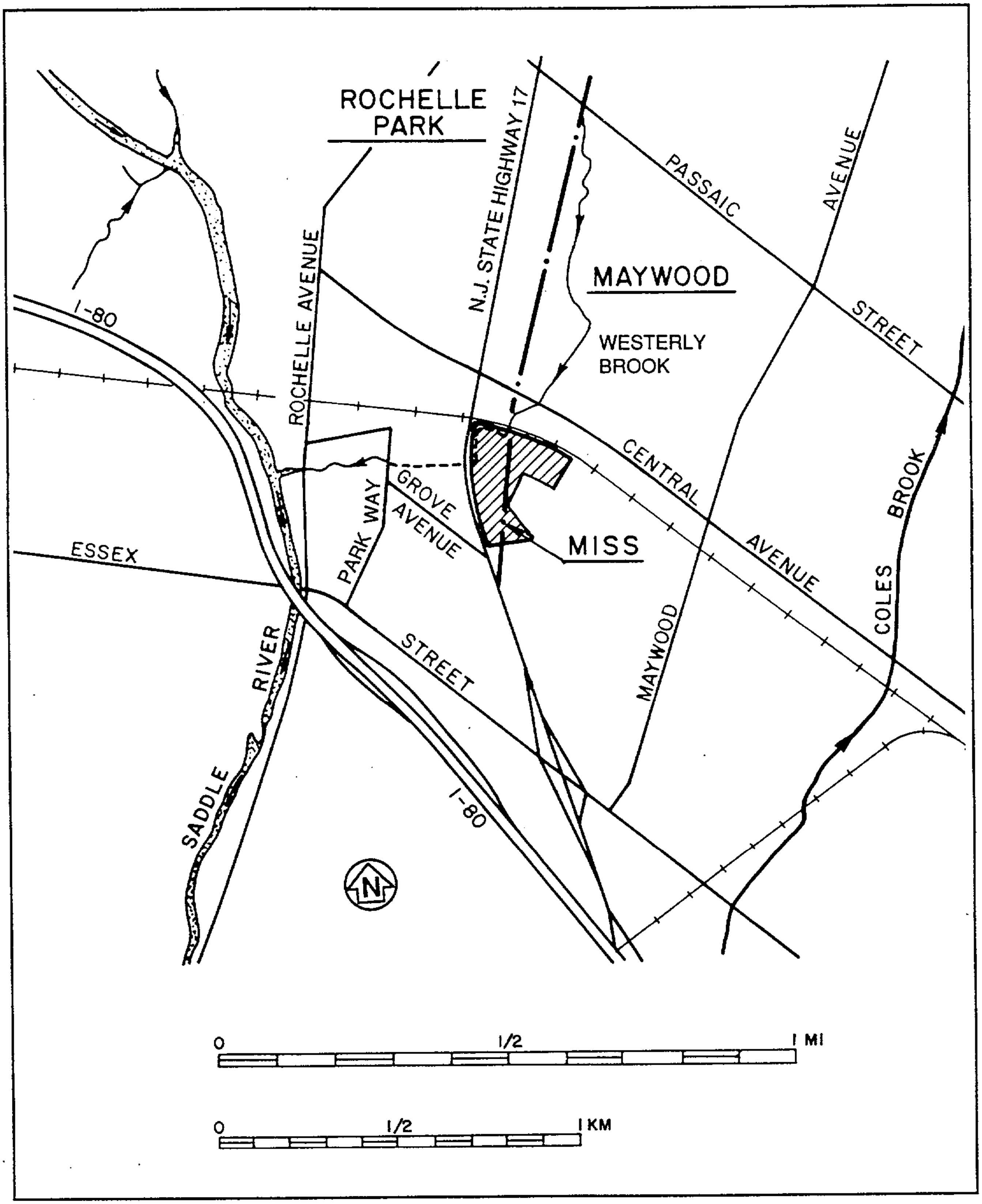

Figure 1-1
Location of MISS

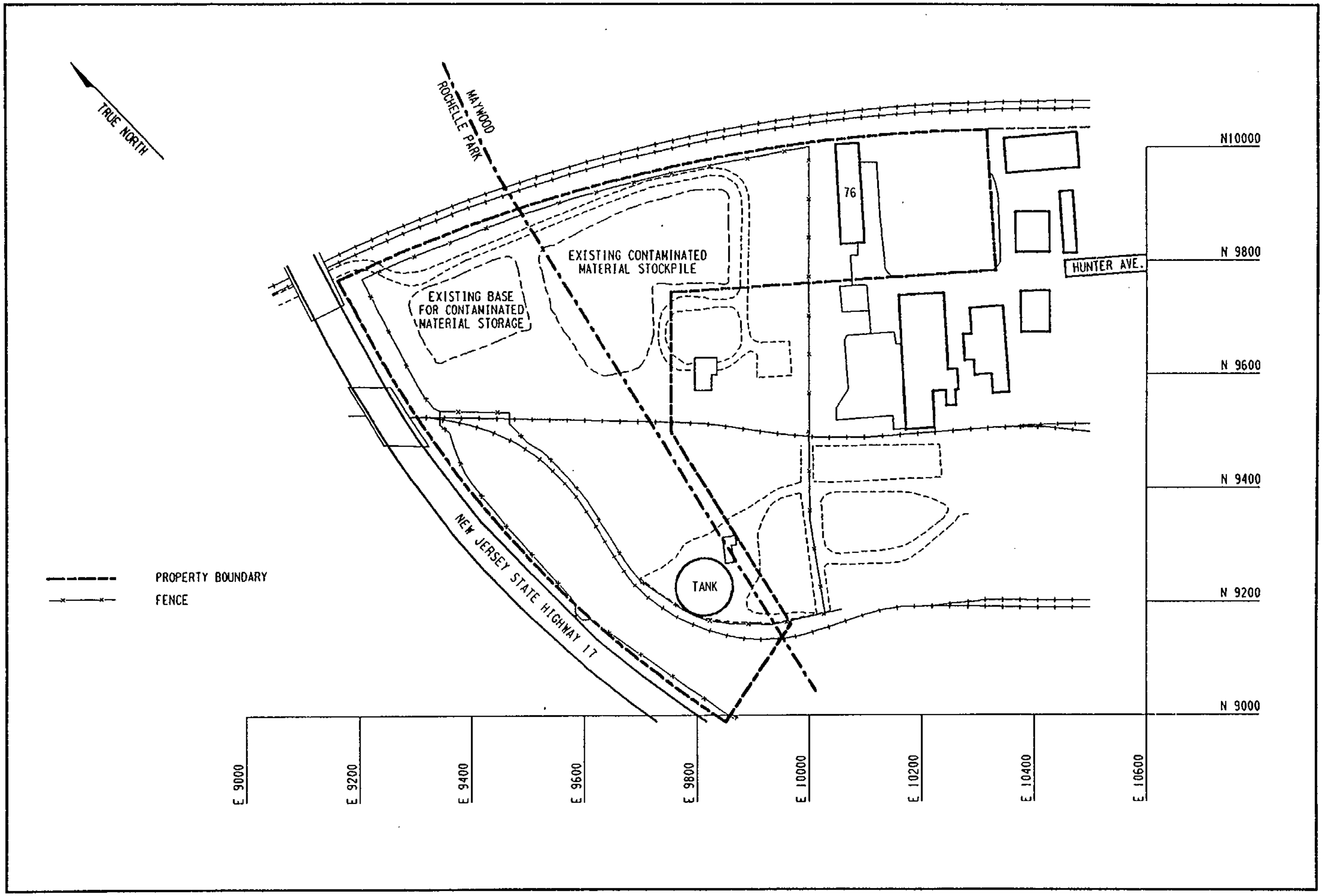

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Figure 1-2
Plan View of MISS

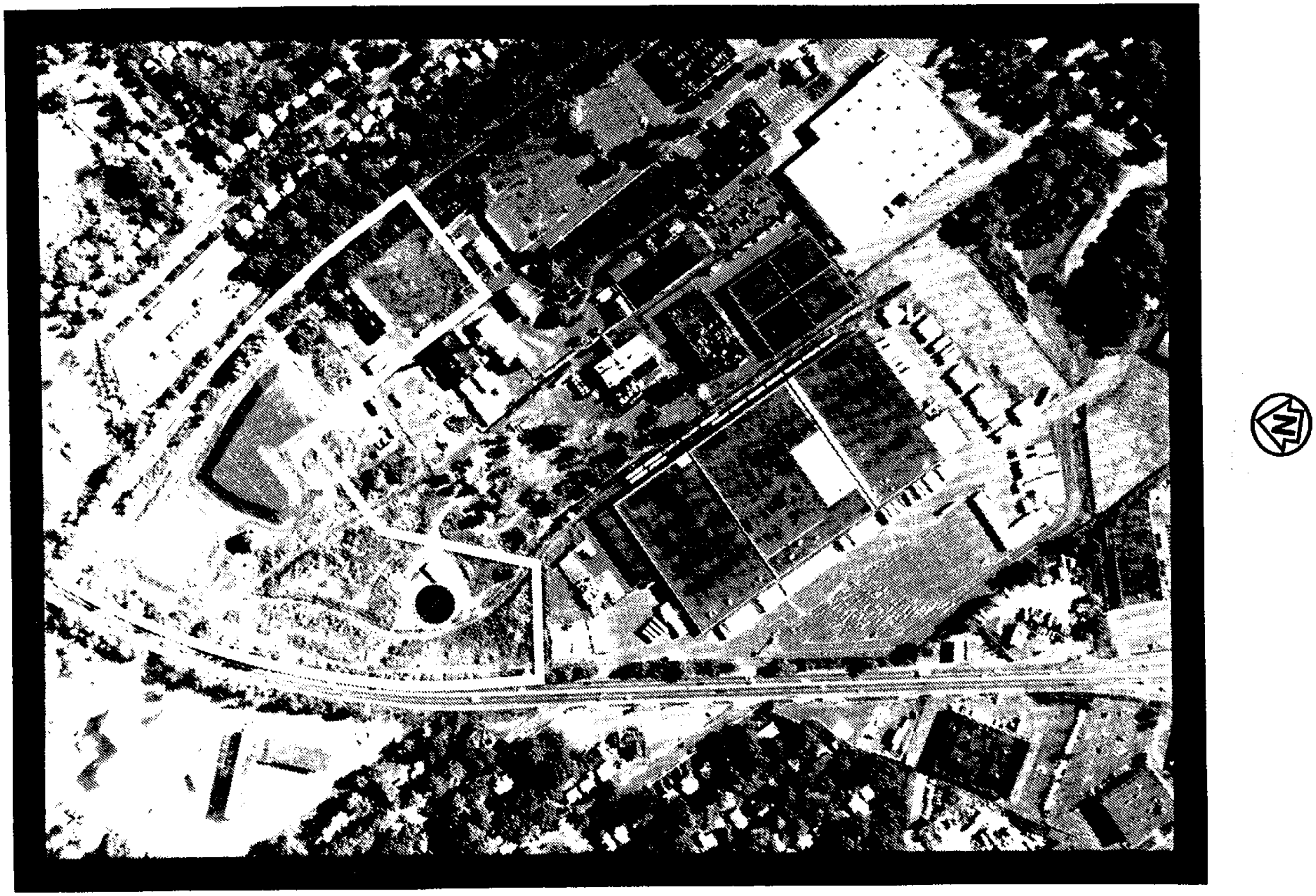
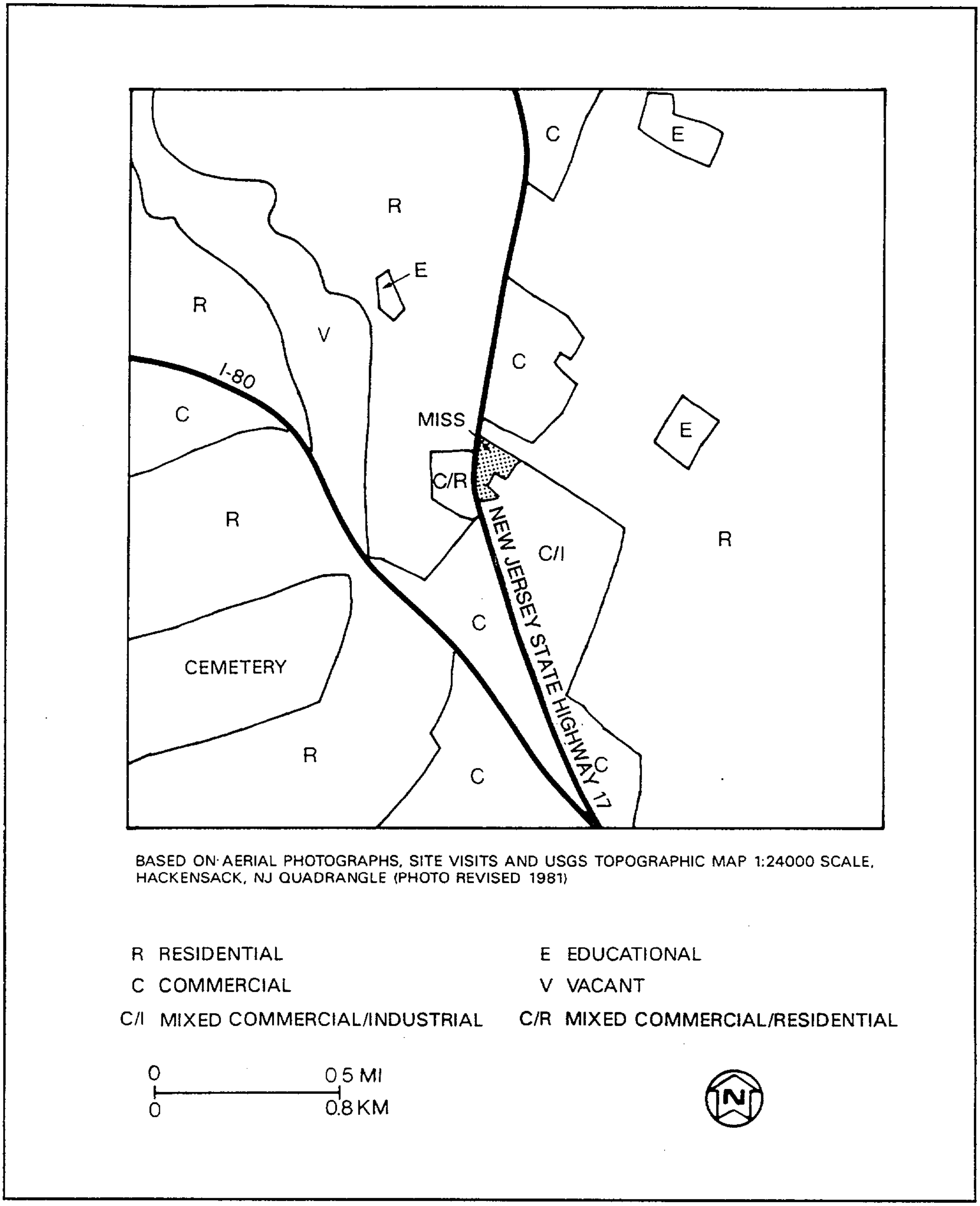


Figure 1-3
Aerial View of MISS and Vicinity



BASED ON AERIAL PHOTOGRAPHS, SITE VISITS AND USGS TOPOGRAPHIC MAP 1:24000 SCALE, HACKENSACK, NJ QUADRANGLE (PHOTO REVISED 1981)

Figure 1-4
Generalized Land Use in the Vicinity of MISS

1.5 CLIMATE

Table 1-1 is a summary of 1990 climatological data from the National Oceanic and Atmospheric Administration for the Newark area [24 km (15 mi) south-southwest of MISS]. Temperature extremes ranged from -13 to 37°C (8.0 to 98°F). Average monthly wind speeds ranged from 12.6 to 18.2 km/h (7.8 to 11.4 mph), and the predominant resultant wind direction was from the west (BNI 1991).

TABLE 1-1
SUMMARY OF CLIMATOLOGICAL DATA FOR THE NEWARK VICINITY, 1990

Month	Temperature (°F)			Total Precip (in.)	Wind	
	Min	Max	Avg		Avg Speed (mph)	Resultant Direction
January	22	66	40.4	4.72	9.6	W
February	8	66	39.8	1.71	11.1	W
March	13	86	44.9	2.81	9.9	W
April	32	94	53.3	3.98	9.9	SW
May	43	83	51.0	6.87	9.8	W
June	51	92	73.4	3.68	9.1	SW
July	58	98	77.8	4.98	8.8	W
August	58	93	76.6	7.71	8.3	NW
September	44	91	68.6	2.72	7.8	W
October	35	88	62.4	5.11	9.6	SW
November	29	79	50.0	2.82	11.4	W
December	21	67	42.3	5.19	10.5	W

Source: BNI 1991.

2.0 SUMMARY OF ENVIRONMENTAL COMPLIANCE

Throughout its history, MISS has been subject to evolving federal and state environmental regulations. The primary regulatory guidelines and limits are given in DOE orders and authorized under six federal acts [the Clean Air Act (CAA); the Clean Water Act (CWA); the Resource Conservation and Recovery Act (RCRA); the Toxic Substances Control Act (TSCA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the National Environmental Policy Act (NEPA)]. The following summaries describe compliance requirements as they existed in 1990, as well as anticipated future regulatory requirements that may affect the site.

2.1 PRIMARY REGULATORY GUIDELINES

DOE Orders for Radionuclide Releases

Site releases must comply with specific DOE orders [5400 series and DOE Order 5820.2A, "Radioactive Waste Management" (DOE 1988)] that establish quantitative limits, derived concentration guidelines (DCGs), and dose limits for radiological releases from DOE facilities. For EPA permitting purposes, DOE orders are treated as legal requirements, and remedial action activities covered by DOE orders conducted at DOE facilities are considered "federally permitted actions" [54 Federal Register (FR) 22524]. A review of environmental monitoring results for calendar year 1990 indicates that MISS was in compliance with all applicable radionuclide release standards in DOE orders. Detailed monitoring results for radionuclides are presented in Section 4.0.

Clean Air Act and National Emission Standards for Hazardous Air Pollutants

The primary federal statute governing air emissions is the CAA [42 United States Code (USC) 7401 et seq.], as amended.

Federal regulations governing air emissions are contained in 40 Code of Federal Regulations (CFR) Parts 50 through 87 and 29 CFR Part 1910.

The only potential sources of onsite air emissions are radionuclide emissions from the waste pile. MISS does not require any state or federal air permits. Because it is a nonoperating DOE facility, Subpart Q of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) is applicable (DOE 1990a). A strategy for determining compliance with the radon flux standard in Subpart Q submitted to and approved by EPA was implemented in July 1990. Radon flux results collected to demonstrate compliance with Subpart Q are provided in Subsection 4.1.1 of this report.

NESHAPs Subpart M contains the National Asbestos Emission Standards. One drum of asbestos is in a storage area; loose asbestos is buried in a 0.5-m^2 (5-ft^2) area identified with surveyor flags. When the buried asbestos is excavated, implementation of standards in Subpart M will be required.

Clean Water Act

Waters discharged to navigable waters of the United States are regulated under the federal CWA, as amended (33 USC 1251 et seq.) and its associated EPA regulations (40 CFR Parts 122, 136, 403, and 405 through 471). New Jersey requirements are codified in New Jersey Water Pollution Control Laws, Title 58, New Jersey Statutes Annotated, Chapters 6A and 10. MISS does not require any state or federal water permits. Non-point-source discharges of stormwater are the only discharges to surface water; no samples or measurements have yet been taken to characterize stormwater flow.

On November 16, 1990, EPA promulgated changes to its stormwater regulation provisions. Although these provisions did not affect reporting obligations for 1990, significant changes in compliance reporting and monitoring are anticipated for 1991. DOE is evaluating whether a stormwater discharge permit will be required for MISS; in the interim, a plan will be developed to comply with the regulation by the deadline (November 16, 1991). The plan will include a data collection methodology that covers all applicable regulatory parameters referenced in the regulation.

Resource Conservation and Recovery Act

RCRA (40 USC 6901 et seq.) is the principal federal statute governing the management of hazardous waste; EPA regulations for implementing RCRA are contained in 40 CFR Parts 260 through 271. New Jersey is an authorized state for implementation of the RCRA program; state RCRA requirements can be found in New Jersey Solid and Hazardous Waste Management Regulations, Title 7, New Jersey Administrative Code (NJAC), Chapter 26. New Jersey also regulates the generation and disposal of asbestos in Title 7, NJAC, Chapter 26.

A limited amount of corrosive hazardous waste generated during site characterization in 1990 was treated in April. No other RCRA-hazardous waste has been detected.

September 25, 1990, was the effective date for implementation of the new toxicity characteristic leaching procedure (TCLP) for determining whether a solid waste exhibits the RCRA characteristic of toxicity. Characterization of the site is not complete, and soil samples taken from the waste pile at MISS for toxicity testing are currently being analyzed. Should any samples fail the TCLP tests, the applicability of RCRA will be reevaluated.

Toxic Substances Control Act

The most common toxic substances regulated by TSCA (15 USC 2601 et seq.) are polychlorinated biphenyls (PCBs) and asbestos. EPA regulations regarding the production, use, and storage, handling, and disposal of PCBs are codified in 40 CFR Part 761. Asbestos regulations are codified in 40 CFR Part 763. TSCA requirements will have to be met in CERCLA remedial actions where they are applicable or relevant and appropriate.

PCB management involves monitoring of in-service equipment; storage and disposal of equipment removed from service; cleanup and management of spill residues; and recordkeeping and reporting. Although PCBs were not expected to be present, onsite sampling for PCBs was conducted in late 1990. Analytical results are pending; should any PCBs be detected, then TSCA provisions will be met.

Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA (42 USC 9601 et seq.) is the primary source of statutory authority for the response actions to be conducted at MISS. EPA regulations governing cleanup activities are found in 40 CFR Part 300, which is the National Oil and Hazardous Substances Contingency Plan. CERCLA Section 121 mandates that CERCLA remedial actions comply with substantive requirements of environmental laws when they are applicable or relevant and appropriate. CERCLA mandates that applicable or relevant and appropriate requirements (ARARs) be attained during remedial actions and, to the greatest extent practicable considering the exigencies of the situation, during removal actions.

All wastes generated during the remedial investigation are subject to an ARAR analysis. ARARs are federal and state environmental statutes and regulations other than CERCLA that provide binding requirements for site-specific actions (see Appendix C). There are three types of ARARs: (1) chemical-specific requirements that are usually health- or risk-based numerical values, (2) performance-, design-, or other action-specific requirements that are usually technology- or activity-based, and (3) location-specific requirements that are restrictions placed on concentrations of hazardous substances or conduct of activities. ARARs are evaluated for their applicability throughout the remedial investigation/feasibility study (RI/FS) process. The ARAR identification process for MISS will be completed before the final RI/FS report is issued.

Because MISS is on the NPL, a federal facilities agreement (FFA) is required for site remedial action. DOE and EPA Region II signed an FFA on September 17, 1990 (EPA 1990). Specifically, the parties to the FFA intend that activities covered by the agreement will achieve compliance with CERCLA and will meet or exceed all ARARs.

Compliance with CERCLA during remediation of FUSRAP sites such as MISS is further ensured by extensive interactions with EPA and monitoring of compliance by DOE Headquarters.

National Environmental Policy Act

In the past, compliance with NEPA (42 USC 4321 et seq.) has been accomplished through the use of action description memoranda and corresponding memoranda-to-file. Actions taken to date have been determined to have had no significant impact on the environment. Preparation of an environmental impact statement (EIS) is required as part of the overall effort for MISS. Compliance with NEPA for site remedial actions will be accomplished by incorporating those elements required by an EIS into the format of the CERCLA RI/FS to produce an RI/FS-EIS, scheduled for completion in 1994. All the field work to support the RI stage of the RI/FS has been completed, and documentation efforts for the RI are under way.

Documentation for the removal of contamination at vicinity properties is scheduled for completion in September 1991. This documentation will be prepared in conjunction with several CERCLA engineering evaluations/cost analyses (EE/CAs) for those vicinity properties at which they are required.

On November 2, 1990, DOE proposed to amend its NEPA compliance requirements to incorporate revised provisions of DOE guidelines. Among the proposed revisions is an expansion of the list of categorical exclusions to include site characterization and environmental monitoring under CERCLA (55 FR 46444, September 7, 1990). Adoption of the amended guidelines would streamline the decision-making process for determining the NEPA documentation required when DOE conducts remedial action activities at its sites.

Other Major Environmental Statutes and Executive Orders

In addition to these DOE orders and statutes, several other major environmental statutes have been reviewed for applicability. For example, the Federal Insecticide, Fungicide, and Rodenticide Act; the Endangered Species Act; the Emergency Planning and Community Right-to-Know-Act; the Safe Drinking Water Act; and the National Historic Preservation Act have all been found to impose no current requirements on MISS. In addition, Executive Orders 11988 ("Floodplain Management") and 11990 ("Protection of Wetlands") have been reviewed for applicability and compliance. MISS is in compliance with all applicable environmental statutes, regulations, and executive orders.

2.2 APPLICABLE ENVIRONMENTAL PERMITS

The FFA for MISS provides, in conjunction with DOE policy, that all applicable permit conditions be met even though no permit applications are required. CERCLA Section 121 provides the statutory authority for an exemption to permitting requirements for onsite CERCLA remedial actions.

DOE is assessing the need for a stormwater discharge permit at MISS. If such a permit is determined to be necessary, the application process will begin in 1991.

2.3 ENVIRONMENTAL IMPACT STATEMENTS AND ENVIRONMENTAL ASSESSMENTS

As stated, two NEPA documents are being generated for MISS. The first of these is the EIS integrated into the CERCLA RI/FS; the RI/FS-EIS is scheduled for completion in 1994. In addition to the EIS, documentation will be generated to support removal of contamination from MISS vicinity properties; this documentation is scheduled to be completed in September 1991 and incorporated into CERCLA EE/CAs to be completed for those vicinity properties that require such documentation.

2.4 SUMMARY OF COMPLIANCE IN CALENDAR YEAR 1991 (FIRST QUARTER)

Only one significant regulatory change for MISS was implemented during the first quarter of 1991. In February, soil contaminated with asbestos and radionuclides was excavated from the area in which a radioactively contaminated, asbestos-covered storage tank was discovered in 1990. The contaminated soil was drummed; labeled in accordance with regulations in Title 7, NJAC, Chapter 26; and stored in Building 76, the drum storage building. The tank will be surveyed and, if contaminant levels exceed DOE guidelines, appropriate disposal options will be investigated. MISS continues to be in compliance with all applicable regulations for releases from the site.

3.0 ENVIRONMENTAL PROGRAM INFORMATION

Routine monitoring for radiation, radioactive materials, and chemical substances on and off MISS is used to document compliance with appropriate standards, provide the public with information, provide a historical record for year-to-year comparisons, and identify environmental impacts. The environmental monitoring program assists in fulfilling the DOE policy of protecting public health and the environment and reducing negative environmental impacts.

The objectives of this report are to:

- Highlight significant programs and efforts
- Describe the environmental monitoring program
- Report 1990 radiological and nonradiological conditions of the site and surrounding areas
- Provide comparison of monitoring results with applicable regulations
- Provide trend analyses, where applicable, to indicate increases or decreases in environmental impact
- Provide detailed information on the input and assumptions used in all dose calculations

The primary audience for the environmental monitoring results includes the general public; property owners; community interest groups; technical staffs of federal, state, and local government agencies; and regulatory personnel.

3.1 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAM

3.1.1 Environmental Monitoring Requirements

Requirements for environmental monitoring of radioactive materials in air, surface water, sediment, and groundwater are found in the DOE orders dealing with radiation protection of the public and the environment. Requirements for environmental monitoring of airborne pollutants are found in NESHAPs; non-radon radionuclide and radon monitoring are required by NESHAPs, Subpart Q. Requirements for environmental monitoring of nonradiological parameters are found in DOE Order 5400.1 (DOE 1989). Nonradiological parameters are monitored to obtain basic information on surface water, sediments, and groundwater.

3.1.2 Monitoring Networks

The following criteria were used in establishing the environmental monitoring networks at MISS:

- All radon and gamma exposure rate monitoring stations, except background stations, are onsite and accessible only to employees and authorized visitors.

- All groundwater wells, both onsite and offsite, have locking caps to provide security.

- Some radon and gamma exposure rate monitoring stations are located on or near the DOE property line to allow determination of exposure at the "fenceline" as required by DOE orders.

- Background stations are located offsite in uncontaminated areas.

The medium-specific networks at MISS include:

- Nineteen radon monitoring stations (2 onsite, 4 onsite quality control, 10 at the fenceline, and 3 background locations)

- Nineteen gamma radiation monitoring stations (2 onsite, 4 onsite quality control, 10 at the fenceline, and 3 background locations)

- Four surface water monitoring locations (3 offsite downstream and 1 offsite upstream)

- Four sediment monitoring locations (3 offsite downstream and 1 offsite upstream)

- Nineteen groundwater monitoring locations (2 upgradient, 8 downgradient onsite, and 9 downgradient offsite)

Details on the monitoring networks are provided in Sections 4.0 and 5.0.

3.1.3 Summary of Environmental Monitoring Data

The following subsections summarize environmental monitoring results for MISS for calendar year 1990. Detailed discussions of the radiological and nonradiological results are provided in Sections 4.0 and 5.0.

Radon

Annual average radon concentrations ranged from 0.3 to 2 pCi/L (1E-2 to 7E-2 Bq/L) including an average background level of 0.3 pCi/L (1E-2 Bq/L) (Subsection 4.1.1). The radon concentrations at all monitoring locations were below the DOE guideline of 3.0 pCi/L (0.1 Bq/L) for interim storage sites and remained close to background levels throughout the year. Thoron (radon-220), a radioactive gas from the thorium-232 decay series, was not included as part of the 1990 environmental monitoring program; however, thoron monitoring will be added to the program in 1991.

External gamma radiation exposure

The annual average external gamma radiation exposure level was 27 mR/yr onsite and 58 mR/yr at the fenceline, excluding a background level of 68 mR/yr. Detailed information on gamma radiation exposure monitoring can be found in Subsection 4.1.2.

Surface water

Surface water sampling was performed quarterly to determine concentrations of total uranium, radium-226, and thorium-232 and to assess any impact of site discharges to Westerly Brook (Subsection 4.1.3). Annual average concentrations of radium-226 ranged from 0.3E-9 to 0.4E-9 µCi/ml (0.01 Bq/L); annual average concentrations of thorium-232 and total uranium were 0.1E-9 and 3E-9 µCi/ml (0.004 to 0.1 Bq/L), respectively. Radionuclide concentrations at downstream sampling locations were essentially the same as upstream (background) concentrations. All concentrations were well below the DCGs for water of 100E-9, 50E-9, and 600E-9 µCi/ml (3.7, 1.9, and 22 Bq/L) for radium-226, thorium-232, and total uranium, respectively.

Surface water samples were analyzed for pH, specific conductance, total organic carbon (TOC), total organic halides (TOX), and metals. Annual average pH ranged from 7.4 to 8.0; annual average specific conductivity values ranged from 486 to 681 µmhos/cm; annual average TOC concentrations ranged from 5 to 8 mg/L; and annual average TOX concentrations ranged from 91 to 320 µg/L. Boron, calcium, iron, magnesium, manganese, sodium, and zinc were regularly detected in surface water; similar concentrations of these metals were detected upstream and downstream of the site. In addition, surface water was analyzed for semivolatile and volatile organic compounds during the third quarter. Four compounds (1,2-dichloroethene, trichloroethene, 1,1,2,2-tetrachloroethane, and chloroform) were detected, all at concentrations less than 50 µg/L.

Sediment

Sediment samples were collected in conjunction with surface water samples as a check for deposition of the contaminants of interest. Annual average concentrations of radium-226 and thorium-232 ranged from 0.4 to 0.5 and 0.3 to 0.7 pCi/g (0.01 to

0.02 and 0.01 to 0.03 Bq/g), respectively. The annual average concentration of total uranium was 1 pCi/g (0.04 Bq/g). Concentrations in downstream sediment did not vary notably from those found in upstream samples (Subsection 4.1.4), and all concentrations were well below the levels of radioactivity commonly found in phosphate fertilizers (Appendix F). There are currently no guidelines in effect for radionuclide concentrations in sediment; however, radium-226 and thorium-232 concentrations in sediment were below the FUSRAP soil guideline of 5 pCi/g (0.2 Bq/g) in the top 15 cm (6 in.) of soil. There are also no guidelines currently in effect for uranium in soil for the Maywood area; however, all uranium concentrations were close to background levels. Sediment samples were also analyzed for metals. Boron, calcium, iron, magnesium, manganese, sodium, and zinc were regularly detected; similar concentrations of these metals were detected upstream and downstream of the site.

Groundwater

Results for radionuclide concentrations in groundwater samples from MISS were generally consistent with previous data. Groundwater quality upgradient of MISS is essentially the same as that downgradient.

Annual average concentrations of radium-226, thorium-232, and total uranium in groundwater ranged from 0.4E-9 to 2E-9, 0.1E-9 to 2E-9, and 2E-9 to 6E-9 μCi/ml (0.02 to 0.07, 0.004 to 0.07, and 0.07 to 0.2 Bq/L), respectively. These concentrations are well below the DCGs for water of 100E-9, 50E-9, and 600E-9 μCi/ml (3.7, 1.9, and 22 Bq/L) for radium-226, thorium-232, and total uranium, respectively. All total uranium values are comparable to measured background levels (Subsection 4.1.5). Thorium-232 concentrations in general were marginally above background levels, and annual average radium-226 concentrations were slightly lower than background levels.

Groundwater samples were analyzed for pH, specific conductance, TOC, TOX, and metals. Annual average pH ranged from 6.3 to 8.9;

annual average specific conductance values ranged from 407 to 8810 μmhos/cm; annual average TOC concentrations ranged from 3 to 87 mg/L; and annual average TOX concentrations ranged from 20 to 240 μg/L. Aluminum, iron, lithium, boron, and zinc were regularly detected; generally, similar concentrations of these metals were found in both upgradient and downgradient wells. In addition, groundwater samples were analyzed during the third quarter for volatile and semivolatile organic compounds. Eight volatile compounds (trichloroethene, 1,1-dichloroethene, 1,2-dichloroethene, toluene, tetrachloroethene, 1,1,1-trichloroethane, chloroform, and vinyl chloride) and three semivolatile compounds [naphthalene, bis(2-chloroethyl)ether, and phenol] were detected in offsite wells. Three volatile compounds and one semivolatile compound were detected in samples from onsite wells.

3.2 APPLICABLE ENVIRONMENTAL PERMITS

The FFA for MISS provides, in conjunction with DOE policy, that all applicable permit conditions will be met even though no permit applications are required. CERCLA Section 121 provides the statutory authority for an exemption to permitting requirements for onsite CERCLA remedial actions.

As stated in the Section 2.0, DOE is assessing the need for a stormwater discharge permit at MISS. Should a determination be made that such a permit is necessary, the application process would begin in 1991.

3.3 ENVIRONMENTAL IMPACT STATEMENTS AND ENVIRONMENTAL ASSESSMENTS

As stated in Section 2.0, two NEPA documents are being generated for MISS. The first of these is the EIS, integrated into the CERCLA RI/FS. The RI/FS-EIS is scheduled for completion in 1994.

In addition to the EIS, documentation will be generated to justify a categorical exclusion for removal of contamination from MISS vicinity properties. This documentation is scheduled to be completed in September 1991 and incorporated into CERCLA EE/CAs to be completed for those vicinity properties that require such documentation.

3.4 SUMMARY OF ENVIRONMENTAL ACTIVITIES

A one-time sampling effort was conducted at MISS during the first quarter of 1990 to study gross alpha and gross beta concentrations in area groundwater. This sampling was conducted to determine whether the current sampling program was adequate or whether additional radionuclides or isotopic analyses should be added to the program. Table 3-1 is a summary of these data. In general, the gross alpha results are in agreement with the sum of the results of the primary analyses conducted (total uranium, radium-226, and thorium-232); although the sum of the primary analyses does not always equal the exact values of the gross radioanalyses, the data are consistent overall. Factors contributing to differences between the data are (1) the contribution of alpha-emitting daughters in the decay chain that are not included in the analysis list above and (2) poor counting statistics for gross alpha results when analyzing samples with very low concentrations of radionuclides. Some gross beta results were elevated as compared with isotopic analytical results, apparently because of the presence of potassium-40, a beta emitter and one of Earth's most abundant natural radionuclides. Potassium-40 concentrations will be quantified in 1991 to verify its contribution to gross beta results. Because gross alpha values did not vary a large amount (e.g., an order of magnitude), and because there is a large concentration of potassium-40 known to exist in the area groundwater, there is no indication of an immediate need to expand the isotopic analyses performed in the current program.

3.5 SELF-ASSESSMENTS

During 1990, DOE conducted two major self-assessments of the FUSRAP environmental monitoring program: the first in June by the

TABLE 3-1

SUMMARY OF GROSS ALPHA AND GROSS BETA RESULTS FOR MISS DURING FIRST QUARTER 1990

Sampling Location[a]	Gross Alpha[b]	Gross Beta[b]	Sum of Isotopic Analyses[b]
MISS-1B	<11	41	5
MISS-2A	<20	<11	6
MISS-2B	<16	<12	3
MISS-3A	<11	130	6
MISS-3B	<14	<15	2
MISS-4B	<15	150	4
MISS-5B	<22	1400	3
MISS-6A	<39	310	11
MISS-6B	<41	460	2
MISS-7B	<10	<14	8
B38W01S	<14	210	3
B38W02D	<12	<13	7
B38W14S	<10	<20	4
B38W14D	<11	240	6
B38W15S	<23	410	5
B38W15D	<14	96	9
B38W18D	<13	31	3

[a] Sampling locations are shown in Figure 4-4.

[b] Concentrations are given in E-9 µCi/ml.
Note: 1E-9 µCi/ml is equivalent to 0.037 Bq/L.

DOE Oak Ridge Operations Environmental Protection Division, the second in November by the DOE Headquarters Office of Environmental Audits. Findings from these two self-assessments focused on monitoring techniques, field documentation of monitoring events, and planning of environmental monitoring locations and events. As a result of the June assessment, corrective actions were developed and implemented before the next quarter's environmental monitoring. Actions remaining consist of developing environmental monitoring plans [required by DOE Order 5400.5 (DOE 1990b)] to document the logic behind the environmental monitoring networks for FUSRAP sites. Work on these plans is currently under way; they are scheduled to be published by December 1991.

4.0 RADIOLOGICAL ENVIRONMENTAL PROGRAM

MISS is not an active site; thus, the only "effluents" released from the site would result from contaminant migration.

Radiological environmental monitoring at MISS in 1990 included sampling for:

- Radon concentrations in air
- External gamma radiation exposure
- Radium-226, thorium-232, and total uranium concentrations in surface water, sediment, and groundwater

The monitoring systems included onsite, fenceline, and offsite stations to provide information on the site's potential effects on human health and the environment.

The information contained in this section of the report includes the quarterly radiological data for each sampling point, yearly averages, and trend information. The methodology for calculating the averages and standard deviations is provided in Appendix A.

Some of the quarterly results are reported using a "less than" (<) sign. This notation is used to denote results that are below the limit of sensitivity of the analytical method, based on a statistical analysis of parameters. For computing annual averages, quarterly values reported as less than a given limit of sensitivity are considered equal to that limit. All quarterly data are reported as received from the laboratory; all calculated values (i.e., averages and standard deviations) have been rounded off using standard rules for significant figures. Where appropriate, data are presented using powers of ten. The number following the "E" denotes the exponent (e.g., 3.2×10^{-1} is given as 3.2E-1).

The following subsections discuss the monitoring program for possible radioactive contaminant migration and results for 1990.

4.1 ENVIRONMENTAL MONITORING FOR RADIOLOGICAL CONTAMINANTS

4.1.1 Radon Monitoring

One potential pathway of radiation exposure from the uranium-238 decay series arises from inhalation of the short-lived radon and radon daughter products. Radon is a radioactive (alpha-emitting) gas that is very mobile in air. Radon monitoring is conducted at MISS to ensure compliance with environmental regulations.

Program description

Quarterly radon concentrations were measured using monitors that contain a piece of alpha-sensitive film enclosed in a small plastic two-piece cup. Radon diffuses through a seam or membrane (depending on the manufacturer of the detector) of the cup until the radon concentrations inside and outside the cup reach equilibrium. Alpha particles from the radioactive decay of radon and its daughters in the cup 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 (i.e., tracks/mm^2) is converted through calibration to the radon concentration in air.

Radon detectors are maintained at 2 onsite, 10 fenceline, and 3 offsite (background) locations, as shown in Figures 4-1 and 4-2. Detectors are spaced along the site boundary to ensure adequate detection capability under most atmospheric conditions.

To determine the radon flux from the storage pile, 30 charcoal canisters were placed on the pile. After the canisters had remained on the pile for 24 hours, they were removed, sealed, and shipped for analysis. No significant weather event that could conceivably have affected the sampling occurred in the three days prior to or during the sampling event. Because radon is a gas,

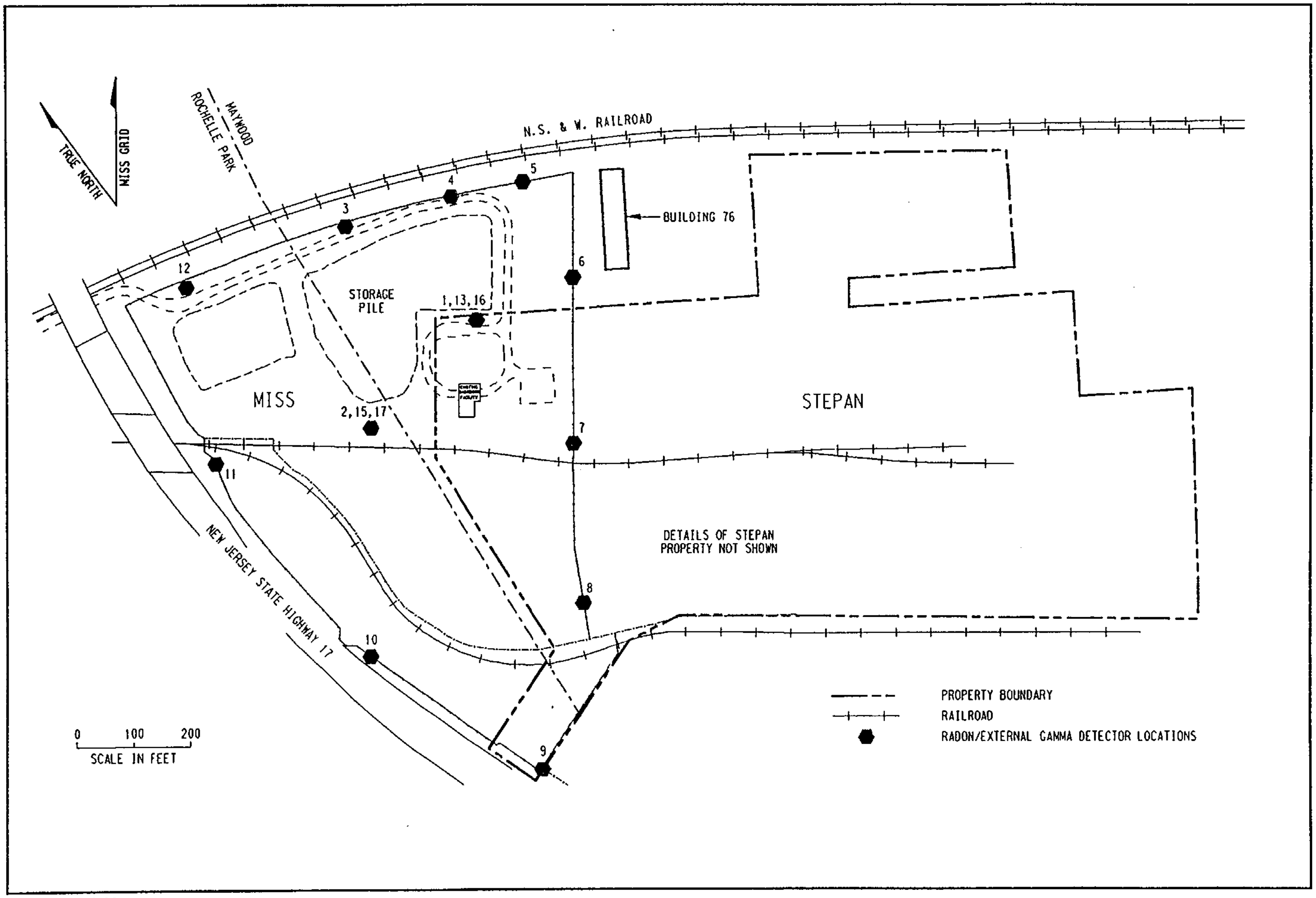


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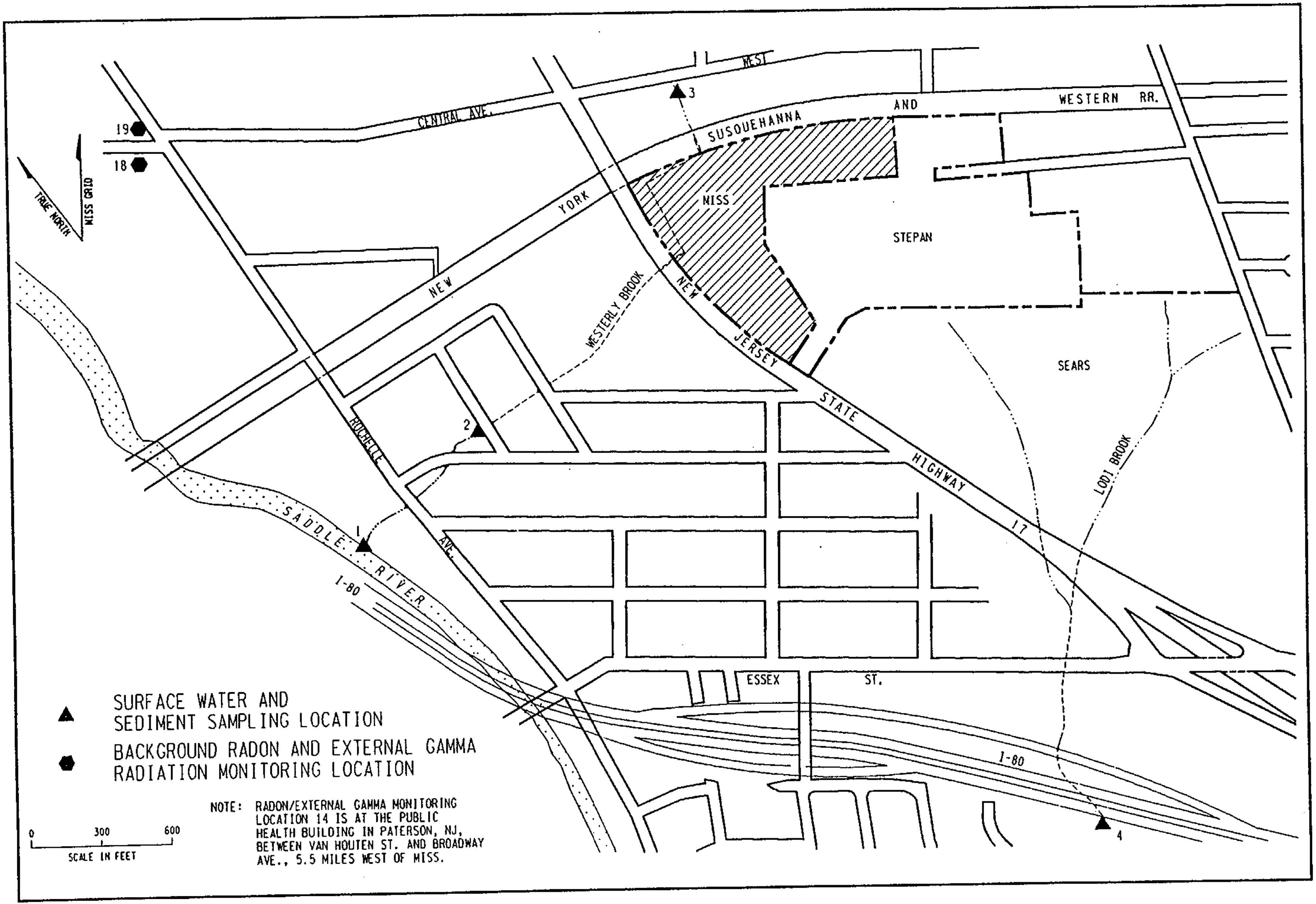
Figure 4-1
Onsite and Fenceline Radon and External Gamma Radiation Monitoring Locations at MISS



NOTE: RADON/EXTERNAL GAMMA MONITORING LOCATION 14 IS AT THE PUBLIC HEALTH BUILDING IN PATERSON, NJ, BETWEEN VAN HOUTEN ST. AND BROADWAY AVE., 5.5 MILES WEST OF MISS.

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Figure 4-2
Offsite Surface Water, Sediment, Radon, and External Gamma Radiation Monitoring Locations for the MISS Area

rain or snow could inhibit the normal radon flux rate and cause the resulting measurements to be lower than average.

Data and discussion

The maximum ambient radon concentration detected was 2.8E-9 μCi/ml (0.10 Bq/L) including background, at location 5, and annual average concentrations ranged from 0.3E-9 to 2E-9 μCi/ml (1E-9 to 7E-2 Bq/L) including background (see Table 4-1). No annual average concentration at the fenceline was greater than 67 percent of the DCG of 3.0 pCi/L (0.11 Bq/L).

The results of the radon flux monitoring demonstrated that the MISS pile had an average flux rate of 0.02 $pCi/m^2/s$ (7E-4 $Bq/m^2/s$) with minimum and maximum flux values of 0.01 and 0.2 $pCi/m^2/s$ (4E-4 and 7E-3 $Bq/m^2/s$), respectively. The MISS pile is in compliance with the limit of 20 $pCi/m^2/s$ (0.74 $Bq/m^2/s$) (an averaged value) specified in 40 CFR Part 61, Subpart Q.

Trends

Comparisons of annual average concentrations of radon in air measured from 1986 through 1990 are presented in Table 4-2. The expected value ranges shown are based on calculation of the standard deviation of the yearly means. The expected range provides a rough check on the occurrence of any trends or unexpected results. If the range varies a great deal from location to location, or if a station consistently falls above or below the expected range, then a trend could be present. Except for locations 5 and 10, average annual radon concentrations for 1990 fell within expected value ranges and standard deviations were consistent between monitoring locations, which are indications that there are no upward trends in radon concentrations at the site.

During the past five years, there has been an observable downward trend at locations 5 and 10. The downward trend at location 5 results from additional fill being placed in this area

TABLE 4-1

CONCENTRATIONS[a,b] OF RADON AT MISS, 1990

Sampling Location[c]	Quarter				Min	Max	Avg
	1	2	3	4			
Fenceline							
3	0.8	<0.3	<0.3	<0.2	0.2	0.8	0.4
4	0.9	0.6	<0.3	--[d]	0.3	0.9	0.6
5	2.8	0.5	0.9	2.5	0.5	2.8	2
6	0.6	<0.3	<0.3	0.2	0.2	0.6	0.4
7	0.8	<0.3	<0.3	<0.2	0.2	0.8	0.4
8	<0.3	<0.3	<0.3	<0.2	0.2	0.3	0.3
9	<0.3	<0.3	<0.3	0.2	0.2	0.3	0.3
10	0.7	0.3	<0.3	0.3	0.3	0.7	0.4
11	<0.3	0.4	<0.3	0.2	0.2	0.4	0.3
12	<0.3	0.5	<0.3	<0.2	0.2	0.5	0.3
Onsite							
1	0.5	<0.3	<0.3	0.2	0.2	0.5	0.3
2	1.0	0.3	<0.3	<0.2	0.2	1.0	0.5
Quality Control							
13[e]	1.1	0.4	<0.3	<0.2	0.2	1.1	0.5
15[f,g]	0.9	0.3	<0.3	<0.2	0.2	0.9	0.4
16[e,g]	<0.3	1.2	<0.3	<0.2	0.2	1.2	0.5
17[f,g]	0.8	1.3	<0.3	<0.2	0.2	1.3	0.7
Background							
14[h]	<0.3	<0.3	<0.3	--[d]	0.3	0.3	0.3
18[i]	0.4	0.5	<0.3	<0.2	0.2	0.5	0.4
19[j]	<0.3	<0.3	<0.3	<0.2	0.2	0.3	0.3

[a] Concentrations are given in units of E-9 µCi/ml.
Note: 1E-9 µCi/ml is equivalent to 0.037 Bq/L.

[b] Background has not been subtracted from the values given for fenceline and onsite stations. Note: Concentrations at some stations were lower than background levels.

[c] Sampling locations are shown in Figures 4-1 and 4-2.

[d] Detector was damaged.

[e] Quality control for station 1.

[f] Quality control for station 2.

[g] Station added to the environmental monitoring program in 1990.

[h] Background detector located at the Department of Health, Paterson, approximately 8.8 km (5.5 mi) west of MISS.

[i] Background detector located at the Rochelle Park Fire Station, approximately 0.8 km (0.5 mi) northwest of MISS.

[j] Background detector located at the Rochelle Park Post Office, approximately 0.8 km (0.5 mi) northwest of MISS.

TABLE 4-2

TREND ANALYSIS FOR CONCENTRATIONS[a,b] OF RADON AT MISS, 1986-1990

Sampling Location[c]	Annual Average Concentration 1986	1987	1988	1989	1990	Average Value	Standard Deviation	Expected Range[d]
Fenceline								
3	1.2	1.5	0.6	0.4	0.4	0.8	0.4	0 - 2
4	1.6	1.1	1.9	0.9	0.6	1	0.5	0 - 2
5	9.9	9.7	7.4	1.0	2	6	4	0 - 10
6	1.9	2.4	1.4	0.6	0.4	1	0.8	0 - 3
7	0.9	1.1	0.8	0.6	0.4	0.8	0.2	0.4 - 1
8	0.8	1.0	0.4	0.4	0.3	0.6	0.3	0 - 1
9	0.9	1.1	0.5	0.5	0.3	0.7	0.3	0.1 - 1
10	6.5	4.9	1.0	0.6	0.4	3	3	0 - 9
11	1.3	0.8	0.8	0.5	0.3	0.7	0.3	0.1 - 1
12	2.6	2.3	1.1	0.8	0.3	1	0.9	0 - 3
Onsite								
1	0.6	0.7	0.6	0.4	0.3	0.5	0.2	0.1 - 0.9
2	1.2	1.2	0.9	0.4	0.5	0.8	0.3	0.2 - 1
13[e]	1.2	1.1	0.4	0.5	0.5	0.7	0.3	0.1 - 1
Background								
14[f]	1.0	0.8	0.3	0.5	0.3	0.6	0.3	0 - 1
18[g]	--	--	--	0.4	0.4	0.4	0	0.4 - 0.4
19[h]	--	--	--	0.4	0.5	0.4	0	0.4 - 0.4

NOTE: Sources for 1986-1989 data are the annual environmental reports for those years (BNI 1987, 1988, 1989, 1990).

[a] Concentrations are given in units of E-9 µCi/ml. Note: 1E-9 µCi/ml is equivalent to 0.037 Bq/L.

[b] Measured background has not been subtracted from the values given for fenceline and onsite locations.

[c] Sampling locations are shown in Figures 4-1 and 4.2.

[d] Average value ±2 standard deviations.

[e] Station 13 is a quality control for station 1.

[f] Background detector located at the Department of Health, Paterson, approximately 8.8 km (5.5 mi) west of MISS.

[g] Background detector located at the Rochelle Park Fire Station, approximately 0.8 km (0.5 mi) northwest of MISS. Established in April 1988.

[h] Background detector located at the Rochelle Park Post Office, approximately 0.8 km (0.5 mi) northwest of MISS. Established in April 1988.

in the fall of 1987. The cause of the downward trend at location 10 is not known.

4.1.2 External Gamma Exposure Monitoring

External gamma radiation levels are measured as part of the routine environmental monitoring program to confirm compliance with environmental regulations.

Program description

Since 1988, the external gamma radiation monitoring system has used tissue-equivalent thermoluminescent dosimeters (TETLDs) to provide realistic values of radiation dose to the tissues of the body. When exposed to penetrating radiation (such as gamma or cosmic radiation), thermoluminescent materials absorb and store a portion of the energy. When the material is heated, the stored energy is released as light; the light is used to calculate an equivalent dose.

Each dosimetry station contains a minimum of four dosimeters. One dosimeter in each station will have been exposed for a full year at the end of each quarter, at which time the exposed dosimeter is exchanged with a new dosimeter. Each dosimeter contains five individual lithium fluoride chips preselected on the basis of having a reproducibility of ±3 percent across a series of laboratory exposures. The responses are averaged, and the average value is then corrected for the shielding effect of the shelter housing (approximately 8 percent). The corrected value is converted to milliroentgen per year (mR/yr). (In determining exposure, 1 mR/yr is approximately equal to 1 mrem/yr.)

External gamma radiation levels are measured at 2 onsite, 10 fenceline, and 3 offsite locations, as shown in Figures 4-1 and 4-2. Background radiation level detectors are stationed at the same locations as the background radon detectors.

Data and discussion

Although TETLDs are state of the art, the dosimeter accuracy is approximately ±10 percent at levels between 100 and 1000 mR/yr and ±25 percent at levels in the range of 70 mR/yr. Therefore, for the low levels that are being monitored at MISS (in the 60-120 mR/yr range), there can be seemingly large differences resulting from inaccuracies of detection and the processing system.

The results of external gamma radiation monitoring are presented in Table 4-3. The annual average exposure level at MISS in 1990 was 27 mR/yr onsite and 58 mR/yr at the fenceline; these values do not include a background value of 68 mR/yr. Information on public exposure can be found in Subsection 4.2.

The background external gamma radiation value for a given location is not constant because the value is affected by a combination of both natural terrestrial and cosmic radiation sources and by factors such as the location of the detector in relation to surface rock outcrops, stone or concrete structures, or highly mineralized soil. Detectors are also influenced by site altitude, annual barometric pressure cycles, and the occurrence and frequency of solar flare activity (Eisenbud 1987).

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

For comparison, Figure 4-3 shows the average annual external radiation levels for locations onsite, at the site fenceline, offsite, and the nation. Based on these data, the radioactive contamination at MISS does not present a health threat to the public from external gamma radiation because values are low and access to the material is restricted.

TABLE 4-3

AVERAGE EXTERNAL GAMMA RADIATION LEVELS[a,b] AT MISS, 1990

Sampling Location[c]	Quarter				Average
	1	2	3	4	
Fenceline					
3	21	13	20	10	16
4	84	74	82	--[d]	80
5	147	136	118	155	139
6	66	--[d]	50	45	54
7	1	30	7	0	10
8	12	10	12	6	10
9	12	13	12	0	9
10	164	138	160	136	150
11	30	26	34	32	31
12	72	81	80	96	82
Average					58
Onsite					
1	29	17	34	17	24
2	36	25	28	32	30
Average					27
Quality Control					
13[e]	22	25	23	15	21
15[f,g]	33	24	32	24	28
16[e,g]	24	22	28	22	24
17[f,g]	44	42	38	41	41
Average					29
Background					
14[h]	64	67	58	--[d]	63
18[i]	71	66	59	58	64
19[j]	84	76	70	81	78
Average					68

---

[a] Levels are given in units of mR/yr.

[b] Average annual background has been subtracted from readings taken at the fenceline and onsite sampling stations.

[c] Sampling locations are shown in Figures 4-1 and 4-2.

[d] TETLD missing.

[e] Quality control for station 1.

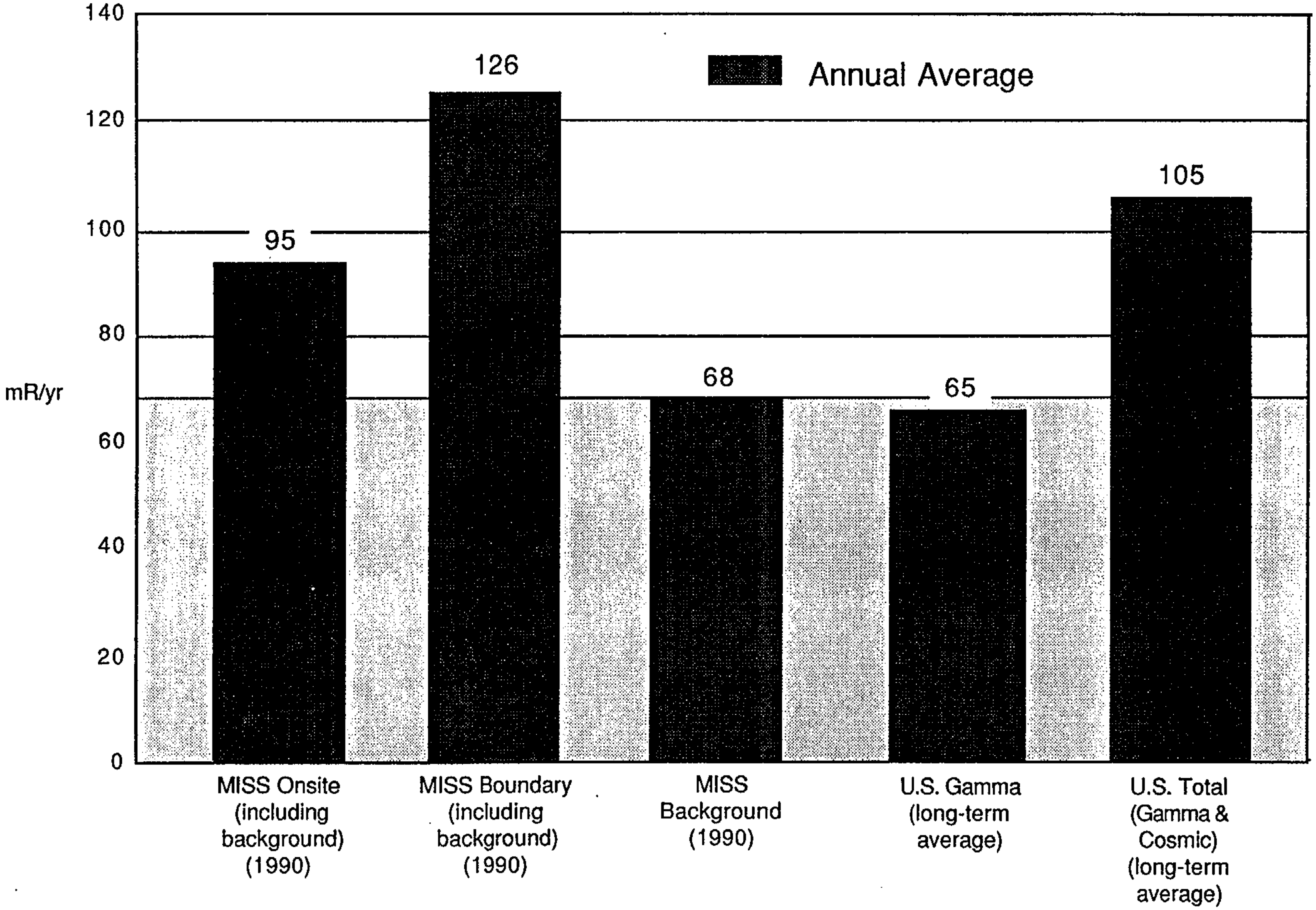
[f] Quality control for station 2.

[g] Station added to the environmental monitoring program in 1990.

[h] Background detector located at the Department of Health, Paterson, approximately 8.8 km (5.5 mi) west of MISS.

[i] Background detector located at the Rochelle Park Fire Station, approximately 0.8 km (0.5 mi) northwest of MISS.

[j] Background detector located at the Rochelle Park Post Office, approximately 0.8 km (0.5 mi) northwest of MISS.



The DOE guideline for external gamma exposure is 100 mrem/yr above background level (DOE 1990b). Note: 1 mrem is approximately equivalent to 1 mR.

Source: Martin Marietta Energy Systems, Inc., 1989. *Portsmouth Gaseous Diffusion Plant Site Environmental Report for 1988*, ES/ESH-8/V4, Oak Ridge, Tenn.

Figure 4-3
External Gamma Radiation Exposure Rates

4.53 4488.1

Trends

Comparisons of annual average external gamma exposure levels measured from 1986 through 1990 are presented in Table 4-4. The expected value ranges shown are based on calculation of standard deviation of the yearly means. The expected range provides a rough check on whether there are any trends present in the data. If the range varies a great deal from location to location, or if a location consistently falls outside the expected range, then a trend could be present. Though measurements at some locations are consistently higher or lower than others, the only potential trend exists in the 1987 to 1989 annual averages calculated for location 10. Small fluctuations seen from year to year can be attributed to fluctuations in background radiation levels and the accuracy of the TETLDs when measuring low exposure levels.

4.1.3 Surface Water Monitoring

Surface water monitoring is conducted to ensure compliance with environmental regulations and to determine whether runoff from MISS contributes to surface water contamination in the area.

Program description

Surface water samples were collected quarterly at sampling locations established on the basis of potential contaminant migration and discharge routes from the site. Sampling points were located both upstream (location 3), to establish background conditions; and downstream (locations 1, 2, and 4), to determine the effect of runoff from the site on the surface waters in the vicinity (Figure 4-2).

Surface water samples were analyzed for total uranium, radium-226, and thorium-232. Total uranium in surface water is typically measured using the fluorometric method, which has been proven to be a sensitive and dependable method for determining

TABLE 4-4

TRENDS ANALYSIS FOR EXTERNAL GAMMA RADIATION LEVELS[a,b] AT MISS, 1986-1990

Sampling Location[c]	Annual Average Level					Average Value	Standard Deviation	Expected Range[d]
	1986	1987	1988	1989	1990			
Fenceline								
3	38	29	21	29	16	27	7.6	12 - 42
4	91	69	109	112	80	92	16	60 - 120
5	172	121	186	154	139	154	23	110 - 200
6	83	67	85	68	54	71	11	49 - 93
7	24	36	16	13	9	20	10	0 - 40
8	18	37	30	9	10	20	10	0 - 40
9	23	39	32	17	9	20	10	0 - 40
10	496	521	317	173	150	331	156	19 - 643
11	50	61	59	35	31	47	12	23 - 71
12	88	79	106	90	82	89	9.4	70 - 110
Onsite								
1	41	36	40	28	24	34	6.7	21 - 47
2	51	43	52	35	30	42	8.7	25 - 59
13[e]	35	33	39	27	21	31	6.3	18 - 44
Background								
14[f]	63	58	78	63	63	65	6.8	51 - 79
18[g]	--	--	--	64	64	64	0	64 - 64
19[h]	--	--	--	56	78	67	11	45 - 89

NOTE: Sources of data for 1986-1989 are the site environmental reports for those years (BNI 1987, 1988, 1989, 1990).

[a] Levels are given in units of mR/yr.

[b] Average quarterly background has been subtracted from fenceline and onsite readings.

[c] Sampling locations are shown in Figures 4-1 and 4-2.

[d] Average value ±2 standard deviations.

[e] Station 13 is a quality control for station 1.

[f] Background detector located at the Department of Health, Paterson, approximately 8.8 km (5.5 mi) west of MISS.

[g] Background detector located at the Rochelle Park Fire Station, approximately 0.8 km (0.5 mi) northwest of MISS. Established in April 1988.

[h] Background detector located at the Rochelle Park Post Office, approximately 0.8 km (0.5 mi) northwest of MISS. Established in April 1988.

trace concentrations of uranium. The first step in the method is to dispense a measured aliquot of sample onto a flux pellet made of sodium fluoride and lithium fluoride. After the flux pellet is dried, the uranium is fused to the pellet by a rotary fusion burner. After cooling, the fluorescence of the fused pellet is measured by a fluorometer; the measured fluorescence is directly proportional to the concentration of total uranium in the sample as compared with spikes, standards, and blanks.

Radium-226 concentrations are determined by radon emanation. This method for detecting radon consists of precipitating radium-226 as sulfate and transferring the treated sulfate to a radon bubbler, where the radon-222 is allowed to come to equilibrium with its radium-226 parent. The radon-222 is then withdrawn into a scintillation cell and counted by the gross alpha technique. The quantity of radon-222 detected in this manner is directly proportional to the quantity of radium-226 originally present in the sample.

Thorium-232 concentrations are determined by the photon/electron-rejecting alpha liquid scintillation (PERALS) method. This method begins with the coprecipitation of radionuclides from a sample by using lead sulfate. Radium is separated onto barium sulfate and precipitated with diethylenetriamine-pentaacetate solution. Thorium is then separated sequentially from barium sulfate supernate by extraction into di(2-ethylhexyl)phosphoric acid. The thorium is then counted on the PERALS instrument. This method has approximately a 95 percent recovery rate for thorium in samples.

Data and discussion

Table 4-5 presents 1990 concentrations of total uranium, radium-226, and thorium-232 in surface water. Annual concentrations of total uranium averaged 2E-9 μCi/ml (7E-2 Bq/L) at the upstream location and 3E-9 μCi/ml (0.1 Bq/L) at downstream locations. The absence of elevated levels in the downstream locations may indicate that uranium is not migrating from the site

TABLE 4-5

CONCENTRATIONS[a] OF TOTAL URANIUM, RADIUM-226, AND THORIUM-232 IN SURFACE WATER AT MISS, 1990

Sampling Location[b]	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Min	Max	Avg
Total Uranium[c]							
1	<3	<3	<3	1.2	1.2	3	3
2	<3	<3	<3	1.3	1.3	3	3
3[d]	<3	<3	<3	0.7	0.7	3	2
4	<3	<3	<3	1	1	3	3
Radium-226							
1	0.2	0.1	0.6	0.1	0.1	0.6	0.3
2	0.1	0.2	0.6	0.1	0.1	0.6	0.3
3[d]	0.2	0.2	0.3	0.4	0.2	0.4	0.3
4	0.2	0.1	0.4	0.8	0.1	0.8	0.4
Thorium-232							
1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
2	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
3[d]	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
4	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1

[a] Concentrations are given in units of E-9 μCi/ml.
Note: 1E-9 μCi/ml is equivalent to 0.037 Bq/L.

[b] Sampling locations are shown in Figure 4-2.

[c] Uranium results for fourth quarter were determined by isotopic analysis instead of the fluorometric method.

[d] Upstream sampling location.

via surface water. Total uranium concentrations were well below the DCG of 600E-9 μCi/ml (22 Bq/L).

The annual average concentration of radium-226 was 0.3E-9 μCi/ml (1E-2 Bq/L) at the upstream location and ranged from 0.3E-9 to 0.4E-9 μCi/ml (1E-2 to 2E-2 Bq/L) at downstream locations. Radium-226 concentrations remained close to background throughout the year and were well below the DCG of 100E-9 μCi/ml (3.7 Bq/L).

Annual concentrations of thorium-232 averaged 0.1E-9 μCi/ml (4E-3 Bq/L) at both upstream and downstream locations. All concentrations remained close to background throughout the year and were well below the DCG of 50E-9 μCi/ml (1.9 Bq/L).

Trends

Comparisons of annual average radionuclide concentrations measured in surface water from 1986 through 1990 are presented in Table 4-6. The expected value ranges shown are based on calculation of standard deviation of the yearly means. The expected range provides a rough check on whether there are any trends present in the data. If the range varies a great deal from location to location, or if a location consistently falls outside the expected range, then a trend could be present. In general, the ranges were fairly consistent between data sets and quarterly results for 1990 fell within the expected range of values.

4.1.4 Sediment Monitoring

Sediment monitoring is conducted to determine whether contaminants are collecting in offsite sediment and to ensure compliance with environmental regulations.

Program description

Sediment samples were collected quarterly at surface water sampling locations where sediment is present. Sampling points were

TABLE 4-6

TREND ANALYSIS FOR TOTAL URANIUM, RADIUM-226, AND THORIUM-232 CONCENTRATIONS[a] IN SURFACE WATER AT MISS, 1986-1990

Sampling Location[b]	Annual Average Concentration					Average Value	Standard Deviation	Expected Range[c]
	1986	1987	1988	1989	1990			
Total Uranium[d]								
1	<3	<3	3	<5	3	3	0.9	2 - 5
2	<3	<3	4.3	<5	3	4	0.9	2 - 6
3[e]	<3	<3	3.8	<5	2	3	1	1 - 6
4[f]	--	--	--	<5[g]	3	--[h]	--[h]	--[h]
Radium-226								
1	0.4	0.4	0.4	0.3	0.3	0.4	0.1	0.3 - 0.5
2	0.4	0.2	0.3	0.3	0.3	0.3	0.1	0.2 - 0.4
3[e]	0.6	0.3	0.3	0.4	0.3	0.4	0.1	0.1 - 0.6
4[f]	--	--	--	0.4[g]	0.4	--[h]	--[h]	--[h]
Thorium-232								
1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	0.0	0.1 - 0.1
2	0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.0	0.1 - 0.1
3[e]	0.1	<0.1	0.1	<0.1	<0.1	0.1	0.0	0.1 - 0.1
4[f]	--	--	--	<0.1[g]	<0.1	--[h]	--[h]	--[h]

NOTE: Sources for 1986-1989 data are the site environmental reports for those years (BNI 1987, 1988, 1989, 1990).

[a] Concentrations are given in units of E-9 µCi/ml; all results include background. Note: 1E-9 µCi/ml is equivalent to 0.037 Bq/L.

[b] Sampling locations are shown in Figure 4-2.

[c] Average value ±2 standard deviations.

[d] Total uranium concentrations were typically determined by the fluorometric method.

[e] Location is upstream of MISS and represents background.

[f] Location established in July 1989.

[g] Value is a result of one sampling effort.

[h] Insufficient data to present meaningful values.

located upstream (location 3), to establish background conditions; and downstream (locations 1, 2, and 4), to determine the effect of the site on sediment in the vicinity (Figure 4-2).

Sediment samples were analyzed for total uranium, radium-226, and thorium-232. Radium-226, thorium-232, and isotopic uranium were eluted in solution, organically extracted, electroplated to a stainless steel disc, and counted by alpha spectrometry. Total uranium concentrations were calculated by summing the results for the isotopic uranium analyses.

Currently, there are no DCGs for radionuclides in sediment; therefore, sediment concentrations are compared with FUSRAP soil guidelines (Appendix C).

Data and discussion

Table 4-7 presents 1990 concentrations of total uranium, radium-226, and thorium-232 in sediment. The annual average concentration of total uranium was 1 pCi/g (0.04 Bq/g) at both upstream and downstream locations.

Annual average concentrations of radium-226 were 0.5 pCi/g (0.02 Bq/g) at the upstream location and ranged from 0.4 to 0.5 pCi/g (0.01 to 0.02 Bq/g) at downstream locations. Radium-226 levels remained close to background throughout the year and were below the FUSRAP soil guidelines.

Annual average concentrations of thorium-232 were 0.3 pCi/g (0.01 Bq/g) at the upstream location and ranged from 0.5 to 0.7 pCi/g (0.02 to 0.03 Bq/g) at downstream locations. Although thorium-232 concentrations slightly exceeded background levels, they remained below the FUSRAP soil guidelines.

Trends

Comparisons of annual average radionuclide concentrations measured in sediment from 1986 through 1990 are presented in Table 4-8. The expected value ranges shown are based on calculation of the standard deviation of the yearly means. The

TABLE 4-7

CONCENTRATIONS[a] OF TOTAL URANIUM, RADIUM-226, AND THORIUM-232 IN SEDIMENT AT MISS, 1990

Sampling Location[b]	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Min	Max	Avg
			Total Uranium[c]				
1	1.0	1.6	0.9	1.3	0.9	1.6	1
2	1.0	1.8	0.9	1.2	0.9	1.8	1
3[d]	0.9	1.1	0.9	1.3	0.9	1.1	1
4	1.0	1.3	1.6	1.2	1.0	1.6	1
			Radium-226				
1	0.4	0.4	0.4	0.5	0.4	0.5	0.4
2	0.3	0.9	0.3	0.7	0.3	0.9	0.5
3[d]	0.3	0.4	0.4	1.0	0.3	1.0	0.5
4	0.4	0.5	0.6	0.8	0.4	0.8	0.5
			Thorium-232				
1	0.4	0.7	0.4	0.5	0.4	0.7	0.5
2	0.5	1.0	0.1	0.5	0.1	1.0	0.5
3[d]	0.3	0.4	0.2	0.5	0.2	0.5	0.3
4	0.4	0.9	0.3	1.3	0.3	1.3	0.7

[a] Concentrations are given in units of pCi/g. Note: 1 pCi/g is equivalent to 0.037 Bq/g.

[b] Sampling locations are shown in Figure 4-2.

[c] Total uranium concentrations were determined by summing the concentrations of uranium-234, uranium-235, and uranium-238.

[d] Upstream sampling location.

TABLE 4-8

TREND ANALYSIS FOR TOTAL URANIUM, RADIUM-226, AND THORIUM-232 CONCENTRATIONS[a] IN SEDIMENT AT MISS, 1986-1990

Sampling Location[b]	Annual Average Concentration					Average Value	Standard Deviation	Expected Range[c]
	1986	1987	1988	1989	1990			
				Total Uranium[d]				
1	1.0	1.2	1.6	1.5	1	1	0.3	0.7 - 1.8
2	1.2	1.1	1.2	0.8	1	1	0.2	0.7 - 1.4
3[e]	0.8	1.1	1.0	1.7	1	1	0.3	0.4 - 1.8
4[f]	--	--	--	1.1[g]	1	--[h]	--[h]	--[h]
				Radium-226				
1	0.2	0.4	0.4	0.5	0.4	0.4	0.1	0.2 - 0.6
2	0.3	0.3	0.4	0.4	0.5	0.4	0.1	0.2 - 0.5
3[e]	0.4	0.4	0.3	0.6	0.5	0.4	0.1	0.2 - 0.7
4[f]	--	--	--	0.5[g]	0.5	--[h]	--[h]	--[h]
				Thorium-232				
1	0.7	0.4	0.4	0.3	0.5	0.5	0.2	0.2 - 0.8
2	0.7	0.3	0.5	0.3	0.5	0.5	0.2	0.1 - 0.8
3[e]	0.4	0.3	0.4	0.3	0.3	0.3	0.1	0.2 - 0.4
4[f]	--	--	--	1.5[g]	0.7	--[h]	--[h]	--[h]

NOTE: Sources of 1986-1989 data are the site environmental reports for those years (BNI 1987, 1988, 1989, 1990).

[a] Concentrations are given in units of pCi/g. Note: 1 pCi/g is equivalent to 0.037 Bq/g.

[b] Sampling locations are shown in Figure 4-2.

[c] Average value ±2 standard deviations.

[d] Total uranium was determined by summing concentrations of uranium-234, uranium-235, and uranium-238.

[e] Location is upstream of MISS.

[f] Location established in July 1989.

[g] Value is a result of one sampling effort.

[h] Insufficient data to present meaningful values.

expected range provides a rough check on whether there are any trends present in the data. If the range varies a great deal from location to location, or if a location consistently falls outside the expected range, then a trend could be present. All annual average concentrations of total uranium, radium-226, and thorium-232 in sediment for 1990 fell within the expected ranges and concentrations have remained fairly consistent over the past five years.

4.1.5 Groundwater Monitoring

Groundwater monitoring is conducted to provide information on potential migration of contaminants through the groundwater system and to ensure compliance with environmental regulations.

Program description

The groundwater monitoring program is designed to provide sufficient coverage of area groundwater conditions. Two groundwater systems (upper and lower) are monitored in the Maywood area. Wells in the upper groundwater system are identified with an "A" or "S"; those in the lower system are identified with a "B" or "D". Wells B38W01S and B38W02D are upgradient, to establish background conditions; all other wells are downgradient, to determine the effect of the site on groundwater in the vicinity (Figure 4-4).

Quarterly groundwater samples were analyzed for total uranium, radium-226, and thorium-232 in the same manner as surface water samples.

Sampling results

Table 4-9 presents 1990 concentrations of total uranium, radium-226, and thorium-232 in groundwater. Annual concentrations of total uranium were 3E-9 μCi/ml (0.11 Bq/L) at upgradient (background) locations, 3E-9 to 4E-9 μCi/ml (0.11 to 0.2 Bq/L) for

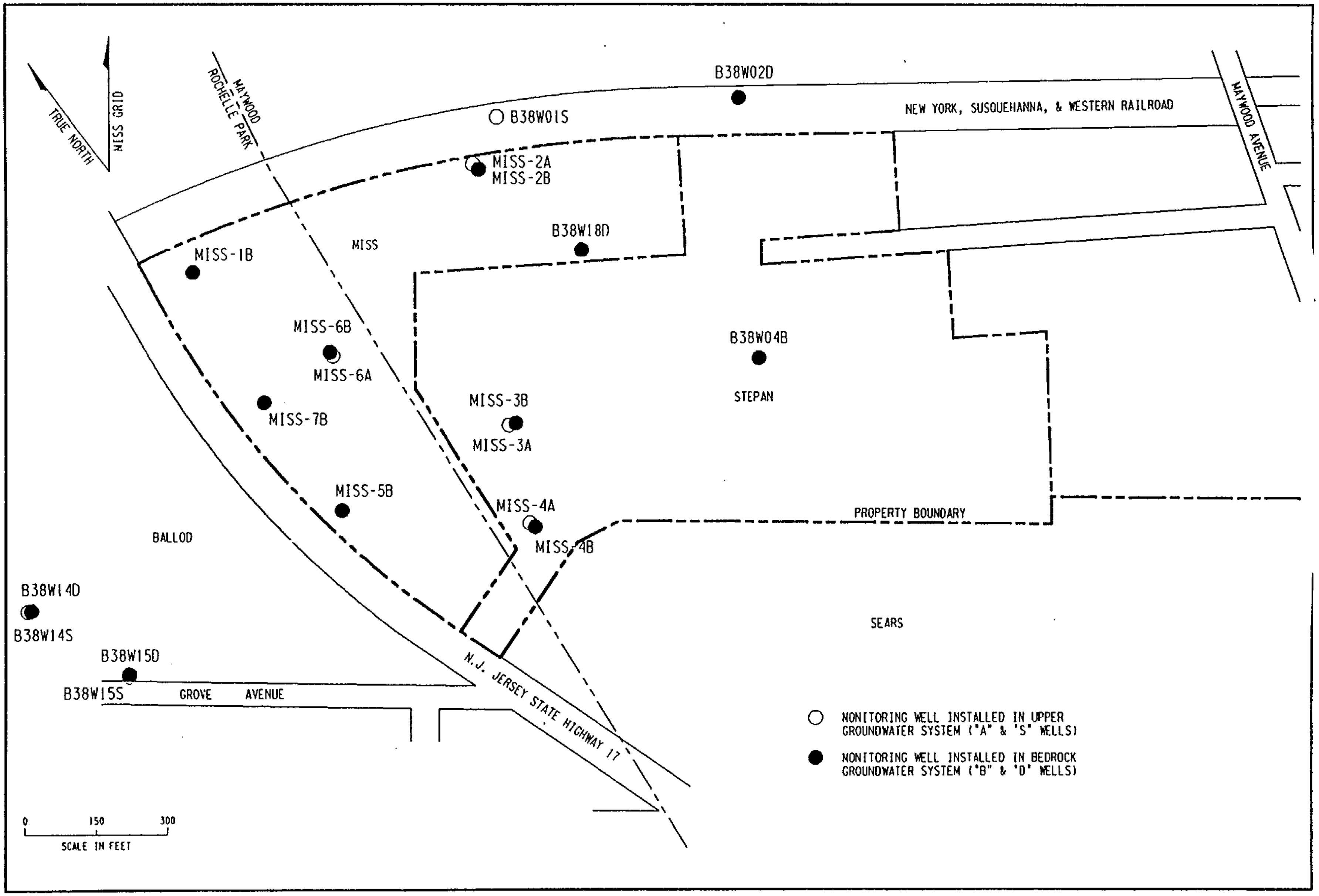


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Figure 4-4

Groundwater Wells Monitored for Radiological and Chemical Contamination in 1990

TABLE 4-9

CONCENTRATIONS[a,b] OF TOTAL URANIUM, RADIUM-226, AND THORIUM-232 IN GROUNDWATER AT MISS, 1990

Page 1 of 2

Sampling Location[c]	Quarter				Min	Max	Avg
	1	2	3	4			
			Total Uranium[d]				
MISS-1B	1.4	<3	<3	<3	1.4	3	3
MISS-2A	3.1	<3	<3	<3	3	3.1	3
MISS-2B	1	<3	<3	<3	1	3	3
MISS-3A	1.8	<3	<3	NA[f]	1.8	3	3
MISS-3B	0.9	<3	<3	NA	0.9	3	2
MISS-4A[e]	--	<3	--	<3	3	3	3
MISS-4B	1.8	<3	<3	<3	1.8	3	3
MISS-5B	1.6	<3	<3	<3	1.6	3	3
MISS-6A	8.9	6.1	<3	4.7	3	8.9	6
MISS-6B	1.1	<3	<3	<3	1.1	3	3
MISS-7B	7	<3	<3	<3	3	7	4
B38W04B[g]	<3	<3	<3	<3	3	3	3
B38W14S	2.9	<3	<3	2	2	3	3
B38W14D	4.7	<3	<3	2.7	2.7	4.7	3
B38W15S	2.7	<3	<3	1.2	1.2	3	3
B38W15D	7.3	<3	<3	<3	3	7.3	4
B38W18D	1.6	<3	<3	<3	1.6	3	3
Background							
B38W01S	1.3	<3	<3	<3	1.3	3	3
B38W02D	4	<3	<3	1	1	4	3
			Radium-226				
MISS-1B	1.9	0.2	0.4	0.2	0.2	1.9	0.7
MISS-2A	2.1	0.3	0.5	0.6	0.3	2.1	0.9
MISS-2B	1.3	0.3	0.3	0.3	0.3	1.3	0.6
MISS-3A	3	0.3	0.6	1	0.3	3	1
MISS-3B	1.2	0.2	0.4	0.2	0.2	1.2	0.5
MISS-4A[e]	--	0.2	--	3	0.2	3	2
MISS-4B	1.8	0.3	0.4	0.4	0.3	1.8	0.7
MISS-5B	1.3	0.2	0.4	0.3	0.2	1.3	0.6
MISS-6A	1.5	0.3	0.4	1	0.3	1.5	0.8
MISS-6B	0.9	0.2	0.3	0.4	0.2	0.9	0.5
MISS-7B	0.8	0.8	0.1	0.4	0.1	0.8	0.5
B38W04B[g]	0.2	0.3	0.7	0.3	0.2	0.7	0.4
B38W14S	1.2	0.1	0.4	0.3	0.1	1.2	0.5
B38W14D	1.3	0.1	0.4	0.3	0.1	1.3	0.5
B38W15S	2	0.4	0.3	0.3	0.3	2	0.8
B38W15D	1.2	<0.1	0.3	0.4	0.1	1.2	0.5
B38W18D	1.3	<0.1	0.4	0.1	0.1	1.3	0.5

TABLE 4-9
(continued)

Page 2 of 2

Sampling Location[c]	Quarter				Min	Max	Avg
	1	2	3	4			
			Radium-226 (cont'd)				
Background							
B38W01S	1	0.2	0.4	0.9	0.2	1	0.7
B38W02D	2.2	0.2	0.4	1	0.2	2.2	1
			Thorium-232				
MISS-1B	0.2	0.5	<0.6	<0.1	0.1	0.6	0.3
MISS-2A	0.7	<0.1	<0.2	0.2	0.1	0.7	0.3
MISS-2B	<0.2	<0.1	<0.3	<0.1	0.1	0.3	0.2
MISS-3A	1	<0.1	<0.1	0.1	0.1	1.0	0.3
MISS-3B	<0.2	<0.1	<0.1	<0.1	0.1	0.2	0.1
MISS-4A[e]	--	0.2	--	3	0.2	3	2
MISS-4B	<0.2	0.1	<0.2	<0.1	0.1	0.2	0.2
MISS-5B	<0.2	0.1	<0.1	<0.1	0.1	0.2	0.1
MISS-6A	0.8	0.2	<0.2	<0.2	0.2	0.8	0.4
MISS-6B	0.2	<0.1	<0.1	0.1	0.1	0.2	0.1
MISS-7B	<0.2	<0.3	<0.1	<0.1	0.1	0.3	0.2
B38W04B[g]	<0.2	<0.1	<0.1	<0.1	0.1	0.1	0.1
B38W14S	<0.2	<0.3	<0.2	<0.1	0.1	0.3	0.2
B38W14D	<0.2	<0.1	<0.2	<0.1	0.1	0.2	0.2
B38W15S	<0.3	<0.1	<0.1	<0.1	0.1	0.3	0.2
B38W15D	0.2	<0.1	<0.1	<0.1	0.1	0.2	0.1
B38W18D	<0.2	<0.1	<0.1	<0.1	0.1	0.2	0.1
Background							
B38W01S	0.2	<0.1	<0.2	0.1	0.1	0.2	0.2
B38W02D	0.5	1.8	<0.2	0.6	0.2	1.8	0.8

---

[a] Concentrations are given in units of E-9 µCi/ml.
Note: 1E-9 µCi/ml is equivalent to 0.037 Bq/L.

[b] Minimum detection limits sometimes vary as a result of inherent differences in detectors.

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

[d] During first quarter, total uranium was determined by alpha spectrometry. Except for the values for MISS-6A, B38W14S, B38W14D, and B38W15S, which were also determined by alpha spectrometry during fourth quarter, all values were determined by the fluorometric method.

[e] Shallow well to monitor groundwater in unconsolidated material. This well frequently does not contain water.

[f] NA - no analysis (sample lost in processing).

[g] Located at Stepan Company, approximately 61 m (200 ft) east of MISS wells 3A and 3B.

offsite downgradient wells, and 2E-9 to 6E-9 µCi/ml (0.07 to 0.2 Bq/L) at onsite downgradient locations. Total uranium concentrations were comparable to background levels and well below the DCG of 600E-9 µCi/ml (22 Bq/L).

Annual average concentrations of radium-226 ranged from 0.7E-9 to 1E-9 µCi/ml (0.03 to 0.04 Bq/L) at upgradient locations, 0.4E-9 to 0.8E-9 µCi/ml (0.02 to 0.03 Bq/L) for offsite wells, and 0.5E-9 to 2E-9 µCi/ml (0.02 to 0.07 Bq/L) at downgradient locations. Radium-226 concentrations were comparable to background levels and well below the DCG of 100E-9 µCi/ml (3.7 Bq/L).

Annual average concentrations of thorium-232 in groundwater ranged from 0.2E-9 to 0.8E-9 µCi/ml (7E-3 to 0.03 Bq/L) at upgradient locations, 0.1E-9 to 0.2E-9 µCi/ml (4E-3 to 0.07 Bq/L) for offsite downgradient wells, and 0.1E-9 to 2E-9 µCi/ml (4E-3 to 0.07 Bq/L) at onsite downgradient locations. Thorium-232 concentrations only slightly exceeded background and were below the DCG of 50E-9 µCi/ml (1.9 Bq/L).

Trends

Comparisons of annual average radionuclide concentrations in groundwater measured from 1986 through 1990 are presented in Table 4-10. The expected value ranges shown are based on calculation of the standard deviation of the yearly means. The expected range provides a rough check on whether there are any trends present in the data. If the range varies a great deal from location to location, or if a location consistently falls outside the expected range, then a trend could be present.

Generally, slightly higher concentrations of uranium are found in wells installed in the upper groundwater system within the site boundary. Total uranium, radium-226, and thorium-232 concentrations in the deeper wells that are drilled to bedrock have remained relatively constant since 1986.

TABLE 4-10

TREND ANALYSIS FOR TOTAL URANIUM, RADIUM-226, AND THORIUM-232 CONCENTRATIONS[a] IN GROUNDWATER AT MISS, 1986-1990

Page 1 of 4

Sampling Location[b]	Annual Average Concentration					Average Value	Standard Deviation	Expected Range[c]
	1986	1987	1988	1989	1990			
Total Uranium[d]								
MISS-1B	1.6	3.3	2.4	2.2	3	3	0.7	1 - 4
MISS-2A	0.6	2.4	1.4	2.1	3	2	1	0 - 4
MISS-2B	0.5	2.1	0.8	1.0	3	3	1	0 - 4
MISS-3A	0.6	2.0	1.5	1.2	3	2	0.9	0 - 4
MISS-3B	0.3	3.3	1.3	0.8	2	2	1	0 - 4
MISS-4A[e]	--	--	3.9	5.5	3	4	1	2 - 7
MISS-4B	0.5	2.0	0.7	1.0	3	1	1	0 - 4
MISS-5B	0.3	1.5	0.7	1.5	3	1	1	0 - 4
MISS-6A	8.4	12.1	8.4	8.0	6	9	2	4 - 13
MISS-6B	0.8	2.2	1.1	1.2	3	2	0.9	0 - 4
MISS-7B	4.7	5.0	6.3	7.0	4	5	1	3 - 8
B38W04B[f]	--	--	0.8	0.9	3	2	1	0 - 4
B38W14S[g]	--	--	--	3.2	3	3	0.1	3 - 3
B38W14D[g]	--	--	--	4.1	3	4	0.8	2 - 5
B38W15S[g]	--	--	--	2.6	3	3	0.3	2 - 3
B38W15D[g]	--	--	--	4.8	4	4	0.6	3 - 6
B38W18D[g]	--	--	--	4.8	3	4	1	1 - 6
Background								
B38W01S[g]	--	--	--	2.0	3	3	0.7	1 - 4
B38W02D[g]	--	--	--	2.2	3	3	0.6	2 - 4

TABLE 4-10

(continued)

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Sampling Location[b]	Annual Average Concentration 1986	1987	1988	1989	1990	Average Value	Standard Deviation	Expected Range[c]
Radium-226								
MISS-1B	0.6	0.4	0.9	1.4	0.7	0.8	0.4	0 - 2
MISS-2A	0.5	0.4	1.0	1.3	0.9	0.8	0.4	0.1 - 2
MISS-2B	1.5	0.4	0.7	1.0	0.6	0.8	0.4	0 - 2
MISS-3A	0.6	0.6	1.2	1.6	1	1	0.4	0.2 - 2
MISS-3B	0.5	0.3	0.8	1.0	0.5	0.6	0.3	0.1 - 1
MISS-4A[e]	--	--	2.8	3.8	2	3	0.9	1 - 5
MISS-4B	0.4	0.5	1.4	1.3	0.7	0.9	0.5	0 - 2
MISS-5B	0.2	0.3	0.7	1.0	0.6	0.6	0.3	0 - 1
MISS-6A	0.4	0.5	2.0	1.3	0.8	1	0.7	0 - 2
MISS-6B	0.5	0.3	0.7	0.9	0.5	0.6	0.2	0.1 - 1
MISS-7B	0.4	0.3	1.5	0.8	0.5	0.7	0.5	0 - 2
B38W04B[f]	--	--	1.0	1.2	0.4	0.9	0.4	0 - 2
B38W14S[g]	--	--	--	1.0	0.5	0.8	0.4	0 - 2
B38W14D[g]	--	--	--	1.0	0.5	0.8	0.4	0 - 2
B38W15S[g]	--	--	--	1.2	0.8	1	0.3	0.4 - 1
B38W15D[g]	--	--	--	0.7	0.5	0.6	0.1	0.3 - 0.9
B38W18D[g]	--	--	--	0.7	0.5	0.6	0.1	0.3 - 0.9
Background								
B38W01S[g]	--	--	--	1.1	0.7	0.9	0.3	0.3 - 2
B38W02D[g]	--	--	--	0.9	1	1	0.1	0.8 - 1

TABLE 4-10

(continued)

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Sampling Location[b]	Annual Average Concentration					Average Value	Standard Deviation	Expected Range[c]
	1986	1987	1988	1989	1990			
Thorium-232								
MISS-1B	<0.2	<0.3	<0.3	<0.3	0.3	0.3	0	0.2 - 0.4
MISS-2A	<0.2	<0.1	0.4	0.5	0.3	0.3	0.2	0 - 0.6
MISS-2B	<0.2	<0.1	<0.3	0.3	0.2	0.2	0.1	0.1 - 0.4
MISS-3A	<0.2	<0.1	0.7	0.5	0.3	0.4	0.2	0 - 0.8
MISS-3B	<0.1	<0.2	<0.3	<0.2	0.1	0.2	0.1	0 - 0.3
MISS-4A[d]	--	--	1.6	3.4	2	2	0.9	0.4 - 4
MISS-4B	<0.1	<0.1	<0.2	<0.2	0.2	0.2	0.1	0.1 - 0.3
MISS-5B	<0.1	<0.1	<0.2	<0.3	0.1	0.2	0.1	0 - 0.3
MISS-6A	0.1	0.3	<0.2	0.5	0.4	0.3	0.2	0 - 0.6
MISS-6B	<0.2	<0.1	0.3	<0.2	0.1	0.2	0.1	0 - 0.3
MISS-7B	<0.2	<0.1	<0.3	<0.2	0.2	0.2	0.1	0.1 - 0.4
B38W04B[f]	--	--	<0.2	<0.2	0.1	0.2	0.1	0.1 - 0.3
B38W14S[g]	--	--	--	0.4	0.2	0.3	0.1	0 - 0.6
B38W14D[g]	--	--	--	0.3	0.2	0.3	0.1	0.1 - 0.4
B38W15S[g]	--	--	--	0.5	0.2	0.4	0.2	0 - 0.8
B38W15D[g]	--	--	--	<0.2	0.1	0.2	0.1	0 - 0.3
B38W18D[g]	--	--	--	0.3	0.1	0.2	0.1	0 - 0.5
Background								
B38W01S[g]	--	--	--	0.2	0.2	0.2	0	0.2 - 0.2
B38W02D[g]	--	--	--	0.3	0.8	0.6	0.4	0 - 1

NOTE: Sources of 1986-1989 data are the annual environmental reports for those years (BNI 1987, 1988, 1989, 1990).

TABLE 4-10

(continued)

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[a] Concentrations are given in units of E-9 μCi/ml. Note: 1E-9 μCi/ml is equivalent to 0.037 Bq/L.

[b] Sampling locations are shown in Figure 4-4.

[c] Average value ±2 standard deviations.

[d] Total uranium concentrations were determined by summing the concentrations of uranium-234, uranium-235, and uranium-238.

[e] Shallow well to monitor groundwater in unconsolidated material. This well frequently does not contain water.

[f] Located at Stepan Company, approximately 61 m (200 ft) east of MISS wells 3A and 3B. Added to monitoring program in April 1988 to represent background.

[g] Installed in late 1988.

4.2 POTENTIAL DOSE TO THE PUBLIC

This section contains information on exposures to a hypothetical maximally exposed individual and the general public from the radioactive materials at MISS. As expected for a relatively stable site such as MISS, all calculated doses were below the DOE guidelines. Doses to the general public 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. This distinction is important because external exposures occur only when a person is near the source of the radionuclides, but internal exposures begin as soon as radionuclides are taken into the body and continue as long as the radionuclides reside in the body. To assess the potential health effects of the materials stored at MISS, radiological exposure pathways were evaluated and radiation doses were calculated for a hypothetical maximally exposed individual and for the population within 80 km (50 mi) of the site. The pathways considered are surface water, groundwater, air, and direct exposure. Exposures from radon and radon daughters are not considered in these calculations (Appendix B). All doses presented in this section are estimated and do not represent actual doses. A summary is provided in Table 4-11.

4.2.1 Maximally Exposed Individual

The hypothetical maximally exposed individual is assumed to be an invalid living 60 m (200 ft) from the western boundary of the site. Using these assumptions, the following doses have been calculated.

Direct exposure

The yearly dose to a hypothetical person living 60 m (200 ft) from the western boundary of the site can be calculated by using the equation given in Appendix B for direct exposure. The

TABLE 4-11

SUMMARY OF CALCULATED DOSES[a] AT MISS, 1990

Type		Dose to Hypothetical Maximally Exposed Individual (mrem/yr)[b]	Collective Dose for Population Within 80 km of Facility (person-rem/yr)[b]
Direct gamma radiation[c]		1.3	--[d]
Drinking water		--[d]	--[d]
Ingestion		--[d]	--[d]
Air immersion		--[d]	--[d]
Inhalation[e]		8.3E-3	2.5
	Total	1.3	2.5
Background[f]		68	5.4E+6[g]
DOE guideline[h]		100	--[i]
Percent of guideline (excluding background)		1.3	--[i]

[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 background.

[d] Negligible contribution.

[e] Calculated using EPA's AIRDOS model (Version 3.0).

[f] Direct gamma exposure only.

[g] Calculated by the following: 68 mrem/yr x (7.9E+7 people).

[h] Source: DOE 1990b.

[i] No DOE guideline.

calculated dose for this hypothetical maximally exposed individual is 1.3 mrem/yr (0.013 mSv/yr), well below the DOE guideline of 100 mrem/yr (1 mSv/yr) above background. This is an extremely conservative approach because it does not account for any shielding from the building and it assumes that the maximally exposed individual spends 100 percent of his time at the property.

Drinking water

Only one pathway, either groundwater or surface water, is used to determine the maximally exposed individual's committed dose. The maximally exposed individual would obtain 100 percent of his drinking water from either surface water or groundwater in the vicinity of the site. Concentrations of total uranium, radium-226, and thorium-232 in surface water in the vicinity of MISS are essentially indistinguishable from normal background levels. Similarly, the concentrations of the radionuclides of concern in groundwater are also at background levels. Therefore, the dose contribution of these radionuclides from surface water or groundwater to the hypothetical maximally exposed individual is negligible.

Air

To calculate a conservative dose to the hypothetical maximally exposed individual, it was assumed that the individual lived and worked within 60 m (200 ft) of the site. Air doses determined using EPA's AIRDOS model were found to be negligible [8.3E-3 mrem/yr (8.3E-5 mSv/yr)], well below the 10 mrem/yr limit given in 40 CFR Part 61, Subpart H. The 1990 Clean Air Act compliance report is provided in Appendix H.

Total dose

The total dose for the hypothetical maximally exposed individual would be the sum of the doses calculated for each exposure pathway. When these doses are added together, the total dose is 1.3 mrem/yr (0.013 mSv/yr). This dose is comparable to the dose an individual would receive from one round-trip flight between New York and Los Angeles (Appendix F).

4.2.2 Population Dose

The collective dose that the general population living within 80 km (50 mi) of the site would receive is calculated as follows.

Direct exposure

Both distance from the site and intervening structures reduce direct gamma exposure from MISS. Given the low doses that the maximally exposed individual receives from direct gamma radiation, the dose to individuals farther from the site would be extremely small. Therefore, it is assumed that there is no detectable exposure to the general public.

Drinking water

Because there were no elevated levels of any of the radionuclides of concern detected in either the surface water or the groundwater, there should be no dose to the general public from either of these pathways.

Air

The AIRDOS model provides an effective dose equivalent for contaminants transported via the atmospheric pathway at different distances from the site (Table 4-12). 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 2.5 person-rem/yr (0.025 person-Sv/yr).

TABLE 4-12

MAXIMUM EFFECTIVE DOSE TO THE GENERAL PUBLIC FROM MISS, 1990

Distance from the Site (m)	Effective Dose Equivalent (mrem/yr)[a,b]	Population Dose (person-rem/yr)[c,d]
0 - 1,000	8.3E-3[e]	0.10
1,000 - 3,000	1.1E-3	0.11
3,000 - 10,000	1.8E-4	0.20
10,000 - 80,000	2.7E-5	2.1
	Total Dose	2.5

---

[a] To be conservative, the effective dose equivalent used for each range was that for the distance closest to the site. The DCG is 100 mrem/yr above background.

[b] Values were obtained using AIRDOS. Note: 1 mrem/yr is equivalent to 0.01 mSv/yr.

[c] A population density of 10,000 people/mi^2 (3.9E-3 people/m^2).

[d] Calculated using:
Population dose = population density x Π x [(outer radius)^2 - (inner radius)^2] x effective dose equivalent.

[e] Effective dose equivalent for 500 m.

Total population dose

The total population dose is the sum of the doses from all exposure pathways. Because the only pathway with a major contribution to the population dose is the atmosphere, the total population dose is equal to that given for the atmospheric pathway [2.5 mrem/yr (0.025 mSv/yr)]. The collective population dose is extremely small when compared with the collective population dose due to natural background gamma radiation of 5.4E+6 person-rem/yr (5.4E+5 person-Sv/yr) for the same population within 80 km (50 mi) of MISS.

5.0 NONRADIOLOGICAL ENVIRONMENTAL PROGRAM

The environmental monitoring program at MISS includes surface water, sediment, and groundwater monitoring for nonradiological parameters.

Nonradiological parameters are monitored as specified by EPA; DOE directives; federal, state, and local statutes, regulations, and requirements applicable to DOE; and the public.

MISS is not an active site; therefore, the only "effluents" from the site would be contaminant migration. Based on current site information, nonradiological contamination of the soil exists in localized areas and currently is not thought to pose a potential threat to human health or the environment.

Tables 5-1 and 5-2 give reporting limits for the metals and volatile and semivolatile organic compound analyses performed for MISS.

5.1 SURFACE WATER MONITORING

5.1.1 Program Description

Nonradiological surface water monitoring was initiated during the third quarter of 1990; sampling locations are shown in Figure 4-2. Surface water was sampled for the indicator parameters pH, specific conductance, TOC, and TOX and for metal content. In addition, volatile and semivolatile organics analyses were performed in the third quarter.

As the name implies, indicator parameters are gross indicators of the presence of contaminants and major changes in water chemistry. Specific conductance and pH provide an indication of the inorganic composition of water. Specific conductance measures the capacity of water to conduct an electrical current and, generally, increases with elevated concentrations of dissolved solids or salinity. Acidity or alkalinity of the water is expressed by pH. A change in pH affects the solubility and

TABLE 5-1
REPORTING LIMITS FOR METALS ANALYSES OF SURFACE WATER, SEDIMENT, AND GROUNDWATER AT MISS

Analyte	Reporting Limit for Sediment (mg/kg)	Reporting Limit for Water (μg/L)
Aluminum	40	200
Antimony	12	60.0
Arsenic		
(ICPAES[a] scan)	100	500
(Atomic absorption)	2	10
Barium	40	200
Beryllium	1	5.0
Boron	20	100.0
Cadmium	1	5.0
Calcium	1000	5000
Chromium	2	10.0
Cobalt	10	50.0
Copper	5	25.0
Iron	20	100
Lead		
(ICPAES scan)	100	500
(Atomic absorption)	1	5
Lithium	20	100
Magnesium	1000	5000
Manganese	3	15.0
Molybdenum	20	100
Nickel	8	40.0
Potassium	1000	5000
Selenium		
(ICPAES scan)	100	500
(Atomic absorption)	1	5
Silver	2	10.0
Sodium	1000	5000
Thallium		
(ICPAES scan)	100	500
(Atomic absorption)	2	10
Vanadium	10	50.0
Zinc	4	20.0

[a] ICPAES - Inductively coupled plasma atomic emission spectrophotometry.

TABLE 5-2

REPORTING LIMITS FOR ORGANIC CHEMICAL ANALYSES OF SURFACE WATER AND GROUNDWATER AT MISS

Page 1 of 3

Compound	Reporting Limit (µg/L)
Volatile Organic Compounds	
Chloromethane	10
Bromomethane	10
Vinyl chloride	10
Chloroethane	10
Methylene chloride	3
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
Trichloroethene	5
Dibromochloromethane	5
1,1,2-trichloroethane	5
Benzene	5
Trans-1,3-dichloropropene	5
Bromoform	5
4-methyl 1-2-pentanone	10
2-hexanone	10
Tetrachloroethene	5
1,1,2,2-tetrachloroethane	5
Toluene	5
Chlorobenzene	5
Ethylbenzene	5
Styrene	5
Xylene (total)	5

TABLE 5-2
(continued)

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Compound	Reporting Limit (μg/L)
Semivolatile Organic Compounds	
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
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

TABLE 5-2

(continued)

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Compound	Reporting Limit (μg/L)
Semivolatile Organic Compounds (cont'd)	
4-nitroaniline	50
4,6-dinitro-2-methylphenol	50
N-nitrosodiphenylamine (1)	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

mobility of chemical contaminants in water. TOC and TOX indicate organic content: TOC measures the total organic content of the water but is not specific to any contaminant, and TOX measures organic compounds containing halogens (e.g., halogenated hydrocarbons).

5.1.2 Data and Discussion

Annual average pH values at downstream locations ranged from 7.4 to 8.0; the annual average value at the upstream location was 7.4 (Table 5-3). Annual average values for specific conductance for downstream locations ranged from 486 to 596 μmhos/cm, and the upstream location had an annual average value of 681 μmhos/cm. Annual average TOC concentrations ranged from 5 to 8 mg/L at the downstream locations; the annual average at the upstream location was 5 mg/L. Annual average TOX concentrations ranged from 100 to 130 μg/L at downstream locations, and the annual average at the upstream location was 320 μg/L. Based on these indicator parameters, the surface water quality at the downstream locations is comparable to that upstream.

Analyses of the third- and fourth-quarter samples for metals showed that boron, calcium, iron, magnesium, manganese, sodium, and zinc were present in samples from all locations (Table 5-4). Downstream concentrations were comparable to upstream concentrations except for elevated levels of zinc in the upstream sample from the fourth quarter. The upstream sample for the fourth quarter also contained low levels of cadmium and copper, which were not found in the downstream samples. Three of the downstream sampling locations contained lithium and potassium, which were not detected in the upstream sample.

Four volatile compounds were detected in the third-quarter samples (Table 5-5): chloroform was detected at the upstream location at a concentration of 7 μg/L, and 1,2-dichloroethene (38 μg/L), trichloroethene (13 μg/L), and 1,1,2,2-tetrachloroethane were detected at downstream location 2. No semivolatile compounds were detected.

TABLE 5-3
ANALYTICAL RESULTS FOR INDICATOR PARAMETERS IN SURFACE WATER AT MISS, 1990

Sampling Location[a]	Quarter 3	Quarter 4	Min	Max	Avg
pH (standard units)					
1	8.3	7.7	7.7	8.3	8.0
2	7.4	7.4	7.4	7.4	7.4
3[b]	7.4	7.4	7.4	7.4	7.4
4	7.7	7.7	7.7	7.7	7.7
Specific Conductance (μmhos/cm)					
1	632	560	560	632	596
2	1040	111	111	1040	576
3[b]	779	582	582	779	681
4	589	383	383	589	486
Total Organic Carbon (mg/L)					
1	4	5	4	5	5
2	11	4	4	11	8
3[b]	3	7	3	7	5
4	4	5	4	5	5
Total Organic Halides (μg/L)					
1	79	120	79	120	100
2	87	95	87	95	91
3[b]	470	170	170	470	320
4	140	120	120	140	130

[a] Sampling locations are shown in Figure 4-2.

[b] Upstream sampling location.

TABLE 5-4

SUMMARY OF METAL CONCENTRATIONS[a] IN SURFACE WATER AT MISS, 1990

Sampling Location[b]	Metal	Quarter		Avg
		3	4	
1	Boron	147	254	201
	Calcium	58,300	118,0000	88,150
	Iron	<100	628	364
	Lithium	112	244	178
	Magnesium	13,600	12,100	12,850
	Manganese	143	629	386
	Potassium	6,760	12,100	9,430
	Sodium	50,500	51,100	50,800
	Zinc	45	69	57
2	Boron	227	244	236
	Calcium	92,700	102,000	97,350
	Iron	<100	1,290	695
	Lithium	618	620	619
	Magnesium	12,500	12,500	12,500
	Manganese	518	614	566
	Potassium	23,100	22,500	22,800
	Sodium	99,000	77,200	88,100
	Zinc	27	39	33
3[c]	Boron	111	183	147
	Cadmium	<5	5	5
	Calcium	73,900	76,200	75,050
	Copper	<25	47	36
	Iron	<100	674	387
	Magnesium	8,890	7,930	8,410
	Manganese	220	330	275
	Sodium	69,100	40,800	54,950
	Zinc	56	43,700	21,878
4	Boron	101	113	107
	Calcium	54,600	57,000	55,800
	Iron	<100	510	305
	Magnesium	12,900	12,500	12,700
	Manganese	78	165	122
	Sodium	45,100	45,200	45,150
	Zinc	44	74	59

[a] Concentrations are reported in units of $\mu g/L$.

[b] Sampling locations are shown in Figure 4-2.

[c] Upstream sampling location.

TABLE 5-5
VOLATILE ORGANIC COMPOUNDS DETECTED[a] IN SURFACE WATER AT MISS DURING THIRD QUARTER 1990

Sampling Location[b]	Compound	Concentration (μg/L)
2	1,2-dichloroethene (total)	38
	Trichloroethene	13
	1,1,2,2-tetrachloroethane	42
3[c]	Chloroform	7

[a] No semivolatile compounds were detected.

[b] Sampling locations are shown in Figure 4-2.

[c] Upstream sampling location.

Based on the results of these analyses, it does not appear that MISS is adversely affecting the quality of the surface water at the Saddle River (location 1).

5.1.3 Trends

Data are currently insufficient to support a trend analysis.

5.2 SEDIMENT MONITORING

5.2.1 Program Description

Sediment samples collected during the fourth quarter from the same locations as those analyzed for radionuclides (Figure 4-2) were analyzed for the presence of metals.

5.2.2 Data and Discussion

Aluminum, chromium, copper, iron, manganese, and zinc were found in both upstream and downstream samples (Table 5-6). In general, concentrations in the downstream samples were comparable to those in the upstream sample; a notable exception was the relatively elevated level of iron found at location 4. Barium, cadmium, calcium, magnesium, nickel, silver, and vanadium were found in the upstream sample; these metals and lead were also found in some downstream samples. Because concentrations of most metals in both upstream and downstream samples were similar, it does not appear that MISS is contributing to metals in sediment.

5.2.3 Trends

Data are currently insufficient to support a trend analysis.

5.3 GROUNDWATER MONITORING

Nonradiological groundwater monitoring is conducted mainly to provide information on the groundwater quality in the area.

TABLE 5-6

ANALYTICAL RESULTS FOR METALS DETECTED IN SEDIMENT AT MISS, FOURTH QUARTER 1990

Page 1 of 2

Sampling Location[a]	Metal	Concentration (mg/kg)
1	Aluminum	3,600
	Chromium	25
	Copper	13
	Iron	6,070
	Lead	26
	Manganese	106
	Zinc	50
2	Aluminum	1,740
	Calcium	3,290
	Chromium	5
	Copper	35
	Iron	5,660
	Magnesium	1,890
	Manganese	95
	Nickel	11
	Silver	2
	Zinc	197
3[b]	Aluminum	4,640
	Barium	158
	Cadmium	3
	Calcium	6,460
	Chromium	21
	Copper	92
	Iron	11,200
	Magnesium	2,520
	Manganese	182
	Nickel	20
	Silver	4
	Vanadium	16
	Zinc	446
4	Aluminum	2,700
	Barium	68
	Cadmium	1
	Calcium	9,380
	Chromium	42

TABLE 5-6
(continued)

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Location	Metal	Concentration (mg/kg)
4 (cont'd)	Copper	125
	Iron	28,100
	Lead	696
	Magnesium	3,540
	Manganese	316
	Nickel	21
	Zinc	368

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[a] Sampling locations are shown in Figure 4-2.

[b] Upstream sampling location.

5.3.1 Program Description

Groundwater samples for nonradiological analyses are collected from the same locations as the radiological samples (Figure 4-4). Chemical analyses for the upgradient wells (B138W01S and B138W02D) provide background water quality data for MISS. Downgradient onsite and offsite wells are monitored for any potential impacts from the contaminants at the site on the groundwater in the vicinity. Groundwater was sampled quarterly for pH, specific conductance, TOC, TOX, and metal content. Analyses for volatile and semivolatile organics were also conducted during the third quarter.

5.3.2 Data and Discussion

Analytical results for indicator parameters show that the groundwater is of a quality that might be expected in a similar area of mixed residential/commercial establishments. Poor-quality groundwater is typical of industrial/urban areas. Annual average specific conductance ranged from 407 to 8810 μmhos/cm for onsite and offsite wells and from 457 to 2309 μmhos/cm for upgradient wells (Table 5-7). The annual average pH varied from slightly acidic (pH 6.3) to basic (pH 8.9). Annual average TOC levels ranged from 3 to 87 mg/L (upgradient ranged from 4 to 11 mg/L), and annual average TOX levels ranged from 20 to 240 μg/L (upgradient ranged from below detectable limits to 20 μg/L) (Table 5-8). Although a few quarterly TOC observations were considerably higher than those for the other three quarters (MISS-2A, first, third, and fourth quarters; MISS-2B, first and third quarters), comparison with previous years' data indicates that this is not unusual. Similarly, a few TOX values appear high relative to other quarterly data (MISS-1B, MISS-2A, and MISS-2B, first quarter; B38W04B and B38W14S, second quarter; MISS-5B, third quarter; and MISS-2B and B38W15S, fourth quarter). As is the case with TOC, this is not unusual.

TABLE 5-7
ANALYTICAL RESULTS FOR INDICATOR PARAMETERS IN GROUNDWATER AT MISS, 1990

Page 1 of 2

Sampling Location[a]	Quarter				Min	Max	Avg
	1	2	3	4			
Specific Conductance (μmhos/cm)							
MISS-1B	622	641	525	221	221	641	502
MISS-2A	6260	3900	4280	2620	2620	6260	4265
MISS-2B	9460	8740	8710	8330	8330	9460	8810
MISS-3A	568	550	603	412	412	603	533
MISS-3B	1410	1600	1490	398	398	1600	1225
MISS-4A	--[b]	1250	--[b]	878	878	1250	1064
MISS-4B	1160	1580	1230	629	629	1580	1150
MISS-5A	--[b]	--[b]	--[b]	1520	1520	1520	1520
MISS-5B	1980	1910	2140	1134	1134	2140	1791
MISS-6A	2020	2050	1520	881	881	2050	1618
MISS-6B	1680	838	1080	1288	838	1680	1222
MISS-7B	4470	3620	3420	1763	1763	4470	3318
B38W04B	--[c]	878	1040	--[c]	878	1040	959
B38W14S	693	699	680	379	379	699	613
B38W14D	536	411	442	239	239	536	407
B38W15S	1720	1160	1510	950	950	1720	1335
B38W15D	2270	316	288	793	288	2270	917
B38W18D	933	856	822	469	469	933	770
Background							
B38W01S	2520	2640	2450	1625	1625	2640	2309
B38W02D	502	486	490	351	351	502	457
pH (standard units)							
MISS-1B	7.7	7.3	7.6	8.7	7.3	8.7	7.8
MISS-2A	7.2	7.1	7.1	7.3	7.1	7.3	7.2
MISS-2B	6.6	8.3	7.7	6.9	6.6	8.3	7.4
MISS-3A	6.0	6.3	5.9	6.8	5.9	6.8	6.3
MISS-3B	6.6	6.4	6.4	6.9	6.4	6.9	6.6
MISS-4A	--[b]	5.8	--[b]	6.8	5.8	6.8	6.3
MISS-4B	6.5	7.0	7.0	7.6	7.0	7.6	7.0
MISS-5A	--[b]	--[b]	--[b]	7.4	7.4	7.4	7.4
MISS-5B	7.7	8.6	8.1	8.8	7.7	8.8	8.3
MISS-6A	7.0	6.7	6.8	7.8	6.7	7.8	7.1
MISS-6B	9.0	9.1	9.3	8.1	8.1	9.3	8.9
MISS-7B	8.2	7.6	8.0	9.3	7.6	9.3	8.3
B38W04B	--[c]	6.8	6.8	--[c]	6.8	6.8	6.8

TABLE 5-7
(continued)

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Sampling Location[a]	Quarter				Min	Max	Avg
	1	2	3	4			
			pH (standard units) (cont'd)				
B38W14S	7.4	7.2	7.4	8.1	7.2	8.1	7.5
B38W14D	7.7	7.3	7.5	8.2	7.3	8.2	7.7
B38W15S	6.6	7.7	7.4	8.3	6.6	8.3	7.5
B38W15D	6.6	8.0	7.7	8.2	6.6	8.2	7.6
B38W18D	6.5	6.2	6.1	6.6	6.1	6.6	6.4
Background							
B38W01S	11.4	11.3	10.9	6.9	6.9	11.4	10
B38W02D	7.6	7.4	7.6	8.1	7.4	8.1	7.7

[a] Sampling locations are shown in Figure 4-4.

[b] Well was dry.

[c] Data not collected.

TABLE 5-8

CONCENTRATIONS OF TOTAL ORGANIC CARBON AND TOTAL ORGANIC HALIDES IN GROUNDWATER AT MISS, 1990

Page 1 of 2

Sampling Location[a]	Quarter				Min	Max	Avg
	1	2	3	4			
Total Organic Carbon (mg/L)							
MISS-1B	5	3	3	31	3	31	11
MISS-2A	119	37	79	111	37	119	87
MISS-2B	47	10	53	27	10	53	34
MISS-3A	7	7	6	11	6	11	8
MISS-3B	8	6	5	11	6	11	8
MISS-4A	--[b]	11	--[b]	31	11	31	21
MISS-4B	14	14	11	14	11	14	13
MISS-5A	--[b]	--[b]	--[b]	15	15	15	15
MISS-5B	9	8	9	11	8	11	9
MISS-6A	30	6	7	19	6	30	16
MISS-6B	9	4	4	11	4	11	7
MISS-7B	3	2	3	4	2	3	3
B38W04B	--[c]	5	4	4	4	5	4
B38W14S	4	12	3	6	4	12	6
B38W14D	25	30	20	43	25	43	30
B38W15S	5	9	5	6	5	9	6
B38W15D	7	8	8	13	7	13	9
B38W18D	4	4	3	12	3	12	6
Background							
B38W01S	5	10	11	19	5	19	11
B38W02D	3	5	3	5	3	5	4
Total Organic Halides (μg/L)							
MISS-1B	260	72	32	80	32	260	111
MISS-2A	270	22	<20	120	20	270	108
MISS-2B	220	52	<20	250	20	250	174
MISS-3A	<20	30	<20	29	20	30	25
MISS-3B	41	32	22	44	22	44	25
MISS-4A	--[b]	20	--[b]	<20	20	20	20
MISS-4B	38	71	120	110	38	120	85
MISS-5A	--[b]	--[b]	--[b]	57	57	57	57
MISS-5B	160	30	490	110	30	490	198
MISS-6A	31	<20	<20	44	20	44	29
MISS-6B	69	<20	<20	47	20	69	39
MISS-7B	35	160	120	100	35	160	104
B38W04B	--[c]	470	140	110	110	470	240
B38W14S	76	240	92	26	26	240	109
B38W14D	140	21	<20	30	20	140	53

TABLE 5-8

(continued)

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Sampling Location[a]	Quarter 1	2	3	4	Min	Max	Avg
	Total Organic Halides (μg/L) (cont'd)						
B38W15S	100	20	27	240	20	240	97
B38W15D	83	74	23	30	23	83	53
B38W18D	<20	23	28	<20	20	28	23
Background							
B38W01S	21	<20	<20	<20	20	21	20
B38W02D	<20	<20	<20	<20	20	20	20

[a] Sampling locations are shown in Figure 4-4.
[b] Well was dry.

Organic sampling showed some chemical contaminants in both onsite and offsite wells (Table 5-9). Tetrachloroethene, vinyl chloride, and 1,2-dichloroethene (total) were found in onsite wells MISS-1B, MISS-4B, and MISS-7B at concentrations ranging from 10 to 180 μg/L. In addition, toluene, trichloroethene, 1,1-dichloroethene, and 1,1,1-trichloroethane were found in samples taken from offsite wells B38W04B, B38W14S, and B38W15S at concentrations ranging from 8 to 360 μg/L. A small amount of chloroform (5 μg/L) was also found in B38W14S. With the exception of chloroform, most of the organic constituents detected are halogenated solvents used as degreasers, dry cleaning agents, or chemical intermediates. The levels of contamination found in these groundwater samples are typical for an industrial area. Only three semivolatile organic compounds were found above detectable limits. Bis(2-chloroethyl)ether was detected in MISS-2B and B38W01S, and phenol was also found in B38W01S. Naphthalene was detected in B38W04B.

Concentrations of metals detected in groundwater at MISS during 1990 are presented in Table 5-10. No definite conclusions regarding metal contaminants may be drawn from the 1990 sampling results; although concentrations of some metals (notably sodium, calcium, potassium, magnesium, and manganese) seem relatively high, these levels are not unusual for industrialized areas and are common constituents that occur naturally in groundwater. Calcium and sodium were found in samples from all wells in all three quarters. In addition, aluminum, boron, chromium, iron, lithium, potassium, and zinc were detected with regularity. Manganese and magnesium were detected in samples from all wells during at least one sampling period. The metals were usually found in similar concentrations in both upgradient and downgradient wells, and no correlation between well location or aquifer sampled and concentration was apparent.

Although concentrations of some of these common elements appear high, they constitute a relatively large percentage of Earth's composition and are, therefore, expected to be present in relatively large amounts in groundwater.

TABLE 5-9

SUMMARY OF VOLATILE AND SEMIVOLATILE COMPOUNDS DETECTED IN GROUNDWATER AT MISS, 1990

Sampling Location[a]	Compound	Concentration ($\mu g/L$)
	Volatile Compounds	
MISS-1B	Tetrachloroethene	10
MISS-4B	Vinyl chloride	180
	1,2-Dichloroethene (total)	180
MISS-7B	1,2-Dichloroethene (total)	14
	Tetrachloroethene	29
B38W04B	Toluene	25
B38W14S	1,1-Dichloroethene	8
	1,2-Dichloroethene (total)	13
	Chloroform	5
	1,1,1-trichloroethane	13
	Trichloroethene	41
	Tetrachloroethene	260
B38W14D	Tetrachloroethene	23
B38W15S	Vinyl chloride	130
	1,1-Dichloroethene	7
	1,2-Dichloroethene (total)	360
	Semivolatile Compounds	
MISS-2B	Bis(2-chloroethyl)ether	40
B38W01S	Phenol	16
	Bis(2-chloroethyl)ether	10
B38W04B	Naphthalene	43

[a] Sampling locations are shown in Figure 4-4.

TABLE 5-10

SUMMARY OF METAL CONCENTRATIONS[a] IN GROUNDWATER AT MISS, 1990

Page 1 of 6

Sampling Location[b]	Metal	Quarter				Min	Max	Avg
		1[c]	2	3	4			
MISS-1B	Calcium		68,600	24,400	19,800	19,800	68,600	37,600
	Iron		<100	<100	3,310	100	3,310	1,170
	Lithium		<100	<100	121	100	121	107
	Magnesium		16,900	10,200	9,860	9,860	16,900	12,320
	Manganese		213	74	117	74	213	140
	Potassium		7,050	6,730	8,470	6,730	8,470	7,420
	Sodium		49,600	47,900	50,800	47,900	50,800	49,400
	Thallium		107	<100	<100	100	107	102
	Zinc		24	35	<20	20	35	26
MISS-2A	Aluminum		241	541	2,010	241	2,010	931
	Arsenic		5,900	2,590	2,350	2,350	5,900	3,613
	Boron		997	1,340	2,250	997	2,250	1,529
	Cadmium		<5	7	<5	5	7	6
	Calcium		68,000	132,000	161,000	68,000	161,000	120,000
	Chromium		<10	208	365	10	365	194
	Copper		129	110	109	109	129	116
	Iron		140	1,180	3,920	140	3,920	1,747
	Lead		<100	<100	108	100	108	103
	Lithium		4,060	<100	9,310	100	9,310	4,490
	Magnesium		5,790	13,400	12,300	5,790	13,400	10,500
	Manganese		25	57	147	25	147	76
	Potassium		<5,000	9,220	11,400	5,000	11,400	8,540
	Silver		13	<10	<10	10	13	11
	Sodium		876,000	831,000	1,000,000	831,000	1,000,000	902,333
	Zinc		49	67	23	23	67	46
MISS-2B	Boron		5,220	5,370	--[d]	5,220	5,370	5,300
	Calcium		47,000	108,000	--	47,000	108,000	77,500
	Chromium		25	28	--	25	28	27
	Iron		357	232	--	232	357	295
	Lithium		9,430	<100	--	100	9,430	4,770
	Magnesium		41,500	44,100	--	41,500	44,100	42,800
	Manganese		132	442	--	132	442	287
	Potassium		38,200	34,500	--	34,500	38,200	36,350
	Sodium		2,200,000	2,430,000	--	2,200 000	2,430,000	2,315,000
	Zinc		30	37	--	30	37	34
MISS-3A	Aluminum		<200	<200	1,970	200	1,970	790
	Boron		<100	<100	102	100	102	101
	Calcium		69,200	61,500	37,600	37,600	69,200	56,100
	Iron		235	15,900	29,700	235	29,700	15,280
	Lithium		124	<100	213	100	213	146

TABLE 5-10

(continued)

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Sampling Location[b]	Metal	Quarter 1[c]	Quarter 2	Quarter 3	Quarter 4	Min	Max	Avg
MISS-3A (cont'd)	Magnesium		8,010	6,760	<5,000	5,000	8,010	6,590
	Manganese		1,330	1,080	1,140	1,080	1,330	1,180
	Potassium		19,000	16,200	24,500	16,200	24,500	19,900
	Sodium		12,300	13,700	23,500	12,300	23,500	16,500
	Zinc		37	90	31	31	90	53
MISS-3B	Boron		139	104	<100	100	139	114
	Calcium		279,000	262,000	81,400	81,400	279,000	207,467
	Iron		<100	20,400	36,300	100	36,300	18,933
	Lithium		<100	<100	116	100	116	105
	Magnesium		14,000	13,100	<5,000	5,000	14,000	10,700
	Manganese		11,100	9,690	2,740	2,740	11,100	7,840
	Potassium		8,070	7,610	6,890	6,890	8,070	7,520
	Sodium		81,700	76,300	6,200	6,200	81,700	54,730
	Zinc		37	64	33	33	64	45
MISS-4A	Aluminum		<200	--[d]	55,000	200	55,000	27,600
	Barium		<200	--	466	200	466	333
	Boron		134	--	117	117	134	126
	Calcium		83,200	--	60,700	60,700	83,200	71,950
	Chromium		<10	--	72	10	72	41
	Copper		<25	--	81	25	81	53
	Iron		<100	--	85,000	100	85,000	42,550
	Magnesium		21,000	--	21,900	21,000	21,900	21,450
	Manganese		4,440	--	3,330	3,330	4,440	3,890
	Nickel		<40	--	60	40	60	50
	Potassium		35,700	--	38,600	35,700	38,600	37,150
	Sodium		52,000	--	44,700	44,700	52,000	48,350
	Vanadium		<50	--	57	50	57	54
	Zinc		97	--	258	97	258	178
MISS-4B	Boron		199	132	175	132	199	169
	Calcium		93,700	79,900	58,600	58,600	93,700	77,400
	Iron		<100	<100	351	100	351	184
	Magnesium		20,200	11,200	10,500	10,500	20,200	13,970
	Manganese		1,520	2,420	1,130	1,130	2,420	1,690
	Potassium		47,200	22,300	32,800	22,300	47,200	34,100
	Sodium		90,400	102,000	100,000	90,400	102,000	97,470
	Zinc		<20	30	<20	20	30	23
MISS-5B	Boron		451	391	453	391	453	432
	Calcium		17,200	69,900	64,100	17,200	69,900	50,400
	Iron		<100	<100	20,600	100	20,600	6,933

TABLE 5-10

(continued)

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Sampling Location[b]	Metal	Quarter 1[c]	2	3	4	Min	Max	Avg
MISS-5B (cont'd)	Lithium		1,510	<100	2,070	100	2,070	1,227
	Magnesium		17,400	18,400	18,400	17,400	18,400	18,070
	Manganese		48	146	360	48	360	185
	Potassium		291,000	242,000	275,000	242,000	291,000	269,000
	Sodium		140,000	111,000	132,000	111,000	140,000	127,000
	Zinc		184	67	46	46	184	99
MISS-6A	Aluminum		<200	<200	5,330	200	5,330	1,910
	Boron		796	836	1,340	796	1,340	991
	Cadmium		<5	<5	6	5	6	5
	Calcium		437,000	273,000	263,000	263,000	437,000	324,000
	Chromium		<10	<10	14	10	14	11
	Copper		36	35	358	35	358	143
	Iron		<100	<100	26,000	100	26,000	8,733
	Lithium		2,690	<100	5,980	100	5,980	2,923
	Magnesium		20,400	13,500	14,400	13,500	20,400	16,100
	Potassium		23,100	27,300	48,100	23,100	48,100	32,833
	Sodium		29,200	30,700	48,700	29,200	48,700	36,200
	Zinc		1,530	1,000	1,610	1,000	1,610	1,380
MISS-6B	Aluminum		<200	<200	302	200	302	234
	Boron		661	734	1,630	661	1,630	1,010
	Calcium		8,490	7,080	59,400	7,080	59,400	24,990
	Iron		<100	<100	5,860	100	5,860	2,020
	Lithium		4,420	<100	16,900	100	16,900	7,140
	Magnesium		<5,000	<5,000	8,210	5,000	8,210	6,070
	Manganese		16	<15	1,350	15	1,350	460
	Potassium		79,600	61,100	111,000	61,100	111,000	83,900
	Sodium		152,000	152,000	377,000	152,000	377,000	227,000
	Zinc		<20	109	<20	20	109	50
MISS-7B	Boron		434	421	554	421	554	470
	Cadmium		<5	33	<5	5	33	14
	Calcium		72,000	37,000	24,600	24,600	72,000	44,533
	Iron		<100	<100	27,100	100	27,100	9,100
	Lithium		1,980	<100	2,940	100	2,940	1,673
	Magnesium		33,800	24,100	1,650	1,650	33,800	19,850
	Manganese		720	153	386	153	720	420
	Potassium		17,100	15,300	20,100	15,300	20,100	17,500
	Sodium		714,000	638,000	751,000	638,000	751,000	701,000
	Zinc		<20	37	25	20	37	27

TABLE 5-10

(continued)

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Sampling Location[b]	Metal	Quarter				Min	Max	Avg
		1[c]	2	3	4			
B38W14S	Aluminum		<200	<200	1,730	200	1,730	710
	Calcium		84,400	84,500	87,500	84,400	87,500	85,467
	Chromium		<10	<10	443	10	443	154
	Copper		<25	<25	91	25	91	47
	Iron		<100	<100	12,300	100	12,300	4,167
	Magnesium		28,000	24,900	25,300	24,900	28,000	26,067
	Manganese		<15	25	1,490	15	1,490	510
	Nickel		<40	<40	98	40	98	59
	Potassium		<5,000	<5,000	5,480	5,000	5,480	5,160
	Sodium		19,200	15,200	15,700	15,200	19,200	16,700
	Vanadium		<50	<50	63	50	63	54
	Zinc		26	33	73	26	73	44
B38W14D	Aluminum		<200	<200	1,010	200	1,010	470
	Cadmium		<5	22	<5	5	22	11
	Calcium		44,600	52,400	53,900	44,600	53,900	50,300
	Chromium		<10	<10	11	10	11	10
	Copper		47	30	101	30	101	59
	Iron		782	1,220	1,800	782	1,800	1,267
	Magnesium		8,180	9,180	8,200	8,180	9,180	8,520
	Manganese		17	74	68	17	74	53
	Potassium		23,000	25,600	30,100	23,000	30,100	26,200
	Silver		<10	133	<10	10	133	51
	Sodium		16,000	16,800	18,100	16,000	18,100	17,000
	Zinc		38	40	176	38	176	85
B38W15S	Aluminum		<200	<200	1,010	200	1,010	470
	Boron		348	354	453	348	453	385
	Calcium		41,800	47,000	53,700	41,800	53,700	47,500
	Iron		<100	<100	2,030	100	2,030	743
	Lithium		951	<100	1,370	100	1,370	807
	Magnesium		15,500	16,700	18,500	15,500	18,500	16,900
	Manganese		1,010	1,170	1,390	1,010	1,390	1,190
	Potassium		117,000	121,000	122,000	117,000	122,000	120,000
	Sodium		175,000	184,000	177,000	175,000	184,000	178,667
	Zinc		<20	22	25	20	25	22

TABLE 5-10

(continued)

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Sampling Location[b]	Metal	Quarter				Min	Max	Avg
		1[c]	2	3	4			
B38W15D	Aluminum		<200	<200	677	200	677	359
	Boron		<100	<100	268	100	268	156
	Calcium		14,100	18,100	55,900	14,100	55,900	29,400
	Chromium		<10	<10	13	10	13	11
	Copper		43	64	27	27	64	45
	Iron		252	983	1,290	252	1,290	842
	Lithium		<100	<100	1,640	100	1,640	613
	Magnesium		<5,000	<5,000	20,600	5,000	20,600	10,200
	Manganese		<15	86	628	15	628	243
	Potassium		44,300	43,900	37,600	37,600	44,300	42,000
	Sodium		22,800	15,100	197,000	15,100	197,000	78,300
	Zinc		98	67	77	67	98	81
B38W18D	Boron		442	431	473	431	473	449
	Calcium		119,000	129,000	125,000	119,000	129,000	124,000
	Iron		<100	<100	3,130	100	3,130	1,110
	Lithium		2,010	<100	2,940	100	2,940	1,683
	Magnesium		11,300	11,600	11,200	11,200	11,600	11,367
	Manganese		2,820	2,760	2,910	2,760	2,910	2,830
	Nickel		44	<40	51	40	51	45
	Potassium		6,030	5,120	7,140	5,120	7,140	6,097
	Sodium		30,400	28,800	28,800	28,800	30,400	29,300
	Zinc		172	156	162	156	172	163
B38W01S	Aluminum		<200	<200	783	200	783	394
	Boron		424	391	653	391	653	489
	Calcium		268,000	298,000	388,000	268,000	388,000	318,000
	Iron		<100	<100	17,200	100	17,200	5,800
	Lithium		2,340	<100	3,120	100	3,120	1,853
	Magnesium		<5,000	<5,000	23,800	5,000	23,800	11,300
	Manganese		<15	<15	1,630	15	1,630	553
	Potassium		141,000	113,000	66,900	66,900	141,000	107,000
	Sodium		202,000	183,000	123,000	123,000	202,000	169,000
	Zinc		<20	<20	21	20	21	20

TABLE 5-10

(continued)

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Sampling Location[b]	Metal	Quarter				Min	Max	Avg
		1[c]	2	3	4			
B38W02D	Aluminum		<200	<200	6,830	200	6,830	2,410
	Barium		240	204	395	204	395	280
	Calcium		84,800	94,400	121,000	84,800	121,000	100,000
	Chromium		<10	<10	22	10	22	14
	Iron		<100	<100	7,590	100	7,590	2,500
	Magnesium		<5,000	<5,000	6,550	5,000	6,550	5,520
	Manganese		<15	<15	1,060	15	1,060	363
	Sodium		7,950	6,840	8,360	6,840	8,360	7,720
	Zinc		<20	<20	105	20	105	48
B38W04B	Boron		927	1,130	1,690	927	1,690	1,249
	Barium		226	260	339	226	339	275
	Calcium		75,400	8,190	89,900	8,190	89,900	57,830
	Iron		1,950	1,300	32,500	1,300	32,500	11,917
	Lithium		1,620	2,250	2,780	1,620	2,780	2,217
	Magnesium		8,770	9,130	9,060	8,770	9,130	8,987
	Manganese		10,400	10,100	9,600	9,600	10,400	10,033
	Sodium		68,800	76,200	73,800	68,800	76,200	72,933
	Zinc		<20	31	<20	20	31	24

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[a] Concentrations are reported in units of μg/L.

[b] Sampling locations are shown in Figure 4-4.

[c] Data not requested during the first quarter.

[d] Well was dry.

5.3.3 Trends

Indicator analyses such as TOC and TOX are used as gross indicators for the presence of organics. Because these parameters can fluctuate greatly between sampling events, trend analyses are not feasible. Consistently high TOC and/or TOX results would indicate the need for organic screening and analyses to identify concentrations of specific contaminants. If specific contaminants were routinely detected, trend analyses would be conducted. In cases where broad-screen organic analyses were performed to support a site characterization or remedial investigation, the data would be presented in the annual site environmental report, but trend analyses would not be performed.

5.4 SPECIAL ACTIVITIES

Mobile ion analyses were performed for groundwater, surface water, and sediment samples at MISS in the fourth quarter of 1990 to detect potential leaching of chemical constituents generated from previous manufacturing process into groundwater or surface water. Results of these analyses, as shown in Table 5-11, indicate that concentrations are low. Additional analyses will be performed in the future to monitor the mobility of these chemical constituents.

TABLE 5-11

SUMMARY OF MOBILE ION CONCENTRATIONS MEASURED IN GROUNDWATER, SURFACE WATER, AND SEDIMENT AT MISS, FOURTH QUARTER 1990

Sampling Location[a]	Parameter		
	Chloride	Nitrate	Phosphate
	Groundwater (mg/L)		
MISS-1B	96	0.4	<0.05[b]
MISS-2A	80	0.2	55
MISS-2B	<5.0[b]	0.2	<0.05[b]
MISS-3A	11	0.4	0.2
MISS-3B	10	0.2	0.08
MISS-4A	9	13	8
MISS-4B	29	0.2	6
MISS-5A	12	0.1	1
MISS-5B	98	0.2	0.2
MISS-6A	10	14	1
MISS-6B	44	0.2	1
MISS-7B	94	0.3	0.9
B38W01S	13	<0.1[b]	0.1
B38W02D	12	1	0.2
B38W04B	202	0.2	0.5
B38W14S	60	1	0.9
B38W14D	19	0.2	0.6
B38W15S	66	0.1	0.1
B38W15D	70	0.4	0.2
B38W18D	14	0.4	<0.05[b]
	Surface Water (mg/L)		
1	56	1	0.2
2	81	1	0.2
3[c]	172	4	0.06
4	<5.0[b]	2	<0.05[b]
	Sediment (mg/kg)		
1	--[b]	2	519
2	--[b]	2	211
3[c]	91	7	572
4	89	2	398

[a] Sampling locations are shown in Figures 4-2 and 4-4.

[b] Concentration is below the reporting limit.

[c] Upstream sampling location.

6.0 GROUNDWATER PROTECTION PROGRAM

6.1 HYDROGEOLOGICAL CHARACTERISTICS

6.1.1 Site Hydrogeology

MISS lies within the glaciated region of the Piedmont Plateau of north-central New Jersey (ANL 1984). The terrain is generally level but includes shallow ditches and small mounds (Cole 1981). The ground surface at MISS slopes westerly toward the Saddle River (the location of the Saddle River is shown in Figure 4-2).

The site is underlain by sedimentary bedrock (sandstone, mudstone, and siltstone) of the Triassic Brunswick Formation (Morton 1981, Carswell 1976). Bedrock is overlain by 0.9 to 4.6 m (3 to 15 ft) of weathered bedrock and unconsolidated glacial deposits of clay, silt, sand, and gravel. The depth of glacial deposits varies considerably in the vicinity of the site. In addition, fill materials consisting primarily of soil and building rubble were placed on the site during its many years of industrial use (Morton 1981).

Both the bedrock and the overlying unconsolidated material are sources of groundwater for the Maywood area. The differences in water levels of these two water-bearing units are seen in the hydrographs (Appendix E). During 1990, however, the differences were not as prominent as in past years. The water table of the upper groundwater system generally lies 1.2 to 3.7 m (4 to 12 ft) below the ground surface. Wells in this zone are screened in unconsolidated materials at depths of 0.8 to 6.7 m (2.5 to 22 ft). The potentiometric surface of the semiconfined bedrock groundwater system is from 2.1 to 5.2 m (7 to 17 ft) below the ground surface. Some of the wells in this zone are open holes with monitored intervals ranging from 5.19 to 17.8 m (17.0 to 58.5 ft). The other wells are screened at depths ranging from 4.03 to 15.4 m (13.2 to 50.5 ft).

6.1.2 Groundwater Quality and Usage

Groundwater obtained regionally from the Brunswick bedrock aquifer is moderately mineralized and is moderately to very hard. Water obtained from the unconsolidated deposits is highly variable in quality but commonly is not mineralized. Wells that draw from the unconsolidated surficial deposits generally have low yields and are used for domestic purposes. However, some wells located in areas with thicker surficial deposits of stratified glacial drift have high yields and have been developed for industrial and public uses (Carswell 1976).

A well canvass of the area within a 4.8-km (3-mi) radius of MISS conducted in 1987 and 1988 yielded records for 56 wells drilled between 1954 and 1987. Thirty-one of these wells were used for domestic purposes, 10 for irrigation, 11 for miscellaneous other uses, 1 for industrial purposes, and 1 as a water supply well for Smithwood Elementary School. Information was not available on two wells. No private wells that obtain water specifically for drinking were identified during the canvass.

6.2 GROUNDWATER MONITORING

6.2.1 Methods

The hydrogeological interpretations are based on groundwater levels measured weekly using an electric downhole water level indicator in 30 monitoring wells during 1990. Groundwater monitoring wells (Figure 6-1) were first installed at MISS in late 1984 through early 1985 (BNI 1985); additional wells were installed on properties surrounding MISS during 1987 and 1988. The 1984 bedrock wells are open holes (no screen or filter pack) below a steel surface casing that is set through the overburden and emplaced with a cement grout seal in the top of the Brunswick Formation. The newer (1987-1988) bedrock wells have stainless steel screens and sand filter packs installed in the bedrock; bentonite seals isolate the screened section from the upper groundwater system. Table 6-1 is a summary of construction

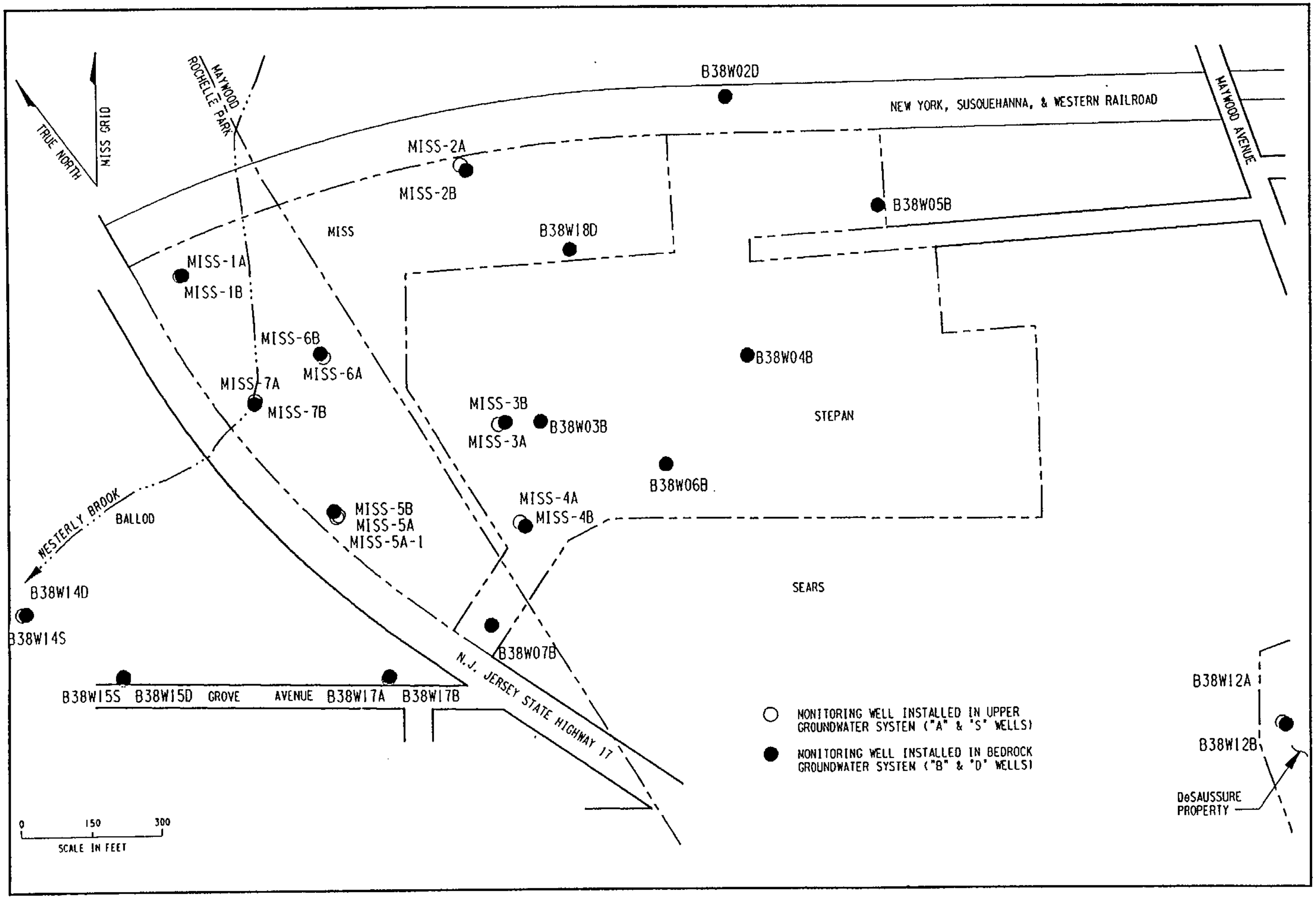

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Figure 6-1
Monitoring Wells Used for Water Level Measurements in 1990

TABLE 6-1

MONITORING WELL CONSTRUCTION SUMMARY FOR MISS

Well Number[a]	Completion Date	Total Depth [m (ft)]	Monitored Interval Below Ground Surface [m-m (ft-ft)]	Construction Material[b]
MISS-1A	Nov. 1984	3.66 (12.0)	1.6-3.47 (5.4-11.4)	PVC
MISS-1B	Nov. 1984	16.3 (53.5)	7.01-16.3 (23.0-53.5);[c] Open hole	Steel
MISS-2A	Oct. 1984	6.10 (20.0)	2.1-5.2 (6.9-16.9)	PVC
MISS-2B	Nov. 1984	17.8 (58.5)	8.7-17.8 (28.5-58.5);[c] Open hole	Steel
MISS-3A	Oct. 1984	4.57 (15.0)	2.0-3.6 (6.7-11.7)	PVC
MISS-3B	Nov. 1984	15.2 (50.0)	6.10-15.2 (20.0-50.0);[c] Open hole	Steel
MISS-4A	Oct. 1984	3.05 (10.0)	1.4-3.0 (4.7-9.7)	PVC
MISS-4B	Nov. 1984	14.3 (47.0)	5.19-14.3 (17.0-47.0);[c] Open hole	Steel
MISS-5A	Nov. 1984	4.58 (15.0)	3.2-4.5 (10.7-14.6)	PVC
MISS-5A1	Nov. 1984	2.4 (8.0)	0.9-2.4 (3.0-8.0)	PVC
MISS-5B	Nov. 1984	16.8 (55.0)	7.6-16.8 (25.0-55.0);[c] Open hole	Steel
MISS-6A	Oct. 1984	4.88 (16.0)	2.2-4.02 (7.2-13.2)	PVC
MISS-6B	Nov. 1984	16.2 (53.0)	7.02-16.2 (23.0-53.0);[c] Open hole	Steel
MISS-7A	Nov. 1984	3.51 (11.5)	1.4-2.9 (4.6-9.6)	PVC
MISS-7B	Nov. 1984	15.0 (49.0)	5.79-15.0 (19.0-49.0);[c] Open hole	Steel
B38W01S	Nov. 1988	7.02 (23.0)	5.20-6.7 (17.0-22.0)	SS
B38W02D	Nov. 1988	13.1 (43.0)	11.3-12.8 (37.0-42:0)	SS
B38W03B	Aug. 1987	12.3 (40.5)	9.09-12.1 (29.8-39.5)	SS
B38W04B	Sept. 1987	11.1 (36.3)	6.9-8.5 (22.7-27.7)	SS
B38W05B	Sept. 1987	13.6 (44.5)	6.92-10.1 (22.7-33.0)	SS
B38W06B	Sept. 1987	11.1 (36.4)	4.85-6.4 (15.9-20.9)	SS
B38W07B	Sept. 1987	12.0 (39.2)	5.64-8.8 (18.5-28.8)	SS
B38W12A	Oct. 1987	4.5 (14.0)	2.1-3.78 (7.4-12.4)	SS
B38W12B	Oct. 1987	15.3 (50.3)	10.5-13.7 (34.5-44.9)	SS
B38W14S	Nov. 1988	3.97 (13.0)	2.4-3.96 (8.0-13.0)	SS
B38W14D	Nov. 1988	15.6 (51.0)	14.0-15.4 (46.0-50.5)	SS
B38W15S	Oct. 1988	5.03 (16.5)	3.20-4.73 (10.5-15.5)	SS
B38W15D	Oct. 1988	14.0 (46.0)	12.2-13.7 (40.0-45.0)	SS
B38W17A	Oct. 1987	4.30 (14.1)	2.4-3.87 (7.7-12.7)	SS
B38W17B	Oct. 1987	13.5 (44.4)	5.67-8.81 (18.6-28.9)	SS
B38W18D	Oct. 1988	12.5 (41.0)	10.7-12.2 (35.0-40.0)	SS

[a] Wells installed in the upper groundwater system are designated with an "A" or "S"; wells installed in the bedrock groundwater system are designated with a "B" or "D".

[b] PVC - polyvinyl chloride; SS - stainless steel.

[c] Carbon steel casing extends through overburden and 0.6 m (2 ft) into bedrock; monitored interval is a 7.6-cm- (3.0-in.-) diameter open hole in bedrock.

Note: Water level elevations for wells monitored in 1990 are shown as hydrographs in Appendix E.

details for wells included in the monitoring program. An example of well construction details is provided in Appendix E. Further information on site geology, hydrogeology, and well installation methods can be found in reports by Carswell (1976) and BNI (1985, 1990).

Water level measurements from monitoring wells were used to prepare two types of graphic exhibits (hydrographs and potentiometric surface maps) that show hydrogeological conditions at the site. Hydrographs are line graphs that display changes in water levels for each monitoring well over a defined time interval. Precipitation records for MISS are not available; however, the MISS hydrographs include bar graphs of U.S. Weather Service precipitation records for the Middlesex, New Jersey, area as an aid in evaluating the influence of precipitation on water level behavior. Middlesex is located about 80 km (50 mi) southeast of Maywood.

The amount of slope (gradient) and flow direction of the MISS groundwater systems are determined from potentiometric surface (water level) maps. These maps are prepared by plotting water level measurements for selected dates (representative of each season) on a base map and contouring the values.

6.2.2 Results and Conclusions

All the hydrographs prepared for the water levels measured in 1990 are shown in Appendix E. Conclusions derived from these hydrographs and from the potentiometric surface maps are presented in the following subsections.

Upper groundwater system

Hydrographs from most of the wells screened in the upper groundwater system show slight seasonal fluctuations in groundwater levels. The levels generally tend to be highest in the spring and lowest in the fall and winter; the seasonal fluctuations are similar to those of 1989 (BNI 1990). Fluctuations of water levels in many wells are similar. In some wells, water level changes appear to be related to precipitation.

The gradient and flow direction of the upper groundwater system were determined from potentiometric surface maps plotted for dates representing all four seasons (Figures 6-2 through 6-5). The general groundwater flow direction at MISS is to the west. Water level readings at MISS-6A were anomalously low in the winter and spring (Figures 6-2 and 6-3). The gradient of the potentiometric surface was 0.010 in the winter and fall, and 0.011 in the spring and summer. The flow gradient, calculated using the western flow direction, was similar to that calculated for 1989 (BNI 1990).

Bedrock groundwater system

Some of the hydrographs from the wells screened in bedrock show slight seasonal fluctuations in groundwater levels. Generally, the levels tend to be highest in the spring and lowest in the fall, which repeats the seasonal fluctuations seen in 1989 (BNI 1990). Water level fluctuations in many of the wells are similar, and some fluctuations may be related to precipitation events.

The gradient and flow direction of the bedrock groundwater system were determined from potentiometric surface maps plotted for dates representing all four seasons (Figures 6-6 through 6-9). The general flow pattern for the bedrock groundwater system at MISS is to the west, similar to that of the upper groundwater system. The gradient of the potentiometric surface was 0.014 in the winter, spring, and summer, and 0.015 in the fall. The flow gradient, calculated using the western flow direction, was similar to that calculated for 1989 (BNI 1990).

As was the case in 1989, water levels from well B38W02D were anomalously high (BNI 1990) and were not included in the contour interpretation.

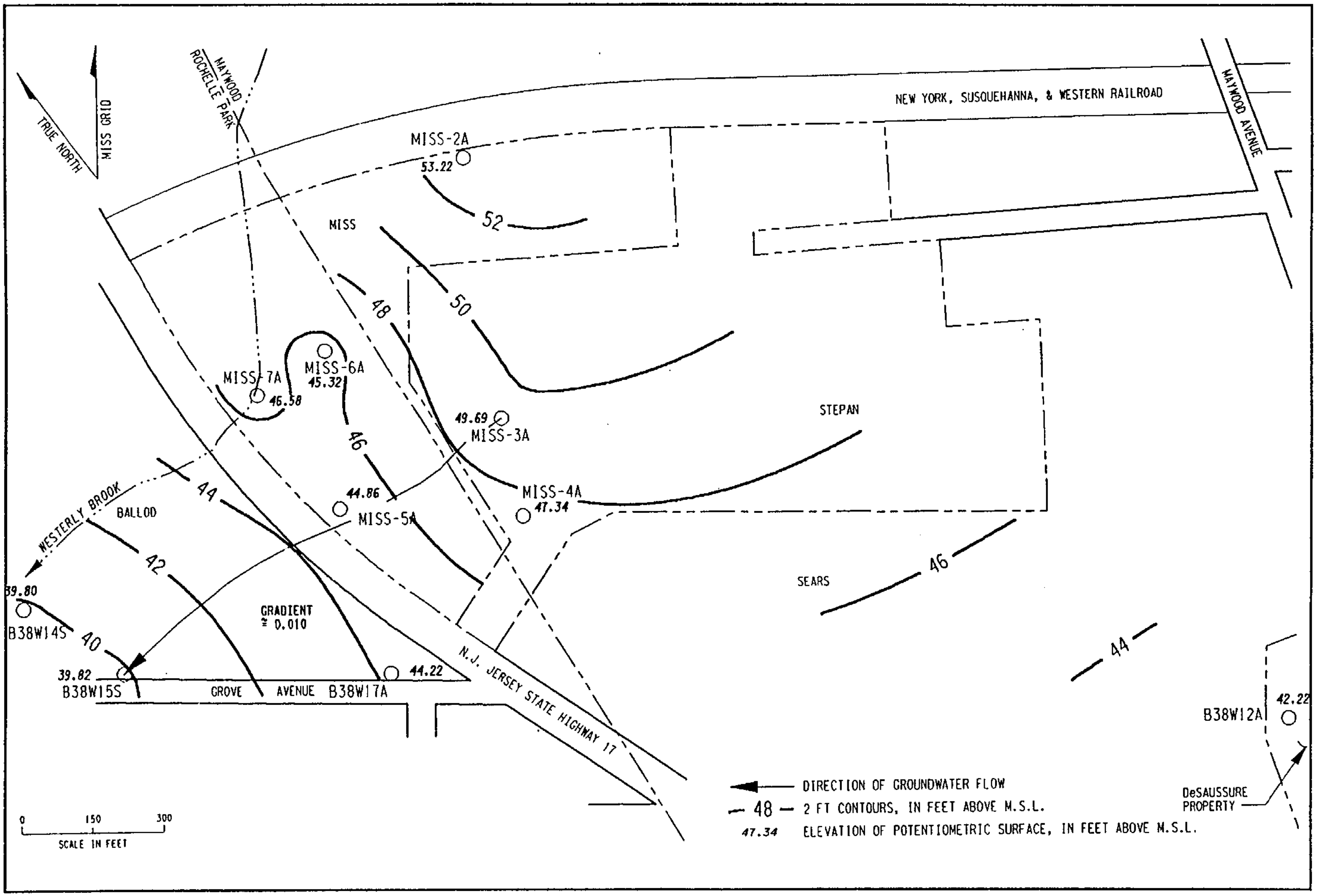

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Figure 6-2

Potentiometric Surface Map of the Upper Groundwater System at MISS (1/3/90)

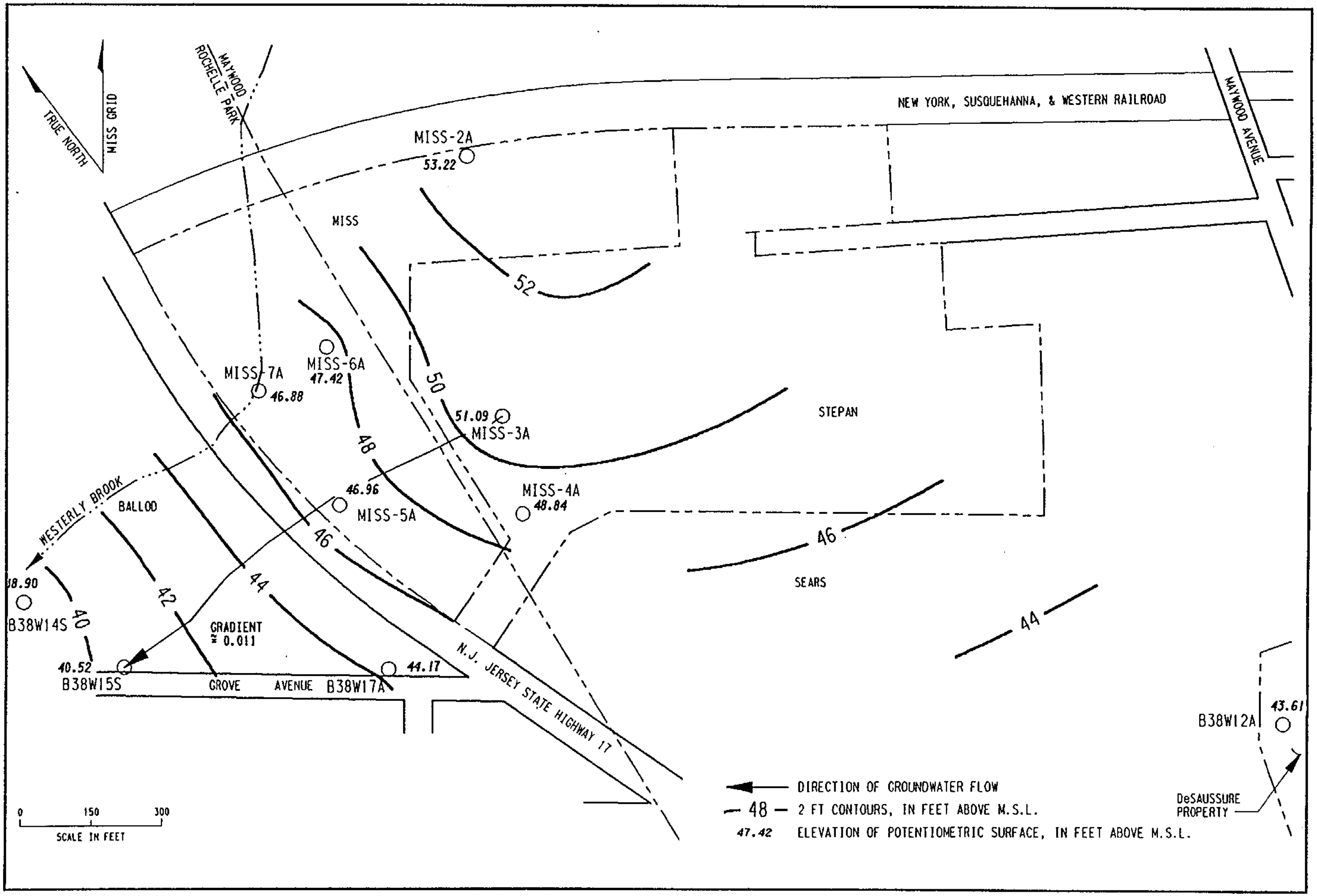

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Figure 6-3
Potentiometric Surface Map of the Upper Groundwater System at MISS (3/22/90)

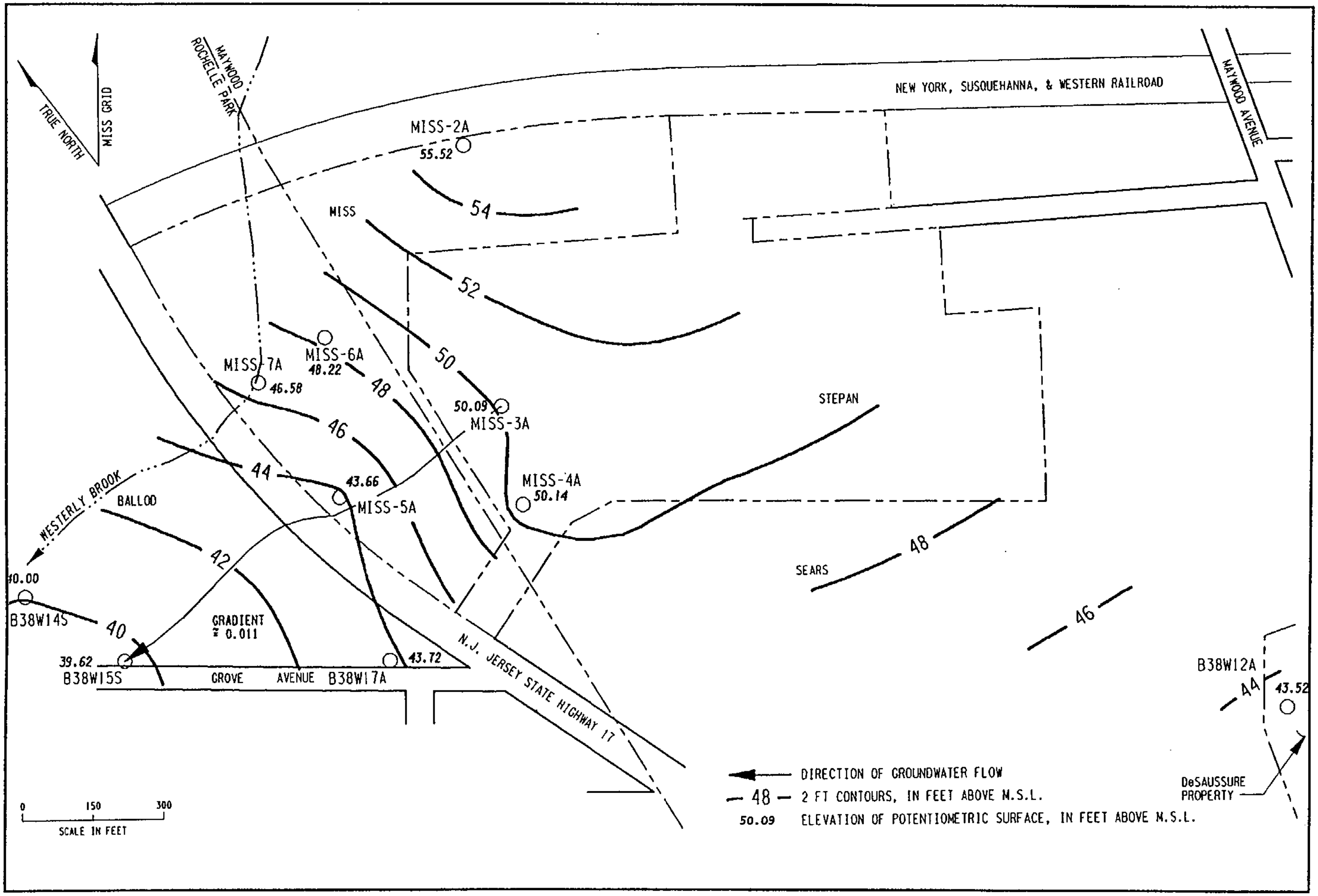

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Figure 6-4
Potentiometric Surface Map of the Upper Groundwater System at MISS (6/28/90)

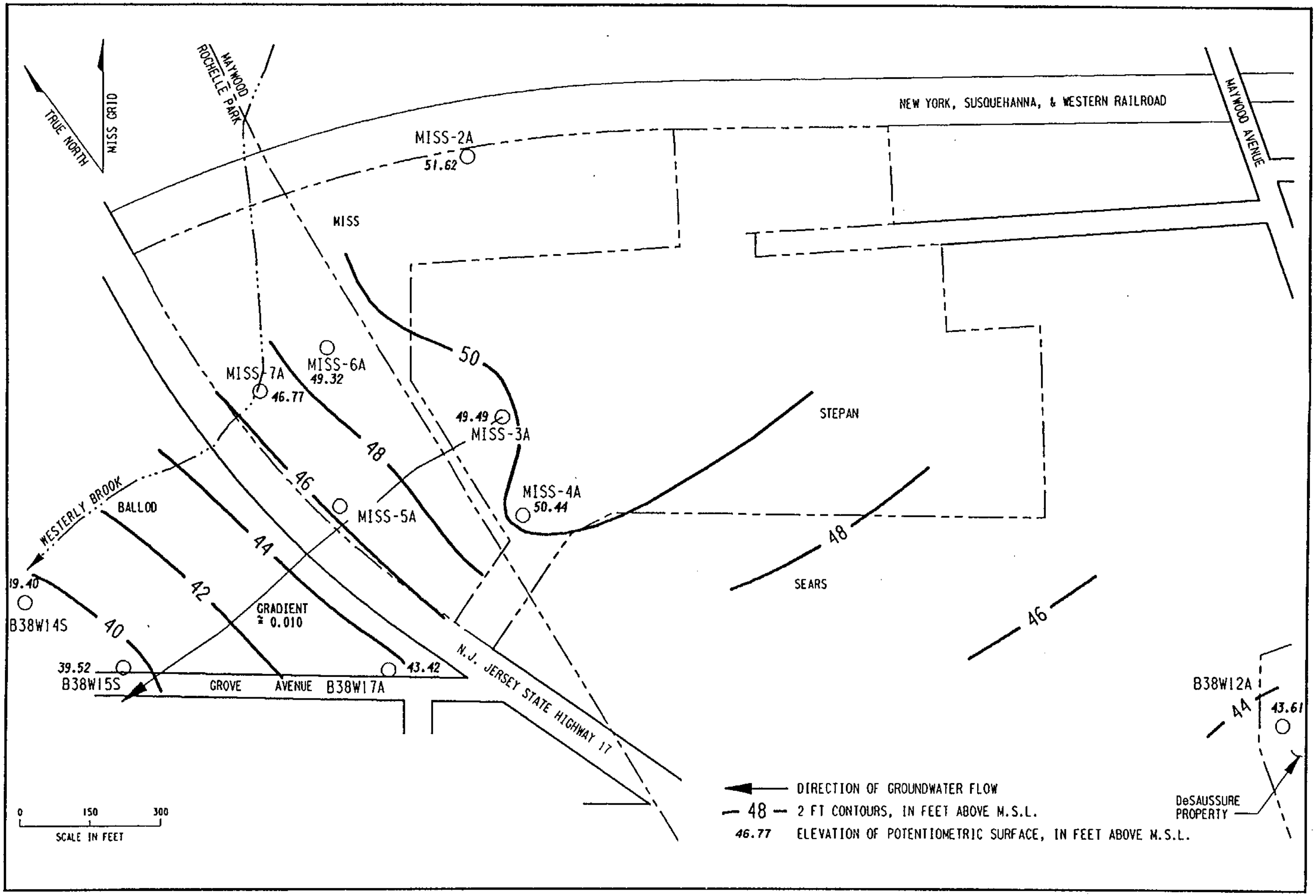

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Figure 6-5
Potentiometric Surface Map of the Upper Groundwater System at MISS (9/20/90)

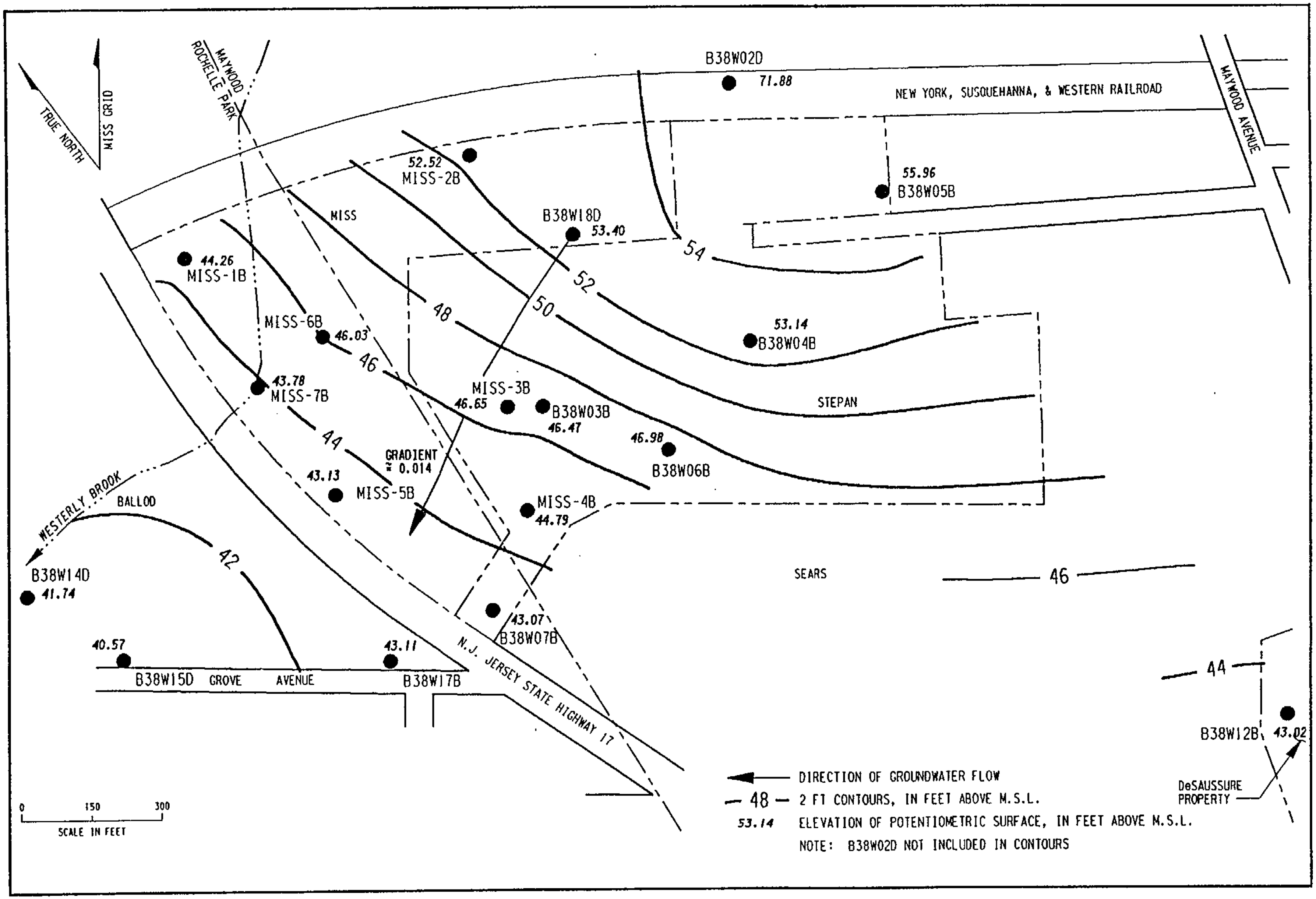

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Figure 6-6
Potentiometric Surface Map of the Bedrock Groundwater System at MISS (1/3/90)

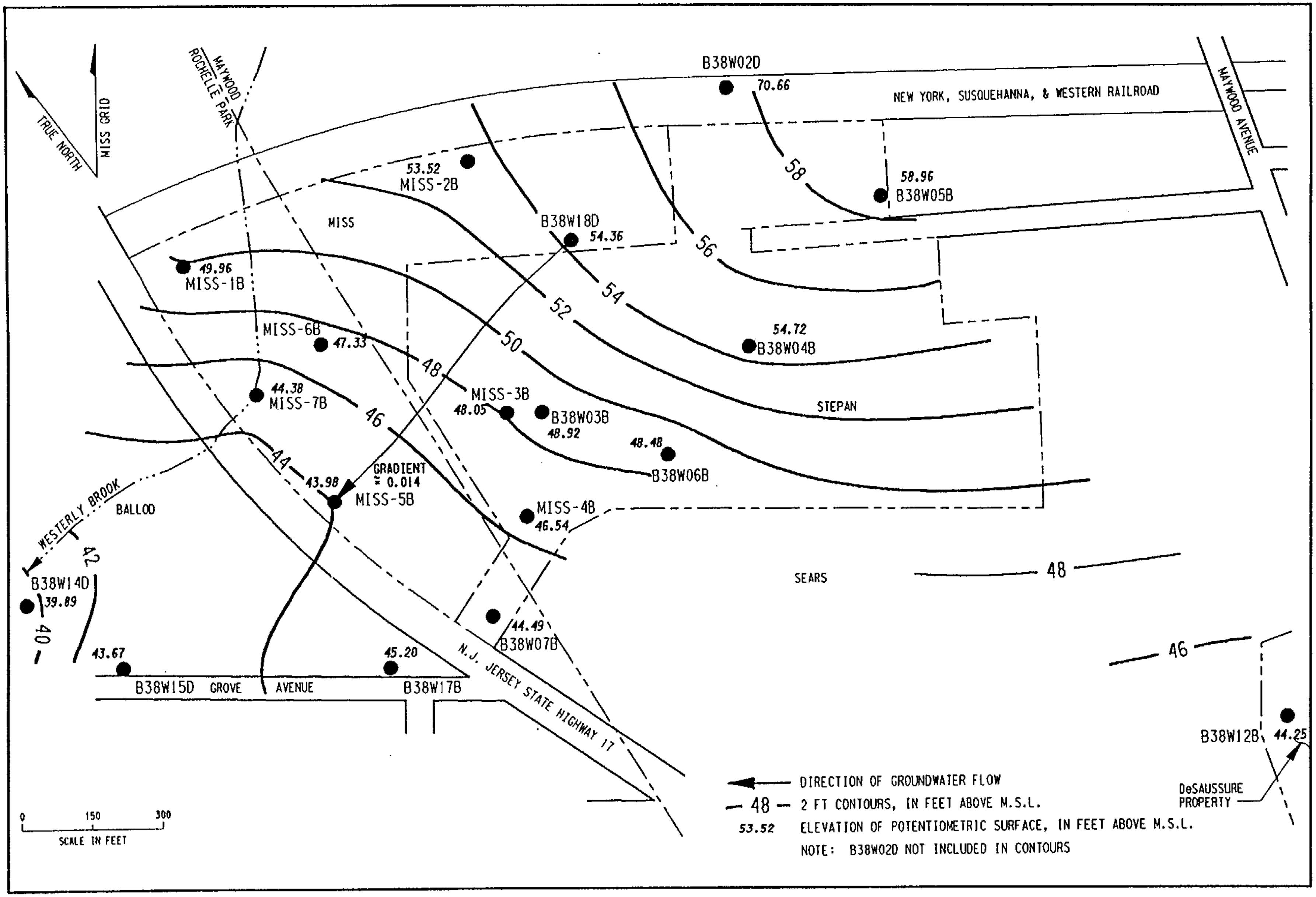

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Figure 6-7
Potentiometric Surface Map of the Bedrock Groundwater System at MISS (3/22/90)

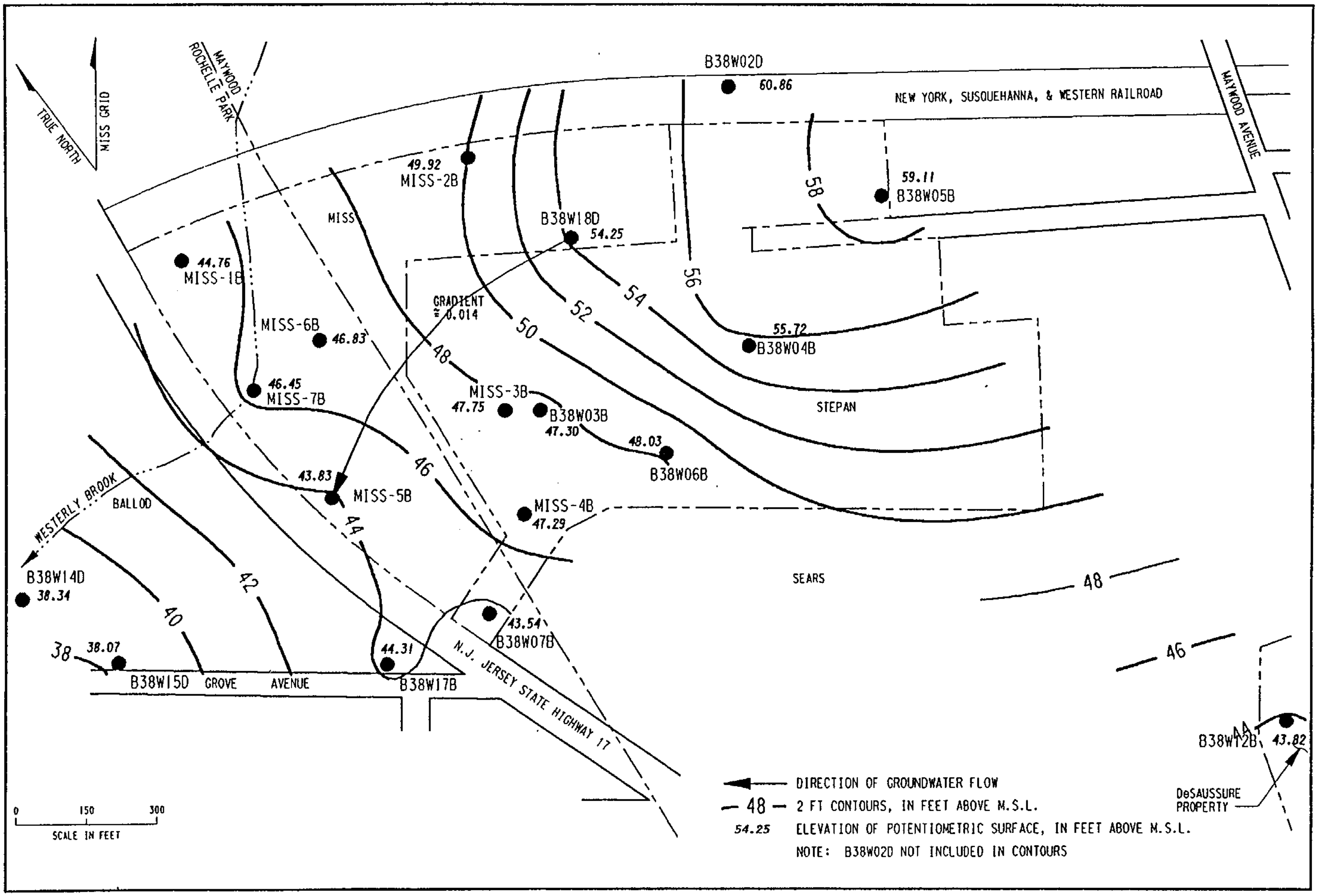

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Figure 6-8

Potentiometric Surface Map of the Bedrock Groundwater System at MISS (6/28/90)

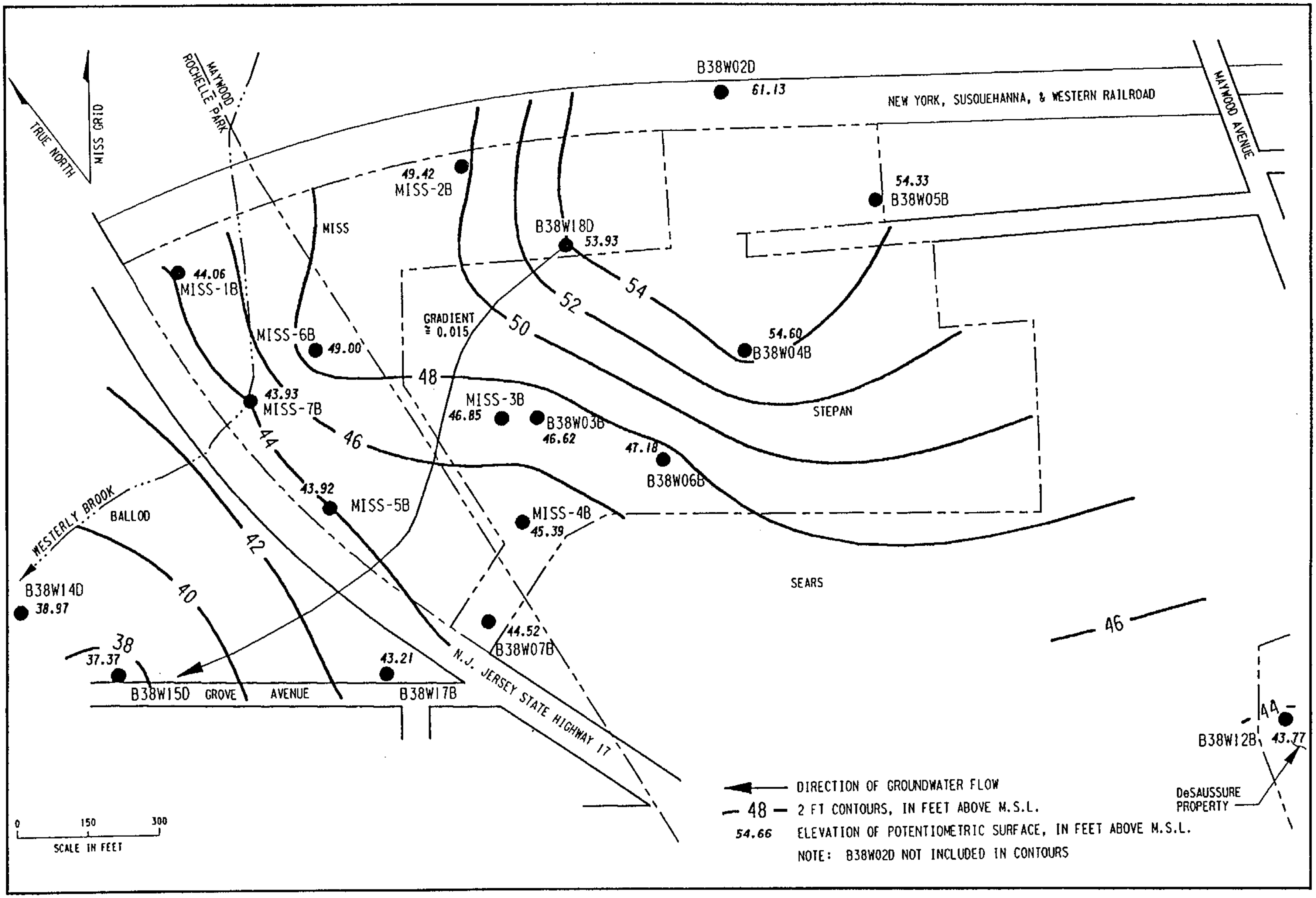

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Figure 6-9
Potentiometric Surface Map of the Bedrock Groundwater System at MISS (9/20/90)

7.0 QUALITY ASSURANCE

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

QA sampling requirements are ensured through the following:

- Samples at all locations are collected using established procedures as outlined in the FUSRAP Integrated Environmental Monitoring Instruction Guide, 191-00-IG-003

- The sampling program design provides for trip blanks, matrix spike and spike duplicates, field blanks (daily), and quality control (QC) duplicate sampling (minimum of 1 in 20)

- Chain-of-custody procedures are performed to maintain traceability of samples and corresponding analytical results

Data management QA is achieved through:

- Completion and recording of parameter-specific data review checklists for each analysis report

- Use of calculation sheets for documenting computations

- Double checking and concurrence on calculations
  - By the originator
  - By an independent, equally qualified second party

- Report preparation and presentations

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

Routine radioanalyses are performed under subcontract by Thermo Analytical/Eberline (TMA/E), Albuquerque, New Mexico. This laboratory participates in the collaborative testing and interlaboratory comparison program with EPA at Las Vegas, Nevada. In this program, samples of various environmental media (water, milk, air filters, and soil) containing one or more radionuclides in known amounts are prepared and distributed to participating laboratories. After analysis, results are forwarded to EPA for comparison with known values and with the results from other laboratories. This program enables the laboratory to regularly evaluate the accuracy of its analyses and take corrective action, if needed. Table 7-1 summarizes results of the comparison studies for water samples. TMA/E also participates in the DOE Environmental Measurements Laboratory interlaboratory quality assessment program. This program consists of receiving and analyzing environmental samples (air filters, water, and soil) on a quarterly basis for specific radiochemical analyses (Table 7-2).

Interlaboratory comparison of the TETLD results is provided by participation in the International Environmental Dosimeter Project sponsored jointly by DOE, EPA, and the Nuclear Regulatory Commission. Additionally, in 1990 TMA/E successfully completed the analytical requirements for the DOE laboratory accreditation program for radiation monitoring devices.

Chemical analyses are performed under subcontract by Weston Analytical Laboratory, Lionsville, Pennsylvania. Weston's standard practices manual has been reviewed and accepted by BNI. Weston maintains an internal QA program and is audited by BNI FUSRAP

TABLE 7-1

SUMMARY COMPARISON OF WATER SAMPLE RESULTS[a,b]

(EPA and TMA/E)

Analysis and Sample Date	Value (pCi/L)[c] EPA	Value (pCi/L)[c] TMA/E	Ratio (TMA/E:EPA)[d]
Alpha			
1/90	12.0 ± 5.0	9.33 ± 1.5	0.78
4/90	90 ± 12.0	96 ± 12	1.07
5/90	22.0 ± 6.0	26.3 ± 2.3	1.20
9/90	10.0 ± 5.0	11.0 ± 1.0	1.10
Beta			
1/90	12.0 ± 5.0	11.7 ± 2.1	0.98
4/90	52.0 ± 5.0	46.0 ± 6.0	0.88
5/90	15.0 ± 5.0	15.0 ± 1.0	1.0
9/90	10.0 ± 5.0	11.0 ± 1.0	1.10
Ra-226			
3/90	4.9 ± 0.7	6.1 ± 0.4	1.24
4/90	5.0 ± 0.8	2.8 ± 0.1	0.56
7/90	12.1 ± 1.8	10.1 ± 0.1	0.84
9/90	12.1 ± 1.8	10.1 ± 0.1	0.84
U (Natural)			
3/90	4.0 ± 6.0	4.0 ± 0.0	1.0
4/90	20.0 ± 6.0	18.7 ± 1.5	0.94
7/90	20.8 ± 3.0	19.8 ± 1.1	0.95

[a] Results from EPA Interlaboratory Comparison Program.

[b] Samples were for comparison only and not site-specific.

[c] 1 pCi/L is equivalent to 0.037 Bq/L.

[d] This ratio can be used to determine the accuracy of TMA/E's analytical procedures.

TABLE 7-2

SUMMARY COMPARISON OF AIR, SOIL, AND WATER SAMPLE RESULTS[a,b]

(EML and TMA/E)

Sample Type	Analysis (09/07/90)	Value		Ratio (TMA/E:EML)[c]
		EML	TMA/E	
Air (Bq/fil)	U-234	0.013	0.022 ± 0.012	1.69
Air (Bq/fil)	U-238	0.013	0.021 ± 0.012	1.62
Soil (Bq/kg)	U-234	28.3	23.9 ± 1.1	0.85
Soil (Bq/kg)	U-238	27.3	23.4 ± 1.0	0.86
Water (Bq/L)	U-234	0.236	0.232 ± 0.019	0.98
Water (Bq/L)	U-238	0.244	0.250 ± 0.041	1.03

[a] Results from Environmental Measurements Laboratory Interlaboratory Quality Assessment Program.

[b] Samples were for comparison only and not site-specific.

[c] This ratio can be used to determine the accuracy of TMA/E's analytical procedures.

personnel on a semiannual basis. The internal QA program involves the following for inorganic chemical analyses:

- Initial calibration and calibration verification
- Continuing calibration verification
- Reagent blank analyses
- Matrix spike analyses
- Duplicate sample analyses
- Laboratory control sample analyses
- Interlaboratory QA/QC

For organic chemical analyses the QA program involves:

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

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

Weston's QA program also includes an independent overview by its project QA coordinator.

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APPENDIX A

METHODOLOGY FOR STATISTICAL ANALYSIS OF DATA

METHODOLOGY FOR STATISTICAL ANALYSIS OF DATA

Average annual concentrations are calculated by averaging the results of all four quarters of sampling. When possible, sampling results are compiled in computer spreadsheets and the minimum, maximum, and average values are calculated for all quarters of data.

Minimums and maximums are derived by comparing sampling results and determining the lowest and highest for the year. An example is given below.

Thorium-230 Results (pCi/L)

Sampling Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Minimum Value	Maximum Value
1	13	7	12	5	5	13

Because 5 pCi/L is less than any other result, it is entered into the minimum value column; 13 pCi/L, the greatest result reported, is entered into the maximum value column.

Average annual concentrations are calculated by adding the results for the year and dividing by the number of quarters for which data have been taken and reported (usually four). An example is given below.

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 taken 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 result is rounded to 9 (number of significant figures is 1). This value is entered into the average value column.

Thorium-230 Results (pCi/L)

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

Expected concentration ranges are calculated to provide a basis for trend analysis of the data. These expected ranges are calculated by taking the average of the annual average concentrations for the past five years (when possible) and calculating a standard deviation for these data. The lower expected range is calculated by subtracting two standard deviations from the average value, and the upper range is calculated by adding two standard deviations to the average values. An example of these calculations is shown below.

Thorium-230 Results (pCi/L)

Sampling Location	Year 1986	 1987	 1988	 1989	 1990	Average Value	Standard Deviation
1	10	5	14	8	5	8	4

The formula for calculation of the standard deviation of a sample xi, ..., xn is:

$$S = \sqrt{S^2} = \sqrt{\frac{\sum (x_i - \overline{x})^2}{n - 1}}$$

Where S = Standard deviation

x_i = Individual values

$\overline{x}$ = Average of values

n = Number of values

n	x_i	$\bar{x}$	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$
1	10	8.4	1.6	2.6
2	5	8.4	-3.4	11.56
3	14	8.4	5.6	31.36
4	8	8.4	-0.4	0.16
5	5	8.4	-3.4	11.56

$$\sum (X_i - \bar{x})^2 = 57.24$$

$$S = \sqrt{\frac{57.24}{5 - 1}} = \sqrt{\frac{57.24}{4}} = \sqrt{14.31} = 3.78,$$

which rounds to 4 because there is only one significant figure.

The calculation for the expected ranges for this example is shown below.

Lower expected range: 8 - 2(4) = 0
Upper expected range: 8 + 2(4) = 20 (rounded to one significant figure)

Annual average values for the current year are compared with these ranges to indicate a possible anomaly or trend. If a discernible trend is found from this comparison, the data are presented in the appropriate section of the report.

APPENDIX B

POPULATION EXPOSURE METHODOLOGY

POPULATION EXPOSURE METHODOLOGY

DOSE CALCULATION 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 a hypothetical maximally exposed individual and the general population and comparing this dose with DOE guidelines. This appendix describes the methodology used to calculate the doses given in Subsection 4.2.

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 are 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 sources 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 maximally exposed individual.

Contamination transported via the atmospheric pathway takes the form of contaminated particulates or dust and can provide a potential dose only when it is inhaled. Doses from radon are intentionally excluded; radon exposure is controlled through compliance with boundary concentration requirements.

Contamination is 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 only poses an exposure problem when the surface water is used to provide municipal drinking water or to water livestock and/or to irrigate crops. Contamination is transported via groundwater when contaminants migrate into the groundwater system and there is a potential receptor.

Primary Radionuclides of Concern

The primary radionuclides of concern for these calculations 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 less than one year are included with the parent radionuclide. Table B-1 lists the pertinent radionuclides, their half-lives, and dose conversion factors for ingestion.

DOSE CALCULATION METHOD

Direct Exposure

As previously indicated, direct exposure is only important in calculating the dose to the hypothetical maximally exposed individual. The dose from direct gamma exposure is determined by using data collected through the TETLD program (described in Section 4.0). These data provide a measure of the amount and energy (in units of mR/yr) of the ionizing radiation at 1.6 m (5 ft) above the ground. For the purposes of this report, it is assumed that the maximally exposed individual lives 60 m (200 ft) from the site and spends 100 percent of his time at the residence.

TABLE B-1
RADIONUCLIDES OF INTEREST

Radionuclide	Half-life[a]	Dose Conversion Factor[b] for Ingestion (mrem/pCi)
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	4.47E+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

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[a] Source: Radiological Health Handbook (HEW 1970).

[b] Source: Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration 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.

The dose to the maximally exposed individual can be determined by assuming that the individual is exposed to a line source located along the western fenceline. Because the average exposure rate is known from the TETLD program for a distance of 1.6 m (5 ft) from the fenceline, the exposure at 60 m (200 ft) from the fenceline can be calculated by using the following equation (Cember 1983).

$$\mathit{Exposure\ at}\ 60\ m = (\mathit{Exposure\ at}\ 1.6\ m)\ x\ \frac{h_1}{h_2}\ x\ \frac{\tan^{-1}(L/h_2)}{\tan^{-1}(L/h_1)}$$

Where h_1 = TETLD distance from the fenceline [1.6 m (5 ft)]
h_2 = Maximally exposed individual's distance from the fenceline [60 m (200 ft)]
L = half of the length of the western side of the site [193 m (578 ft)]

The exposure rate at 1.6 m (5 ft) can be calculated by taking the average of the results from the four detectors along this portion of the fenceline (9, 10, 11, and 12). The average exposure rate for these detectors was 68 mR/yr. Using the formula above, the exposure rate at 60 m (200 ft) is approximately 1.3 mR/yr. Because 1 mR/yr is approximately equal to 1 mrem/yr (1E-2 mSv/yr), the resulting dose would be 1.3 mrem/yr (1.3E-2 mSv/yr) assuming 24-h continuous residence. This exposure scenario assumes continuous exposure and does not account for shielding provided by the structure.

Surface Water

Exposures from contaminants in surface water are important in calculating the dose to both the hypothetical maximally exposed individual and the nearby population. The data used to support the surface water dose calculation consist of measurements of concentrations of contaminants in surface water at the site and of the amount of dilution provided by tributaries or rivers between the site and the intake. Thus, the dose to the maximally exposed individual can be calculated by the following:

$$D_s = \sum_{i=1}^{N} Ci \ x \ (Fs \div Fi) \ x \ Ua \ x \ DCFi$$

Where D_s = Committed effective dose from surface water
Ci = Concentration of the i^{th} radionuclide in surface water at the site
Fs = Average annual flow of surface water at the site
Fi = Average flow of surface water at the intake
Ua = Annual consumption of liquid (approx. 730 L/yr)
DCFi = Dose conversion factor for the i^{th} radionuclide

To determine the dose to the population, the same equation would be used and the dose would be multiplied by the population group served by the drinking water supply. It is important to note that for the population dose, the intake point is probably not the same as that for the maximally exposed individual.

The approach outlined above for the surface water pathway does not account for radionuclides settling out or for any municipal water treatment.

Groundwater

Exposures from contaminants in groundwater are important in calculating the dose to both the hypothetical 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. The dose for the maximally exposed individual can be calculated by using the following equation:

$$Dgw = \sum_{i=1}^{N} (Ci) \; x \; (D) \; x \; (Ua) \; x \; (DCFi)$$

Where Dgw = Committed effective dose from groundwater
Ci = Concentration of the i^{th} radionuclide in groundwater at the site
D = Estimated dilution factor
Ua = Annual consumption of water (approx. 730 L/yr)
DCFi = Dose conversion factor for the i^{th} radionuclide

To determine the dose to the population, the same equation would be used and the dose would be multiplied by the population group served by the drinking water supply. It is important to note that the population intake point is usually different from that of the maximally exposed individual.

The approach given above for the groundwater pathway does not account for any water treatment.

Atmospheric

The dose to the hypothetical maximally exposed individual from particulate radionuclides transported via the atmospheric pathway is calculated using EPA's computer model AIRDOS. Doses to the general public via this pathway are also calculated using AIRDOS results. Results are provided in Subsection 4.2.

The release of particulates was calculated using a model for wind erosion because there were no other mechanisms for releasing particulates from the site. The wind erosion model used was taken from the DOE "Remedial Action Priority System Mathematical Formulation." The input into the model consisted of site-specific average soil concentrations, local meteorological data (Section 1.0), and areas of contamination.

The site was modeled as two areas: the interim storage pile and the remainder of the site. Assumptions used in the calculation model were (1) an assumed particle size of 0.05 mm, (2) the pile cover is modeled assuming that the contamination is 99 percent covered by vegetation, and (3) there were very few mechanical disturbances at the site per month.

APPENDIX C
ENVIRONMENTAL STANDARDS

ENVIRONMENTAL STANDARDS

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

DERIVED CONCENTRATION GUIDELINES

As referenced in Section 2.0, 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 guidelines (DCGs). A DCG is defined as the concentration of a radionuclide in air or water that, under conditions of continuous exposure 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)	Inhaled Air DCGs[b] D	W	Y
Radium-226	2E-1	1E-7	--	1E-12	--
Thorium-230	2E-4	3E-7	--	4E-14	5E-14
" 232	2E-4	5E-8	--	7E-15	1E-14
Uranium-234	2E-3	5E-6	--	--	9E-14
" 235	2E-3	5E-6	--	--	1E-13
" 238	2E-3	6E-6	--	--	1E-13
Radon-222[c]	3E-9	3E-9	--	--	3E-9
" 220[c]	3E-9	3E-9	--	--	3E-9

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

[b] 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).

[c] 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 for releases from DOE facilities.

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:** U.S. Department of Energy, "Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Surplus Facilities Management Program Sites," Revision 2, March 1987.

POTENTIAL STATE ARARS

The following list of New Jersey laws and regulations have been identified as potential ARARs for the management of MSP. Where differences between state and federal requirements exist, the more restrictive requirement will apply.

Potential ARAR	Requirement
New Jersey Environmental Cleanup Responsibility Act, Title 13, New Jersey Statutes Annotated (NJSA), Chapter 1K, Subchapter 6 (13:1K-6 et seq.)	Provides rules for the orderly closing of operations and transfer of real property utilized for the generation, handling, storage, and disposal of hazardous substances and waste. Imposes preconditions on any closure or transfer of these operations by requiring the adequate preparation and implementation of acceptable cleanup procedures.
New Jersey Hazardous Waste Facilities Siting Act, 13 NJSA 1E-49 et seq.	Provides rules to ensure proper treatment, storage, and disposal of hazardous waste by providing for the siting, design, construction, operation, and use of acceptable hazardous waste facilities.
New Jersey Underground Storage Tank Law, 58 NJSA 10A-21 et seq.	Provides for the registration, testing, monitoring, and cleanup of underground storage tanks to detect leaks and discharges as early as possible.

New Jersey Solid and Hazardous Waste Management Regulations, Title 7, New Jersey Administrative Code (NJAC), Chapter 26	Establishes the state equivalent of the federal Resource Conservation and Recovery Act. The act also regulates asbestos and sanitary landfills, and establishes fees and a fee schedule to fund the program.
New Jersey Underground Storage Tank Rules, 7 NJAC, Chapter 14B	Establishes regulations for underground storage tanks, registration requirements, and sets forth penalties for violations of these provisions.
New Jersey Environmental Cleanup Responsibility Act Rules, 7 NJAC, Chapter 26B	Provides rules governing the implementation of the Environmental Cleanup Responsibility Act, which regulates the closing, characterization, and cleanup of regulated industrial facilities.
New Jersey Solid and Hazardous Waste Disclosure Rules, 7 NJAC 26-16 et seq.	Provides standards of conduct and ability for those persons who wish to operate a solid or hazardous waste facility or engage in the transport of solid or hazardous waste. It establishes a licensing program to exclude from positions of responsibility persons deficient in reliability, expertise, and competence from participating in these industries.
New Jersey Toxic Catastrophe Prevention Act Program Rules, 7 NJAC, Chapter 31	Provides rules for owners and operators of facilities required to register with NJDEP because they manage extraordinarily hazardous substances in the registration quantity established for such substances. The rules are intended to protect the public from catastrophic accidents from chemical releases of extraordinarily hazardous substances to the environment.

New Jersey Rules on Confidentiality of Hazardous Waste Information, 7 NJAC 26-17 et seq.	Sets forth procedures for making information received by NJDEP in administering the hazardous waste program available to the public and maintaining confidentiality of certain parts of that information.
New Jersey Air Pollution Control Laws, Title 26, New Jersey Revised Statutes (NJRS), Chapter 2 C, Air Pollution Control	Empowers the New Jersey Department of Health to formulate, promulgate, amend, and repeal codes and regulations that prevent and control air pollution.
New Jersey Regulations on Permits and Certificates, 7 NJAC 27-8 et seq.	Establishes requirements for permitting air control apparatus and establishes program fees to fund the permitting program.
New Jersey Regulations on Volatile Organic Substances, 7 NJAC 27-16 et seq.	Provides rules for the storage, transfer, and other source operations to minimize the amount of volatile organic substances into the atmosphere in excess of the emission rates contained in this rule.
New Jersey Regulations on Toxic Substances, 7 NJAC 27-17 et seq.	Provides rules for emissions of specific toxic volatile organic substances, including permit requirements, emission standards, and test procedures.
New Jersey Testing Procedures for Volatile Organic Substances, 7 NJAC 27B-3 et seq.	Prescribes sampling and analytical procedures for determining the presence and concentrations of volatile organic substances.
New Jersey Testing Procedures for Opacity Emissions, 7 NJAC 27B-2 et seq.	Promulgates procedures for determining whether a discharge exceeds opacity standards.
New Jersey Air Administrative Penalties Rules, 7 NJAC 27A-3 et seq.	Promulgates civil administrative penalties for violations of air emission standards, as well as civil administrative penalties for other violations of New Jersey's air rules.

New Jersey Water Pollution Control laws, 58 NJSA, Chapters 6A and 10	Establishes rules for the prevention and response to the discharge of petroleum and other hazardous substances to waters of the state. This law also establishes the New Jersey Pollutant Discharge Elimination System (NJPDES).
New Jersey Water Quality Planning Act, 58 NJSA 11A et seq.	This act was promulgated to restore and maintain the chemical, physical, and biological integrity of the waters of the state, and develop waste treatment management planning processes to assure adequate control of sources of water pollutants.
New Jersey Hazardous Discharge Law, 13 NJSA 1K-15 et seq.	Establishes reporting requirements for owners and operators of active or inactive industrial facilities who know or suspect a hazardous substance discharge. It provides the method and information required in the report, as well as penalties for failure to report a hazardous substance discharge.
New Jersey Safe Drinking Water Act, 58 NJSA 12A-1 et seq.	Empowers the state to promulgate and enforce regulations to maintain the quality of drinking water; to establish minimum standards for drinking water; and regulate the collection, treatment, monitoring, storage, and distribution of potable water.
New Jersey Rules on Discharge of Petroleum and Other Hazardous Substances, 7 NJAC 1E-1.1 et seq.	Regulates every discharge of petroleum and other hazardous substances except those in compliance with a permit. Sets forth reporting, design, and maintenance requirements for major facilities handling petroleum or hazardous substances.
New Jersey Pretreatment Regulations, 7 NJAC, Chapters 5 and 9	Provides water quality standards for the discharge of pollutants into state waters.

New Jersey Pollutant Discharge Elimination System Regulations, 7 NJAC 14A-1 et seq.	Provides procedures and guidelines for implementation and operation of the NJPDES permit program. It regulates the discharge of pollutants to surface and groundwater, and regulates the discharge of industrial pollutants to publicly and privately owned treatment works.
New Jersey Civil Penalties and Hearings Regulations, 7 NJAC 14-8.1 et seq.	Establishes rules for the assessment of civil penalties for violations of water quality standards, effluent limitations, or permit violations.
New Jersey Hazardous Substance Discharge Reports and Notices Rules, 7 NJAC 1E-5.1 et seq.	Establishes requirements governing the implementation of the Hazardous Substance Discharge Reports and Notices Act by setting reporting and notice procedures to be followed by industrial facilities.
New Jersey Drinking Water Regulations, 7 NJAC 10-1 et seq.	Implements the New Jersey Safe Drinking Water Act by specifying maximum contaminant levels, treatment techniques, testing procedures, sampling frequencies, and quality control.
New Jersey Surface Water Quality Standards, 7 NJAC 9-4 et seq.	Establishes rules for defining classes of waters and use designations; establishes water-quality-based effluent limitations, procedures for modification of water-quality-based effluent limitations, and procedures for reclassifying water uses.
New Jersey Groundwater Quality Standards, 7 NJAC, Chapter 9	Contains rules for the enhancement of groundwater resources, use classifications, quality criteria, and designated uses of the groundwaters of the state.
New Jersey Wetlands Act, 13 NJSA, Chapter 9A	Establishes requirements for the protection of the state's wetlands.

New Jersey Freshwater Wetlands Protection Act, 13 NJSA, Chapter 9B	Establishes requirements for the protection of New Jersey's freshwater wetlands.
New Jersey Freshwater Wetlands Regulations, 7 NJAC, 7A	Provides regulations to implement the New Jersey Freshwater Wetlands Protection Act.

POTENTIAL FEDERAL ARARs

In addition to the federal regulations identified in Section 2.0, the following have been identified as potential ARARs.

Potential ARAR	Requirement
Occupational Safety and Health Administration General Industry Standards, 29 CFR 1910	Health and safety standards are established for hazardous waste operations, including limits for exposure to noise and certain hazardous materials.
Occupational Safety and Health Administration Standards Hazardous Waste Operations and Emergency Response, 29 CFR 1910	General worker protection requirements are established, as are requirements for worker training and the development of emergency response plan and a safety and health program for employees. Procedures are established for hazardous waste operations, including decontamination of radioactive waste, shipping and transport, and container handling.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 40 CFR 192	Contains limited permissible concentrations of radium, thorium, radon, and gamma radiation.
Radiation Protection for Occupational Workers, DOE Order 5480.11	Standards and program requirements are established for worker protection from ionizing radiation, including derived air concentration guides for inhalation and immersion. The basic dose limit of 100 mrem/yr also applies to any member of the public entering a controlled area.

Standards for Protection Against Radiation, 48 FR 20721	The standard for uranium-238 in inhaled air is 3E-12 μCi/ml daily, 1E-12 μCi/ml weekly; the standard for thorium-232 in inhaled air is 4E-15 μCi/ml weekly and 8E-15 μCi/ml yearly; the standard for thorium-230 in inhaled air is 2E-14 μCi/ml yearly; and the standard for radium-226 in inhaled air is 9E-13 μCi/ml weekly.

APPENDIX D

PARAMETERS FOR ANALYSIS

PARAMETERS FOR ANALYSIS AT MISS, 1990

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Medium	Parameter	Technique
Groundwater	Total uranium	Fluorometric
	Radium-226	Emanation
	Thorium-232	Gamma spectrometry
	Total organic halides	Carbonaceous analyzer
	Total organic carbon	Coulometric determination
	Total metals: aluminum, antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, zinc	Inductively coupled plasma atomic emission spectrophotometry (ICPAES)
	Arsenic, lead, mercury, selenium, thallium	Atomic absorption (AA) spectrophotometry
	Specific conductance	Electrometric
	pH	Electrometric
	Volatile compounds	Gas chromatography/ mass spectroscopy
	Semivolatile compounds	Gas chromatography/ mass spectroscopy
Surface Water	Total uranium	Fluorometric
	Radium-226	Emanation
	Thorium-232	Gamma spectrometry
	Total organic halides	Carbonaceous analyzer
	Total organic carbon	Coulometric determination
	Total metals: aluminum, antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, zinc	Inductively coupled plasma atomic emission spectrophotometry (ICPAES)
	Arsenic, lead, mercury, selenium, thallium	Atomic absorption (AA) spectrophotometry
	Specific conductance	Electrometric
	pH	Electrometric

FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.141	0.00	3.70	5.36	6.19	3.57	1.96	0.00
NNW	0.028	1.67	3.15	5.05	5.13	3.38	1.91	0.00
NW	0.029	0.00	3.15	4.44	5.02	3.17	2.16	0.00
WNW	0.028	0.00	2.54	4.36	5.12	3.12	1.69	0.00
W	0.049	0.00	2.34	3.44	5.33	2.86	1.83	0.00
WSW	0.043	0.00	2.33	3.42	5.14	3.13	1.98	0.00
SW	0.048	1.67	2.62	3.90	5.61	3.49	2.28	0.00
SSW	0.047	0.00	2.78	4.37	5.71	3.96	2.24	0.00
S	0.082	1.67	3.07	4.27	6.44	4.11	2.23	0.00
SSE	0.061	1.67	3.34	4.38	6.90	4.11	1.98	0.00
SE	0.086	0.00	3.45	4.83	7.58	4.18	2.22	0.00
ESE	0.059	0.00	2.83	4.66	7.42	4.11	2.15	0.00
E	0.092	0.00	3.18	4.38	6.99	4.03	2.20	0.00
ENE	0.080	0.00	3.25	4.10	5.52	3.85	2.25	0.00
NE	0.060	0.00	3.30	4.42	5.22	3.63	2.27	0.00
NNE	0.068	0.00	3.24	4.62	6.00	3.71	2.15	0.00

```
                     CLEAN AIR ACT COMPLIANCE REPORT      3/20/91 10:56 AM

Facility: Maywood Interim Storage Site (Stepan Chemical)
 Address: 100, N. Hunter Avenue          City: Maywood              State: NJ
Comments: Formerly Utilized Sites Remedial Action Program - U.S D.O.E.
    Year: 1990
                          Dose Equivalent Rates to Nearby
                       ________Individuals (mrem/year)_________
        Effective     ||                                      ||
     Dose Equivalent  ||               0.0083                 ||
                      ||  ____________________________________||
       Highest Organ  ||                                      ||
        Dose is to    ||               0.0520                 ||
       ENDOSTEUM      ||______________________________________||

  -----------------------EMISSION INFORMATION------------------------

:---------:-----:----:--------:--------:
| Radio-  |     |    |  Area  |  Area  |
| nuclide |Class|Amad|   #1   |   #2   |
|         |     |    | (Ci/y) | (Ci/y) |
| ------- |-----|----|--------|--------|
| U-238   |  Y  | 1.0| 1.4E-07| 2.1E-06|
| U-235   |  Y  | 1.0| 1.4E-07| 2.0E-06|
| U-234   |  Y  | 1.0| 6.2E-09| 9.2E-08|
| RA-226  |  Y  | 1.0| 8.2E-09| 8.2E-07|
| TH-232  |  Y  | 1.0| 1.1E-07| 4.0E-06|
|_________|_____|____|________|________|
  Total Area (m**2)  | 6.7E+03| 4.7E+04|
                     |________|________|

  -------------------------SITE INFORMATION--------------------------

                   :------------------:                      :---------------:
       Wind Data   |   LEA0435.WND    |   Temperature (C)    |      12       |
     Food Source   |     LOCAL        |   Rainfall (cm/y)    |     122       |
     Distance to   |      300         |    Lid Height (m)    |    1000       |
 Individuals (m)   :__________________:                      :_______________:

    *NOTE:  The results of this computer model are dose estimates.
            They are only to be used for the purpose of determining
            compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.
```

ORGAN DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL

ORGAN	DOSE EQUIVALENT RATE TO THE ORGAN (mrem/y)
GONADS	7.4E-05
BREAST	7.8E-05
RED MARROW	4.2E-03
LUNGS	5.1E-02
THYROID	7.3E-05
ENDOSTEUM	5.2E-02
REMAINDER	3.0E-04
EFFECTIVE	8.3E-03

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL BY PATHWAY FOR ALL RADIONUCLIDES

	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
INGESTION	2.5E-04	4.5E-03
INHALATION	8.0E-03	4.8E-02
AIR IMMERSION	7.7E-10	9.5E-10
GROUND SURFACE	2.3E-05	2.8E-05
TOTAL:	8.3E-03	5.2E-02

Maywood Interim Storage Site (Stepan Chemical)

3/20/91 10:56 AM

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL BY RADIONUCLIDE FOR ALL PATHWAYS

RADIONUCLIDE	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/y)
U-238	1.0E-03	1.1E-03
U-235	1.1E-03	1.2E-03
U-234	5.2E-05	5.7E-05
RA-226	4.5E-04	7.4E-04
TH-232	5.6E-03	4.9E-02
TOTAL :	8.3E-03	5.2E-02

Maywood Interim Storage Site (Stepan Chemical)

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF DISTANCE IN THE DIRECTIONS OF THE MAXIMALLY EXPOSED INDIVIDUAL FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTION : NORTH

DISTANCE (meters)	EFFECTIVE DOSE EQUIVALENT (mrem/y)
300	8.3E-03
1000	1.1E-03
3000	1.8E-04
10000	2.7E-05
80000	1.0E-06

3/20/91 10:56 AM

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS:	N	NNE	NE	ENE	E	ESE	SE	SSE
DISTANCE (METERS):								
300	8.3E-03	7.5E-03	7.1E-03	8.1E-03	7.6E-03	5.7E-03	5.3E-03	5.5E-03
1000	1.1E-03	6.6E-04	6.8E-04	8.7E-04	8.4E-04	4.7E-04	6.0E-04	4.8E-04
3000	1.8E-04	1.0E-04	1.1E-04	1.4E-04	1.3E-04	7.4E-05	9.4E-05	7.6E-05
10000	2.7E-05	1.6E-05	1.7E-05	2.2E-05	2.1E-05	1.2E-05	1.5E-05	1.2E-05
80000	1.0E-06	6.3E-07	6.6E-07	8.4E-07	7.8E-07	4.5E-07	6.2E-07	4.9E-07

	S	SSW	SW	WSW	W	WNW	NW	NNW
DISTANCE (METERS):								
300	6.1E-03	5.4E-03	5.5E-03	6.4E-03	6.3E-03	4.4E-03	3.3E-03	4.8E-03
1000	7.4E-04	4.7E-04	5.7E-04	6.4E-04	7.2E-04	3.9E-04	3.2E-04	3.1E-04
3000	1.2E-04	7.3E-05	8.7E-05	9.7E-05	1.1E-04	5.9E-05	5.0E-05	4.7E-05
10000	1.8E-05	1.2E-05	1.4E-05	1.5E-05	1.6E-05	8.8E-06	7.8E-06	7.2E-06
80000	7.2E-07	4.4E-07	4.9E-07	4.3E-07	4.6E-07	2.5E-07	2.6E-07	2.4E-07

APPENDIX E

SAMPLE OBSERVATION WELL CONSTRUCTION LOGS AND HYDROGRAPHS SHOWING WATER LEVEL ELEVATIONS

MONITORING WELL

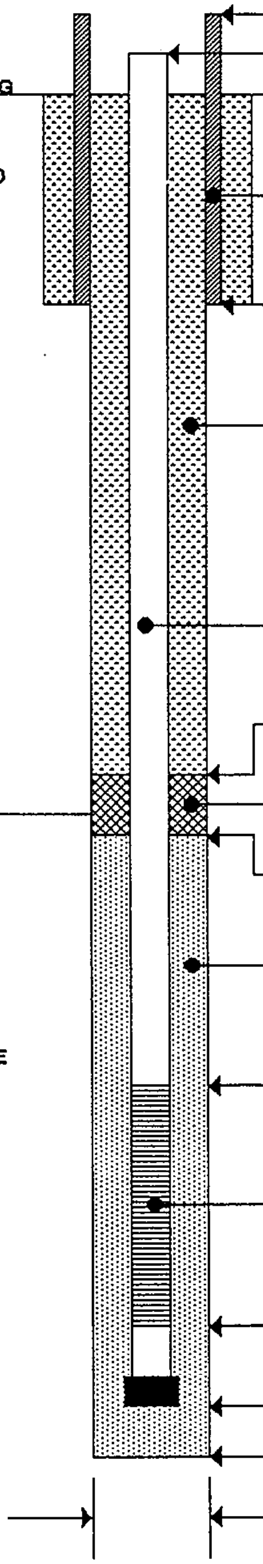
PROJECT FUSRAP			WELL NO. B38W5B
JOB NO. 14501-138	SITE Stepan Chemical Parking Lot	COORDINATES N 9,880.0 E 10,772.0	
BEGUN 9-16-87	COMPLETE 9-21-87	PREPARED BY C.A. Clark	REFERENCE POINT FOR MEASUREMENTS Ground surface

GENERALIZED GEOLOGIC LOG

0.0-14.4 Ft.
SILT w/ Sand-Silty SAND

14.4-17.0 Ft.
SILTSTONE

17.0-49.0 Ft.
SANDSTONE and SILTSTONE



	DEPTH (FT)	ELEV. (FTMSL)
TOP OF SURFACE CASING		
TOP OF RISER CASING	2.9	70.9
	0.0	68.1
BOTTOM OF SURFACE CASING	3.0	65.1
TOP OF SEAL	16.5	51.6
TOP OF FILTER PACK	18.5	49.6
TOP OF SCREEN	22.7	45.4
BOTTOM OF SCREEN	33.0	35.1
BOTTOM OF SUMP	44.5	23.6
BOTTOM OF HOLE	44.0	24.1

SURFACE CASING
DIAMETER/TYPE:
6" O.D./Schedule 40 steel

BACKFILL MATERIAL TYPE
Bentonite cement grout

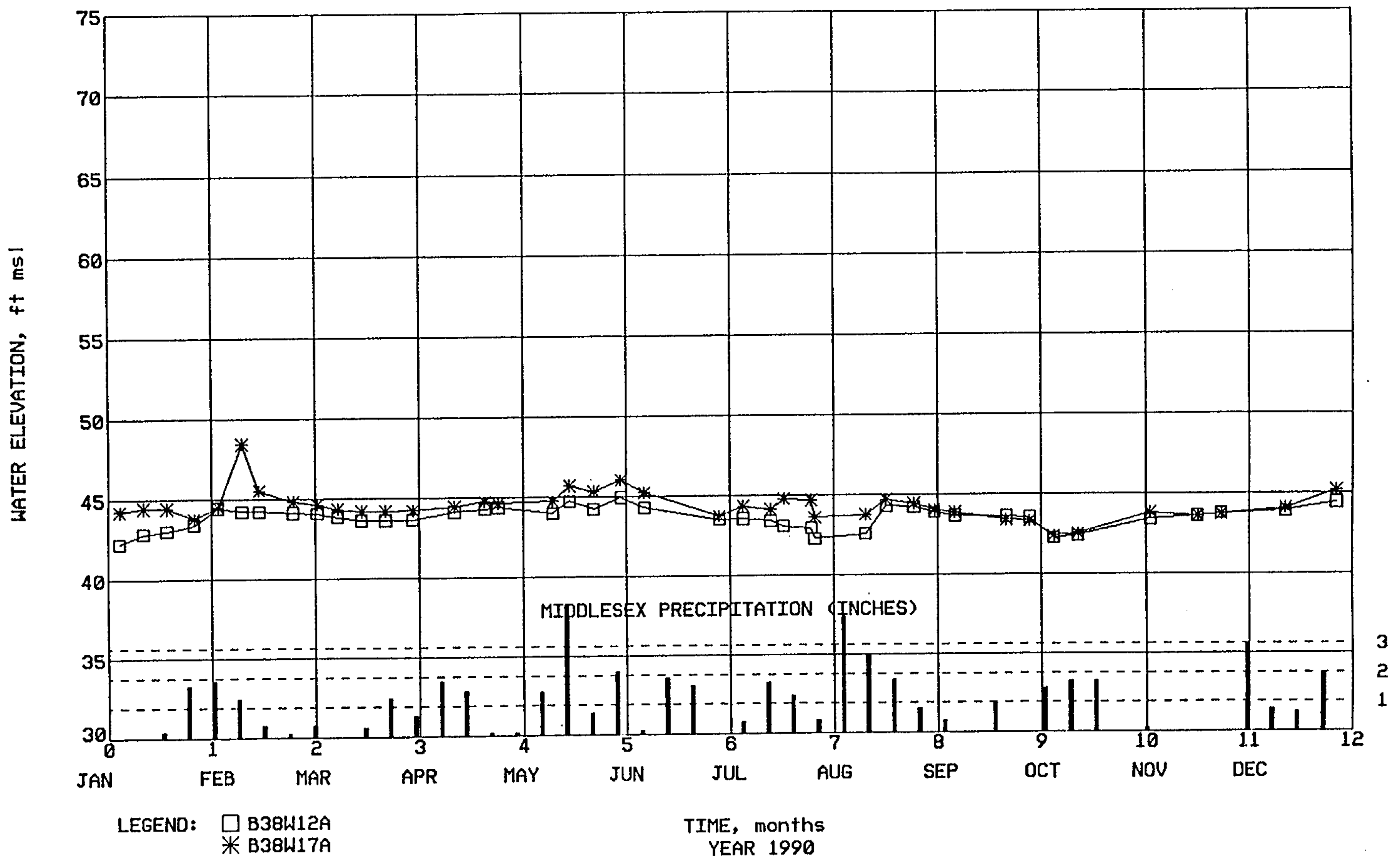
RISER CASING
DIAMETER/TYPE:
2" I.D./316L stainless 5S flush

ANNULAR SEAL TYPE
Peltonite bentonite pellet

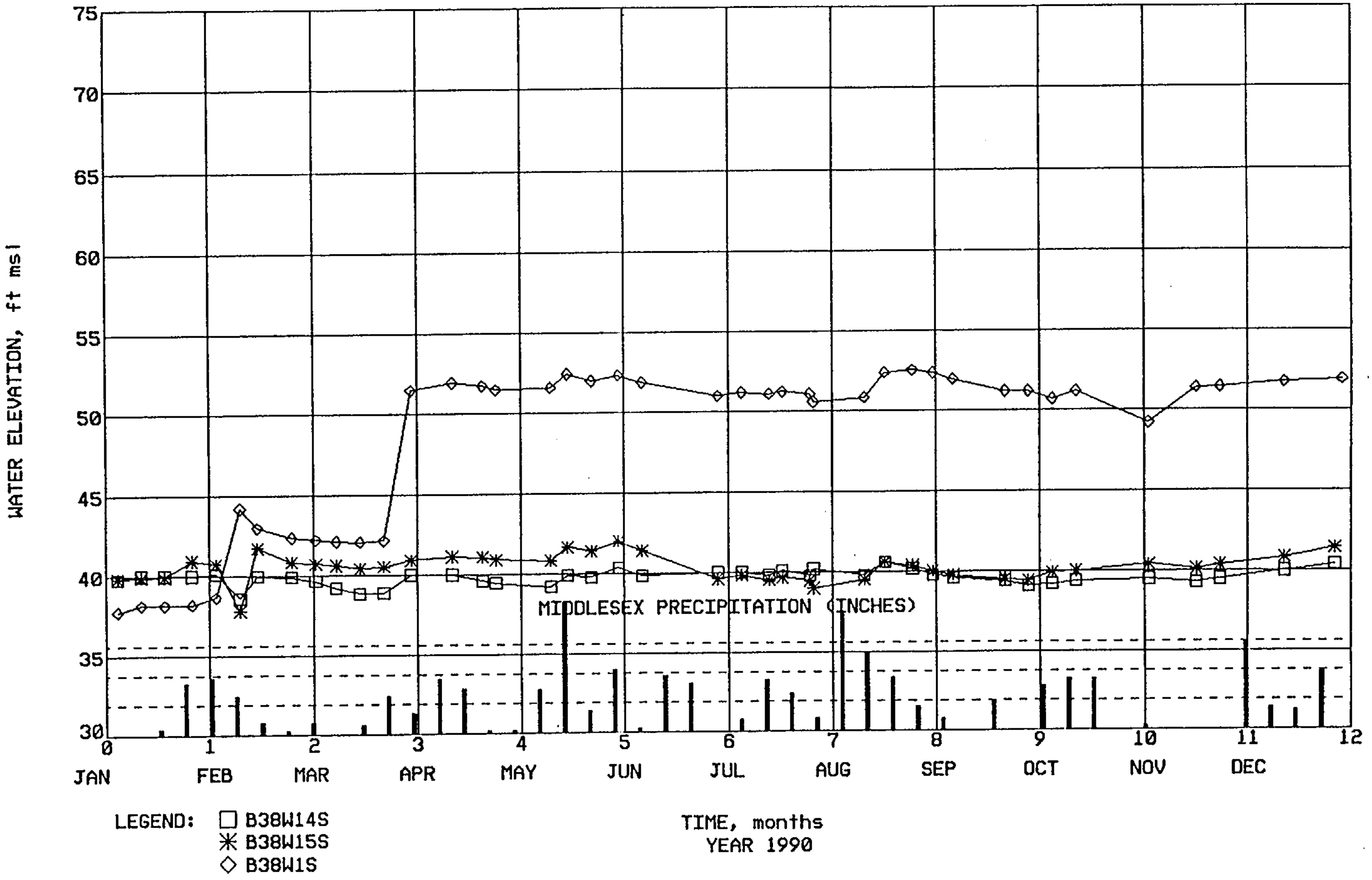
FILTER PACK TYPE
Morie # 0 well gravel

SCREEN
DIAMETER: 2" I.D.
TYPE: 316L stainless continuous slot
OPENING WIDTH: 0.01 INCH

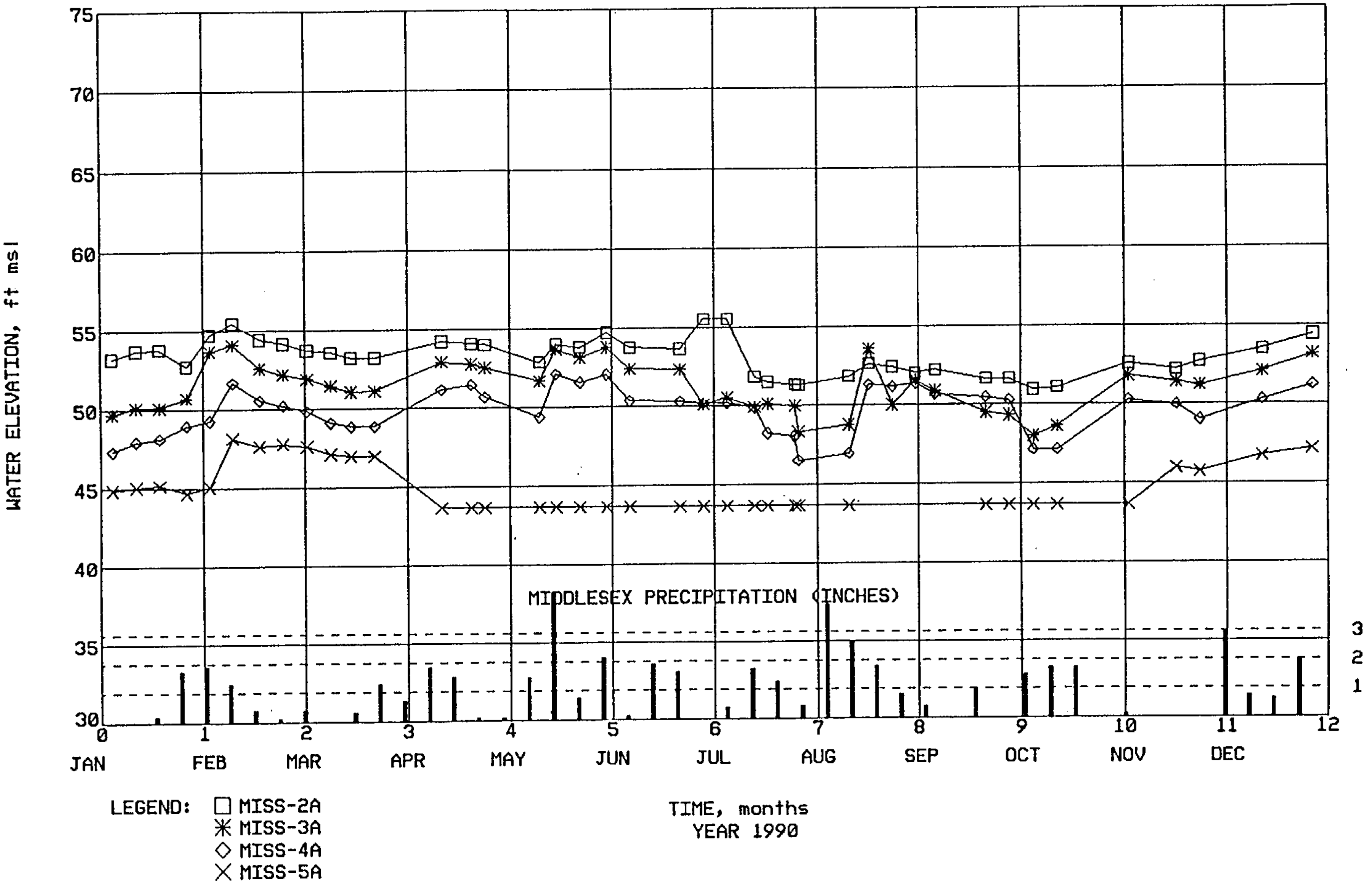
HOLE DIAMETER: 6.5"



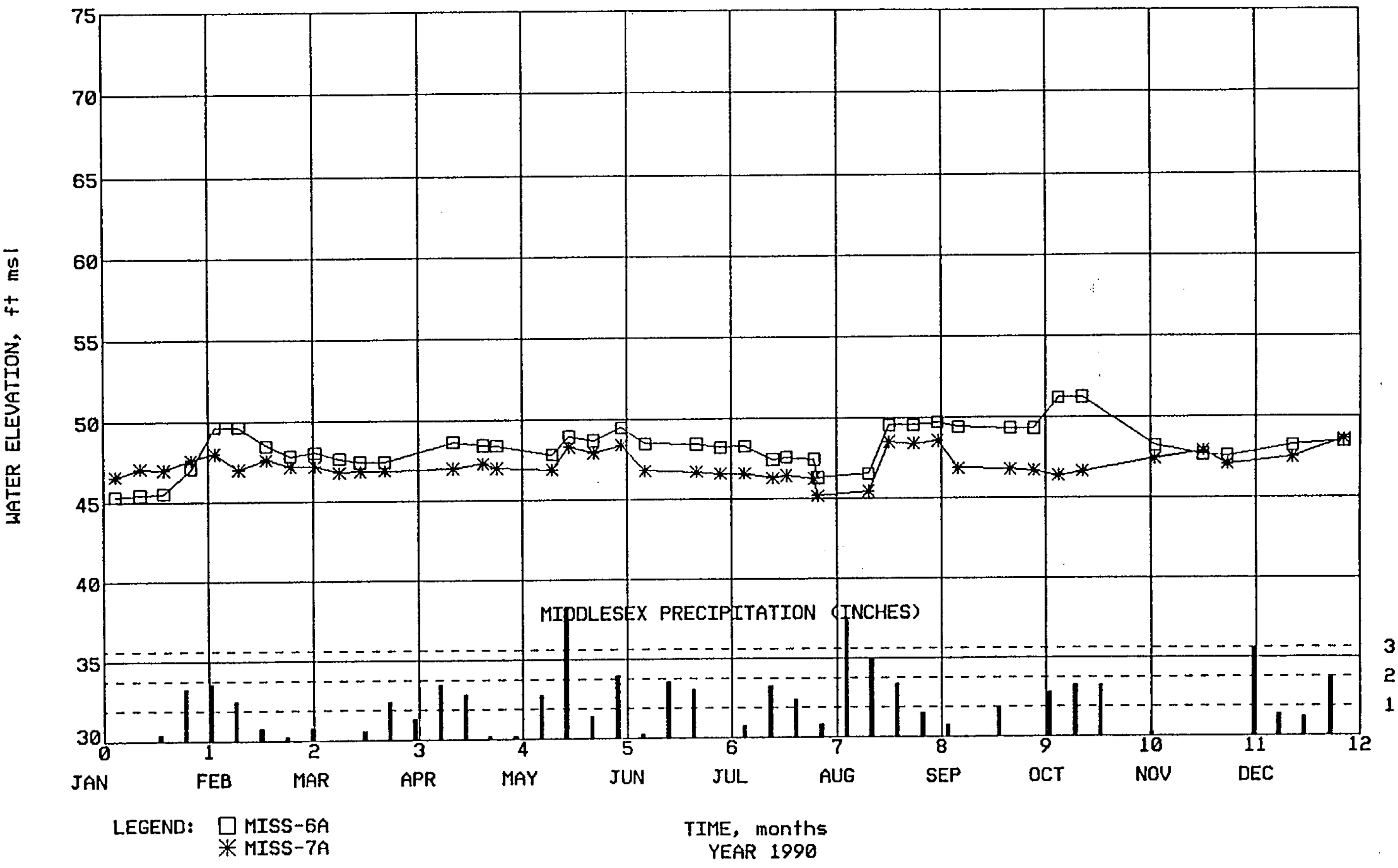
MISS HYDROGRAPHS - UPPER GROUNDWATER SYSTEM



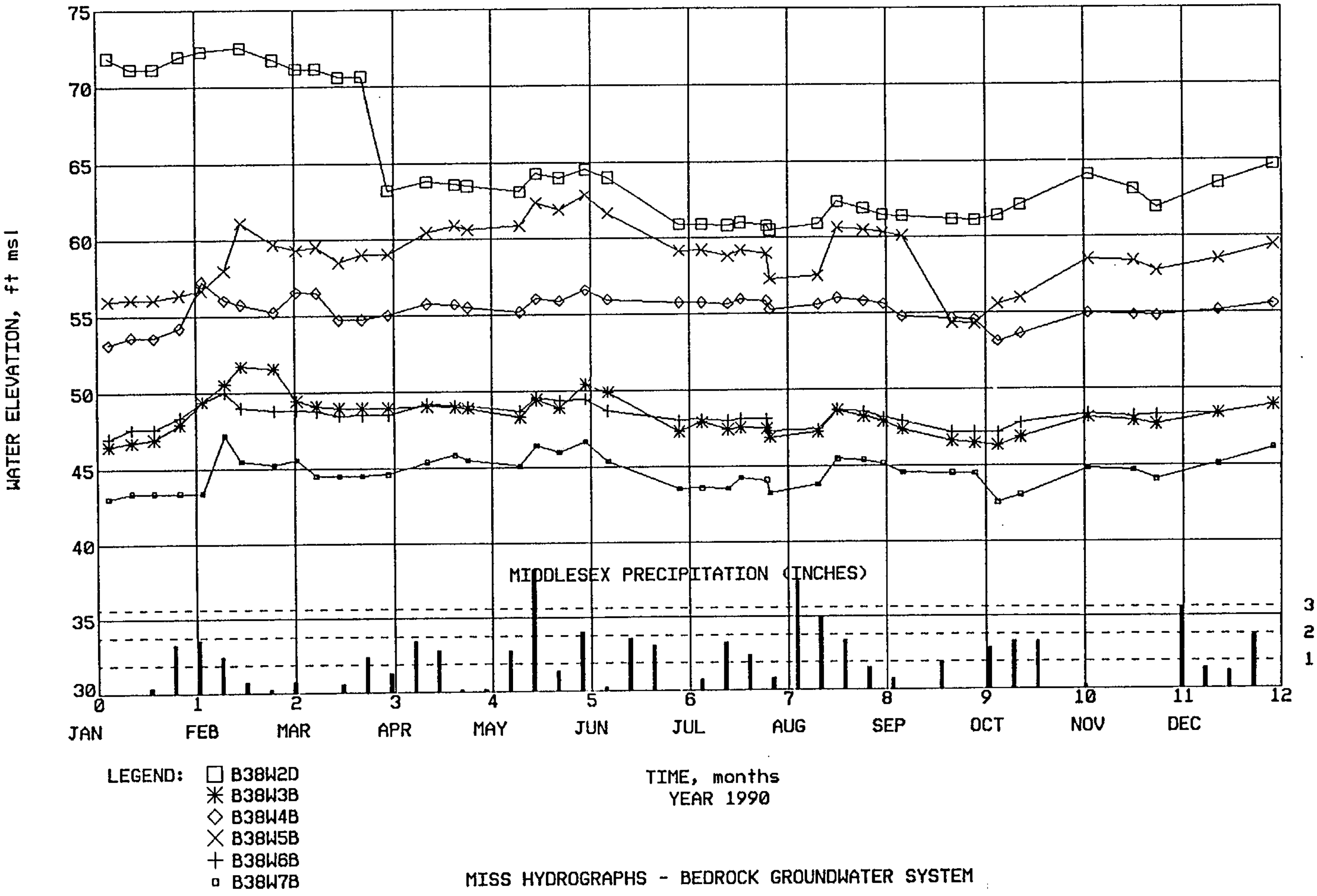
MISS HYDROGRAPHS - UPPER GROUNDWATER SYSTEM



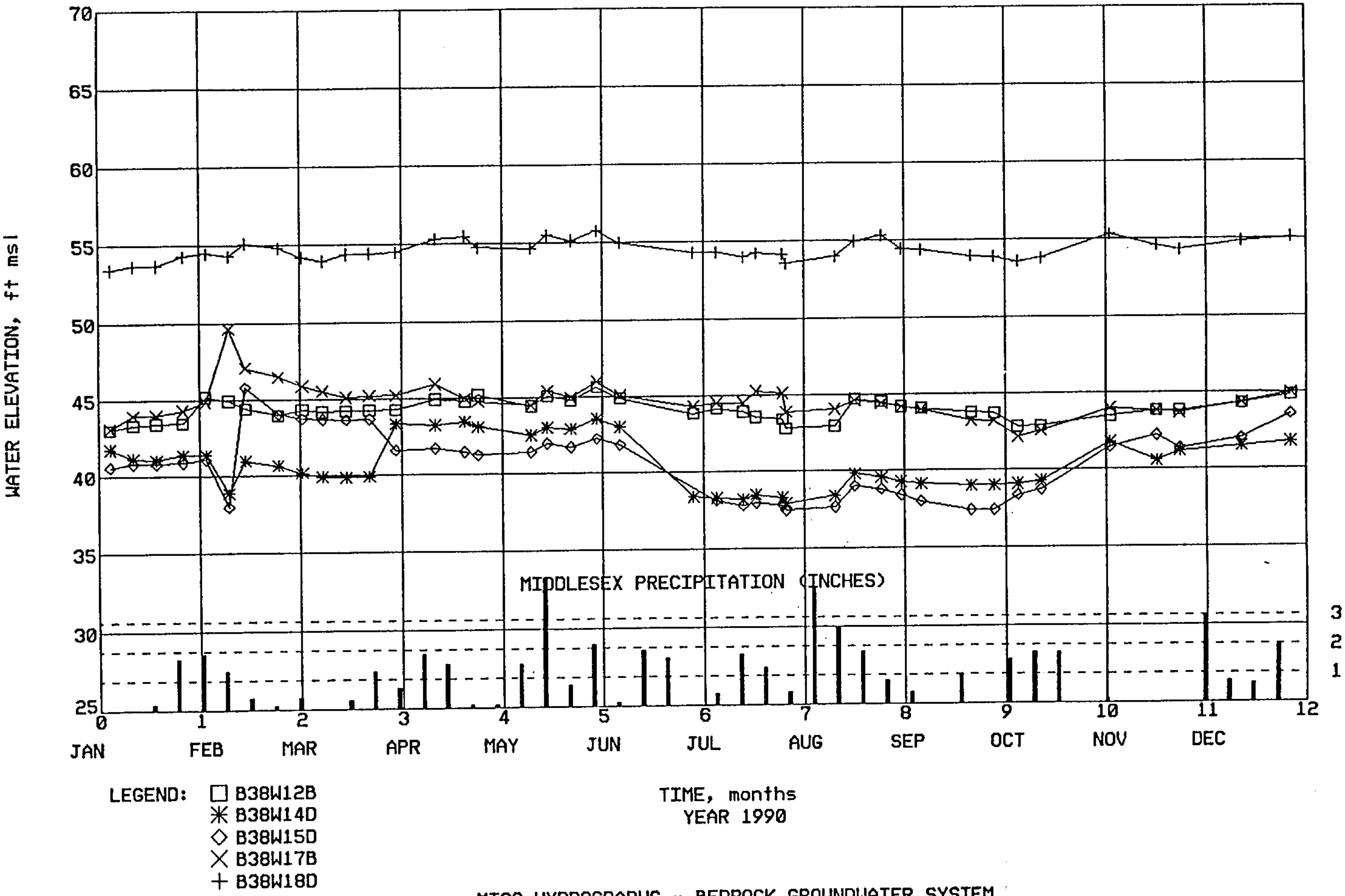
MISS HYDROGRAPHS - UPPER GROUNDWATER SYSTEM



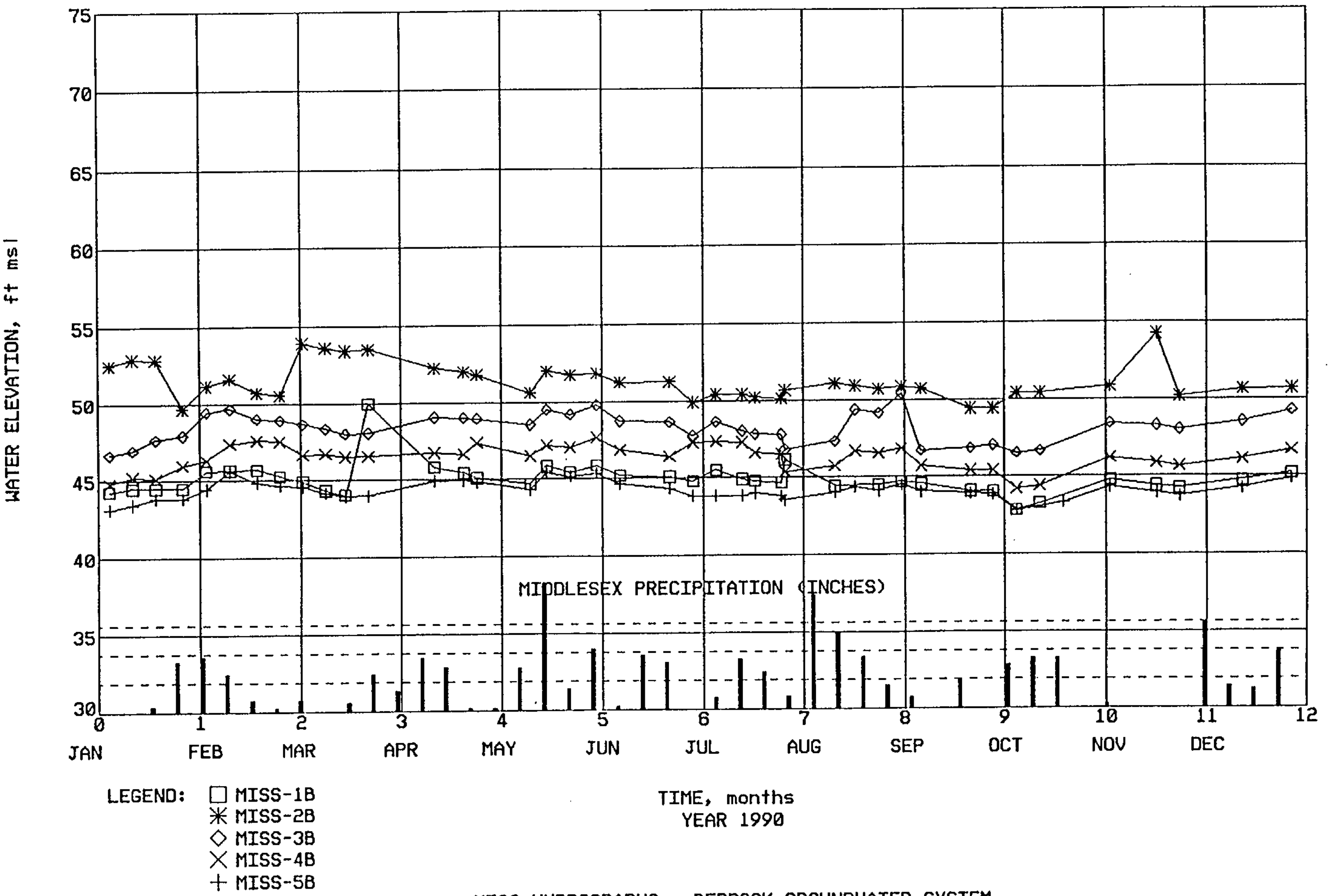
MISS HYDROGRAPHS - UPPER GROUNDWATER SYSTEM



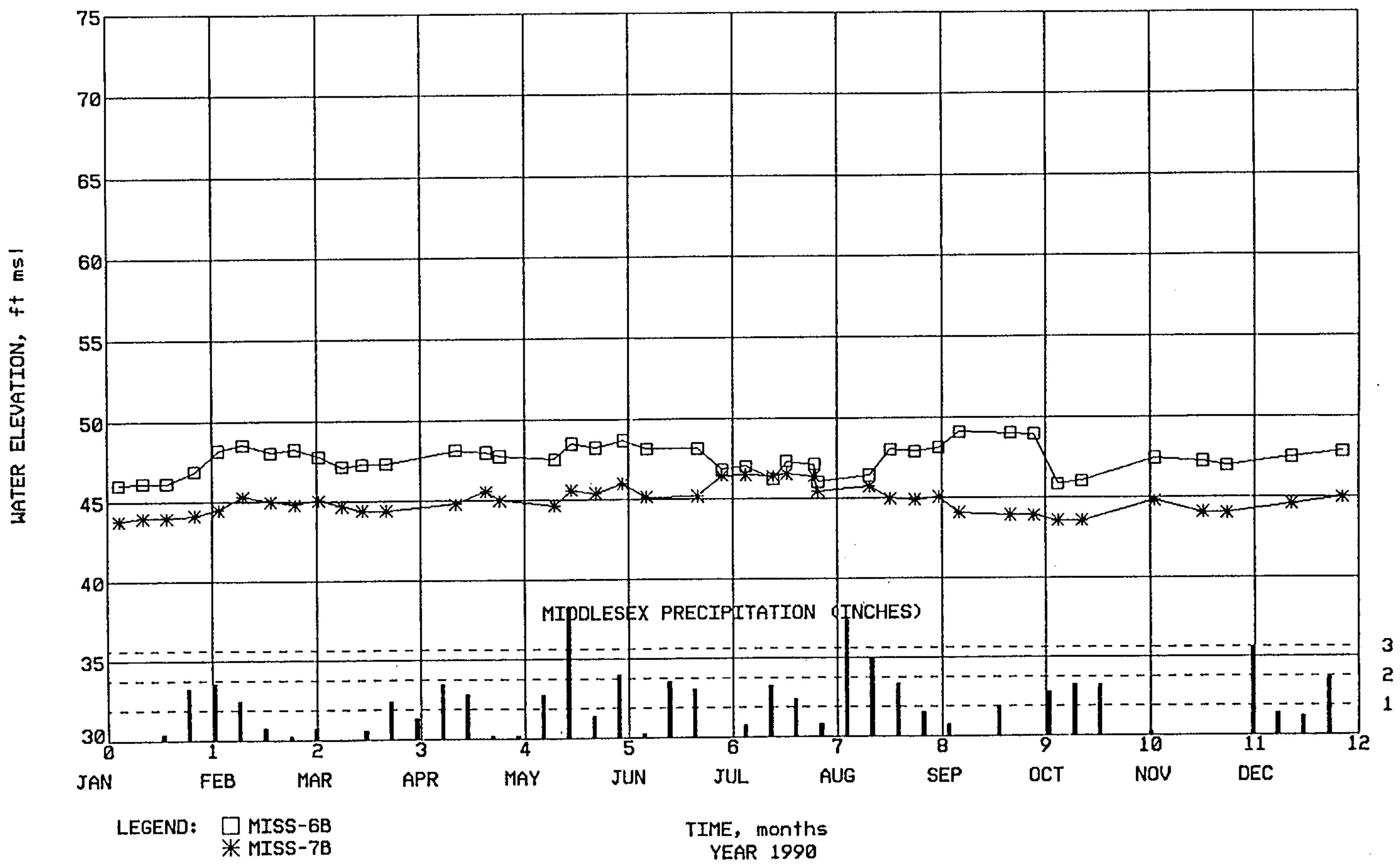
MISS HYDROGRAPHS - BEDROCK GROUNDWATER SYSTEM



MISS HYDROGRAPHS - BEDROCK GROUNDWATER SYSTEM



MISS HYDROGRAPHS - BEDROCK GROUNDWATER SYSTEM



MISS HYDROGRAPHS - BEDROCK GROUNDWATER SYSTEM

APPENDIX F

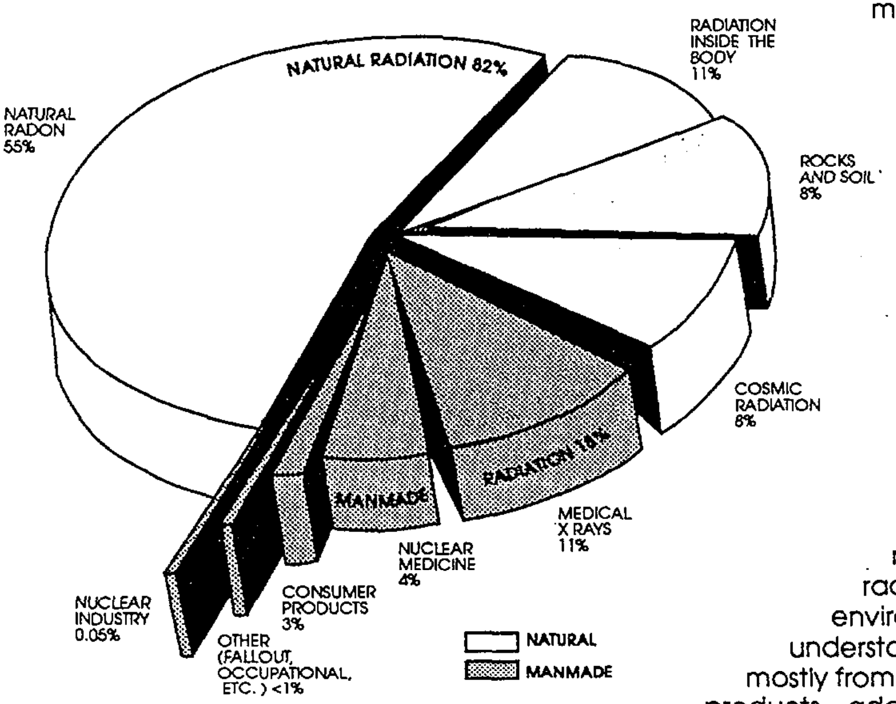
RADIATION IN THE ENVIRONMENT

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.

Units of Measure

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

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

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

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 (Increases about 1/2 mrem for each additional 100 feet in elevation)	26 mrem/year
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
McAipe, 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/year
Color Television	<1 mrem/year
Gas Lantern Mantle (thorium-232)	2 mrem/year
Highway Construction	4 mrem/year
Airplane Travel at 39,000 feet (cosmic)	0.5 mrem/hour
Natural Gas Heating and Cooking (radon-222)	2 mrem/year
Phosphate Fertilizers	4 mrem/year

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

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

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

International Nuclear Weapons Test Fallout from pre–1980 atmospheric tests

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

References

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.
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Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources: Report Number 95. National Council on Radiaton Protection and Measurments , 1987.
Radiation in Medicine and Industry. A.P. Jacoboson and G.P. Sakolosky, 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.

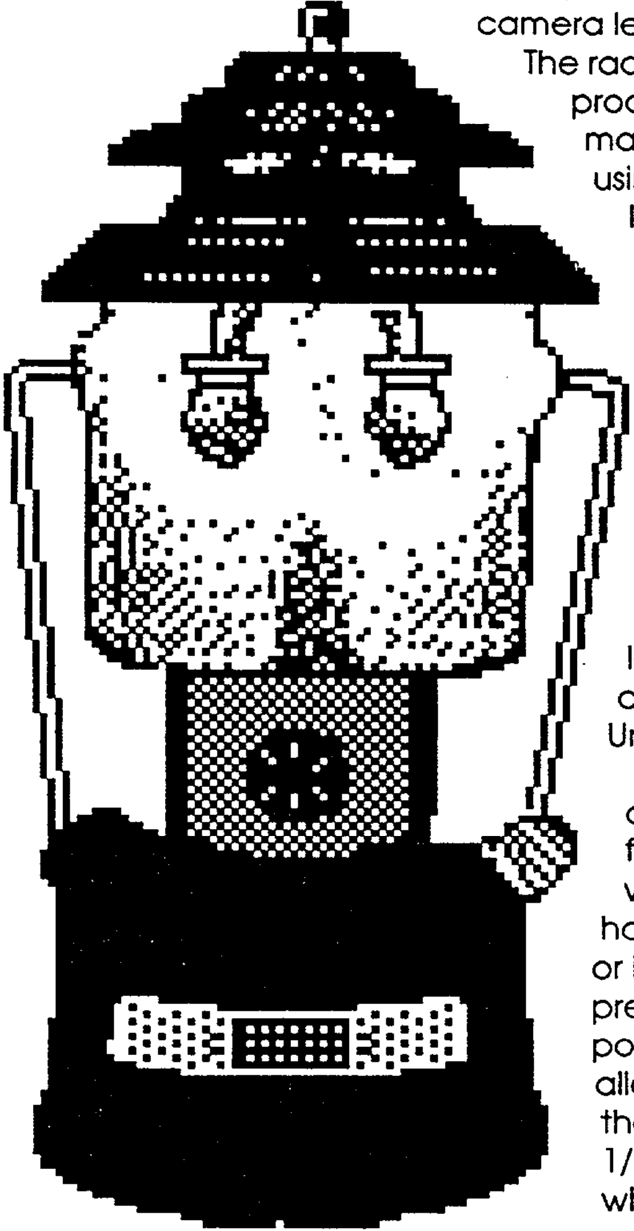
UNIT OF RADIOACTIVITY	SYMBOL	DISINTEGRATIONS PER MINUTE	DOLLAR ANALOGY	EXAMPLES OF RADIOACTIVE MATERIALS
1 Curie	Ci	$2x10^{12}$ or 2 Trillion	2 Times the Annual Federal Budget	Nuclear Medicine Generator
1 Millicurie	mCi	$2x10^{9}$ or 2 Billion	Cost of a New Interstate Highway from Atlanta to San Francisco	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 G
CONVERSION FACTORS

TABLE G-1
CONVERSION FACTORS

1 yr = 8,760 h

1 L = 1,000 ml

1 µCi = 1,000,000 pCi

1 pCi = 0.000001 µCi

0.037 Bq/L = 10^{-9} µCi/ml = 1 pCi/L

0.037 Bq/L = 0.000000001 µCi/ml

1 µCi/ml = 1,000,000,000 pCi/L

$1E^{-6}$ = 1E-6 = 1E-06 = 0.000001 = 1×10^{-6}

$1E^{-7}$ = 1E-7 = 1E-07 = 0.0000001 = 1×10^{-7}

$1E^{-8}$ = 1E-8 = 1E-08 = 0.00000001 = 1×10^{-8}

$1E^{-9}$ = 1E-9 = 1E-09 = 0.000000001 = 1×10^{-9}

$1E^{-10}$ = 1E-10 = 0.0000000001 = 1×10^{-10}

APPENDIX H

CLEAN AIR ACT COMPLIANCE REPORT
FOR MAYWOOD INTERIM STORAGE SITE

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: Maywood Interim Storage Site (Stepan Chemical)
Address: 100, N. Hunter Avenue
Maywood , NJ. 07607
Annual Assessment for Year: 1990
Date Submitted: 3/20/91

Comments: Formerly Utilized Sites Remedial Action Program - U.S D.O.E.

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METEOROLOGICAL AND PLANT INFORMATION SUPPLIED TO PROGRAM----

AVERAGE VERTICAL TEMPERATURE GRADIENT OF THE AIR (DEG K/METER)
   IN STABILITY CLASS E                                                 0.0728
   IN STABILITY CLASS F                                                 0.1090
   IN STABILITY CLASS G                                                 0.1455


PLUME DEPLETION AND DEPOSITION PARAMETERS

NUCLIDE      GRAVITATIONAL   DEPOSITION VELOCITY SCAVENGING   EFFECTIVE DECAY
             FALL VELOCITY                       COEFFICIENT  CONSTANT IN PLUME
             (METERS/SEC)       (METERS/SEC)       (1/SEC)    (PER DAY)


U-238           0.000             0.00180         0.122E-04            0.000E+00
U-235           0.000             0.00180         0.122E-04            0.000E+00
U-234           0.000             0.00180         0.122E-04            0.000E+00
RA-226          0.000             0.00180         0.122E-04            0.000E+00
TH-232          0.000             0.00180         0.122E-04            0.000E+00
```

FREQUENCY OF ATMOSPHERIC STABILITY CLASSES FOR EACH DIRECTION

SECTOR	FRACTION OF TIME IN EACH STABILITY CLASS						
	A	B	C	D	E	F	G
N	0.0000	0.0300	0.2042	0.6347	0.0890	0.0421	0.0000
NNW	0.0051	0.0224	0.1778	0.6169	0.1039	0.0740	0.0000
NW	0.0000	0.0213	0.1184	0.6929	0.0847	0.0826	0.0000
WNW	0.0000	0.0176	0.0765	0.7082	0.0959	0.1017	0.0000
W	0.0000	0.0259	0.0692	0.6788	0.0969	0.1292	0.0000
WSW	0.0000	0.0295	0.0773	0.6385	0.1043	0.1504	0.0000
SW	0.0029	0.0351	0.0774	0.6372	0.1262	0.1211	0.0000
SSW	0.0000	0.0341	0.1081	0.6200	0.1518	0.0859	0.0000
S	0.0017	0.0229	0.0960	0.6580	0.1492	0.0722	0.0000
SSE	0.0023	0.0181	0.0786	0.6961	0.1634	0.0415	0.0000
SE	0.0000	0.0128	0.0532	0.7688	0.1267	0.0384	0.0000
ESE	0.0000	0.0141	0.0433	0.7504	0.1296	0.0625	0.0000
E	0.0000	0.0189	0.0871	0.6810	0.1317	0.0814	0.0000
ENE	0.0000	0.0199	0.1448	0.5329	0.2053	0.0971	0.0000
NE	0.0000	0.0383	0.1512	0.4917	0.2185	0.1003	0.0000
NNE	0.0000	0.0182	0.1230	0.6261	0.1683	0.0644	0.0000

FREQUENCIES OF WIND DIRECTIONS AND RECIPROCAL-AVERAGED WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.141	0.00	3.02	4.73	5.11	3.33	1.43	0.00
NNW	0.028	1.19	1.98	4.42	3.91	3.16	1.39	0.00
NW	0.029	0.00	1.98	3.32	3.96	2.98	1.68	0.00
WNW	0.028	0.00	1.95	3.12	3.72	2.94	1.20	0.00
W	0.049	0.00	1.59	2.44	3.91	2.75	1.31	0.00
WSW	0.043	0.00	1.49	2.76	3.95	2.95	1.46	0.00
SW	0.048	1.19	1.63	3.07	4.48	3.26	1.87	0.00
SSW	0.047	0.00	1.84	3.89	4.94	3.77	1.80	0.00
S	0.082	1.19	2.60	3.87	5.59	3.97	1.78	0.00
SSE	0.061	1.19	2.67	3.97	6.17	3.97	1.46	0.00
SE	0.086	0.00	2.74	4.37	6.81	4.07	1.77	0.00
ESE	0.059	0.00	2.00	3.98	6.73	3.97	1.66	0.00
E	0.092	0.00	2.16	3.69	6.02	3.85	1.74	0.00
ENE	0.080	0.00	2.15	3.81	4.66	3.63	1.81	0.00
NE	0.060	0.00	2.48	3.90	4.32	3.39	1.85	0.00
NNE	0.068	0.00	2.16	3.82	4.92	3.48	1.67	0.00

APPENDIX I

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PARAMETERS FOR ANALYSIS AT MISS, 1990
(continued)

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Medium	Parameter	Technique
Surface Water (cont'd)	Volatile compounds	Gas chromatography/ mass spectroscopy
	Semivolatile compounds	Gas chromatography/ mass spectroscopy
Sediment	Total uranium	Alpha spectrometry
	Radium-226	Gamma spectrometry
	Thorium-232	Gamma spectrometry
	Total metals: aluminum, antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, zinc	Inductively coupled plasma atomic emission spectrophotometry (ICPAES)
	Arsenic, lead, mercury, selenium, thallium	Atomic absorption (AA) spectrophometry
Air	Radon-222	Track-etch
	External gamma radiation	Thermoluminescence