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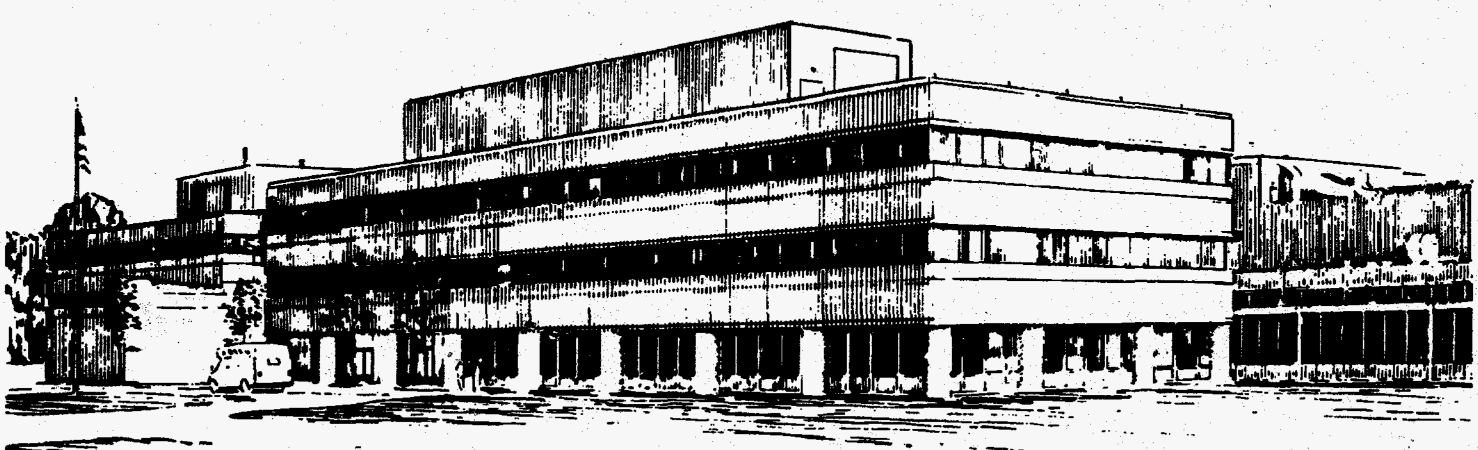
Princeton Plasma Physics Laboratory Annual Site Environmental Report for Calendar Year 1997

by

V.L. Finley and J.D. Levine

January 1999

PRINCETON PLASMA PHYSICS LABORATORY



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Annual Site Environmental Report

for Calendar Year 1997

By Virginia L. Finley and Jerry D. Levine

Princeton Plasma Physics Laboratory

P. O. Box 451

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Princeton Plasma Physics Laboratory (PPPL)
Certification of Monitoring Data for
Annual Site Environmental Report for 1997

Contained in the following report are data for radioactivity in the environment collected and analyzed by Princeton Plasma Physics Laboratory's Radiological Environmental Monitoring Laboratory (REML). The REML is located on-site and is certified for analyzing radiological parameters through the New Jersey Department of Environmental Protection's Laboratory Certification Program, Certification Number 12471. Non-radiological surface and ground water and soil samples are analyzed by NJDEP certified subcontractor laboratories – QC, Inc., Reliance Laboratory, or Core Laboratory, subcontractor to Harding Lawson Associates. To the best of our knowledge, these data, as contained in the "Annual Site Environmental Report for 1997," are documented and certified to be correct.

Signed:

Virginia L. Finley,
Head, Environmental Compliance
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Princeton Plasma Physics Laboratory

Annual Site Environmental Report

For Calendar Year 1997 - Abstract

The results of the 1997 environmental surveillance and monitoring program for the Princeton Plasma Physics Laboratory (PPPL) are presented and discussed. The purpose of this report is to provide the U.S. Department of Energy and the public with information on the level of radioactive and non-radioactive pollutants, if any, that are added to the environment as a result of PPPL's operations.

During Calendar Year 1997, PPPL's Tokamak Fusion Test Reactor (TFTR) completed fifteen years of fusion experiments begun in 1982. Over the course of three and half years of deuterium-tritium (D-T) plasma experiments, PPPL set a world record of 10.7 million watts of controlled fusion power; more than 700 tritium shots pulsed into the reactor vessel generating more than 5.6 x 10^{20} neutrons and 1.6 gigajoules of fusion energy; and researchers studied plasma science experimental data, which included "enhanced reverse shear techniques."

As TFTR was completing its historic operations, PPPL participated with the Oak Ridge National Laboratory, Columbia University, and the University of Washington (Seattle) in a collaboration effort to design the National Spherical Torus Experiment (NSTX). This next device, NSTX, is located in the former TFTR Hot Cell on D site, and it is designed to be a smaller and more economical tokamak fusion reactor. Construction of this device began in late 1997, and first plasma is scheduled for early 1999.

For 1997, the U. S. Department of Energy in its Laboratory Appraisal report rated the overall performance of Princeton Plasma Physics Laboratory as "excellent." The report cited the Laboratory's consistently excellent scientific and technological achievements and its successful management practices, which included high marks for environmental management, employee health and safety, human resources administration, science education, and communications.

Ground-water investigations continued under a voluntary agreement with the New Jersey Department of Environmental Protection. PPPL monitored for the presence of non-radiological contaminants, mainly volatile organic compounds (components of degreasing solvents). Monitoring revealed the presence of low levels of volatile organic compounds in an adjacent area to PPPL.

Also, PPPL's radiological monitoring program characterized the ambient, background levels of tritium in the environment and from the TFTR stack; the data are presented in this report.

Virginia L. Finley and Jerry D. Levine, authors

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List of Acronyms

AFS	Air Facility Subsystem
AGT	above ground tank
AHC	aromatic hydrocarbons
AIRS	Aerometric Information Retrieval System
AIRDOS-EPA	Air Model for USEPA
ALARA	as low as reasonably achievable
APEC	area of potential environmental concern
AR or AR-41	Argon, Argon-41
BOD	biological oxygen demand
BN	base neutral priority pollutant organic compounds
BPX	Burning Plasma Experiment
Bq	Becquerel
BTEX	Benzene, toluene, ethylbenzene, and xylenes
C_4	C site of James Forrestal Campus, part of PPPL site
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAS	Coil Assembly and Storage Building
CASL	Calibration and Service Laboratory
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFCs	chlorofluorocarbons
CFR	Code of Federal Regulations
Ci	Curie (3.7 ^{E10} Becquerel)
CICADA	Central Instrumentation, Control, and Data Aquisition
Cl or Cl-40	Chlorine, Chlorine-40
cm	centimeter
COD	chemical oxygen demand
CS	C site stellarator (PPPL)
CWA	Clean Water Act
CY	calendar year
D	deuterium
D&D	decontamination and decommissioning
D-D	deuterium-deuterium
D-T	deuterium-tritium
D-11, D-12	detention basin monitoring wells number 11 and 12
DATS	differential atmospheric tritium sampler
DeCon	Decontamination (Room)
DMR	discharge monitoring report
DOE	Department of Energy
DOE-CH	Department of Energy - Chicago Operations Office
DOE-EH	Department of Energy – Environment, Safety and Health
DOE-EM	Department of Energy – Environmental Management
DOE-HQ	Department of Energy - Headquarters
DOE-OFES	Department of Energy - Office of Fusion Energy Sciences
DOE-PG	Department of Energy - Princeton Group
D&R	Delaware & Raritan (Canal)
DRCC	Delaware & Raritan Canal Commission
DSN	discharge serial number
EA	Environmental Assessment
EDE	effective dose equivalent
EHS	Environment, Health & Safety
EM-30	Waste Management - DOE
EM-40	Environmental Restoration - DOE
EML	Environmental Monitoring Laboratory (DOE)
EO	Executive Order
EPA	Environmental Protection Agency (US)
EPCRA	Emergency Planning and Community Right to Know Act
ERDA	Energy Research and Development Agency, DOE predecessor agency
ER/WM	Environmental Restoration/Waste Management (PPPL)
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health
F&EM	Facilities and Environmental Management Division (PPPL)
FCPC	Field Coil Power Conversion Building
FFCA	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact

List of Acronyms

FSAR	Final Safety Analysis Report
FSCD	Freehold Soil Conservation District (Middlesex and Monmouth Counties)
g	gram
GBq	giga Becquerel or 10^9Bq
GP	General Permit (Wetlands)
GPMP	Groundwater Protection and Monitoring Program
GW	ground water
H-3	tritium
HAPs	Hazardous Air Pollutants
HMSF	Hazardous Material Storage Facility
HQ	Headquarters
HRS	Hazard Ranking System
HT	tritium (elemental)
HTO	tritiated water
HVAC	heating, ventilation, and air-conditioning
ICRF	Ion Cyclotron Radio Frequency
IC_{25}	inhibition concentration 25 percent
JFC	James Forrestal Campus
km	kilometer
kV	kilovolt (thousand volts)
LEC	liquid effluent collection (tanks)
LEPC	Local Emergency Planning Committee
LLNL	Lawrence Livermore National Laboratory
LOB	Laboratory Office Building
LOI	Letter of Interpretation (Wetlands)
LLW	Low level waste (radiological waste)
m	meter
MCHD	Middlesex County Health Department
MeV	million electron volts
MG	Motor Generator (Building)
mg/L	milligram per liter
MOU	*Memorandum of Understanding*
mrem	milli radiation equivalent man
mR/h	milliRoentgen per hour
MSDS	Material Safety Data Sheet
m/s	meters per second
msl	mean sea level
mSv	milliSievert
MW	monitoring well
n	neutron
N or N-	Nitrogen
NAAQS	National Ambient Air Quality Standards
NB	Neutral beam
NBPC	Neutral Beam Power Conversion Building
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic and Preservation Act
NIST	National Institute of Standards and Technology
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection (prior to 1991 and after July 1994)
NJDEPE	New Jersey Department of Environmental Protection and Energy (1991 to June 1994)
NJPDES	New Jersey Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NOEC	no observable effect concentration
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NRC	National Response Center
NSTX	National Spherical Torus Experiment
nSv	nanoSievert
OH	ohmic heating
OSHA	Occupational Safety and Health Agency
P1, P2	piezometer 1 and 2
PBX-M	Princeton Beta Experiment - Modification
PCAST	Presidential Committee Science and Technology

List of Acronyms

PCBs	polychlorinated biphenyls
PCE	perchloroethylene, tetrachloroethene, or tetrachloroethylene
pCi/L	picoCuries per liter
PFC	Princeton Forrestal Center
PLT	Princeton Large Torus
POTWs	publicly owned treatment works
ppb	parts per billion
ppm	part per million
PPPL	Princeton Plasma Physics Laboratory
PSTP	Proposed Sie Treatment Plan for the Federal Facility Compliance Act
RAA	Remedial Alternative Assessment
RACT	reasonably achieveable control technology
RCRA	Resource Conservation and Recovery Act
REAM	remote environmental atmospheric monitoring (station)
REML	Radiological Environmental Monitoring Laboratory
RESA	Research Equipment Storage and Assembly Building
RI	Remedial Investigation
RMS	Remote Monitoring Station
RQ	reportable quantity
S or S-	Sulfur
SAD	Safety Assessment Document
SARA	Superfund Amendments and Reauthorization Act of 1986
SBRSA	Stony Brook Regional Sewerage Authority
SDWA	Safe Drinking Water Act
SF_6	sulfur hexafluoride
SPCC	Spill Prevention Control and Countermeasure
SNAP	significant new alternatives policy
S&R	shutdown and removal (TFTR)
T	tritium
TBq	tera Becquerel or 10^{12}Bq
TCA	trichloroethane
TCE	trichloroethene or trichloroethylene
TCLP	toxic characteristic leaching procedure (RCRA)
TDS	total dissolved solids
TFTR	Tokamak Fusion Test Reactor
TPH	total petroleum hydrocarbons
TR	trailer atmospheric monitors
TRI	Toxic Reduction Inventory (CERCLA)
TPX	Tokamak Physics Experiment
TSCA	Toxic Substance Control Act
TSDS	tritium storage and delivery system
TSS	total suspended solids
TW	test wells
TWA	treatment works approval
USDA	US Department of Agriculture
USGS	US Geological Survey
USEPA	US Environmental Protection Agency
UST	underground storage tanks
VOCs	volatile organic compounds
c/Q	atmospheric dilution factor (NOAA)
µg/L	micrograms per liter
µSv	microSievert

List of Exhibits Contained in the Text

NOTE: ***All data tables are located in Section 11.0 beginning on page 44.***

Chapter

1

Princeton Plasma Physics Laboratory

Annual Site Environmental Report for Calendar Year 1997

Executive Summary

This report presents the results of the environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Year (1997). The report is prepared to provide the U.S. Department of Energy (DOE) and the public with information on the level of radioactive and non-radioactive pollutants, if any, added to the environment as a result of PPPL operations. The report also summarizes environmental initiatives, assessments, and programs that were undertaken in 1997. The objective of the Annual Site Environmental Report is to document evidence that PPPL's environmental protection programs protect the public health and the environment.

The Princeton Plasma Physics Laboratory has engaged in fusion energy research since 1951 (Fig. 1). The long-range goal of the U.S. Magnetic Fusion Energy Research Program is to develop and demonstrate the practical application of fusion power as an alternative energy source. In 1997, PPPL had one of its two large tokamak devices in operation—the Tokamak Fusion Test Reactor (TFTR) (Fig. 2). The other device, the Princeton Beta Experiment-Modification or PBX-M, did not operate in 1997 (Fig. 3).

On April 4,1997, PPPL completed its historic fifteen years of fusion experiments at TFTR, which begun in 1982. Having set a world record on November 2, 1994, by achieving approximately 10.7 million watts of controlled fusion power during the deuterium-tritium (D-T) plasma experiments, researchers continued to analyze data generated by these experiments, including studying "enhanced reversed shear techniques." Those techniques involved a magnetic-field configuration, which dramatically reduced plasma turbulence and increased particle confinement in the interior regions of the plasma.

Over the course of three and a half years, since November 1993 when deuterium-tritium experiments began in TFTR, more than 700 tritium experiments were conducted, which generated approximately 5.6×10^{20} neutrons and 1.6 gigajoules of fusion energy. These achievements represent steps forward toward the reality of a commercial fusion reactor in the twenty-first century. For twenty-two years—since December 1973, when the goal of D-T experiments was presented to the Energy Research and Development Administration (ERDA-the predecessor of the Department of Energy or DOE)—PPPL has planned, designed, constructed, operated, and maintained TFTR culminating in the success of D-T experiments.

The National Spherical Torus Experiment (NSTX) program, a national collaboration with the Oak Ridge National Laboratory, Columbia University, and the University of Washington (Seattle), is a major effort to produce a smaller and more economical tokamak fusion reactor or volumetric neutron source. NSTX is located in the former TFTR Hot Cell on D site; the design phase was completed in 1997; and construction of this device began in the fourth quarter of 1997. First plasma is scheduled for early 1999.

The 1997 performance of the Princeton Plasma Physics Laboratory was rated "outstanding" by the U.S. Department of Energy in the Laboratory Appraisal report issued early in 1998 [DOE98]. The report cited the Laboratory's consistently excellent scientific and technological achievements, its successful management practices, and included high marks in a host of other areas including environmental management, employee health and safety, human resources administration, science education, and communications.

To strengthen the idea that fusion will provide an environmentally attractive and economically viable energy option for the next century, PPPL continued its environmental monitoring programs. In 1997, PPPL's radiological monitoring program measured on-site and off-site tritium in air, making comparisons with baseline data. Capable of detecting small changes in the ambient levels of tritium in the air, highly sensitive monitors are located at six off-site stations within 1 km of TFTR and at a baseline location. On-site tritium levels are monitored by four air monitoring stations, located on the perimeter of D site, and by a tritium monitor in the TFTR stack. These monitoring stations are required by National Emission Standard for Hazardous Air Pollutants (NESHAPs) regulations with limits set by the U.S. Environmental Protection Agency. Also included in PPPL's radiological environmental monitoring program is precipitation, surface, ground, and wastewater monitoring.

The results of the radiological monitoring program for 1997 were as follows. 1) Radiation exposure, via airborne and sanitary sewer effluents, was measured at low levels. 2) Total maximum off-site dose from all sources—airborne, sanitary sewerage, and direct radiation—was 0.51 mrem/year, which is a fraction of the 10-mrem/year TFTR design objective and the 100-mrem/year DOE limit. 3) Total airborne exposure at the nearest business was 0.10 mrem/year, which is well below the 10-mrem/year NESHAPs limit (see Table 2).

PPPL's non-radiological environmental monitoring program demonstrates compliance with applicable environmental requirements, which includes monthly surface water monitoring for New Jersey Pollutant Discharge Elimination System (NJPDES) discharge permit, NJ0023922. Two discharge locations are identified by Discharge Serial Numbers (DSN): DSN001—the outfall at an on-site detention basin and DSN003—a filter back wash discharge from the Delaware & Raritan Canal pump house. Also, PPPL is required to conduct quarterly chronic toxicity testing at DSN001. As required by the NJPDES ground water (GW) permit, NJ0086029, PPPL collects quarterly ground-water samples from seven monitoring wells and twice-annual samples from the detection basin inflows.

In 1997, PPPL continued its remedial investigation and remedial alternative assessment for C and D sites of the James Forrestal Campus, which is leased to the Department of Energy (DOE) by Princeton University. Since 1989, ground-water data has revealed volatile organic compound (most probably from solvents) contamination at low levels in three locations on-site. In February 1993, Princeton University signed a voluntary agreement, or Memorandum of Understanding (MOU), with the New Jersey Department of Environmental Protection. PPPL's work plan included ground-water sampling, soil sampling, and soil removal from two locations, which exceeded the New Jersey Soil Cleanup Standards.

PPPL has and continues to emphasize environment, safety, and health (ES&H) in accordance with DOE requirements at the facility. The expectations are that the Laboratory will continue to excel in ES&H as it has in its fusion research program. Efforts are geared not only to fully comply with applicable local, state, and federal regulations, but also to achieve a level of excellence. PPPL has state-of-the-art monitoring and best management practices, and is an institution that serves other research facilities with valuable information gathered from its fusion program.

To view current activities and news about PPPL, visit http://www.pppl.gov

Chapter

2

Introduction

2.1 General

Beginning in December 1993, TFTR began deuterium-tritium (D-T) experiments, and in 1994, set new records by producing over ten million watts of energy. The TFTR is a toroidal magnetic fusion energy research device in which a deuterium-tritium (D-T) plasma is magnetically confined and heated to extremely high temperatures by neutral-beam injectors and radio-frequency waves. The TFTR began its first full year of operation in 1983. The total number of neutrons produced in 1997, 7.78×10^{19}, were produced from D-D and D-T operations (Exhibit 2-1); neutron production is a measure of the amount of energy produced during the experiments. Neutron generation is an actual measurement based on data from neutron detectors.

Exhibit 2-1. TFTR Neutron Production 1987-1997

Year	Deuterium-Deuterium Total Neutron Production	Deuterium-Tritium Total Neutron Production
1987	3×10^{18}	
1988	9.04×10^{18}	
1989	6.4×10^{18}	
1990	2.3×10^{19}	
1991	1.56×10^{18}	
1992	1.53×10^{19}	
1993	7.2×10^{18}	1.65×10^{19}
1994	1.3×10^{19}	1.85×10^{20}
1995	2.3×10^{19}	2.04×10^{20}
1996	1.73×10^{19}	8.34×10^{19}
1997	1.04×10^{19}	6.74×10^{19}

Due to federal budget reductions, the experiments, and therefore, the operations of TFTR were concluded in early 1997. Also affected by the budget reduction, the Decontamination and Decommissioning (D&D) project for TFTR was placed on indefinite hold.

As stated in the Strategic Plan, the new Mission of the Fusion Energy Sciences Program is: "Advanced plasma science, fusion science, and fusion technology - the knowledge base needed for an economically and environmentally attractive fusion energy source." In order to support this mission, PPPL management presented its vision of PPPL's role as a National Center for Fusion Science in the Plan. TFTR experiments/operations came to a conclusion in April 1997, with a safe shutdown completed in September 1997. Data analysis continued to assess the scientific and technical achievements. Pursuit of national and international collaborations were accomplished through programs, which sent PPPL researchers to other facilities in the United States and abroad and invited others to collaborate at PPPL.

PPPL continued its collaboration with the Korean fusion science and technology program. The accelerated and improved National Spherical Torus Experiment (NSTX) program, a national collaboration with the Oak Ridge National Laboratory, Columbia University, and the University of Washington (Seattle), is a major effort to produce a smaller and more economical fusion reactor or volumetric neutron source. NSTX is to be located in the former TFTR Hot Cell on D site; the design phase was completed in 1997; and construction of this device began in the fourth quarter of 1997. First plasma is scheduled for the spring of 1999.

2.2 Description of the Site

The Princeton Plasma Physics Laboratory site is in the center of a highly urbanized region extending from Boston, Massachusetts, to Washington, D.C., and beyond. The closest urban centers are New Brunswick, 14 miles to the northeast, and Trenton, 12 miles to the southwest. Major metropolitan areas, including New York City, Philadelphia, and Newark, are within 50 miles of the site. As shown in Figure 4, the site is in central New Jersey within Middlesex County, with the municipalities of Princeton, Plainsboro, Kingston, West Windsor, and Cranbury in the immediate vicinity. The Princeton area continues to experience a substantial increase in new business moving into the Route 1 corridor near the site. Also, the main campus of Princeton University, located primarily within the Borough of Princeton, is approximately three miles to the west of the site.

A demographic study or population study of the surrounding 50 kilometers was completed in 1987 as part of the Environmental Assessment for the former Burning Plasma Experiment (BPX) [Be87a]. Other information gathered and updated from previous TFTR studies included socioeconomic information [Be87b] and an ecological survey [En87].

PPPL is located on the C and D sites of the James Forrestal Research Campus of Princeton University (Fig. 7). The site is surrounded by undisturbed areas with upland forest, wetlands, and a minor stream (Bee Brook) flowing along its eastern boundary and by open, grassy areas and cultivated fields on the west. In an aerial photo (Fig. 1), the general layout of the facilities at the C and D sites of Forrestal Campus is viewed; the specific location of TFTR is at D site (on the left side of photo).

The D site is completely surrounded with a chain-linked fence for controlled access. As an unfenced site with access controls for security reasons, PPPL openly operates C site, allowing the public access for educational purposes. This free access to C site warranted a thorough evaluation of on-site discharges, as well as the potential for off-site releases of radioactive and toxic non-radioactive effluents. An extensive monitoring program, which is tailored to these needs, was instituted and expanded over recent years. The PPPL radiological environmental monitoring program generally follows the guidance given in two DOE reports; A Guide for: Environmental Radiological Surveillance at U.S. Department of Energy Installations [Co81] and Environmental Dose Assessment Methods for Normal Operations at DOE Nuclear Sites (PNL-4410) [St82].

The environmental monitoring program document contains the requirement for adherence to standards given in DOE Orders, in particular, DOE Order 5400.5, "Radiation Protection of the Public and the Environment" [DOE93a]. The order pertains to permissible dose equivalents and concentration guides and gives guidance on maintaining exposures "to as low as reasonably achievable" (ALARA). On December 14, 1993, 10 CFR 835, became effective and replaced DOE Order 5480.11, "Radiation Protection for Occupational Workers," guidelines for DOE nuclear facilities [DOE89]. While issuance of this regulation did not have a major impact on

PPPL operations, the regulation did incorporate some changes in personnel monitoring requirements. Specific criteria for implementing the requirements on TFTR are contained in the TFTR Technical Safety Requirements document (OPR-R-23). These criteria are shown in Table 1.

The emphasis of the radiation monitoring program was placed on exposure pathways appropriate to fusion energy projects at PPPL. These pathways include external exposure from direct penetrating radiation. During TFTR D-T experiments, external exposure from airborne radionuclides, such as argon-41 (Ar-41), nitrogen-13 (N-13), nitrogen-16 (N-16), and internal exposure from radionuclides, such as tritium (H-3) in air and water, were monitored. Tritium releases continue to be measured following TFTR shut down. Six major critical pathways are considered as appropriate (see Exhibit 2-2). Prompt radiation, which is emitted immediately during operations, was also considered and measured during D-T operations. The radiation monitoring program, described in the TFTR Final Safety Analysis Report [FSAR82], was updated to reflect the current environment around TFTR (see Exhibit 2-3). A tritium monitor was installed on the TFTR stack in late 1990; 187.68 Curies (Ci) (124.66 HTO and 63.02 Ci HT), 7.0 TBq of tritium, were released from the stack in 1997.

Exhibit 2-2. Critical Pathways Discharge Pathway

Path	Identification
A1	Atmospheric ---> Whole Body Exposure
A2	Atmospheric ---> Inhalation Exposure
A3	Atmospheric ---> Deposition on Soil & Vegetation Ingestion, Whole Body Exposure
L1	Liquid Water Way ---> Drinking Water Supply --> Man
L2	Liquid Water Way ---> External Exposure
L3	Liquid Water Way ---> Fish ---> Man

Preliminary meteorological data and its associated methodology were reported in Section 2 of the 1982 TFTR FSAR. Subsequently, improved methodologies were implemented. A meteorological tower was erected and began operation in November 1983 (Notes: previous reports included the meteorological data; this compilation was discontinued. However, the data is still being collected and saved.) [Mc83, Ku95] Improved measurements and methodologies are included in the amended FSAR, which is updated annually.

A tracer gas-release test was conducted from July to September 1988 to look at site-specific air-diffusion parameters. These tests were commissioned to determine actual site conditions *versus* model predictions in relation to future activities. Test results indicated that actual dispersion and dilution of effluents in the vicinity of PPPL are enhanced by up to a factor of 16 over that predicted by Nuclear Regulatory Commission approved standard Gaussian diffusion models [St89]. Additionally, as a result of these tracer gas-release tests, a 10-m wind speed and wind-direction sensor was added to the meteorological tower in 1990 to monitor PPPL on-site meteorology more precisely. The U.S. Environmental Protection Agency (EPA) was petitioned through the Department of Energy-Princeton Group (DOE-PG) to use the more realistic χ/Q values from these tests in the AIRDOS-EPA model used for the National Emission Standards for Hazardous Air Pollutants (NESHAPs) calculations. Approval was received in 1991.

DOE Order 5400.1, "General Environmental Protection Program" [DOE90], requires PPPL to have an environmental radiological and non-radiological monitoring plan that contains meteorological, air, water, ground water, and radiological plans [PPPL92]. This environmental monitoring plan was completed in 1991, with revisions made in 1992 and 1995. Further revisions are planned for 1998.

Exhibit 2-3. Radiation Monitoring Program Covering Critical Pathways

Type of Sample	Critical Path I.D.	Sample Point Description	Sampling Frequency	Analysis
Surface	L1,L2,L3 & A3	1) Cooling Water Discharge Drainage 2) Bee Brook upstream & downstream 3) D&R Canal	Monthly	Tritium & Gamma Spectroscopy
Soil & Sod	A3	Within 1 km radius		Tritium & Gamma Spectroscopy
Biota (Fruits & Vegetables)	A3	Within 3 km radius	Seasonal	Tritium & Gamma Spectroscopy
Surface Water	L1, L2	Liquid Effluent Collection Tanks	As Required by Rate of Filling	Tritium & Gamma Spectroscopy, Volume
Air	A1-A3	Test Cell	Continuous	Activated Air (Gross b H-3) (HT and HTO)
Air	A1-A3	Vault	Continuous	H-3 (HT and HTO)
Air	A1-A3	HVAC Discharge (Stack)	Continuous	Activated Air (Gross b) HT and HTO, Particulates, Volume
Direct & Air (on-site)		4 Locations at TFTR Facility Boundary	Continuous	g, n, H-3 (HT and HTO), Gross b for activated air
Direct & Air (off-site)		6 locations off site with 1 km radius	Continuous integrated)	H-3 (HT and HTO)

H-3 = tritium
HT = elemental tritium
HTO = tritiated water

Gross b = Gross beta
g = gamma
n = neutron

2.3 Environmental Setting

The climate of central New Jersey is classified as mid-latitude, rainy climate with mild winters, hot summers, and no dry season. Temperatures range from below zero to above 100 degrees F occurring once every five years. Approximately half the year or from late April until mid-October, the days are freeze-free. Normally, the climate is fairly humid with a total of 40 to 44 inches precipitation evenly distributed throughout the year. Droughts occur about once every 15 years [PSAR78].

The PPPL is situated on the eastern edge of the Piedmont Physiographic Province, approximately one-half mile from the western edge of the Atlantic Coastal Plain Province. The site is underlain largely by gently dipping and faulted sedimentary rock of the Newark Basin. The Newark Basin is one of several rift basins that were filled with sedimentary material during the Triassic Period. At PPPL, bedrock is part of the Stockton Formation, which is reportedly more than 500 feet thick and consists of fractured red siltstone and sandstone [Le87]. The formation strikes approximately north 65 degrees east, and dips approximately 8 degrees to the northwest. The occurrence of limited amounts of clean sand near the surface indicates the presence of the Pennsauken Formation. This alluvial material was probably deposited during the Aftonian Interglacial period of the Pleistocene Ice Age.

Within 25 miles, there are a number of documented faults; the closest of which is the Hopewell fault located about 8 miles from the site. The Flemington Fault and Ramapo Faults are located within 20 miles. None of these faults are considered to be "active" by the U.S. Geological Survey. This area of the country (eastern central US) is not earthquake-prone, with the occurrence of minor earthquakes that have caused little or no damage.

The Millstone River and its supporting tributaries geographically dominate the region. The well-watered soils of the area have provided a wealth of natural resources including good agricultural lands from prehistoric times to the present. Land use was characterized by several small early centers of historic settlement and dispersed farmland. It has now been developed into townhouses, industrial parks, apartment complexes and shopping centers [Gr 77].

The topography of the site is relatively flat and open with elevations ranging from 110 feet in the northwestern corner to 80 feet above mean sea level along the southern boundary. The low-lying typography of the Millstone River drainage reflects the glacial origins of the surface soils; sandy loams with varying percents of clay predominate.

Two soil series are recognized for the immediate environs of the site. Each reflects differences in drainage and subsurface water tables. Along the low-lying banks of stream tributaries, Bee Brook, the soils are classified Nixon-Nixon Variant and Fallsington Variant Association and Urban Land [Le87]. This series is characterized by nearly level to gently sloping upland soils, deep, moderate to well drained, with a loamy subsoil and substratum. The yellowish-white sands contain patches of mottled coloring caused by prolonged wetness. Here, the water table fluctuates between 1.5 and 2.5 feet below the surface in wet periods and drops below 5 feet during the drier months.

In the slightly higher elevations (above 70 feet), the sandy loams are better drained and belong to the Sassafras series. The extensive farmlands and nurseries of the area indicate this soil provided a good environment for agricultural purposes, both today and in the past.

An upland forest type with Oak forest dominant characterizes vegetation of the site. Associated with the various oaks are Red maple, Hickories, Sweetgums, Beech, Scarlet oak, and Ash. Red, white, and black oaks are isolated in the lower poorly drained areas. Along the damp borders of Bee Brook, a bank of Sweetgum, Hickory, Beech, and Red maple define the watercourse. The forest throughout most of the site has been removed either for farmland during the last century or recently for the construction of new facilities. Grass has replaced much of the open areas.

The understory of the wooded areas is fairly open with isolated patches of shrubs, vines, and saplings occurring mostly in the uplands area. The more poorly drained areas have a low ground cover of ferns, grasses, and leaf litter.

An archaeological survey was conducted in 1978 as part of the TFTR site environmental assessment study. From historical records, personal interviews, and field investigations, one projectile point and a stone cistern were found. The site apparently had limited occupation during prehistoric time and has only in recent times been actively used for farming. There are examples of prehistoric occupation in those areas nearer the Millstone River, which are within a mile of the site.

Chapter

3

1997 COMPLIANCE SUMMARY

3.1 Environmental Compliance

Princeton Plasma Physics Laboratory's (PPPL) goal is to be in compliance with all applicable state, federal, and local environmental regulations. As a part of PPPL's Project Mission Statement, PPPL initiates those actions that enhance its compliance efforts and fully document how it is meeting the requirements. The compliance status of each applicable federal environmental statute is listed below:

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

PPPL is not involved nor has been involved with CERCLA-mandated cleanup actions. As a result of the 1991 DOE-HQ Tiger Team assessment, an action plan was developed to conduct a more comprehensive documentation for CERCLA inventory of past hazardous substances. A CERCLA inventory was completed in 1993 [Dy93], and no further CERCLA actions were warranted by the results of the inventory.

3.1.2 Resource Conservation and Recovery Act (RCRA) and Solid Waste

The Laboratory is in compliance with all terms and conditions required of a hazardous waste generator. In 1997, PPPL shipped off site approximately 7.8 tons (7.08 metric tons) of waste to facilities permitted to treat, store, or dispose of hazardous wastes. The three largest sources of waste generated at PPPL were 1) RCRA-regulated, flammable liquids, 2) batteries containing acid (hazardous under RCRA), which were sent to a recycler, and 3) potassium permanganate /sodium hydroxide from the REML [PPPL98].

PPPL is also in compliance with the requirements of the RCRA-mandated Underground Storage Tank Program (also see 3.1.6 and 3.3.3). Following 40 CFR 280 and New Jersey regulations, PPPL removed five underground storage tanks in 1994. In January 1995, PPPL discontinued service from one tank, which was then abandoned in-place in accordance with the New Jersey Underground Storage Tank regulations. As directed by the NJ Department of Environmental Protection (NJDEP) State Case Manager, PPPL submitted a Site Assessment report as part of the Remedial Investigation and Remedial Alternative Assessment Report in March 1997 [HLA97].

In 1997, PPPL's waste hauler removed 110.9 metric tons of solid wastes to a sanitary landfill. In addition, PPPL generated 104.3 metric tons of construction waste that was not recyclable [Ki98].

3.1.3 National Environmental Policy Act (NEPA)

Thirty-four (34) PPPL activities received NEPA reviews in 1997, with all of these determined to be Categorical Exclusions according to the NEPA regulations and guidelines of the Council on Environmental Quality (CEQ) and DOE, or covered in a previously approved environmental assessment (EA).

No EAs or Environmental Impact Statements (EISs) were completed or were in progress in 1997.

3.1.4 Clean Air Act (CAA)

PPPL was in compliance with the requirements of the CAA in 1997. The last required Air Emission Survey for 1994 was submitted in 1995 to NJDEP, who then submitted the survey to the US Environmental Protection Agency (USEPA). The data were incorporated into a national database, the *Aerometric Information Retrieval System* (AIRS), and *the Air Facility Subsystem* (AFS) where it became public information.

In August 1995, PPPL submitted a request for Annual Emission Statement Non-Applicability to the NJDEP. In support of this non-applicability statement, PPPL determined the maximum annual quantity of air contaminants 1) allowed to be emitted by permit from all permitted sources, 2) emitted from all unpermitted source operations operating at their maximum design capacity, and 3) emitted as fugitive emissions. The only regulated air contaminant that has the potential to be emitted by PPPL source operations above the air contaminant thresholds is nitrogen oxides (NO_x). The air contaminant reporting threshold for NO_x in accordance with NJAC 7:27-21.2 is 25 tons per year. PPPL determined that its potential to emit NO_x from permitted sources operating under federally enforceable permit conditions is below this threshold. In March 1996, the NJDEP approved PPPL's exemption for the non-applicability statement.

In addition to filing the non-applicability statement, PPPL submitted a negative declaration for the New Jersey Operating Permit Program. The CAA Title V Operating Permit program is implemented through the State of New Jersey. The negative declaration for the PPPL site was submitted to the NJDEP in August 1995 and was approved in March 1996 with an effective approval date of November 29, 1995. This effective approval date reflects the date that the TFTR emergency diesel generator operating hours were reduced and hence reduced the facility's potential to emit NO_x above the 25 ton-per-year threshold. The TFTR emergency diesel generator permit was the last of the PPPL permits to be amended as part of the negative declaration process.

As a result of a self-assessment by PPPL, the DOE Tiger Team assessment findings, and the Clean Air Act Amendments (CAAA) of 1990, preparation of a detailed air emission inventory was completed in May 1994. The purpose of the inventory was to estimate significant air emissions from each source so that a manageable air emission control program could be established. The inventory includes air emission quantities, point and fugitive emission sources, air-emission producing activities, and permit applicability. The air emission inventory is updated on a tri-annual basis and was partially revised during preparation of the negative declaration and non-applicability statement documents.

In October 1995, PPPL requested of NJDEP a total, fuel use limit for all four boilers. NJDEP granted that request and imposed a maximum annual fuel use limitation for the C site boilers of 227,370 gallons of #4 fuel oil and 88.6 million cubic feet of natural gas. Prior to this date, each boiler was limited by a specific fuel use for #4 fuel oil and natural gas. That arrangement did not allow the boilers to operate at maximum efficiency because specific boilers would be restricted to burn oil during optimal environmental conditions. PPPL continues to operate successfully within the above-stated limitations. For the entire year of 1997, PPPL was in compliance with the fuel use restriction by using a total of 10,206 gallons of #4 fuel oil and 36.3 million cubic feet of natural gas. The four boiler permits (see Exhibit 3.3) were issued as temporary. In 1997, NJDEP stopped issuing 90-day renewal notices, and instead, the last notice remained in effect until a NJDEP representative inspected the facility.

In 1996, PPPL complied with the Stratospheric Ozone Protection Program of the Clean Air Act. More specifically, PPPL currently complies with Section 608 of the Act, which prohibits the venting of ozone-depleting substances through the use of certified refrigerant recovery units. In October 1996, PPPL submitted an inventory of Class I and II ozone-depleting substances (chlorofluorocarbons or CFCs) to DOE. In addition, PPPL safely disposes of equipment containing ozone-depleting substances by removing refrigerant to specified levels before disposal of equipment. PPPL employs trained and certified technicians to service and repair equipment containing ozone-depleting substances and to operate the Laboratory's four refrigerant recovery units.

In March 1995, NJDEP requested that PPPL determine the amount of sulfur hexafluoride (SF_6) released annually from TFTR. Prior to 1995, the amount of SF_6 needed to maintain the SF_6 systems ranged from 28,060 pounds to 36,340 pounds per year. In 1997, 3,335 pounds of SF_6 were used to maintain the modulator regulators, the ICRF, and the NB high voltage and ion source enclosures. With the shutdown of TFTR, SF_6 was removed from the systems and stored for future use.

Through its Procurement and Materiel Control Divisions, PPPL is working to meet requirements of Executive Order 12843, "Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances." The ER/WM and Maintenance & Operations Divisions are working to identify and inventory present and future uses of Class I and Class II ozone-depleting substances.

3.1.5 National Emission Standards for Hazardous Air Pollutants (NESHAPs)

PPPL added a stack sampler to the Tokamak Fusion Test Reactor (TFTR) facility for tritium releases, which has been independently verified as meeting National Emission Standard for Hazardous Air Pollutants (NESHAPs) radionuclide emission monitoring requirements. In August 1993, PPPL received USEPA's concurrence on this determination. In 1997, the levels of tritium released during TFTR deuterium-tritium (D-T) operations were measured: 124.66 curies of tritiated water or HTO and 63.02 curies of elemental tritium or HT (see Table 4) [GA98].

In 1997, the effective dose equivalent to a person at the business nearest PPPL, due to radionuclide air emissions, was 0.12 mrem (1.2 μSv), which is significantly lower than the NESHAPs standard of 10 mrem/yr (Table 2). During their most-recent inspection of PPPL facilities in March 1998, representatives from USEPA Region II indicated that PPPL was in compliance with NESHAPs requirements.

3.1.6 Clean Water Act (CWA)

PPPL is in compliance with the requirements of the CWA. An assessment of ground water has been undertaken as part of an effort that followed identification of leaking underground storage tanks (USTs) containing heating oil and vehicle fuel. Quarterly ground water monitoring for petroleum hydrocarbons and volatile organic compounds was conducted until September 1997 (see Section 6.1.3 B). The data collected for 24 quarters (6 years) were consistent: trace or no petroleum hydrocarbons were detected and the tanks were not the source of any low levels of volatile organic compounds. PPPL concluded quarterly ground-water monitoring should not continue, rather, this program was incorporated into a site-wide monitoring program.

Under the CWA and "New Jersey Discharge of Petroleum and Hazardous Substances" regulation (New Jersey Administrative Code Title 7, Chapter 1E), PPPL reported no releases to the NJDEP in 1997.

3.1.7 National Pollutant Discharge Elimination System (NPDES)

In 1997, PPPL operated under the requirements of New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge permit (NJ0023922). The NJDEP issued the renewed surface water permit on January 21, 1994, effective date of March 1, 1994 [NJDEP94]. The NJPDES surface water permit will expire on February 28, 1999. In a timely manner, *i.e.*,180 days prior to the permit's expiration, PPPL submitted the NJPDES renewal application to NJDEP.

In 1997, the monitoring locations in the permit are the detention basin outfall, discharge serial number 001 (DSN001), and the filter backwash discharge (DSN003) at the Delaware & Raritan Canal pump house. These two locations are designated as monthly sampling points. DSN002 was not sampled during 1997.

Effective June 1, 1996, sampling at DSN002 was eliminated from the NJPDES surface water permit requirements. DSN002 is located on the southwestern boundary where storm water runoff flowed to the wetlands area south of PPPL. Previously, at DSN002, a number of exceedances of total suspended solids occurred due to natural scouring of the swale.

PPPL completed the identification of wastewater streams (industrial discharge) into the Stony Brook Regional Sewerage Authority (SBRSA) system. A site sanitary survey was completed in 1993 and updated in 1995. It is estimated that approximately 3 percent of the combined sewerage flow from PPPL are classified as industrial wastewater and 97 percent as domestic wastewater. In February 1995, SBRSA issued a revised final permit requiring sampling of only the liquid effluent collection (LEC) tank discharge, which collects water from D site where TFTR is located.

Following discussions with SBRSA, PPPL and DOE-PG agreed to report LEC tank data to SBRSA on a monthly basis (tritium, pH, and temperature). The SBRSA industrial discharge permit was changed from a permit to a license in February 1996 with the elimination of the annual sampling requirement, except for chemical oxygen demand (COD). Monthly sampling for tritium, pH and temperature at the LEC tanks remains a requirement of the license. PPPL worked to eliminate the photo laboratory waste stream as an industrial flow to the sanitary sewer. Filters were installed to remove silver from the photographic process wash and rinse water. With the purchase of digital photographic equipment in 1997, the photo laboratory was totally eliminated as a discharge point.

3.1.8 Safe Drinking Water Act (SDWA)

The PPPL receives its drinking water from the Elizabethtown Water Company. While Elizabethtown is responsible for providing safe drinking water, PPPL periodically tests incoming water quality. In 1994, PPPL installed a new backflow prevention system beneath the elevated water tower. In the event of a fire or other emergency situation, PPPL can switch from Delaware & Raritan Canal water (non-potable) to potable water for its non-contact water supply. In 1997, due to breaks in the D&R Canal supply lines, potable water was used for make-up water to the cooling towers and other water systems.

On a quarterly frequency, PPPL inspects and pressure tests the back flow prevention equipment at both locations: the main potable water connection where Elizabethtown Water enters C site and the new system beneath the elevated water tower. A back flow prevention equipment prevents contamination of the potable water supply *via* a large cross-connection. On an annual basis, these systems are completely disassembled, inspected, and tested in the presence of an Elizabethtown Water Company representative. In order to maintain an uncontaminated potable water supply, other cross-connection equipment is tested annually. These inspection reports are submitted to the NJDEP annually.

3.1.9 Toxic Substance Control Act (TSCA)

PPPL is in compliance with the terms and conditions of TSCA for the protection of human health and the environment by requiring that specific chemicals be controlled and regulations restricting use is implemented. The last PPPL polychlorinated biphenyl (PCB) transformers were removed from the site in 1990. At the end of 1997, there were 653 PCB capacitors, which met the regulation criteria, remaining on-site. These capacitors are located in buildings with concrete floors and are protected from the weather, and of the 653 capacitors, 640 capacitors also have secondary containment.

3.1.10 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Certified subcontractors who meet all the requirements of FIFRA, performed the application of herbicides, pesticides, and fertilizers. PPPL Maintenance & Operations Division (M&O) monitors this subcontract. No fertilizers were applied; Pendulum and Roundup were used in limited amounts, 6.5 and 1.0 gallons, respectively.

3.1.11 Endangered Species Act (ESA)

In 1997, PPPL occupied 88.5 acres of the Forrestal Campus of Princeton University. Historically, the 1975 "Final Environmental Statement for the Tokamak Fusion Test Reactor Facilities," the approved "Environmental Assessment (EA) for the TFTR Deuterium-Tritium (D-T) Modifications," and the approved "TFTR Decommissioning and Decontamination (D&D) and Tokamak Physics Experiment (TPX) Environmental Assessment" have indicated that there are no endangered species on-site. [ERDA75] [DOE92] [DOE93b]

As of 1993, the NJDEP, Division of Parks and Forestry, *Natural Heritage Data Base* [Dy93], reported that there are no records for rare plants, animals, or natural communities on the PPPL site. There are records for a number of occurrences of rare species that may be on or near waterways surrounding the site. As the Natural Heritage data is based on a literature search and on individuals' observations of endangered species in the vicinity of PPPL and is not based on site-specific surveys and/or observations, the data obtained from this database are not considered definitive.

In 1997, as part of the Remedial Investigation, Amy S. Greene Environmental Consultants, Inc conducted a baseline ecological evaluation [AM98]. The New Jersey Audubon Society has visually verified and reported a pair of Cooper's Hawk (*Accipiter cooperii*) nesting within one mile of the PPPL property [NJB97]. Cooper's hawks are presently listed as threatened in the state of New Jersey [NJDEP97]

3.1.12 National Historic Preservation Act (NHPA)

There are no identified historical or archaeological resources at PPPL. No buildings or structures have been identified as historical [Gr77].

3.1.13 Executive Orders (EO) 11988, "Floodplain Management"

The PPPL is in compliance with EO 11988, "Floodplain Management." Delineation of the 500 and the 100-year floodplains was completed in February 1994. The 500-year and the 100-year floodplains are located at the 85-foot elevation and at the 80-foot elevation above mean sea level, respectively [NJDEP84] (see Fig. 8).

In 1995, PPPL began preparing a site-wide stormwater management plan. It would have included the proposed second cell detention basin, which was in the conceptual design phase. In the process, PPPL discovered that the Princeton Forrestal Center (PFC), the management group for Princeton University's corporate office and research complex, included the PPPL site in their Stormwater Management Plan. This plan was submitted to the Delaware Raritan Canal Commission (DRCC) in 1980 and a Certificate of Approval was signed on May 20, 1980. The 72-acre parcel that PPPL occupies is included in PFC's stormwater management plan-Phase I. The 72-acre parcel is part of the Bee Brook watershed and therefore includes PPPL in the PFC stormwater plan.

One condition of the PFC Storm Water Management Plan is that the average density of development does not exceed a maximum of ≤60% impervious coverage in developable areas. PPPL meets the ≤60% impervious coverage limit and is in compliance with the stormwater requirements. PPPL determined that the aforementioned, second detention basin was not required. The Site-Wide Stormwater Management Plan was completed in February 1996 [SE96].

In 1997, PPPL prepared a Site-Wide Storm Water Pollution Prevention Plan. Incorporating the Storm Water Management Plan, Spill Prevention Control and Countermeasure (SPCC) Plan, and other best management practices, this plan was a culmination of activities already in practice at PPPL.

3.1.14 Executive Orders (EO) 11990, "Protection of Wetlands"

PPPL is in compliance with the EO 11990, "Protection of Wetlands." Formal study and delineation of wetland boundaries within the PPPL 72-acre site are complete. Using infrared film for aerial photographs, the presence of wetland-type vegetation was found on the north and eastern boundaries of the Laboratory property. In July 1993, an "Application for a Letter of Interpretation" (LOI) for the entire 72-acre site was filed with the NJDEP Land Use Regulation Program. The LOI application included: US Geological Survey (USGS) topographic maps, National Wetlands Inventory maps, US Department of Agriculture (USDA) Soil Conservation maps, aerial photographs, and vegetation maps. These maps were used to prepare the delineation program and the target critical areas.

Wetland boundaries were flagged based on an analysis of soil type, vegetation identification, and area hydrology, *i.e.*, depth to ground water. Soil profiles to determine soil type were conducted through soil borings, which were also analyzed for indications of seasonal high water table. A wetland delineation map that indicated the boundary, sequential flag numbers, and soil boring locations was prepared (see Fig. 8).

The Land Use Regulation Program within NJDEP continues to be the lead agency for establishing the extent of state and federally regulated wetlands and waters. The U.S. Army Corps of Engineers retains the right to re-evaluate and modify wetland boundary determinations at any time.

In 1997, PPPL conducted no activities that require wetland permits prior to actions on site. Wherever possible, PPPL seeks alternatives to modifying or disrupting the wetlands and/or transition zone.

3.1.15 Executive Order 12856, "Federal Compliance with Right-to-Know and Pollution Prevention Requirements," and Superfund Amendments and Reauthorization Act (SARA) Title III, Emergency Planning and Community Right-to-Know Act (EPCRA)

Emergency Planning and Community Right-to-Know Act, Title III of the 1986 SARA amendments to CERCLA created a system for planning responses to emergency situations involving hazardous materials and for providing information to the public regarding the use and storage of hazardous materials. Under the reporting requirements of Executive Order 12856 and SARA Title III, PPPL has complied with the following:

Exhibit 3-2. Summary of PPPL Reporting Requirements

EPCRA 302-303: Planning Notification	YES [✓]	NO [ ]	NOT REQ. [ ]
EPCRA 304: EHS* Release Notification	YES [ ]	NO [ ]	NOT REQ. [✓]
EPCRA 311-312: MSDS/Chemical Inventory	YES [✓]	NO [ ]	NOT REQ. [ ]
EPCRA 313: TRI Inventory	YES [ ]	NO [ ]	NOT REQ. [✓]

*EHS = Environment, Health and Safety

In 1997, PPPL submitted an annual chemical inventory to be in compliance with SARA Title III (EPCRA 312). This inventory reports the quantities of chemicals listed on the CERCLA regulations.

Under SARA Title III, PPPL provides the following to the applicable emergency response agencies: 1) An inventory of hazardous substances stored on-site, 2) Material Safety Data Sheets (MSDS), and 3) completed SARA Tier I forms listing each hazardous substance stored by users above a certain threshold planning quantity (typically 10,000 pounds, but lower for certain compounds). Exhibit 3-3 lists hazardous compounds at PPPL reported under SARA Title III for 1997 [PPPL1997a].

Exhibit 3-3. Hazard Class of Chemicals at PPPL

Compound	Fire	Sudden Release of Pressure	Acute Health Hazard	Reactive	Chronic Health Hazard
Carbon dioxide		✓		✓	
Chlorodifluoromethane (HCFC-22)		✓		✓	
Dichlorodifluoromethane (CFC 12)		✓		✓	
Fuel Oil	✓				
Gasoline	✓				✓
Helium		✓			
Nitrogen		✓			
Petroleum Oil	✓				
Polychlorinated Biphenyls					✓
Sulfur Hexafluoride		✓			
Sulfuric acid			✓	✓	
Trichlorotrifluoroethane (CFC 113)				✓	

Section 304 of SARA Title III requires that the Local Emergency Planning Committee (LEPC) and state emergency planning agencies be notified of accidental or unplanned releases of certain hazardous substances to the environment. To ensure compliance with such notification provisions, a Laboratory-wide procedure, ESH-013, "Non-Emergency Environmental Release—Notification and Reporting," includes SARA Title III requirements. The NJDEP administers SARA Title III reporting for the USEPA and has modified the Tier I form to include SARA Title III reporting requirements and NJDEP reporting requirements.

Because PPPL's use of chemicals listed on the Toxic Release Inventory (TRI) is below the threshold amounts, PPPL is technically not required to submit the TRI. Following DOE's guidance issued in 1994, PPPL completed an annual submittal to DOE for 1997 that included the TRI cover page and laboratory exemption report.

3.1.16 Federal Facility Compliance Act (FFCA)

The Federal Facility Compliance Act (FFCA) requires the Department of Energy (DOE) to prepare "Site Treatment Plans" for the treatment of mixed waste, waste containing both hazardous and radioactive components. Based on the possibility of the site generating mixed waste, which could require treatment on site, PPPL was identified on the list of DOE sites that would be included in the FFCA process [PPPL95]. In 1995, PPPL prepared its "Proposed Site Treatment Plan (PSTP) for Princeton Plasma Physics Laboratory (PPPL)."

PPPL has developed an approach where any potential mixed waste would be treated in the original accumulation container within 90 days of generation of the hazardous waste. This treatment option was discussed with the State of New Jersey and USEPA Region II regulators, who were in agreement with this approach. Based on their agreement, this approach will keep PPPL in compliance with the applicable Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions. However, DOE will provide the state and USEPA with annual updates and will keep the regulators apprised of the status of activities. If mixed wastes were generated that could not be treated in original accumulation containers, PPPL would notify the regulators and provide them with a revised "Site Treatment Plan" [PPPL95].

3.1.17 Safety

PPPL's 1997 performance with respect to worker safety was as follows:

1.	Recordable injury case rate:	1.88 per 100 employees
2.	Lost Work Day case rate:	0.51 per 100 employees
3.	Lost Work day rate:	7.69 per 100 employees
4.	Number of radioactive contaminations (external):	0
5.	Number of Safety Occurrence reports: (OSHA confined space, chemical exposure, and lock out/tag out incidents)	1

3.2 Current Issues and Actions

3.2.1 Air Issues and Actions

Several small, fundamental projects at PPPL that capture the intent of Section 612, "Significant New Alternatives Policy Program (SNAP)," are underway. In 1997, proposals for alternative refrigerants and retrofits for large equipment (chilled water systems) that use ozone-depleting substances were submitted to DOE for approval and funding. Through PPPL's Waste Minimization and Pollution Prevention program, PPPL is continuing to examine substitutes for degreasing compounds, especially for the future TFTR shutdown and removal activities. Specifically, the DeCon room (former Hot Cell) degreaser will not operate using a chlorofluorocarbon as the solvent. A detergent containing no volatile organic compounds or hazardous air pollutants (HAPs) will be used.

In 1996, PPPL received approval from NJDEP for a negative declaration and a non-applicability statement for the CAA Operating Permit Program and the NJDEP Annual Emission Statement, respectively. In support of the negative declaration and non-applicability statement, several amendments were made to existing permits. The TFTR emergency diesel generator was limited to 200 hours of operation per year and the boilers were limited to a total emission rate of ten tons per year based on fuel limitations. Through these amendments PPPL determined that its potential to emit NO_x from permitted sources is 23 tons per year. This estimate is based upon exaggerated fuel consumption. The actual NO_x emissions from PPPL permitted sources based on actual fuel consumption and operating hours during 1997 was 2.9 tons per year.

3.2.2 NJPDES Surface Water Permit No. NJ0023922 Issues and Actions

During 1997, two non-compliances were reported: one for total suspended solids (TSS) exceedance and one for missing a parameter; both occurred at DSN003 (Delaware & Raritan Canal pump house discharge) (see Table 19). The total suspended solid limit was exceeded, probably due to high solids in the D&R Canal at the time the sample was collected and was not due to PPPL operation of the pump house. The missed sample was due to an error by the analytical laboratory, and could not be corrected before the end of the sampling period; the results were received late in the day of the last day of the month.

During NJDEP's review of the TFTR deuterium-tritium (D-T) Environmental Assessment (EA), an issue regarding the elevated temperature in Bee Brook at location B2 was raised. The New Jersey Surface Water Quality Standards limit the temperature of the discharged water to a maximum increase of 2.8°C (5.0°F) above ambient water temperature at any time. It has been noted that there are times in the winter when the delta t (Δt or the difference in temperature between the discharged and surface waters) was greater than the 2.8°C limit.

Through a site investigation, PPPL determined dewatering various building foundations and directing the ground-water flow to the basin caused higher water temperatures. Temperature of ground water is a near constant 12.8° C (55°F) all year round, while in the winter surface water temperatures drop to as low as 0°C (32°F). For 1997, the average amount of ground water pumped to dewater D site (TFTR and MG basements) and C site (LOB and CS basements) was 311,752 gallons per day; this average daily withdrawal was only slightly below the withdrawal rate in 1996 (316,025 gallons per day) (see Table 33). This flow accounts for most of the flow from the basin.

In September 1997, the NJDEP conducted its annual inspection of the facility including record maintenance. The inspector rated PPPL "acceptable," with no deficiencies noted.

Under NJPDES requirements, Chronic Toxicity Testing was conducted quarterly using the effluent from the basin, DSN001. The test organisms, *Pimephales promelas* or fathead minnows, survived in 100 percent concentration of PPPL's detention basin discharge over the test period for all tests.

3.2.3 NJPDES Ground Water Permit No. NJ0086029 Issues and Actions

PPPL's ground water discharge permit (NJ0086029) expired on December 31, 1994. A renewal application was prepared and included a report on ground-water quality based on quarterly ground water samples collected from December 1989 through February 1994 [Fi94]. In this application, the PPPL and DOE-PG requested that NJDEP delete from the permit three off-site wells, for which the adjudicatory hearing was requested.

In 1997, NJDEP did not issue a renewed NJPDES ground water permit; PPPL and DOE-PG continue to comply with the requirements of the expired permit. DOE-PG has requested that the NJDEP review past ground water data and reduce the frequency and number of sampling locations in the renewed permit. In October 1997, representatives of DOE-PG, PPPL, and NJDEP met to review the status of the ground water NJPDES permit program. The NJDEP has proposed a Ground Water Protection Plan (GWPP) be prepared by the permittee, in which data and recommendations are presented to reduce sampling locations, sampling frequency, and parameters.

One of the requirements of the NJPDES permit was to conduct a site-wide hydrological study. Based on quarterly ground-water monitoring data and the site-wide hydrological studies (presence of volatile organic compounds in ground water), NJDEP required further investigation of James Forrestal Campus. Princeton University signed a Memorandum of Understanding (MOU) in February 1993. Princeton University has responsibility for investigating A/B sites, and PPPL and DOE-PG have responsibility for C and D sites.

Under the terms of the MOU, PPPL has conducted several rounds of environmental characterization and remediation. In 1995, after the NJDEP granted "conditional approval" of PPPL's Remedial Investigation Work Plan, soil and ground water samples were collected and analyzed for seven (7) identified areas of potential environmental concern (APECs). Results from these samples indicated that only two (2) APECs contained chemicals above the most stringent NJDEP Soil Cleanup Criteria applicable. In 1996, contaminated soil and sediments were removed from these APECs for off-site treatment and disposal. Post-excavation sampling confirmed that the NJDEP Soil Cleanup Criteria were met by the remedial actions.

In 1996, PPPL installed four new monitoring wells south of the CAS/RESA Building, in order to fully delineate the extent of ground water contamination in this area. These wells and other ground water characterization activities lead to the identification of a new APEC near the former PPPL Annex Building (see Figure 1). The Remedial Investigation activities conducted in 1995 and 1996 are documented in the Remedial Investigation Report prepared by Harding Lawson Associates, which was submitted to NJDEP in March 1997 [HLA97]. Characterization in the former Annex Building area was conducted during the summer of 1997. Eight new ground water monitoring wells were installed in the area of the former Annex Building.

In 1997, DOE-PG amended its lease with Princeton University to include an additional 16.5 acres adjacent to the existing 72 acres for a total of 88.5 acres. These additional acres include the site of the former Annex Building, which is under the investigation described above.

3.2.4 Tiger Team and Self-Assessments Issues and Actions

PPPL was audited by a DOE Tiger Team between February 11, 1991, and March 12, 1991. During PPPL's own self-assessment performed in late 1990, PPPL had identified over 70 percent of the Tiger Team findings. There were 54 environmental findings; none of which represented situations that presented an immediate risk to public health or to the environment or that warranted an immediate cessation of operations. An Action Plan was finalized by PPPL in April 1991 and approved and officially released by DOE/HQ in April 1992. Of the 612 milestones addressing the 300 Tiger Team findings and concerns, only 3 milestones remain; 99.5 percent have been completed as of early 1998.

3.2.5 Integrated Safety Management

PPPL developed a description document outlining how the Laboratory implements Integrated Safety Management (ISM), which every PPPL Department and Project endorsed. Integrated Safety Management at PPPL is accomplished consistent with DOE policy, requirements, and guidance in a manner that applies controls and precautions tailored appropriately to the hazards of the projects and work being performed. ISM at PPPL is comprised of two components. (1) The governing policy that safety be integrated into work management and work practices at all levels. (2) The distinct policies, programs, procedures, and cultural beliefs that have been developed as the structure that PPPL workers utilize in fulfilling the Laboratory's environment, safety, and health responsibilities.

Although the term "integrated safety management" has only become prevalent in recent years, integrating safety into the management of work and into work practices has been the Laboratory's philosophy and practice for years. Therefore, no new systems or programs are required to implement ISM at PPPL. The Laboratory has established policies, procedures and manuals that define the Laboratory's ES&H objectives. These documents continue to be updated and improved, and form the basis for the Laboratory's Integrated Safety Management Plan. PPPL is conducting small group meetings with the various staff to review how PPPL implements ISM and one of the Laboratory's "Critical Outcomes" cited in the FY99 Institutional Plan is to assure full implementation of the Integrated Safety Management Program.

3.3 <u>Environmental Permits</u>

PPPL Environmental Restoration/Waste Management Division maintains a list of Environmental Permits (see Exhibit 3-3) which is updated bi-monthly. A discussion of environmental permits required by the applicable statutes is found in Sections 3.0 and 6.0, "Environmental Non-Radiological Program Information."

Exhibit 3-3. PPPL Environmental Permits

Permit No.	Permit Type	Effective Date	Expiration Date	Status
0086029	NJPDES Groundwater	4/1/89	12/31/96	In compliance. Renewal application submitted to NJDEP 7/5/94.
0023922	NJPDES Surface water	1/21/94 Effective 3/01/94	02/28/99	In compliance. Chronic toxicity testing back to quarterly schedule.
092187	TFTR Diesel Exhaust	10/24/89	10/24/99	Current
096074	C-site Diesel Exhaust	6/28/90	6/28/00	Current
094831	DeCon Room Degreaser Vent formerly Hot Cell	3/30/90	6/16/97	Id. No. 15952 Current. Permit modifications in progress.
826	Elizabethtown Water Physical Connection	4/1/93	3/31/98	Current
061295	Boiler #2 Stack Vent	3/31/82	7/11/97 extended	Current. Temporary 90-day permit
061296 *118817*	Boiler #3 Stack Vent Mod. to Boiler #3	3/31/82 10/21/94	7/6/97 extended	Current. Temporary 90-day permit
061297	Boiler #4 Stack Vent	3/31/82	7/11/97 extended	Current. Temporary 90-day permit
061299	Boiler #5 Stack Vent	3/31/82	7/11/97 extended	Current. Temporary 90-day permit
061298	Oil Tank Vent #2	3/31/82	3/31/97	Cancelled
0128306	Medical Waste Gener.	7/22/91	7/21/98	Current
DR-18A	D&R Canal Water Use	7/1/84	6/30/2009	Current
12471	REML Laboratory Cert.	7/1/91	6/30/98	Current
111580	CAS Dust Collector	3/10/93	3/10/98	Current
113444	FED Dust Collector	7/23/93	7/23/98	Current
113445	Shop Dust Collector	7/23/93	7/23/98	Current
separate list	Well Permits	NA	NA	Current
114785	Air Permit - AGT 15,000 gal. Diesel Oil	10/25/93	10/25/98	Current
119065	Air Permit - AGT 25,000 gal.# 4 Oil	10/25/94	10/25/99	Current
22-93-NC	SBRSA Indus. Disc.	2/15/95	2/25/00	Current
1218-910001.2	Wetlands-LOI	1/13/94	1/13/99	Wetlands Delin. Plan
10944W	Water Use Registration	6/10/96	NA	Wells 4&5 annual report

Chapter 4

ENVIRONMENTAL PROGRAM INFORMATION

4.1 Summary of Radiological Monitoring Programs

Monitoring for sources of potential radiological exposures is extensive. Begun in 1981, real-time prompt gamma and/or neutron environmental monitoring on the TFTR site established baselines prior to machine operation. In 1997, the following air stations were monitored:

Exhibit 4-1. Radiological Air Monitoring Stations

Station Name	Number/Description	Figure
Remote Environmental Air Monitoring (REAM)-off site	Stations *R 1- 6*: Tritium	6
TFTR radiological monitoring system (RMS) on D site	8 Neutron detectors and gamma ionization detectors and passive tritium monitors at *T 1-4*:	5
Radiological monitoring system (RMS) at property line stations	2 Neutron detectors and gamma ionization detectors at Northeast (*RMS-NE*) and Southeast (*RMS-SE*)	5

Water samples are collected at the same locations for both non-radiological and radiological samples that are analyzed for tritium, HTO (Exhibit 4-2).

Exhibit 4-2. Radiological and Non-Radiological Water Monitoring Stations

Station #	Location/Figure #	Description
B1	Off-site / 5	Bee Brook Upstream of discharge from detention basin
B2	Off-site /5	Bee Brook Downstream of discharge from detention basin
C1	Off-site / 6	Delaware & Raritan Canal (Plainsboro)
D1	On-site / 5	D site Manhole-stormwater sewer
DSN001	On-site / 5	Surface Water Discharge from the detention basin
E1	On-site / 6	Elizabethtown Water Company - potable water supply
M1	Off-site / 6	Millstone River - Plainsboro & West Windsor boundary-Route 1
P1	Off-site / 6	Plainsboro Surface Water - Millstone River
P2	Off-site / 6	Plainsboro Surface Water - Devils Brook

The most recent and comprehensive assessment of population distribution in the vicinity of PPPL was completed for the Burning Plasma Experiment (BPX) Environmental Assessment (EA) [Be87a]. PPPL is situated in the metropolitan corridor between New York City to the northeast and Philadelphia to the southwest. Census data indicate that approximately 16 million people live within 80 km (50 miles) of the site and approximately 212,000 within 16 km (10 miles) of PPPL.

The overall, integrated, effective-dose equivalent (EDE) from all sources (excluding natural background) to a hypothetical individual residing at the nearest business was calculated to be 0.12 mrem (1 μSv) for 1997 (see Table 2). Detailed person-rem calculations for the surrounding population were not performed, because the value would be insignificant in comparison to the approximately 100 mrem (1 mSv) that each individual receives from the natural background, exclusive of radon, in New Jersey. However, scaling and estimating[1] were performed and yielded a value of 6.1 person rem (0.06 person-Sievert) out to 80 km (also see Table 2).

4.2 Summary of Non-Radiological Monitoring Program

During 1997, PPPL operated under the current NJPDES surface water permit, No. NJ0023922, which became effective on March 1, 1994. As stated in the permit conditions, PPPL monitored monthly the discharge of the detention basin, discharge serial number—DSN001. Once each month, water quality at DSN001 is assessed by monitoring temperature, pH, petroleum hydrocarbons, total suspended solids, chemical oxygen demand, chlorine-produced oxidants, and flow. Additional parameters measured are biological oxygen demand, phenols, ammonia-nitrogen, and total dissolved solids. Monthly data exists for this location dating back to 1984. Monthly sampling continued at DSN003— a filter backwash discharge located at the Delaware and Raritan Canal pump house (Fig 6).

As a requirement of the permit, a chronic toxicity characterization study was conducted to test the DSN001 effluent. Quarterly study results were submitted for March, June, September, and December 1997 tests. Quarterly chronic toxicity testing was conducted with the fathead minnow (*Pimephales promelas*) as the test organism. Following the December 1997 test, PPPL and DOE-PG requested that the NJDEP reduce the quarterly frequency to annual based on successful completion of twelve consecutive chronic toxicity tests.

In 1991, NJDEP required a monitoring program to determine if ground water is being impacted from the five former underground storage tanks removed in 1989. PPPL had a total of eleven underground storage tanks; five tanks were removed in 1989, five more tanks were removed in 1994, and one tank was abandoned in-place in 1995. This ground-water monitoring program, separate and distinct from the NJPDES groundwater discharge permit requirements, required monitoring of 10 wells, which are located near the former tanks; total petroleum hydrocarbons (TPHs) and volatile organic compounds were analyzed quarterly.

As a requirement of the NJPDES ground-water permit, Discharge Permit No. NJ0086029, seven ground water monitoring wells were sampled quarterly in 1997 (Exhibit 6-2 and Figs. 5 & 7). Exhibit 4-3 presents the required parameters, wells, frequency, and permit standard. Under May 5, 1997-adopted NJPDES regulations, NJDEP extended expiration dates for all permits until a new ground-water discharge permit could be issued.

[1]Scaling was done using the ratio of the actual released amount of airborne radionuclides to the quantities cited in the TFTR D-T EA multiplied by the calculated dose. For calculating the liquid component, assumptions are described in Table 2, Note 14. Other sources are negligible contributors.

Exhibit 4-3. NJPDES NJ0086029 Ground Water Discharge Standards and Monitoring Requirements for Ground Water Monitoring Wells

Parameters (these wells only)	Standards	Feb.	May	Aug.	Nov.
Ammonia-Nitrogen	0.5 mg/L		X	X	X
Base/Neutral Extractable	See Note below			X	
Chloride	250 mg/L			X	X
Chromium (hex.) & compounds - (D-12, MW-14, MW-15, MW-16)	0.05 mg/L			X	X
Lead and compounds	0.05 mg/L			X	X
pH- field determined	Standard Units	X	X	X	X
Petroleum Hydrocarbons				X	
Phenols	0.3 mg/L			X	X
Specific Conductance - field determined	μmho/cm	X	X	X	X
Sulfate	250 mg/L	X	X	X	X
Total Dissolved Solids	500 mg/L	X	X	X	X
Total Organic Carbon				X	
Total Organic Halogen				X	
Total Volatile Organic -D-11,D-12,TW-3	See Note below		X	X	
Tritium - (D-11, D-12, TW-3)				X	

Elevation of top of casing, depth to water table from top of casing and from ground level reported every quarter. All monitoring wells D-11, D-12, MW-14, MW-15, MW-16, TW-2, and TW-3 are sampled except where so noted.

Note: 40 CFR Part 136-Methods 624 and 625 shall be used to identify and monitor for the volatile organic compounds and base/neutral toxic pollutants as identified in Appendix B of the NJPDES Regulations (NJAC 7:14A-1 *et seq.*).

In 1993, Princeton University entered into an agreement called a Memorandum of Understanding (MOU) with the Department of Environmental Protection to investigate and to potentially remediate ground-water contamination. In September 1994, PPPL prepared a revised work plan for the remedial investigation required under the MOU and submitted it to NJDEP (see Sections 3.2.3, 6.1.3 B, and 7.0 for further discussion of the MOU).

In December 1996, a round of ground-water samples was performed for all monitoring wells, including the four newly installed wells on the south side of C site (Fig. 5). The results exceeded New Jersey Ground Water Quality Standards for volatile organic compounds, mainly tetrachloroethene and trichloroethene (see Tables 35 & 36). This monitoring activity lead to the investigation in a new direction toward the former Annex Building where hazardous materials had been stored prior to the construction of the Hazardous Materials Handling Facility (HAZMAT Building). In August 1997, eight additional wells were drilled (see Fig. 5), and samples were collected in September 1997 (see Tables 35-37).

4.3 Environmental Permits

Environmental permits held by DOE-PG are listed in Exhibit 3-3 and are discussed in Section 3.0, "Environmental Compliance Summary" and Section 6.0, "Environmental Non-Radiological Program Information," of this report.

4.4 Environmental Impact Statements and Environmental Assessments

No Environmental Impact Statements or Environmental Assessments were prepared in 1997.

4.5 Summary of Significant Environmental Activities at PPPL

4.5.1 Tritium in the Environment

In the August 1995 sample for well TW-1, located north of the TFTR stack, the tritium concentration was found to be above background or baseline concentration, 789 *versus* 150 picoCuries/Liter (pCi/L), respectively. As a result of this finding, PPPL began an investigation into the cause of the concentration increase. More wells and ground water sumps were sampled, underground utilities were tested for leaks, soil was tested, and roof drains were evaluated. In addition, on and off-site rainwater sampling stations were established and sampled.

Results of this investigation were that no leaks were found emanating from underground utilities; soil results supported this finding. Drain samples from the LECT roof as well as soil samples next to drain spouts showed that tritium concentrations were elevated. Rain water samples (May 8, 1997) showed elevated levels of tritium at inner east station, R1E (61,660 pCi/L), when TFTR was undergoing shutdown activities, and atmospheric releases were also elevated (Tables 4 & 7). Numerous scientific studies have documented the effects of atmospheric tritium releases and the subsequent "washout" in precipitation. Rain droplets act as a scrubber and wash tritiated water vapor (HTO) out of the plume from the stack [Mu90]. Water infiltrates into the ground, and eventually, some of the tritium reaches the ground water table and monitoring wells. In 1997, the highest concentration of tritium in the ground water was 2,472 pCi/L at TW-5 and 2,077 pCi/L at TW-1 in May 1997 (*versus* the Safe Drinking Water Act tritium limit of 20,000 pCi/L).

Ground water results showed that tritium concentrations fluctuate over time. PPPL believes that the tritium concentration in the atmosphere, the amount of precipitation (rainfall – Tables 3, 7 & 8), and the time of year all have an effect on the concentration in the ground water (Table 6). Monitoring of ground water, precipitation, and the TFTR vent stack continued into 1998.

4.5.2 New Jersey Pollutant Discharge Elimination System Ground and Surface Water Permits

Representatives from DOE, NJDEP, and PPPL met to discuss the NJPDES ground water permit pre-draft conditions. Mixing of surface and ground water occurred within the previously unlined detention basin and was regulated in the ground-water permit through required measurements of detention basin water quality. This concern of surface and ground water mixing has been eliminated since the installation of a detention basin liner in October 1994. The issue of volatile organic compounds present in the ground water is being addressed by the Remedial Investigation conducted under the MOU between Princeton University and the NJDEP (see Section 3.2.3). NJDEP was concerned about water quality in the detention basin and the possibility of a liner breach causing ground water contamination beneath the detention basin. In 1996, PPPL collected additional data, including water quality and flow measurements to better understand the ground water and surface water flow through the basin. A draft report was prepared but was not submitted to NJDEP due to pending changes to the NJPDES regulations.

In May 1997, NJPDES regulations (NJAC 7:14A) were adopted. The ground water discharge program was modified, and the Ground Water Pollution Plan (GWPP) was offered as an option to a conventional discharge permit. In order for PPPL to apply for the GWPP option, the above report on ground water monitoring requires revision and updating to include data collected in 1997.

4.5.3 Waste Minimization Activities and Pollution Prevention Awareness

PPPL site-wide Waste Minimization/Pollution Prevention Program accomplished the following in 1997. The hazardous waste recycling program continued with PPPL's solid waste stream reduced by the recycling of 160,200 pounds of paper, 26,130 pounds of aluminum cans, plastic and glass bottles. These accomplishments are attributable to the continuation of the Sanitary Waste Evaluation [PPPL97b].

In 1997, approximately 112,000 Curies of tritium was shipped to Savannah River for reprocessing; this was the result of "off-loading" of PPPL's tritium inventory following the shutdown of TFTR. This represents a diversion of 2,373 cubic feet of low-level waste (LLW) from burial and an associated cost avoidance of $1.66 million.

Energy savings were recognized by PPPL operating the building automation program, which employs three conservation measures. 1) Automated shutdown of lights, air handlers, etc. based on time of day, 2) temperature adjustments of ± 1 °F during occupancy hours (60 hours per week), and 3) lowering building temperatures during the winter and raising temperatures during the summer when the buildings are unoccupied (108 hours per week) were employed.

4.5.4 Storm Water Management

As a condition of Princeton Forrestal Center (PFC) Stormwater Management Plan, a limit of 60 percent impervious cover of developable land is imposed on the PPPL site. This condition exists because PFC, the management group for Princeton University's corporate office and research complex, had included PPPL's 88.5 acres as part of the Bee Brook watershed in its Stormwater Management Plan. Excluding the stream protection corridor (used as retention capacity for stormwater runoff) and delineated wetlands, PPPL was at 55.5 percent developed as of November 1995. In 1997, by removing temporary trailers and implementing the "Stormwater Pollution Prevention Plan," PPPL lowered this percentage, thereby maintaining high storm water quality.

4.5.5 Environmental Training

In 1997, the 8-hour refresher course for the "Health and Safety for Hazardous Waste Site Investigation Personnel" or OSHA HAZWOPER refresher was taught by instructors from the Environmental and Occupational Health Sciences Institute (EOHSI). PPPL personnel had the opportunity to attend the 8-hour course for Supervisors of Hazardous Waste Operations," at EOHSI's Piscataway, N. J. facility. EOHSI is jointly sponsored by the University of Medicine and Dentistry of New Jersey-Robert Wood Johnson Medical School and Rutgers, the State University of New Jersey. Through a grant for the Department of Energy, EOHIS provided these training courses.

Chapter

5

ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

5.1 Radiological Emissions and Doses

5.1.1 Penetrating Radiation

The TFTR commenced high power Deuterium-Tritium operations in December 1993, which continued through early April 1997. These operations were a potential source of neutron and gamma/x-ray exposure. The Princeton Beta Experiment Modification (PBX-M) did not operate in 1997.

Laboratory policy states that when occupational exposures have the potential to exceed 1,000 mrem per year (10 mSv/y), the appropriate project manager must petition the PPPL Environment, Safety, and Health (ES&H) Executive Board for an exemption. This value (1,000 mrem per year limit) is 20 percent of the DOE legal limit for occupational exposure. In addition, the Laboratory applies the DOE ALARA (as low as reasonably achievable) policy to all its operations. This philosophy for control of occupational exposure means that environmental radiation levels, as a result of experimental device operation, are also very low.

From all operational sources of radiation, the design objective for TFTR is less than 10 mrem per year (0.1 mSv/y) above natural background at the PPPL site boundary. In 1997, TFTR produced D-D (2.4 MeV) and D-T (14.0 MeV) neutrons and gamma/x-rays in the range of 0 to 10 MeV.

In 1993, the number of neutrons produced was 7.2×10^{18} for D-D and 1.65×10^{19} for D-T. In 1994, TFTR continued an extensive D-T operations schedule and increased the neutron production to 1.3×10^{19} D-D and 1.85×10^{20} D-T. With the continuance of D-T operations in 1995, neutron production increased to 2.3×10^{19} D-D and 2.04×10^{20} D-T. For 1996, TFTR's neutron production was 1.73×10^{19} D-D and 8.34×10^{19} D-T. In 1997, the last year of TFTR operations, 1.04×10^{19} D-D and 6.74×10^{19} D-T neutrons were generated (see Exhibit 2.1) [Ja98].

The TFTR real-time site boundary monitors are Reuter-Stokes Sentri 1011 pressurized ionization chambers and ^{3}He-moderated neutron detectors. Electronics in the ionization chambers were modified to allow integration of any prompt gamma radiation resulting from a TFTR machine pulse, which may be above natural background. Data were stored and processed using the Central Instrumentation, Control, and Data Acquisition (CICADA) computer system. Four of these monitoring stations are placed at the TFTR facility boundary and two are located at the PPPL property line (see Fig. 5, locations T1 to T4, RMS-NE and RMS-SE). In addition, eight ionization chambers of lower sensitivity, paired with neutron monitors, are located nearer the TFTR device (four outside the test cell wall, three in the basement, and one on the roof). These eight detector locations are for personnel safety and are not used as indicators of environmental conditions. However, data collected from them are used to help correlate the environmental measurements. Besides the moderated ^{3}He, and fission neutron detectors, passive area dosimeters were also used for monitoring neutron and gamma/χ dose equivalents at various locations throughout the TFTR facility. Monitors are calibrated and traceable to the National Institute of Standards and Technology (NIST).

5.1.2 Sanitary Sewage

Drainage from TFTR sumps is collected in the Liquid Effluent Collection (LEC) tanks; each of three tanks has a total capacity of 15,000 gallons. Prior to release of these tanks to the sanitary sewer system, *i.e.*, Stony Brook Regional Sewerage Authority (SBRSA), a sample is collected and analyzed for tritium concentration and gross beta. All samples for 1997 showed effluent quantity and concentrations of radionuclides (tritium) to be within allowable limits established in New Jersey regulations (1 Ci/y for all radionuclides) and by 40 CFR 141.16 and DOE Order 5400.5 (2×10^6 pCi/liter for tritium). As shown in Table 12, the 1997 total amount of tritium released to the sanitary sewer was 0.366 Curies, about thirty-seven percent of the allowable 1.0 Curie per year.

5.1.3 Radioactive and Mixed Waste

In 1997, low-level radioactive wastes were stored on-site, either in the Radioactive Waste Facility or within a controlled area of TFTR. The low-level radioactive shipments made in 1997 consisted of 1,997.7 cubic feet (ft^3) of material, with an activity of 31,903 Curies (Ci). No shipments of low-level radioactive mixed waste were made in 1997.

5.1.4 Airborne Emission

A. Differential Atmospheric Tritium Samplers (DATS)

Differential Atmospheric Tritium Sampler (DATS) are used to measure elemental (HT) and oxide (HTO) tritium at the TFTR stack and at eleven (11) remote environmental sampling locations: 4 TFTR facility boundary trailers (T1 to T4), 6 remote environmental air monitoring stations (R 1 to R6) and one baseline station. In 1995, the baseline location was moved from Montgomery Township to Hopewell Township, NJ. All of the aforementioned sampling is performed continuously.

Projected dose equivalent at the site boundary from emissions of airborne radioactivity (HTO, HT, Ar-41, N-13, N-16, Cl-40, and S-37) was 0.47 mrem (4.7 μSv) (see Table 2). Projected dose equivalent at the nearest off-site business from airborne emissions of these radionuclides was 0.12 mrem (1.2 μSv). Installed in 1992, the stack sampling system continues to provide tritium emissions data (Table 4 and Fig. 14) for tritium concentrations exceeding the minimal detectable levels of the DATS. Engineering changes to ensure representative sampling of tritium was completed in 1993, and EPA accepted the stack sampling system for use in complying with NESHAPS. Measurements at the TFTR D site facility boundary have shown ambient levels in the range of 13.1 to 2,532.5 pCi/m^3 of elemental and oxide tritium concentrations (Table 10 and Figs. 9 & 11). Measurements from off-site monitoring stations are shown in Table 11 and Figures 10 & 12, "Air Tritium (HT)" and "Air Tritium (HTO)," respectively. Ar-41, N-13, N-16, Cl-40, and S-37 are air activation products from neutrons produced during TFTR experiments.

In November 1983, a three-level, 60-meter tower was installed for gathering meteorological data. Analysis indicates that the site is dominated by neutral to moderately stable conditions, with moderately unstable to extremely unstable conditions occurring less than a few percent of the time. Average surface winds are about 2.1 meters per second (m/s) and rise to about 4.1 m/s at 60 m [Ko86].

5.2 Unplanned Releases

There were no unplanned releases in 1997.

5.3 Environmental Monitoring

5.3.1 Waterborne Radioactivity

A. Surface Water

Surface-water samples at ten locations (three on-site: D1, DSN001, and E1; and seven off-site: B1, B2, B3, DSN003, M1, P1, and P2) have been analyzed for tritium (Table 5). The locations, DSN003 (Delaware & Raritan Canal pump house) and E1 (Elizabethtown Water), replaced the baseline (Rock Brook in Montgomery Township) in November 1995. Five of these locations have been monitored since 1982. Downstream sampling occurs after mixing of effluent and ambient water is complete. Locations are indicated on Figures 5 (on-site) and 6 (off-site locations).

In August 1995, the method for analyzing tritium in environmental water samples was modified. The electrolysis procedure was eliminated; the modified tritium analysis included a 5-hour count time, which proved to be a more efficient way to process samples without losing reliability. A second result was that the method detection limit changed from previously below 100 pCi/L to between 100 and 200 pCi/L.

Tritium analysis by liquid scintillation methods has shown tritium values to be generally comparable to the baseline level (Table 5). In February 1997, at baseline location E1, Elizabethtown Water Company, tritium was detected at 4,374 pCi/Liter. As an explanation for this data, it is unlikely that the source is tritium from TFTR for the following reasons. 1) At the time of the sample, no increases in tritium oxide in stack effluent or in tritium concentrations in precipitation were observed. 2) No other surface water locations closer to PPPL exhibited elevated tritium concentrations during this period. 3) The source of water for E1 originated far off-site from PPPL (thus E 1 is considered a baseline source).

Rain water samples collected and analyzed in 1997 ranged from less than 131 to 61,660 pCi/liter (see Tables 3, 7, & 8 and Figs. 15 & 16), which varies from the 1996 range of <100 to 21,140 pCi/liter (see Table 9). In the two weeks prior to collecting the highest level rainwater sample (61,660 pCi/L), TFTR released 21.61 Curies HTO; this release occurred during the TFTR shutdown period immediately following cessation of operations, when the torus was being prepared for long term shutdown. These releases account for approximately 17.3 percent of the annual 1997 total for tritium released to the atmosphere. Based on this data and associated literature [Mu77, Mu82, Mu90], it is believed that the observed increase in tritium concentrations in rain water is due to washout by precipitation a portion of the tritium released from the TFTR stack. Monitoring of tritium concentrations in rainwater will continue.

Exhibit 5.1 - Total Rainfall in Inches (centimeters)

Dry: < 40"	Average: 40-50"	Wet: >50"
1988	1991 - 45 (114 cm)	1989 –55 (140cm)
1995 – 35.6 (90 cm)	1992 – 42 (107cm)	1990 – 50.3 (128cm)
	1993 – 42.7 (109cm)	1994 – 51 (130cm)
	1997 – 41.99 (107cm)	1996 – 61 (155cm)

In April 1988, PPPL initiated the collection of precipitation. Exhibit 5-1 shows the occurrence of dry, average, and wet years (see Table 3 for 1998 rainfall by week) [Ch98].

B. Ground Water

Ten on-site wells- TW-8, MW-4, MW-5I, MW-7S, MW-12S, D-11R and D-12 on C site, and TW-1, TW-5, and TW-10 on D site (Fig. 5)-were sampled in 1997. Since the onset of D-T operations, ground water results (Table 6 and Fig.13) were slightly elevated in TW-1 and TW-5; for 1997, TW-1 showed tritium concentrations ranging from 1104 pCi/Liter to 2077 pCi/Liter. Beginning in August 1995, more frequent ground-water monitoring and sampling of different wells began. This increase in scope of ground-water monitoring was prompted by the increase in tritium level in well TW-1.

An investigation into the potential sources began in the fall of 1995. Leak tests and checks of lines and equipment in the area near TW-1 (north side of D site) were performed; none were found to be leaking tritiated water into the ground water. From PPPL's environmental monitoring data and the available scientific literature [Mu77, Mu83, Mu90], the most likely source of the tritium detected in the on-site ground water samples is from the atmospheric venting of tritium from TFTR operations and the resulting "wash-out' during precipitation (Figure 19). Ground water monitoring of the wells and the foundation sump (dewatering sump for the TFTR and Motor Generator buildings) will continue.

C. Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. In April 1984, a sampling point at the input to PPPL was established (E1 location) to provide baseline data for water coming onto the site. Radiological analysis has included gamma spectroscopy and tritium-concentration determination. In 1997, tritium measurements of potable water ranged from 31.6 to 4,374 pCi/liter (Table 5) (see 5.3.1A above). The higher tritium concentration may not be valid due to possible memory carry-over from a previous sample, which was measured at a higher concentration.

5.3.2 Foodstuffs and Soil and Vegetation

There were no foodstuffs, soil, or vegetation samples gathered for analysis in 1997. In 1996, the HP Manager reviewed the requirement for soil/biota sampling. At that time, a decision was made to discontinue the sampling program. In general the decision was made because the program had "No Value Added". A heavier concentrated effort was placed on the water sampling and monitoring which produced more relevant results.

The capability to perform soil/biota analysis has been retained and is now performed using Oxidation, when necessary.

Chapter

6

ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

6.1 New Jersey Pollutant Discharge Elimination System (NJPDES) Program

6.1.1 Surface and Storm Water

To comply with permit requirements of the New Jersey Pollutant Discharge Elimination System (NJPDES) permit, NJ0023922, PPPL submitted to NJDEP monthly discharge monitoring reports (DMRs) for Discharge Serial Number (DSN)—DSN001, DSN002, and DSN003 (see Tables 18 & 19). During 1997, PPPL was within allowable limits for all testing parameters at DSN001. The last exceedance at DSN001 was reported in November 1993 for total suspended solids (73 mg/L *vs.* 50 mg/L—the permit limit). One exceedance in September 1997, occurred at DSN003 (27 mg/L for total suspended solids exceeded the monthly average limit of 20 mg/L). Previous to this exceedance, a total suspended solid concentration of 50 mg/L exceeded the permit limit of 20 mg/L in May 1995, at DSN003 (filter back wash for the pumps at the Delaware & Raritan Canal).,.

Detention basin inflows or influents are monitored twice each year, in May and August (see Tables 17 & 29), pursuant to PPPL NJPDES ground water discharge permit, NJ0086029. Volatile organic compounds were detected at Inflow 2 in concentrations above method detection limits for volatile organic compounds—tetrachloroethene (3.62 μg/L), and chloroform (2.09 μg/L). Located on the north side of the detention basin, Inflow 2 receives ground water from the D site TFTR and MG basement sump pumps and stormwater from the transformer yard sumps.

Located on the west side of the detention basin, Inflow 1 receives water from the C site MG, LOB, and CS basement sumps, C and D site cooling tower and boiler blowdown, and non-contact heat exchanger cooling water, as well as stormwater. At Inflow 1, volatile organic compounds were detected: chloroform at 13.2 μg/L and bromodichloromethane at 4.03 μg/L. Both water from the D&R Canal and the cooling tower are chlorinated to prevent fouling.

Based on 12 months of flow data, greater than 164 million gallons of water were discharged from the detention basin in 1997. The lined detention basin operates with a permanent oil boom, oil sensors that are capable of sending an alarm signal to Security, an outfall exit valve mechanism, and a fence around the perimeter of the basin. Presently, the detention basin is operated in a flow-through mode.

6.1.2 Chronic Toxicity Characterization Study

In 1997, chronic toxicity testing for DSN001 effluent continued. In all chronic toxicity tests, *Pimephales promelas* (fathead minnow) was the only test species required [NJDEP95]. NJDEP chose the fathead minnow as the more sensitive species for the Chronic Toxicity Biomonitoring requirements (Table 18). For all tests in 1997, the survival rate, as defined by the NJ Surface Water Quality Standards, was 100 percent no observable effect concentration (NOEC), and the inhibition concentration 25 (IC_{25}) was greater than one hundred percent. The last unsuccessful test occurred in March 1995, the fathead minnows survived in the 50 percent dilution, *i.e.*, mortality was observed in the 100 percent effluent test.

6.1.3 Ground Water

Since 1989, PPPL has monitored ground-water quality in seven wells in compliance with the NJPDES ground-water discharge permit, NJ0086029; four of the seven wells are located on PPPL C and D sites, and three wells are located on A and B sites. The wells on A & B sites are not on DOE-leased property, but are on the adjacent James Forrestal Campus property. The permit also contained a requirement for conducting a site hydrological study, including soil sampling or a soil gas survey [Ne90].

The permit was issued effective April 1, 1989, and the expiration date was extended to December 31, 1996. In July 1994, DOE-PG submitted to NJDEP the NJPDES permit renewal application. Included in that application was the "Ground Water Quality Report for the NJPDES Permit Renewal Application Permit No. NJ0086029," which summarized data from 1989 to 1994 [Fi94]. As yet, a renewed permit has not been issued.

A. NJPDES Quarterly Ground Water Monitoring Program from 1989 to 1997

In this section, the NJPDES Quarterly Ground Water Monitoring Program from 1989 to 1997 is discussed in three parts: A and B site wells (MW-14, MW-15, and MW-16); C and D site wells (D-11, D-12, TW-2, and TW-3); and the detention basin Inflows 1 and 2.

Since November 1989, three A and B site wells—MW-14, MW-15, and MW-16—have been sampled quarterly (see Tables 24 & 32). All results were below permit standards with one exception: in August 1994, 4-Bromophenyl-phenyl Ether (base/neutral compound) was detected at 110 µg/l for MW-14. The cause of this anomaly is unknown; no other parameters were found above the detection limits for the 1997-sampling event. These wells are also sampled by Princeton University's environmental contractor, [EN91], and are included in the University's ground-water monitoring program. In the NJPDES permit renewal application, PPPL and DOE-PG made a formal request to NJDEP that these wells be removed from ground water permit requirements.

The C and D site wells—D-11 or D-11R, D-12, TW-2, and TW-3—have been sampled quarterly since November 1989. A new well, D-11R, was installed in September 1996 as a replacement for D-11, which was then abandoned. When the under-drain system beneath the detention basin liner was installed in October 1994, the level of ground water dropped sufficiently to render well D-11 dry. In 1997, all ground water results, except for volatile organic compounds, were below permit standards (see Tables 24-32). Volatile organic compounds in ground-water samples are discussed in the following paragraph and in the following section "Regional Ground Water Monitoring Program."

The detection of tetrachloroethene (PCE) was observed in at least one ground-water sample analyzed for volatile organic compounds from November 1989 to August 1997 with two exceptions: May 1990 and May 1996 events. Otherwise, PCE was consistently detected in wells D-11R and/or D-12. In well TW-3, PCE was periodically detected. In previous years, higher concentrations of PCE were found in this well (TW-3) at concentrations of 26 mg/L and 36 mg/L. In February and August 1997, trichloroethene (TCE) was detected in well D-12 as was cis-1,2-dichloroethene (Tables 27 & 28).

Detention basin inflows are sampled twice annually—in May and August. PCE was found five times in Inflow 2 samples: August 1990, September 1991, August 1993, August 1994, and August 1996. The compound 1,1,1-trichloroethane (TCA) was detected once in Inflow 2 during

August 1990. PCE was detected once in Inflow 1 during August 1993. Of these VOCs, only PCE and chloroform were detected in the Inflow 2 sample collected during August 1997.

B. Regional Ground Water Monitoring Program

In 1993, a Memorandum of Understanding (MOU) was signed between Princeton University, the landowner of the James Forrestal Campus, and the NJ Department of Environmental Protection (NJDEP). In this MOU, a remedial investigation and remedial alternative assessment were required. For C and D sites, PPPL's environmental subcontractor prepared a draft work plan for the remedial investigation, which included a ground-water investigation [HLA94]. The Remedial Investigation is discussed in Section 3.2.3 and is fully documented in the Remedial Investigation Report prepared by Harding Lawson Associates and submitted to NJDEP in early 1997 [HLA97].

Regional Ground Water Monitoring Program studies are discussed in Section 6.1.3 A, "Hydrological Studies from 1989 to 1993," of this report. In evaluating data from those studies, the NJPDES Quarterly Ground Water Monitoring Program, and remedial investigation results, an overall pattern appears for volatile organic compounds (VOCs) found in ground water monitoring wells at PPPL. The VOC that is most commonly detected and present in the highest concentrations is tetrachloroethene (PCE). The potential source of the PCE appeared to be located near the CAS/RESA Building to the south where VOCs were historically used and stored. Monitoring well, MW-13 - located next to the CAS/RESA Building, is up-gradient of the two detention basin wells, where VOCs have also been detected. The highest concentrations of contaminants would be expected in those wells closest to the source.

In 1996, PPPL installed four new monitoring wells in the vicinity of the CAS/RESA Building (including two wells in the wetlands). These wells and other ground water characterization activities lead to the identification of a new area of potential environmental concern (APEC) near the location of the former PPPL Annex Building in the woods southwest of CAS/RESA. Additional characterization in the former Annex Building area included soil profiles and installing new wells in 1997 (Tables 35-37).

The second area where PCE is detected in the ground water is an area due north of TFTR (undeveloped wetlands), as indicated by results from wells TW- 1, -3, and -7 (Tables 35 & 36). The presence of PCE in some deeper monitoring wells (TW-3) indicates a potential off-site source of VOCs, possibly as part of regional ground water contamination. PPPL has no record of using chlorinated solvents in this area. While the concentrations of PCE and/or TCE in eleven wells were above the ground water quality standards, only three wells listed on Tables 35 and 36 are sampled as part of a permit requirement. The other eight occurrences do not exceed any permit limits.

The C and D sites sump pump systems (TFTR-S1, LOB-S3, MG-S2, MG-S4, MG-S5, MG-S6, and CS-S7) were also sampled at the same time wells were sampled in June 1994, March and May 1995, December 1996, February and September 1997 (Tables 35 & 36). Occurrence of PCE in all the sumps except MG-S5 can be attributed to the PCE present in the ground water.

From August 1991 to September 1997, PPPL has collected ground-water samples from wells located near the former underground storage tanks for annual (August) analysis of volatile organic compounds (VOCs) and quarterly total petroleum hydrocarbons (TPHs). Ground-water samples are collected from wells P-2, MW-4, MW-5S, MW-5I, MW-6S, MW-6I, MW-7S, MW-7I, MW-8S, and MW-8I and analyzed for TPHs.

In each quarterly report, results of analytical data and monthly contour maps were submitted to NJDEP (Tables 20-23) [MP91a,b] [MP92a,b] [RES92a,b][RES93a,b,c,d] [AAC94a,c,d,e] [AAC95a,b,c,d]. Results of VOC analyses are discussed above. For twenty-four quarters, total petroleum hydrocarbons, when detected, were predominately in the intermediate (I wells) ground-water zone. In general, intermediate wells are bedrock wells open from 30 to 45 feet below grade or at elevations of 45 to 60 feet above mean sea level (msl). A change in analytical methodology from 418 Freon extraction method to the gas chromatography method (5081) resulted in a change in the method detection limit of less than 5 mg/L.

6.2 Non-Radiological Programs

The following sections briefly describe PPPL's environmental programs required by federal, state, or local agencies. The programs were developed to comply with regulations governing air, water, wastewater, soil, land use, and hazardous materials, as well as with DOE orders or programs.

6.2.1 Non-Radiological Emissions Monitoring Programs

A. Airborne Effluents

PPPL maintains New Jersey Department of Environmental Protection (NJDEP) air permits for its four boilers located on C site. The permit certificate numbers 061295 through 061299 were issued as 90-day temporary certificates; however, NJDEP stopped issuing the temporary certificates. The permits are valid until NJDEP inspects the facility and issues the permanent ones. In 1994, PPPL received permit amendments to the existing air permits for Boilers #2, #4, and #5; PPPL modified these boilers to burn natural gas and fuel oil, prior to the submittal of permit applications to NJDEP. After the re-submittal of the Boiler #2 application for correction of a fuel-use error, NJDEP issued a permit amendment for Boiler #2 to burn both fuel types in 1995. In 1995, PPPL submitted a permit amendment for proposed modifications to Boiler #3, which would allow the boiler to burn natural gas or fuel oil as appropriate. Upon receiving approval from NJDEP, these modifications to Boiler #3 were made. In 1997, PPPL operated all boilers with natural gas as the primary fuel; the boilers were shutdown for the entire summer months for maintenance and repairs.

Measurements of actual boiler emissions are not required. Emissions were initially calculated and then recalculated for the amendments and alterations to the boiler permits, using NJDEP and AP-42 [EPA] formulas. These formulas are based on appropriate boiler emission factors, percent sulfur content of the fuel and number of gallons of oil burned per hour in each boiler. To optimize boiler efficiency and to reduce fuel cost in accordance with DOE Order 4330.2D, "In-House Energy Management," [DOE88b] PPPL utilizes an outside contractor to tune all the boilers on an annual basis and provide a report for each boiler. The report includes the boiler efficiency, oxygen content, flue-gas temperature and carbon dioxide content of the stack gas for both oil and natural gas fuels. The PPPL boiler operations Chief Engineer maintains a record of this information on file.

A permit modification for the Hot Cell (now located in the DeCon room) degreaser was submitted in 1995, to NJDEP to allow venting of the degreaser to the Tokamak Fusion Test Reactor (TFTR) stack. Discussions with NJDEP involved the definition of the word "stack." The TFTR stack is unlike a conventional stack in an industrial setting, and therefore, the uniqueness of the TFTR stack had to be established. The NJDEP agreed that this stack should be regulated under the Environmental Protection Agency's (EPA) National Emissions Standard for Hazardous Air Pollutants (NESHAPs) program, which it is. The permit modification for the Hot Cell degreaser was approved, and modifications were completed.

Applications for air permit modifications for the C and D site emergency diesel-generators were also prepared. PPPL requested that 1) a change in the fuel type from #2 fuel oil to #1 fuel oil, and 2) a reduction in the number of operation hours be made in these permits in support of limiting the amount of nitrogen oxides (NO_x) released from these generators. In 1996, the permit modifications were approved by NJDEP. These changes were essential to the Operating Permit Negative Declaration and Emission Statement Non-Applicability exemptions for they were the basis for determining that PPPL's sources in total emit below the threshold of 25 tons of NO_x per year.

Five additional air permits are maintained by PPPL: two permits for two above ground storage tanks and three permits for three dust collectors. The above-ground storage tanks (25,000 and 15,000 -gallon capacities) emit volatile organic compounds that originate from #4 fuel oil and #1 diesel oil, respectively. The FED and CAS dust collector emissions originate from general wood working operations. The Shop building dust collector emissions originate from metal working operations.

B. Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. The PPPL used approximately 24.56 million gallons in 1997 [Ga98]. In 1994, a cross-connection was installed beneath the water tower to provide potable water to the tower for the fire-protection system and other systems. Potable water usage showed an decrease from 1995 (40.7 million gallons) to 1996 (27.82 million gallons), which is closer to 1994 water usage (28.6 million gallons).

C. Process (non-potable) Water

In 1986, a multimedia sand filter with crushed carbon was installed to allow the D site cooling tower make-up water to be changed from potable water to process-water (non-potable) supply. In 1987, PPPL made a changeover from potable water to Delaware & Raritan (D&R) Canal non-potable water for the cooling-water systems. Non-potable water is pumped from the D&R Canal as authorized by a permit agreement with the New Jersey Water Supply Authority. The present agreement gives PPPL the right to draw up to half a million gallons of water per day for process and fire-fighting purposes.

Filtration to remove solids, chlorination, and corrosion inhibitor is the primary water treatment at the canal pump house. Located at the canal pump house, the filter-backwash, discharge number (DSN003), is a separate discharge point in the NJPDES surface-water permit and is monitored monthly (Table 20). PPPL used approximately 32.8 million gallons of canal water during 1997; this compares to 96.2 million gallons of canal water during 1996 [An97] and the1995 usage of 67.2 million gallons. A sampling point (C1) was established to provide baseline data for process water coming on-site. Table 14 indicates results of water quality analysis at the canal.

D. Surface Water

Surface water is monitored for potential non-radioactive pollutants both on-site and at surface-water discharge pathways (upstream and downstream) off-site. Other sampling locations—Bee Brook (B1 & B2), D site Ditch #5 (D1), Delaware & Raritan Canal (C1), Millstone River (M1), and Plainsboro (P1 & P2) sampling points (Tables 13-16)—are not required by regulation, but are a part of PPPL's environmental monitoring program.

E. Sanitary Sewage

Sanitary sewage is discharged to the publicly owned treatment works (POTW) operated by South Brunswick Township, which is part of the Stony Brook Regional Sewerage Authority (SBRSA). During 1994, due to malfunctioning metering devices, PPPL, South Brunswick Sewerage Authority, and the Township of Plainsboro agreed upon an estimated volume. The estimated volume was based on historical data of approximate flow rates from PPPL. This volume was adjusted for the interconnections with Forrestal Campus A and B sites and a private business. For 1997, PPPL estimates a total discharge of 5.82 million gallons of sanitary sewage to the South Brunswick sewerage treatment system [Ga98].

In 1994, Industrial Discharge Permit (22-93-NC) was received; comments were submitted by PPPL and DOE-PG to Stony Brook Regional Sewerage Authority (SBRSA). In 1996, the SBRSA permit was changed to a license and required monthly measurement of radioactivity, flow, pH and temperature at the LEC tanks (designated compliance and sampling location) and annual sampling for chemical oxygen demand only. During 1997, PPPL performed monthly radiological and non-radiological analyses to meet these license requirements (see Table 12).

By switching to a digital photography format, PPPL eliminated photo laboratory waste as an industrial flow to the sanitary sewer in 1997.

F. Spill Prevention Control and Countermeasure

PPPL maintains a Spill Prevention Control and Countermeasure Plan (SPCC), which was revised in 1995 [VNH96]. The SPCC Plan is incorporated as a supplement to the PPPL Emergency Preparedness Plan.

G. Herbicides and Fertilizers

During 1997, PPPL's Facilities and Environmental Management Division (F&EM) managed the use of herbicides by outside contractors. These materials are applied in accordance with state and federal regulations. Chemicals are applied by certified applicators. No fertilizers were used during 1997.

The quantities applied during 1997 were as follows: no fertilizers, Pendulum 6.5 gallons, and Roundup 1 gallon. No herbicides or fertilizers are stored on site; therefore, no disposal of these types of regulated chemicals is required by PPPL.

H. Polychlorinated Biphenyls (PCBs)

At the end of 1997, PPPL's inventory of equipment containing polychlorinated biphenyls (PCBs) was 653 large, regulated capacitors. No regulated PCB capacitors were removed in 1997. However, as they are taken out of service, the disposal records are listed in the Annual Hazardous Waste Generators Report [PPPL96b].

I. Hazardous Wastes

The last Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) was submitted for 1996 in accordance with EPA requirements [PPPL96b]. A description of Resource Conservation and Recovery Act (RCRA) compliance is found in Section 3.1.2 of this report. The 1996-1997 Hazardous Waste Generator Annual Report was submitted in early 1998 [PPPL98].

J. DOE-HQ Environmental Survey

In 1988, a comprehensive environmental survey was conducted by DOE-HQ and outside subcontractors. No significant environmental impact findings were noted at PPPL during this survey. In 1989, a plan of action for findings was forwarded to DOE. With installation of the detention basin liner in 1994—the longest lead time item—all findings have been closed out.

Soil sampling for petroleum hydrocarbons from former spills and for chromium in soils from previous use in cooling towers was accomplished in November 1988 [DOEx]. At the time data was evaluated from this sampling, DOE determined that no follow-up action by PPPL was warranted. In 1994, NJDEP re-reviewed DOE's data and required as part of the Remedial Investigation/Remedial Alternative Assessment Program further soil sampling around the C site cooling tower for chromium contamination. Soil sampling was conducted and detected low levels of chromium in soil next to the former chromium reduction pits. This soil was removed in 1996, and this action item was closed. No further actions occurred in 1997.

6.2.2 Continuous Release Reporting

Under CERCLA's reporting requirement for the release of a listed hazardous substance in quantities equal to or greater than its reportable quantity, the National Response Center is notified and the facility is required to report annually to EPA. Because PPPL has not released any CERCLA-regulated hazardous substances, no "Continuous Release Reports" have been filed with EPA.

6.2.3 Environmental Occurrences

No reports to the New Jersey Department of Environmental Protection or to the National Response Center (NRC) were made since there were no releases that required notification to NJDEP nor exceeded reportable quantities (RQ) for any listed substance.

6.2.4 SARA Title III Reporting Requirements

NJDEP administers the Superfund Amendments and Reauthorization Act (SARA) Title III (also known as the Emergency Reporting and Community Right-to-Know Act) reporting for EPA Region II. The modified Tier I form includes SARA Title III and NJDEP-specific reporting requirements. PPPL submitted the SARA Title III Report to NJDEP in February 1997 [PPPL97a]. No significant changes from the previous year were noted. Though PPPL does not exceed threshold amounts for chemicals listed on the Toxic Release Inventory (TRI), PPPL completed the TRI cover page and laboratory exemptions report for 1996, and submitted these documents to DOE. Since PPPL did not exceed the threshold amounts, no TRI submittal was completed for 1997.

The SARA Title III reports included information about twelve compounds used at PPPL. Of the twelve, six compounds are in their gaseous form and are therefore classified as sudden release of pressure hazards; three gaseous compounds are also classified as acute health hazards: carbon dioxide, chlorodifluoromethane, and dichlorodifluoromethane (CFC-12). There are seven liquid compounds; nitrogen is used in both gaseous and liquid forms. Fuel oil, gasoline, and petroleum oil are flammables; trichlorotrifluoroethane (CFC-113) and sulfuric acid are the liquid compounds that are classified as acute health hazards; sulfuric acid is also reactive. PCB's and gasoline are listed as chronic health hazards.

6.3 Safety

PPPL's 1997 performance with respect to worker safety was as follows:

1.	Recordable injury case rate:	1.88 per 100 employees
2.	Lost Work Day case rate:	0.51 per 100 employees
3.	Lost Work day rate:	7.69 per 100 employees
4.	Number of radioactive contaminations (external):	0
5.	Number of Safety Occurrence reports: (OSHA confined space, chemical exposure, and lock out/tag out incidents)	1

Chapter

7

GROUND WATER PROTECTION

PPPL's Ground Water Program focus is the "Groundwater Protection Management Plan" (GPMP), required by DOE Order 5400.1, "General Environmental Protection Program." The GPMP is a written plan that PPPL uses as a management tool, to ensure protection of ground water. The GPMP was implemented in parallel with several ground-water investigations. As required by NJDEP, PPPL performed these investigations to address potential impacts from former underground storage tanks (USTs) and the detention basin. Prior to these investigations, the U.S. Geological Survey (USGS) performed an investigation in the vicinity of TFTR to evaluate effects of a potential spill of radioactive water. Also, PPPL conducted a soil gas survey, which was used to locate monitoring wells. In all, PPPL has installed 44 wells to monitor ground-water quality. Remedial investigations and remedial alternative assessment studies at PPPL are ongoing as required by conditions of the Memorandum of Understanding (MOU). Since 1995, PPPL has conducted monthly monitoring of tritium in water - ground, sump, surface, and precipitation.

The results of the investigations cited above are summarized below in the following sections of this report: "NJPDES Quarterly Ground Water Monitoring Program from 1989 to 1997" and "Regional Ground Water Monitoring Program" (see Section 6.1.3 A and B of this report).

Generally, all parameters measured in the above investigations meet the New Jersey Ground Water Quality Standards. The exceptions are the detection of two volatile organic compounds consistently found —tetrachloroethene (PCE) and trichloroethene (TCE)— in a number of the ground-water monitoring wells. In 1990, PPPL initiated, as required by the New Jersey Pollutant Discharge Elimination System (NJPDES) permit, a hydrologic investigation to characterize ground-water quality and determine ground-water flow and direction. Numerous studies and tasks were performed to meet this requirement and are discussed in previous sections in this report. Ground-water monitoring results showed the presence of volatile organic compounds (VOCs) —mainly, PCE, TCE, and their natural degradation products—in a number of shallow wells on C site; in a number of intermediate depth wells, petroleum hydrocarbons were detected. These VOCs are commonly used or contained in solvents or metal degreasing agents. The source of the petroleum hydrocarbons is believed to have originated from former underground storage tanks that were removed when PPPL detected hydrocarbons in the soil.

In 1994-95, the remaining USTs were removed with one tank abandoned in-place, and replaced with above ground storage tanks. PPPL determined that the hazard of digging up one tank, buried next to a high-voltage electrical transformer yard, was too great a risk. The tank passed a tightness-test; soil borings around the tank showed no indications of any leakage from the tank or its associated piping. Upon receipt of NJDEP's approval to leave the tank in place, it was emptied, cleaned, and filled with concrete in accordance with to NJDEP regulations.

No strong correlation exists between the soil gas survey conducted in 1990 and the ground water data collected from 1991 through 1994. In the area next to the Facilities and Environmental Management (F&EM) Building, the presence of chlorinated solvents - TCE and PCE - and total petroleum hydrocarbons were confirmed through monitoring of the ground water. In the area south of the Coil Storage and Assembly (CAS) building and the Research Equipment Storage and Assembly (RESA) Building, ground water was found to contain the three chlorinated solvents. Only tetrachloroethene was detected in the soil gas survey.

In the area south of the Receiving Warehouse, no apparent correlation between the findings of the soil gas survey and ground-water quality was found; while the soil gas survey indicated the presence of the three chlorinated solvents, ground water was found to be uncontaminated in this area. Also, east of TFTR, no correlation was found between the presence of TCA during the soil gas survey and its absence in the ground water. Of the three chlorinated solvents found during the soil gas survey in the area northeast of TFTR and the Mockup Buildings, only tetrachloroethene was detected in ground-water samples.

Foundation dewatering sumps located on D site largely influence the ground-water gradient. The sumps create a shallow cone of depression drawing ground water toward them. Under natural conditions, ground-water flow is to the south/southeast toward Bee Brook; it appears that all ground water (except in the northwestern corner) is drawn radially toward the D site sumps.

Under the terms of the MOU, PPPL has conducted several rounds of environmental characterization and remediation. In 1995, after the NJDEP granted "conditional approval" of PPPL's Remedial Investigation Work Plan, soil and ground water samples were collected and analyzed for the seven (7) identified areas of potential environmental concern (APECs). Results from these samples indicated that only two (2) APECs contained chemicals above the most stringent NJDEP Soil Cleanup Criteria applicable. In 1996, contaminated soil and sediments were removed from these APECs for off-site treatment and disposal. Post-excavation sampling confirmed that the NJDEP Soil Cleanup Criteria were met by the remedial actions.

In 1996, PPPL also installed four new monitoring wells south of the CAS/RESA Building area, in order to delineate the extent of ground water contamination in this area. These wells and other ground water characterization activities lead to the identification of a new APEC near the former PPPL Annex Building (see Figure 20), and the expansion of the site boundaries for a total of 88.5 acres. The Remedial Investigation activities conducted in 1995 and 1996 are documented in the Remedial Investigation Report prepared by Harding Lawson Associates, which was submitted to NJDEP in March 1997 [HLA97]. Characterization of soil and ground water in the former Annex Building area was conducted during 1997 (Figures 17 & 18).

In the August 1995 sample for well TW-1, located north of the TFTR stack, the tritium concentration was found to be above the background or baseline concentration, 789 *versus* 150 picoCuries/Liter (pCi/L), respectively. As a result of this finding, PPPL began an investigation into the cause of the concentration increase. More wells and ground water sumps were sampled, underground utilities were tested for leaks, soil was tested, and roof drains were sampled. In addition, rainwater sampling stations were established and sampled.

The results of this program were that no leaks were found emanating from underground utilities, and soil results supported this finding. Drain samples from the liquid effluent collection tank roof showed that tritium concentrations were elevated as well as soil samples next to drain spouts. Rain water samples showed elevated levels of tritium during May 1997 (61,660 pCi/L at station R1East) when TFTR was being shutdown, and atmospheric releases were also elevated. A number of documents have described the effect of tritium releases and rain. Rain droplets act as a scrubber and wash tritiated water vapor (HTO) out of the plume from the stack [Mu90]. The water infiltrates into the ground, and eventually, some of the tritium reaches the ground water table and the monitoring wells.

The highest concentrations of tritium in the ground water in May 1997 were 2,472 pCi/L at TW-5, and 2,077 pCi/L at TW-1 (compared to the Drinking Water standard of 20,000 pCi/L). The ground water results showed that the tritium concentrations fluctuate over time. PPPL believes that tritium concentrations in the atmosphere, amount of precipitation (rainfall), and time of year all have an effect on the concentration in the ground water monitoring.

Chapter

8

QUALITY ASSURANCE

Analysis of environmental samples for radioactivity was accomplished on-site by the Radiological Environmental Monitoring Laboratory (REML). REML procedures follow DOE's Environmental Measurements Laboratory's EML HASL-300 Manual [Vo82] or other nationally recognized standards. Approved analytical techniques are documented in REML procedures [REML90]. PPPL participates in the EPA Laboratory Performance Evaluation (Las Vegas) program as part of maintaining its radiological certification. For non-radiological parameters, PPPL receives proficiency evaluation samples from EPA (Cincinnati, OH). These programs provide blind samples for analysis and subsequent comparison to values obtained by other participants, as well as to known values.

In 1984, PPPL initiated a program to have its REML certified by the State of New Jersey through the EPA Quality Assurance (QA) program. REML complies with EPA and NJDEP QA requirements for certification. In March 1986, REML facilities and procedures were reviewed and inspected by EPA/Las Vegas and NJDEP. The laboratory was certified for tritium analysis in urine (bioassays) and water and has been recertified in these areas annually since 1988.

In 1997, REML performed EPA semi-annual performance evaluation tests for radionuclides in water. REML passed all tests for tritium and gamma in water (Table 34).

In 1997, PPPL followed its internal procedures, EN-OP-001—"Surface Water Sampling Procedure," EN-OP-002—"Ground Water Sampling Procedures," and EN-OP-008—"Stormwater Sampling Procedures." These procedures provide in detail descriptions of all NJPDES permit-required sampling and analytical methods for collection of samples, analyses of these samples, and quality assurance/quality control requirements. All subcontractor laboratories and/or PPPL employees are required to follow these procedures. Chain-of-custody forms are required for all samples; holding times are closely checked to ensure that the analysis was performed within established holding times and that the data is valid. Field blanks are required for all ground water sampling, and trip blanks are required for all volatile organic compound analyses. Subcontractor laboratories used by PPPL are certified by NJDEP and participate in the state's QA program; the subcontractor laboratories must also follow their own internal quality assurance plans [QC96].

Chapter

9

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Chapter

10

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Chapter

11

TABLES

Table 1. TFTR Radiological Design Objectives and Regulatory Limits[a]

CONDITION		PUBLIC	EXPOSURE[b]	OCCUPATIONAL	EXPOSURE
		REGULATORY LIMIT	DESIGN OBJECTIVE	REGULATORY LIMIT	DESIGN OBJECTIVE
<u>ROUTINE OPERATION</u> Dose equivalent to an individual from routine operations (rem per year, unless otherwise indicated)	NORMAL OPERATIONS	0.1 Total, 0.01[c] Airborne, 0.004 Drinking Water	0.01 Total	5	1
	ANTICIPATED EVENTS $(1 > P \geq 10^{-2})$	0.5 Total (including normal operation)	0.05 per event		
<u>ACCIDENTS</u> Dose equivalent to an individual from an accidental release (rem per event)	UNLIKELY EVENTS $10^{-2} > P \geq 10^{-4}$	2.5	0.5	(e)	(e)
	EXTREMELY UNLIKELY EVENTS $10^{-4} > P \geq 10^{-6}$	25	5[d]	(e)	(e)
	INCREDIBLE EVENTS $10^{-6} > P$	NA	NA	NA	NA

P = Probability of occurrence in a year.

[a] All operations must be planned to incorporate the radiation safety guidelines, practices and procedures included in PPPL ESHD 5008, Section 10.

[b] Evaluated at the PPPL site boundary.

[c] Compliance with this limit is to be determined by calculating the highest effective dose equivalent to any member of the public at any offsite point where there is a residence, school, business or office.

[d] For design basis accidents (DBAs), i.e., postulated accidents or natural forces and resulting conditions for which the confinement structure, systems, components and equipment must meet their functional goals, the design objective is 0.5 rem.

(e) See PPPL ESHD-5008, Section 10, Chapter 12 for emergency personnel exposure limits.

Table 2. Summary of 1997 Emissions and Doses from D-Site Operations

RADIONUCLIDE & PATHWAY	QUANTITY RELEASED IN 1997[1]	EDE AT SITE BOUNDARY	EDE AT NEAREST BUSINESS[2]	POPULATION DOSE WITHIN 80 KM[3]
Tritium (air)	124.66 Ci HTO[4] 63.02 Ci HT	4.3×10^{-1} mrem[5]	1.0×10^{-1} mrem[6]	6.1 person-rem[7]
Ar-41 (air)	5.74 Ci[4]	2.3×10^{-2} mrem[8]	6.4×10^{-3} mrem[6]	3.3×10^{-2} person-rem9
N-13 (air)	3.56 Ci[4]	1.0×10^{-2} mrem[8]	2.8×10^{-3} mrem[6]	1.2×10^{-3} person-rem9
N-16 (air)	0.27 Ci[4]	1.8×10^{-5} mrem[8]	5.1×10^{-6} mrem[6]	Negligible
Cl-40 (air)	0.44 Ci4	3.6×10^{-3} mrem[8]	1.0×10^{-3} mrem[6]	Negligible
S-37 (air)	0.45 Ci4	4.9×10^{-3} mrem[8]	1.4×10^{-3} mrem[6]	Negligible
Direct/Scattered n/g Radiation	------------------	2.7×10^{-2} mrem[10]	6.9×10^{-3} mrem[11]	Negligible
Tritium (HTO) (water)	3.66×10^{-1} Ci[12]	7.3×10^{-3} mrem[13]	------------------	1.0×10^{-2} person-rem[14]
Total	------------------	5.1×10^{-1} mrem	1.2×10^{-1} mrem	6.1 person-rem
Background	------------------	600 mrem[15]	600 mrem	1.6×10^{6} person-rem

[1]Tritium (HTO and HT) quantities are as measured by the D-Site passive stack monitor and as calculated from projected releases from the RWSB. Ar-41, N-13, N-16, Cl-40, and S-37 quantities are based on production of 1.04 E19 D-D neutrons and 6.74 E19 D-T neutrons in 1997, using methodology of JL-542, Rev.1, 2/5/93 for releases during D-T operation; & 8.37 E-20 Ci Ar-41 per DD neutron derived from DOE 6/18/90 letter to EPA.

[2]At Princeton Bank Building, 351 meters east of D-Site stack.

[3]Based on year 1995 population figures as utilized for TFTR D-T EA. See Table 4 of Bentz and Bender, 1987.

[4]Measured for tritium released from the D-Site stack and calculated from projected tritium releases from the RWSB (see footnote #1); per table compiled by D. Jassby, 4/10/97 for other air emissions (i.e., source of neutron production data).

[5]For D-Site stack releases, based on NOAA X/Q [Start, 1989] and JL-457, 7/2/92, Table 1 (1% of HT releases are assumed to convert to HTO); *(124.10 Ci x 2.6 E-03 mrem/Ci) + (0.6302 Ci x 2.6 E-03 mrem/Ci) + (62.3898 Ci x 1.05 E-07 mrem/Ci)*. For RWSB releases, based on PPPL NEPA Planning Form #1004 and airborne HTO measurements in the RWSB (0.56 Ci x 0.19625 mrem/Ci).

[6]Based on 28% of the NOAA X/Q at the site boundary [Start, 1989] for D-Site stack releases, and 8.3% of X/Q at the site boundary for RWSB releases (JL-844, 4/8/96).

[7]Scaling from values used for the TFTR D-T EA, we get (187.68 Ci/500 Ci) x 16.2 person-rem = 6.1 person-rem.

[8]Based on NOAA X/Q [Start, 1989] and JL-457, 7/2/92, Table 1; Ar-41: 5.74 Ci x 4.0 E-03 mrem/Ci. N-13: 3.56 Ci x 2.8 E-03 mrem/Ci. N-16: 0.27 Ci x 6.71 E-05 mrem/Ci. Cl-40: 0.44 Ci x 8.2 E-03 mrem/Ci. S-37: 0.45 Ci x 1.08 E-02 mrem/Ci.

[9]Scaling from values used for the TFTR D-T EA, we get for Ar-41: (5.74 Ci/115 Ci) x 0.67 person-rem = 3.3 E-02 person-rem; for N-13: (3.56 Ci/434 Ci) x 0.149 person-rem = 1.2 E-03 person-rem.

[10]Based on 1997 neutron production (see Note 1) and neutron and gamma radiation dose per neutron given in Table 4 of PPPL Report PPPL-3020, "Measurements of TFTR D-T Radiation Shielding Efficiency," 11/94.

[11]Based on inverse square decrease between site boundary (176 meters) and nearest business (351 meters).

[12] Released from Liquid Effluent Collection Tanks (LECT) to Stony Brook Sewer Authority treatment facility via PPPL sanitary sewer system.

[13] Based on usage of 1 E10 liters/yr for Stony Brook treatment facility, as per TFTR D-T EA, the dose to a person who drank all his/her water from the waterway (Millstone River) into which the treatment facility discharged in 1997 would be [(3.66 E-01 Ci/yr)(/1 E10 l/yr)] x [(4 mrem)/(2 E-08 Ci/l)] = 7.3 E-03 mrem.

[14] Based on use of Millstone River as drinking water source for 500,000 people for 1 day per year (estimate by Elizabethtown Water Company of actual use is a few hours once every several years).

[15] Based on 100 mrem annual background dose exclusive of radon, plus dose due to exposure to average radon concentration in Plainsboro homes (Memo, J. Greco to J. Levine, 11/13/90, "Radon Dose Equivalent," JMG-160).

Table 3. Precipitation and Tritium in Precipitation at PPPL for 1997

Start Date	Week	Inch	Inch/Month	Month	Accumulation	Tritium pCi/L
6-Jan-97	1	0.475			0.475	
13-Jan-97	2	1.075			1.550	
20-Jan-97	3	1.425			2.975	
27-Jan-97	4	0.800	3.775	January	3.775	
3-Feb-97	5	1.250			5.025	
10-Feb-97	6	0.875			5.900	
17-Feb-97	7	0.050			5.950	
24-Feb-97	8	0.425	2.600	February	6.375	
3-Mar-97	9	1.225			7.600	
10-Mar-97	10	0.950			8.550	
17-Mar-97	11	0.000			8.550	
24-Mar-97	12	1.525			10.075	
31-Mar-97	13	1.000	4.700	March	11.075	
7-Apr-97	14	1.000			12.075	
14-Apr-97	15	0.550			12.625	
21-Apr-97	16	1.125			13.750	864.4
28-Apr-97	17	0.950	3.625	April	14.700	
5-May-97	18	0.875			15.575	
12-May-97	19	0.050			15.625	
19-May-97	20	2.550			18.175	
26-May-97	21	0.925	4.400	May	19.100	
2-Jun-97	22	0.600			19.700	
9-Jun-97	23	0.350			20.050	
16-Jun-97	24	1.725			21.775	
23-Jun-97	25	0.000			21.775	
30-Jun-97	26	0.700	3.375	June	22.475	
7-Jul-97	27	1.350			23.825	
14-Jul-97	28	0.100			23.925	
21-Jul-97	29	4.050			27.975	
28-Jul-97	30	0.000	5.500	July	27.975	
4-Aug-97	31	0.825			28.800	
11-Aug-97	32	0.550			29.350	
18-Aug-97	33	1.500			30.850	333.3
25-Aug-97	34	0.050	2.925	August	30.900	
1-Sep-97	35	0.100			31.000	
8-Sep-97	36	0.900			31.900	
15-Sep-97	37	0.100			32.000	
22-Sep-97	38	0.400			32.400	
29-Sep-97	39	0.000	1.500	September	32.400	
6-Oct-97	40	0.000			32.400	
13-Oct-97	41	0.400			32.800	
20-Oct-97	42	1.800			34.600	
27-Oct-97	43	1.425	3.625	October	36.025	
3-Nov-97	44	0.040			36.065	
10-Nov-97	45	0.625			36.690	
17-Nov-97	46	0.950			37.640	
24-Nov-97	47	0.200	1.815	November	37.840	
1-Dec-97	48	0.225			38.065	
8-Dec-97	49	0.425			38.490	
15-Dec-97	50	0.000			38.490	
22-Dec-97	51	1.850			40.340	
29-Dec-97	52	1.650	4.150	December	41.990	

Table 4. Weekly Tritium Released from TFTR Stack for 1997

Week Ending	HTO (Ci)	HT (Ci)	Weekly Total (Ci)	Total (Ci) Annual
January 8	0.679	0.436	1.115	1.115
January 15	0.778	0.117	0.895	2.010
January 22	4.900	0.555	5.455	7.465
January 29	0.881	0.128	1.009	8.474
February 5	2.660	0.829	3.489	11.963
February 12	1.665	0.197	1.862	13.825
February 19	1.259	0.188	1.447	15.272
February 26	1.327	0.198	1.525	16.797
March 5	0.885	0.367	1.252	18.049
March 12	0.787	0.280	1.067	19.116
March 19	0.717	0.408	1.125	20.241
March 26	0.896	0.408	1.304	21.545
April 2	0.638	0.509	1.147	22.692
April 9	0.705	0.105	0.810	23.502
April 16	0.759	0.253	1.012	24.514
April 23	1.749	0.852	2.601	27.115
April 30	4.950	0.770	5.720	32.835
May 7	16.660	0.903	17.563	50.398
May 14	1.805	0.180	1.985	52.383
May 21	4.290	6.376	10.666	63.049
May 28	4.660	8.790	13.450	76.499
June 4	7.390	4.995	12.385	88.884
June 6	3.140	2.700	5.840	94.724
June 9	3.870	2.170	6.040	100.764
June 11	2.480	0.362	2.842	103.606
June 18	11.680	4.640	16.320	119.926
June 25	6.980	1.572	8.552	128.478
July 2	5.450	0.832	6.282	134.760
July 10	6.470	1.204	7.674	142.434
July 16	1.965	1.015	2.980	145.414
July 23	1.524	0.458	1.982	147.396
July 30	0.937	0.300	1.237	148.633
August 6	0.802	0.122	0.924	149.557
August 13	0.548	0.378	0.926	150.483
August 20	0.446	0.103	0.549	151.032
August 27	0.688	0.360	1.048	152.080
September 3	0.198	0.027	0.225	152.305
September 10	0.244	2.580	2.824	155.129
September 18	0.438	0.348	0.786	155.915
September 24	0.748	2.053	2.801	158.716
October 1	1.341	2.699	4.040	162.756
October 8	8.840	2.380	11.220	173.976
October 15	0.570	0.729	1.299	175.275
October 22	0.420	0.445	0.865	176.140
October 29	0.343	0.684	1.027	177.167
November 5	0.293	0.330	0.623	177.790
November 12	0.416	0.705	1.121	178.911
November 19	0.242	0.428	0.670	179.581
November 26	0.657	1.010	1.667	181.248
December 3	0.310	1.060	1.370	182.618
December 10	0.088	3.070	3.158	185.775
December 17	0.290	0.382	0.672	186.447
December 31	0.635	0.029	0.664	187.111

Table 5. Tritium Concentrations in Surface Water for 1997 (in picoCuries/Liter)

Month	Bee Brook B1	Bee Brook B2	Bee Brook B3	PPPL Basin DSN001	PPPL D-site D1
January	382.9	509.0		576.6	
February	405.4	459.5		445.9	
March	450.5	603.6		567.6	423.4
April	468.5	581.1		743.2	
May	594.6	689.2		756.8	360.4
June	112.6	315.3	130.6	468.5	
July	130.6	261.3	184.7	612.6	
August	455.4	557.7	323.9	578.8	355.4
September	274.8	432.4	283.8	567.6	
October	684.7	500.0	364.9	486.5	
November	409.9	761.3		644.1	
December	301.8	545.0	319.8	135.1	

Month	D&R Canal DSN003	Potable Water E1	Millstone River M1	Cranbury Brook P1	Devil's Brook P2
January	310.8	58.56		85.59	
February	103.6	4374		112.6	
March	261.3	279. 3	238.7	297.3	234.2
April	270.3	351.4			
May	157.7	130.6	112.6	121.6	139.6
June	76.58	31.56			824.3
July	166.7		85.59	112.6	153.2
August		309.9	304.1	209.9	199.5
September	225.2	189.2	243.2	288.3	261.3
October	220.7	310.8	216.2	306.3	193.7
November	378.4	306.3	315.3	382.9	279.3
December	351.4	247.7	157.7	112.6	

Table 6. Tritium (HTO) Concentration in Ground Water (Sumps & Wells) for 1997 (in picoCuries/Liter)

Date	TFTR Sump	D-site MG sump	TW-1	TW-5	TW-8	TW-10	D-12	MW-12S
January	765.8							
February	4,269	961.7	1,523	1,302	734.2			153.2
March	770.3		1,176	1,545	806.3		328.8	409.9
April	680.2	702.7	1,590	1,838	1,216		400.9	342.3
May	675.7	630.6	2,077	2,472	1,487	184.7	270.3	746.8
June	608.1	486.5	1,342	1,446	774.8			
July	567.6	400.9	1,104	1,063	779.3		112.3	103.6
August	585.6	387.4					229.7	
September	612.6	409.9	1,320	1,167	864.9	346.8	319.8	265.8
October	400.9	423.4						
November	765.8	644	1,108	964	846.8	234.2	351.4	351.4
December	509.0	445.9	1,131	1,149	738.7	229.7	387.4	

Date	D-11R	MW-14	MW-15	MW-16	Inflow 1	Inflow 2	LOB Roof	LOB Sump	MW-4
January									
February	229.7	360.4	400.9	306.3					
March									
April									
May	130.6	157.7	121.6	117.1	761.3	657.7			
June									2590
July							1568		
August	121.6	94.59	162.2	157.7					
September								391.9	
October									
November	166.7	256.8	252.3	238.7					
December									

Date	C site MG S4	C site MG S5	C site MG S7	MW-17	MW-18	MW-22	MW-24S	MW-5I	MW-7S
September	418.9	310.8	360.4	364.8	234.2	261.3	252.3	392.9	301.8

Table 7. Tritium (HTO) Concentrations in Precipitation for 1997 (picoCuries/Liter)

Month	Date	Inner East R1E	Inner West R1W	Inner South R1S	Inner North R1N	Inner North Dupl. R1ND
January	16	2685	797.3	1446	806.3	585.6
	29	2374	1293	1113	806.3	819.8
February	6	6486	4824	1766	1613	1622
	14	1905		2243	144.1	243.2
March	7	2860	1761	1252	936.9	725.2
	17	3081	2122	941.4	1270	1225
April	2	1829	432.4	4901	378.4	283.8
	14	1221	1559	2338	1545	1541
	30	3761	1095	19,210	509	558.6
May	8	61,660	342.3	15,090	1892	1775
	28	4977	572.1	7162	495.5	774.8
June	4	265.8	3626	1131	333.3	991
	19	16,890	3428	4644	2194	2099
July	14	5761	1734	2347	2216	3514
	25	171.2	189.2	1036	162.2	265.8
August	18	1545	441.4	1086	599.1	459.5
	21	445.9	980.2	436.9	418.9	279.3
September						
October	1	1815	932.4	3716	846.8	1081
	30	887.4	306.3	1482	202.7	274.8
November	12	482	666.7	842.3	432.4	387.4
	26	675.7	653.2	1,248	337.8	455
December	18	693.7	526.1	1,550	402.7	395.5

Month	Date	Outer East R2E	Outer West R2W	Outer South R2S	Outer North R2N	Far North R3N
January	16	1059	252.3	639.6	292.8	
	29	968.5		324.3	581.1	
February	6	2725	1649	504.5	1491	
	14	1563	1329	1653	445.9	
March	7	1698	1018	851.4	684.7	
	17	1153	1126	1514	644.1	
April	2	698.2	301.8	1635	364.9	
	14	666.7	1685	824.3	1239	
	30	2270	1644	5671	297.3	
May	8	39,490	126.1	3968	2396	
	28	2392	319.8	986.5		
June	4	166.7	6027	175.7	234.2	
	19	2784	1230	2023	1180	252.3
July	14	2568	554.1	842.3	1473	
	25	130.6	171.2	432.4	3468	94.59
August	18	1320	909.9	1171		864.9
	21	364.9	310.8	882.9	252.3	243.2
September						
October	1	1955	459.5	1054	518	405.4
	30	509	382.9	581.1	130.6	63.06
November	12	261.3	464	324.3	315.3	0
	26	427.9	432.4	459.2	355.9	328.8
December	18	242.8	268.5	570.7	318.5	298.2

Table 8. Tritium Concentrations in Precipitation (R1 to R6) for 1997 (in picoCuries/Liter)

Date	R1	R2	R4	R5	R6
Jan. 21				324.3	319.8
Jan.27	211.7			144.1	148.6
Feb. 17	270.3	220.7	139.6	306.3	261.3
Mar. 4	450.5	324.3		292.8	306.3
Mar.11				252.3	
Mar.17				283.8	292.8
Apr. 1	261.3	261.3		337.8	288.3
Apr. 14				800.9	755.9
Apr. 22	171.2		247.7	248.6	175.7
May 5					126.1
May 12		162.2		103.6	
May 27	166.2	157.7	220.7	112.6	121.6
Jun. 3	337.8	112.6		144.1	229.7
Jun. 24	157.7		491.0	540.5	148.6
Jul.14		175.7	108.1	477.5	180.2
Jul. 29	45.05	117.1	405.4	855.9	675.7
Aug. 11				171.1	
Aug. 18				148.6	
Aug.25	220.7	247.7		270.3	
Sept. 3			337.8	355.9	256.8
Sept. 15				261.3	225.2
Oct. 7				207.2	
Oct.28	229.7	261.3		283.8	229.7
Nov. 3		337.8	400.9	423.4	391.9
Nov. 17	378.4			342.3	
Nov. 24		369.4			418.9
Nov.25				378.4	
Dec. 8				297.3	

Table 9. Annual Range of Tritium Concentration at PPPL in Precipitation from 1985 to 1997

Year	Tritium Range picoCuries/Liter	Precipitation inches
1985	40 to 160	
1986	40 to 140	
1987	26 to 144	
1988	34 to 105	
1989	7 to 90	55.345
1990	14 to 94	50.332
1991	10 to 154	45.075
1992	10 to 838	41.860
1993	25 to 145	42.731
1994	32 to 1,130	51.260
1995	<19 to 2,561	35.625
1996	<100 to 21, 140	61.035
1997	131 to 61,660	41.990

Table 10. Tritium Concentrations in Air (T1-4 and Baseline) for 1997 (in picoCuries/m^3)

Month	T1 HTO	T2 HTO	T3 HTO	T4 HTO	Baseline
January	31.870	99.743	186.469	108.422	15.494
February	55.604	125.435	312.530	68.141	10.265
March	57.210	116.703	185.862	41.749	13.305
April	60.738	109.854	508.330	65.353	15.701
May	340.183	935.532	1,551.600	254.362	26.680
June	492.467	670.150	1,303.912	418.884	23.878
July	43.589	401.279	473.343	36.242	13.054
August	82.367	205.322	228.498	42.313	6.131
September	76.138	239.210	219.302	44.915	42.073
October	56.470	373.967	241.838	37.892	2.841
November	125.242	464.550	193.676	291.145	18.336
December	31.778	85.269	116.712	27.876	9.376
Month	**T1 HT**	**T2 HT**	**T3 HT**	**T4 HT**	**Baseline**
January	31.164	30.802	126.667	39.416	43.327
February	27.825	24.626	39.968	23.756	13.442
March	25.529	28.912	53.317	21.315	20.734
April	33.331	29.499	64.526	19.173	14.881
May	175.717	151.663	368.552	138.282	27.728
June	122.719	125.175	173.670	107.265	25.189
July	84.519	2,532.529	68.877	13.059	30.325
August	74.270	1,263.890	50.859	33.441	19.893
September	161.009	1,100.065	81.439	33.077	32.380
October	156.093	659.352	33.924	24.578	4.500
November	1,762.810	775.672	113.398	320.457	25.342
December	57.719	284.416	34.387	108.205	22.304

Table 11. Tritium Concentrations in Air (R1-6 and Baseline) for 1997 (in picoCuries/m^3)

Month	R1 HTO	R2 HTO	R3 HTO	R4 HTO	R5 HTO	R6 HTO	BSN HTO
January	12.941	17.154	18.483	41.951	24.771	10.468	15.494
February	8.629	16.052	16.573	38.617	28.794	9.846	10.265
March	13.031	16.656	19.897	24.118	35.937	17.461	13.305
April	23.644	22.996	18.692	30.204	42.717	31.633	15.701
May	35.141	52.217	99.661	74.116	85.190	31.616	26.680
June	47.150	45.949	189.664	107.108	99.419	47.790	23.878
July	10.885	10.618	44.687	24.557	34.358	8.189	13.054
August	20.581	12.618	43.973	35.607	31.606	16.907	6.131
September	26.954	22.642	65.629	52.861	28.768	36.810	42.073
October	15.697	21.317	70.046	27.791	23.042	20.585	2.841
November	323.463	287.572	19.037	16.816	25.139	12.535	18.336
December	16.728	24.076	28.312	27.792	26.820	18.245	9.376
Month	**R1 HT**	**R2 HT**	**R3 HT**	**R4 HT**	**R5 HT**	**R6 HT**	**BSN HT**
January	30.251	32.877	40.320	59.723	39.540	16.998	43.327
February	14.076	15.135	25.506	12.266	37.478	15.859	13.442
March	18.111	21.676	22.745	208.979	44.767	31.281	20.734
April	16.865	26.582	44.869	18.829	29.041	44.045	14.881
May	33.054	515.586	63.243	40.791	45.038	44.922	27.728
June	33.508	31.349	33.613	23.535	35.178	29.546	25.189
July	9.659	15.400	15.431	9.281	14.455	8.414	30.325
August	17.855	15.800	22.853	11.820	35.214	18.344	19.893
September	21.023	31.932	35.762	17.564	509.083	27.141	32.380
October	16.097	11.364	110.947	16.561	301.455	21.814	4.500
November	483.427	638.892	31.362	20.491	35.202	26.749	25.342
December	56.772	36.861	86.195	73.348	48.782	27.974	22.304

Table 12. 1997 Liquid Effluent Collection Tank Release Data

Sample Date	Tank #	Gallons Discharged	Tritium Sample LLD (pCi/L)	Tritium Sample Activity (pCi/L)	Total Tank Activity (Ci)	Annual Cum. Activity (Ci)	Gross Beta Sample LLD (pCi/L)	Gross Beta Sample Activity (pCi/L)
2/5/97	2	3,150	394	133,000	0.00158	0.00158	195	552
3/28/97	2	6,300	366	551,000	0.0131	0.0147	195	2,490
5/6/97	2	7,800	322	1,190,000	0.0351	0.0499	195	5,360
5/13/97	2	4,500	314	297,000	0.00506	0.0549	195	1,460
6/4/97	2	6,900	305	184,000	0.00481	0.0597	195	602
6/17/97	2	9,000	296	1,160,000	0.0396	0.0993	195	5,110
6/25/97	2	11,250	319	1,580,000	0.0672	0.166	195	6,580
7/14/97	3	12,750	331	1,120,000	0.0543	0.221	196	4,800
7/22/97	3	10,500	326	463,000	0.0184	0.239	196	1,980
8/13/97	3	10,500	328	170,000	0.00675	0.246	196	563
8/27/97	3	10,200	355	98,2000	0.00379	0.250	194	346
9/22/97	3	12,750	371	404,000	0.0195	0.269	195	1,450
10/14/97	3	10,200	378	139,000	0.00535	0.275	195	504
11/21/97	3	12,750	403	1,310,000	0.0632	0.338	195	4,410
12/18/97	3	11,100	315	667,000	0.0280	0.366	195	2,080

Ci - Curies
LLD - Low limit of detection
pCi/L - picoCuries/Liter

Table 13. 1997 Surface Water Analysis for Bee Brook, Locations B1 and B2

Parameters/Units	*B1 5/16/97*	*B1 8/8/97*	*B2 5/16/97*	*B2 8/16/97*
Ammonia-N, mg/L	<0.100	<0.100	<0.100	<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.30	<3.10	<2.30	<3.10
Chemical Oxygen Demand, mg/L	15.2	13.5	8.30	6.5
Chromium, mg/L	<0.010	<0.010	<0.010	<0.010
Flow, approximate gpm	371.82	139.32	989.45	297.64
Petroleum hydrocarbons, mg/L	<0.500	<0.500	<0.500	<0.500
pH, standard units	7.1	7.3	7.1	7.3
Phenolics, as phenol, mg/L	<0.005	<0.005	0.011	<0.005
Temperature, °C	13.3	18.0	14.0	20.0
Total Dissolved Solids, mg/L	136	150	158	222
Total Suspended Solids, mg/L	4.00	7.00	6.00	8.00

Location B1 = Bee Brook upsteam of PPPL basin discharge
Location B2 = Bee Brook downstream of PPPL basin discharge

Table 14. 1997 Surface Water Analysis for Delaware & Raritan Canal, Location C1, and Ditch #5, Location D1

Parameters/Units	*C1 5/16/97*	*C1 8/8/97*	*D1 5/16/97*	*D1 8/16/97*
Ammonia-N, mg/L	<0.100	<0.100	<0.100	<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.30	<3.10	<2.30	<3.10
Chemical Oxygen Demand, mg/L	7.10	9.00	2.50	8.00
Chromium, mg/L			<0.010	<0.010
Flow, approximate gpm			1301.61	
Petroleum hydrocarbons, mg/L	<0.500	<0.500	<0.500	<0.500
pH, standard units	6.8	6.9	6.8	7.0
Phenolics, as phenol, mg/L	<0.005	<0.005	0.013	<0.005
Temperature, °C	16.8	24.0	16.0	25.0
Total Dissolved Solids, mg/L	102	156	152	178
Total Suspended Solids, mg/L	16.0	16.0	<2.0	3.00

Location C1 = Delaware & Raritan Canal State Park at Maple Avenue, Plainsboro midway on pedestrian bridge
Location D1 = PPPL D site manhole opposite former ES&H office

See Figure 6 for locations.

Table 15. 1997 Surface Water Analysis for Elizabethtown Water, Location E1, and Millstone River, Location M1

Parameters/Units	E1 5/16/97	E1 8/8/97	M1 5/16/97	M1 8/16/97
Ammonia-N, mg/L	<0.100	<0.100	0.230	0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.30	<3.10	2.40	<3.10
Chemical Oxygen Demand, mg/L	2.50	5.40	14.2	12.2
Petroleum hydrocarbons, mg/L	<0.500	<0.500	<0.500	<0.500
pH, standard units	6.7	6.9	6.9	7.1
Phenolics, as phenol, mg/L	<0.005	<0.005	0.01	<0.005
Temperature, °C	15.0	23.0	17.2	25.0
Total Dissolved Solids, mg/L	206	256	124	130
Total Suspended Solids, mg/L	<2.00	<2.00	14.0	9.00

Location E1 = Elizabethtown Water (potable) collected at Main Gate Security Booth
Location M1 = Millstone River at Route 1 bridge midspan on northbound side
See Figure 6 for locations.

Table 16. 1997 Surface Water Analysis for Plainsboro, Locations P1 and P2

Parameters/Units	P1 5/16/97	P1 8/8/97	P2 5/16/97	P2 8/16/97
Ammonia-N, mg/L	<0.100	<0.100	<0.100	<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	3.30	<3.10	<2.30	<3.10
Chemical Oxygen Demand, mg/L	19.2	14.5	20.2	13.0
Petroleum hydrocarbons, mg/L	<0.500	<0.500	<0.500	<0.500
pH, standard units	6.7	6.9	6.6	7.0
Phenolics, as phenol, mg/L	<0.005	<0.005	0.011	<0.005
Temperature, °C	17.9	24.0	13.7	17.0
Total Dissolved Solids, mg/L	108	108	82	100
Total Suspended Solids, mg/L	16.0	4.0	4.0	3.00

Location P1 = Cranbury Brook at George Davison Road, Plainsboro midspan on bridge southbound
Location P2 = Devil's Brook at Schalks Road overpass, adjacent to Amtrak railroad tracks
See Figure 6 for locations.

Table 17. 1997 Detention Basin Influents Analysis (NJPDES NJ0086029)

Parameters/Units	Inflow 1 5/16/97	Inflow 1 8/8/97	Inflow 2 5/16/97	Inflow 2 8/16/97
Ammonia-N, mg/L	<0.100	<0.100	<.0500	<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.30	<3.10	<2.30	<3.10
Chemical Oxygen Demand, mg/L	3.50	6.30	<2.0	13.1
Chromium, mg/L	<0.010	<0.010	<0.010	<0.010
Petroleum hydrocarbons, mg/L	<0.005	<0.005	<0.005	<0.005
pH, standard units	7.2	6.9	7.4	6.9
Phenolics, as phenol, mg/L	0.011	<0.005	0.009	<0.005
Settleable solids, %	<0.5		<0.5	
Temperature, °C	17.0	23.0	16.5	19.0
Total Dissolved Solids, mg/L	176.0	250	220.0	254
Total Volatile Organics (GC/MS), µg/L		see Table 30		see Table 30

Locations Flow 1 = Detention basin influent located on western side of basin
Locations Flow 2 = Detention basin influent located on northern side of basin

Table 18. 1997 Monthly Surface Water Analysis for the Detention Basin Outfall, Location DSN001 (NJPDES NJ0023922)

Permit Limit	Units	Parameters	1/10	2/7	3/7	4/4	5/16	6/6
NA	mg/L	Ammonia-N		0.800			<0.100	
NA	mg/L	Biochemical Oxygen Demand, 5-day total		<2.00			<2.30	
50 mg/L	mg/L	Chemical Oxygen Demand	5.4	5.30	3.37	4.13	5.7 8.10	7.80
NL	mg/L	Chlorine Produced Oxidants as chlorine, free		0.18			0.20	
NA	mg/L	Chromium, total		<0.010				
100	percent	Chronic Toxicity Test NOEC (% effluent) IC_{25} (% effluent) *Pimephales promelas*			 100 >100			 100 >100
NA	gpm	Flow	826.4	307.64	264.58	282.64	198.61	191.57
10 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
6.0-9.0	S.U.	pH	6.4	7.1	7.2	6.3	7.0	7.1
NA	mg/L	Phenolics, as phenol		<0.005			<0.005	
30 °C max.	°C	Temperature	15.00	9.00	6.67	15.2	15.9	17.7
NA	mg/L	Total Dissolved Solids		200			190	
50 mg/L	mg/L	Total Suspended Solids	3.0	<2.00	3.00	4.00	<2.0 10.0	5.0

Permit Limit	Units	Parameters	7/11	8/8	9/10	10/14	11/5	12/3
NA	mg/L	Ammonia-N		<0.100		0.100	17.0	
NA	mg/L	Biochemical Oxygen Demand, 5-day total		<3.10		<2.90	<2.50	
50 mg/L	mg/L	Chemical Oxygen Demand	5.5	12.0	3.90	2.60	16.5	6.50
NL	mg/L	Chlorine Produced Oxidants as chlorine, free		0.28			0.14	
NA	mg/L	Chromium, total		<0.010			<0.010	
100	percent	Chronic Toxicity Test NOEC (% effluent) IC_{25} (% effluent) *Pimephales promelas*			 100 >100			 100 >100
NA	gpm	Flow	97.75	96.11	155.14	156.14	413.88	756.85
10 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
6.0-9.0	S.U.	pH	7.4	7.0	7.4	8.1	6.8	6.50
NA	mg/L	Phenolics, as phenol		<0.005		<0.005	<0.005	
30 °C max.	°C	Temperature	21.5	20.0	20.0	20.8	17.4	10.0
NA	mg/L	Total Dissolved Solids		234		207	453	
50 mg/L	mg/L	Total Suspended Solids	8.0	13.0	10.0	3.0	3.0	<2.0

Blank indicates no measurement
NA = not applicable
NL = no limit

Table 19. 1997 Monthly Surface Water Analysis for the Canal Pump House, Location DSN003 (NJPDES NJ0023922

Permit	Limit								
Monthly Avg.	**Daily Max.**	**Units**	**Parameters**	**1/10**	**2/7**	**3/7**	**4/4**	**5/16**	**6/6**
NA	NA	mg/L	Ammonia-N		<0.100			<0.100	
NA	NA	mg/L	Biochemical Oxygen Demand		<3.00			<2.30	
NL	NL	mg/L	Chlorine Produced Oxidants		0.19			0.20	
NA	NA	mg/L	Chromium		<0.010			<0.010	
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
NA	6.0-9.0	S.U.	pH	6.9	7.3	7.5	6.7	6.9	7.2
NA	NA	mg/L	Phenolics, as phenol		0.006			0.008	
NA	NA	$^\circ$C	Temperature	3.0	1.0		11.1	16.4	17.7
NA	NA	mg/L	Total Dissolved Solids					110	
20 mg/L	60 mg/L	mg/L	Total Suspended Solids	2.0	10.0	3.0	17.0	10.0	15.0

Permit	Limit								
Monthly Avg.	**Daily Max.**	**Units**	**Parameters**	**7/11**	**8/8**	**9/10**	**10/14**	**11/5**	**12/3**
NA	NA	mg/L	Ammonia-N		<0.100			<0.100	
NA	NA	mg/L	Biochemical Oxygen Demand		<3.10			<2.50	
NL	NL	mg/L	Chlorine Produced Oxidants		0.35			0.10	
NA	NA	mg/L	Chromium		<0.010			<0.010	
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
NA	6.0-9.0	S.U.	pH	7.0	6.9	7.4	7.8	7.0	7.2
NA	NA	mg/L	Phenolics, as phenol		<0.005			<0.005	
NA	NA	$^\circ$C	Temperature	25.6	25.0	22.0	20.3	11.2	
NA	NA	mg/L	Total Dissolved Solids		142			187	
20 mg/L	60 mg/L	mg/L	Total Suspended Solids	12.0	16	27.0		4.0	2.0
			Chemical Oxygen Demand				6.20	10.3	

Flow = 250 gallons per minute X 2 minutes per cycle X 15 cycles per day = 7,500 gallons per day
Blank indicates no measurement
NA = not applicable
NL = no limit

Table 20. Total Petroleum Hydrocarbon Results for 1997 from Ground Water Monitoring Program - Sampled by PPPL & Analyzed by Reliance Lab (in mg/L)

Well Number	3/97	6/97	9/97
P-2	<5.0	<1.0	<1.0
MW-4	<5.0	<1.0	<1.0
MW-5S	<5.0	<1.0	<1.0
MW-5I	<5.0	<1.0	<1.0
MW-6S	<5.0	<1.0	<1.0
MW-6I	<5.0	<1.0	<1.0
MW-7S	<5.0	<1.0	<1.0
MW-7I	<5.0	<1.0	<1.0
MW-8S	<5.0	<1.0	<1.0
MW-8I	<5.0	<1.0	<1.0

Table 21. Ground Water Monitoring Program Volatile Organic Compound Results — March 1997 Sampled by PPPL & Analyzed by Reliance Lab (in mg/L)

Parameter	P-2 3/18/97	P-3* 3/18/97	MW-4 3/18/97	MW-5S 3/18/97	MW-5I 3/18/97	MW-6S 3/18/97
Target VOC						
1,1-Dichloroethene	<1.1	<1.1	<1.1	<0.059	**1.0T**	<1.1
1,1-Dichloroethane	<0.8	<0.8	<0.8	<0.097	**1.2**	**2.3**
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<0.18	<1.0	**1.3**
Trichloroethene	<0.8	<0.8	<0.8	<0.15	**11.3**	**1.0**
Tetrachloroethene	<0.9	<0.9	<0.9	**2.1**	**2.0**	**4.7**
Chloroform	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Total Conc. Target VOC	0	0	0	**2.1**	**15.5**	**9.3**
Non-Target VOC (Number of Compounds)	0	0	0	0	0	**143 (1)**

Parameter	MW-6I 3/18/97	MW-7S 3/18/97	MW-7I 3/18/97	MW-8S 3/18/97	MW-8I 3/18/97	Trip Blank 3/18/97
Target VOC						
1,1-Dichloroethene	<1.1	**4.2**	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane	<0.8	**13.2**	<0.8	<0.8	<0.8	<0.8
1,1,1-Trichloroethane	<1.0	**8.2**	<1.0	<1.0	<1.0	<1.0
Trichloroethene	<0.8	**2.6**	<0.8	**1.5**	<0.15	<0.8
Tetrachloroethene	<0.9	**12.9**	<0.9	**17.0**	<0.9	<0.9
Chloroform	<0.8	1.6	<0.8	<0.8	<0.8	<0.8
Total Conc. Target VOC	0.	**41.1**	0	**18.5**	0	0
Non-Target VOC (Number of Compounds)	0	**(3.4) 1**	0	0	0	0

P-3 is duplicate of P2
T = Estimated value
VOC - volatile organic compounds, 40 CFR Method 624

Table 22. Ground Water Monitoring Program Volatile Organic Compound Results—June 1997 Sampled by PPPL & Analyzed by Reliance Lab (in mg/L)

Parameter	P-2 6/16/97	MW-4 6/16/97	MW-5S 6/16/97	MW-5I 6/16/97	MW-6S 6/16/97
Target VOC					
1,1-Dichloroethene	<1.1	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane	<0.8	<0.8	<0.8	<0.8	<0.8
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	<0.8	<0.8	<0.8	**8.7**	<0.8
Tetrachloroethene	<0.9	<0.9	**2.9**	**1.6**	<0.9
Chloroform	<0.8	<0.8	<0.8	<0.8	<0.8
Total Conc. Target VOC	0	0	**2.9**	**10.3**	0
Non-Target VOC (Number of Compounds)	0	0	0	0	**128 (1)**

Parameter	MW-6I 6/16/97	MW-7S 6/16/97	MW-7I 6/16/97	MW-8S 6/16/97	MW-8I 6/16/97	Trip Blank 6/16/97
Target VOC						
1,1-Dichloroethene	<1.1	**3.8**	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane	<0.8	**11**	<0.8	<0.8	<0.8	<0.8
1,1,1-Trichloroethane	<1.0	**7.3**	1.0U	<1.0	<1.0	<1.0
Trichloroethene	<0.8	**1.7**	<0.8	<0.8	<0.8	<0.8
Tetrachloroethene	<0.9	**9.1**	<0.9	**10**	<0.9	<0.9
Chloroform	<0.8	**1.5**	<0.8	<0.8	<0.8	<0.8
Total Conc. Target VOC	0	**34.4**	0	**10**	0	0
Non-Target VOC (Number of Compounds)	0	**4 (1)**	0	0	0	0

VOC - volatile organic compounds, 40 CFR 101 Method 624

Table 23. Ground Water Monitoring Program Volatile Organic Compound Results — September 1997 Sampled by PPPL & Analyzed by Harding Lawson (in μg/L)

Parameter	*MW-5S*	*MW-5I 9/4/97*	*MW-6S 9/4/97*	*MW-6S Duplic.*	*MW-6I 9/1/97*
Target VOC	No Sample				
1,1-Dichloroethene	Dry well	<0.034	**1.13**	**0.982**	<0.034
1,1-Dichloroethane		**0.165**	**5.14**	**4.52**	<0.022
1,1,1-Trichloroethane		<0.027	**2.15**	**2.02**	<0.027
Trichloroethene		**2.05**	**4.86**	**4.15**	<0.10
Tetrachloroethene		**0.404T**	**19.8**	**17.40**	<0.08
Chloroform		<0.079	**1.10**	**0.98**	<0.079
Total Conc. Target VOC		**2.619**	**34.18**	**30.052**	0
Non-Target VOC (Number of Compounds)		0	0	0	0

Parameter	*MW-7S 9/4/97*	*MW-7I 9/4/97*	*MW-8S 9/4/97*	*MW-8I 9/4/97*	*Trip Blank 9/4/97*
Target VOC					
1,1-Dichloroethene	**1.54**	<0.034	<0.034	<0.034	<0.034
1,1-Dichloroethane	**5.92**	<0.022	**0.294**	<0.022	<0.022
1,1,1-Trichloroethane	**4.27**	<0.027	<0.027	<0.027	<0.027
Trichloroethene	**0.948**	<0.10	**0.696**	<0.10	<0.10
Tetrachloroethene	**5.57**	**0.216**	**6.85**	<0.08	<0.08
Chloroform	**0.838**	<0.079	<0.079	<0.079	<0.079
Total Conc. Target VOC	**19.086**	**0.216**	**7.84**	0	0
Non-Target VOC (Number of Compounds)	0	0	0	0	0

T = Estimated Value

Table 24. Ground Water Analysis for Wells MW-14, MW-15, and MW-16 for 1997

Parameters Units	NJPDES Permit Standard	MW-14 2/12/97	MW-14 5/14/97	MW-14 8/13/97	MW-14 11/6/97
Ammonia-Nitrogen, mg/L	*0.5*		<0.100	<0.100	<0.100
Chloride, mg/L	*250*			2.90	4.00
Chromium, dissolved, hexavalent, mg/L	*0.05*			<0.010	<0.010
Conductivity, mmhos/cm^2		27.9	64.5	54	67.5
Lead, total, mg/L	*0.05*			<0.005	0.0053
Nitrate-Nitrogen, mg/L	*10*			1.50	2.0
Petroleum Hydrocarbon by IR, mg/L				<0.500	
pH, units		5.14	5.56	4.66	5.33
Phenolics as phenol, mg/L	*0.3*			<0.005	<0.005
Sulfate, mg/L	*250*	15.8	27.4	15.3	16.3
Total Dissolved Solids, mg/L	*500*	70.0	74.0	90.0	93.0
Total Organic Carbon, mg/L				1.04	
Total Organic Halides, mg/L				0.0101	

Parameters Units	NJPDES Permit Standard	MW-15 2/12/97	MW-15 5/14/97	MW-15 8/13/97	MW-15 11/6/97
Ammonia-Nitrogen, mg/L	*0.5*		<0.100	<0.100	<0.100
Chloride, mg/L	*250*			4.40	4.50
Chromium, dissolved, hexavalent, mg/L	*0.05*			<0.010	<0.010
Conductivity, μmhos/cm^2		36.4	79.3	50.5	57.0
Lead, total, mg/L	*0.05*			<0.050	0.0081
Nitrate-Nitrogen, mg/L	*10*			<0.400	0.700
Petroleum Hydrocarbon by IR, mg/L				<0.500	
pH, units		6.29	6.65	4.98	5.36
Phenolics as phenol, mg/L	*0.3*			<0.005	<0.005
Sulfate, mg/L	*250*	8.90	7.38	8.08	11.1
Total Dissolved Solids, mg/L	*500*	64.0	64.0	70.0	93.0
Total Organic Carbon, mg/L				<1.00	
Total Organic Halides, mg/L				<0.005	

Parameters Units	NJPDES Permit Standard	MW-16 2/12/97	MW-16 5/14/97	MW-16 8/13/97	MW-16 11/6/97
Ammonia-Nitrogen, mg/L	*0.5*		<0.100	<0.100	<0.100
Chloride, mg/L	*250*			5.80	6 .00
Chromium, dissolved, hexavalent, mg/L	*0.05*			<0.010	<0.010
Conductivity, μmhos/cm^2		230	287	852	857
Lead, total, mg/L	*0.05*			<0.005	0.0064
Nitrate-Nitrogen, mg/L	*10*			0.500	0.500
Petroleum Hydrocarbon by IR, mg/L				<0.500	
pH, units		6.05	6.32	6.14	6.2
Phenolics as phenol, mg/L	*0.3*			<0.010	<0.010
Sulfate, mg/L	*250*	36.2	45.0	54.1	34.5
Total Dissolved Solids, mg/L	*500*	152	160	264	267
Total Organic Carbon, mg/L				2.90	
Total Organic Halides, mg/L				0.0880	

Blank indicates no measurement.

Table 25. Ground Water Analysis for Wells D-11R and D-12 for 1997

Parameters Units	NJPDES Permit Std	D-11R 2/12/97	D-11R 5/14/97	D-11R 8/12/97	D-11R 11/6/97
Ammonia-Nitrogen, mg/L	*0.5*	<0.100	<0.100	<0.100	<0.100
Chloride, mg/L	*250*			16.0	17.4
Chromium,dissolved, hexavalent,mg/L	*0.05*			<0.010	<0.010
Conductivity, μmhos/cm^2		294	521	282	400
Lead, total, mg/L	*0.05*			<0.005	0.0058
Nitrate-Nitrogen, mg/L	*10*	<0.400	<0.400	<0.400	<0.400
Petroleum Hydrocarbon by IR, mg/L				<0.500	
pH, units		6.44	6.81	6.45	6.05
Phenolics as phenol, mg/L	*0.3*	<0.010	<0.010	<0.005	<0.005
Sulfate, mg/L	*250*	10.6	9.66	12.9	16.1
Total Dissolved Solids, mg/L	*500*	182	200	172	30.0
Total Organic Carbon, mg/L				<1.0	
Total Organic Halides, mg/L				0.00890	
Tritium, pCi/L			131	121.6	

Parameters Units	NJPDES Permit Std	D-12 2/12/97	D-12 5/14/97	D-12 8/12/97	D-12 116/97
Ammonia-Nitrogen, mg/L	*0.5*	<0.100	<0.100	<0.100	<0.100
Chloride, mg/L	*250*			18.5	26.8
Chromium, dissolved,hexavalent,mg/L	*0.05*			<0.010	<0.010
Conductivity, μmhos/cm^2		281	524	195	377
Lead, total, mg/L	*0.05*			<0.005	0.0078
Nitrate-Nitrogen, mg/L	*10*	<0.400	<0.400	<0.400	<0.400
Petroleum Hydrocarbon by IR, mg/L				<0.500	
pH, units		6.08	5.88	5.13	4.75
Phenolics as phenol, mg/L	*0.3*		<0.010	<0.005	<0.005
Sulfate, mg/L	*250*	28.2	31.0	32.8	32.4
Total Dissolved Solids, mg/L	*500*	162	154	182	150
Total Organic Carbon, mg/L				2.50	
Total Organic Halides, mg/L				0.0412	
Tritium, pCi/L			158	229.7	

Blank indicates no measurement.

Table 26. Ground Water Analysis for Wells TW-2 and TW-3 for 1997

Parameters Units	NJPDES Permit Standards	TW-2 2/12/97	TW-2 5/15/97	TW-2 8/13/97	TW-2 11/6/97
Ammonia-Nitrogen, mg/L	*0.5*		<0.100	<0.100	<0.100
Chloride, mg/L	*250*			14.7	23.8
Conductivity, μmhos/cm^2		387	419	420	831
Lead,total, mg/L	*0.05*			<0.005	0.0054
Nitrate-Nitrogen, mg/L	*10*			<0.400	<0.400
Petroleum Hydrocarbon by IR, mg/L				<0.500	
pH, units		7.02	7.71	7.09	4.26
Phenolics as phenol, mg/L	*0.3*			<0.005	<0.005
Sulfate, mg/L	*250*	22.4	15.3	19.5	21.0
Total Dissolved Solids, mg/L	*500*	272	228	236	250
Total Organic Carbon, mg/L				<1.0	
Total Organic Halides, mg/L				<0.005	

Parameters Units	NJPDES Permit Standards	TW-3 2/12/97	TW-3 5/15/97	TW-3 8/13/97	TW-3 11/6/97
Ammonia-Nitrogen, mg/L	*0.5*		<0.100	<0.100	<0.100
Chloride, mg/L	*250*			20.9	18.4
Conductivity, μmhos/cm^2		365	446	424	560
Lead, dissolved, mg/L	*0.05*			<0.005	<0.005
Nitrate-Nitrogen, mg/L	*10*			<0.400	<0.400
Petroleum Hydrocarbon by IR, mg/L				<0.500	
pH, units		6.86	7.49	6.82	7.00
Phenolics as phenol, mg/L	*0.3*			<0.005	<0.005
Sulfate, mg/L	*250*	20.2	20.9	24.5	24.1
Total Dissolved Solids, mg/L	*500*	252	248	250	233
Total Organic Carbon, mg/L				<1.0	
Total Organic Halides, mg/L				0.0226	
Tritium, pCi/L			378	400.9	

Blank indicates no measurement.

Table 27. Ground Water Volatile Organics Analytical Results from Detention Basin Discharge DSN001 and Wells D-11R and D-12 — February 1997 (in µg/L)

Parameter	*DEP GW Quality Criteria*	*DSN001 2/12/97*	*D-11R 2/12/97*	*D-12 2/12/97*
Methyl Chloride (Chloromethane)	*30*	<10	<10	<10
Methyl Bromide (Bromomethane)	*10*	<10	<10	<10
Vinyl Chloride	*0.08*	<5	<5	<5
Chloroethane	*NL*	<10	<10	<10
Methylene Chloride	*400*	<2	<2	<2
Acrolein	*NA*	<5	<5	<5
Acrylonitrile	*0.06*	<2	<2	<2
1,1-Dichloroethane	*70*	<5	<5	<5
1,2-Dichloroethane	*0.3*	<2	<2	<2
1,1-Dichloroethene	*1*	<1	<1	<1
1,2-trans-Dichloroethene	*100*	<2	<2	<2
1,2-Dichloropropane	*0.5*	<1	<1	<1
1,3-trans-Dichloropropene	*0.2*	<2	<2	<2
Chloroform	*6*	<1	<1	<1
1,1,1-Trichloroethane	*30*	<1	<1	<1
1,1,2-Trichloroethane	*3*	<5	<5	<5
Trichloroethene	*1*	<1	<1	**2.24**
Carbon Tetrachloride	*0.4*	<1	<1	<1
Bromodichloromethane	*0.3*	<2	<2	<2
Chlorodibromomethane	*10*	<1	<1	<1
Benzene	*0.2*	<5	<5	<5
2-Chloroethyl Vinyl Ether	*NL*	<10	<10	<10
Bromoform	*4*	<1	<1	<1
Tetrachloroethene	*0.4*	**1.31**	**5.06**	**4.18**
1,1,2,2-Tetrachloroethane	*2*	<1	<1	<1
Toluene	*1,000*	<5	<5	<5
Chlorobenzene	*4*	<2	<2	<2
Ethylbenzene	*700*	<5	<5	<5
1,3-Dichlorobenzene	*600*	<5	<5	<5
1,4-Dichlorobenzene	*75*	<5	<5	<5
1,2-Dichlorobenzene	*600*	<5	<5	<5
cis-1,2-Dichloroethene	*10*	<2	<2	<2

**No Trip Blank analyzed for February 1997 samples.*
NA Not available
NL Not Listed on NJDEP's Ground water (GW) Quality Criteria.

Table 28. Ground Water Volatile Organics Analytical Results from Detention Basin Discharge DSN001 and Wells D-11R, D-12, and TW-3 — May 1997 (in µg/L)

Parameter	*DEP GW Quality Criteria*	*DSN-001 5/14*	*D-11R 5/14*	*D-12 5/14*	*Trip Blank 5/14*	*TW-3 5/15*	*Trip Blank 5/15*
Chloromethane	*30*	<10	<10	<10	<10	<10	<10
Bromomethane	*10*	<10	<10	<10	<10	<10	<10
Vinyl Chloride	*0.08*	<5	<5	<5	<5	<5	<5
Chloroethane	*NL*	<10	<10	<10	<10	<10	<10
Methylene Chloride	*400*	<2	<2	<2	<2	<2	<2
Acrolein	*NA*	<5	<5	<5	<5	<5	<5
Acrylonitrile	*0.06*	<2	<2	<2	<2	<2	<2
1,1-Dichloroethane	*70*	<5	<5	2.27T	<5	<5	<5
1,2-Dichloroethane	*0.3*	<2	<2	<2	<2	<2	<2
1,1-Dichloroethene	*1*	<1	<1	<1	<1	<1	<1
1,2-trans-Dichloroethene	*100*	<2	<2	<2	<2	<2	<2
1,2-Dichloropropane	*0.5*	<1	<1	<1	<1	<1	<1
1,3-trans-Dichloropropene	*0.2*	<2	<2	<2	<2	<2	<2
Chloroform	*6*	<1	<1	<1	<1	<1	<1
1,1,1-Trichloroethane	*30*	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	*3*	<5	<5	<5	<5	<5	<5
Trichloroethene	*1*	<1	<1	3.34	<1	<1	<1
Carbon Tetrachloride	*0.4*	<1	<1	<1	<1	<1	<1
Bromodichloromethane	*0.3*	<2	<2	<2	<2	<2	<2
Chlorodibromomethane	*10*	<1	<1	<1	<1	<1	<1
Benzene	*0.2*	<5	<5	<5	<5	<5	<5
2-Chloroethyl Vinyl Ether	*NL*	<10	<10	<10	<10	<10	<10
Bromoform	*4*	<1	<1	<1	<1	<1	<1
Tetrachloroethene	*0.4*	1.69	5.25	5.98	<1	<1	<1
1,1,2,2-Tetrachloroethane	*2*	<1	<1	<1	<1	<1	<1
Toluene	*1,000*	<5	<5	<5	<5	<5	<5
Chlorobenzene	*4*	<2	<2	<2	<2	<2	<2
Ethylbenzene	*700*	<5	<5	<5	<5	<5	<5
1,3-Dichlorobenzene	*600*	<5	<5	<5	<5	<5	<5
1,4-Dichlorobenzene	*75*	<5	<5	<5	<5	<5	<5
1,2-Dichlorobenzene	*600*	<5	<5	<5	<5	<5	<5
cis-1,2-Dichloroethene	*10*	<2	<2	3.35	<2	<2	<2

NA Not available
NL Not Listed on NJDEP's Ground water (GW) Quality Criteria.
T Value reported is less than criteria of detection.

Table 29. Volatile Organics Analytical Results from Wells TW-3, D-11R, D-12, and Detention Basin Inflows 1 and 2— August 1997 (in µg/L)

Parameter	*DEP GW Quality Criteria*	*TW-3*	*D-11R*	*D-12*	*Inflow 1*	*Inflow 2*	*Trip Blank*
Methyl Chloride (Chloromethane)	*30*	<10	<10	<10	<10	<10	<10
Methyl Bromide (Bromomethane)	*10*	<10	<10	<10	<10	<10	<10
Vinyl Chloride	*0.08*	<5	<5	<5	<5	<5	<5
Chloroethane	*NL*	<10	<10	<10	<10	<10	<10
Methylene Chloride	*400*	<2	<2	<2	<2	<2	<2
Acrolein	*NA*	<10	<10	<10	<50	<50	<10
Acrylonitrile	*0.06*	<5	<5	<5	<50	<50	<5
1,1-Dichloroethane	*70*	<5	<5	<5	<5	<5	<5
1,2-Dichloroethane	*0.3*	<2	<2	<2	<2	<2	<2
1,1-Dichloroethene	*1*	<2	<2	<2	<2	<2	<2
1,2-trans-Dichloroethene	*100*	<5	<5	<5	<5	<5	<5
1,2-Dichloropropane	*0.5*	<1	<1	<1	<1	<1	<1
1,3-trans-Dichloropropene	*0.2*	<5	<5	<5	<5	<5	<5
Chloroform	*6*	<1	<1	<1	**13.2**	**2.09**	<1
1,1,1-Trichloroethane	*30*	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	*3*	<2	<2	<2	<2	<2	<2
Trichloroethene	*1*	<1	<1	**4.26**	<1	<1	<1
Carbon Tetrachloride	*0.4*	<2	<2	<2	<2	<2	<2
Chlorodibromomethane	*0.3*	<1	<1	<1	<1	<1	<1
Bromodichloromethane		<1	<1	<1	**4.03**	<1	<1
Benzene	*0.2*	<1	<1	<1	<1	<1	<1
2-Chloroethyl Vinyl Ether	*NL*	<10	<10	<10	<10	<10	<10
Bromoform	*4*	<1	<1	<1	<1	<1	<1
Tetrachloroethene	*0.4*	**9.64**	**5.40**	**10.3**	<1	**3.62**	<1
1,1,2,2-Tetrachloroethane	*2*	<1	<1	<1	<1	<1	<1
Toluene	*1,000*	<5	<5	<5	<5	<5	<5
Chlorobenzene	*4*	<5	<5	<5	<5	<5	<5
Ethylbenzene	*700*	<1	<1	<1	<1	<1	<1
cis-1,3-Dichloropropene	*NA*	<5	<5	<5	<5	<5	<5
1,2-Dichlorobenzene	*600*	<5	<5	<5	<5	<5	<5
1,3-Dichlorobenzene	*600*	<5	<5	<5	<5	<5	<5
1,4-Dichlorobenzene	*75*	<5	<5	<5	<5	<5	<5
Trichlorofluoromethane	*NL*	<5	<5	<5	<5	<5	<5

NA Not available
NL Not listed on NJDEP Ground Water Quality Criteria.
T Value reported is less than criteria of detection.

Table 30. Ground Water Base Neutrals Analytical Results— February 1997 (in µg/L)

Parameter	DSN001 2/12/97	D-11R 2/12/97	D-12 2/12/97
Acenaphthene	<2	<2	<2
Acenaphthylene	<2	<2	<2
Anthracene	<2	<2	<2
Benzidine	<20	<20	<20
Benzo (a)anthracene	<2	<2	<2
Benzo (a)pyrene	<2	<2	<2
Benzo (b)fluoranthene	<2	<2	<2
Benzo (k)fluoranthene	<2	<2	<2
Benzo (g,h,i)perylene	<2	<2	<2
bis(2-Chloroethoxy)methane	<10	<10	<10
bis(2-Chloroethyl)ether	<5	<5	<5
bis(2-Chloroisopropyl)ether	<5	<5	<5
Bis(2-Ethylhexyl)phthalate	3.46TB	4.37TB	5.83
4-Bromophenyl-phenylether	<5	<5	<5
N-Butylbenzylphthalate	*	*	*
2-Chloronaphthalene	<5	<5	<5
4-Chlorophenyl-phenylether	<5	<5	<5
Chrysene	<2	<2	<2
1.2,5,6 Dibenzanthracene	<2	<2	<2
1,2-Dichlorobenzene	<5	<5	<5
1,3-Dichlorobenzene	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5
3,3-Dichlorobenzidine	<5	<5	<5
Diethylphthalate	<5	<5	<5
Dimethylphthalate	<10	<10	<10
Di-n-butylphthalate	<5	<5	<5
2,4-Dinitro-2-methylphenol	<5	<5	<5
2,4-Dinitrotoluene	<5	<5	<5
2,6-Dinitrotoluene	<5	<5	<5
Di-n-octylphthalate	<10	<10	<10
1,2-Diphenylhydrazine	<5	<5	<5
Fluoranthene	<5	<5	<5
Fluorene	<2	<2	<2
Hexachlorobenzene	<5	<5	<5
Hexachlorobutadiene	<5	<5	<5
Hexachlorocyclopentadiene	<5	<5	<5
Hexachloroethane	<5	<5	<5
Indeno (1,2,3-cd)pyrene	<2	<2	<2
Isophorone	<5	<5	<5
Naphthalene	<2	<2	<2
Nitrobenzene	<5	<5	<5
N-nitrosodimethylamine	<10	<10	<10
N-Nitroso-di-n-propylamine	<10	<10	<10
N-Nitrosodiphenylamine	<10	<10	<10
Phenathrene	<2	<2	<2
Pyrene	<5	<5	<5
1,2,4-Trichlorobenzene	<5	<5	<5

B Found in method blank.
T Value reported is less than criteria of detection.

Table 31. Ground Water Base Neutrals Analytical Results— May 1997 (in µg/L)

Parameter	DSN001 5/14/97	D-11R 5/14/97	D-12 5/14/97
Acenaphthene	<2	<2	<2
Acenaphthylene	<2	<2	<2
Anthracene	<2	<2	<2
Benzidine	<20	<20	<20
Benzo (a)anthracene	<2	<2	<2
Benzo (a)pyrene	<2	<2	<2
Benzo (b)fluoranthene	<2	<2	<2
Benzo (k)fluoranthene	<2	<2	<2
Benzo (g,h,i)perylene	<2	<2	<2
bis(2-Chloroethoxy)methane	<10	<10	<10
bis(2-Chloroethyl)ether	<5	<5	<5
bis(2-Chloroisopropyl)ether	<5	<5	<5
Bis(2-Ethylhexyl)phthalate	<5	<5	<5
4-Bromophenyl-phenylether	<5	<5	<5
N-Butylbenzylphthalate	<5	<5	<5
2-Chloronaphthalene	<5	<5	<5
4-Chlorophenyl-phenylether	<5	<5	<5
Chrysene	<2	<2	<2
1.2,5,6 Dibenzanthracene	<2	<2	<2
1,2-Dichlorobenzene	<5	<5	<5
1,3-Dichlorobenzene	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5
3,3-Dichlorobenzidine	<5	<5	<5
Diethylphthalate	<5	<5	<5
Dimethylphthalate	<10	<10	<10
Di-n-butylphthalate	1.26TB	1.11TB	1.63TB
2,4-Dinitro-2-methylphenol	<5	<5	<5
2,4-Dinitrotoluene	<5	<5	<5
2,6-Dinitrotoluene	<5	<5	<5
Di-n-octylphthalate	<10	<10	<10
1,2-Diphenylhydrazine	<5	<5	<5
Fluoranthene	<5	<5	<5
Fluorene	<2	<2	<2
Hexachlorobenzene	<5	<5	<5
Hexachlorobutadiene	<5	<5	<5
Hexachlorocyclopentadiene	<5	<5	<5
Hexachloroethane	<5	<5	<5
Indeno (1,2,3-cd)pyrene	<2	<2	<2
Isophorone	<5	<5	<5
Naphthalene	<2	<2	<2
Nitrobenzene	<5	<5	<5
N-nitrosodimethylamine	<10	<10	<10
N-Nitroso-di-n-propylamine	<10	<10	<10
N-Nitrosodiphenylamine	<10	<10	<10
Phenathrene	<2	<2	<2
Pyrene	<5	<5	<5
1,2,4-Trichlorobenzene	<5	<5	<5

B Found in method blank.
T Value reported is less than criteria of detection.

Table 32. Ground Water Base Neutrals Analytical Results— August 1997 (in µg/L)

Parameter	D-11R	D-12	MW-14	MW-15	MW-16	TW-2	TW-3
Acenaphthene	<2	<2	<2	<2	<2	<2	<2
Acenaphthylene	<2	<2	<2	<2	<2	<2	<2
Anthracene	<2	<2	<2	<2	<2	<2	<2
Benzidine	<20	<20	<20	<20	<20	<20	<20
Benzo (a)anthracene	<2	<2	<2	<2	<2	<2	<2
Benzo (a)pyrene	<2	<2	<2	<2	<2	<2	<2
Benzo (b)fluoranthene	<2	<2	<2	<2	<2	<2	<2
Benzo (k)fluoranthene	<2	<2	<2	<2	<2	<2	<2
Benzo (g,h,i)perylene	<2	<2	<2	<2	<2	<2	<2
bis(2-Chloroethoxy)methane	<10	<10	<10	<10	<10	<10	<10
bis(2-Chloroethyl)ether	<5	<5	<5	<5	<5	<5	<5
bis(2-Chloroisopropyl)ether	<5	<5	<5	<5	<5	<5	<5
Bis(2-Ethylhexyl)phthalate	4.20TB	3.97TB	3.37TB	2.87TB	2.56TB	3.56TB	2.82TB
4-Bromophenyl-phenylether	<5	<5	<5	<5	<5	<5	<5
N-Butylbenzylphthalate	<5	<5	<5	<5	<5	<5	<5
2-Chloronaphthalene	<5	<5	<5	<5	<5	<5	<5
4-Chlorophenyl-phenylether	<5	<5	<5	<5	<5	<5	<5
Chrysene	<2	<2	<2	<2	<2	<2	<2
1.2,5,6 Dibenzanthracene	<2	<2	<2	<2	<2	<2	<2
1,2-Dichlorobenzene	<5	<5	<5	<5	<5	<5	<5
1,3-Dichlorobenzene	<5	<5	<5	<5	<5	<5	<5
1,4-Dichlorobenzene	<5	<5	<5	<5	<5	<5	<5
3,3-Dichlorobenzidine	<5	<5	<5	<5	<5	<5	<5
Diethylphthalate	<10	<10	<10	<10	<10	<10	<10
Dimethylphthalate	<10	<10	<10	<10	<10	<10	<10
Di-n-butylphthalate	8.88B	4.65TB	1.69TB	3.95TB	1.13TB	2.51TB	1.88TB
2,4-Dinitro-2-methylphenol							
2,4-Dinitrotoluene	<5	<5	<5	<5	<5	<5	<5
2,6-Dinitrotoluene	<5	<5	<5	<5	<5	<5	<5
Di-n-octylphthalate	<10	<10	<10	<10	<10	<10	<10
1,2-Diphenylhydrazine	<5	<5	<5	<5	<5	<5	<5
Fluoranthene	<5	<5	<5	<5	<5	<5	<5
Fluorene	<2	<2	<2	<2	<2	<2	<2
Hexachlorobenzene	<5	<5	<5	<5	<5	<5	<5
Hexachlorobutadiene	<5	<5	<5	<5	<5	<5	<5
Hexachlorocyclopentadiene	<5	<5	<5	<5	<5	<5	<5
Hexachloroethane	<5	<5	<5	<5	<5	<5	<5
Indeno (1,2,3-cd)pyrene	<2	<2	<2	<2	<2	<2	<2
Isophorone	<5	<5	<5	<5	<5	<5	<5
Naphthalene	<2	<2	<2	<2	<2	<2	<2
Nitrobenzene	<5	<5	<5	<5	<5	<5	<5
N-nitrosodimethylamine	<10	<10	<10	<10	<10	<10	<10
N-Nitroso-di-n-propylamine	<10	<10	<10	<10	<10	<10	<10
N-Nitrosodiphenylamine	<10	<10	<10	<10	<10	<10	<10
Phenathrene	<2	<2	<2	<2	<2	<2	<2
Pyrene	<5	<5	<5	<5	<5	<5	<5
1,2,4-Trichlorobenzene	<5	<5	<5	<5	<5	<5	<5

B Found in method blank.
T Value reported is less than criteria of detection.

Table 33. 1997 Summary of Ground Water Pumped at PPPL

Month	TFTR Sump	D-site MG Sump	LOB Basement	CS Basement	Daily Avg. Flow (gal.)
January	164,331	116,788	96,111	7,362	384,592
February	155,186	125,109	80,869	4,543	365,707
March	156,966	103,770	87,000	4,900	352,636
April	155,534	109,667	85,693	5,282	356,176
May	154,150	119,560	87,520	6,100	367,330
June	141,969	105,819	66,926	4,114	318,828
July	179,357	85,906	35,698	566	301,527
August	225,450	129,986	19,783	321	375,540
September	113,112	97,574	684	72	211,442
October	95,164	97,200	4,114	0	196,478
November	96,879	138,420	4,783	0	240,082
December	92,731	169,672	7,971	310	270,684
Average	**144,236**	**116,623**	**48,929**	**2,870**	**311,752**

Table 34. 1997 Quality Assurance Data for Radiological and Non-Radiological Samples

Laboratory, Program, and Parameter	Reported Value	Actual Value	Acceptance Range
PPPL EPA (ESD-LV,Mar. 97) Tritium in water (picoCuries/Liter or pCi/L)	7,773.00	7,900.0	6,529.4 - 9,270.6
PPPL EPA (WP037)			
pH (S.U.)	9.20	9.30	9.11- 9.5
Total residual chlorine (mg/L)	2.91	2.63	2.38 - 3.22
PPPL EPA (ESD-LV, Aug. 97) Tritium in water (picoCuries/Liter)	10,426.33	11,010	9,099.8 - 12,920.2
PPPL EPA (July 97) Gamma in water (pCi/L)			
Cobalt 60	19.54	18	13 - 23
Zinc 65	111	100	90 - 110
Cesium 134	21.45	22	17 - 27
Cesium 137	53.21	49	44 - 53
Barium 133	26.34	25	20 - 30
PPPL EPA (WP038)			
pH	6.62	6.58	6.44-6.74
Total residual chlorine (mg/L)	1.395	1.39	1.14-1.73
Nitrate as N (mg/L)	33.58	31.0	25.4-35.7
Orthophosphate as P (mg/L)	6.483	1.50	1.29-1.72
QC, Inc. (PPPL ann. QA)			
Total hardness (mg/L)	440	424	365 - 483
Total suspended solids (mg/L)	72.0	79	67.2 - 90.9
Chromium (mg/L)	0.761	0.829	0.680 - 0.978
Copper (mg/L)	0.624	0.653	0.535 - 0.771
Lead (mg/L)	0.679	0.676	0.554 - 0.798
Total organic carbon (mg/L)	37.0	38.0	32.3 - 43.7
Biochemical oxygen demand (mg/L)	53.6	58.6	39.2 - 70.9
Chemical oxygen demand (mg/L)	85.0	97.6	83.0 - 112

Table 35. Tetrachloroethene Results Exceeding NJDEP Ground Water Quality Standard for Class II-A Aquifers - June 1994 through September 1997 (in μg/L)

Date	6/94	3/95	5/95	12/96	2/97	9/97
Well or Sump #						
D-11 or 11R	**1.9**	**4.62**	**1.35**	**5.36 TN**	**5.18**	**4.53**
D-12	**11**	**9.87**	**10.6**	**5.53 TN**	**3.87**	**8.81**
TFTR-S1	**3**	**5.37**	**4.16**	**4.2 TN**	**3.73**	**3.8**
DMG-S2	**30**	**39.3**	**58.7**	**42.8 TN**	**50.1**	**54.8**
LOB-S3	**2.3**	**2.14**	**2.01**	**1.01 TN**	0.998	**4.37**
C MG-S4	**2.3**	**9.5**	**4.44**	**2.05 TN**	**2.39**	**1.82**
C-MG-S5	<1	<1	<1	0.304 TN	<0,23	0.24
C-MG-S6	**11**	**20.9**	**8.66**	**19 TN**	**14.4**	NS
CS-S7	NS	NS	NS	NS	NS	0.252
MW-1	<1	<1	<1	<0.23	<0.23	<0.08
MW-2	<1	<1	<1	<0.23	<0.23	<1.12
MW-3	**25**	**14.7**	**15.4**	**5.83 TN**	**4.93**	0.68
MW-5S	NS	NS	NS	0.838 TN	0.944	NS-dry
MW-5I	**3.6**	**5.53**	<1	**2.11 TN**	**1.73**	0.404
MW-6S	**2.8**	NS	**13.1**	**36.7 TN**	**7.93**	**19.80/17.4**
MW-7I	**7.4**	**6.87**	**2.79**	0.246 TN	<0.23	<0.08
MW-7S	**12**	**13.8**	**17.2**	**7.54 TN**	**10.4**	**5.57**
MW-8S	**14**	**9.23**	**7.48**	**7.43 TN**	**12.1**	**6.85**
MW-9	**78**	**89.9**	**79.8**	**113 TN**	**93.9**	**63.6**
MW-9I						<1.12
MW-10I	NS	NS	NS	NS	NS	
MW-13	**120**	**126**	**111**	**111 TN**	**123**	**74.9**
MW-13I						**19**
MW-17				**2.55 TN**	0.59	**37.1/40**
MW-18				0.722 TN	0.762	**1.05**
MW-19S						**150**
MW-19I						<1.12
MW-21S						**22**
MW-21I						<1.12
MW-22						<1.12
MW-23S						<1.12
MW-24S						<1.12
TW-1	**1.7**	<1	**1.57**	0.932 JN	0.51	<1.12
TW-2	**2.2**	<1	<1	0.638 JN	0.46	<1.12
TW-3	**14**	<1	**5.15**	<0.23	**1.77**	**8**
TW-4	<1	<1	<1	**13.5 TN**	**11.8**	<1.12
TW-6	<1	<1	<1	NS	NS	NS
TW-7	**30**	**3.75**	**21.7**	<0.23	<0.23	<1.12
TW-10	<1	**1.34**	<1	0.576 N	0.472	<1.12

Bold is used for all concentrations above the 1.0 ug/L ground water standard.
Blank space indicates that the time of sampling, well did not exist.
NS = Not sampled
T = Estimated value
N = Tentatively Identified Compound (TIC) was presumptively present

Table 36. Trichloroethene Results Exceeding NJDEP Ground Water Quality Standard for Class II-A Aquifers - June 1994 through September 1997 (in µg/L)

Date	6/94	3/95	5/95	12/96	2/97	12/97
Well or Sump #						
D-11 or 11R	<1	<1	<1	**2.22 TN**	0.354	0.428
D-12	**1.7**	**5.16**	**5.43**	0.262 JN	**1.97**	**3.69**
TFTR-S1	<1	<1	<1	0.266 JN	0.186	0.192
DMG-S2	**2.1**	**4.96**	<10	**3.71 TN**	**4.36**	**5.57**
LOB-S3	<1	<1	<1	<0.15	<0.15	<0.10
C MG-S4	**2.1**	**1.08**	**4.89**	0.382 JN	0.24	**3.40**
C-MG-S5	<1	<1	<1	<0.15	<0.15	<0.10
C-MG-S6	<1	**1.8**	<1	**1.44 TN**	0.87	NS
CS-S7	NS	NS	NS	NS	NS	<0.10
MW-1	<1	<1	<1	NS	NS	<0.10
MW-2	<1	<1	<1	<0.15	<0.15	<1.04
MW-3	<1	<1	<1	<0.15	<0.15	0.214
MW-5S	<1	<1	<1	<0.15	<0.15	NS-dry
MW-5I	**5.2**	**8.1**	**5.8**	**9.87 TN**	**9.84**	**2.05**
MW-6S	<1	**8.15**	**25.1**	**9.82 TN**	**1.89**	**4.86/4.15**
MW-7I	**3**	**4.13**	**2.21**	0.264 JN	<0.15	0.216
MW-7S	**2**	**3.48**	**4.5**	**1.45 TN**	**2.23**	0.948
MW-8S	**1.6**	**1.62**	**1.38**	0.892 JN	**1.25**	0.696
MW-9	**1.7**	<5	<10	<3	<0.15	**1.57**
MW-9I						<0.10
MW-10I	NS	NS	NS	NS	NS	<1.04
MW-13	**1.8**	<10	<10	<3	**1.71**	**3.02**
MW-13I						0.22
MW-17				<0.15	<0.15	**1.18/1.10**
MW-18				0.146 TN	0.161	0.616
MW-19S						<1.04
MW-19I						<1.04
MW-21S						<1.04
MW-21I						<1.04/<1.04
MW-22						<1.04
MW-23S						<1.04
MW-24S						<1.04
TW-1	<1	<1	<1	<0.15	<0.15	<1.04
TW-2	<1	<1	<1	<0.15	<0.15	<1.04
TW-3	<1	<1	<1	<0.15	<0.15	<1.04
TW-4	<1	**1.07**	**1.12**	**1.16 TN**	**1.04**	<1.04
TW-6	<1	<1	<1	NS	NS	NS
TW-7	**1.3**	<1	<2.5	0.282 TN	0.268	<1.04
TW-10	<1	<1	<1	0.358 TN	0.304	<1.04

Bold is used for all concentrations above the 1.0 ug/L ground water standard.
Blank space indicates that the time of sampling, well did not exist.
Two numbers for one sample date indicates duplicate sample results
NS = Not sampled
T = Estimated value
N = Tentatively Identified Compound (TIC) was presumptively present

Table 37. Additional Ground Water Analysis for the Remedial Investigation Program - September 1997

Parameters in mg/L (Ground Water Quality Standard)	*TW-3*	*TW-4*	*MW-2*	*MW-5I*	*MW-6S*	*MW-106S Dup. MW-6S*	*MW-6I*
Alkalinity, Carbonate	148	148	56	83	117	125	49
Ammonia-Nitrogen(*0.5)*	0.18	0.11	<0.02	1.04	0.40	0.20	0.10
Biochemical Oxygen Demand	3	3	<2	<2	<2	<2	<2
Calcium	43,000	43,900	8,300	20,400	61,000	58,700	7,700
Chloride *(250)*	22.20	23.30	18.80	31.80	153	151	31.20
Chemical Oxygen Demand	<1.94	<1.94	<1.94	<1.94	<1.94	<1.94	<1.94
Dissolved Organic Carbon	2.50	4.30		2.40	3.10	4.0	3.20
Ferric Iron	1.62	0.37	5.34	0.16	<0.03	<0.02	0.70
Ferrous Iron	0.18		0.86		0.10	<0.02	0.30
Manganese	300	250	899	49	18	20	49
Nitrate-Nitrogen	0.03	0.03	0.13	0.02	0.32	0.47	0.02
Phosphorus	0.04	0.03	0.01	<0.01	0.12	0.10	<0.01
Potassium	1,800	1,800	1,700	5,200	3,000	2,900	12,000
Sodium	1,400	16,000	19,000	19,000		38,000	
Sulfate *(250)*	22.40	22.10	1.97	11.20	30.90	32.30	9.65
Sulfite	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Total Organic Carbon	<0.33	2.30	<0.33	<0.33	2.0	36.20	2.40

Parameters (Mg/L) Ground Water Quality Standard	*MW-8S*	*MW-9*	*MW-9I*	*MW-13*	*MW-13I*	*MW-17*	*MW-1017 Dup. MW-17*
Alkalinity, Carbonate	1	36	39	56	110	24	24
Ammonia-Nitrogen *(0.5)*	<0.02	0.30	0.20	0.37	0.21	0.41	0.30
Biochemical Oxygen Demand	<2	<2	<2	<2	<2	<2	<2
Calcium	76,400	13,000	20,100	9,900	28,900	8,900	8,900
Chloride *(250)*	372	9.20	4.03	9.30	5.09	6.5	6.42
Chemical Oxygen Demand	<1.94	<1.94	9.70	12.8	<1.94	<1.94	<1.94
Dissolved Organic Carbon	3.10	3.40	2.40	5.80	2.5	2.10	2.20
Ferric Iron	0.07	0.05	0.24	5.80	0.09	3.60	4.07
Ferrous Iron		0.03	0.09	1.40	0.09		
Manganese	280	8.5	42	1,410	130	66	67
Nitrate-Nitrogen	1.54	0.33	0.05	0.04	0.21	0.39	0.39
Phosphorus	0.23	0.09	0.11	0.43	0.10	0.73	0.42
Potassium	2,600	1,400	2,000	1,000	2,300	2,700	2,700
Sodium	78,300	9,900	8,400	15,000	10,000	6,900	6,900
Sulfate *(250)*	12.80	24.90	17.30	22.10	19.90	20.40	20.30
Sulfite	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Total Organic Carbon	6.9	1.10	<0.33	2.30	1.5	1.12	<0.33

Blank indicates no measurement.

Chapter

12

FIGURES

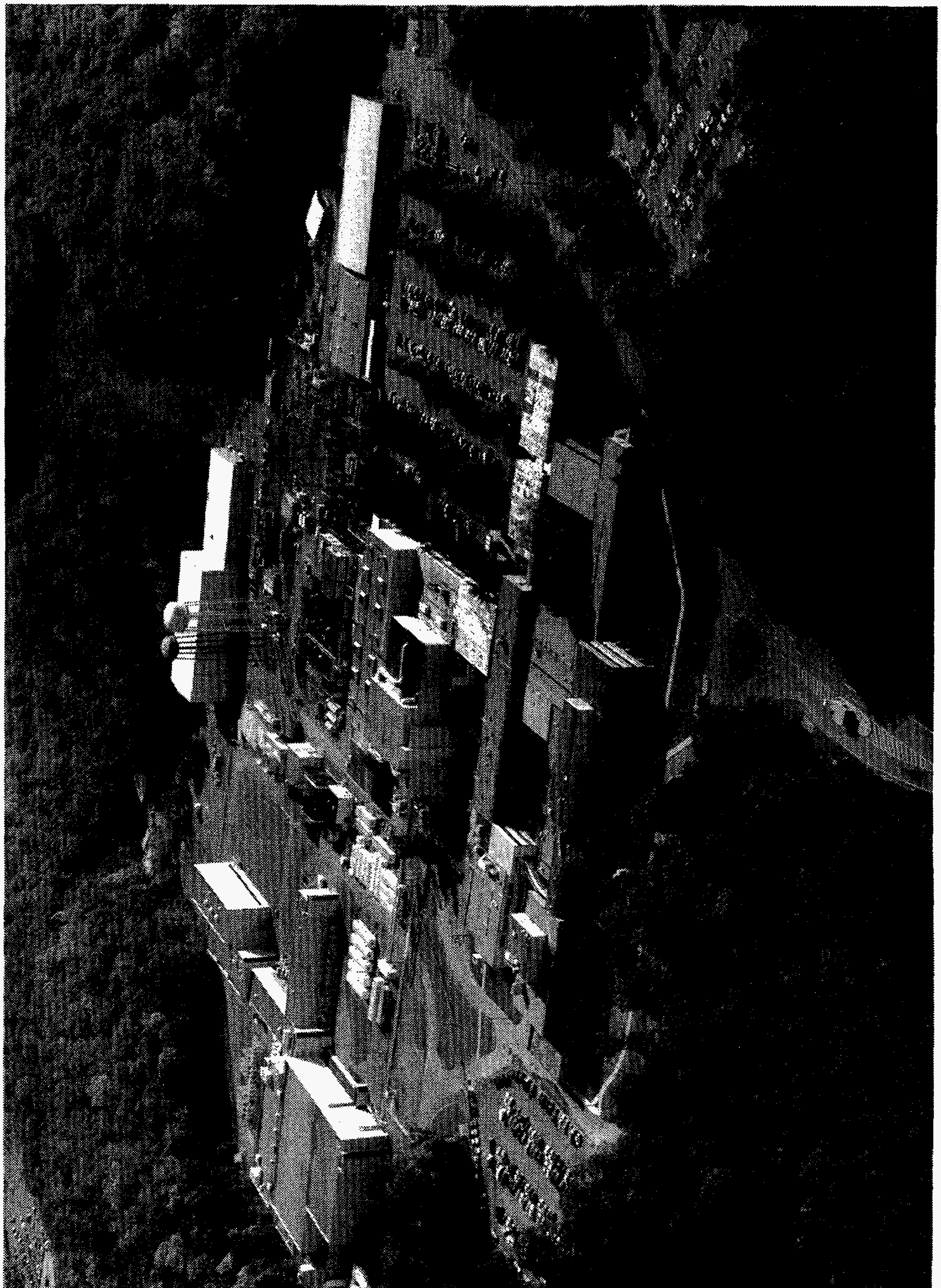


FIGURE 1. AERIAL VIEW OF PPPL

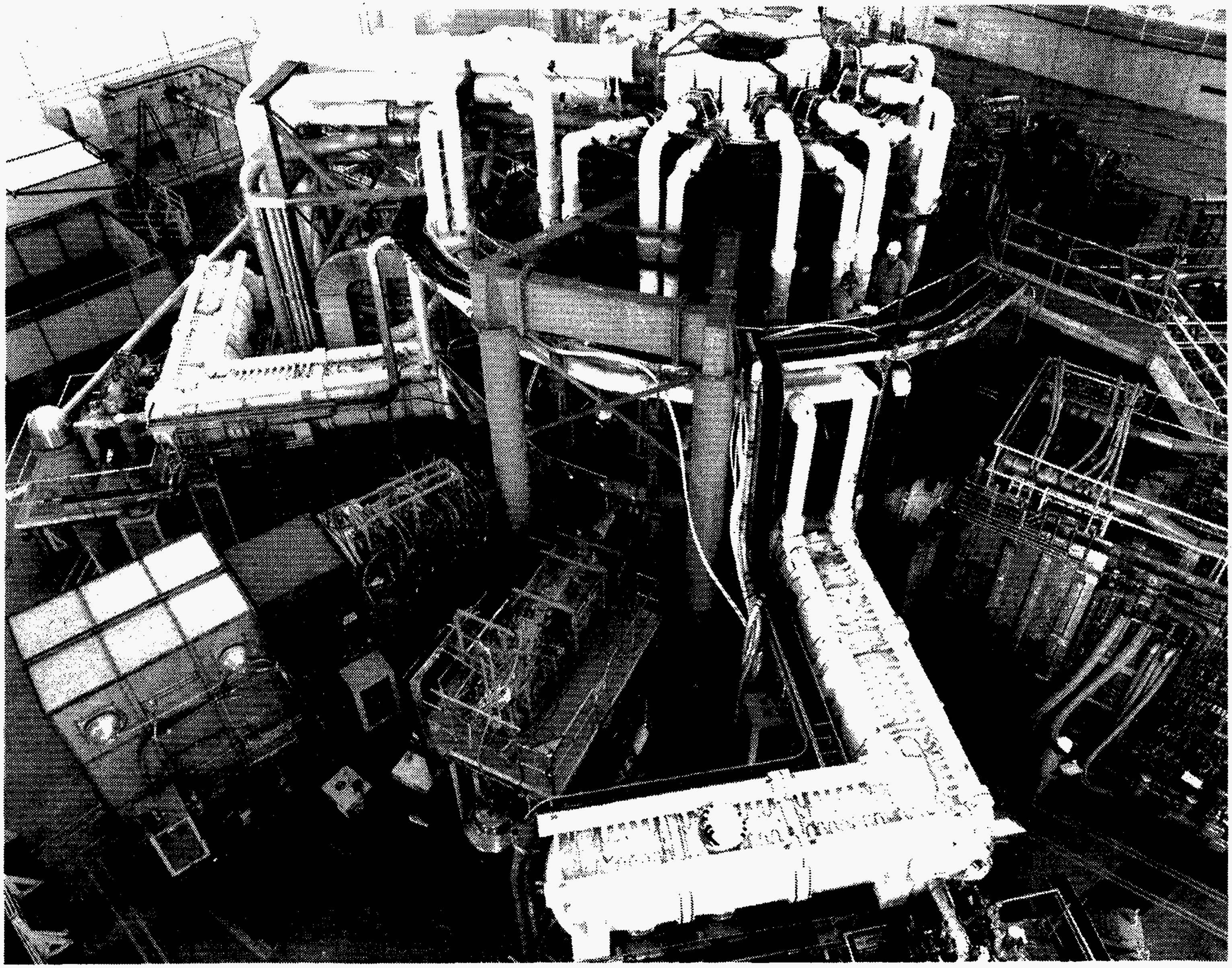


FIGURE 2. TOKAMAK FUSION TEST REACTOR (TFTR)

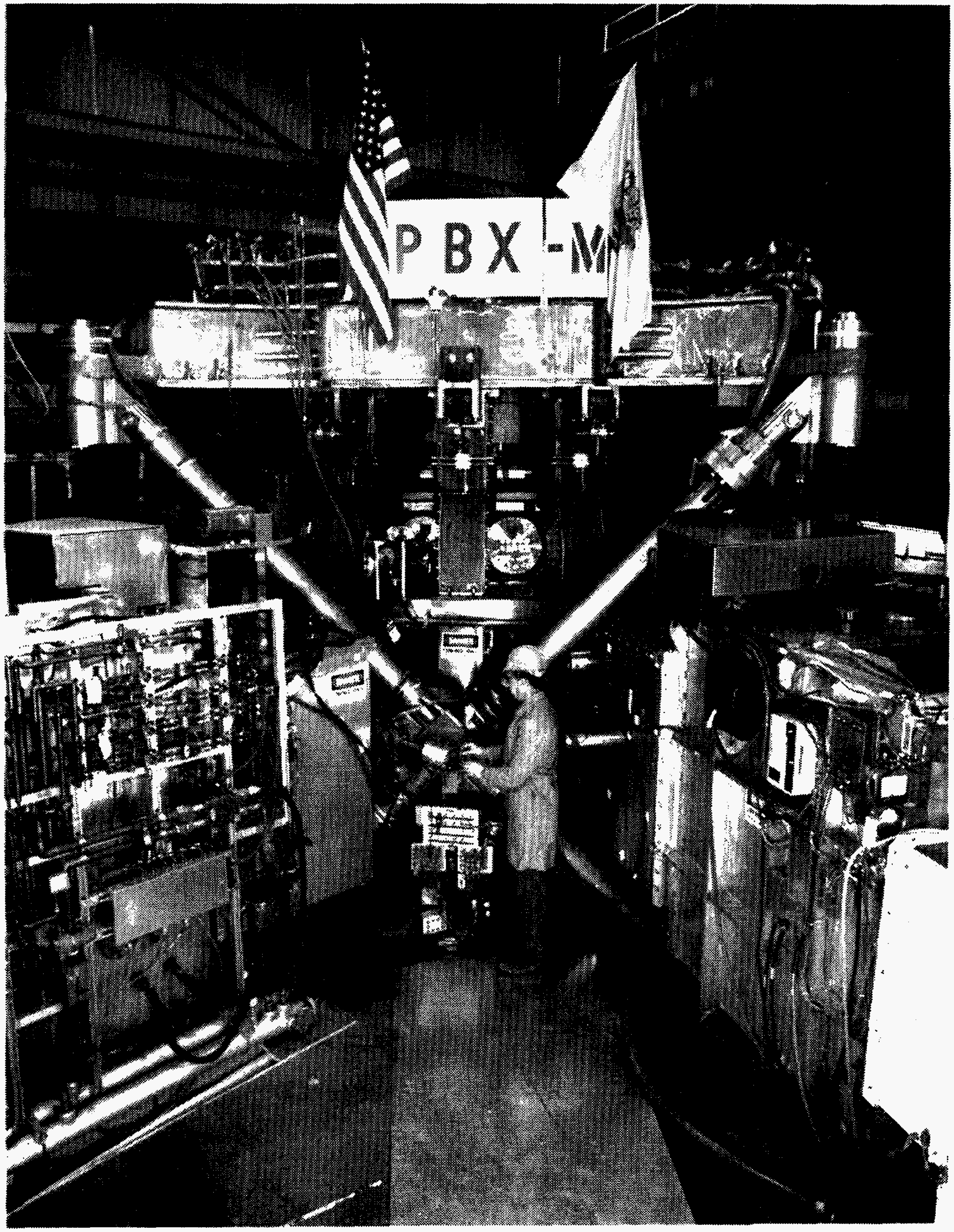


FIGURE 3. PRINCETON BETA EXPERIMENT – MODIFICATION (PBX-M)

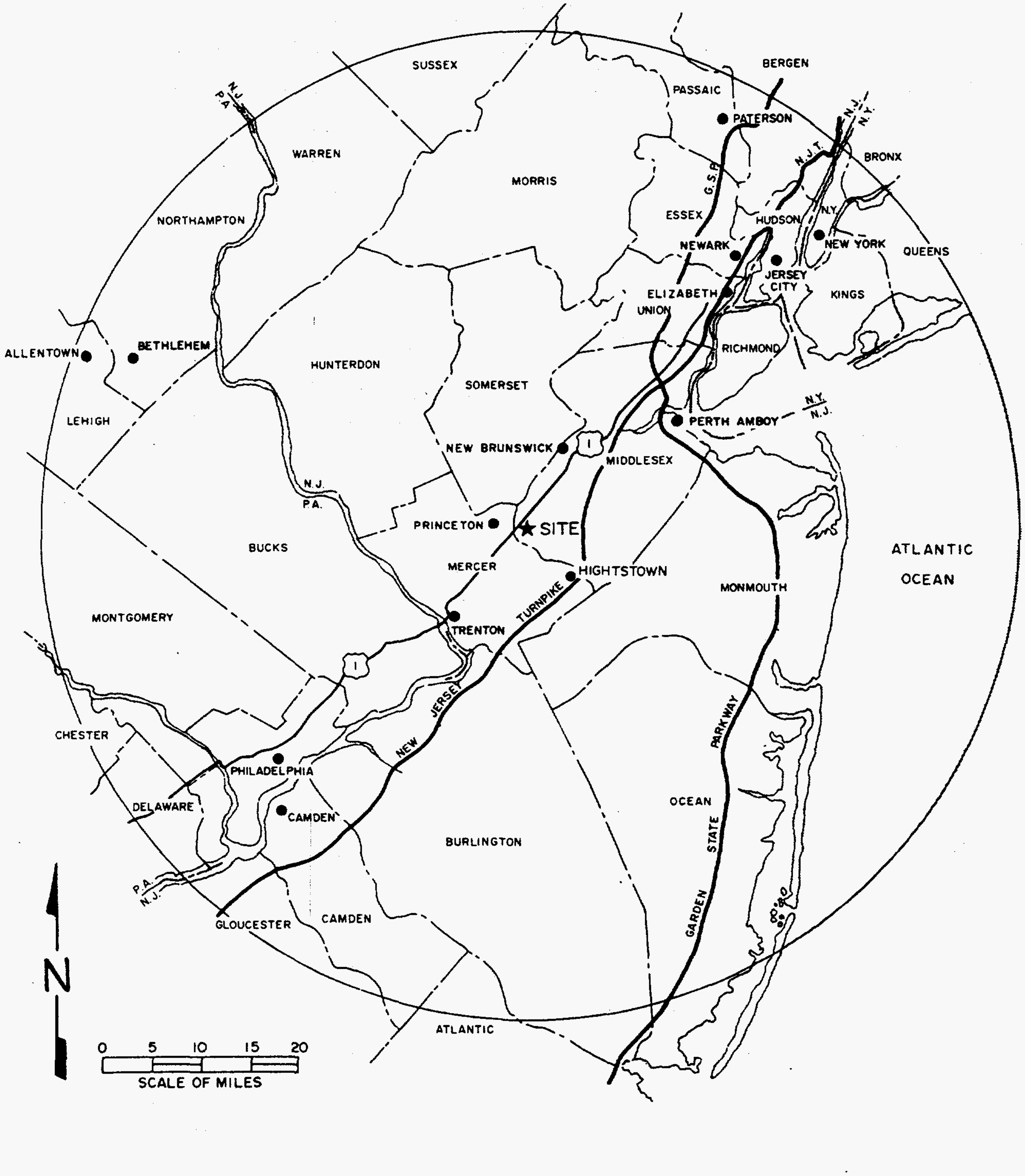


FIGURE 4. REGION SURROUNDING PPPL (50-MILE RADIUS SHOWN)

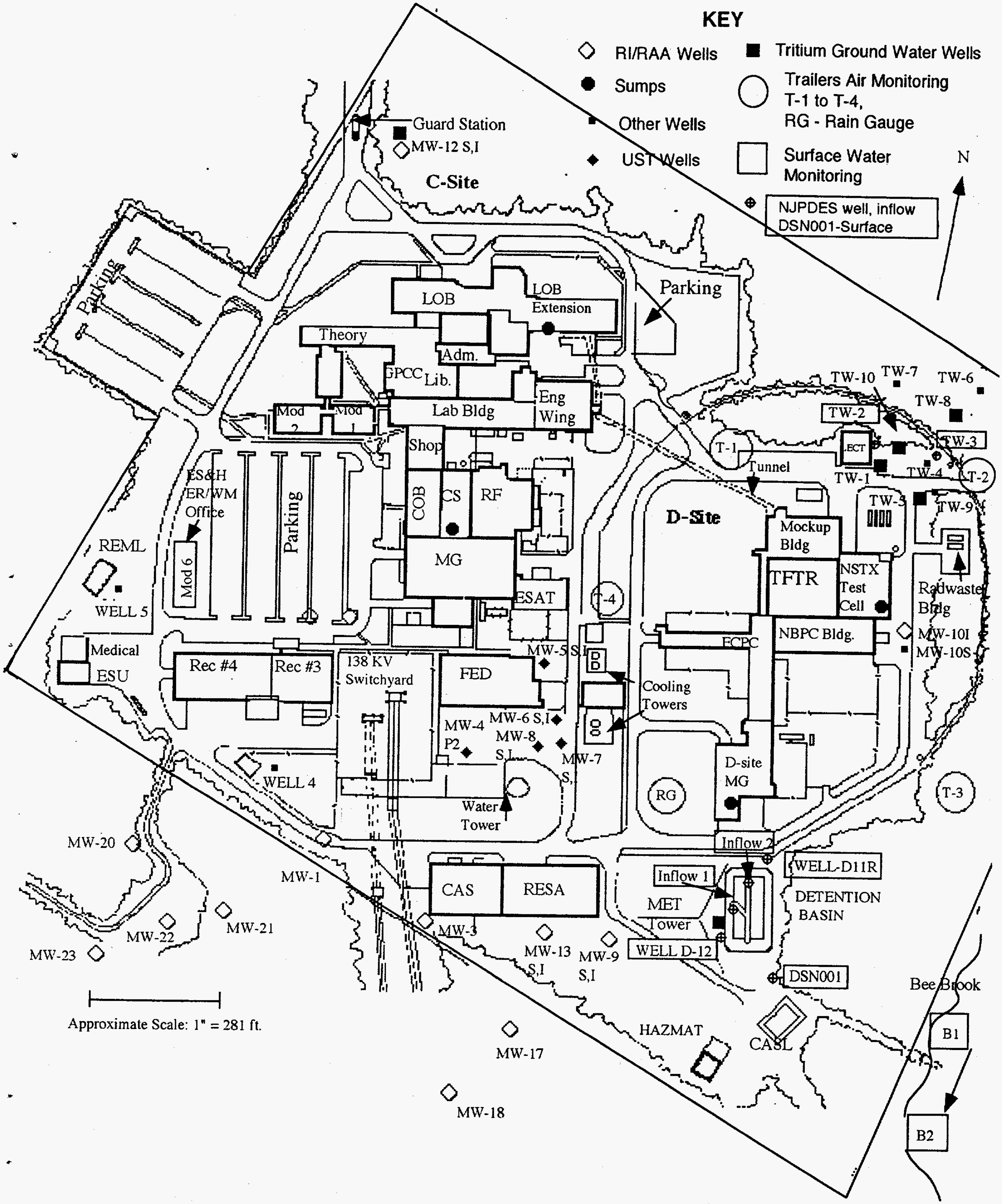


FIGURE 5. PPPL C and D SITES of JAMES FORRESTAL CAMPUS

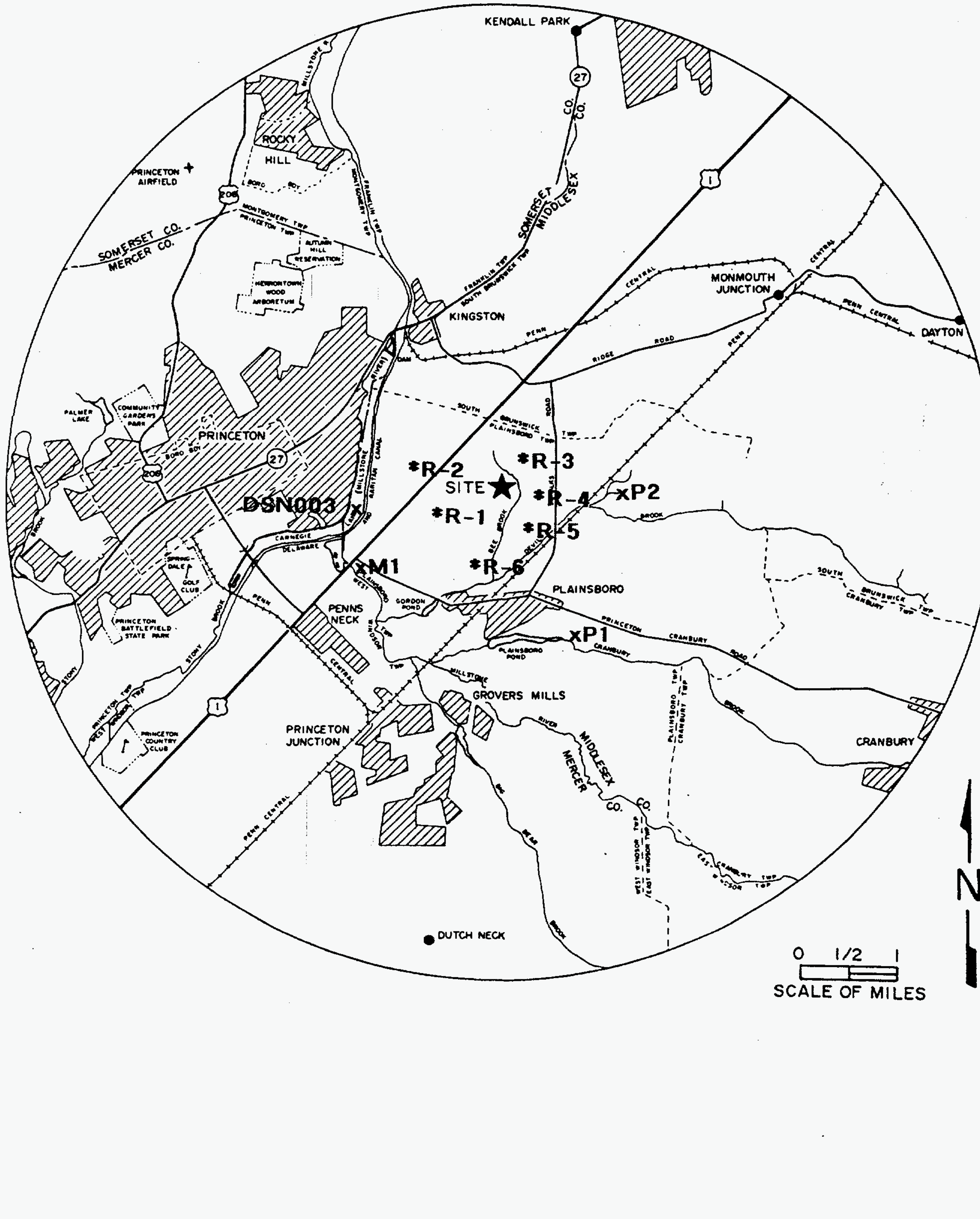


FIGURE 6 OFF-SITE MONITORING LOCATIONS

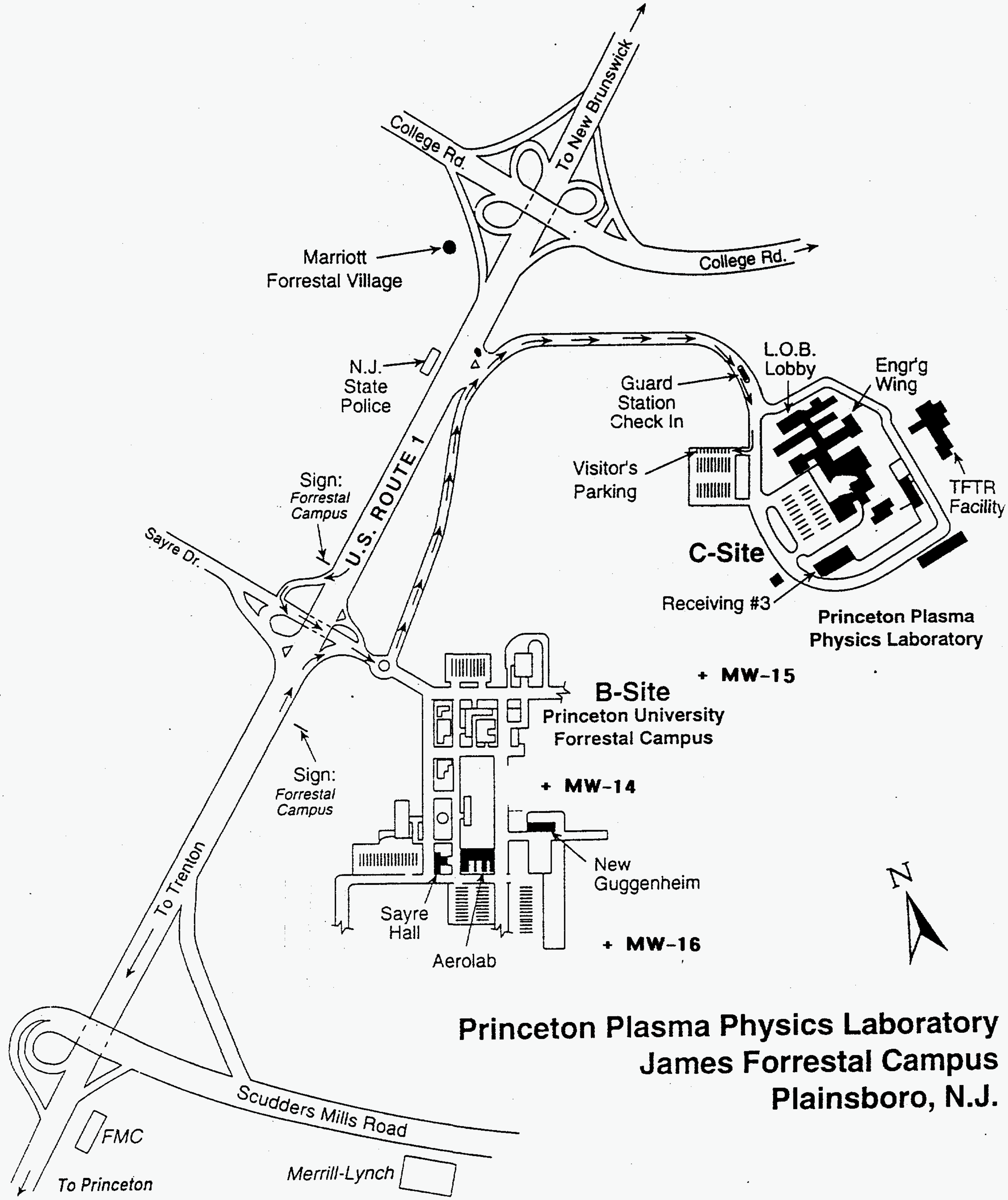


FIGURE 7. PPPL JAMES FORRESTAL CAMPUS A and B SITE WELL LOCATIONS

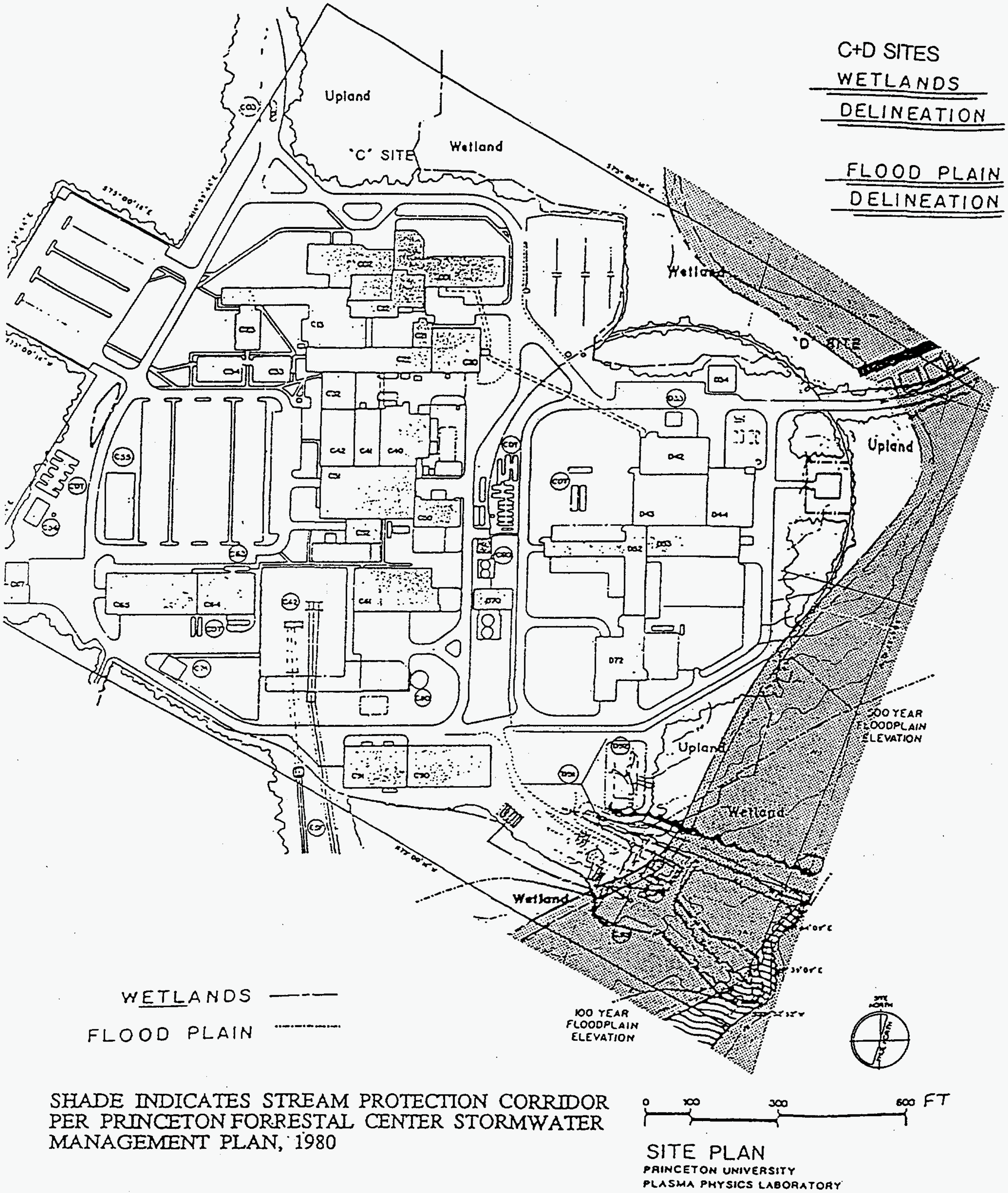


FIGURE 8. PPPL SITE MAP – FLOODPLAIN and WETLANDS DELINEATIONS

Figure 9. Tritium (HT) in Air Stations T1-T4 and Baseline for 1997 (in picoCuries/cubic meter)

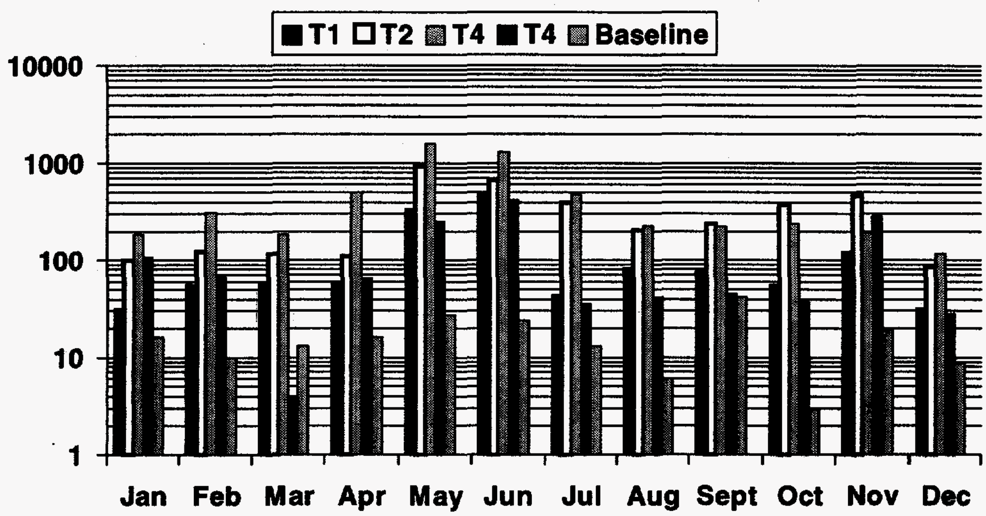


Figure 10. Tritium (HT) in Air Stations R1-R6 and Baseline for 1997 (in picoCuries/cubic meter)

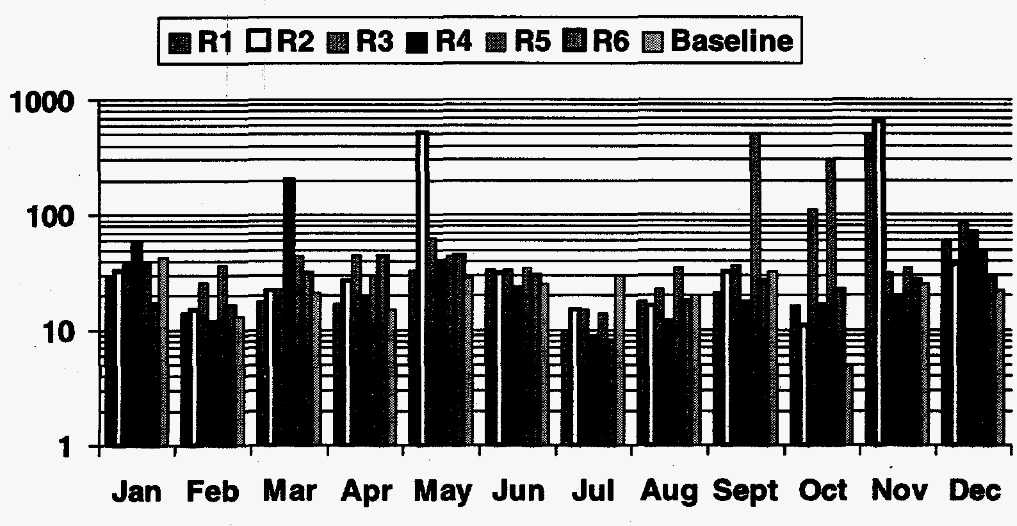


Figure 11. Tritium (HTO) in Air StationsT1-T4 and Baseline for 1997 (in picoCuries/cubic meter)

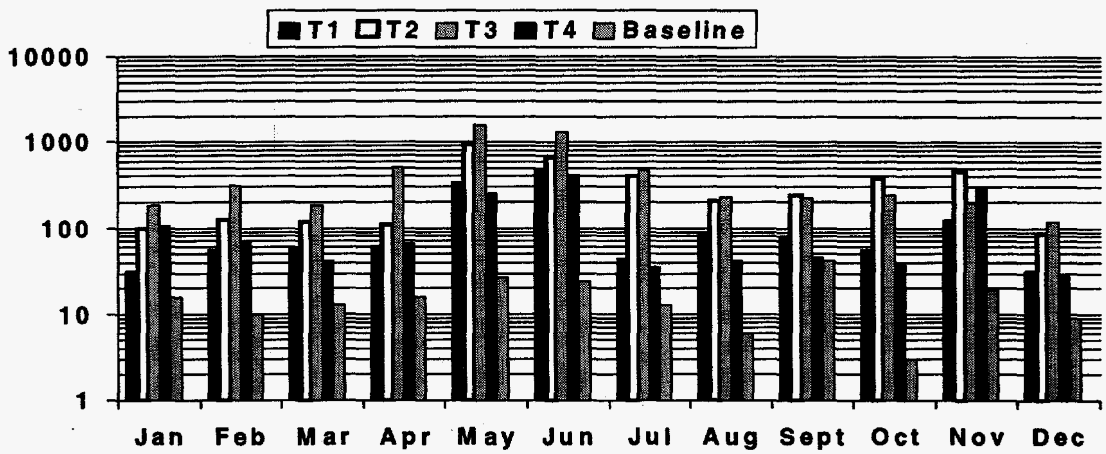


Figure 12. Tritium (HTO) in Air Stations R1-R6 and Baseline for 1997 (in picoCuries/cubic meter)

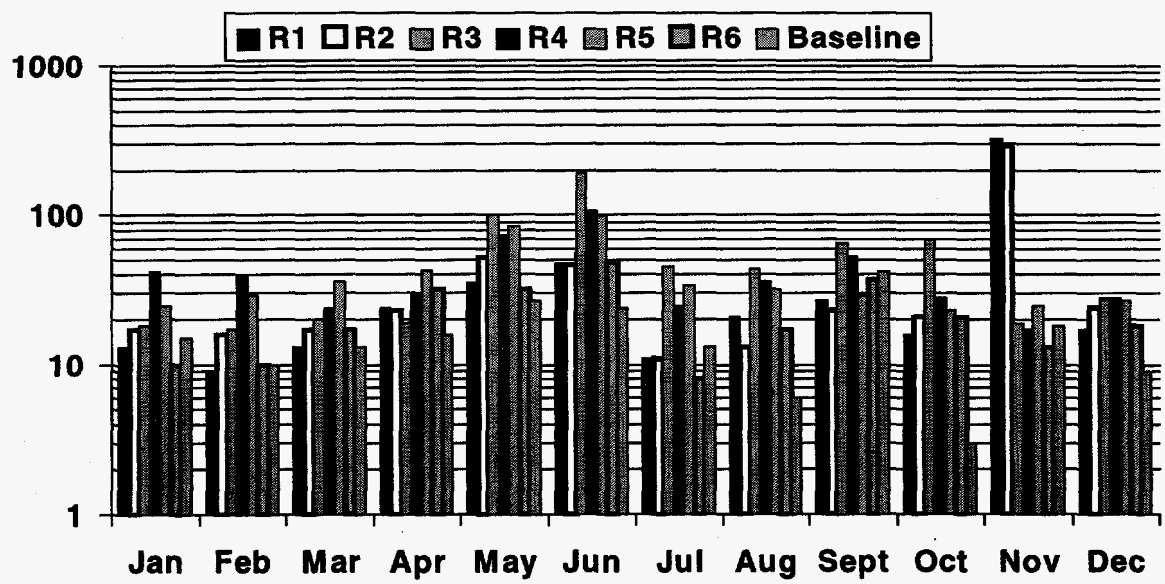


Figure 13. 1997 Tritium Results in Ground Water (in picoCuries/Liter)

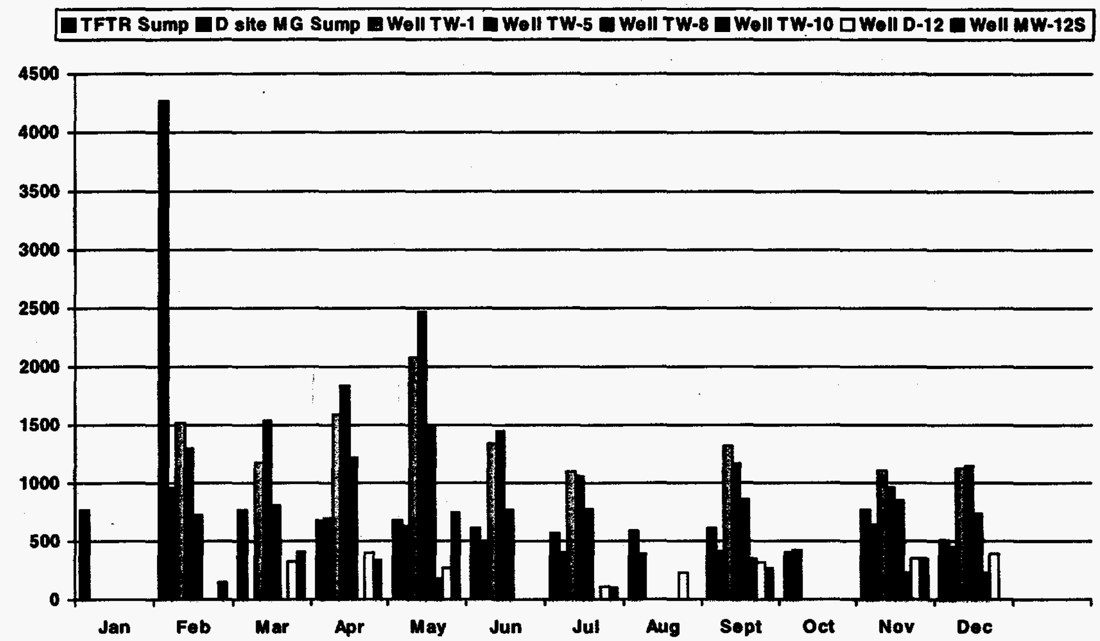


Figure 14. 1997 Monthly Stack Release Summary (HT & HTO) in Curies

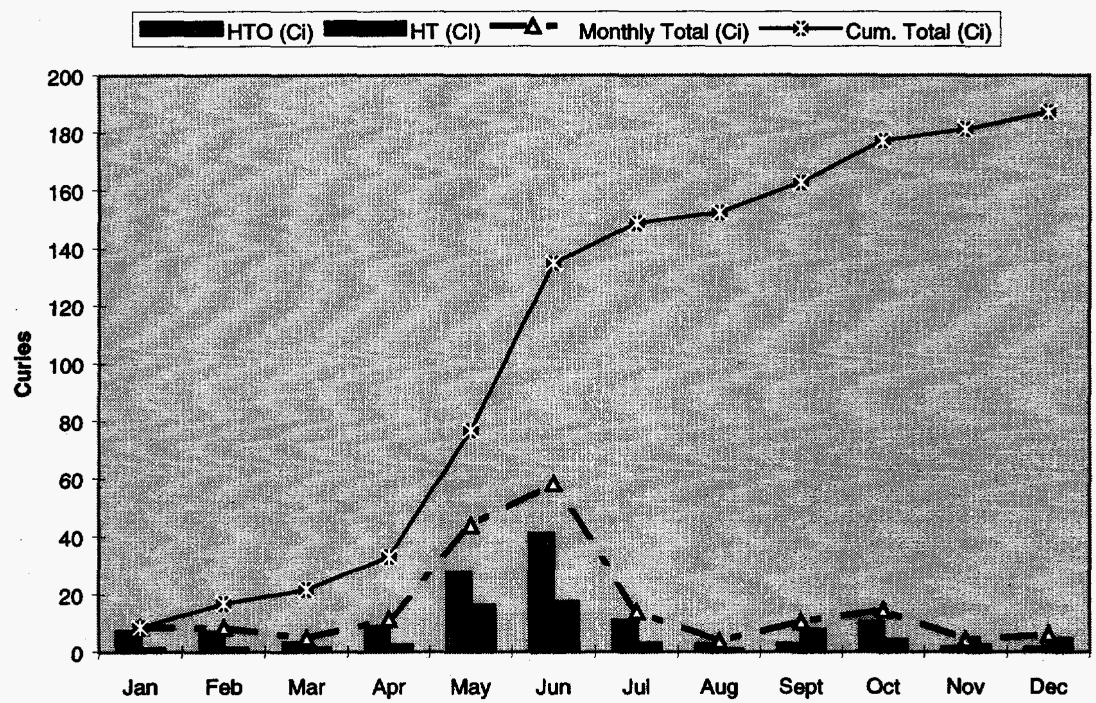


Figure 15. 1997 Tritium Concentrations in Rain Water (R1-Inner stations) in picoCuries/Liter

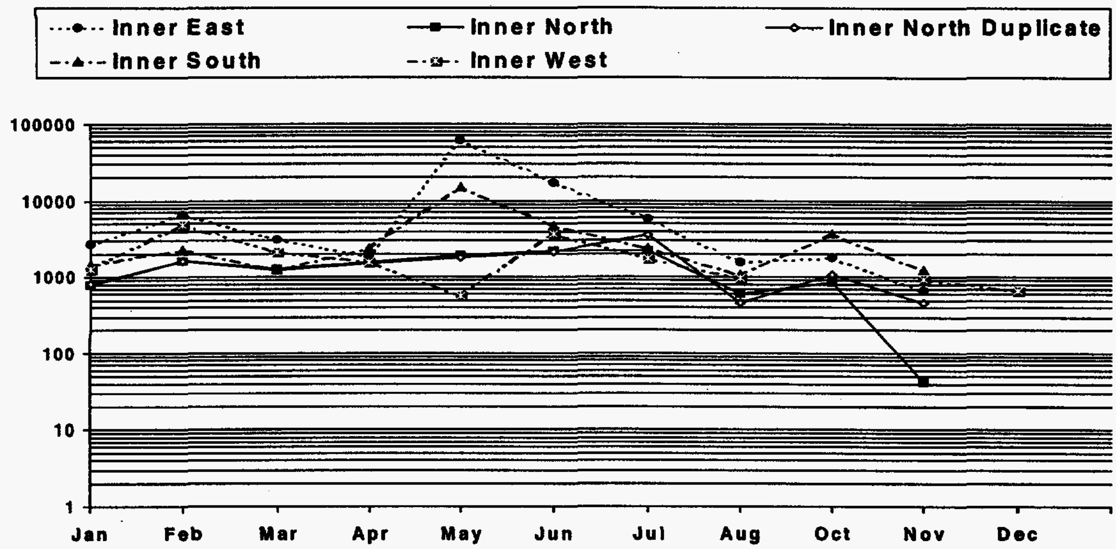
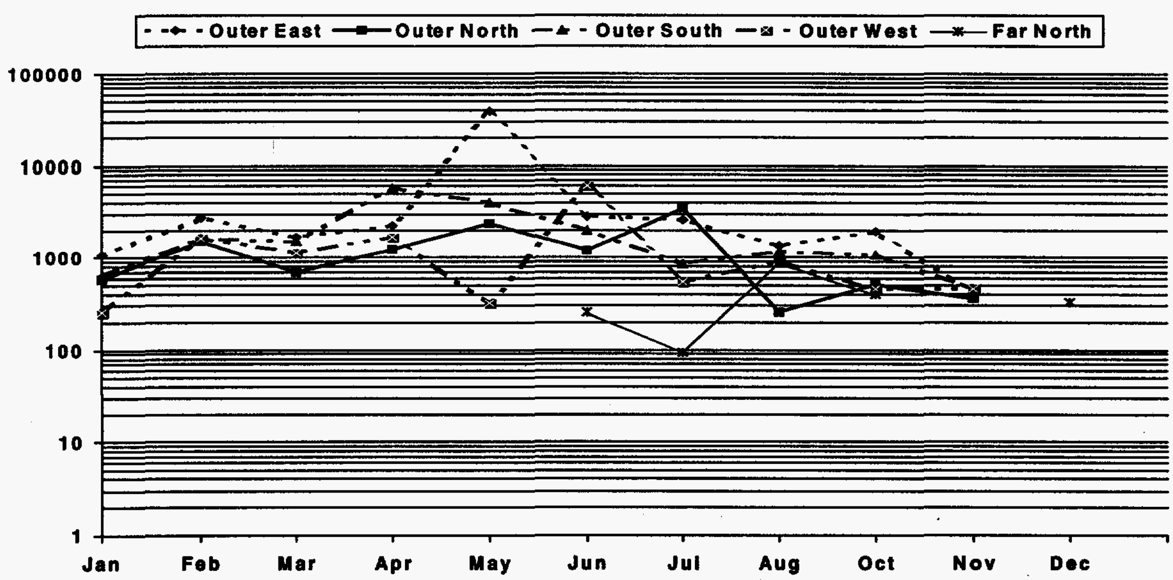


Figure 16. Tritium Concentration in Rain Water (R2 & R3 - Outer stations) in picoCuries/Liter



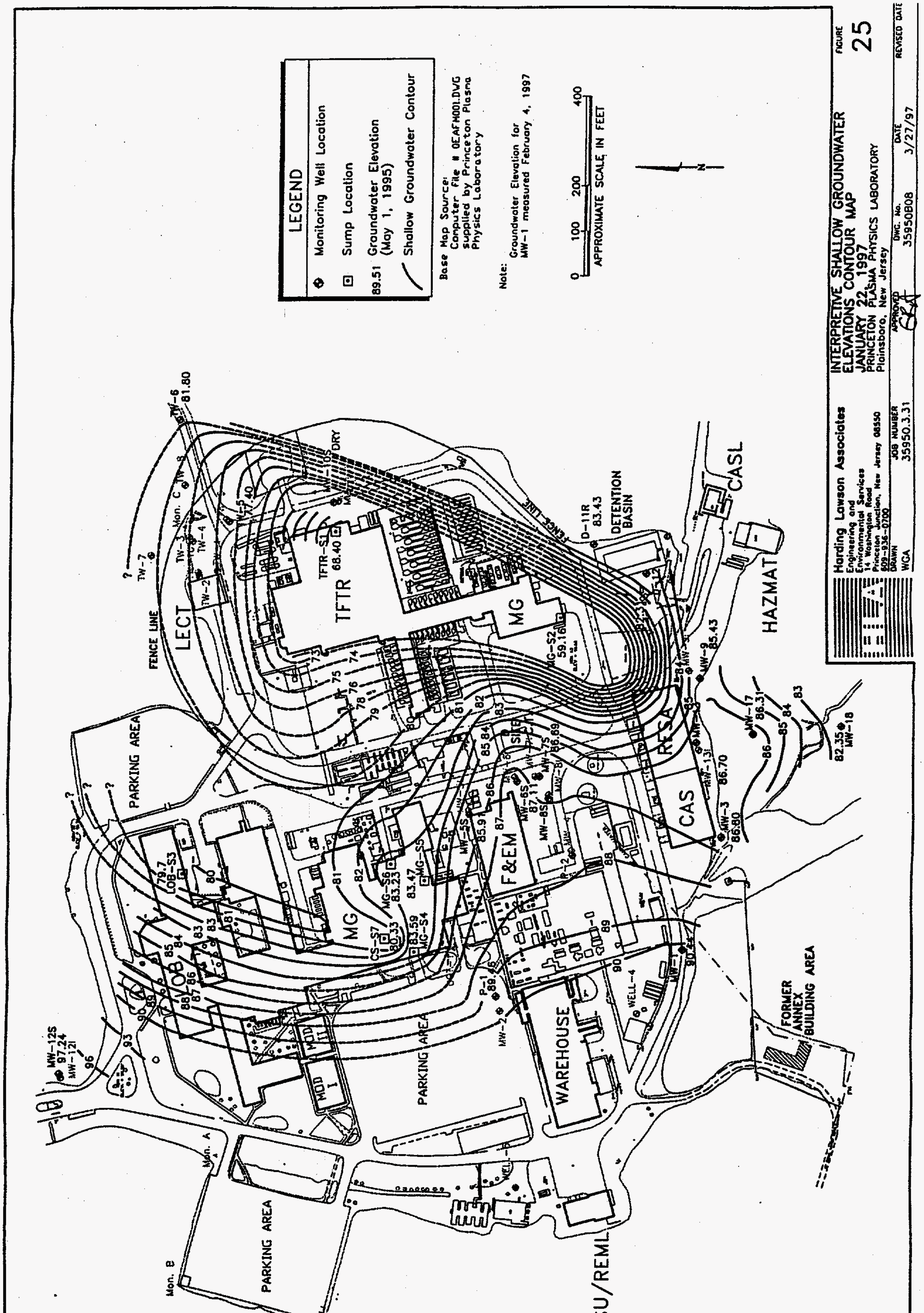


FIGURE 17. SHALLOW GROUND WATER ELEVATIONS CONTOUR MAP – JANUARY 1997

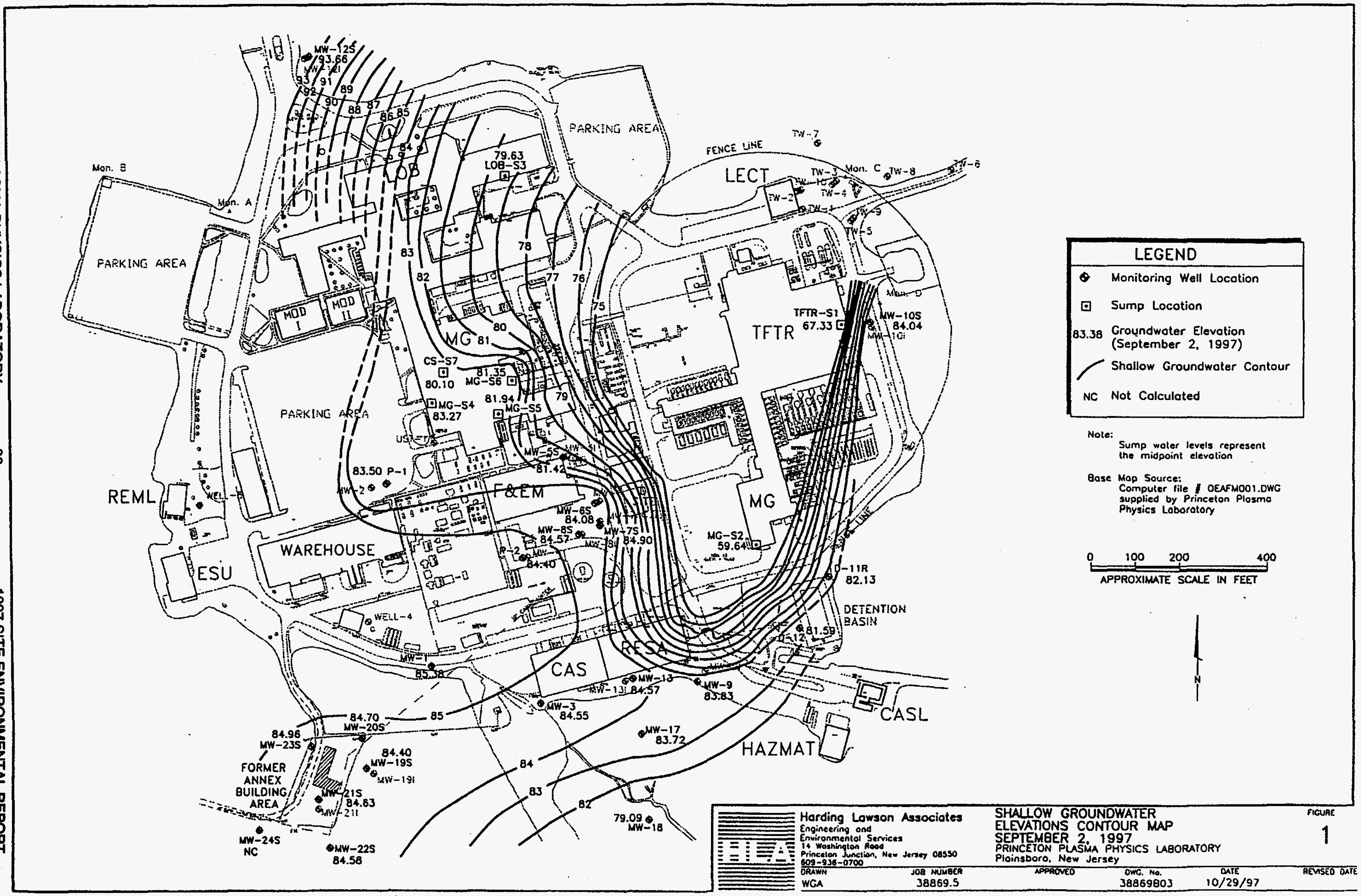
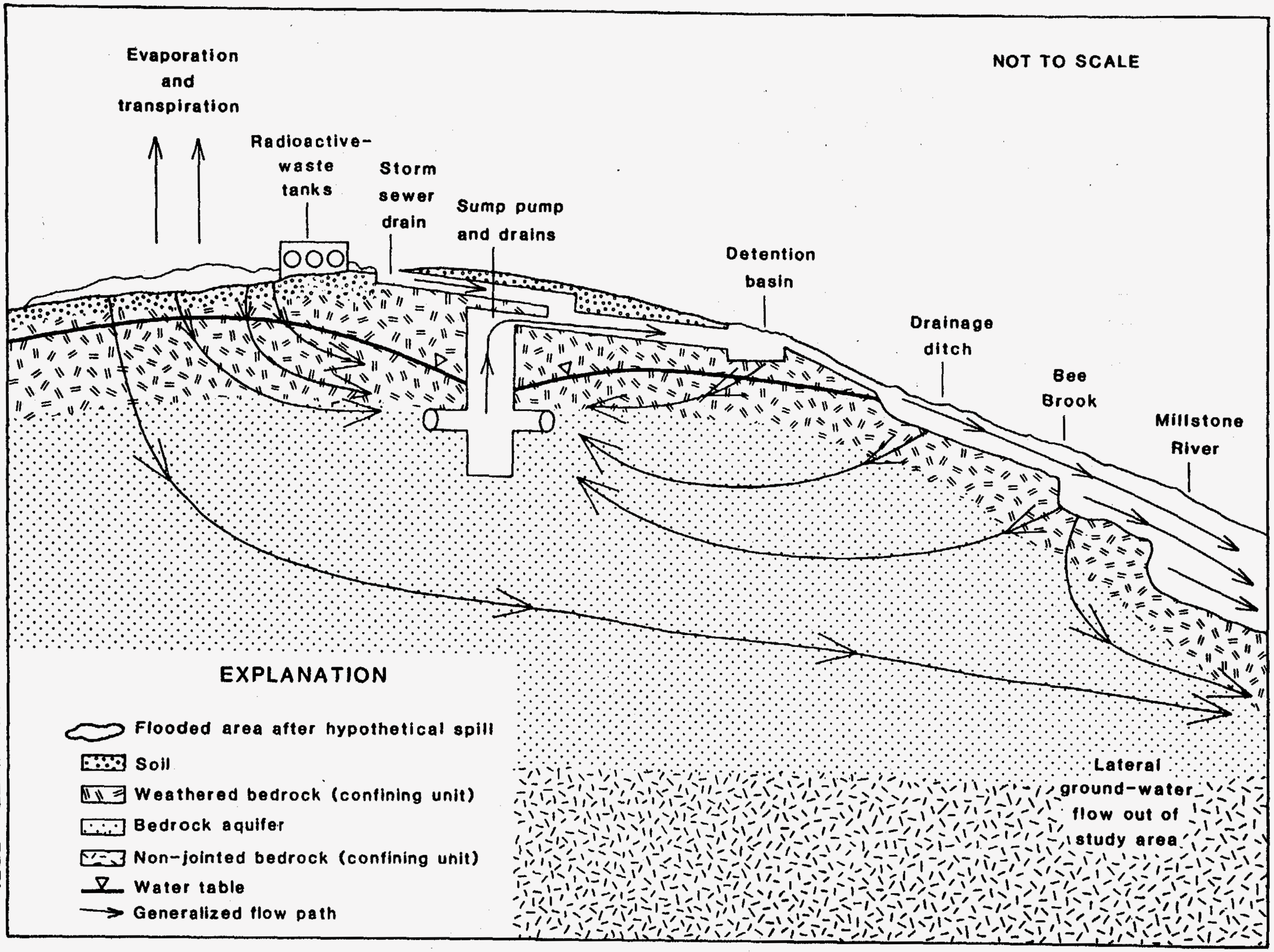


FIGURE 18. SHALLOW GROUND WATER ELEVATIONS CONTOUR MAP –SEPTEMBER 1997

FIGURE 19. POTENTIOMETRIC SURFACE of the BEDROCK AQUIFER at PPPL [from Le87]



-Schematic representation of hydrogeologic framework and potential flow paths of spilled water.

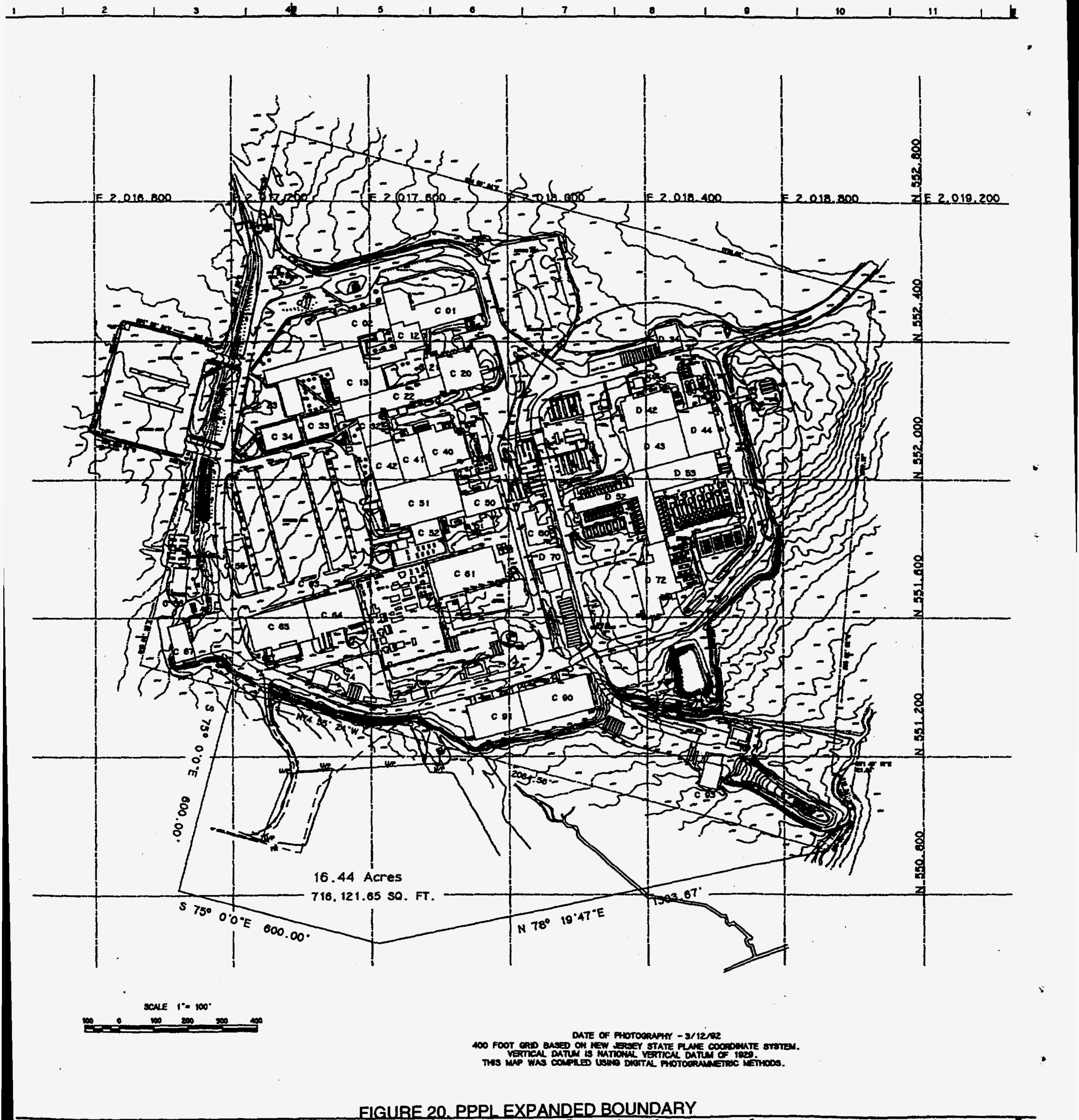


FIGURE 20. PPPL EXPANDED BOUNDARY

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