Princeton Plasma Physics Laboratory

PPPL- 4396

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Annual Site Environmental Report for
Calendar Year 2004

Virginia Finley

March, 2009

Prepared for the U.S. Department of Energy under Contract DE-AC02-76CH03073.

PPPL
PRINCETON PLASMA PHYSICS LABORATORY

ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2004

DIRECTOR R. GOLDSTON PRESENTS PPPL MAINTENANCE DIVISION WITH DOE POLLUTION PREVENTION AWARD FOR HIGH ACHIEVEMENT IN 2004

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Operated by Princeton University
For the U.S. Department of Energy
Under Contract DE-AC02-76-CHO-3073
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List of Acronyms

AEA	Atomic Energy Act of 1954
ALARA	as low as reasonably achievable
APEC	area of potential environmental concern
ARD	America Recycles Day (November 15th annually)
AST	above-ground storage tank
B1, B2	Bee Brook 1 (upstream of DSN001) and 2 (downstream of DSN001) (surface water stations)
BPX	Burning Plasma Experiment
Bq	Becquerel
BTEX	Benzene, toluene, ethyl benzene, and xylenes
C	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
CDX-U	Current Drive Experiment – Upgrade (at PPPL)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFCs	chlorofluorocarbons
CFR	Code of Federal Regulations
Ci	Curie (3.7 E10 Becquerel)
cm	centimeter
COD	chemical oxygen demand
CPO	chlorine produced oxidants as known as total residual chlorine
CS	C site Stellarator (PPPL)
CWA	Clean Water Act
CY	calendar year
D	deuterium
D&D	deconstruction and decontamination
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
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/NNSA	Department of Energy/National Nuclear Security Administration
DOE-OFES	Department of Energy - Office of Fusion Energy Sciences
DOE-PSO	Department of Energy - Princeton Site Office
D&R	Delaware & Raritan (Canal)
DRCC	Delaware & Raritan Canal Commission
DSN	discharge serial number
E1	Elizabethtown Water (Potable water supplier – surface water station)
EA	Environmental Assessment
EDE	effective dose equivalent
EHS	Environment, Health & Safety
EIS	Environmental Impact Statement
EML	Environmental Monitoring Laboratory (DOE)
EMS	Environmental Management System
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
ERO	Emergency Response Organization
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health
FABA	Former Annex Building Area
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
FSAR	Final Safety Analysis Report
FSCD	Freehold Soil Conservation District (Middlesex and Monmouth Counties)
g	gram
GBq	giga Becquerel or 10^9Bq

List of Acronyms

GCUA	Gloucester County Utility Authority
GP	General Permit (Wetlands)
gdp	gallons per day
GPMP	Ground water Protection and Monitoring Program
GWPP	Ground Water Protection Plan
GW	ground water
H-3	tritium
HAPs	Hazardous Air Pollutants
HMSF	Hazardous Material Storage Facility
HQ	Headquarters
HT	tritium (elemental)
HTO	tritiated water
HVAC	heating, ventilation, and air-conditioning
ICRF	Ion Cyclotron Radio Frequency
IC_{25}	inhibition concentration 25 percent
ISM	Integrated Safety Management
ISO14001	International Standards Organization 14001 (Environmental Management System – EMS)
ITER	International Thermonuclear Experimental Reactor
JET	Joint European Torus facility (United Kingdom)
JFC	James Forrestal Campus
km	kilometer
kV	kilovolt (thousand volts)
LEC	liquid effluent collection (tanks)
LEPC	Local Emergency Planning Committee
LSB	Lyman Spitzer Building (Formerly Laboratory Office Building)
LOI	Letter of Interpretation (Wetlands)
LLW	Low level waste (radiological waste)
m	meter
M1	Millstone River (surface water station)
MC&A	Material Control & Accountability (nuclear materials)
MCHD	Middlesex County Health Department
MESD	Materiel & Environmental Services Division (PPPL)
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
MRI	Magnetorotational Instability experiment
MRX	Magnetic Reconnection Experiment
MSDS	Material Safety Data Sheet
m/s	meters per second
msl	mean sea level
mSv	milliSievert
MT	metric ton (equivalent to 2,204.6 pounds or 1.10 tons)
MW	monitoring well
n	neutron
N or N-	Nitrogen
NAAQS	National Ambient Air Quality Standards
NB	Neutral beam
NBPC	Neutral Beam Power Conversion building
NCSX	National Compact Stellarator Experiment
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)
NJPDES	New Jersey Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NOEC	no observable effect concentration
NOV	notice of violation
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

List of Acronyms

nSv	nanoSievert
NTS	Nevada Test Site (DOE site)
OEM	Office of Emergency Management
OH	ohmic heating
ORNL	Oak ridge National Laboratory
OSHA	Occupational Safety and Health Agency
P1, P2	Plainsboro 1 (Cranbury Brook) and 2 (Devil's Brook) (surface water stations)
PBX-M	Princeton Beta Experiment - Modification
PCBs	polychlorinated biphenyls
PCE	perchloroethylene, tetrachloroethene, or tetrachloroethylene
pCi/L	picoCuries per liter
PEARL	Princeton Environmental. Analytical, and Radiological Laboratory
PFC	Princeton Forrestal Center
PLT	Princeton Large Torus
Pots	publicly owned treatment works
ppb	parts per billion
ppm	part per million
PPPL	Princeton Plasma Physics Laboratory
PSTP	Proposed Site Treatment Plan for the Federal Facility Compliance Act
PTE	potential to emit (air emissions)
RAA	Remedial Alternative Assessment
RACT	reasonably achievable 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
RWHF	Radiological Waste Handling Facility
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
SERC	State Emergency Response Commission
SF_6	sulfur hexafluoride
SPCC	Spill Prevention Control and Countermeasure
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
TPHC	total petroleum hydrocarbons
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
UIC	underground injection control
USDA	US Department of Agriculture
USGS	US Geological Survey
USEPA	US Environmental Protection Agency
UST	underground storage tanks
VOCs	volatile organic compounds
χ/Q	atmospheric dilution factor (NOAA)
μg/L	micrograms per liter
μSv	microSievert

List of Exhibits Contained in the Text

Exhibit #	Title	Page

NOTE: Data tables are located in Appendix A beginning on page 77.

Princeton Plasma Physics Laboratory (PPPL)
Certification of Monitoring Data for
Annual Site Environmental Report for 2004

Contained in the following report are data for radioactivity in the environment collected and analyzed by Princeton Plasma Physics Laboratory's Princeton Environmental, Analytical, and Radiological Laboratory (PEARL). The PEARL is located on-site and is certified for analyzing radiological and non-radiological parameters through the New Jersey Department of Environmental Protection's Laboratory Certification Program, Certification Number 12471. Non-radiological surface and ground water samples are analyzed by NJDEP certified subcontractor laboratories – QC, Inc. and Reliance Laboratory. To the best of our knowledge, these data, as contained in the "Annual Site Environmental Report for 2004," are documented and certified to be correct.

Signed:

Virginia L. Finley,
Head, Environmental Compliance
Materiel & Environmental Services Division

Jerry D. Levine,
Head, Environment. Safety, & Health Division

Approved:

Robert S. Sheneman
Head, Materiel & Environmental Services Division

Chapter
1

Princeton Plasma Physics Laboratory

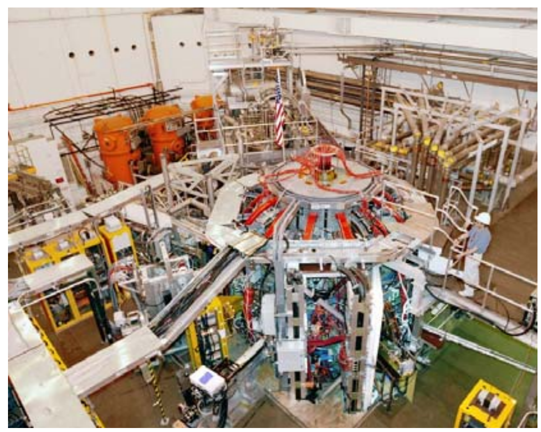
Annual Site Environmental Report for Calendar Year 2004

Executive Summary

This report presents the results of environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Years 2004. 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, that are added to the environment as a result of PPPL operations. The report also summarizes environmental initiatives, assessments, and programs that were undertaken in 2004. The objective of the Annual Site Environmental Report is to document PPPL's efforts to protect the public's health and the environment through its environmental protection, safety, and health programs.

The Princeton Plasma Physics Laboratory has engaged in fusion energy research since 1951. The reaction occurring in our sun as well as in other stars is fusion. In this fusion reaction, the nuclei of hydrogen atoms, in a plasma state, fuse or join resulting in the formation of helium atoms and the release of neutrons and energy. Unlike the sun, PPPL's fusion reactions are magnetically confined within a vessel or reactor under vacuum conditions. 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 a safe, alternative energy source.

The National Spherical Torus Experiment Heated by Neutral Beam Injection



Calendar Year 2004 marked the sixth year of the National Spherical Torus Experiment (NSTX) operations, accomplishing a 21-run week milestone. From groundbreaking in May 1998 to the creation of the first plasma on February 12, 1999, NSTX was completed within budget and ahead of the target schedule. PPPL re-used the former TFTR Hot Cell of D-site to house NSTX, which contributed to the cost savings. For the NSTX collaborators, the project was a major effort to produce a smaller, more economical fusion reactor or volumetric neutron source.

The NSTX program is a national collaboration; the following institutions are NSTX research participants.

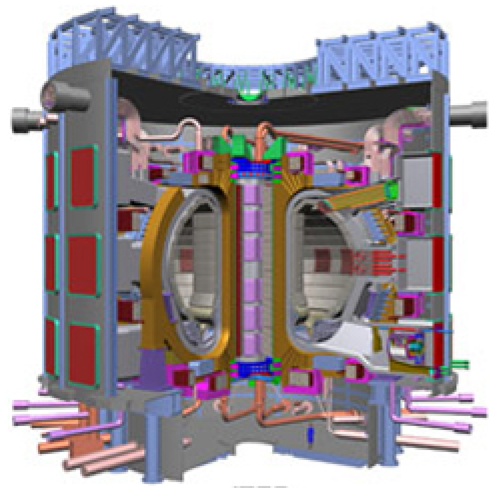
Columbia University
Fusion Physics & Technology, Inc.
General Atomics
Johns Hopkins University
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Massachusetts Institute of Technology
Oak Ridge National Laboratory
Sandia National Laboratory
University of California at Davis
University of California at Los Angeles
University of California at San Diego
University of Washington at Seattle

The International Thermonuclear Experimental Reactor (ITER) project was again supported by the United States, joining with the People's Republic of China, the European Union nations, Japan, the Republic of Korea, and the Russian Federation following the formal announcement by Department of Energy Secretary, Spencer Abraham in January 2003.

"Throughout its history, Princeton Plasma Physics Laboratory has earned a reputation for the highest-quality science and top-flight management," Secretary of Energy Spencer Abraham said. [PPPL04f]

In July 2003, U.S. Department of Energy announced the selection of PPPL as the host for the U.S. Project Office for ITER. PPPL, in partnership with Oak Ridge National Laboratory (ORNL), will be responsible for the U.S.'s participation in the ITER project, including staffing and facilities. The US ITER project is the pairing of PPPL as the country's premier site for magnetic fusion research with ORNL as the DOE's largest science and energy laboratory with a major fusion energy science program.

Artist's Rendition of the International Thermonuclear Experimental Reactor (ITER)



ITER

At PPPL, the National Compact Stellarator Experiment (NCSX) having completed its design milestone began the next step toward reality. Fabrication of major component contracts were awarded to two companies for the coil winding forms (molds) and the NCSX vacuum chamber. The coils are the electromagnets that create forces to hold the plasma together, and the vacuum chamber is the "bottle" that will contain the plasma. The unique feature of NCSX is its shape, which will resemble a twisted doughnut. It is scheduled to begin operations in 2008.

The Magnetorotational Instability (MRI) experiment at PPPL is a newly constructed device that will observe the astrophysical nature of accretion or matter collecting process of star and planet formation. The MRI will not use actual plasma, unlike most of PPPL experiments. It will use two concentric cylinders that rotate independently about a common axis. Inside the cylinders is a mixture of liquid metals: gallium, indium and tin. The apparatus and primary mission of this project will be the first to test the theory "indicates magnetorotational instability (MRI), a disruptive plasma process, plays a major role in accretion." [Hotline, November 2004, Vol. 26, No.2, PPPL04g]

To further strengthen the premise that fusion will provide an environmentally attractive and economically viable energy option for the 21st century, PPPL continued its experimental programs while conducting the associated environmental monitoring programs.

In 2004, PPPL's radiological environmental monitoring program measured tritium in the air at on-site and off-site sampling stations. PPPL is capable of detecting small changes in the ambient levels of tritium by using highly sensitive monitors. The operation of an in-stack monitor located on D-site is a requirement of the National Emission Standard for Hazardous Air Pollutants (NESHAPs) regulations with limits set by the Environmental Protection Agency (EPA). Also included in PPPL's radiological environmental monitoring program, are precipitation, surface, ground, and wastewater monitoring.

The dose results of the radiological monitoring program for 2004 were as follows:

1. Total maximum off-site dose from all sources—airborne and liquid releases—was 0.06 mrem/year.
2. Dose at the nearest business due to airborne releases was 0.02 mrem/year.
3. The collective effective dose equivalent for the population living within 80 kilometers was 0.47 person-rem.

The total maximum off-site dose for 2004 was the lowest since 1993, prior to D-T experiments. The dose is a small fraction of the 10-mrem/year PPPL objective and the 100-mrem/year DOE limit.

PPPL's 2004 Pollution Prevention and Community Outreach Programs included Earth Day and America Recycles Day celebrations. In April 2004, PPPL participated in Earth Day activities at the Sovereign Bank Arena in Trenton, NJ, which were sponsored by the Mercer County Improvement Authority. Many children and their families visited the Earth Day Fair where PPPL displayed information about its Pollution Prevention and Recycling Program.

In November 2004, PPPL celebrated America Recycles Day with the presentation of ten "Green Machine" awards that were given to staff members whose efforts have contributed greatly to the Laboratory's progress in Recycling and Buying Recycled Products.

In January 2005, PPPL was awarded the Department of Energy's Pollution Prevention Award for achieving in 2004 its 2010 goal of greater than 50 percent recycling rate for its municipal solid waste (trash). The photo on this report cover is the award being presented by PPPL's Director, Dr. Robert Goldston, to the Environment, Safety & Health and Infrastructure Support Department.

PPPL's Pollution Prevention Program results in 2004 were based on:

1. Usage of recycled material *versus* non-recycled material;
2. Reduction of waste to landfills and/or disposers - hazardous waste (48.4%) and solid waste (50.74%) - accomplished by actively seeking waste recyclers, and
3. Buying recycled rate of 88.3% in 2004 (goal being 100%).

PPPL's Community Outreach Program included facilities tours given to school, governmental, service, and private groups, representation at numerous community events, Science on Saturday seminars for the general public, hosting the Regional competition of the New Jersey High School Science Bowl, and participation through the Science Education Program, in local schools and at professional meetings.

PPPL's non-radiological environmental monitoring program demonstrates compliance with applicable environmental requirements. The program includes monthly surface water monitoring and annual chronic toxicity testing. In 2004, annual ground-water monitoring continued as a requirement of the Remedial Action Work Plan that includes reporting of the sampling results from selected wells, sumps, and surface water. Since 1989, PPPL's investigations have revealed volatile organic compound (VOC) contamination (most likely from solvents) at low levels in three ground-water locations. Based on these results, the VOC contaminants are biodegrading in the ground. PPPL's remedial action work plan relies on existing building drains for containment and extraction.

An Occupational Safety and Health Administration (OSHA) Audit Team conducted a comprehensive compliance audit of PPPL in August 2003. The objective of the compliance audit was to identify those instances of non-compliance with current OSHA standards with sufficient detail to enable DOE and PPPL to determine methods and costs to come into compliance. Of the 200-identified deficiencies, PPPL had corrected by the end of calendar year 2004: 100% of the electrical and subcontractor work; 95% of the piping and fabrication work; and 75% of the administrative actions. PPPL continues to correct the remaining actions with of goal of completing all by the end of fiscal year 2005.

In March 2004, PPPL's Emergency Response Organization (ERO) joined with Plainsboro Township police, emergency, and fire resources to participate in an emergency response exercise. An unannounced drill or "No-Notice Emergency Exercise" was conducted by staff from the Department of Energy/National Nuclear Security Administration (DOE/NNSA) Office of Emergency Management (OEM), who evaluated the ERO's performance. The DOE/NNSA OEM concluded that members of the ERO worked well together and appropriately addressed the issues of the simulated emergency.

The Laboratory is expected to continue excelling in all aspects of ES&H as it has in its fusion research program. Efforts are geared not only to full compliance with applicable local, state, and federal regulations, but also to achieve a level of excellence in ES&H performance. PPPL is an institution that serves other research facilities and the nation with valuable information gathered from its fusion research program.

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

Chapter 2

Introduction

2.1 Site Mission

The U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) is a Collaborative National Center for plasma and fusion science. Its primary mission is to develop scientific understanding and key innovations leading to an attractive fusion energy source [PPPL98a]. Related missions include conducting world-class research along the broad frontier of plasma science and providing the highest quality of scientific education and experimentation.

At PPPL, the National Spherical Torus Experiment (NSTX) is a collaborative project among 14 Department of Energy National Laboratories, universities, and institutions. Also located at PPPL are smaller experimental devices, such as the Magnetic Reconnection Experiment (MRX), the Current Drive Experiment-Upgrade (CDX-U) and Hall Thruster, which investigate plasma physics phenomena.

As a part of off and on--site collaborative projects, PPPL scientists assist fusion programs both in the United States and other countries. Particularly, PPPL collaborated with Oak Ridge National Laboratory on the National Stellarator Tokamak Experiment (NSTX) located at PPPL and the Joint European Torus (JET) facility located in the United Kingdom, to further fusion science.

2.2 Site Location

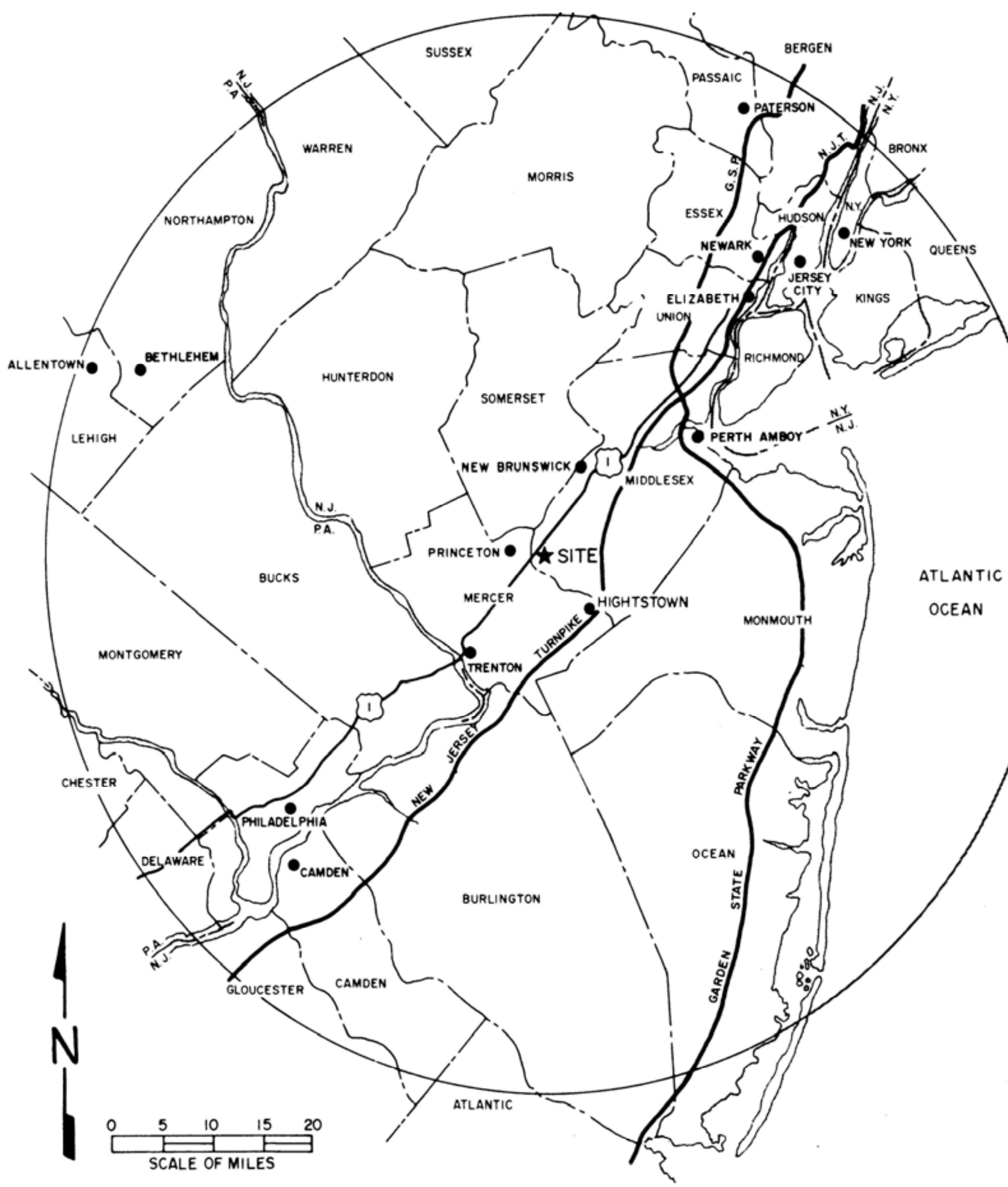
The Princeton Plasma Physics Laboratory site is in the center of a highly urbanized Northeast region. The closest urban centers are New Brunswick, 14 miles (22.5 km) to the northeast, and Trenton, 12 miles (19 km) to the southwest. Major surrounding cities, including New York City, Philadelphia, and Newark, are within 50 miles (80 km) of the site.

As shown in Exhibit 2-1, the site is located in Plainsboro Township within Middlesex County (central New Jersey), adjacent to the municipalities of Princeton, Kingston, West Windsor, and Cranbury, NJ. The Princeton area continues to experience a substantial increase in new businesses locating along the Route 1 corridor near the site. Also, the main campus of Princeton University, primarily located within the Borough of Princeton, is approximately three miles to the west of the site.

In the early 1950's, Dr. Lyman Spitzer's vision for plasma physics culminated in Project Matterhorn, which gained approval of the U.S. Atomic Energy Commission. Its mission was to contain and harness the nuclear burning of hydrogen at temperatures exceeding those found in the sun. Dr. Spitzer became known as the father of the "Stellarator" and was PPPL Director until 1961. Named for Dr. Spitzer's A, B, and C stellarators, PPPL was first located on A- and B-sites of the James Forrestal Campus; and in 1959, PPPL moved to its present location at C-site. In the late 1970's, D-site became the home of the Tokamak Fusion Test Reactor (TFTR), which was dismantled and removed (1999-2002), and has been home to the National Spherical Torus Experiment (NSTX) since 1998 (Exhibit 2-2).

Undisturbed areas surrounding the site include upland forest, wetlands, open grassy areas, and a minor stream (Bee Brook), which flows along its eastern boundary.

Exhibit 2-1. Region Surrounding PPPL (50-mile radius shown)



These areas are designated as open space in the JFC site development plan. The following aerial photo (Exhibit 2-3) shows the general layout of the facilities at the C- and D-sites of Forrestal Campus as viewed from the north; former TFTR and NSTX Test Cells are located at D-site (on the left side of photo).

Exhibit 2-2. PPPL James Forrestal Campus, Plainsboro, NJ

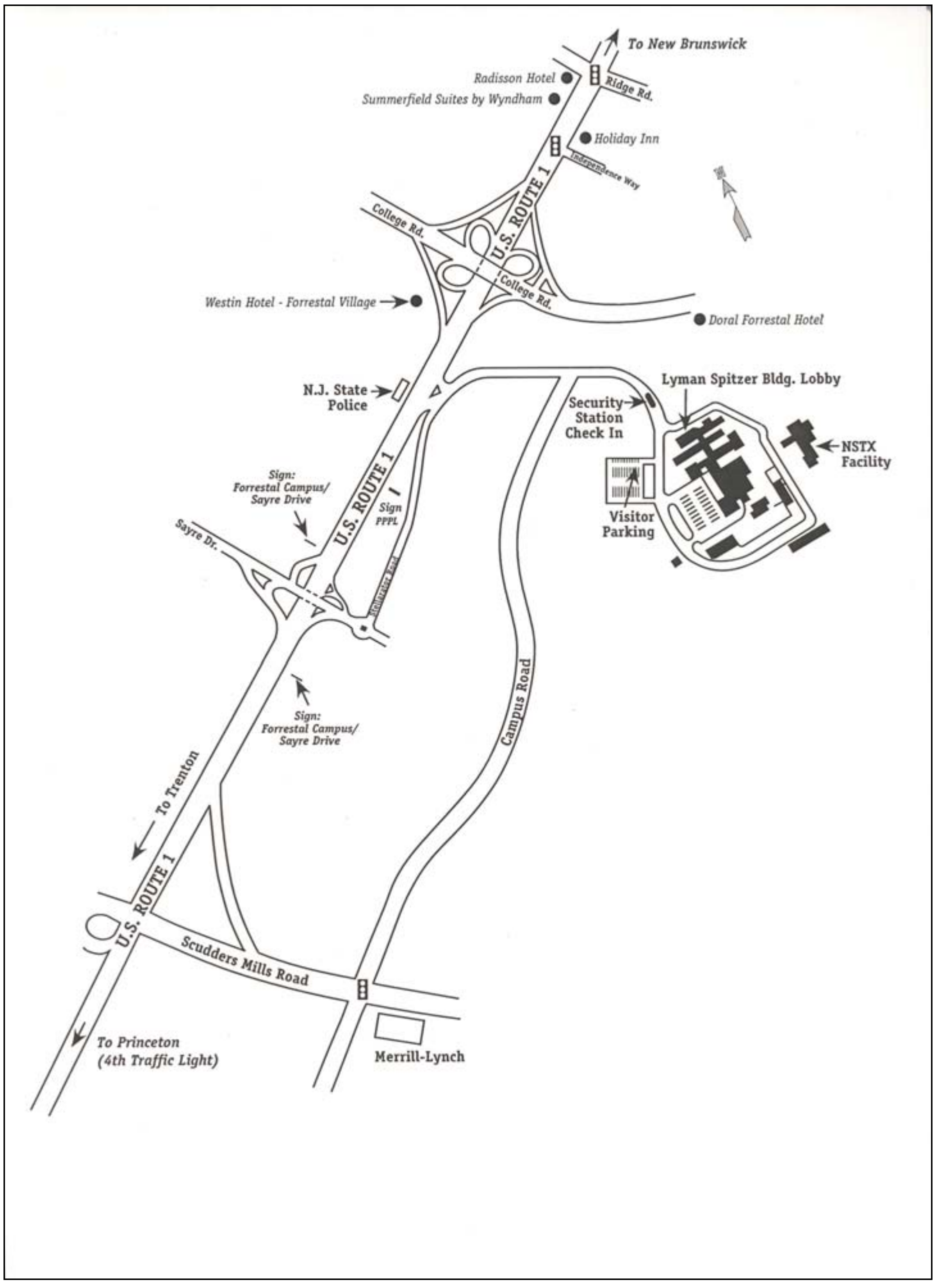


Exhibit 2-3. Aerial View of PPPL

D-site is fully surrounded with a barbed -wire, chain-linked fence for security purposes. PPPL openly operates C-site, allowing the public access for educational purposes. This type of access to C-site warranted a thorough evaluation of on-site discharges, as well as the potential for off-site releases of radioactive and non-radioactive effluents. To maintain access to C-site, PPPL instituted an extensive monitoring program that was expanded in 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].

2.3 General 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 Fahrenheit (°F) (17.8°Celsius (C) to 37.8° C); extreme temperatures typically occur once every five years. Approximately half the year, from late April until mid-October, the days are freeze-free.

Normally, the climate is moderately humid with a total average precipitation of 46 inches (116 cm) evenly distributed throughout the year. Droughts typically occur about once every 15 years [PSAR78]. In 2004, the annual rainfall total, 40.53 inches (102.9 cm) was below the average rainfall for central New Jersey. This below-average level was primarily due to dry weather in the first six months (January-June) when the average precipitation was 2.5 inches (6.35 cm); the normal monthly average is closer to 4 inches (10.2 cm) (Appendix A, Table 2) [Ch 05].

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. Apparently, the site had limited occupation during prehistoric time and has only in recent times been actively used for farming. There are examples of prehistoric occupation in areas closer to the Millstone River, which are within a mile of the site [Gr77].

2.4 Primary Operations and Activities

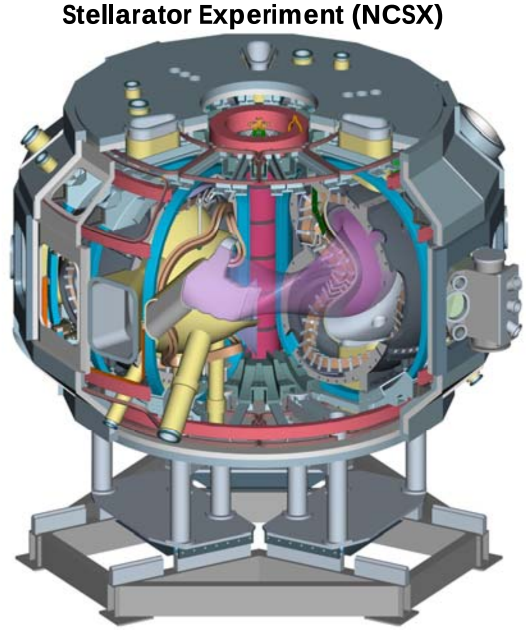
The fusion experiments, such as NSTX, MRX, or CDX-U, currently operated at PPPL. In 2003, TFTR was fully dismantled, and the area was vacated, availing the space for the National Compact Stellarator Experiment (NCSX) Coil Winding Facility. The former test cell has sufficient space to store many of the TFTR's support systems for future use.

Next door to the former TFTR Test Cell is the NSTX Test Cell. Since its start-up in February 1999, NSTX has consistently exceeded its target milestones. On August 5, 2004, the device completed its 21.1 weeks of operations, having accomplished many of its goals – one being production of almost 2500 plasma discharges.

NSTX produced one million amperes of plasma current, setting a new world record for a spherical torus device. This device is designed to test the physics principles of spherical-shaped plasmas forming a sphere with a hole through its center. Plasma shaping is an important parameter to plasma stability and performance ultimately enabling viable fusion power.

Following the dismantlement and removal of Princeton Beta Experiment – Modified, PBX-M, in 2003, the combination of the test cells (PBX-M and the former Princeton Large Torus - PLT) will be home to PPPL's newest device, the National Compact Stellarator Experiment, NCSX. NCSX completed its final design stages in 2004 (Exhibit 2-4). Fabrication contracts were awarded and plans to begin construction in 2005 and operations to begin in 2008.

Exhibit 2-4. The National Compact Stellarator Experiment (NCSX)



"The success of the most widely studied magnetic fusion concept, the tokamak, has shown the advantage of bending the plasma into a torodial, or doughnut, shape for achieving reactor-level plasma parameters for a short time. …The 'bootstrap current' (theoretically predicted self-generating current) can be used to make the tokamak into a continuously sustained 'advance tokamak' configuration, but up to 20% of the plant's output power would still have to be re-circulated to drive active plasma controls needed to prevent the disruption of a tokamak plasma." [PPPL01b].

In Exhibit 2-4, the uniquely twisted shape of the vacuum vessel is shown in purple in this cut-away view. The scale of the device is about six-feet (two meters) above the floor where the vessel sits on its pedestals.

Exhibit 2-5. NCSX Vacuum Vessel Prototype (note its unique shape)

2.5 Relevant Demographic Information

A demographic study of the surrounding 31.1 miles (50 kilometers) was completed in 1987 as part of the Environmental Assessment for the proposed Burning Plasma Experiment (BPX), which was also known as Compact Ignition Tokamak (CIT) [Be87a]. From the 2000 US Census Bureau Statistics, Middlesex County has a population of 750,162; adjacent counties of Mercer, Monmouth, Somerset, and Union have populations of 350,761, 615,301, 297,490, and, 522,541 respectively [US00]. Other information gathered and updated from previous TFTR studies include socioeconomic information [Be87b] and an ecological survey, which were studies describing pre-TFTR conditions [En87].

(Photo of Professor Goldston inside a vacuum vessel prototype; the picture was digitally enhanced to include a plasma sphere.)

Chapter 3

2004 COMPLIANCE SUMMARY

3.1 Environmental Restoration and Waste Management

Princeton Plasma Physics Laboratory's (PPPL) environmental goal is full compliance with all applicable state, federal, and local environmental regulations. As a part of PPPL's Project Mission Statement, PPPL initiates actions that enhance its compliance efforts and fully documents meeting the requirements. The process of compliance with each applicable federal, state, and local environmental statute or regulation, and executive and DOE orders [DOE03a & b] are discussed in this chapter.

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

During 2004, PPPL had no involvement with CERCLA-mandated cleanup actions. Resulting from the 1991 assessment by Department of Energy – Headquarters' (DOE-HQ) environmental team, known as the Tiger Team, an action plan was developed to conduct a more comprehensive documentation of past CERCLA hazardous substances releases. A CERCLA inventory was completed in 1993 [Dy93], and no further CERCLA actions were warranted.

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

The Laboratory complies with all the requirements of a hazardous waste generator. In 2004, PPPL shipped off site approximately 12.91 tons (11.71 metric tons, MT) of waste to facilities permitted to treat, store, or dispose of hazardous wastes and 48.4% (12.11 tons, 10.98 MT) of its waste were recycled [MP05a]. Summaries of PPPL's annual hazardous waste generation rates and waste reduction/recycling efforts are presented in Exhibits 3-1 and 3-2. In 2004, PPPL recycled 50.74% of its municipal solid waste stream, which exceeded its goal of 50% recycled waste [McG05].

Exhibit 3-1 shows the three largest quantities by waste type generated from 1998 to 2004. The waste types and quantities are highly variable from year to year; between 2003 and 2004, mercury removal from PPPL was a high priority not previously undertaken. Mercury was one of the three largest waste categories to be removed, either recycled or incinerated. Another variable is the number and nature of petroleum spills that require cleanup and removal of oily gravel/soil debris.

PPPL complied with the requirements of the RCRA-mandated Underground Storage Tank (UST) Program having completed UST-related actions. In 1995, PPPL completed the removal or in-place closure of all its on-site underground storage tanks. In March 1997, PPPL submitted a Site Assessment Report as part of the Remedial Investigation and Remedial Alternative Assessment (RI/RAA) Report [HLA97]. In March 2000, NJDEP issued a "No Further Action" determination for the UST closure in a letter to Princeton University.

Exhibit 3-1. Hazardous Waste Quantity Comparisons 1998-2004 (3 largest quantities)

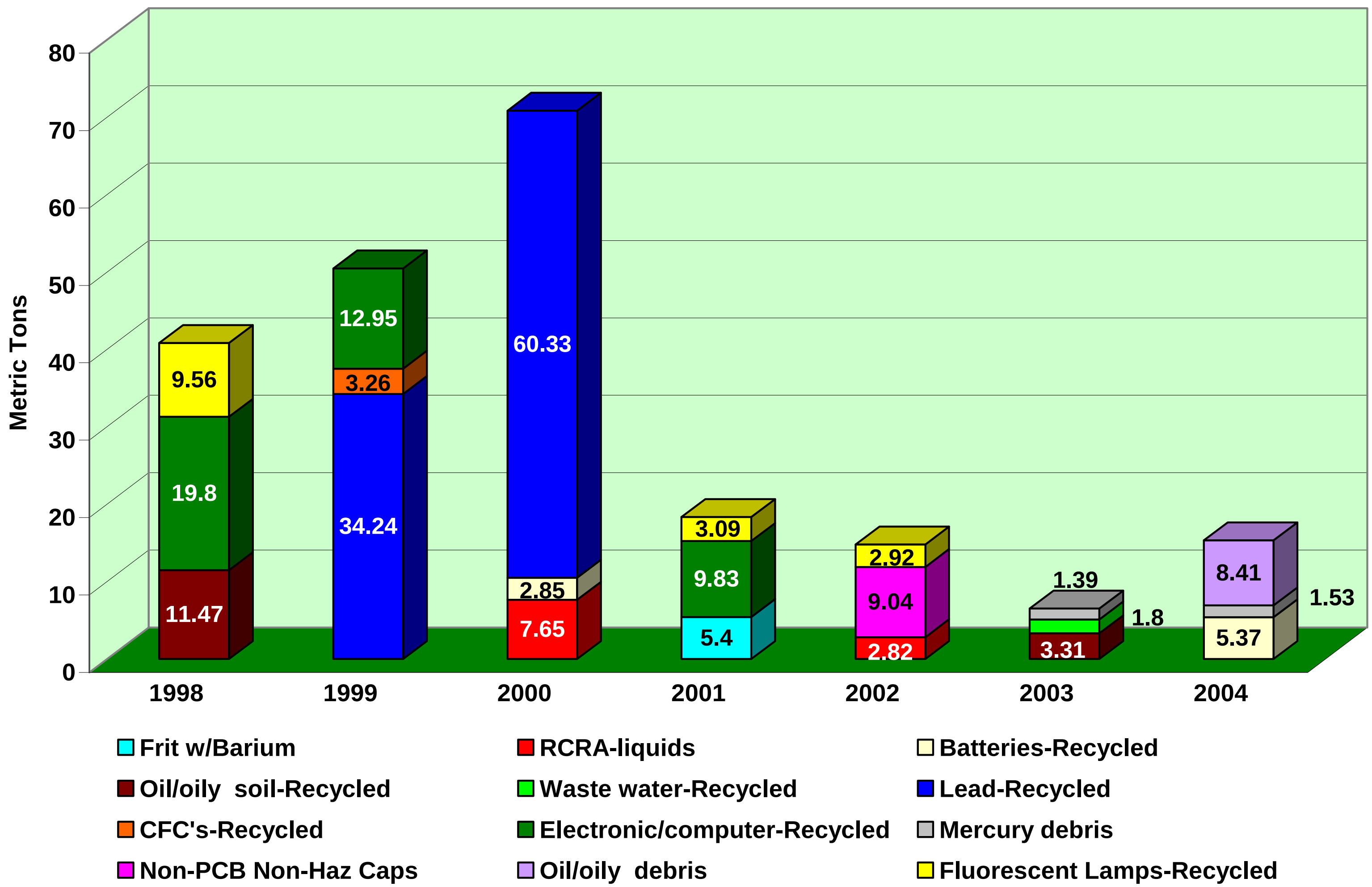


Exhibit 3-2. 2004 Waste Reduction

View PPPL Pollution Prevention accomplishments @http://tis.eh.doe.gov/p2/wastemin/RecycleRpt.Asp

Metric ton equals 2,205 pounds or 1.10 tons

Type	Source	Amount	Fate
Hazardous	**Recycled / Total Hazardous Waste**	**48. 40%**	
Waste	Oil and oily debris	1.30 MT	Recycled
	Lab wastes, solvents	0.71 MT	Incinerated
	Batteries - lithium	0.03MT	Incinerated
	Batteries (includes lead acid)	5.37 MT	Recycled
	Lead debris	0.43 MT	Incinerated
	Non-PCBs Non-Haz. Capacitors	0.61 MT	Incinerated
	Fluorescent lamps (contain Hg)	0.82 MT	Recycled
	Mercury debris	1.53 MT	Incinerated
	Mercury	1.49 MT	Recycled
	Oily debris	8.41 MT	Land-filled
	Waste water	1.28 MT	Recycled
	Waste acid	0.73 MT	Treated

Type	Source	Amount	Fate
TSCA	Asbestos	160 cu. yds.	Land-filled
Waste	PCB capacitors, ballasts &debris	1.48 MT	Incinerated
	Ballasts incl. Ballasts (PCBs)	0.19 MT	Recycled
Municipal	**Office Waste Stream**	**50.74 %**	
Solid	Front end trash	55.85 MT	Land-filled
Waste	Aluminum & glass (bottles & cans)	8.77 MT	Recycled
(MSW)	Cardboard/ Paper (mixed)	48.76 MT	Recycled
	Industrial Waste Stream	**100 %**	
[Kin05a]	Scrap metals aluminum & stainless steel copper & wiring & iron	137.85 MT	Recycled
	Electronic Media	6.57 MT	Recycled
	Toner cartridge	0.11MT	Recycled
	Hazardous Waste Stream	**77.31 %**	
	Properly disposed	3.10 MT	
	Batteries	4.75 MT	Recycled
	Computer monitor	2.71MT	Recycled
	Lead	2.33MT	Recycled
	Mercury	0.04 MT	Recycled
	Fluorescent lighting	0.85 MT	Recycled
	Construction waste	**54.9 %**	
	Construction & Demolition trash	105.16	Land-filled
	Wood	28.55	Recycled
	Concrete	99.48	Recycled
	Buy Recycled Products Rate-unadjusted	**88.3 %**	**Goal is 100 %**

3.1.3 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, which is 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 (STP) for Princeton Plasma Physics Laboratory (PPPL)." PPPL does not currently generate mixed waste and has no future plans to generate mixed waste.

PPPL 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 Environmental Protection Agency (EPA) Region II regulators, who were in agreement with this approach. Based on their agreement, this approach keeps PPPL in compliance with the applicable Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions. DOE provides the state and EPA with annual updates and keeps the regulators apprised 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].

3.1.4 National Environmental Policy Act (NEPA)

Twenty-eight (28) PPPL activities in 2004, received NEPA reviews. All of these activities were determined to be categorical exclusions (CX) in accordance with the NEPA regulations and guidelines of the Council on Environmental Quality (CEQ) and DOE, or covered in a previously approved environmental assessment (EA). [Lev05b].

3.1.5 Toxic Substance Control Act (TSCA)

PPPL complies 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 are implemented. The last TSCA-regulated polychlorinated biphenyl (PCB) transformers were removed from the site in 1990.

In September 1998, 640 regulated capacitors were removed from the total inventory of 645 capacitors. At the end of 2004, only 5 PCB capacitors that met the regulation criteria remained at PPPL [MP05b].

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

Certified subcontractors, who meet all the requirements of FIFRA, performed the application of herbicides, pesticides, and fertilizers. The PPPL Maintenance & Operations Division (M&O) monitors this subcontract. The following list of herbicides/insecticide/fertilizer was used on the PPPL site in 2004 [Kin05b].

Herbicides:	**Roundup (15 gallons)**
	Momentum (8.5gallons)
Insecticide:	**Malathion (0.8 gallons)**
Fertilizer:	**NPK (900 lbs.)**

3.1.7 Spill Prevention Control and Countermeasure (SPCC)

As a requirement of 40 CFR 112 "Oil Pollution Prevention" regulation changes, PPPL revised the Spill Prevention Control and Countermeasures (SPCC) plan in 2004 [PPPL04e]. There are numerous transformers containing non-PCB mineral oil as well as fuel oil tanks (25,000 and 15,000 gallon aboveground storage tanks) for supplying fuel to the boilers and generators located on-site. Smaller vehicle refueling tanks and equipment oil storage tanks containing petroleum products are included in PPPL's SPCC plan. The SPCC plan is reviewed annually and must be updated at least every five years.

The most recent US EPA Region 2 inspection of the facility occurred in June 1998. Under state regulations, NJDEP classified PPPL as a non-major facility [NJDEP98a]. The threshold of 200,000 gallons of petroleum (not in transformers) is not exceeded. PPPL being a minor facility, the Discharge Prevention Control and Containment (DPCC) plan and Discharge Cleanup and Reporting plan (DCR) requirements do not apply.

In November 2004, NJDEP notified PPPL that although PPPL has reporting obligations under the regulations to call the HOTLINE, the 30-day written discharge confirmation report was no longer required. PPPL notifies NJDEP when oil/hazardous materials are accidentally released to a pervious surface, and PPPL proceeds to control the release and clean-up the spill.

3.2 Radiation Protection

3.2.1 DOE Order 5400.5, *Radiation Protection of the Public and the Environment*

For radiation protection of the public and the environment, PPPL follows the requirements documented in the Radiological Monitoring Plan contained in PPPL's Environmental Monitoring Plan [PPPL99b]; the Plan meets the requirements stated in DOE Order 5400.5 [DOE93a].

Through its monitoring program, the Plan provides assurance that the release of radioactive material on-site or off-site will be within regulatory limits and PPPL's policy of all radiation exposures "As Low As Reasonably Achievable" (ALARA). The order pertains to permissible dose equivalents and concentration guides as well as giving guidance on maintaining exposures to ALARA limits.

When 10 CFR 835, "Occupational Radiation Protection," became effective, PPPL made operational changes reflected in personnel monitoring requirements. Specific criteria for implementing the requirements are included in the NSTX Safety Assessment Document [PPPL01a]. These criteria are shown in Appendix A, Table 1.

The radiation monitoring program emphasizes exposure pathways appropriate to PPPL's fusion energy projects. These pathways include external exposure from direct penetrating radiation.

During the TFTR deuterium and tritium experiments, internal exposure from radionuclides, such as tritium (HT and HTO) in air and water, was monitored. Tritium releases continue to be measured following TFTR shut down, during TFTR Decontamination and Decommissioning (D&D) Project, and post-D&D. Six major critical pathways are considered as appropriate (see Exhibit 3-3).

The radiation monitoring program, described in the TFTR Final Safety Analysis Report [FSAR82], was updated to reflect the environment around TFTR and D site (Exhibit 3-4).

Exhibit 3-3. Critical Pathways

Path	Source and Pathway
A1	Atmospheric ---> Whole Body Exposure
A2	Atmospheric ---> Inhalation Exposure
A3	Atmospheric ---> Soil & Vegetation Deposition---> Ingestion/Whole Body Exposure
L1	Liquid Water Way ---> Drinking Water Supply --> Human
L2	Liquid Water Way ---> External Exposure
L3	Liquid Water Way ---> Fish ---> Human

PPPL's Environment, Safety & Health Directives (ESHD) 5008, Section 10, "Radiation Safety," Subpart L, "Release of Materials and Equipment from Radiological Areas," and Subpart P, "Radiological Environmental Monitoring Program," support the requirements for compliance with DOE 5400.5 {PPPL00d]. Monitoring of equipment and the environment ensures radiation protection for employees and public good.

3.2.2 DOE Order 435.1, *Radioactive Waste Management*

To comply with the requirements of DOE Order 435.1, PPPL manages its radioactive waste by two implementing documents [DOE99b]:

1. PPPL ESHD 5008, Section 7, "Waste Management" [PPPL00c]; and
2. Environmental Restoration/Waste Management (ER/WM), EM-CP-21, Low-level Radioactive and Mixed Waste Certification Plan [PPPL98c].

Exhibit 3-4. Radiation Monitoring Program Covering Critical Pathways

Type of Sample	Critical Pathway	Sample Location	Sampling Frequency	Type of Analysis
Surface Water	L1, L2, L3 & A3	1 – Basin Outfall (DSN001) 2 – Delaware & Raritan Canal (DSN003) 3 – Off-site (Bee, Cranbury, Devils Brooks, Millstone River)	1 – Monthly 2 – Monthly 3 - Quarterly	All surface water samples –HTO
Rain Water	L1, L2, & L3	1– Within 250 and 500' radius of D-site stack (N,S,E, & W) 2 –Within 1 km radius (co-located with air monitoring stations)	Monthly (as filled)	HTO
Ground Water	L1, L2, & L3	1– Select ground water monitoring wells 2 –D-site sumps (Air shaft and MG basement)	1 –Monthly 2 –Monthly	HTO
Sanitary Waste Water	L1 & L2	Liquid effluent collection tanks (3 tanks each 15,000 gal. on D-site)	As required- dependent on fill rate	HTO Gross beta
Air	A1, A2, & A3	TFTR Test Cell	Continuously	HT and HTO
Air	A1, A2, & A3	Tritium Vault	Continuously	HT and HTO
Air	A1, A2, & A3	D-site Stack (HVAC)	Continuously	HT and HTO, Particulates
Direct & Air (on-site)		4 air monitoring trailers on D-site facility boundary	Continuously	g, n, HT and HTO,
Direct & Air (off-site)		6 locations off-site with 1 km radius	Continuously	HT and HTO

HT = elemental tritium HTO = tritiated water Gross b = Gross beta g = gamma n = neutron

The first document discusses roles and responsibilities for the management of radioactive waste and describes the Radioactive Waste Handling Facility (RWHF) operations. The second document describes PPPL's organization and methodology for characterizing, handling, and certifying low-level radioactive and mixed waste that may be generated by PPPL. This plan includes transportation and subsequent burial at DOE's Hanford Burial Site in the state of Washington and the Nevada Test Site outside of Las Vegas, Nevada. Other M&ES procedures provide specific instructions for sampling, packaging and preparing waste for shipment/disposal.

3.2.3 Atomic Energy Act (AEA) of 1954 (442 USC 2001 et seq.)

PPPL complies with the requirements of the Atomic Energy Act (AEA) of 1954 through the adherence to PPPL's plan developed for controlling radioactive material. PPPL's "Nuclear Materials Control and Accountability (MC&A) Plan" describes the system for control and accountability of nuclear materials in PPPL's custody [PPPL98d]. PPPL's management assures that nuclear material used at PPPL is properly controlled, inventoried, and accounted for as required in DOE Order 474.1 [DOE00].

The objective of the MC&A program is to provide a basis for planning, implementing, and evaluating an information and control system. The system is a combination of checks and balances sufficient to detect and assist in the prevention of the unauthorized use and removal of nuclear materials from PPPL.

3.3 <u>Air Quality and Protection</u>

3.3.1 Clean Air Act (CAA)

PPPL complied with the requirements of the CAA in 2004. Under Title I, "Non-attainment Provisions," PPPL is located in a severe 17-ozone non-attainment area (ozone attainment to be reached 15 to 17 years following date of regulations, *i.e.* 2005 - 2007). This classification limits the threshold potential-to-emit (PTE) to 25 tons per year of nitrogen oxides (NO_x) and 10 tons per year of volatile organic compounds (VOCs). Formed during the burning of fossil fuels in boilers, generators, vehicle engines, *etc.*, NO_x and VOCs are precursors to ozone formation.

At PPPL, NO_x is the class of regulated air contaminant that could exceed PTE thresholds limit of greater than 25 tons per year. Annually, PPPL calculates total emissions using natural gas and fuel oil consumption and hours of operations for all four boilers in order to meet this limit. PPPL's emergency diesel generators are limited by the maximum hours of operation permitted annually.

PPPL requested from NJDEP the fuel limits (Exhibits 3-5 and 3-6) and limited hours of operations for the generators. NJDEP granted the request and imposed a maximum annual fuel (oil and natural gas) use limitation for the C-site boilers as a whole rather than the individual boiler fuel use limit. PPPL continues to operate successfully within the stated limitations (typically less than 30% of the limitations) [NJDEP95b, Kir05]. In 2004, actual NO_x emission from the four boilers was calculated to be 5.80 tons, well below the regulatory limit of 15.26 tons per year (see Exhibit 3-7).

Exhibit 3-5. No. 2 and 4 Fuel Oil Consumption (gallons) from 2000 to 2004

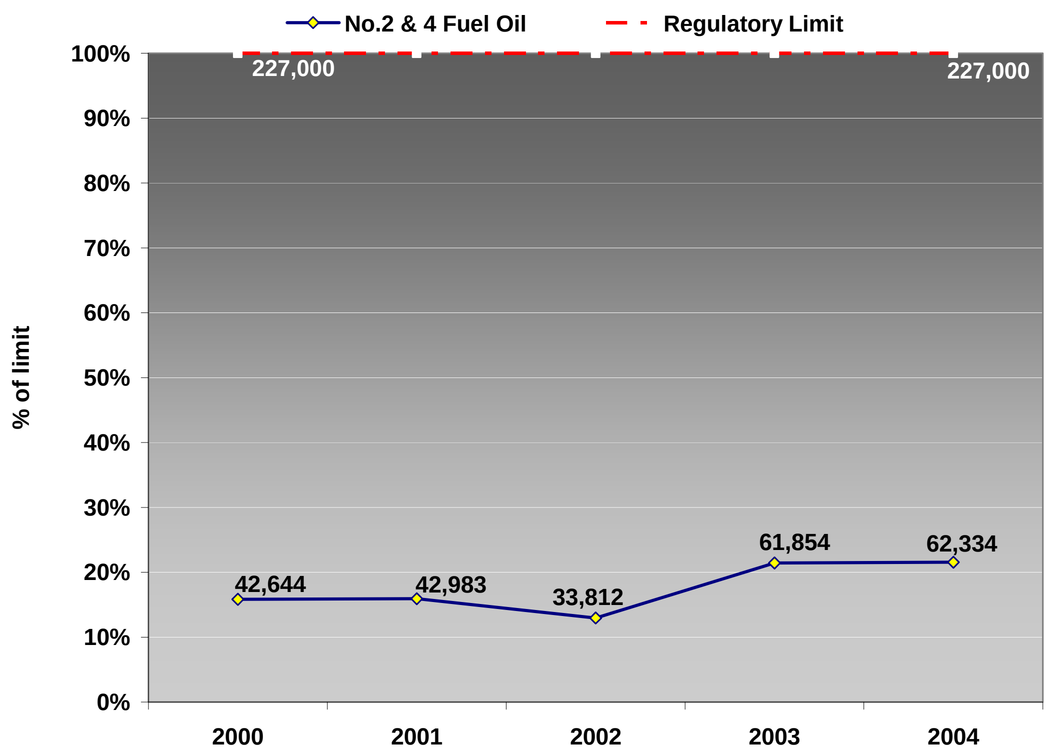


Exhibit 3-6. Natural Gas Consumption (ccf) from 2000 to 2004

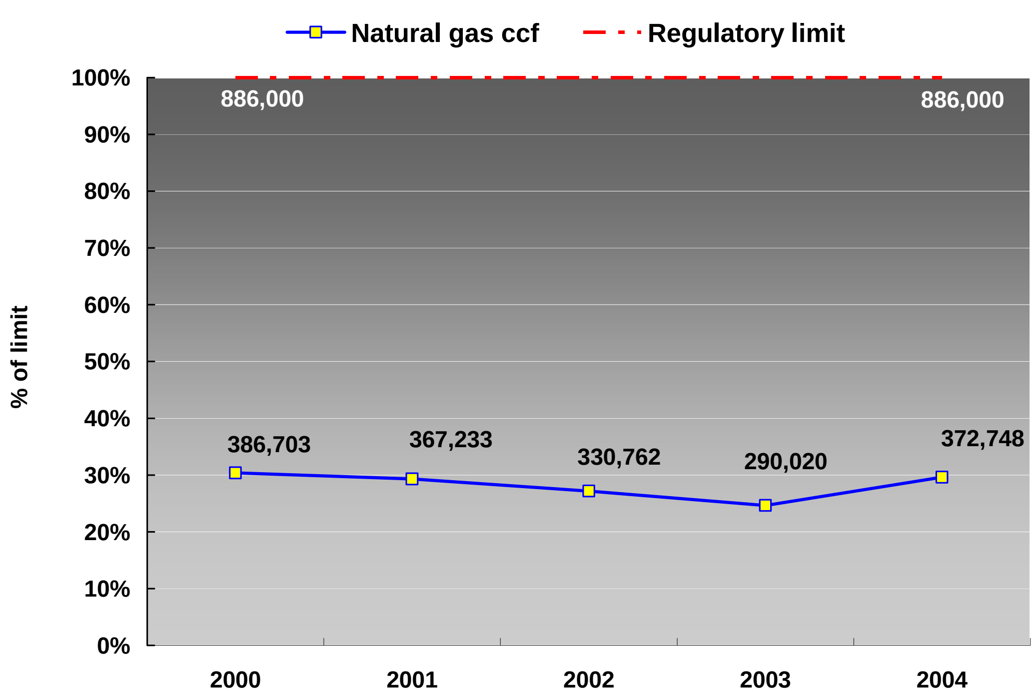
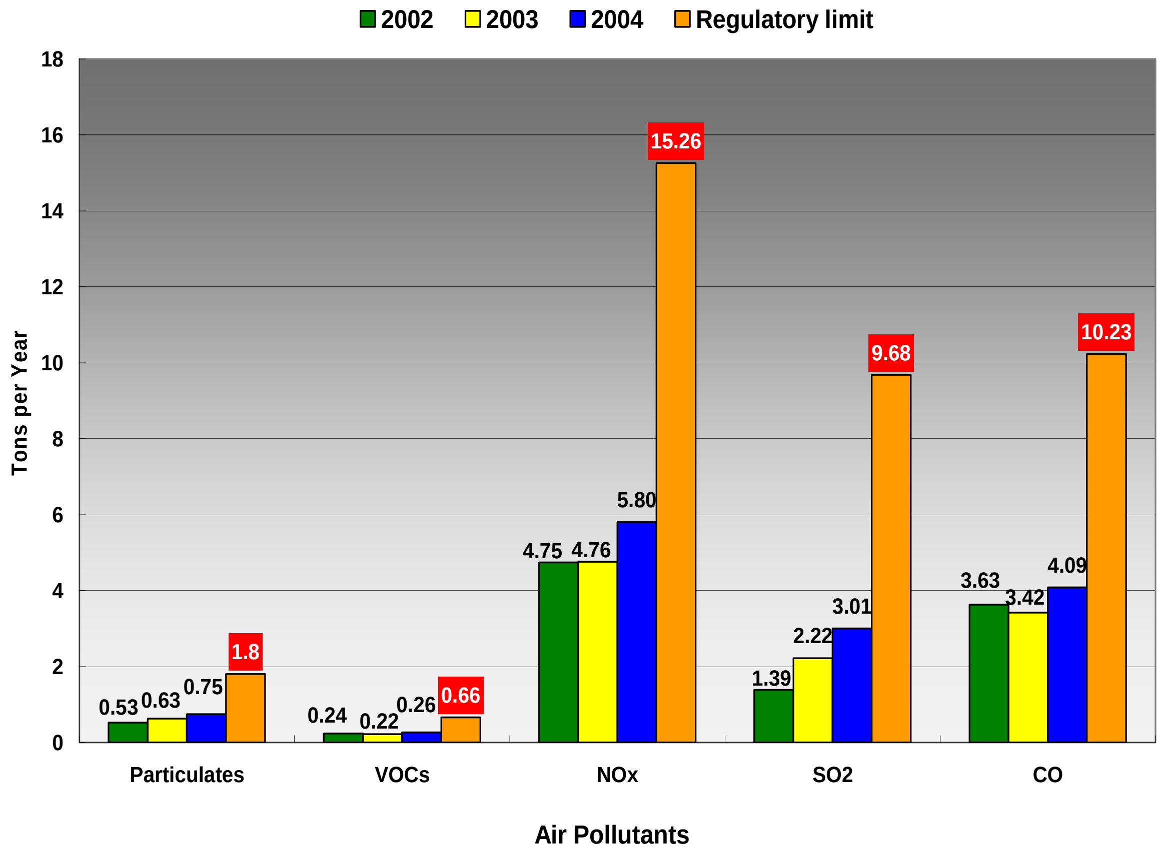


Exhibit 3-7. 2002 to 2004 Total Air Emissions from Boilers 2-5



As a requirement of New Jersey Administrative Code (NJAC) Title 7:27-21, "Emissions Statements," PPPL submitted the 1994 Air Emission Survey to NJDEP; this Emission Survey was the last survey submitted. In March 1996, the NJDEP approved PPPL's request for Annual Emission Statement Non-Applicability.

The CAA Title V, "Operating Permit Program," is implemented through the State of New Jersey. In August 1995, PPPL filed a negative declaration for the New Jersey Operating Permit Program. By reducing the annual operating hours from 500 to 200 for the D-site (formerly TFTR) emergency diesel generator, PPPL lowered the NO_x potential to emit to below the 25 ton-per-year threshold. NJDEP granted approval in March 1996, effective November 29, 1995.

Under CAA Title VI, "Stratospheric Ozone Depletion," PPPL's use of certified refrigerant recovery units and trained technicians comply with Section 608 of the CAA, which prohibits the venting of ozone-depleting substances. PPPL maintains an inventory of Class I and II ozone-depleting substances (chlorofluorocarbons or CFCs).

PPPL safely disposes of equipment containing ozone-depleting substances by removing refrigerants to specified levels prior to disposal of equipment. PPPL employs trained and certified technicians to service and repair equipment containing ozone-depleting substances (ODS) and to operate the four refrigerant recovery units. In March 2002, PPPL replaced three older chiller units with units operating with non-Class I and II refrigerants. These units supply facility air-conditioning and process cooling of NSTX. In 2004, fire protection systems that contain Halon 1211 or 1301 were the only remaining Class I ODS on-site.

In its efforts to track gases that contribute to global warming, 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. During TFTR operations, SF_6 maintained high-voltage electrical equipment - modulator regulators, ion cyclotron radio frequency (ICRF), and neutral beam (NB) high voltage and ion source enclosures. Following TFTR shutdown in 1997, no additional SF_6 was purchased. PPPL removed the remaining inventory of SF_6 from those systems, and currently SF_6 is used only in NSTX's high voltage regulators.

3.3.2 National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61, Subpart H- Emissions of Radionuclides)

PPPL has an in-stack sampler within the D-site stack to monitor tritium releases. The monitor has been independently verified as meeting NESHAPs radionuclide emission monitoring requirements. In August 1993, EPA concurred with this determination. Exhibit 3-8 presents the total air releases from the D-site stack that occurred from 1994 to 2004 and the associated activities.

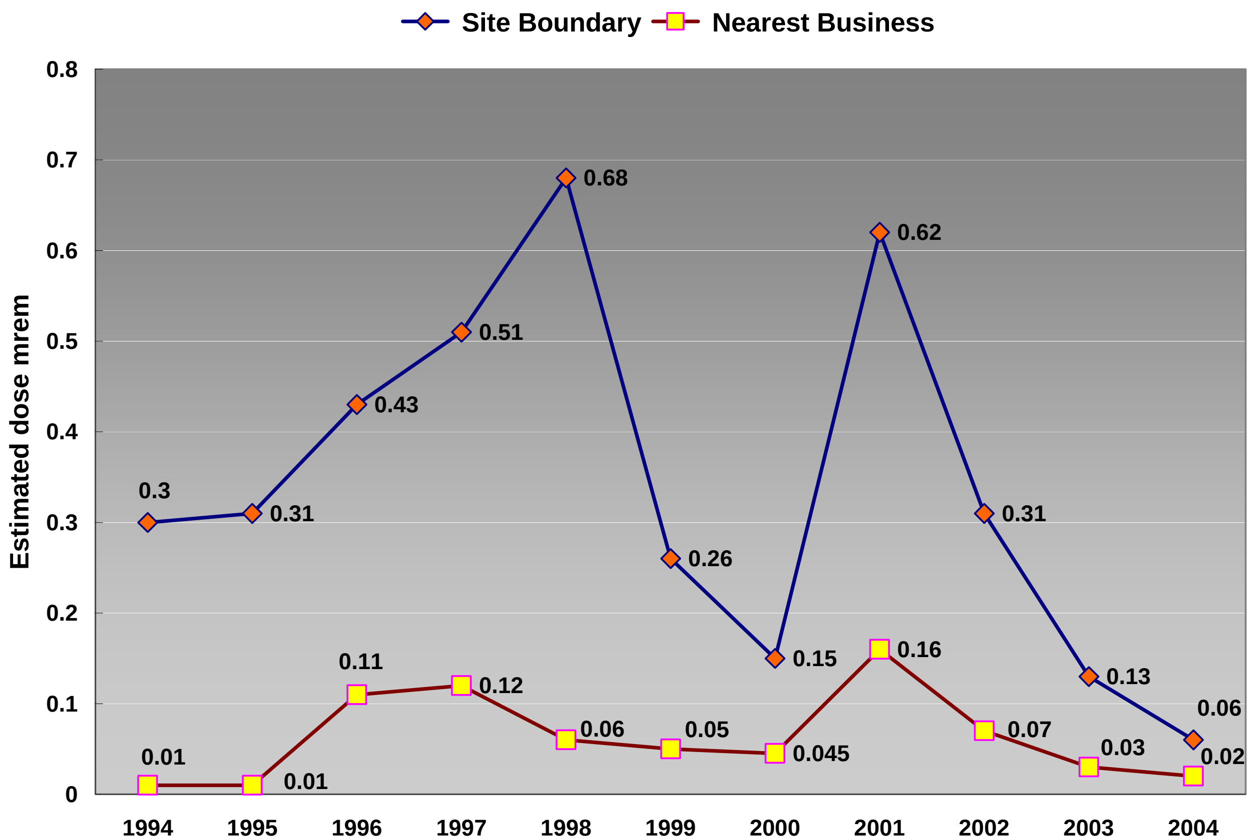
In 2004, the levels of tritium released during operations were: 21.117 curies of HTO and 1.259 curies of HT (Exhibit 3-8 and App. A, Table 3). This represents the lowest level of tritium releases in 11 years. This decrease in the levels of tritium released was largely due to the end of TFTR D&D operations. This decrease is also reflected in the Site and Boundary dose calculations (Exhibit 3-9).

Exhibit 3-8. Total Air Releases from D-Site (formerly TFTR) Stack from 1994 to 2004

Annual Limit is 500 Curie

Calendar Year	HTO (Curies)	HT (Curies)	Total Curies (HTO + HT)	Activities
1994	45.55	93.13	138.68	TFTR D-T Operations
1995	37.031	24.87	61.901	TFTR D-T Operations
1996	118.624	64.88	183.504	TFTR D-T Operations
1997	124.093	63.019	187.112	TFTR shutdown
1998	45.867	28.982	74.849	TFTR shutdown
1999	59.712	21.779	81.491	TFTR D&D preparation
2000	58.320	18.073	76.393	TFTR D&D activities
2001	221.242	38.742	259.984	TFTR D&D activities
2002	96.495	13.761	110.256	TFTR D&D activities
2003	34.329	1.789	36.118	NSTX Operations
2004	21.117	1.259	22.970	NSTX Operations

Exhibit 3-9. Estimated Dose (mrem) from PPPL Operations from 1994 to 2004



The Annual Limit of 10 mrem/year applies to the estimated dose equivalent at the site boundary only.

In 2004, the effective dose equivalent (EDE) to a person at the business nearest PPPL, due to radionuclide air emissions, was 0.020 mrem (0.20 μSv), which is significantly lower than the NESHAPs standard of 10 mrem/yr (Exhibit 3-9) [Lev05a]. During their most recent inspection of PPPL's facilities in March 1998, representatives from EPA Region II indicated that PPPL complied with NESHAPs requirements [Lev05c].

3.4 Water Quality and Protection

3.4.1 Clean Water Act (CWA)

PPPL complies with the requirements of the CWA. Based on an assessment of leaking underground storage tanks (USTs) that contained fuel oil, PPPL conducted quarterly ground water monitoring for petroleum hydrocarbons and VOCs until September 1997 (see Section 6.1.3). The data collected for 24 quarters (6 years) were consistent: trace or no petroleum hydrocarbons were detected and the former USTs were not contributing to ground water contamination.

Under the CWA and "New Jersey Discharge of Petroleum and Hazardous Substances" regulation (New Jersey Administrative Code Title 7, Chapter 1E), PPPL reported 3 releases during CY 2004, mineral oil in transformer yard, lawnmower hydraulic oil, and the employee vehicle motor oil, respectively [PPPL04 a, b, & d].

3.4.2 National Pollutant Discharge Elimination System (NPDES)

In 2004, 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 April 29, 1999, with an effective date of June 1, 1999 [NJDEP99]. In December 2003, the permit renewal application was submitted to NJDEP 180 days prior to its expiration date (June 1, 2004) [PPPL03]. PPPL is awaiting a new permit and continues to operate under the conditions of the expired permit.

In 2004, the monitoring locations designated in the permit are the detention basin outfall (DSN001) and the filter backwash discharge (DSN003) located at the Delaware & Raritan (D&R) Canal pump house. Similar to the period 2000 to 2001, all monthly/quarterly samples analyzed in 2004 for Discharge Monitoring Program of the NJPDES permit were within the permit limits, *i.e.*, no non-compliances. During the previous two years, 2002-2003, non-compliances occurred at DSN001 twice - chlorine produced oxidants (CPO) and four times - chemical oxygen demand (COD).

On March 4, 2004, the Stony Brook Regional Sewerage Authority (SBRSA), the publicly owned treatment works that receives PPPL's sanitary wastewater stream, notified PPPL that the discharge license was terminated [SBRSA04**]**. PPPL continues to maintain its inventory of wastewater streams (industrial discharges) and monitors the quantity and quality discharged. SBRSA's only requirement of PPPL is to report the total quarterly volume discharged from the D-site liquid effluent collection tanks (LEC).

3.4.3 Safe Drinking Water Act (SDWA)

The PPPL receives its drinking water from the New Jersey American Water Company (NJAWC), formerly Elizabethtown Water Company. While NJAWC provides and tests the drinking water, PPPL periodically tests incoming water quality (App. A, Table 14).

PPPL is able to switch from D & R Canal water (non-potable) to potable water for its non-contact water supply in the event of a a fire or other emergency situation or when D&R Canal water is unavailable**.**

Exhibit 3-10. NJPDES Non-Compliances 2000-2004

Outfall No.	Para-meter	# Non-compliance	# Samples	#Compliant Samples	% Compliant	Date(s) Exceeded	Description/Solution
DSN001	CPO	2	7	5	71	8/7/02	Automated chlorination equipment installed.
DSN001	COD	4	19	15	79	6/6/03 7/1/03 11/7/03	Basin cleaned & inspected; discharge closely monitored.
DSN001 2000-01 **2004**		**0**	81	81	**100**	None	pH, Temp., COD, CPO,TSS, TPHC monthly; Tot. P & PCE quarterly
DSN003 2000-**04**		**0**	44	44	**100**	None	pH, CPO,TPHC monthly; TSS (2) quarterly

On a quarterly basis, PPPL inspects and pressure tests the back flow prevention equipment at both locations: the main potable water connection where NJAWC water enters C site and the cross-connect system beneath the elevated water tower. 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 a NJAWC representative. These inspection reports are submitted to the NJDEP.

3.5 Other Environmental Statutes

3.5.1 Endangered Species Act (ESA)

PPPL occupies 88.5 acres of the Forrestal Campus of Princeton University. As documented in historical environmental assessments, no endangered species have been indicated on-site [ERDA75] [DOE92] [DOE93b] [Dy93].

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].

3.5.2. Migratory Bird Treaty Act

In 2004, PPPL took no migratory bird species nor conducted any programs or actions that call for such activities as banding, marking or scientific collection, taxidermy and/or depredation control.

3.5.3 National Historic Preservation Act (NHPA)

At PPPL, no identified archaeological resources, no buildings or structures have been identified as historical [Gr77]. Adjacent to the Delaware & Raritan (D&R) Canal, PPPL operates a pump house to withdraw water for cooling /process water and fire protection. The D&R Canal Historic District is listed on the National and State Register of Historic Places and includes 100 yards on either side of the Canal center line.

3.6 DOE Order 450.1 *Environmental Protection Program*

3.6.1 Pollution Prevention Activities

In 2004, PPPL continued to pursue waste minimization and pollution prevention opportunities through active recycling efforts and through the purchasing of recycled-content products. A refined "Dumpster Diving" survey method of PPPL's solid waste stream documented the amount of recycled versus waste materials.

Exhibit 3-11. Scale Digital Reading (in lbs)

Exhibit 3-12.Truck on Scale

In 2003, a digital read-out for the large truck scale was installed to measure the weight of municipal solid waste and the recycled materials in the MSW stream taken from PPPL.

3.6.2 Site Environmental Compliance and EMS Audits

In 2004, PPPL's Quality Assurance Division performed twenty audits of which five involved environmental topics: Hazardous Waste treatment (2), subcontractor analytical laboratories (2) and Radiological Waste (1) – waste acceptance criteria. Each audit is tracked through PPPL's internal QA Audit Database. EMS audits will be conducted upon adoption and full implementation of PPPL's EMS program in 2005 [Ya05].

3.6.3 Beneficial Landscaping

The area that PPPL modified adjacent to the detention basin in 2003, was maintained as tall meadow grass, which required infrequent mowing. Other areas were reviewed for beneficial landscape opportunities.

In 2004, PPPL planted a variety of "deer resistant" plants, which limited success. The local deer population lost the adjacent farmer's field located to the west of PPPL site to an office building complex in 2004. Therefore, PPPL's vegetation is under greater grazing pressure by deer and other local residents, groundhogs in particular.

3.6.4 Progress on DOE Secretarial Goals Including Ozone-Depleting Substances Reduction

Exhibit 3-13, "PPPL's Recycling Rates for FY 2004 and CY2004 by Month," shows the status of PPPL's achievement toward the FY2010 goal of 50% recycling rate for municipal sold waste (MSW).

Exhibit 3-13 PPPL's Recycling Rates for FY 2004 and CY 2004 by Month

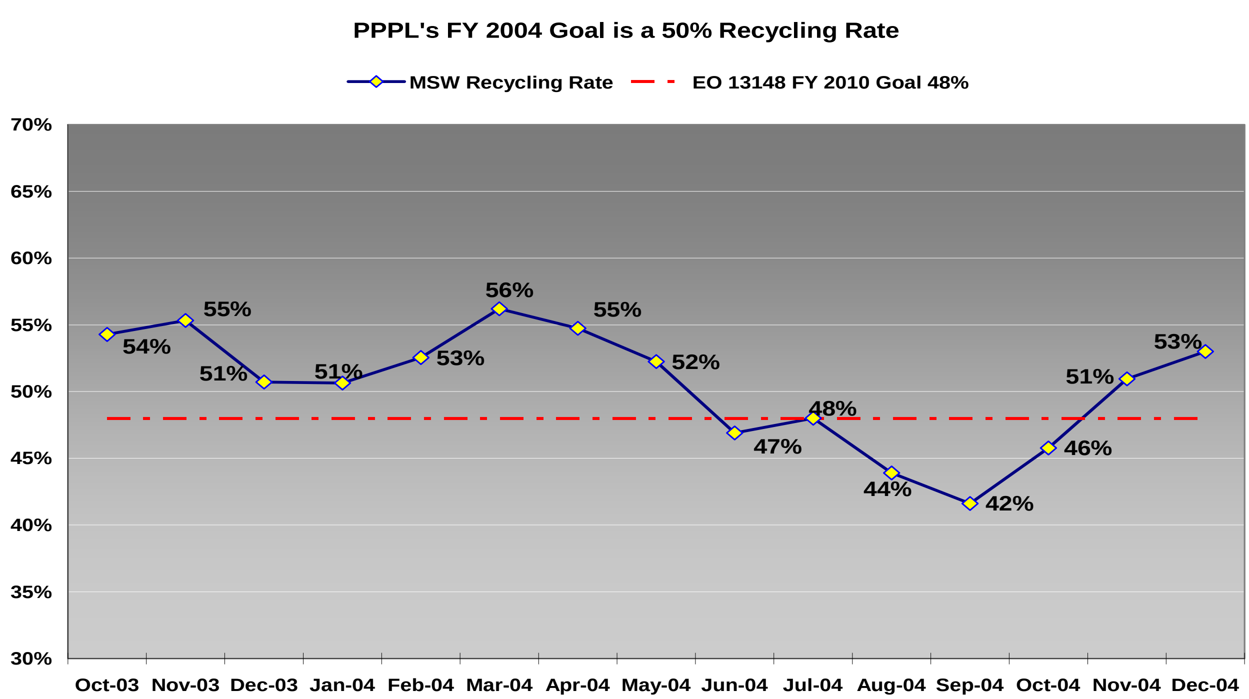


Exhibit 3-14. PPPL's Progress Toward Meeting Executive Order 13148 Pollution Prevention, Energy Efficiency, and Transportation Goals in Fiscal Year (FY) 2004

Pollution Prevention	Criteria	Baseline	FY 2005 Target	FY 2004 Data
Goal 1 metric tons(MT)	Hazardous Waste Generated (90% reduction of 1993 baseline)	29	2.9	11.71
cubic meters (m^3)	Mixed Waste Generated (80% reduction of 1993 baseline)	2	0.4	0
cubic meters (m^3)	Low Level Waste Generated (80% reduction of 1993 baseline)	22	4.4	0
cubic meters (m^3)	TRU/Mixed TRU Waste Generated (80% reduction of 1993 baseline)	0	0	0
Goal 2 Pounds	TRI Chemical Releases (90% reduction of 1993 baseline)	0	0	0
Goal 3 metric tons (MT)	Sanitary Waste Generated (75% reduction of 1993 baseline)	1,410	352.5	113.38
Goal 4 Percent (%)	Sanitary Waste Recycled (45% recycle versus disposal)	N/A	45% recycling rate in 2005	50.74%
Goal 5 Metric tons (MT)	Waste Reduced from Cleanup - Stabilization (C/S) Activities (% of total waste from C/S activities)	N/A	Reduce 10% per year FY 2001 to FY 2005	0
Goal 6 Percent (%)	Purchases of EPA-designated items with Recycled Content (100% by recycled costs versus non-recycled)	N/A	100%	88.3% Adjusted 100%
Goal 10	Class I Ozone Depleting Substances Uses	N/A	N/A	N/A
Energy Efficiency	**Criteria**	**Baseline**	**FY 2005 Target**	**FY 2004 Data**
Goal 7 BTUs/Ft^2	Unit Energy Consumption (30% of 1985 baseline for building)	249,007	174,305	179,900
Goal 8 Percent (%)	Request for bid packages for energy supply with clean energy provisions (% of requests with provisions versus those without)	N/A	100%	%
Percent (%)	Purchase of electricity from less greenhouse gas-intensive sources (% of electricity from less greenhouse gas sources to total consumption)	N/A		6%
Goal 9 Percent (%)	Replacement of chillers (% of total 150 ton or larger pre-1984 units with class I refrigerants replaced)	Five (5) units	100%	100%
Goal 11 US tons	Greenhouse gas emission from energy use (25% reduction of greenhouse gas emission reduced relative to 1990 baseline)	3,806	2,855	6,746
Transportation	**Criteria**	**Baseline**	**FY 2005 Target**	**FY 2004 Data**
Goal 12 gallons	Petroleum consumption by fleet vehicles (80% of petroleum fuel used in relation to FY00 baseline)	8,076	6,461	10,806
Goal 13 Percent (%)	New alternative fuel light truck purchase (%of new truck purchase with alternative fuel capability)	N/A	80%	100%
Goal 14 Percent (%)	Usage rate of alternative fuel vehicles (% use versus total availability)	N/A	75%	%

Overall during calendar year 2004, the recycling rate was above PPPL's 50% goal and the EO 13148's 48% goal. The summer months recycling rates appear lower, however, recycle rates improved in the 4^{th} quarter CY 2004 [Kin05a, McG05].

Hazardous waste and municipal solid waste reduction activities are discussed in Section 3.1.2 (see Exhibits 3-1 and 3.-2). Specifically, the activities that most affected the 2004 recycling rate were deconstruction of the C-site cooling tower and removal of scrap metals from the CS basement.

Exhibit 3-14, "PPPL's Progress in Meeting Executive Order 13148 Pollution Prevention, Energy Efficiency, and Transportation Goals in 2004," provides the status of PPPL's activities and accomplishments in pursing these fourteen goals. As of 2002, the remaining Class I CFCs were Halon 1211 and 1301 used in fire protection systems.

PPPL's progress toward achieving these goals had greater success in the pollution prevention category than in the energy efficiency category. This difference is mainly due to PPPL's ability to control its waste streams and its inability to control the number of degree days, *i.e.*, the cold or hot weather temperatures.

3.7 Executive Orders (EO)

3.7.1 Executive Order (EO) 13148, "Greening the Government through Leadership in Environmental Management"

On Earth Day, April 21, 2000, President Clinton signed this EO, which set goals for all government agencies to achieve reductions in toxic chemicals, hazardous, and ozone-depleting substances, environmental compliance, environmental management systems, and environmentally and economically beneficial landscaping. Each agency develops a written implementation plan, which is submitted to EPA and annual progress reports on the progress achieved to meet the goals by the set deadlines.

PPPL is in the process of integrating the Environmental Management System (EMS) as part of the Integrated Safety Management System (ISMS) program that was developed in 1999 [PPPL99a]. The EO13148 requires that the EMS be implemented by the end of 2005.

3.7.2 Executive Order (EO) 11988, "Floodplain Management"

In 2004, PPPL complied 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 mean sea level (msl), respectively [NJDEP84] (Exhibit 3-15).

The 88.5-acre parcel that PPPL occupies is included in Princeton Forrestal Center's (PFC) Storm Water Management Plan-Phase I [PFC80]. The 88.5-acre parcel is part of the Bee Brook watershed included in the PFC storm water plan.

One condition of the PFC Storm Water Management Plan is that the average density of development cannot exceed a maximum of 60% impervious coverage of developable areas. PPPL meets the $\leq$60% impervious coverage limit. The Site-Wide Storm water Management Plan was completed in February 1996, and PPPL is in compliance with this Plan [SE96].

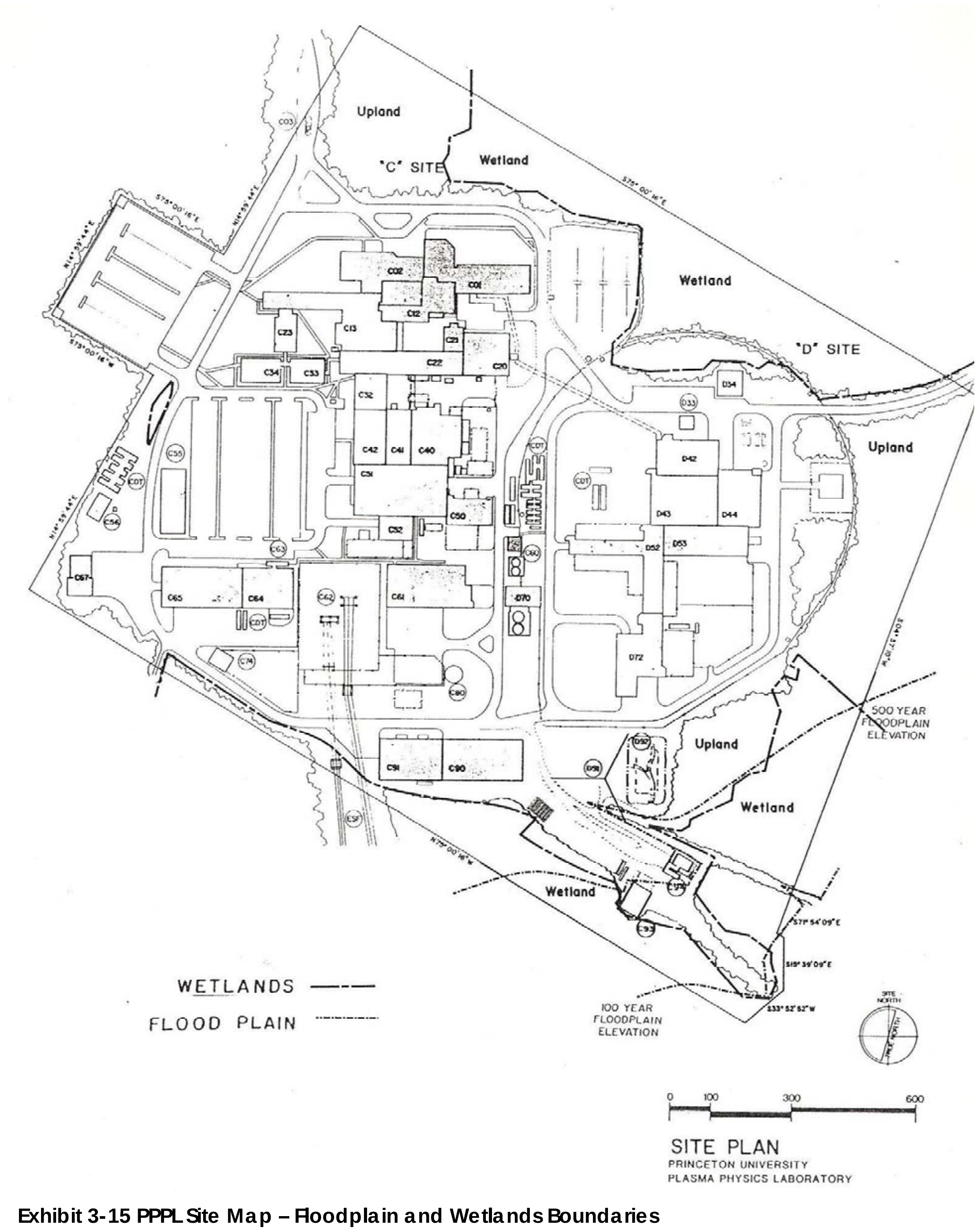


Exhibit 3-15 PPPL Site Map – Floodplain and Wetlands Boundaries

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 summary of activities already in practice at PPPL. The plan will be reviewed and updated triennially or as site changes warrant.

3.7.3 Executive Order (EO) 11990, "Protection of Wetlands"

In 2004, PPPL complied with EO 11990, "Protection of Wetlands." 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 have the right to re-evaluate and modify wetland boundary determinations at any time.

In 1994, PPPL received a "Letter of Interpretation" (LOI) from NJDEP for the wetland boundaries and wetlands classification. This LOI is needed before NJDEP issues wetlands permits for a site. It is valid for a five-year period with the option to renew for an additional five years. In 1999. PPPL submitted a renewal application to NJDEP and was granted the five-year extension, beginning in January 1999 and valid through January 2004 (Exhibit 3-15).

3.7.4 Executive Order (EO) 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 EO 12856 and SARA Title III, PPPL complied with the following:

PPPL submitted an annual chemical inventory in compliance with SARA Title III (EPCRA Section 312) in 2004. This inventory reports the quantities of chemicals listed in the CERCLA regulations (Exhibit 3-17). Under SARA Title III, PPPL provides the following to the emergency response agencies:

1. An inventory of hazardous substances stored on-site;
2. Material Safety Data Sheets (MSDS); and
3. SARA Tier I form.

PPPL completed the listing of each hazardous substance stored by users above a certain threshold planning quantity (typically 10,000 pounds, but lower for certain compounds). Exhibit 3-16 lists hazardous compounds at PPPL reported under SARA Title III for 2004 [PPPL 05a]. These chemicals are found in 40 CFR Part 372, Subpart D, which lists names and chemical abstract system numbers for toxic chemicals.

Of the twelve, seven chemicals are in their gaseous form and are therefore classified as sudden release of pressure hazards; five gaseous compounds are also classified as acute health hazards. There are five liquid chemicals; nitrogen is used in both gaseous and liquid forms, and one solid chemical, lead.

Exhibit 3-16. Summary of PPPL EPCRA Reporting Requirements

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

EHS – Extremely hazardous substances (No EHS are on-site at PPPL)
TRI – Toxic Release Inventory

Exhibit 3-17. Hazard Class of Chemicals at PPPL

Compound	Category
Bromochlorodifluoro-methane (Halon 1211)	Sudden release of pressure & Acute health effects
Bromotrifluoromethane (Halon 1301)	Sudden release of pressure & Acute health effects
Carbon dioxide	Sudden release of pressure & Reactive
Diesel Fuel Oil	Fire
Gasoline	Fire & Chronic Health Hazard
Helium	Sudden release of pressure
Lead	Chronic health effects
Nitrogen	Sudden release of pressure
Petroleum Oil	Fire
Propane	Sudden release of pressure
Sulfur Hexafluoride	Sudden release of pressure
Sulfuric acid	Acute Health Hazard & Reactive

Fuel oil, gasoline, petroleum oil, and propane are flammables; sulfuric acid is the liquid compound that is classified as acute health hazard and a reactive. to the environment.

Section 304 of SARA Title III requires that the Local Emergency Planning Committee (LEPC) and State Emergency Response Commission (SERC) be notified of accidental or unplanned releases of certain hazardous substances 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 [PPPL98b]. 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 [PPPL05a].

Because PPPL's use of chemicals listed on the Toxic Release Inventory (TRI) is below threshold amounts, PPPL is not required to submit the annual TRI. Following DOE's guidance, PPPL completed an annual submittal to DOE for 1997 that included the TRI cover page and laboratory exemption report. PPPL did not submit a TRI in 2004 (none required).

3.8 Other Major Issues and Actions

3.8.1 Air Quality

Through PPPL's Air Environmental Permitting Program, PPPL received a new permit from NJDEP for modifications to all four boilers to burn No. 2 fuel oil in addition to the existing permit provisions. The boilers are allowed to burn natural gas or No. 2 or

No. 4 fuel oil. No. 2 fuel oil is a lighter and cleaner burning petroleum distillate and its use instead of No. 4 will lower the amount of nitrogen oxides (NO_x) emitted. As required by the new permit, a Compliance Plan was implemented, and records are being kept to meet those requirements.

During the 2004 summer, AST-1 was emptied and the tank interior was cleaned (see Exhibit 3-18); its associated fuel lines and pumps were replaced to accommodate No. 2 fuel oil. The exterior of the AST was painted as well (Exhibit 3-19).

Exhibit 3-18 Cleaning AST-1 Looking West Toward Boiler Room

Exhibit 3-19 Painting AST-1

3.8.2 Surface Water Quality

Under NJPDES requirements, PPPL eliminated chlorine-produced oxidants (CPO) from its discharges (basin outfall designate serial number, DSN001, and D&R Canal pump house outfall (DSN003). CPO is created by the reaction of chlorine combining with organic material in the water. Chlorine is added to prevent bio-fouling in water pipes and cooling tower equipment. CPO is generally harmful to biota in the receiving streams.

Since 2002 when PPPL installed an automated chlorine controller and a new metering system in the D&R Canal water system and 2003 when a similar system was installed at the D-site cooling tower, the CPO limit has not been exceeded - post-operation of either of the chlorine metering systems. By reducing or limiting the amount of chlorine added to these systems, PPPL protects its water systems/equipment while also protecting the environment by reducing CPO in its surface water discharge.

In 2004, no elevated chemical oxygen demand (COD) concentrations (<50 mg/L monthly average) were reported at DSN001. The recurrence of the 2003 elevated COD concentrations was not found during CY 2004; COD was below 10 mg/L for six out of twelve months. COD concentrations were measured above 30 mg/L but below the 50 mg/L permit limit only twice, once in July and in September (Exhibit 3-2)].

In order to maintain good water quality in the basin and its outfall, PPPL conducted an annual basin clean up in April 2004.

Exhibit 3-20. 2004 Chemical Oxygen Demand & Total Organic Carbon at DSN001 & 003

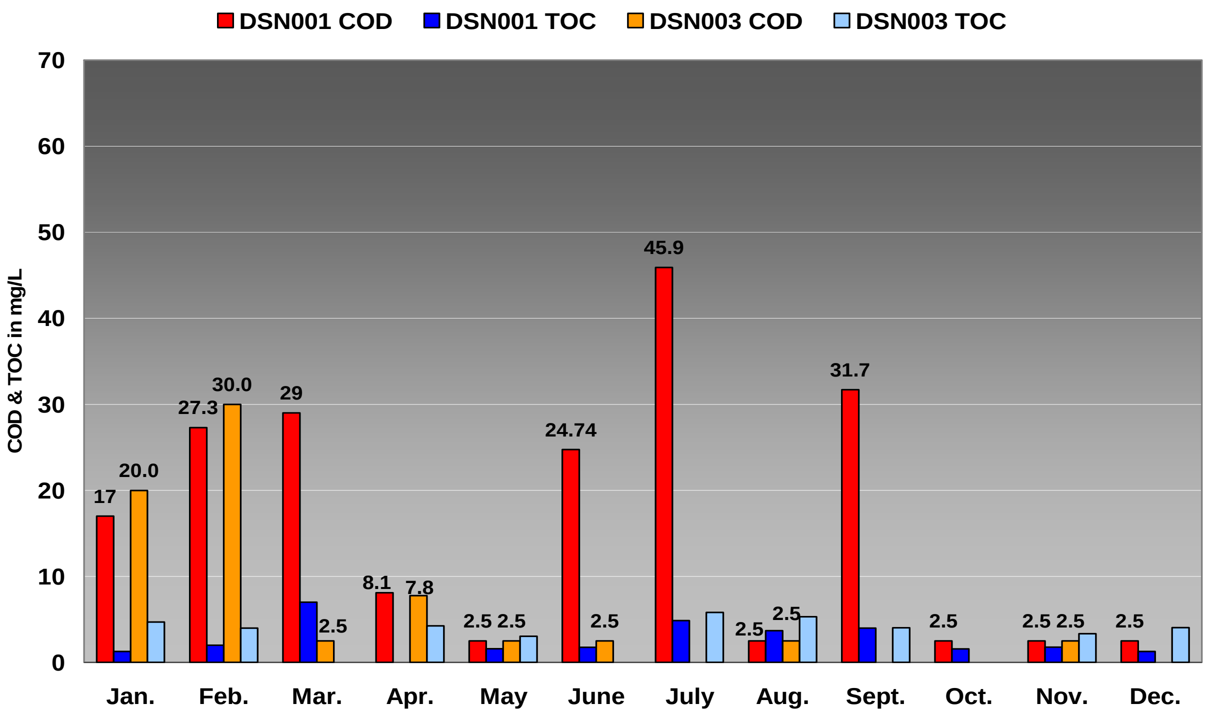
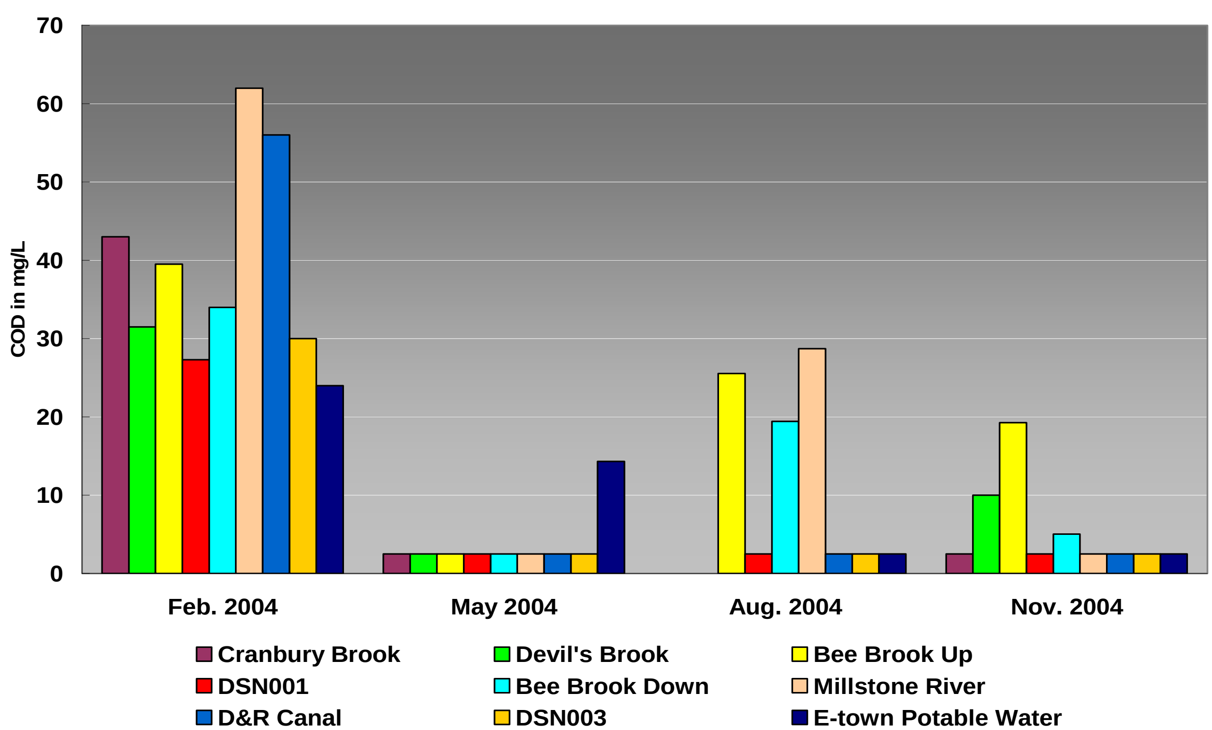


Exhibit 3-21 Chemical Oxygen Demand 2004



PPPL's continues to monitor the level of COD concentration at the discharges (DSN001 & 003) each month in addition to 7 off-site locations once each quarter (App. A Tables 11-17). The COD concentrations at the off-site locations (Feb., May, Aug., & Nov.) were usually the same as or higher than either DSN001 or DSN003 COD levels (Exhibit 3-21).

3.8.3 Ground Water Quality

Under New Jersey's State program for NJPDES ground water discharges, PPPL's permit (NJ0086029) in May 2001, NJDEP issued the revised ground water discharge permit. The requirement to monitor groundwater from seven monitoring wells and two basin inflows was eliminated.

Beginning in 1993, PPPL and DOE-PSO have been monitoring ground water under a Memorandum of Understanding (MOU) signed by NJDEP and Princeton University. Princeton University agreed to investigate A- and B-sites while PPPL and DOE-PSO were to investigate C-and D-sites of the James Forrestal Research Campus. A summary of major project milestones is presented below:

1993 Prepared specifications for Remedial Investigation and Remedial Alternative Assessment project (RI/RAA).

1994 Harding Lawson Associates (HLA) began RI/RAA. Sampled existing wells, sumps, and soil borings. Soil beneath the Facilities Building and adjacent to C Site Cooling Tower removed.

1995 HLA conducted ground water sampling; prepared RI/RAA report.; completed UST closure activities.

1996 RI/RAA report submitted. Installed four new monitoring wells south of the CAS/RESA Building to delineate extent of contamination.

1997 New area of potential environmental concern (APEC) near the former PPPL Annex Building identified by sampling ground water from eight new wells and soil borings. Report submitted.

1998 Phase 3 RI report submitted to NJDEP in September 1998 [HLA98].

1999 Phase 4 RI and Remedial Action Selection reports submitted in October. Ground water monitoring continued.

2000 Remedial Action Work Plan submitted to NJDEP in May, quarterly ground water monitoring continued [Sh00, Sh01].

2001 Remedial Action Monitoring Report submitted; quarterly monitoring continued [Sh01 & Sh03].

2002 Remedial Action Monitoring Report submitted; quarterly monitoring continued [Sh01 & Sh03].

2003 Remedial Action Monitoring continued; quarterly March and June 2003; first annual monitoring performed in October 2003. Fourteen monitoring wells permanently removed [Sh04].

2004 Continued to annually monitor (in September 2004) the wells and sumps and report results to NJDEP[Sh05].

3.8.4 4th Annual America Recyles Day Celebration

In December, PPPL presented "Green Machine" awards to 10 custodial employees for their outstanding contributions to PPPL's pollution prevention activities. The awards were based on their efforts to help PPPL achieve its recycling goal of 50% or greater of waste that went into the recycling bins and not into the trash or municipal solid waste stream. PPPL calculates the amount using the waste hauls pick-up tickets that show the weight of the trash or recycled material being removed from PPPL (see Section 3.6.1, Exhibits 3-11 & 3-12).

3.8.5 Facility Improvements

In 2004, the C-site cooling tower was demolished and removed; it had been used for cooling the experiment and other office buildings. The demand for cooling water declined over time, and C-site cooling tower deemed expendable.

Removal of the tower required removal of the corrugated transite panels and baffles prior to demolition and removal of the framing. This work was performed by sub-contractors trained and qualified to remove asbestos. Following asbestos abatement, a demolition contractor completed the tower demolition (Exhibits 3-22, 3-23 & 3-24).

Exhibit 3-22.
Workers Preparing Asbestos-Work Site

Exhibit 3-23
Worker Using Bucket with Safety Equipment for Cooling Tower Demolition Project

Exhibit 3-24 C-site Cooling Tower Removed

3.8.6 Safety

PPPL's 2004 performance with respect to worker safety were as follows [Lev05b]:

2004

Total recordable case rate: 1.705 per 200,000 hours worked
Days away, restricted or transferred (DART) case rate: 1.06 per 200,000 hours worked
DART day rate: 62.6 per 200,000 hours worked
Number of radioactive contaminations (external): 0

Number of Safety Occurrence reports: 0
(OSHA confined space, chemical exposure and lock out/tag out incidents)

3.9 Continous Release Reporting

In 2004, PPPL had no continuous releases to report.

3.10 Unplanned Releases

During CY2004, three unplanned releases of hazardous or petroleum substances occurred. In March, AC Power Division's tanker containing transformer oil released 5 gallons in the neutral beam yard. A line ruptured and spilled onto gravel. In April, PPPL's landscape subcontractor released hydraulic oil from a lawnmower onto gravel. In August, an employee's vehicle spilled engine oil on the stoned divider in the parking lot. All releases were minor (>5 gals. total) resulting in cleanup of oily soil and/or gravel.

3.11 Current Issues and Actions

3.11.1 Environmental Management Systems

The benefits of comprehensive Environmental Management Systems (EMS) and the associated International Standard Organization (ISO) 14001 standard, are being reviewed. PPPL is evaluating the EO 13148 – "Greening the Government through Leadership in Environmental Management," – and developing an action plan to implement an EMS under the requirement of its DOE contract. Many of the elements of an EMS are presently instituted in plans, policies, and procedures at PPPL, however, integration into PPPL's ISM and recognition of the EMS approach and laboratory management procedures and policies are being revisited to fully comply with EO13148.

3.12 Summary of Environmental Permits

The following table (Exhibit 3-25) presents the different regulatory requirements/permits with which PPPL must comply. It is not solely a list of environmental permits, but rather a list that specifies the citation for environmental regulations, PPPL's requirement or permit, and where data reports may be found. A discussion of environmental permits required by the applicable statutes is found in Sections 5.0 and 6.0, "Environmental Radiological and Non-Radiological Program Information."

Exhibit 3-25. PPPL Environmental Requirements

Media	Regulatory Citation	Requirement/Permit	Data Reported
Air	40 CFR 61 – National Emission Standards for Hazardous Air Pollutants (NESHAPs)	Monitor D site stack for tritium	Reported in the annual Site Environmental Report (ASER)
	40 CFR 82 – Protection of Stratospheric Ozone	Training & certification; Chillers, HVAC, fire suppression systems, cylinders	Ozone Depleting Substances (ODS) Inventory
	NJAC 7:27- – Air Pollution Control –Subchapter 8 Permits and Certificates	4 Boiler stacks; 2 Storage tank vents; 3 Dust collectors; 2 Diesel generators.	Fuel use reported in ASER; Generator hours recorded in logbook
Asbestos	29 CFR 1910.1001, 1910.1200 – OSHA General Industry Standard	Identify locations prior to removal (roofing, tiles, walls, pipes, insulation, etc.)	Reporting to EPA prior to removal; Track generated quantities
EPCRA	40 CFR 370 – Hazardous Chemical Reporting: Community Right-to-Know	SARA Title III listed substances above threshold amounts	Section 312 annual report to EPA in March; Also reported in ASER
Laboratory Certification	NJAC 7:18 - Regulations Governing Laboratory Certification and Environmental Measurements	Princeton Environmental, Analytical, and Radiological Laboratory (PEARL) – tritium, COD, and analyze immed. parameters	Annual application; semi-annual performance testing; results reported in ASER
Land Use - Wetlands	NJAC 7:7A – Freshwater Wetlands Protection Act Rules	Delineated wetlands; 26-kV tower maintenance, well installations	Status reported in quarterly updates; Also, reported in ASER
Meteorology	DOE Order 430.1A - Life Cycle Asset Management	Meteorological tower – 3 levels (10, 30, and 60 meters) Rain gauge	Data are no longer required Precipitation reported in ASER
Safe Drinking Water	40 CFR 141.16 –National Primary Drinking Water Regulations	Best Management Practices - Tritium analyzed in ground, surface, & rain water	20,000 pCi/L or 4 mrem/year annual dose. Reported in ASER
Soil	NJAC 7:1E – Discharge of Petroleum and Other Hazardous Substances	Reporting discharge of petroleum or hazardous substances on soil/ unpaved areas/ water	30-Day confirmation report to NJDEP; Also reported in ASER
	Standards for Soil Erosion and Sediment Control Act Chapter 251	Projects which create soil disturbance greater than 5,000 sq. feet	Quarterly status reported in updates
SPCC	NJAC 7:1E – Discharge of Petroleum and Other Hazardous Substances 40 CFR 110 – Discharge of Oil 40 CFR 112 – Oil Pollution Prevention	PPPL designated minor facility – no DPCC or DCR required; Spill Prevention, Control, and Countermeasure Plan (SPCC) required	SPCC Plan required; Inspections, records, procedures
TSCA	40 CFR 761- Polychlorinated Biphenyls (PCBs)	Label, inspect, records of polychlorinated biphenyls (PCBs) in capacitors	Inventory; Disposal records; Also reported in ASER

Exhibit 3-25. Environmental Requirements (cont.)

Media	Regulatory Citation	Requirement/Permit	Data Reported
Waste - Hazardous	40 CFR 260 –279 – Resource Conservation and Recovery Act (RCRA) NJAC 7:26-8 – Hazardous Waste Regulations	On-site 90 –day temporary storage; EPA ID # NJ1960011152 Manifest records	Biennial report to NJDEP
Waste - Medical	NJAC 7:26-3A Regulated Medical Waste	Disposal of medical wastes generated from dispensary	Annual report to NJDEP
Waste - Sanitary	NJAC 7:28 – Bureau of Radiation Protection	Liquid effluent collection (LEC) tanks sampled for: Tritium Gross beta	Tritium concentrations not to exceed 1 Curie per year
	DOE Order 5400.5 – Radiation Protection of the Public and the Environment	LEC tank - Tritium Gross beta	2 million picoCuries/Liter per discharge limit
	Stony Brook Regional Sewerage Authority Industrial Discharge License (22-96-NC)	LEC tank sampled for: Tritium & Gross beta pH, temperature, Chemical oxygen demand (COD) Quantity released	Monthly Discharge Report – Self Reporting Form to SBRSA Also, reported in ASER
Waste - Solid	NJAC 7:26 – Solid Waste	Registered Solid waste hauler; recycling separation of materials	Recycle report for paper, cardboard, glass/aluminum, plastics, scrap metals, batteries, office waste, *etc*.; Also reported in ASER
Water - Ground	NJAC 7:14A – The New Jersey Pollutant Discharge Elimination System (NJPDES)	Integrity testing of the liner once every 3 years.	Last inspection/test in 2003
	NJAC 7:19 – Water Supply Allocation Rules	Two former production wells (Wells 4 & 5) quantities pumped not to exceed 100,000 GPD	Annual report to NJDEP
	NJAC 7:26E – Technical Requirements for Site Remediation	Investigation –annually ground water monitoring, 12 wells, 2 sumps, and one surface water location	Remedial Investigation reports to NJDEP; Also , reported in ASER
Water - Potable	NJAC 7:10 – Safe Drinking Water Act	Quarterly inspection of back-flow preventors; annual internal inspection	Annual report to NJDEP & water purveyor
Water – Storm	NJAC 7:13 – Flood Hazard Area Control	Basin inspection & maintenance	Records
Water - Surface	NJAC 7:14A – The New Jersey Pollutant Discharge Elimination System (NJPDES)	Monthly surface water samples at two locations – DSN 001 and 003; annual chronic toxicity test @ DSN 001	Monthly discharge monitoring reports to NJDEP; annual chronic toxicity test report to NJDEP; Also, reported in ASER

Chapter 4

ENVIRONMENTAL PROGRAM INFORMATION

4.1 Environmental Management System (EMS) and Environmental Protection Programs (EPP) at PPPL

4.1.1 EMS

In the EO 13148, "Greening of the Government through Leadership in Environmental Management," a requirement to prepare and implement an EMS program was placed upon all Federal Agencies, including Department of Energy (DOE) Laboratories and other facilities.

In 2004, members of PPPL's Environmental Review Committee (ERC), DOE-Princeton Site Office (DOE-PSO), and other Divisions within PPPL that formed the EMS subcommittee, prepared an EMS manual. The Manual presented how the EMS Program was to be implemented through existing program documents, policies, and procedures, and identified those areas where actions were needed. An EMS presentation to PPPL's Environment, Safety and Health Executive Board informed these management members of the need for their support, both in employees' time and budget.

PPPL's EMS Program is a part of the Site Integrated Safety Management System (ISMS). In 2000, ISMS was implemented as required by DOE Safety Management System Policy -450.4.

4.1.2 EPP

DOE Order 450.1, "Environmental Protection Program," was approved on January 15, 2003. As this Order requires the protection of air, water, land, and other natural and cultural resources that may be impacted by DOE and PPPL operations, the ERC subcommittee was similarly tasked with the action to spearhead the Laboratory's adoption of the Order's requirements. These requirements are to be implemented within 12 months of the inclusion of the Contractor Requirement Document (CRD) into the facility goals and contract, which occurred in May 2003.

Formalized programs are to be developed in order to fulfill CRD goals: environmentally and economically beneficial landscaping; supply specifications and acquisitions and operational assessments for pollution prevention projects; and ozone-depleting substance management. The integration of EMS into ISMS as well as revisions to implementing documents is under review.

Progress toward the CRD goals are discussed in Sections 3.3.1, Clean Air Act (CAA), 3.6.3, Beneficial Landscaping, and 3.6.4, Progress on DOE Secretarial Goals Including Ozone-Depleting Substances Reduction.

Since the Clean Water Action Plan of January 1998, PPPL has actively pursued ways to improve water quality. There are two surface water discharges permitted under the New Jersey Pollutant Discharge Elimination System (NJPDES) regulations with monthly monitoring occurring at both outfalls since 1992. Improvements include the following actions taken by PPPL: for the detention basin- real-time flow meter data, annual maintenance and triennial liner inspections, new aeration/bubbler equipment, new oil boom and planned upgraded oil-detection instrumentation (Exhibit 4-1).

PPPL installed two new chlorine metering systems, one at the Delaware & Raritan Canal pump house and one at the D-site cooling tower that lowered the amount of chlorine used. To improve stormwater quality, site-wide grounds clean-ups and landscaping of disturbed areas reduce or eliminate runoff. For water conservation, PPPL has replaced old water lines.

Annually, PPPL representatives meet with local officials to provide the current status of projects at the Laboratory; both experimental related and environmental topics are discussed.

Exhibit 4-1. New Bubbler in Basin.

Exhibit 4-2. Radiological Air Monitoring Stations

Station Name	Number/Description	Exhibit #
Remote Environmental Air Monitoring (REAM)-off site	Stations *R 1- 6*: Tritium	4-4
Radiological monitoring system (RMS) on D site	Passive tritium monitors at *T 1-4*:	4-3

Exhibit 4-3. Radiological and Non-Radiological Water Monitoring Stations

Station #	Location/Exhibit #	Description
B1	Off-site / 4-3	Bee Brook Upstream of discharge from detention basin
B2	Off-site / 4-3	Bee Brook Downstream of discharge from detention basin
C1	Off-site / 4-4	Delaware & Raritan Canal (Plainsboro)
DSN001	On-site / 4-3	Surface Water Discharge from the detention basin
DSN003	Off-site / 4-4	Delaware & Raritan Canal pump house outfall
E1	On-site / 4-3	Elizabethtown Water Company - potable water supply
M1	Off-site / 4-4	Millstone River - Plainsboro & West Windsor boundary- Route 1
P1	Off-site / 4-4	Plainsboro Surface Water - Millstone River
P2	Off-site / 4-4	Plainsboro Surface Water - Devils Brook
D-MG & TFTR	On-site /4-3	Basement sumps that drain ground water to detention basin
D-11R & D-12	On-site /4-3	Ground water monitoring wells next to detention basin
TW-1,2,3,& 10	On-site /4-3	Ground water monitoring wells north of NSTX
LECT 1,2,or 3	On-site /4-3	Liquid effluent collection tanks north of NSTX
R Series R1S to R2N	On-site /4-3	8-Rain water monitoring locations for North, South, East, & West @ 250 & 500 ft. from stack
Rainwater R1-R6	Off-site /4-3	Rain water monitoring locations (5 co-located with air DATS)

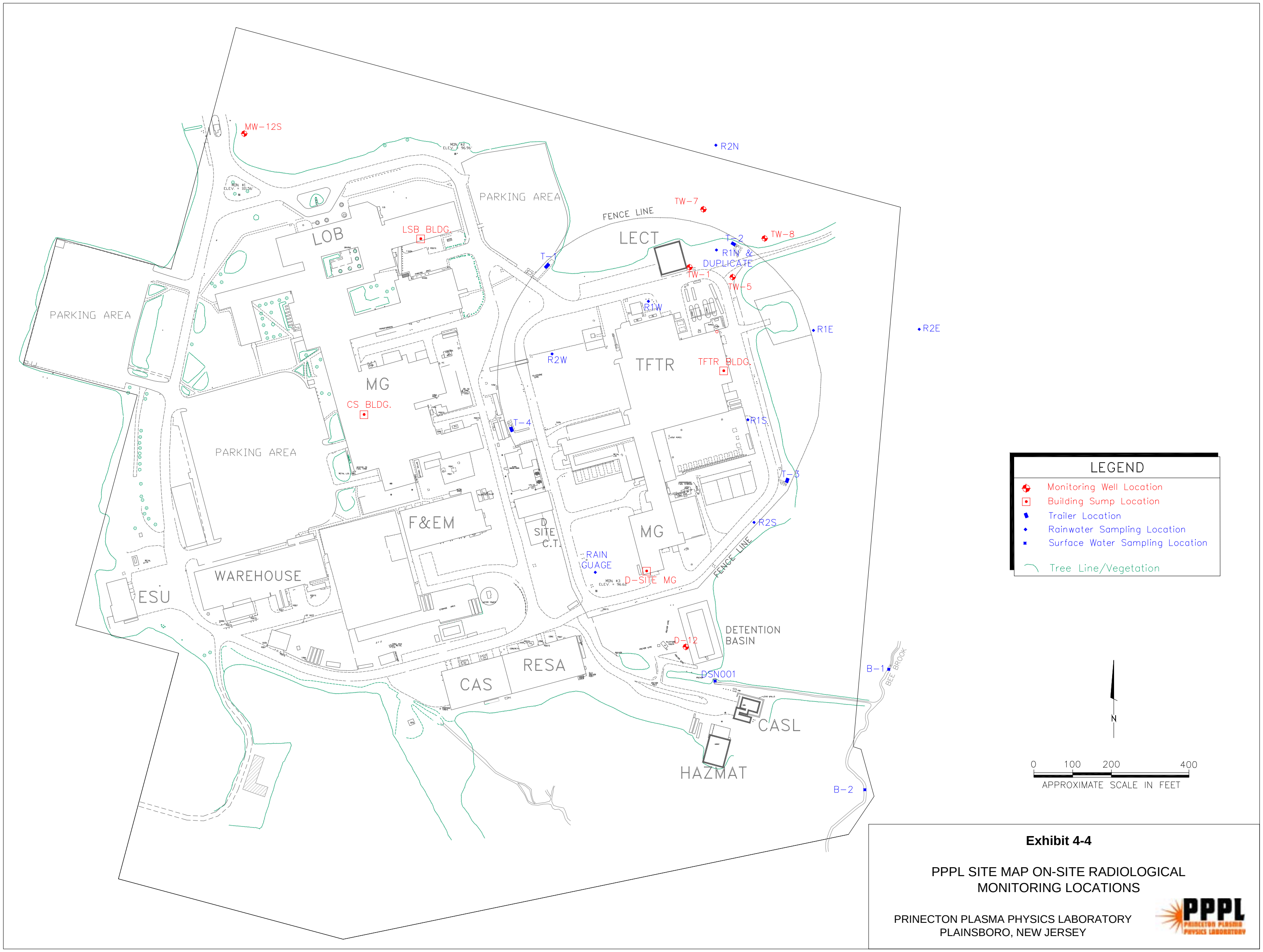
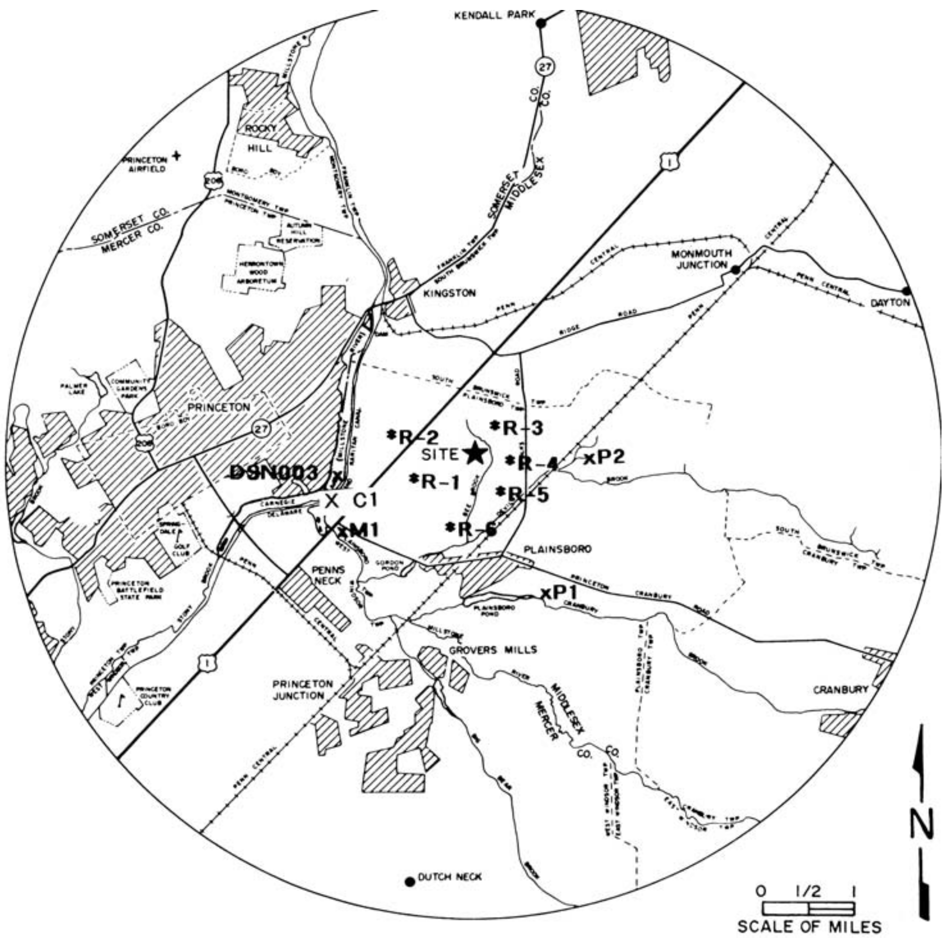


Exhibit 4-4. PPPL Site Map On-site Radiological Monitoring Locations

Exhibit 4-5. Off-site Monitoring Locations



4.2 Summary of Radiological Monitoring Programs

The monitoring for sources of potential radiological exposures is extensive. In 1981, real-time prompt gamma and/or neutron environmental monitoring on D-site began to establish baselines prior to TFTR operations. Exhibit 4-2 lists the air stations that were monitored for radiological parameters in 2004.

Surface, ground, rain, and process water samples are collected at the same locations for both non-radiological and radiological (HTO) analysis (Exhibits 4-3, 4-4, and 4-5)

PPPL is situated in the metropolitan corridor between New York City to the northeast and Philadelphia to the southwest. Census data indicate that approximately 18 million people live within 50 miles radius (80 km) of the site and approximately 253,000 within 10 miles (16 km) of PPPL based on the 2000 population census [US00].

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 0.02 mrem (0.2 μSv) for 2004 (see Exhibits 5-1 & 5-2)[Lev05a]. Detailed person-radioactive equivalent man (rem) calculations for the surrounding population was not performed, because the value would be insignificant in comparison to the approximately 100 mrem (1.0 mSv) that each individual receives from natural background, excluding radon, in New Jersey.

4.3 Summary of Non-Radiological Monitoring Program

During 2004, PPPL operated under New Jersey Pollutant Discharge Elimination System (NJPDES) surface water permit, number NJ0023922, expiring on June 4, 2004. PPPL continued monthly monitoring of the detention basin, discharge as stated in the permit conditions. Monthly DSN001 data exists dating back to 1984.

Monthly water quality monitoring at DSN001:

- Temperature, pH
- Petroleum hydrocarbon (TPHC)
- Total suspended solids (TSS)
- Chemical oxygen demand (COD)
- Chlorine-produced oxidants (CPO)
- Flow

Quarterly: Total phosphate (Tot. P)
Tetrachloroethylene (PCE)

Annual: Chronic Toxicity Testing

Monthly sampling for TPHC, pH, and CPO continued at DSN003— a filter backwash discharge located at the Delaware and Raritan Canal pump house. Quarterly monitoring included total suspended solids (TSS) at the discharge and intake (D&R Canal water designated as C1) without a limit for TSS (Exhibit 4-5).

As a requirement of the surface water permit, a chronic toxicity characterization study was conducted test the DSN001 effluent with the fathead minnow (*Pimephales promelas*) as the test organism. The annual study results were submitted for the June 2004 tests [PPPL04]. PPPL's discharge water and the control tests were the same – no mortality to the test specimens.

Ground water monitoring conducted under the Environmental Restoration program is discussed in Chapters 6.0 and 7.0.

4.4 Environmental Requirements

Environmental requirements, for which DOE and PPPL are held accountable, are listed in Exhibit 3-25 and are discussed in Chapters 3.0, "Environmental Compliance Summary" and 6.0, "Environmental Non-Radiological Program Information," of this report.

4.5 Environmental Impact Statements and Environmental Assessments

No Environmental Impact Statements or Environmental Assessments were prepared in 2004.

4.6 Summary of Significant Environmental Activities at PPPL

4.6.1 Regulatory Inspections/Audits

In July 2004, a NJDEP Enforcement Inspector conducted the annual inspection of the Discharge to Surface Water Permit (NJPDES NJ0023922) [NJDEP04]. After reviewing the records and visually inspecting the two permitted outfalls, the result was an acceptable rating based on compliance with the permit conditions and no permit limits were exceeded during 2004.

4.6.2 Basin Management

As a condition of the NJPDES Ground Water Discharge Permit (DGW), PPPL prepared an Operations and Maintenance (O&M) Manual for the detention basin. The basin collects flow from C-site (Boilers 2 and 3 blowdown, D-site cooling tower blow-down, non-contact cooling water, ground water from basement sumps, and stormwater) and D-site (ground water from basement sumps and stormwater).

At the outfall of the basin, an ultrasonic transducer measures the water level above a weir, and the flow rate is monitored and logged into a recorder. A slide gate controls the level of water in the basin under normal conditions and cranks to an open/closed position.

PPPL cleaned the basin in April 2004. Following the basin cleaning, a new oil boom was installed; it had not been replaced since its installation in late 1994 (Exhibit 4-6). The boom was placed so that the sump drain (white drum with PVC pipes on the top) discharged its water on the upstream side of the boom. Should oil contaminate the ground water under the basin liner, the oil would be contained by the boom (Exhibit 4-7). A new bubbler was installed (Exhibit 4-8).

Exhibit 4-6. Old Oil Boom

4.6.3 Tritium in the Environment

Since TFTR deuterium-tritium (D-T) experiments began in 1994, PPPL monitored tritium in continuous air samples from the test cell stack (vent). Five monitoring wells and two ground-water sumps, ten on-site and six off-site rainwater-monitoring stations and surface water at one on-site and one off-site station were sampled monthly from 1995 through 2004 (Exhibit 4-9) [Lev05c].

Exhibit 4-7. New Oil Boom (note sump is discharging)

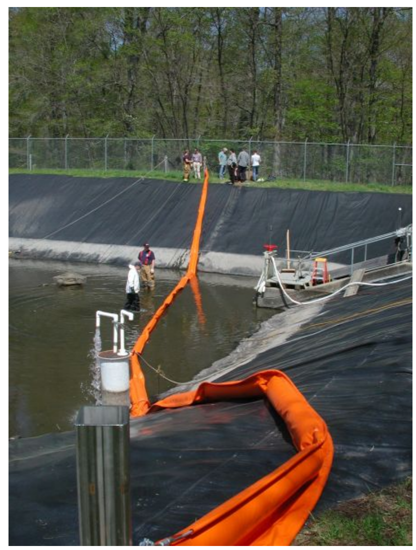


Exhibit 4-8. Bubbler showing ripples on surface

Exhibit 4-9. 2004 Highest Tritium Concentrations in Environmental Samples

(see App. A Tables 3 to 8)

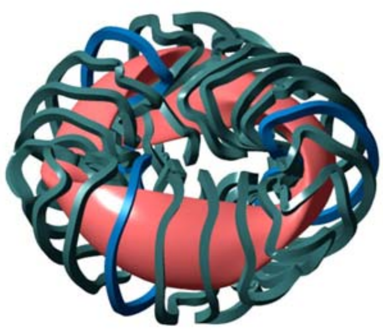
Media	Location	Highest HTO	Stack Data (Date)
Air	T2(NE D-site)	5.92 pCi/m^3	
	R1 (WSW of PPPL)	2.64 pCi/m^3	
	D-site Stack	7.842Ci	7.842HTO (Mar. 24)
Well	TW-18	502 pCi/L	7.842 Ci HTO(Mar. 24)
Rain water	R1E	427pCi/L	0.553 Ci HTO (June 1)
	REAM 5	261pCi/L	0.349 Ci HTO (Apr. 14)

Ci = Curie pCi/L = picoCuries per Liter HTO = tritiated water

4.6.4 TFTR Test Cell Renamed Coil Winding Facility for Fabrication of NCSX Magnetic Coils

With the completion of the three-year project to dismantle and remove the Tokamak Fusion Test Reactor (TFTR), the test cell on D-site was a large empty room with the exception of Neutral Beam boxes (to be used in the future). In 2004, the Test Cell was ready for its next assignment as the Coil Winding Facility for the National Compact Stellarator Experiment (NCSX) (Exhibit 4-10).

Exhibit 4-10. NCSX Plasma and Magnetic Coil Configuration



The fabrication of NCSX's modular coils is among the most complex. Eighteen winding non-magnetic stainless steel casting with surfaces machined to a tolerance of ±0.020 inch will be used to cast the magnets; the largest being 110 inches tall and each weighing approximately 6,000 pounds. Coil fabrication will begin in 2005.

4.6.5 PPPL Partners with Oak Ridge National Laboratory to Host US ITER

In July 2004, the Department of Energy announced that PPPL, in partnership with Oak Ridge National Laboratory (ORNL), were selected to host the U.S. project team office for the International Thermonuclear Experimental Reactor (ITER). ITER is the major, multi-national, fusion experiment being funded by the European Union, Japan, China, Russia, South Korea, and the United States. The U.S. ITER Project Office at PPPL will be responsible for project management of U.S. activities to support the construction of this research facility and to provide technical assistance, hardware, personnel and expertise, for the U.S. fusion community.

4.6.6 PPPL Open House 2004

In June 2004, PPPL hosted an Open House. About 2,000 visitors attended this event, which highlighted NSTX. A special guest, Doreen Spitzer, the wife of the late Lyman Spitzer, founder of PPPL, was able to attend with her family (pictured in Exhibit 4-11).

Exhibit 4-11. NSTX Program Director M. Peng with Doreen Spitzer and family (standing in front of NCSX full-scale drawing).

Events featured activities ranging from cryogenics shows that demonstrated how oddly ordinary objects behave when super-cooled to the temperature of liquid nitrogen to tours of the Hall Thruster, a plasma-based propulsion system for satellites. Self-guided tours of experimental areas were aided by staff that provided information and answered questions. From the comments received from the public, they expressed their enjoyment of the program and the staff whom they found enthusiastic and friendly, as well as knowledgeable.

For more information, PPPL's "Hotline" articles are located on the laboratory's web site at: http://www.pppl.gov/

Chapter

5

ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

5.1 Radiological Emissions and Doses

For 2004, the releases of tritium in air and water and the total effective dose equivalent (EDE) contribution at the site boundary and for the population within 80 kilometers of PPPL are summarized in Exhibit 5-1 below. The calculated EDEs at the site boundary are six-hundredths of one mrem for 2004, far below the annual limit of 10 mrem per year [Lev05a].

Exhibit 5-1. Summary of 2004 Emissions and Doses from D Site Operations

Radionuclide & Pathway	Source	Source Term Curies (Bq)	EDE in mrem/yr (mSv/yr) at Site Boundary	Percent of Total	Collective EDE w/in 80 km in person-rem (person-Sv)
Tritium (air)	D-site stack	HTO 21.711 (8.03×10^{11}) HT 1.259 (4.66×10^{10})	0.0565 (5.65×10^{-4})	97.66	0.463994 (4.64×10^{-3})
Tritium (water)	LEC tank	0.0408 (HTO) (1.51×10^{9})	0.000816 (8.16×10^{-6})	1.41	0.001118 (1.12×10^{-5})
Tritium (water)	Surface Ground	353 pCi/L (basin outfall) 502 pCi/L (Test Well (TW) 1)	0.000480 (4.80×10^{-6})	0.83	0.000658 (6.58×10^{-6})
Direct/Scattered neutron & Gamma Radiation	NSTX	4.1 X10^{16} DD neutrons + 8.2 X10^{14} DT neutrons	0.0000477 (4.77×10^{-7})	0.08	Negligible
Argon-41 (Air)	NSTX	0.000972 (3.60×10^{7})	0.0000117 (1.17×10^{-7})	0.02	0.000022 (2.20×10^{-7})
Total			0.0578554 (5.79×10^{-4})		0.465792 (4.66×10^{-3})

Bq = Bequerel
mSv = milli Sievert
EDE = effective dose equivalent
HT = elemental tritium
HTO = tritium oxide
LEC = liquid effluent collection tanks
mrem = milli radiation equivalent man
RWHF = Radioactive Waste Handling Facility-Compactor & vial crusher

Estimated dose equivalent at the nearest business is **0.0158 mrem (1.58x 10^{-4} mSv)** due to tritium air emissions from the D-site stack, Ar-41 air emissions from the NSTX Test Cell (from neutron activation of air from NSTX operations), and direct/scattered neutron and gamma radiation from NSTX operations. Using COMPLY (computer code) Level 4 for airborne emissions, this dose is equivalent is 0.029 mrem/yr (2.90×10^{-4} mSv/yr), compared to the NESHAPS standard of 10 mrem/yr (0.1 mSv/yr).

Annual limit is 10 mrem/year; background is about 360 mrem/year.

Half life of tritium (HTO & HT) is 12.3 years.

Airborne doses assume maximum exposed individual is in continuous residence at the site boundary; waterborne doses assume that maximum exposed individual uses the ultimate destination of liquid discharges (Millstone River) as sole source of drinking water.

Laboratory policy states that when occupational exposures have the potential to exceed 1,000 mrem per year (10 mSv/y), the PPPL Environment, Safety, and Health (ES&H) Executive Board must be requested to approve 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 "ALARA" (As Low As Reasonably Achievable) policy to all its operations. This philosophy for control of occupational exposure means that environmental radiation levels for device operation are also very low. From all operational sources of radiation, the ALARA goal for maximum individual occupational exposure was less than 100 mrem per year (1.0 mSv/year) above natural background at PPPL.

5.1.1 Penetrating Radiation

The NSTX conducted experiments during 2004 that generated neutron and gamma radiation. Experimental shots were conducted using neutral beam injection, which generated deuterium-deuterium (D-D) (MeV) neutrons. Approximately 2% of these shots are assumed to also generate deuterium-tritium (D-T) (MeV) neutrons. Gamma and x-ray radiation generated in the range of 0-10 MeV during these experiments contributed to the total penetrating radiation dose at the site boundary of 9.1×10^{-5} mrem from D-D neutrons and 0.7×10^{-5} mrem from D-T neutrons. [Lev05a].

5.1.2 Sanitary Sewage

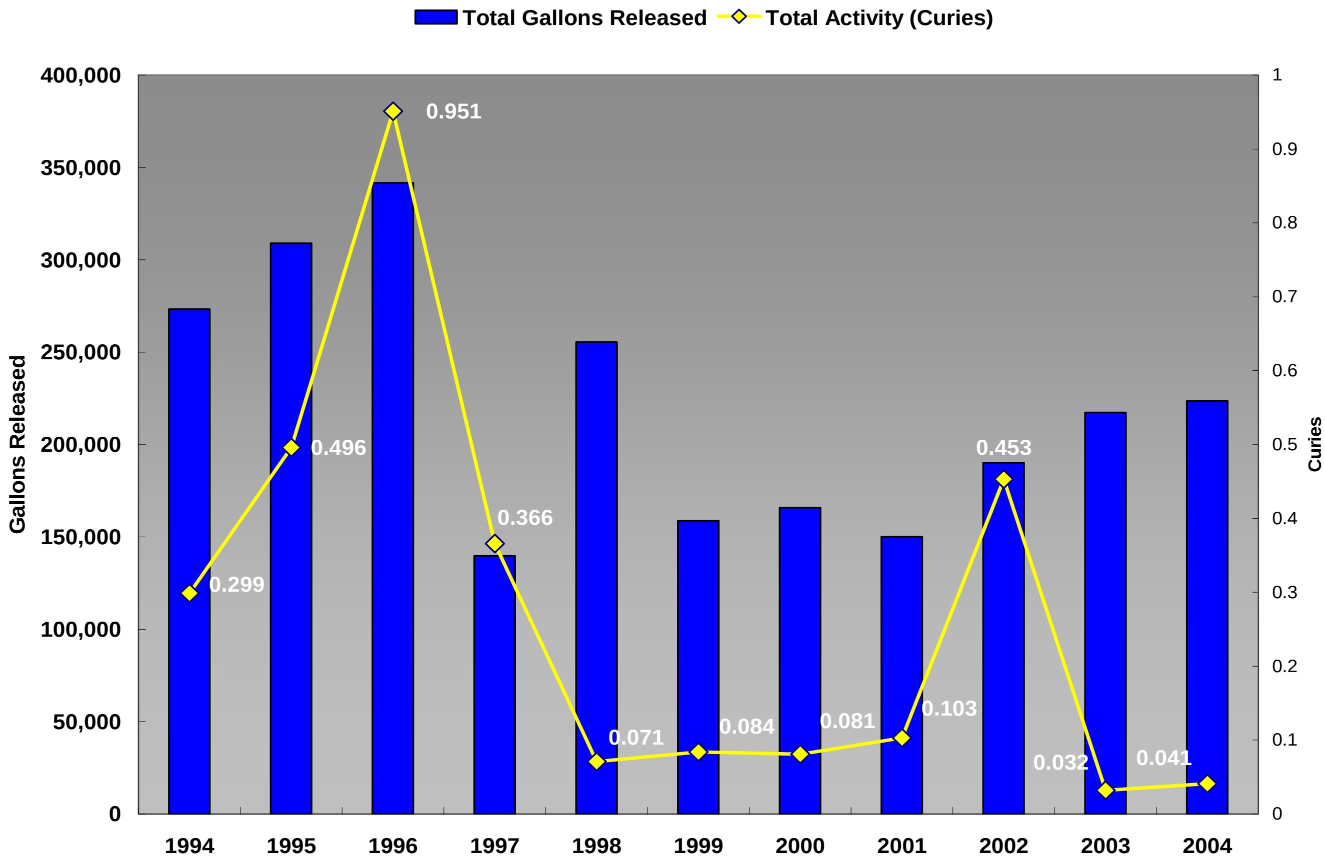
Drainage from D site sumps in radiological areas is collected in the Liquid Effluent Collection (LEC) tanks; each of three tanks has a total capacity of 15,000 gallons. Prior to release of these tanks to the sanitary sewer system, *i.e.*, Stony Brook Regional Sewerage Authority (SBRSA), a sample is collected and analyzed for tritium concentration and gross beta. All samples for 2004 showed effluent quantity and concentrations of radionuclides (tritium) to be within allowable limits established in New Jersey regulations (1 Ci/y for all radionuclides) (40 CFR 141.16 limit is 20,000 pCi/L) and DOE Order 5400.5 (2×10^6pCi/liter for tritium).

As shown in Exhibit 5-3, the 2004 total amount of tritium released to the sanitary sewer was 0.041 Curies, about four percent of the allowable 1.0-Curie per year limit. In Appendix A Table 10, the gross beta activity is reported; the gross beta activity ranges from <194 to 357 pCi/L.

Exhibit 5-2. Total Annual Releases to Sanitary System from 1994 to 2004

Calendar Year	Total Gallons Released	Total Activity (Curies)
1994	273,250	0.299
1995	308,930	0.496
1996	341,625	0.951
1997	139,650	0.366
1998	255,450	0.071
1999	158,760	0.084
2000	165,900	0.081
2001	150,150	0.103
2002	190,200	0.453
2003	217,320	0.032
2004	223,650	0.041

Exhibit 5-3. Total Annual Releases to Sanitary System from the Liquid Effluent Collection Tanks 1994-2004



5.1.3 Radioactive and Mixed Waste

In 2004, low-level radioactive wastes were stored on-site prior to off-site disposal in the Radioactive Waste Handling Facility (RWHF) (Exhibits 5-4 and 5-5). Low-level radioactive shipments made in 2004 consisted of materials removed during TFTR Deconstruction & Decontamination (D&D) project and compacted solid waste, including personal protective clothing. No low-level radioactive mixed waste was generated in 2004 [MP05b].

Exhibit 5-4. Total Low-Level Radioactive Waste 1997-2004

Year	Cubic feet (ft^3) or Kilograms (kg)	Total Activity in Curies (Bq)
1997	1,997.7 ft^3	31,903.0 (1.18×10^{15})
1998	533.74 ft^3	204.80 (7.58×10^{12})
1999	1188 ft^3	213.76 (7.91×10^{12})
2000	4,235.7 ft^3	50.0 (1.85×10^{12})
2001	19,949.8 ft^3	1,288.43 (4.77×10^{13})
2002	858,568 kgs	4,950.14 (1.83×10^{14})
2003	8,208 kgs	0.03 (1.11×10^{9})
2004	4,467 kgs	0.0202 (7.48×10^{8})

Exhibit 5-5. B-box with Liner in RWHF For Shipping Radioactive Waste to NTS

In CY 04, PPPL made one shipment to Neveda Test Site (NTS) for burial. The shipment was contained in B-boxes that were specially designed for shipping radioactive waste to an approved burial site. In order for PPPL to send this type of waste to NTS, PPPL applied to NTS and after a rigorous review process received approval from NTS, which includes prior to each shipment preparing a waste profile for their approval. Periodically, NTS audits PPPL's rad waste program that includes training and records.

5.1.4 Airborne Emission - *Differential Atmospheric Tritium Samplers (DATS)*

PPPL uses the differential atmospheric tritium sampler (DATS) to measure elemental and oxide tritium at the D site stack (Exhibit 5-6).

DATS are similarly used at eleven (11) environmental sampling stations: 4 located on D site facility boundary trailers (T1 to T4), 6 located at remote environmental air monitoring stations (R 1 to R6) (App. A, Table 4). The baseline location was located in Roebling, N.J. (Burlington County). All of the aforementioned monitoring is performed continuously.

Exhibit 5-6. Preparing the DATS

Tritium (HTO and HT) was released and monitored at the D site stack (App. A, Table 3 and Exhibit 3-4). Projected dose equivalent at the nearest off-site business from airborne emissions of tritium was 0.02 mrem/year (2.0×10^{-4} mSv/year) in 2004. Measurements at the D site facility boundary have measured concentrations in the range from 0.392 to 7.24 pCi/m^3 elemental tritium (HT) and from 0.392 to 5.92pCi/m^3 oxide tritium (HTO) in 2004 (Appendix A, Table 4). Measurements from off-site monitoring stations are shown in Appendix A, Table 4 "Air Tritium (HT)" and "Air Tritium (HTO)," respectively.

The EDE at the site boundary was calculated based on annual tritium totals as measured at the stack (DATS air) and water samples at the LEC tanks and highest measurements from well and surface water during 2004 (see Exhibit 4-3).

5.2 <u>Release of Property Containing Residual Radioactive Material</u>

Release of property containing residual radioactivity material is performed in accordance with PPPL ES&H Directives (ESHD) 5008, Section 10, Subpart L.

Such property cannot be released for unrestricted use unless it is demonstrated that contamination levels on accessible surfaces are less than the values in Appendix D of ES&HD 5008, Section 10, and that prior use does not suggest that contamination levels on inaccessible surfaces exceed Appendix D values. For tritium and tritiated compounds, the removable surface contamination value used for this purpose is 1,000 dpm/100 cm^2. No active or contaminated materials were free-released in 2004. All materials were either reused in controlled environments or properly disposed.

5.3 Protection of Biota

The highest measured concentrations of tritium in surface and ground water in 2004 was 502 pCi/L (Well TW-1, App. A Table 6). This concentration is a very small fraction of the water biota concentration guide (BCG) (for HTO) of 3 $x10^8$ pCi/L for aquatic system evaluations, and the water BCG (for HTO) of 2 x 10^8 pCi/L for terrestrial system evaluations, per DOE Standard STD-1153-2002 ("A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota").

5.4 Unplanned Releases

There were no unplanned radiological releases in 2004.

5.5 Environmental Radiological Monitoring

5.5.1 Waterborne Radioactivity

A. Surface Water

Surface-water samples at nine locations (two on-site: DSN001, and E1; and seven off-site: B1, B2, C1, DSN003, M1, P1, and P2) have been analyzed for tritium (App. A, Table 5). Locations are indicated on Exhibits 4-3 (on-site) and 4-4 (off-site locations).

In February 2004, at on-site location, DSN001 basin outfall, the tritium concentration was detected at 353 pCi/L, which was the highest for surface water samples.

Rain water samples were collected and analyzed and ranged from below detection to 427 pCi/liter in 2004 (App. A, Table 7), which is lower than the seven-year high of 61,660 pCi/liter. With the end of TFTR D&D project in September 2002, the decrease in rain, surface, and ground water tritium concentrations has mirrored the decreased tritium emissions measured at the D-site stack.

Based on this data and associated literature [Jo74, Mu77, Mu82, Mu90], it is believed that the observed increase in tritium concentrations in rain water is due to washout by precipitation of a portion of the tritium released from the D-site stack. Monitoring of tritium concentrations in rain water continues.

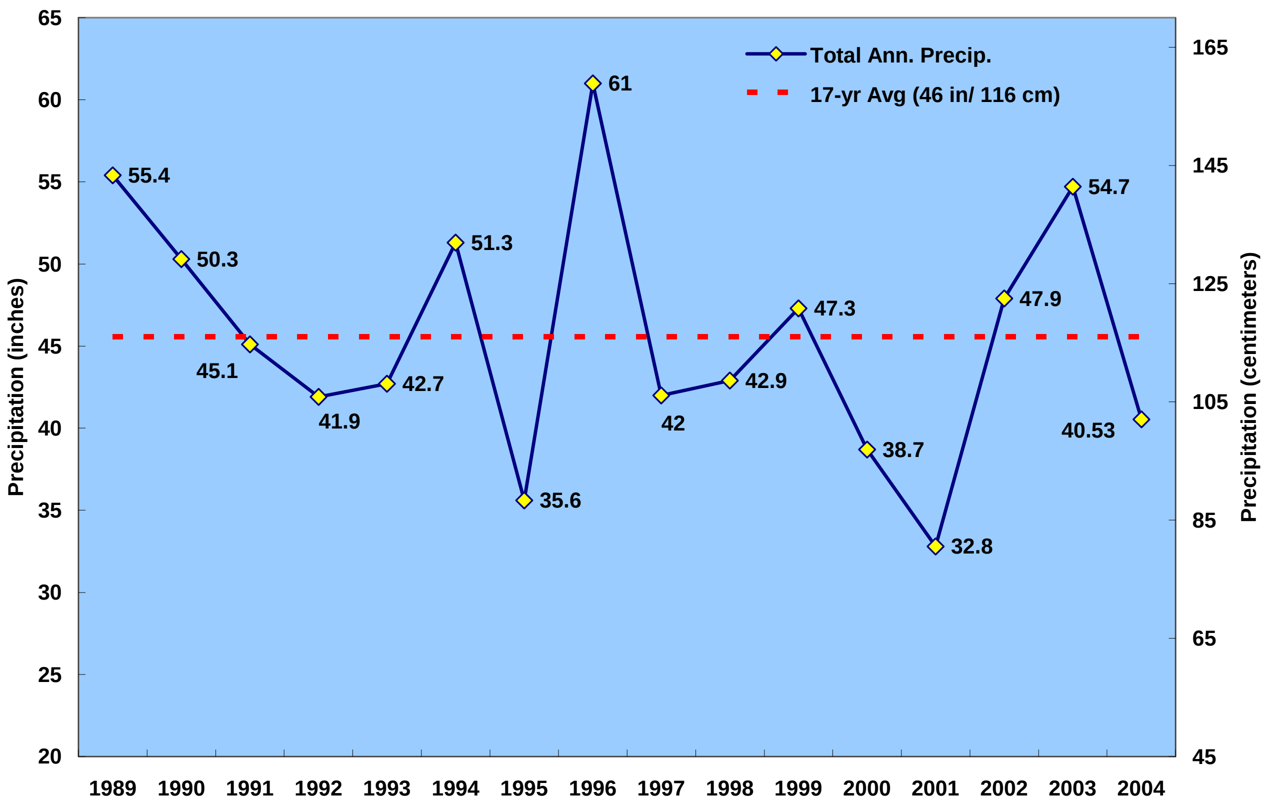
In April 1988, PPPL began precipitation measurements. On a weekly basis, on-site precipitation is measured by a rain gauge. Exhibit 5-7 shows the occurrence of dry and wet years compared to the 45-inch average (App. A, Table 2 for 2004 weekly rainfall) [Ch05]. While 2001 was the driest year since measurements began, the above-average rainfall in 2002 and 2003 ended the drought and water emergency in New Jersey. Though total precipitation in 2004 was below the mean (40.53 versus

45.6 inches), 2004 was considered a normal year for rainfall.

B. Ground Water

In August 1995, PPPL began to monitor tritium levels in on-site ground water more intensely. This increase in the scope of ground-water monitoring was prompted by the slight increase in tritium levels 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.

Exhibit 5-7.Total Annual Precipitation from 1989 to 2004



Rainfall collected in 1988 for 10 months; est. >40 inches.

In 2004, the highest concentration of tritium was found in well MW-12S (2,225 pCi/L). From PPPL's environmental monitoring data and the available scientific literature [Jo74, Mu77, Mu82, Mu90], the most likely source of the tritium detected in the on-site ground water samples is from the atmospheric venting of tritium from the D-site stack and the resulting "wash-out' during precipitation. Ground water monitoring of the wells and the foundation sump (dewatering sump for D-site buildings) will continue.

C. Drinking (Potable) Water

Potable water is supplied by the public utility, Elizabethtown Water Company. 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 2004, tritium concentrations at this location ranged from <19 pCi/L to 81 pCi/liter (App. A Table 5).

5.5.2 Foodstuffs, Soil, and Vegetation

There were no foodstuffs, soil, or vegetation samples gathered for analysis in 2004. In 1996, the Health Physics (HP) Manager reviewed the requirement for soil/biota sampling. At that time, a decision was made to discontinue the sampling program. Tritium was not detected in almost all samples and these data were not adding to the understanding of tritium transport in the environment. A heavier concentration was placed on water sampling and monitoring which produced more relevant results.

Chapter 6

ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

6.1 New Jersey Pollutant Discharge Elimination System (NJPDES) Program

6.1.1 Surface and Storm Water

In compliance with permit requirements of the New Jersey Pollutant Discharge Elimination System (NJPDES) permit, NJ0023922, PPPL-DOE submitted to NJDEP monthly discharge monitoring reports (DMRs) for Discharge Serial Number (DSN)—DSN001 and DSN003 (App. A , Tables 18 & 19). During 2004, PPPL's discharges were within allowable limits for all tested parameters. In December 2003, PPPL submitted the renewal application for the NJPDES permit; in 2004, PPPL continued to comply with the permit requirements though the permit expiration date was June 1, 2004. In 2004, PPPL continued to monitor the total suspended solids concentration at DSN 003 and intake (at C1 -upstream of the D&R Canal pump house) quarterly.

Changes to the basin include the annual basin cleanup that occurred in April 2004 (see Exhibit 6-1); a new oil boom replaced the original boom installed in 1994; and the aerator installed in 2000 was replaced with a bubbler type aerator in July 2004. The bubbler allow for increased dissolved oxygen, which improves the basin's water quality.

Exhibit 6-1. Annual basin cleaning

6.1.2 Chronic Toxicity Characterization Study

In June 2004, 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.

As the result of the annual chronic toxicity test, the survival rate defined by the NJ Surface Water Quality Standards was >100 percent (statistically possible) no observable effect concentration (NOEC) [PPPL04i]. The last unsuccessful test occurred in March 1995 when the fathead minnows' mortality was observed in the 100 percent effluent test (Exhibit 6-2).

Exhibit 6-2. Summary of Chronic Toxicity Testing (*One test result <100 NOEC failed))

Test Freq.	Bi-month	Quarter	Semi-annual	Annual
1994		4*		
1995		4*		
1996	3	2		
1997		4		
1998		3		
1999			March	October
2000				December
2001				November
2002				September
2003				October
2004				June

6.1.3 Ground Water

In 1985, the US Geological Survey (USGS) in co-operation with PPPL and DOE, installed 10 monitoring wells north of the TFTR on D-site. The purpose was to collect ground water elevation and quality data. In particular, USGS modeled the ground water flow from PPPL as a hypothetical spill of radioactive water from the liquid effluent collection tanks. The study concluded that the ground water flow would be a less likely pathway [Le87]. In 2004, three of these wells are used to collect ground water samples that are analyzed for tritium (App. A, Table 6). The tritium concentrations are compared over time.

In 1989, PPPL installed monitored ground-water quality in five wells in compliance with the NJPDES ground-water discharge permit, NJ0086029; in 2004, one well is monitored quarterly for tritium analysis and annually under the Remediation program [NJDEP01].

A. *NJPDES Ground Water Program in 2004*

PPPL is no longer required to collect quarterly ground water samples as a condition of this permit. PPPL maintains compliance through its Operation and Maintenance Manual for the detention basin.

As discussed in Chapter 7, "Site Hydrology, Ground Water and Public Drinking Water Protection," the volatile organic compounds detected in the ground water monitoring wells adjacent to the basin are not believed to originate from the detention basin, but rather are the result of historical contamination in the Former Annex Building Area (FABA).

An estimated 49.5 million gallons of water were discharged from the detention basin in 2004. Beginning in December 2000, flow from the basin was measured using an ultrasonic flow transducer; data are downloaded to a data spreadsheet from which total daily and daily average flows were calculated. The lined retention basin operates with a permanent oil boom (new boom installed 2004), an oil detection system that is capable of sending an alarm signal to Security and automatically closing the discharge valve, and a chain-link fence around the perimeter of the basin. The retention basin is operated in a flow-through mode.

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). For C and D sites, the Remedial Investigation is discussed in Section 3.2.3 and is fully documented in the *Remedial Investigation and Remedial*

Action Selection Report (RI & RASR) approved by NJDEP in 2000 [PPPL00a]. The Remedial Action Work Plan (RAWP) was submitted by the DOE-PPPL in May 2000 and conditionally approved by NJDEP in June 2000 [PPPL00b].

In 2004, ground water monitoring activities were continued in the area of potential environmental concern (APEC) near the location of the former PPPL Annex Building in the wooded area southwest of CAS/RESA. (Exhibit 6-3 and App. A, Table 20) [Sh05]. Samples are collected from 12 wells, 2 sumps, and 1 surface water location.

Exhibit 6-3. Ground Water Monitoring Field Equipment – Using a Backpack Air Compressor

Volatile organic compounds (VOCs) probably from degreasing solvents were detected above the NJ Ground Water Standard (1.0 μg/L) in 5 of the 12 wells/sumps sampled. The highest concentrations of tetrachloroethylene (PCE) were measured in well MW-19S (154 μg/L), but is lower than in 2003 (229 μg/L), and in D-site MG sump (65.4 μg/L, also lower than in 2003 (88.6 μg/L). The de-watering sumps located in the D-site MG and TFTR basements draw ground water radially from the shallow aquifer, controlling ground water flow, which prevents off-site contaminant migration and slowly extracts contaminated ground water. The probable source of the PCE is from the former Annex building that in the mid-1980's housed hazardous waste.

6.2 Non-Radiological Programs

The following sections briefly describe PPPL's environmental programs required by federal, state, or local agencies. These 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 was modified in 2003 to include the burning of No. 2 fuel oil in addition to No. 4 fuel oil and natural gas. The boiler permits were part of NJDEP's inspection of the facility; the facility was determined to be in compliance of the air regulations and permit requirements (Exhibit 6-4).

Measurements of actual boiler emissions are not required. To optimize boiler efficiency and to reduce fuel cost in accordance with DOE Order 4330.2D, "In-House Energy Management," [DOE88] 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 (# 4) and natural gas fuels. The PPPL boiler operations Chief Engineer maintains records of this information [Kir05].

PPPL maintains the following equipment that requires air permits:

Exhibit 6-4. Air-Permitted Equipment

Type of Air Permit	Location
Dust collectors	M&O woodworking shop CAS metalworking area Shop wood working area
Storage tanks vents	25,000 gal. No. 2 & 4 oil 15,000 gal. No. 1 oil
Diesel generators	D-site generator C-site generator
Utility boilers	Units 2,3,4, & 5 in M&OD

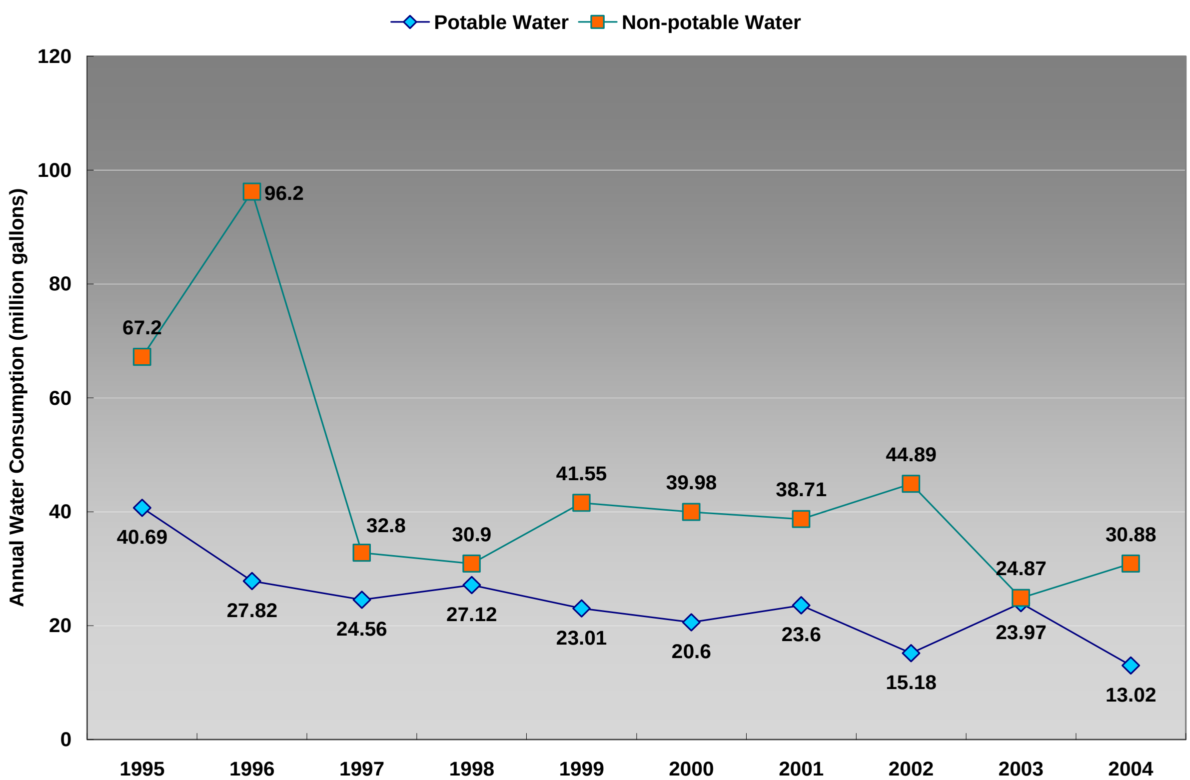
B. Drinking (Potable) Water

Potable water is supplied by the public utility, New Jersey American Water Company, formerly Elizabethtown Water Co. The PPPL used approximately 13.02 million gallons in 2004 (Exhibits 6-5 and 6-6) [Kir05]. In 1994, a cross-connection was installed beneath the water tower to provide back-up potable water to the tower for the fire-protection system and other systems.

Exhibit 6-5. PPPL Potable Water Use (Elizabethtown-NJ American Water Co.)

CY	In million gallons
1995	40.69
1996	27.82
1997	24.56
1998	27.12
1999	23.01
2000	20.6
2001	23.6
2002	15.18
2003	23.97
2004	13.02

Exhibit 6-6.
PPPL's Potable and Non-Potable Water Use from 1995 to 2004



C. *Process (Non-potable) Water*

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 through a contract with the New Jersey Water Supply Authority that allows for the withdrawal of up to 500,000 gallons per day for process cooling and fire protection (Exhibits 6-6 and 6-7) [Kir05].

Exhibit 6-7. PPPL Non-Potable Water Use (D&R Canal)

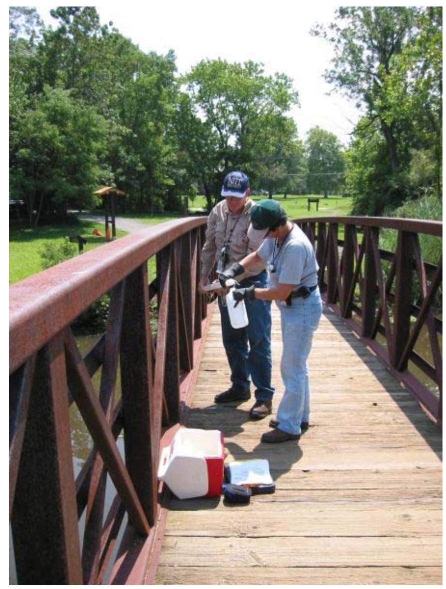
CY	In million gallons
1995	67.2
1996	96.2
1997	32.8
1998	30.9
1999	41.55
2000	39.98
2001	38.71
2002	44.89
2003	24.87
2004	30.88

Filtration to remove solids and the addition of chlorine and a corrosion inhibitor are the primary water treatment at the canal pump house. Discharge serial number DSN003, located at the canal pump house filter-backwash, is a separate discharge point in the NJPDES surface-water permit and is monitored monthly (App. A, Table 19). A sampling point (C1) was established to provide baseline data for surface water that is pumped from the D&R Canal for non-potable uses. Appendix A Table 13 summarizes results of water quality analysis at the D&R 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), Elizabethtown Water Co. (potable water supplier-E1), Delaware & Raritan Canal (C1), Millstone River (M1), and Plainsboro (P1 & P2) sampling points (App. A Tables 11-17)—are not required by regulation, but are a part of PPPL's environmental surveillance program (Exhibit 6-8).

Exhibit 6-8. Collecting Water Samples (C1 Station), at Midpoint on Footbridge over D&R Canal



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, who is part of SBRSA system, and the Township of Plainsboro agreed upon an estimated volume of sewage discharged.

The estimated volume was based on historical data of approximate flow rates from PPPL. For 2004, PPPL estimates a total annual discharge of 4 million gallons of sanitary sewage to the South Brunswick sewerage treatment plant [Kir05**].**

Beginning in 1996, Stony Brook Regional Sewerage Authority (SBRSA) required monthly measurement of radioactivity, flow, pH, temperature and chemical oxygen demand (COD)at the LEC tanks (designated compliance and sampling location) as stated an Industrial Discharge License (22-96-NC). In March 2004, SBRSA terminated the license and its requirements, except the quarterly reporting of total volume discharged from the LEC tanks..

For the months January-March, PPPL continued monthly radiological and non-radiological analyses to meet the license requirements (App. A. Table 10). PPPL continued to periodically collect samples during the remainder of CY2004.

F. Spill Prevention Control and Counter-measure

Spill Prevention Control and Counter-measure PPPL maintain a Spill Prevention Control and Countermeasure Plan (SPCC), which was updated in 2004 by a Professional Engineer within the PPPL Materiel & Environmental Services Division (M&ES). This updated SPCC was reviewed internally by all the owners of equipment covered by the SPCC and Quality Assurance. The current SPCC is approved by the Heads, M&ES and ES&H and Infrastructure Support (PPPL04e).

The SPCC Plan is incorporated as a supplement to the PPPL Emergency Preparedness Plan. Besides the 5-year major revision as required by the EPA, PPPL M&ES will complete a review every year and make any minor changes required to the SPCC.

G. Herbicides and Fertilizers

During 2004, PPPL's Maintenance & Operations (M&O) Division 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.

The quantities applied during 2004 were as follows: herbicides - Roundup (15 gals.), and Momentum (8.5 gals.); insecticides - Malathion (0.8 gals.); and fertilizer – NPK (900 lbs.) [Kin05b]. 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 2004, PPPL's inventory of equipment included five-polychlorinated biphenyl (PCB)-regulated capacitors. 640 regulated-PCB capacitors were removed from PPPL in 1998. [MP05a].

I. Hazardous Wastes

The Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) was submitted to the NJDEP for 2003-2004. A description of Resource Conservation and Recovery Act (RCRA) compliance is found in Section 3.1.2 of this report.

Exhibit 6-9. An Enclosure in HAZMAT Building for Lead Separation from Concrete Shielding Blocks

Exhibit 6-10. Concrete Shielding Blocks with Lead

Shown in Exhibits 6-9 and 6-10 are: an enclosure constructed within the Hazardous Waste Handling Facility (HAZMAT) to contain lead particles from contaminating the building and a side-view of lead in a block. Prior to the disposal of the shielding blocks, the embedded lead was separated from the concrete blocks and disposed of a hazardous waste. Special precautions, including training and lead testing, were taken for this lead work.

6.2.2 Continuous Release Reporting

Under CERCLA's reporting requirements for the release of listed hazardous substances 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

During CY2004, three unplanned releases of petroleum substances occurred. In March 2004, PPPL reported to the NJDEP Hotline that PPPL released transformer oil (~5 gallons) from tanker located in the Neutral Beam transformer yard. A line beneath the tanker ruptured and released oil onto the graveled area., In April, the landscape subcontract's lawnmower leaked hydraulic oil (~1 quart) onto gravel. In August, an employee's vehicle spilled engine oil (~5 quarts) onto a stoned divider in the parking lot (see Exhibits 6-11 and 6-12). In all three instances, PPPL cleaned-up the area, removed the oily soil, tested the soil, and replaced it with clean gravel/stone [PPPL04a, b, & d].

Exhibit 6-11. Collecting Soil Samples in Area of Oiil Spill

Exhibit 6-12. Testing for Oil in Soil Sample

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 March 2004 [PPPL05]. No significant changes from the previous year were noted. The SARA Title III reports included information about eleven compounds used at PPPL as listed in Exhibit 3-17.

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 2004.

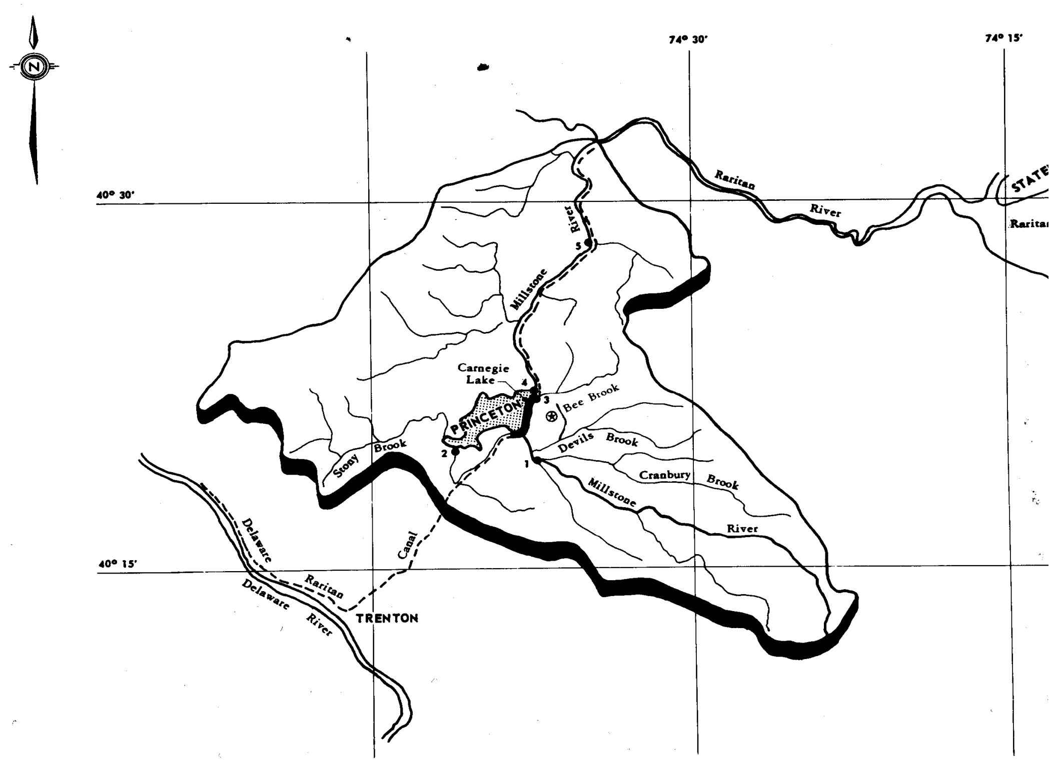
Chapter
7

SITE HYDROLOGY, GROUND WATER, AND DRINKING WATER PROTECTION

PPPL is located within the Bee Brook Watershed. Bee Brook is a tributary to the Millstone River, which is part of the Raritan River Watershed (Exhibit 7-1). NJDEP has developed a watershed-based management program for prospective environmental planning and has divided the State of New Jersey into twenty watershed basins.

Locally, the Bee Brook Watershed encompasses approximately 700 acres within the Princeton Forrestal Center and James Forrestal Campus tracts. It begins at College Road East (approximately 1600 feet east of US Route 1), flows south in a wide flood plain, and then discharges into Devil's Brook at the entrance to Mill Pond [Sa80].

Exhibit 7-1 Millstone River Watershed Basin



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 [Lew87]. Regionally, 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 determined to be "active" by the U.S. Geological Survey. This area of the country (eastern central US) is not earthquake-prone, despite 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 industrial parks, housing developments, 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 topography 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 [Lew87].

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. On a regional scale, the water table fluctuates between 1.5 and 2.5 feet below the surface in wet periods and drops below 5 feet during 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 in the area indicate this soil provides a good environment for agricultural purposes, both today and in the past.

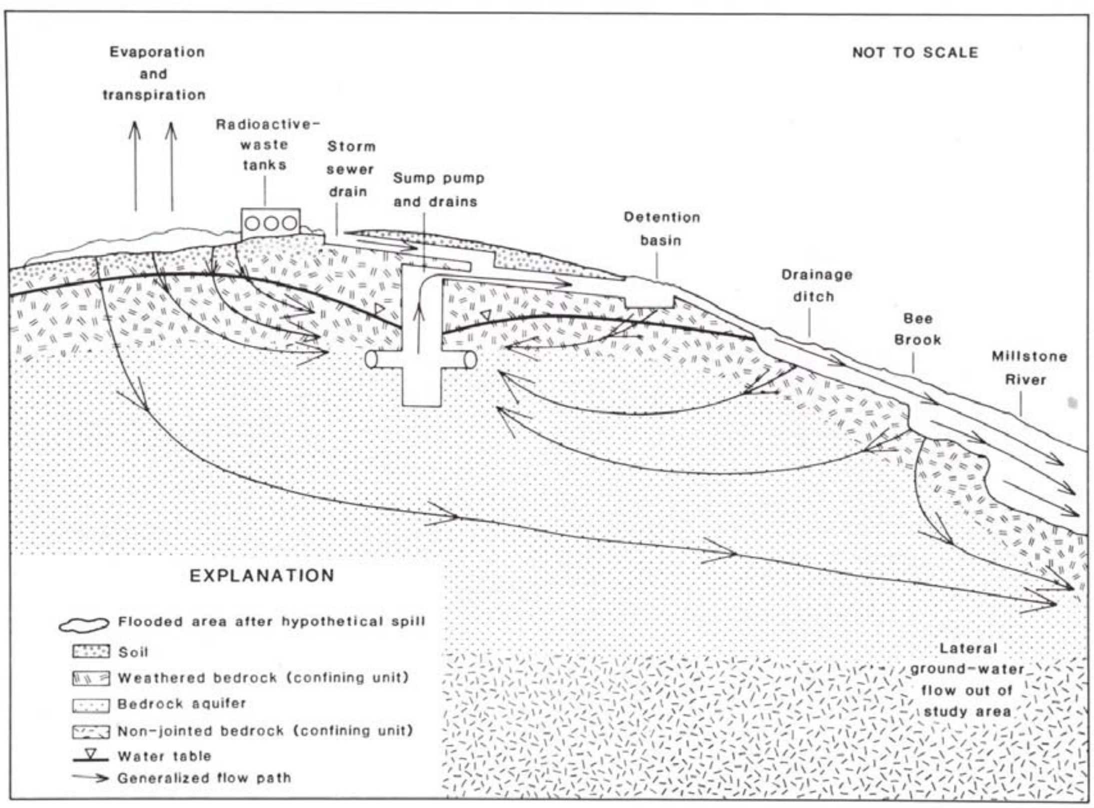
An upland forest type with dominant Oak forest characterizes vegetation of the site. Associated with the various oaks are Red Maple, Hickories, Sweetgums, Beech, Scarlet Oak, and Ash. Red, White, and Black Oaks are isolated in the lower poorly drained areas. Along the damp borders of Bee Brook, a bank 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 under-story of the wooded areas is partially open with isolated patches of shrubs, vines, and saplings occurring mostly in the uplands area. The poorly drained areas have a low ground cover of ferns, grasses, and leaf litter.

All of PPPL's storm water runoff flows to Bee Brook, either directly *via* the detention basin (DSN001) or along the western swale to the wetlands south of the site. Approximately 45 % of the site's total area is covered by impervious surfaces - buildings, roadways and parking lots, and storage trailers.

PPPL's Stormwater Management Plan allows for a maximum impervious coverage of 60 % of the developable land, which excludes wetlands – 18 acres of the 88.5 acres (Exhibit 3-14) [SE96].

Exhibit 7-2. Generalized Potentiometric Surface of the Bedrock Aquifer at PPPL [Le87]



Also, the 500-year flood plain elevation (85 ft above mean sea level) delineates the storm protection corridor, which is vital to the flood and water quality control program for PPPL as well as the Princeton Forrestal Center site. This "corridor" is preserved and protected from development by Princeton Forrestal Center in the Site Development Plan [PFC80].

The general direction of ground-water flow on the site is from the northwest of PPPL toward the southeast in the direction of Bee and Devil's Brooks. The operation of several building foundation drain sump pumps creates a local and shallow cone of depression radially toward the sumps (Exhibits 7-2 & 7-3).

Ground water is pumped from the sumps into the detention basin, which flows into Bee Brook. Bee Brook is hydraulically connected with ground water; during flooding stages, the brook recharges ground water and during low-flow periods, ground water discharges to the brook.

Under several regulatory programs administered by NJDEP, PPPL has performed ground water investigations to address potential impacts from former underground storage tanks (USTs), a formerly unlined detention basin, and in areas where spills occurred or may have occurred in the past. In all, PPPL has installed a total of 44 wells to monitor ground-water quality. Remedial Investigations and Remedial Alternative Assessment (RI/RAA) studies were conducted to delineate shallow ground water contamination and identify a suitable remedy as required by conditions of the Memorandum of Understanding (MOU) between Princeton University and NJDEP. A Remedial Action Work Plan was approved by NJDEP in 2000. Ground water monitoring continues as part of the selected remedy.

In September 2003, PPPL sealed 13 monitoring wells that were no longer needed for specific or site-wide monitoring programs. The wells were sealed by a New Jersey-licensed well driller using methods approved by NJDEP regulations. NJDEP approval was granted prior to the closure of these wells.

Ground-water monitoring results show that tetrachloroethylene (PCE) and their natural degradation products are present in a number of shallow and intermediate-depth wells on C site (Exhibit 7-4). These VOCs are commonly contained in solvents or metal degreasing agents.

By mid-1995, all USTs at PPPL were removed with the exception of one tank that was abandoned in-place with NJDEP's approval. PPPL replaced all USTs 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. It was then emptied, cleaned, and filled with concrete in accordance with NJDEP regulations.

Foundation de-watering sumps located on D-site influence ground-water flow across the site. The sumps create a significant 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 ground water beneath the site (except in the northwestern corner) is drawn radially toward the D site sumps.

During Phase 1 and 2 of the Remedial Investigation, samples from wells and other ground water characterization activities lead to the identification of a new area of potential environmental concern (APEC) near the Former Annex Building Area (FABA). This finding expanded the site boundaries by 16.5 acres for a total of 88.5 acres. Characterization of soil and ground water in the former Annex Building area was conducted during 1997 and 1998 [HLA98].

Phase 3 activities were conducted to:

- Baseline Ecological Evaluation;
- Investigate soil and ground water quality at the Former Annex Building Area (FABA);
- Further assess PCE and other VOC concentrations and distribution in ground water.

In the Remedial Action Selection Report, PPPL proposed to NJDEP that no active ground water remediation beyond the capture and extraction performed by the building dewatering system should be implemented at the site. The natural attenuation processes in the subsurface augments building foundation-dewatering system. In a letter dated March 28, 2000, NJDEP approved the Remedial Investigation and Remedial Action Selection Reports [Sh99]. In response, PPPL prepared and submitted a Remedial Action Work Plan (RAWP) outlining continual operation of the ground water extraction system and a long-term monitoring program [Sh00]. The RAWP was submitted to NJDEP in May 2000 and is being implemented [HLA98, Sh00, Sh01, Sh03].

In January 2002 an Aquifer Classification Exception Area (CEA) Request was submitted to NJDEP. The CEA designation identifies specific areas where state-wide Ground Water Quality Standards are not met and will not be met for some time. CEAs are granted for a specific area and aquifer and for specific contaminants. The CEA for PPPL is shown on Figure 7-3 and only addresses specific VOCs in the shallow (<60 feet deep) aquifer. The CEA request was approved by NJDEP in August 2002.

In 2004, RAWP activities accomplished the following (see Exhibits 7-3 & 7-4):

1. Annual ground water monitoring was conducted in September 2004, which was the first annual monitoring event that occurred under the revised scope as approved by NJDEP;
2. Examination of long-term analytical data indicates a decline of VOC concentrations in most areas of the contaminant plume;
3. Products of anaerobic bio-degradation, such as cis-1,2-dichloroethylene (c-1,2-DCE), are evidence that natural attenuation occurs in the wetlands adjacent to CAS/RESA;
4. Contaminated ground water is captured by building sumps and is not migrating off-site.
5. VOCs in ground water do not pose a risk to site workers or the surrounding public.

Natural attenuation processes are active as evidenced by presence of degradation compounds in ground water down gradient of source. PCE is degraded into trichloroethylene (TCE) and c-1,2-DCE, and the presence of dissolved methane, reduced dissolved oxygen levels and negative redox values also provides definitive evidence of on-going biological degradation (See App. A, Tables 38-39) [Sh03, Sh04]

The second investigation began in August 1995, when the tritium concentration from well TW-1, located north of the TFTR stack, was found to be above the background or baseline concentration, 789 *versus* 150 pico Curies/Liter (pCi/L), respectively. As a result of this finding, PPPL began looking 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; soil results and utility testing inspections supported this finding. Drain samples from the liquid effluent collection tank roof showed that tritium concentrations were elevated as were soil samples next to drain spouts.

Based on site-specific studies and a review of the scientific literature, PPPL determined the most likely source of tritium detected in the ground water was atmospheric releases of tritium and the subsequent "wash out" and percolation of tritium into the subsurface. A number of published and un-published studies 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.

During 2004, the highest concentration of tritium in the ground water was detected at well TW-1 in March 2004 (502 pCi/L); compared with highest tritium concentration in ground water occurring in 2003 (3,365 pCi/L), this level is near background levels (<41 to <411 pCi/L) . This concentration is also about 2% of the USEPA Drinking Water standard (20,000 pCi/L).

Results of nine years of tritium monitoring show a pattern of elevated ground water concentrations between three and six months after elevated tritium levels are detected in precipitation. 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 of tritium detected in the ground water. PPPL continues to monitor tritium concentrations in atmospheric releases, precipitation, ground water and surface water as part of its radiological environmental surveillance program. ✵

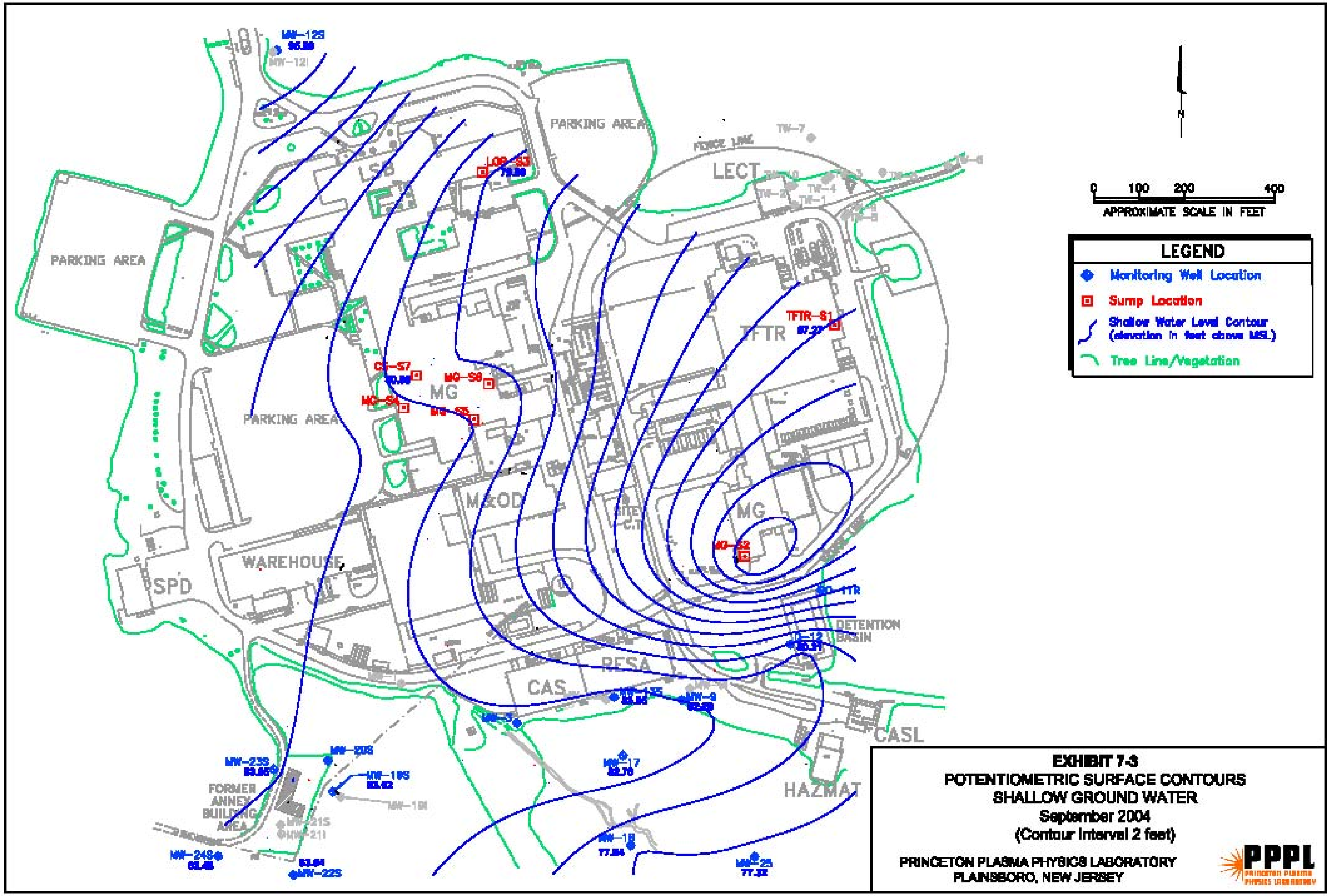
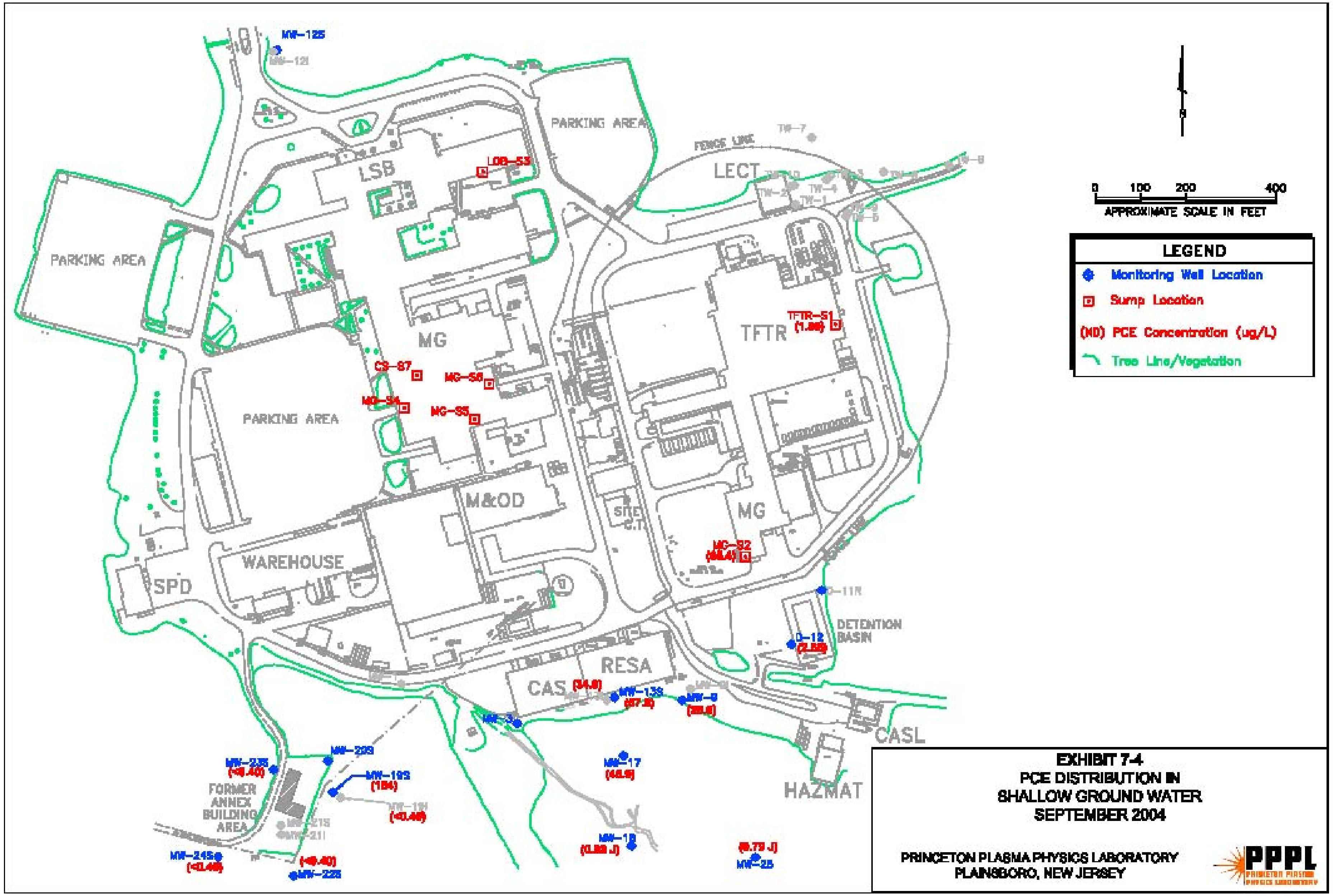


EXHIBIT 7-3
POTENTIOMETRIC SURFACE CONTOURS
SHALLOW GROUND WATER
September 2004
(Contour Interval 2 feet)



MW-12S
PARKING AREA
PARKING AREA
PARKING AREA
FENCE LINE
LSB
LOB-S3
LECT
MG
CS-S7
MG-S6
MG-S4
MG-S5
TFTR
TFTR-S1
M&OD
SITE C.T.
MG
MG-S2
WAREHOUSE
SPD
D-11R
DETENTION BASIN
D-12
RESA
CAS
MW-13S
MW-9
MW-3
CASL
HAZMAT
MW-17
MW-18
MW-23S
MW-20S
MW-19S
(184)
FORMER ANNEX BUILDING AREA
MW-24S
MW-22S
(0.79 J)
MW-25
APPROXIMATE SCALE IN FEET
LEGEND
Monitoring Well Location
Sump Location
(ND) PCE Concentration (ug/L)
Tree Line/Vegetation
EXHIBIT 7-4
PCE DISTRIBUTION IN
SHALLOW GROUND WATER
SEPTEMBER 2004
PRINCETON PLASMA PHYSICS LABORATORY
PLAINSBORO, NEW JERSEY
PPPL

Chapter 8

QUALITY ASSURANCE

In 2004, analyses of environmental samples for radioactivity and other parameters were conducted by PPPL's on-site analytical laboratory (Exhibits 8-1 and 8-2).

Exhibit 8-1.
Chemical Oxygen Demand Samples (including Quality Control Samples) at PEARL Facility

The PEARL procedures follow the DOE's Environmental Measurements Laboratory's *EML HASL-300 Manual* [Vo82], EPA's *Methods and Guidance for Analysis of Water* [EPA99] *and Standard Methods of Water and Wastewater Analysis* [SM92] that are nationally recognized standards. PPPL's approved procedures are documented on Health Physics web page. [PPPL00e].

To maintain its radiological certification, PPPL participates in the DOE Environmental Monitoring Laboratory (EML) program and New Jersey Department of Environmental Protection (NJDEP) Laboratory Certification program. For non-radiological parameters, PPPL participates in NJDEP Laboratory Certification program (NJ ID #12471).

A requirement of the certification program is to analyze within the acceptance range the quality control (QC) and proficiency test (PT) samples that are purchased from outside laboratory suppliers. These PT samples are provided as blind samples for analysis; the test results are submitted prior to the end of the study.

Exhibit 8-2.
Distilling Sample for Tritium Analysis Performed at PEARL Facility

Results are supplied to PPPL and NJDEP to confirm a laboratories' ability to correctly analyze those parameters being tested [see App. A, Table 21].

Beginning in 1984, PPPL participated in a NJDEP certification program initially through the USEPA Quality Assurance (QA) program. In March 1986, EPA/Las Vegas and NJDEP reviewed PPPL's procedures and inspected its facilities. The laboratory became certified for tritium analysis in urine (bioassays) and water. In 2001, USEPA turned the QA program over to the states; NJDEP chooses a contractor laboratory, ERA, to supply the radiological proficiency tests.

For non-radiological proficiency testing, the results in Appendix A, Tables 21, show that PEARL's results were in the acceptable range except for Total residual chlorine in February 2004 (voluntary QA program), and COD and Specific conductance in June 2004 (required QA program – APG NJDEP contracted supplier). For the required QA program, those two parameters, COD and Specific conductance, were retested in December 2004 and were in the acceptance range..

Gamma spectroscopy instruments were operational in 2004.

PPPL followed its internal procedures, EM-OP-31—"Surface Water Sampling Procedure," and EM-OP-38—"Ground Water Sampling Procedures." These procedures provide detailed descriptions of all NJPDES permit-required sampling and analytical methods for collection of samples, analyses of these samples, and quality assurance/quality control requirements. Chain-of-custody forms are required for all samples; holding times are closely checked to ensure that analyses are performed within established holding times and that the data is valid; trip blanks are required for all 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.

PPPL conducts a subcontractor laboratory audit at least once during the three-year contract period. In 2004, Accredited Laboratory, Carteret, NJ and QC Laboratory, Southampton, PA, were audited by PPPL. ✵

ACKNOWLEDGMENTS

ES&H and Infrastructure Support Department:
- Jack Anderson - review and comments on this report
- Jim Graham - providing web site assistance
- Margaret Kevin-King - fertilizer, herbicide, and pesticide data and the recycling data
- Charlie Kircher - fuel consumption data and on-site water-utilization
- Jerry Levine - NEPA data, safety statistics, and dose calculations

Materiel & Environmental Services Division:
- John Bennevich – supplying many photos, waste statistics
- Tom McGeachen -SPCC, EO Goals and Status, and P^2 E^2 data
- Maria Pueyo – TSCA, hazardous, and radiological waste data
- Keith Rule – basin management and upgrades, OSHA statistics
- Rob Sheneman - ground water data, review and comments on this report

Health Physics Branch:
- George Ascione - radiological and calibration data
- Keith Case – meteorological data
- Carl Szathmary - in-house radiochemical and water analyses

Quality Assurance Division:
- Lynne Yager - OSHA Statistics and audits

Environment, Safety,& Health Division:
- Bill Slavin - SARA Title III and Toxic Release Inventory information

Information Services Division:
- Elle Starkman - Photos of NSTX and photos from the "PPPL Hotline"
- Patti Wieser – "PPPL Hotline" articles

This work is supported by the U.S. Department of Energy Contract No. DE-AC02-76CHO3073.

Chapter

10

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Appendix A

TABLES

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

CONDITION		PUBLIC	EXPOSURE[b]	OCCUPA-TIONAL	EXPOSURE
		REGULATORY LIMIT	DESIGN OBJECTIVE	REGULATORY LIMIT	DESIGN OBJECTIVE
ROUTINE OPERATION 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		
ACCIDENTS 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 radiation safety guidelines, practices and procedures included in PPPL ESHD 5008, Section 10.

[b] Evaluated at 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 10.1302 for emergency personnel exposure limits.

Table 2. Annual Precipitation Data for 2004

START DATE	WEEK	INCH	INCH/MONTH	MONTH	ACCUMLATION
5-Jan-04	1	0.6500			0.6500
12-Jan-04	2	0.6500			1.3000
19-Jan-04	3	0.1000			1.4000
26-Jan-04	4	0.2000			1.6000
2-Feb-04	5	2.5500	1.6000	January	4.1500
9-Feb-04	6	0.0000			4.1500
16-Feb-04	7	0.0000			4.1500
23-Feb-04	8	0.0000			4.1500
1-Mar-04	9	1.2500	2.5500	February	5.4000
8-Mar-04	10	0.0000			5.4000
15-Mar-04	11	1.1500			6.5500
22-Mar-04	12	0.1000			6.6500
29-Mar-04	13	1.2500	3.7500	March	7.9000
5-Apr-04	14	1.9000			9.8000
12-Apr-04	15	0.0000			9.8000
19-Apr-04	16	1.5000			11.3000
26-Apr-04	17	0.5000			11.8000
3-May-04	18	0.6000	3.9000	April	12.4000
10-May-04	19	0.3500			12.7500
17-May-04	20	0.1500			12.9000
24-May-04	21	1.0500			13.9500
31-May-04	22	0.2500	2.4000	May	14.2000
7-Jun-04	23	0.2000			14.4000
14-Jun-04	24	0.5500			14.9500
21-Jun-04	25	0.2500			15.2000
28-Jun-04	26	0.2500	1.2500	June	15.4500
5-Jul-04	27	2.4250			17.8750
12-Jul-04	28	0.8500			18.7250
19-Jul-04	29	1.3500			20.0750
26-Jul-04	30	2.1500			22.2250
2-Aug-04	31	0.0000	6.7750	July	22.2250
9-Aug-04	32	1.6000			23.8250
16-Aug-04	33	0.7500			24.5750
23-Aug-04	34	0.0000			24.5750
30-Aug-04	35	0.2000	2.5500	August	24.7750
6-Sep-04	36	0.2000			24.9750
13-Sep-04	37	0.4000			25.3750
20-Sep-04	38	0.0000			25.3750
27-Sep-04	39	5.0500			30.4250
4-Oct-04	40	0.0000	5.6500	September	30.4250
11-Oct-04	41	0.5000			30.9250
18-Oct-04	42	1.2000			32.1250
25-Oct-04	43	0.1500			32.2750
1-Nov-04	44	1.2500	1.8500	October	33.5250
8-Nov-04	45	1.3000			34.8250
15-Nov-04	46	0.3000			35.1250
22-Nov-03	47	1.4500			36.5750
29-Nov-04	48	0.8500	5.1500	November	37.4250
6-Dec-04	49	2.0000			39.4250
13-Dec-04	50	0.0000			39.4250
20-Dec-04	51	0.9000			40.3250
27-Dec-04	52	0.2000	3.1000	December	40.5250

Table 3. D–Site Tritium Stack Releases in Curies in 2004

Week Ending	HTO (Ci)	HT (Ci)	Weekly total (Ci)	Month	Annual Total (Ci)
Baseline 1/2/02	0	0	0	0	**0**
7-Jan-04	0.178	0.006	0.184		0.184
14-Jan-04	0.204	0.024	0.228		0.412
21-Jan-04	0.386	0.007	0.393		0.805
28-Jan-04	0.149	0.010	0.159	**January**	0.964
4-Feb-04	1.070	0.016	1.086		2.050
11-Feb-04	0.113	0.018	0.131		2.181
18-Feb-04	0.091	0.011	0.102		2.283
25-Feb-04	0.537	0.036	0.573	**February**	2.856
3-Mar-04	0.492	0.024	0.516		3.372
10-Mar-04	0.347	0.014	0.361		3.733
17-Mar-04	0.116	0.513	0.629		4.362
24-Mar-04	7.842	0.041	7.883	**March**	12.245
31-Mar-04	0.469	0.014	0.483		12.728
7-Apr-04	0.572	0.028	0.600		13.328
14-Apr-04	0.349	0.012	0.361		13.689
21-Apr-04	0.435	0.004	0.439		14.128
28-Apr-04	0.417	0.030	0.447	**April**	14.575
5-May-04	0.453	0.007	0.460		15.035
12-May-04	0.928	0.039	0.967		16.002
19-May-04	0.609	0.011	0.620		16.622
26-May-04	0.572	0.030	0.602	**May**	17.224
2-Jun-04	0.553	0.014	0.567		17.791
9-Jun-04	0.464	0.014	0.478		18.269
16-Jun-04	0.270	0.005	0.275		18.544
23-Jun-04	0.171	0.008	0.179	**June**	18.723
30-Jun-04	0.112	0.012	0.124		18.847
7-Jul-04	0.137	0.006	0.143		18.990
14-Jul-04	0.148	0.003	0.151		19.141
21-Jul-04	0.119	0.009	0.128		19.269
28-Jul-04	0.110	0.013	0.123	**July**	19.392
4-Aug-04	0.106	0.008	0.114		19.506
11-Aug-04	0.117	0.009	0.126		19.632
18-Aug-04	0.001	0.001	0.002		19.634
25-Aug-04	0.111	0.005	0.116	**August**	19.750
1-Sep-04	0.133	0.010	0.143		19.893
8-Sep-04	0.137	0.009	0.146		20.039
15-Sep-04	0.143	0.012	0.155		20.194
22-Sep-04	0.145	0.009	0.154		20.348
29-Sep-04	0.135	0.011	0.146	**September**	20.494
6-Oct-04	0.157	0.010	0.167		20.661
13-Oct-04	0.155	0.012	0.167		20.828
20-Oct-04	0.147	0.010	0.157		20.985
27-Oct-04	0.190	0.014	0.204	**October**	21.189
3-Nov-04	0.234	0.019	0.253		21.442
10-Nov-04	0.186	0.019	0.205		21.647
17-Nov-04	0.174	0.015	0.189		21.836
8-Dec-04	0.263	0.025	0.288	**November**	22.124
15-Dec-04	0.280	0.029	0.309		22.433
22-Dec-04	0.228	0.027	0.255		22.688
29-Dec-04	0.256	0.026	0.282	**December**	22.970
	21.711	1.259	22.970	**Total 2004**	**22.970**

Table 4. Ranges of Air Tritium Concentrations (in pCi/m3) Collected On-Site (T1-T4) and Off-Site (R1-R6 & BM1) in 2004

Station	HTO pCi/m3	HT pCi/m3
T1	0.584 -2.84	0.584 - 4.51
T2	0.531 - 5.92	0.531 - 6.37
T3	0.737 - 4.77	0.737 - 7.24
T4	0.392 - 2.62	0.392 - 3.80
R1	0.441 - 2.64	0.522 - 3.18
R2	0.448 - 1.42	0.448 - 4.72
R3	0.406 - 1.54	0.406 - 1.92
R4	0.396 - 2.33	0.505 - 2.61
R5	0.396 - 2.01	0.396 - 2.06
R6	0.300 - 1.19	0.300 - 1.43
BM1	0.266 - 1.45	0.266 - 2.04

Table 5. Surface Water Tritium Concentrations for 2004(in picoCuries/Liter)

BOLD indicates above the level of detection.

Sample Location	Bee Brook (B1)	Bee Brook (B2)	Basin (DSN001)	D&R Canal (C1)	D&R Canal (DSN003)
January			**247**		**225**
February	68	127	**353**	≤Bkg.	32
March			**141**		9
April			23		**338**
May	18	104	144	≤Bkg.	≤Bkg.
June			**190**		<108
July			38		≤Bkg.
August	121	**243**	**260**	146	43
September			82		
October			18		51
November	<19	28	16	<19	<41
December			**83**		<82

Sample Location	Potable Water (E1)	Millstone River (M1)	Cranbury Brook (P1)	Devil's Brook (P2)
January				
February	≤Bkg.	≤Bkg.	≤Bkg.	≤Bkg.
March				
April				
May	≤Bkg.	63	≤Bkg.	≤Bkg.
June				
July				
August	81	74	≤Bkg.	≤Bkg.
September				
October				
November	<19	<19	<41	19
December				

Table 6. Ground Water Tritium Concentrations for 2004 (in picoCuries/liter)

Well No. or Sump Location	Well TW-1	Well TW-5	Well TW-8	Well MW-12S	Well D-12	Air Shaft Sump	D-site MG Sump
January	<103	**364**	**441**	<89	<89	**303**	**350**
February	**465**	**368**	**370**	<89	<89	175	**149**
March	**502**	**339**	**418**	≤Bkg.	≤Bkg.	**122**	**140**
April	**333**		≤Bkg.		<176	**185**	**158**
May	**447**	**308**	**304**	≤Bkg.	≤Bkg.	**257**	**210**
June	**368**	**319**	**331**	≤Bkg.	≤Bkg.	**195**	≤Bkg.
July	**446**	**244**	**243**	<165	<158	<220	<220
August	**318**	<246	<246	≤Bkg.	≤Bkg.	<369	<369
September	**340**	**187**	<173	<173	≤Bkg.	**143**	<114
October	**404**	**220**	**239**	<19	<133	**184**	<173
November	**293**	**86**	**77**	<41	<27	**114**	<411
December	**298**	**136**	**193**	<62	<62	**131**	**113**

BOLD indicates highest concentrations above background levels.

Table 7. Rain Water Tritium Concentrations (in picoCuries/liter) Collected On-Site in 2004

250 feet from Stack	R1E (East)	R1W (West)	R1S (South)	R1N (North)	R1ND (Duplicate)
March 02	<105	<105	**383**	<105	<105
March 30	**179**	≤Bkg.	**392**	**187**	<158
April 16	<106	**122**	**344**	<106	<106
June 01	**427**	<162	**295**	<162	<162
July 14	**410**	<199	≤Bkg.	<199	<199
August 19	≤Bkg.	**119**	≤Bkg.	≤Bkg.	≤Bkg.
October 06	≤Bkg.	<133	<133	<133	≤Bkg.
November 09	**59**	<27	**86**	**202**	**164**
December 08	**89**	**177**	**68**	**99**	**155**

500 feet from Stack	R2E (East)	R2W (West)	R2S (South)	R2N (North)	R3N (Far field)
March 02	<105	<105	≤Bkg.	<124	
March 30		<124	<124		
March 31	<124			**119**	
April 16		<106	**167**		
April 20	≤Bkg.			≤Bkg.	
June 01		<108	**150**		
June 02	**149**				**220**
July 14		<199	≤Bkg.		
July 15	≤Bkg.			≤Bkg.	
August 19	<114	41	≤Bkg.	<114	
October 06	<133	≤Bkg.	<133		
November 09	<27	<27	<27		
December 08		**57**	<41		

BOLD indicates highest concentrations above background levels.

Table 8. Rain Water Tritium Concentrations (in picoCuries/liter) Collected Off-Site in 2004

	REAM 1	REAM 2	REAM 4	REAM 5	REAM 6
February 19		<89			
February 20					≤Bkg
March 24					<158
April 16	≤Bkg	≤Bkg		**261**	
June 18			<108	<108	
July 06				≤Bkg	
August 06			≤Bkg	≤Bkg	<162
August 10	≤Bkg				
September 14		≤Bkg		≤Bkg	
October 07		<19		<19	
October 28		<19			
October 29				<19	<19
November 19			<41		

Table 9. Annual Range of Tritium Concentration at PPPL in Precipitation from 1985 to 2004

Year	Tritium Range picoCuries/Liter	Precipitation In Inches	Difference from Middlesex County Avg. Precipitation of 46.5 inches/yr
1985	40 to 160		
1986	40 to 140		
1987	26 to 144		
1988	34 to 105		
1989	7 to 90	55.4	+8.8
1990	14 to 94	50.3	+3.8
1991	10 to 154	45.1	-1.5
1992	10 to 838	41.9	-4.6
1993	25 to 145	42.7	-3.8
1994	32 to 1,130	51.3	+4.8
1995	<19 to 2,561	35.6	-10.9
1996	<100 to 21,140	61.0	+14.5
1997	131 to 61,660	42.0	-4.5
1998	<108 to 26,450	42.9	-3.6
1999	<58 to 7,817	47.3 (38.7 w/out Floyd)	+0.8 (-7.8)
2000	<31 to 3,617	38.7	-7.8
2001	153 to 14,830	32.8	-13.7
2002	24 to 3,921	47.9	+1.4
2003	9 to 1,126	54.7	+8.2
2004	27 to 427	40.5	-6.0

Table 10. Liquid Effluent Collection Tank Release Data for 2004

Sample Date	Gallons Released	COD (mg/l)	Tritium Sample LLD (pCi/L)	Tritium Sample Activity (pCi/L)	Total Tank Activity (Ci)	Annual Cumulative Activity (Ci)	Gross Beta Sample LLD (pCi/L)	Gross Beta Sample Activity (pCi/L)
3/3/2004	12,000	<20	200	11,300	0.000515	0.000515	192	<192
3/29/2004	11,250	<20	216	12,800	0.000545	0.00106	195	<195
4/6/2004	12,000	29.049	217	3,410	0.000155	0.001215	195	<195
4/9/2004	11,250	NS	212	2,840	0.000121	0.001336	195	<195
5/13/2004	11,400	<20	198	44,400	0.00192	0.003256	195	<195
5/25/2004	10,800	<20	233	64,700	0.00265	0.005906	195	<195
6/10/2004	10,800	<20	230	57,900	0.00237	0.008276	196	<196
6/22/2004	10,800	<20	205	51,500	0.0021	0.010376	196	<196
7/1/2004	12,600	<20	203	51,200	0.00244	0.012816	195	<195
7/14/2004	10,800	NS	213	46,700	0.00191	0.014726	196	<196
7/26/2004	10,800	NS	207	67,200	0.00275	0.017476	196	<196
7/30/2004	10,800	38.811	203	64,800	0.00265	0.020126	196	<196
8/4/2004	10,800	NS	267	54,800	0.00224	0.022366	196	357
8/17/2004	12,750	NS	271	59,900	0.00289	0.025256	195	<195
8/24/2004	10,500	<20	274	63,400	0.00252	0.027776	195	354
9/1/2004	10,950	33.246	285	64,400	0.00267	0.030446	195	296
9/15/2004	11,250	NS	267	63,000	0.00268	0.033126	195	237
9/21/2004	10,500	21.221	269	72,800	0.00289	0.036016	195	355
10/12/2004	10,800	<20	222	81,900	0.00335	0.0394	195	<195
12/15/2004	10,800	25.984	226	34,100	0.00139	0.0408	195	<195
Total gals. released in 2004	223,650							

Table 11. Surface Water Analysis for Bee Brook, B1, in 2004

Sample Date	2/5/04	5/11/04	8/4/04	11/2/04
Ammonia nitrogen as N, mg/L		0.11	<0.10	
Biological Oxygen Demand, mg/L		2.6	<2.5	
Chemical Oxygen Demand, mg/L	48.43, 31	<5.0	25.550	19.253
Nitrate-nitrogen, mg/L				<0.50
Oxidation-Reduction Potential, mV	54	16	6	31
pH, standard units	6.02	6.60	6.62	6.23
Phosphorus, total, mg/L	0.05	0.104	0.084	<0.05
Temperature, °C	0	16.3	23.4	11.5
Total Suspended Solids, mg/L	6.00	3.00	5.30	2.00
Total Organic Carbon, mg/L	7.00	8.39	7.38	13.4
Total Dissolved Solids, mg/L		206	177	

Location B1 = Bee Brook upstream of PPPL basin discharge
See Exhibit 4-3 for location.

Table12. Surface Water Analysis for Bee Brook, B2, in 2004

Sample Date	2/5/04	5/11/04	8/4/04	11/2/04
Ammonia nitrogen as N, mg/L		<0.10	<0.10	
Biological Oxygen Demand, mg/L		<2.2	<2.5	
Chemical Oxygen Demand, mg/L	28.98, 39	<5.0	19.422	5.031
Nitrate-nitrogen, mg/L				0.8
Oxidation-Reduction Potential, mV	15	17	-44	-7
pH, standard units	6.72	7.19	7.51	6.92
Phosphorus, total, mg/L	0.05	0.088	0.092	<0.05
Temperature, °C	2.2	17.5	24.4	13.7
Total Suspended Solids, mg/L	2.00	5.30	19.7	<2.00
Total Organic Carbon, mg/L	5.00	5.07	3.85	5.08
Total Dissolved Solids, mg/L		286	237	

Location B2 = Bee Brook downstream of PPPL basin discharge

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Table 13. Surface Water Analysis for Delaware & Raritan Canal, C1, in 2004

Sample Date	2/5/04	5/11/04	8/4/04	11/2/04
Ammonia nitrogen as N, mg/L		<0.10	0.120	
Biological Oxygen Demand, mg/L		<2.2	<2.5	
Chemical Oxygen Demand, mg/L	44.4, 68	<5.00	<5.00	<5.00
Nitrate-nitrogen, mg/L				0.9
Oxidation-Reduction Potential, mV	16	-8	12	9
pH, standard units	6.68	7.02	6.51	6.70
Phosphorus, total, mg/L	0.05	0.08	0.092	<0.05
Temperature, °C	0.2	22.2	27.7	14.1
Total Suspended Solids, mg/L	62	7.00	4.70	2.00
Total Organic Carbon, mg/L	2.00	4.12	6.63	3.50
Total Dissolved Solids, mg/L		126	106	

Location C1 = Delaware & Raritan Canal State Park at Mapleton Avenue, Plainsboro midway on pedestrian bridge
See Exhibit 4-3 for location.

Table 14. Surface Water Analysis for Elizabethtown Water, E1, in 2004

Sample Date	2/5/04	5/11/04	8/4/04	11/2/04
Ammonia nitrogen as N, mg/L		0.22	0.23	
Biological Oxygen Demand, mg/L		<2.2	<2.5	
Chemical Oxygen Demand, mg/L	27.12, 21	14.31	<5.0	<5.0
Nitrate-nitrogen, mg/L				1.4
Oxidation-Reduction Potential, mV	18	0	19	-4
pH, standard units	6.66	6.86	7.08	6.84
Phosphorus, total, mg/L	0.05	<0.05	<0.05	<0.05
Temperature, °C	NS	NS	NS	NS
Total Suspended Solids, mg/L	<2.00	<2.00	<2.00	<2.00
Total Organic Carbon, mg/L	1.0	1.93	2.79	1.94
Total Dissolved Solids, mg/L		283	211	

Location E1 = Elizabethtown Water (potable) collected at Main Gate Security Booth
mid-span on bridge across Millstone River
See Exhibit 4-3 for location.

Table 15. Surface Water Analysis for Millstone River, M1, in 2004

Sample Date	2/5/04	5/11/04	8/4/04	11/2/04
Ammonia nitrogen as N, mg/L		0.24	0.210	
Biological Oxygen Demand, mg/L		2.9	2.90	
Chemical Oxygen Demand, mg/L	36.99, 86	<5.0	28.706	<5.0
Nitrate-nitrogen, mg/L				3.0
Oxidation-Reduction Potential, mV	74	18	15	8
pH, standard units	5.63	6.57	6.48	6.67
Phosphorus, total, mg/L	0.05	0.088	0.084	<0.05
Temperature, ^{o}C	1.6	*25.6*	29.0	15.3
Total Suspended Solids, mg/L	17	*6*	6.70	6.70
Total Organic Carbon, mg/L	4	6.28	7.15	5.26
Total Dissolved Solids, mg/L		180	151	

Location M1 = Millstone River at Delaware & Raritan Canal State Park at Mapleton Road,
NS = Not sampled

Table 16. Surface Water Analysis for Cranbury Brook (Plainsboro), P1, in 2004

Sample Date	2/5/04	5/11/04	8/4/04	11/2/04
Ammonia nitrogen as N, mg/L		0.13	0.13	
Biological Oxygen Demand, mg/L		4.8	<2.50	
Chemical Oxygen Demand, mg/L	41.93, 44	<5.0		<5.0
Nitrate-nitrogen, mg/L				1.7
Oxidation-Reduction Potential, mV	76	34	23	57
pH, standard units	5.66	6.31	6.29	5.73
Phosphorus, total, mg/L	0.05	0.104	0.068	<0.05
Temperature, ^{o}C	2.1	25	26.4	14.5
Total Suspended Solids, mg/L	12	8.7	2.3	6.0
Total Organic Carbon, mg/L	5	6.69	7.33	3.97
Total Dissolved Solids, mg/L		160	134	

Location P1 = Cranbury Brook at George Davison Road, Plainsboro mid-span on bridge southbound

Table 17. Surface Water Analysis for Devil's Brook (Plainsboro), P2, in 2004

Sample Date	2/5/04	5/11/04	8/4/04	11/2/04
Ammonia nitrogen as N, mg/L		0.14	<0.10	
Biological Oxygen Demand, mg/L		5.3	<2.50	
Chemical Oxygen Demand, mg/L	35.45, 28	<5.0		9.99
Nitrate-nitrogen, mg/L				<0.50
Oxidation-Reduction Potential, mV	53	31	35	41
pH, standard units	6.02	6.37	6.12	6.23
Phosphorus, total, mg/L	0.05	0.08	0.084	<0.05
Temperature, ^{o}C	2	24.3	23.0	13.2
Total Suspended Solids, mg/L	6	12	9.30	4.3
Total Organic Carbon, mg/L	6	11.1	17.9	11.9
Total Dissolved Solids, mg/L		83	140	

Location P2 = Devil's Brook at Schalks Road overpass, adjacent to Amtrak railroad tracks

Table 18. DSN001 - Detention Basin Outfall 2004 Surface Water Analysis (NJPDES NJ0023922)

Permit Limit	Units	Parameters	1/7/04	2/5/04	3/3/04	4/6/04	5/11/04	6/8/04
	NA	mg/L	Ammo nia-N					<0.10
	mg/L	Biological Oxygen Demand					<2.2	
50 mg/L	mg/L	Chemical Oxygen Demand	29.494 5	27.301	23.5 34.23	8.078	<5.00	24.736
NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	mgd	Flow, Avg. Monthly	0.120	0.136	0.126	0.234	0.142	0.082
NA	mV	Oxidation-Reduction Potential	-23	-20	-61	-25	-42	-53
10 mg/L	mg/L	Petroleum Hydrocarbons	0.58	<0.500 <0.500	<0.500	<0.500	0.64	<0.500
6.0-9.0	S.U.	pH	7.39	7.35	8.02	7.44	7.58	7.82
	mg/L	Phosphorus, Total		0.124 <0.10			0.096	
	µg/L	Tetrachloroethylene		0.6 0.49			0.83	
30 °C max.	°C	Temperature	9.0	8.4	14.65	11.4	18.1	19.5
NA	mg/L	Total Dissolved Solids					340	
	mg/L	Total Organic Carbon	1.28	2, 1.9	7		1.59	1.74
50 mg/L	mg/L	Total Suspended Solids	<2.00	2.00 3.00	<2.00	<2.00	3.00	5.00

Permit Limit	Units	Parameters	7/7/04	8/4/04	9/8/04	10/6/04	11/2/04	12/9/04
NA	mg/L	Ammonia-N		<0.1				
	mg/L	Biological Oxygen Demand		<2.5				
50 mg/L	mg/L	Chemical Oxygen Demand	45.914	<5.00	31.655	<5.00 <5.00	<5.00	<5.00
0.016	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
100	percent	Chronic Toxicity Test NOEC (% effluent) *Pimephales promelas*			>100			
NA	mgd	Flow, Avg. Monthly	0.139	0.083	0.119	0.085	0.153	0.204
NA	mg/L	Nitrate-N					1.20	
NL	mV	Oxidation-Reduction Potential	-70	-57	-28	-56.5	-60	-14
10 mg/L	mg/L	Petroleum Hydrocarbons	0.68	<0.500	<0.500	<0.500	<0.500	<0.500
6.0-9.0	S.U.	pH	8.05	7.75	7.31	7.82	7.86	7.02
	mg/L	Phosphorus, Total		0.051			<0.050	
	µg/L	Tetrachloroethylene		0.87J			0.75J	
30 °C max.	°C	Temperature	23.4	25	22.9	16.8	15	12.5
	mg/L	Total Dissolved Solids		277				
NA	mg/L	Total Organic Carbon	4.85	3.70	4.00	1.56	1.74	1.27
50 mg/L	mg/L	Total Suspended Solids	8.70	5.30	4. 00	4.00	2.70	3 .0

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

Table 19. D&R Canal Pump House - DSN003 2004 Monthly Surface Water Analysis (NJPDES NJ0023922)

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	1/7/04	2/5/04	3/3/04	4/21/04	5/11/04	6/8/04
NA	NA	mg/L	Ammonia-N					<0.1	
		mg/L	Biological Oxygen Demand					<2.2	
NA	NA	mg/L	Chemical Oxygen Demand	19.98	36.99 23	<5.0	7.75	<5.00	<5.00
NL	NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NL	NL	mV	Oxidation-Reduction Potential	42	30	-40		-4	-1
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	0.57	<0.50	<0.50	<0.50	<0.50	<0.50
NA	6.0-9.0	S.U.	pH	6.32	6.45	7.65	7.11	6.89	6.89
NA		mg/L	Phosphorus, Total		<0.10			0.831	
NA	NA	°C	Temperature	7.0	2.0	17.3	19.7	20.9	28
		mg/L	Total Dissolved Solids					143	
NA	NA	mg/L	Total Organic Carbon	4.7	4		4.24	3.04	
20 mg/L	60 mg/L	mg/L	Total Suspended Solids		1.0			6.70	

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	7/7/04	8/4/04	9/23/04	10/6/04	11/2/04	12/9/04
NA	NA	mg/L	Ammonia-N		<0.10				
		mg/L	Biological Oxygen Demand		<2.5				
NA	NA	mg/L	Chemical Oxygen Demand		<5.00			<5.00	
NL	NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	NA	mg/L	Nitrate-N					1.00	
NL	NL	mV	Oxidation-Reduction Potential	-18	27	35	18	11.5	30
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	0.760	<0.50	1.1	<0.50	<0.50	<0.50
NA	6.0-9.0	S.U.	pH	7.10	6.24	6.35	6.37	6.53	6.34
NA	NA	mg/L	Phosphorus, Total		0.084			<0.050	
NA	NA	° C	Temperature	27.7	25.0	19.3	15.9	13.0	7.3
NA	NA	mg/L	Total Dissolved Solids		91				
NA	NA	mg/L	Total Organic Carbon	5.8	5.8	4.02		3.33	4.04
NL	NL	mg/L	Total Suspended Solids		5.00			<2.00	

Flow = 250 gallons per minute X 2 minutes per cycle X 10 cycles per day = 5,000 gallons per day
** Permit changed from monthly to quarterly monitoring and no limit for Total suspended solids*
Blank indicates no measurement
NA = not applicable
NL = no limit

Table 20. Summary of Ground Water Sampling Results – 2002 to 2004
Target Chlorinated Volatile Organic Compounds

Location	Date	PCE (ug/L)	TCE (ug/L)	c-1,2-DCE (ug/L)	1,1-DCE (ug/L)	1,1,1-TCA (ug/L)
NJ GWQS		**1.0**	**1.0**	**70.0**	**2.0**	**30.0**
MW-13I	7/29/2002	38.2	0.52 J	< 0.6	0.76 J	2.96 J
	10/20/2003	38.7	3.42	3.04NJ	<1.2	2.9
	9/22/04	**34.8**	**<0.9**	**<0.5**	**<1.2**	**2.72**
MW-13S	7/29/2002	51.4	1.57 J	4.5 NJ	<0.4	1.72 J
	10/20/2003	75.5	315	10.4NJ	<1.2	1.68
	9/22/2004	**57.8**	**431**	**18**	**1.2J**	**1.35**
MW-18	7/30/2002	0.62 J	0.5 J	< 0.8	< 0.8	< 0.8
	10/20/2003	0.74J	0.54J	<0.7	<1.2	<0.7
	9/22/2004	**0.83J**	**<0.5**	**< 0.5**	**< 1.2**	**< 0.9**
MW-19I	7/30/2002	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
	10/20/2003	<0.4	<0.3	<1.0	<1.2	<0.9
	9/22/2004	**< 0.4**	**< 0.5**	**< 0.5**	**<1.2**	**< 0.9**
MW-19S	11/20/2002	214	12.8	61.2	< 0.7	0.55 J
	10/21/2003	229	14.9	52.5	< 6.0	< 4.5
	9/22/2004	**154**	**9.3**	**34.1**	**<1.2**	**<0.9**
MW-22S	11/20/2002	< 0.6	0.25	< 0.6	< 0.7	0.84 J
	10/21/2003	< 0.8	< 0.8	< 0.8	< 0.8	0.68 J
	9/22/2004	**<0.4**	**<0.5**	**<0.5**	**<1.2**	**<0.9**
MW-23S	7/30/2002	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
	10/21/2003	< 0.8	< 0.8	< 0.8	< 0.8	0.68 J
	9/22/2004	**<0.4**	**<0.5**	**<0.5**	**<1.2**	**<0.9**
MW-24S	7/30/2002	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
	10/21/2003	< 0.4	< 0.3	<1.0	< 1.2	<0.9
	9/22/2004	**<0.4**	**<0.5**	**<0.5**	**<1.2**	**<0.9**
MW-25	11/21/2002	0.90 J	< 0.6	4.21	< 0.6	< 0.7
	10/21/2003	0.9 J	0.5 J	5.31NJ	0.6 J	< 0.7
	9/22/04	**0.79**	**<0.5**	**5.21 NJ**	**<1.2**	**<0.9**
D-Site MG	7/29/2002	88.6	6.31	3.61 NJ	2.01 J	1.36 J
Building Sump	10/21/2003	77.5	5.76	3.81NJ	1.52	0.93J
	9/22/2004	**65.4**	**6.63**	**7.08 NJ**	**1.52**	**<0.9**
D-site Air Shaft	7/29/2002	2.88 J	< 0.8	< 0.8	< 0.8	< 0.8
Building Sump	6/18/2003	5.19	<0.8	<0.7	<0.6	<0.7
	9/22/2004	**1.89**	**<0.5**	**<0.5**	**<1.2**	**<0.9**

Notes:
"J" indicates a value that is greater than the MDL but lower than the lowest standard.
"N" indicates presumptive evidence of a compound.
PCE – Tetrachloroethene TCE – Trichloroethene
c-1,2-DCE – cis-1,2-Dichlorothene 1,1-DCE – 1,1-Dichloroethene 1,1,1-TCA – 1,1,1-Trichloroethane

Table 21. Quality Assurance Data for Radiological and Non-Radiological Samples for 2004

Laboratory, Program, and Parameter	Reported Value	Actual Value	Acceptance Range
ERA (picoCuries/Liter)			
RAD-55	15,500	14,300	11,800-16,800
RAD-58	6030	5890	4870-6910
RAD-60	26,100	30,200	25,000-35,400
PPPL Test Results- February 2004 WP0104			
Total residual chlorine (mg/L)	4.69	3.52	2.90-4.14
pH (S.U.)	8.30	8.16	8.06-8.54
Chemical oxygen demand (mg/L)	160.89	165	127-188
Specific conductance (μmhos/cm)	805.5	760	697-823
June 2004 WP			
Chemical oxygen demand (mg/L)	35.453	23	11.9-33.2
Specific conductance (μmhos/cm)	669	575	531-625
pH (S.U.)	8.25	8.46	8.21-8.70
Total residual chlorine (mg/L)	0.967	0.931	0.681-1.10
July 2004 WP0204			
Chemical oxygen demand (mg/L)	274.1	241	188-271
Specific conductance (μmhos/cm)	883.7	879	806-952
pH (S.U.)	8.72	8.72	8.46-8.98
Total residual chlorine (mg/L)	4.10	4.74	3.93-5.55
December 2004 WP			
Chemical oxygen demand (mg/L)	162.90	152	116-174
Specific conductance (μmhos/cm)	778	784	701-827

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