Princeton Plasma Physics Laboratory

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ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEARS 2005-2006

INSTALLATION OF AN ENERGY STAR® ROOF ON THEORY WING AT PPPL

Princeton Plasma Physics Laboratory
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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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In 2006, PPPL began to actively purchase Energy Star® rated products, from roofing materials to electronic equipment.

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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 15 th 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 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 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 ⁹ Bq

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
nSv	nanoSievert

List of Acronyms

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/era	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

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**Princeton Plasma Physics Laboratory (PPPL)
Certification of Monitoring Data for
Annual Site Environmental Report for 2005 and 2006**

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 Accutest Laboratory. To the best of our knowledge, these data, as contained in the "Annual Site Environmental Report for 2005 and 2006," are documented and certified to be correct.

Signed:

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Princeton Plasma Physics Laboratory

Annual Site Environmental Report for Calendar Year 2005-2006

Executive Summary

This report presents the results of environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Years 2005-2006. 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 2005-2006. 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. Fusion is the reaction that occurs in our sun as well as in other stars. During 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.

Calendar Years 2005-2006 marked the seventh and eighth years of the National Spherical Torus Experiment (NSTX) operations, accomplishing 18 and 12.5-run weeks. 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, *i.e.* a volumetric neutron source.

The National Spherical Torus Experiment Heated by Neutral Beam Injection

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*

Cadarache, France selected as the site for ITER

On June 28, 2005, the location of the International Thermonuclear Experimental Reactor or ITER, which in Latin means “the way,” was decided at a ministerial-level meeting in Moscow. A bilateral agreement was reached between France and Japan that ITER will be built at Cadarache, France and that the “Broader Approach,” the complementary development projects, would be located in Japan.

The former Japanese Deputy Minister of Science and Technology, Ambassador Kaname Ikeda, was nominated for Director of ITER Organization. He inaugurated the “Joint Work Site” at Cadarache in December 2005. Another important milestone was the addition of its newest party member, India, that brought the total to thirty-three nation participants.

PPPL partnered with Oak Ridge National Laboratory, hosts the U.S. ITER Project office. This office coordinates U.S. ITER activities.

<http://www.iter.org/default.aspx>

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

Secretary of Energy Samuel Bodman visits PPPL

On November 21, 2006, Secretary Bodman toured PPPL, addressed the staff, and held a press briefing where he described the Laboratory as “the most advanced center for fusion energy research in the U.S.” His visit coincided with the historic ITER agreement signed in Paris, France by ministers from the European Union, Japan, China, India, South Korea, the Russian Federation, and the United States. Secretary Bodman said as a leader in the U.S. fusion program, PPPL will play a key role in the ITER project [PPPL06e].

Secretary Bodman stressed the importance of engaging more young people in science, engineering, and mathematics and emphasized the need for more women in these disciplines. Lastly, he addressed PPPL’s mission to harness fusion energy and its past and future contributions to the field of plasma physics [PPPL06e].

Plainsboro Mayor, Peter Cantu, Secretary Samuel Bodman, and PPPL Director Rob Goldston tour NSTX

Secretary Bodman addresses PPPL staff

PPPL Achievements 2005-2006

For outstanding achievement in recycling, the New Jersey Department of Protection presented PPPL with an award for 2005. PPPL was also recognized by the *Environmental Protection Magazine* for its excellent environmental performance and was the sole Federal Facility recipient of this honor in 2006.

In 2005, PPPL received the US Department of Energy's Pollution Prevention and Environmental Stewardship award for the second consecutive year. PPPL was recognized for its substitution of petroleum-based

products with bio-based fuels and lubricants for its vehicles and facilities' equipment.

At PPPL, the National Compact Stellarator Experiment (NCSX) began awarding contracts for fabrication of major component contracts 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. Unique to NCSX is its shape, which resembles a twisted doughnut. In the former TFTR test cell, the Coil Winding and Facility was constructed and coil winding began.

Deputy Director, DOE's Office of Science Ray Orbach tours NCSX Coil Winding Facility (April 2006)
From the left are NCSX staff members M. Anderson, S. Raftopoulos, and R. Tucker, Jr., H. Neilson, R. Orbach.

The coil winding forms alone weigh three tons. In total 18 modular coils will be fabricated at PPPL. The anticipated start-up date for NCSX is 2009. (Note: This project was cancelled in early 2009).

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.

D. Voorhees works on the second coil in the NCSX Coil Winding Facility at D-site

In 2005-2006, 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 2005 were as follows:

1. Total maximum off-site dose from all sources—airborne and liquid releases—was 0.01 mrem/year.
2. Dose at the nearest business due to airborne releases was 0.003 mrem/year.
3. The collective effective dose equivalent for the population

living within 80 kilometers was 0.11 person-rem.

The total maximum off-site dose for 2005 was the lowest since 1993, prior to D-T experiments. The dose is a fraction of the 10-mrem/year PPPL objective and the 100-mrem/year DOE limit.

The dose results of the radiological monitoring program for 2006 were as follows:

1. Total maximum off-site dose from all sources—airborne and liquid releases—was 0.0158 mrem/year.
2. Dose at the nearest business due to airborne releases was 0.0041 mrem/year.
3. The collective effective dose equivalent for the population living within 80 kilometers was 0.1258 person-rem.

The total maximum off-site dose for 2005-2006 doses are a small fraction of the 10-mrem/year PPPL objective and the 100-mrem/year DOE limit.

PPPL's 2005 Pollution Prevention and Community Outreach Programs included Earth Day and America Recycles Day celebrations. In April 2005 and 2006, PPPL participated in Earth Day activities at the Mercer County Park, 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.

For PPPL's 2006 Earth Day program, the Laboratory's Environmental Management System (EMS) was formally presented to the Laboratory staff. The EMS program began in 2001 with full implementation by the end of CY2005.

Earth Day 2006

PPPL's Pollution Prevention Program results in 2005 and 2006 were based on:

1. Usage of recycled material *versus* non-recycled material;
2. Reduction of waste to landfills and/or disposers - hazardous waste (66%, 61.8%) and solid waste (52.3%, 47.5%) - accomplished by actively seeking waste recyclers, and
3. Buying recycled rate of 87.8% and 74.9% in 2005 and 2006, respectively (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 2005-2006, annual ground-water monitoring continued as a requirement of the Remedial Action Work Plan including sampling results reporting from selected wells, sumps, and surface water locations. 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 over time, the VOC contaminants are biodegrading through natural attenuation in the ground water. PPPL's remedial action work plan relies on existing building drains for containment and extraction.

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.govhttp://www.pppl.gov/Sustainable.cfm>

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, East and 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 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. 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).

Surrounding the site are preserved lands that are undisturbed areas including upland forest, wetlands, open grassy areas, and a minor stream, Bee Brook, which flows along PPPL’s 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 by 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 about 46 inches (116 cm) evenly distributed throughout the year. Droughts typically occur about once every 15 years [PSAR78]. In 2005, the annual rainfall total, 48.4 inches (122.9 cm) was above the average rainfall for central New Jersey. This above-average level was primarily due to wet weather in the October when 14.45 inches (36.7 cm) were recorded (Table A-2) [Ch 06]. 2006 was another above-average year for annual precipitation (48.09 inches, 122.2 cm) due in part to above-average

rainfall in October (7.25 inches, 18.4 cm).

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 operate 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 September 13, 2005 the device completed its 18.0 weeks of operations, having accomplished many of its goals - one being production of almost 2200 plasma discharges; on June 23, 2006 NSTX completed 12.7 weeks of operations, having accomplished many of its goals including the production of over 1600 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).

In 2005, fabrication subcontracts were awarded for the construction of the vacuum vessel. Its complex design required that PPPL's Quality Assurance and Engineering staff work closely with the fabricator. PPPL engineers and technical staff began fabrication of the magnetic coils in the former TFTR Test Cell, now called the NCSX Coil Winding Facility. The process included copper wire wound on a 360° frame shaped to conform to the twisted vacuum vessel. In order for the copper wire to maintain its shape, the coil was placed in a large oven (called an autoclave) impregnated with an epoxy, then baked and cooled to allow for the epoxy to "cure."

"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].

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

Exhibit 2-4 shows the uniquely twisted shape of the vacuum vessel 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.

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]. *

2005-2006 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 2005-2006, 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 2005, PPPL shipped off site approximately 6.51 tons (5.1 metric tons, MT) of waste to facilities permitted to treat, store, or dispose of hazardous wastes and 65.94% or 12.61 tons (11.46 MT) of its wastes were recycled [MP06b]. Summaries of PPPL's annual hazardous waste generation rates and waste reduction/recycling efforts are presented in Exhibits 3-1 and 3-2. In 2005, PPPL recycled 52.28% of its municipal solid waste stream, which exceeded its goal of 50% recycled waste [McG06].

In 2006, PPPL shipped off site approximately 8.11 tons (7.36 metric tons, MT) of waste to facilities permitted to treat, store, or dispose of hazardous wastes and 61.76% or 13.10 tons (11.88 MT) of its wastes were recycled [MP07b]. Summaries of PPPL's annual hazardous waste generation rates and waste reduction/recycling efforts are presented in Exhibits 3-1 and 3-3. In 2006, PPPL recycled 47.48% of its municipal solid waste stream, which did not meet its goal of 50% recycled waste [McG07].

Exhibit 3-1 compares the three largest quantities by waste type generated from 1998 to 2006. The waste types and quantities are highly variable from year to year. For example, between 2004 and 2006, the largest waste categories were oil and oily debris, used oil, and electronic and computer monitors, respectively, that were either incinerated or recycled. Another

Exhibit 3-1. Hazardous Waste Comparisons 1998-2006 (3 largest categories)

Exhibit 3-2. 2005 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 Waste	Recycled / Total Hazardous Waste	65.98%	
	Oil used	2.67 MT	Recycled
	Oily sand, soil, gravel	1.71 MT	Recycled
	Batteries (includes lead acid)	2.28 MT	Recycled
	Fluorescent lamps (contain Hg)	1.13 MT	Recycled
	Computer monitors	2.58 MT	Recycled
	Ignitrons	0.8 MT	Recycled
	Mercury /Mercury debris	0.14 MT	Recycled
	PCB caps	0.15 MT	Recycled
	Batteries – lithium /acid debris	0.09 MT	Incinerated
	Medical waste	0.01 MT	Incinerated
	Lab wastes, transformer oil	0.32 MT	Incinerated
	Ethylene glycol	0.21 MT	Incinerated
	Gallium, Lead debris, Misc.	0.40 MT	Incinerated
	Solvents	1.32 MT	Incinerated
	PCBs/Non-PCBs Capacitors, waste	0.67 MT	Incinerated
	Oily debris	0.92 MT	Land-filled
	Cyanide	0.17 MT	Treated
	Waste water	1.72 MT	Treated
TSCA Waste	Asbestos	120 cu. yds.	Land-filled
	PCB capacitors, ballasts & debris	0.67 MT	Incinerated
	Ballasts incl. Ballasts (PCBs)	0.15 MT	Recycled
Municipal Solid Waste (MSW)	Office Waste Stream	52.28 %	
	Front end trash	55.28 MT	Land-filled
	Aluminum & glass (bottles & cans)	9.25 MT	Recycled
	Cardboard/ Paper (mixed)	51.30 MT	Recycled
	Industrial Waste Stream	100 %	
	Scrap metals (Al, SS, Cu, Fe)	145.78 MT	Recycled
	Electronic Media	11.21 MT	Recycled
	Toner cartridge	0.56MT	Recycled
	Construction waste	11.24 %	
	Construction & Demolition trash	102.08 MT	Land-filled
	Wood	5.58	Recycled
	Concrete	6.35	Recycled
	Buy Recycled Products Rate-unadjusted	87.83 %	Goal is 100 %

[Kin06a]

Exhibit 3-3. 2006 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 Waste	Recycled / Total Hazardous Waste	61.76%	
	Oil used	1.16 MT	Recycled
	Oily sand, soil, gravel	0.63 MT	Recycled
	Batteries (includes lead acid)	3.26 MT	Recycled
	Fluorescent lamps (contain Hg)	0.76 MT	Recycled
	Computer monitors	4.45 MT	Recycled
	Ozzy Juice	0.28 MT	Recycled
	Mercury /Mercury debris	0.01 MT	Recycled
	PCB caps, ballasts	0.83MT	Recycled
	Scintillation fluid	0.59 MT	Recycled
	Batteries – lithium /acid debris	0.03 MT	Incinerated
	Medical waste	0.01 MT	Incinerated
	Lab wastes, silver paper	1.17 MT	Incinerated
	Ethylene glycol	0.88 MT	Incinerated
	Gallium, Lead debris, Misc.	0.17 MT	Incinerated
	Cadmium debris	0.20 MT	Incinerated
	Solvents	1.12 MT	Incinerated
	PCBs/Non-PCBs Capacitors, waste	0.43 MT	Incinerated
	Oily debris	0.86 MT	Land-filled
	Cyanide	0.05 MT	Treated
	Waste water	2.43 MT	Treated
TSCA Waste	Asbestos	40 cu. yds.	Land-filled
	PCB capacitors, ballasts & debris	0.43 MT	Incinerated
	Ballasts incl. Ballasts (PCBs)	0.83MT	Recycled
Municipal Solid Waste (MSW)	Office Waste Stream	47.48 %	
	Front end trash	60.74 MT	Land-filled
	Aluminum & glass (bottles & cans)	5.93 MT	Recycled
	Cardboard/ Paper (mixed)	48.99 MT	Recycled
	Industrial Waste Stream	100 %	
	Scrap metals (Al, SS, Cu, Fe)	107.08 MT	Recycled
	Electronic Media	16.09 MT	Recycled
	Toner cartridge	0.27MT	Recycled
	Construction waste	88.23 %	
	Construction & Demolition trash	126.1 MT	Land-filled
	Wood	6.87	Recycled
	Concrete	901.49	Recycled
	Other	37.14	
	Buy Recycled Products Rate-unadjusted	74.91 %	Goal is 100 %

[Kin07a][MP07b][TMcG07]

variable is the number and nature of petroleum spills that require cleanup and removal of oily gravel and/or soil debris.

PPPL is in compliance 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 correspondence with Princeton University.

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)

Thirty-one (31) PPPL activities in 2005 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). [Lev06b].

Thirty-five (35) PPPL activities in 2006 received NEPA reviews [Lev07b].

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 2005-2006, only 5 PCB capacitors that met the regulation criteria remained at PPPL [MP06a, 07a].

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 2005-2006 [Kin06b, Kin07b].

2005	
Herbicides:	Roundup (2.5 gallons)
Fertilizer:	NPK (480 lbs.)
2006	
Herbicides:	Chaser (3 qts.)
	Roundup (2 gallons)
	Dimension (4.5 gallons)
Insecticide:	Sevin Carbaryl (1 pt.)

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 [PPPL04a]. There are numerous transformers containing non-PCB mineral oil as well as fuel oil tanks (25,000, 15,000 and 5,000 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 inspection of the facility conducted occurred in June 1998 by US EPA Region 2. Under New Jersey regulations, NJDEP classified PPPL as a non-major facility [NJDEP98a]. The

threshold, 200,000 gallons of petroleum (not in transformers), was not exceeded. As a minor facility, the Discharge Prevention Control and Containment (DPCC) plan and Discharge Cleanup and Reporting plan (DCR) requirements do not apply to PPPL.

In November 2004, NJDEP notified PPPL that although PPPL has reporting obligations under the regulations to call the NJDEP 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 Appendices A and B, Table 1 (herein noted as Tables 1-A & 1-B).

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

Following the end of TFTR deuterium and tritium (isotopes of hydrogen, D-T) 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 3-4).

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 3-5). 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 the public.

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 using the following documents [DOE99b]:

- PPPL ESHD 5008, Section 7, *Waste Management* [PPPL03a]; and
- Environmental Restoration/Waste Management (ER/WM), EM-CP-21, *Low-level Radioactive and Mixed Waste Certification Plan* [PPPL98b].

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.

Exhibit 3-4. Critical Pathways

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

Exhibit 3-5. Radiation Monitoring Program Covering Critical Pathways

Type of Sample	Critical Pathway Exhibit 3-4	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, and Millstone River)	1 – Monthly 2 – Monthly 3 – Quarterly	All surface water samples –HTO
Rain Water	L1, L2, & L3	Within 250 and 500' radius of D-site stack (N,S,E, & W) 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 basements	Monthly	HTO
Sanitary Waste Water	L1 & L2	Liquid effluent collection tanks (3 tanks each 15,000 gal. on D-site)	As required	HTO Gross b
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 &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

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 [PPPL04ba]. PPPL's management assures that nuclear material used at PPPL is properly controlled, inventoried, and accounted 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 Air Quality and Protection

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 (Exhibit 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, Kir06, Kir07]. In 2005, actual NO_x emission from the four boilers was calculated to be 6.37 tons, well below the regulatory limit of 15.26 tons per year (see Exhibit 3-7).

In 2006, actual NO_x emission from the four boilers was calculated to be 5.11 tons, well below the regulatory limit of 15.26 tons per year (see Exhibit 3-7).

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 (SF₆) released annually from TFTR. Prior to 1995, the amount of SF₆ needed to maintain the SF₆ systems ranged from 28,060 pounds to 36,340 pounds per year. During TFTR operations, SF₆ maintained high-voltage electrical equipment - modulator regulators, ion cyclotron radio frequency (ICRF), and neutral beam (NB) high voltage and ion source enclosures.

Exhibit 3-6. Natural Gas and No. 2 and 4 Fuel Oil Consumption from 2000 to 2006

Note: No. 2 Fuel oil consumption first began December 2004.
No. 4 Fuel oil no longer burned after December 2004.

Exhibit 3-7. 2002 to 2006 Total Air Emissions from Boilers 2-5

Following TFTR shutdown in 1997, PPPL removed the remaining inventory of SF₆ from those systems. Currently SF₆ is used only in NSTX's high voltage regulators with lesser quantities of SF₆ purchased.

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 2006 and the associated activities.

In 2005, the levels of tritium released during operations were: 4.392 curies of HTO and 0.800 curies of HT (Exhibit 3-8 and Table 3-A). This represents the lowest level of tritium releases in 12 years (since 1993). 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). In 2006, the levels of tritium released during operations were: 5.553 curies of HTO and 0.579 curies of HT (Exhibit 3-8 and Table 3-B).

In 2005 and 2006, the effective dose equivalents (EDE) to a person at the business nearest PPPL, due to radionuclide air emissions, were 0.003 mrem (0.03 µSv) and 0.004 mrem (0.04 µSv), respectively, which is significantly lower than the NESHAPs standard of 10 mrem/yr (Exhibit 3-9) [Lev06a, 07a].

Exhibit 3-8. Total Air Releases from D-Site (formerly TFTR) Stack from 1994 to 2006

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
2005	4.392	0.800	5.192	NSTX Operations
2006	5.553	0.579	6.132	NSTX Operations

Annual Limit is 500 Curies.

Exhibit 3-9. Estimated Dose (mrem) from PPPL Operations from 1994 to 2006

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

During their most recent inspection of PPPL's facilities in March 1998, representatives from EPA Region II indicated that PPPL complied with NESHAPs requirements [Lev06c, Lev07c].

(see Section 6.1.3). The data collected for 24 quarters (6 years) were consistent: trace levels of PHCs or no PHCs were detected and the former USTs were not contributing to ground water contamination.

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 (PHCs) and VOCs until September 1997

Under the CWA and "New Jersey Discharge of Petroleum and Hazardous Substances" regulation (New Jersey Administrative Code Title 7, Chapter 1E), PPPL reported one release during CY05, mineral oil spill for the transformer filter skid, and two releases in CY06: 1. an overflow of hydraulic fluid (~2 quarts) from a drip pan under the Grove crane and 2. ~30 gallons of diesel oil from the

D-site generator. About 15 to 20 gallons were collected [PPPL05b, 06b, and 06d].

3.4.2 National Pollutant Discharge Elimination System (NPDES)

In 2005, 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 permit (EDP) - 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) [PPPL03b].

In 2005, 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. These two locations and D&R Canal upstream (C1) are designated as monitoring points. Similar to the period 2000 to 2001 and 2004, all monthly/quarterly samples analyzed in 2005 for Discharge Monitoring Program of the NJPDES permit were within the permit limits, *i.e.*, no non-compliances.

In 2006, the chemical oxygen demand (COD) concentration limit of 50 mg/L was exceeded twice in May (157.6 and 83.3 mg/L) at the basin outfall. A source of the high COD concentrations could not be determined; however, neither could laboratory error be ruled out.

In February 2006 (EDP 2/1/06), the revised NJPDES permit was issued by NJDEP. New permit conditions included

a change from quarterly to monthly monitoring of total phosphorus (Total P) and tetrachloroethylene also known as perchloroethylene (PCE) and calculating the quantity or loading in kilograms (kg)/day for total phosphorus, PCE, chlorine-produced oxidants (CPO) at DSN001 and CPO at DSN003.

Additional monitoring for the "Waste Characterization Report" (WCR) annually at DSN001 and once in five years at DSN003 was added to the permit requirements. The WCR from NJDEP's List of Toxic Pollutants (NJAC 7:14A-4 Appendix A) include the Priority Pollutants: acid compounds, base/neutral, volatile organic compounds, metals and cyanide, total phenols, pesticides/polychlorinated biphenyls (PCBs), and conventional/non-conventional pollutants. 4 to 4.5 years after the effective date of the permit, acute toxicity testing at DSN003 is required. A Total P study to determine nutrient loading capacity for the receiving water body (Bee Brook) and a remedial action PCE study were new additions to the permit conditions.

On March 4, 2004, the Stony Brook Regional Sewerage Authority (SBRSA), the publicly owned treatment works (POTW) that receives PPPL's sanitary wastewater stream, notified PPPL that the discharge license was no longer required due to a change in SBRSA regulations [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).

Exhibit 3-10. NJPDES Non-Compliances 2000-2006

Outfall No.	Parameter	# Non-compliance	# Samples	#Compliant Samples	% Compliant	Date(s) Exceeded	Description/Solution
DSN001 2000-01 2004-05		0	93	93	100	None	pH, Temp., COD, CPO, TSS, TPHC monthly; Tot. P & PCE quarterly
DSN001 2002	CPO	2	7	5	71	8/7/02	Automated chlorination equipment installed.
DSN001 2003	COD	4	19	15	79	6/6/03 7/1/03 11/7/03	Basin cleaned & inspected discharge closely monitored.
DSN001 2006	COD	2	25	23	92	5/9/06	COD max (>50 mg/L) Two non-compliances
DSN003 2000-06		0	59	59	100	None	pH, CPO, TPHC monthly; TSS (2) quarterly; monthly after Feb. 2006.

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 non-contact water supply, PPPL periodically tests incoming water quality (Tables 14-A and 14-B).

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 fire or other emergency situation or when D&R Canal water is unavailable.

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. The reports are reviewed by NJAWC and Middlesex County Health Department representatives. These inspection reports are submitted to the NJDEP annually.

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, and 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 2005-2006, 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 2005-2006, PPPL continued to pursue waste minimization and pollution prevention opportunities through active recycling efforts and through the purchasing of recycled-content products. Spring and autumn laboratory-wide clean-up weeks allowed employees to take the time to recycle office and shop materials that accumulated. As more and more people generated their presentations electronically (PowerPoint® or other programs), the use of transparency films declined. The manufacturer of these transparency films, 3M Company, was contacted, and PPPL sent almost two hundred pounds of old transparencies back to them for recycling.

In 2005, PPPL's recycling rate was 52.3% that was landfill-avoided. The DOE goal of 45% recycle versus disposal rate was met and accomplished by active participation of most Laboratory employees. In 2006, the calibration and source laboratory (CASL) was demolished and the concrete debris recycled. Nearly 95% of the building was removed and recycled with little waste being sent to a landfill.

Exhibit 3-11. CASL Prior to Demolition

Exhibit 3-12. CASL Being Dismantled

3.6.2 Site Environmental Compliance and EMS Audits

In 2005, 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. [Ya06, 07] In 2006, EMS aspects and impacts audits were conducted following the adoption and full implementation of PPPL's EMS that occurred in 2005.

3.6.3 Beneficial Landscaping

In 2005, PPPL prepared the first Beneficial Landscaping Plan, which outlined areas that required improved landscaping from an aesthetic as well as a practical viewpoint. Well-planned and maintained landscaping improves stormwater quality by reducing soil erosion and by reducing the rainfall amount that is allowed to runoff

Exhibit 3-13. Swale Looking North Taken in 2005.

the property. Exhibits 3-13 to 3-16, shown below, document the progress of PPPL's landscaping efforts in 2006. This plan is reviewed and revised annually.

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

In FY2005, "PPPL's Progress in Meeting EO 13148," Goal 4 shows that PPPL's achievement of 50.74% exceeds the FY2010 goal of 50% recycling rate for municipal solid waste (MSW) (Exhibit 3-17).

Exhibit 3-14. Swale Looking South After Modifications

Exhibit 3-15. Topsoil to Cover Eroded Shoulder

Exhibit 3-16. New Sod Covering Bare Soil Along Curb

Exhibit 3-17. PPPL's Progress Toward Meeting Executive Order 13148 Pollution Prevention, Energy Efficiency, and Transportation Goals in Fiscal Years (FY) 2005-2006

Pollution Prevention	Criteria	Baseline	FY 2005 Target	FY 2005 Data	FY2006 Data
Goal 1 metric tons(MT)	Hazardous Waste Generated (90% reduction of 1993 baseline)	29	2.9	3.16	4.06
cubic meters (m ³)	Mixed Waste Generated (80% reduction of 1993 baseline)	2	0.4	0	0
cubic meters (m ³)	Low Level Waste Generated (80% reduction of 1993 baseline)	22	4.4	30.29	11.12
cubic meters (m ³)	TRU/Mixed TRU Waste Generated (80% reduction of 1993 baseline)	0	0	0	0
Goal 2 Pounds	TRI Chemical Releases (90% reduction of 1993 baseline)	0	0	0	0
Goal 3 metric tons (MT)	Sanitary Waste Generated (75% reduction of 1993 baseline)	1,410	352.5	127.7	127.5
Goal 4 Percent (%)	Sanitary Waste Recycled (45% recycle versus disposal)	N/A	45% recycling rate in 2005	50.74%	47.48
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	0
Goal 6 Percent (%)	Purchases of EPA-designated items with Recycled Content (100% by recycled costs versus non-recycled)	N/A	100%	87.83	74.91
Goal 10	Class I Ozone Depleting Substances Uses	N/A	N/A	N/A	
Energy Efficiency	Criteria	Baseline	FY 2005 Target	FY 2005 Data	FY2006 Data
Goal 7 BTUs/Ft ²	Unit Energy Consumption (30% of 1985 baseline for building)	249,007	174,305	159,924	126,937
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		5.5%	
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%	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	2,048	1,578
Transportation	Criteria	Baseline	FY 2005 Target	FY 2005 Data	FY2006 Data
Goal 12 gallons	Petroleum consumption by fleet vehicles (80% of petroleum fuel used in relation to FY00 baseline)	8,169	6,535	7,837	6,667
Goal 13 Percent (%)	New alternative fuel light truck purchase (%of new truck purchase with alternative fuel capability)	N/A	80%	100%	100%
Goal 14 Percent (%)	Usage rate of alternative fuel vehicles (% use vs. total availability)	N/A	75%	100%	100%

Overall during 2005, the recycling rate (50.7%) was above PPPL's 50% goal and the EO 13148's 45% goal [Kin06a, McG06]. Though PPPL did not meet its internal goal of 50% recycling *vs.* disposal rates in 2006 (47.5%), the EO/DOE goal (45 %) was met [Kin07a, McG07].

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 2005-2006 recycling rate were deconstruction of the CASL modular building and recycled metals from the removal of 50-meter meteorological tower.

Exhibit 3-17, "PPPL's Progress in Meeting Executive Order 13148 Pollution Prevention, Energy Efficiency, and Transportation Goals in Fiscal Years 2005-2006," provides the status of PPPL's activities and accomplishments in pursuing 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.

At the end of 2005, PPPL completed 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 requirement for full EMS implementation by December 31, 2005 was met and PPPL's EMS aspects and impact assessments and activities continued in 2006.

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

In 2005-2006, 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 3-18).

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 ≤60% impervious coverage limit. PPPL's Site-Wide Storm Water Management Plan completed in February 1996, and PPPL is in compliance with this Plan [SE96].

In 1997, PPPL prepared a Site-Wide Storm Water Pollution Prevention Plan. Incorporating the Storm Water Management Plan, Spill Prevention Control and Countermeasure (SPCC) Plan, and other best management practices, this plan was a 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 2005-2006, 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 defining the wetland boundaries and wetlands classification. This LOI is needed before NJDEP issues wetlands permits for a site. The LOI 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 a five-year extension, from January 1999 to January 2004 (Exhibit 3-18).

In 2005, PPPL began preparing a modified application for a wetlands' LOI, expanding PPPL's boundaries to include the former annex building area (~16 additional acres).

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 2005-2006. This inventory reports the quantities of chemicals listed in the CERCLA regulations (Exhibit 3-19). Under SARA Title III, PPPL provides to the applicable emergency response agencies:

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

PPPL completed the listing of each hazardous substance stored above a certain threshold planning quantity (typically 10,000 pounds, but lower for certain compounds). Exhibit 3-20 lists hazardous compounds at PPPL for 2005-2006 [PPPL 06a, 07a].

Exhibit 3-18 PPPL Site Map – Floodplain and Wetlands Boundaries

Exhibit 3-19. 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

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 3-20. Hazard Class of Chemicals at PPPL

Compound	Category
Bromochlorodifluoromethane (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 an 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 [PPPL05a]. 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 [PPPL06a, 07a].

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 2005-2006 (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 allowing for all four boilers to be modified to burn No. 2 fuel oil. All boilers are permitted to burn natural gas, or either No. 2 or No. 4 fuel oil (Exhibit 3-6). Since December 2004, only No. 2 fuel oil, a lighter and cleaner burning petroleum distillate, has been burned; lower sulfur dioxides (SO₂) emissions resulted from burning No. 2 instead of No. 4 (Exhibit 3-7). As required by the air permit, a Compliance Plan was implemented, and records are being kept to meet those requirements.

3.8.2 Surface Water Quality

Under NJPDES requirements, PPPL closely regulated chlorine-produced oxidants (CPO) from its discharges (basin outfall designate serial number), DSN001, and DSN003 (D&R Canal pump house outfall). 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.

In 2002 PPPL installed an automated chlorine controller and a new metering system in the D&R Canal water system, and in 2003 a similar system was installed at the D-site cooling tower. With the operation of both the chlorine metering systems since 2003, the CPO limit has not been exceeded once. By reducing or limiting the amount of chlorine added, PPPL protects its water systems/equipment while also

protecting the environment by reducing CPO in its surface water discharge.

In 2005, all chemical oxygen demand (COD) concentrations reported at DSN001 were <50 mg/L (monthly average). COD concentration was measured twice above 30 mg/L but below the 50 mg/L permit limit, once in January and December (Table 18-A).

Elevated COD concentrations occurred during CY 2006 (Exhibit 3-21); in May 2006, PEARL (PPPL's in-house analytical laboratory) analyzed a basin discharge (DSN001) sample with a result of 157.6 mg/L, an elevated COD concentration. PPPL requested that QC, Inc. analyze COD from a sample that was collected at the same time; the COD concentration was found to be below the detection level (<10 mg/L).

Further analyses of the same sample by PEARL resulted in concentrations varying from 37.1 to 83.3 mg/L. PEARL checked its COD equipment to determine if an equipment malfunction was the cause of the elevated COD; no definitive cause was found.

Samples collected later in May showed no elevation of COD concentrations. The cause of the elevated COD in early May 2006 was not determined to be from PPPL operations, *i.e.*, boilers or cooling tower discharges or from other activities.

In order to maintain good water quality in the basin and its outfall, PPPL conducted an annual basin clean up in April 2005 and again in April 2006. Every three years, the basin liner is inspected for its integrity, *i.e.* wear and tear that could lead to possible failure or leakage from the basin into ground water below the liner.

Exhibit 3-21. May 2006 Chemical Oxygen Demand (mg/L) at DSN001

In April 2006, a certified liner inspector determined that the liner's integrity was sound and required only minor patches at the top where the landscapers had mowed too close to the liner edge. Basin water level is well below the top of the liner.

PPPL continues to monitor the level of COD concentration at the discharges (DSN001 & 003) each month as well as at seven off-site locations quarterly (Tables 11-A to 17-A and 11-B to 17-B).

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 ground water 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].
- 2005 Continued to annually monitor (in November 2005) the wells and sumps and report results to NJDEP[Sh06].
- 2006 Continued to annually monitor (in September 2006) the wells and sumps and report results to NJDEP[Sh07].

3.8.4 EARTH Day/Week at PPPL

Each April, PPPL displays posters in PPPL's Lobby for laboratory employees. These posters provide information regarding PPPL's efforts to be good environmental stewards and resources

for how employees can be environmentally active in their homes, for example by recycling and lowering their energy usage. These posters are brought to a local Earth Day Community event for school-aged children and their parents (Exhibit 3-22).

Earth Day 2006 program included the presentation of "Green Machine Awards" to 20 employees for their outstanding contributions to PPPL's pollution prevention activities (Exhibit 3-23 & 3-24). The awards were based on their efforts to help PPPL of the trash or recycled material being removed from PPPL (Section 3.6.1) The program also included "*Energy Star Savings at Work & Home*" presented by Edward Linky of USEPA Region 2.

Exhibit 3-22. PPPL Participates at 2005 Earth Day Activities - Mercer County Park

Exhibit 3-23. 2006 Earth Day at PPPL Employee Displays

Exhibit 3-24. 2006 Green Mmachine Recipients

For its use of bio-based products in Fiscal Year 2005, PPPL was presented with the U.S. Department of Energy (DOE) Pollution Prevention and Environmental Stewardship Accomplishment Award. This award recognized the Laboratory's Maintenance and Operations, and Materiel & Environmental Services staffs' accomplishment and "outstanding commitment to pollution prevention and environmental stewardship through the use of bio-based products in hydraulic systems and cleaning products." This is the second year the Lab received this recognition and award (Exhibit 3-25).

Exhibit 3-25. 2006 Pollution Prevention and Environmental Stewardship Award

3.8.5 Facility Improvements

In 2005, the Facilities removed the hydraulic oil for the elevator lifts and replaced the oil with a bio-based fluid that is bio-degradable and non-hazardous.

2006 was a busy year for Facilities - an EnergySTAR® roof replaced the old roofing on the Theory wing (on cover), RESA air-conditioning units were replaced with new, more efficiency (non-CFC) units, and many landscaping projects were undertaken, such as removal of gravel shoulders, replacing them with grass and curbing (Section 3.6.3). Also, in 2006, Facilities removed the 50-meter high meteorological tower near the basin (Exhibit 3-26). The instruments and equipment had previously been dismantled; the tower remained until it was determined that it would not be reused. The metal structure was recycled.

Exhibit 3-26. Meteorological Tower Dismantled

3.8.6 Safety

PPPL's 2005 and 2006 performance with respect to worker safety were as follows [Lev06b, 07b]:

Total recordable case rate:

2005 - 0.71 per 200,000 hours worked

2006 - 2.39 per 200,000 hours worked

Days away, restricted or transferred (DART) case rate:

2005 - 0.00 per 200,000 hours worked

2006 - -0.96 per 200,000 hours worked

DART day rate:

2005 - 0.00 per 200,000 hours worked

2006 - 110.48 per 200,000 hours worked

Number of radioactive contaminations (external):

2005 - 0 and 2006 - 0

Number of Safety Occurrence reports: 2005-0
(OSHA confined space, chemical exposure and lock out/tag out incidents)

3.9 Continuous Release Reporting

In 2005-2006, PPPL had no continuous releases to report.

3.10 Unplanned Releases

During CY 2005-2006, three unplanned releases of hazardous or petroleum substances occurred. In June 2005, AC Power Division's filter released 1 quart of transformer oil onto gravel. In July 2006, PPPL's crane released 2 quarts of hydraulic oil onto gravel. In December 2006, the D-site emergency diesel generator released approximately 30 gallons of diesel oil resulting in cleanup of oily soil and gravel. Fifteen to twenty gallons of diesel fuel were recovered with the remaining fuel being recovered

via excavation of contaminated soil and gravel.

3.11 Current Issues and Actions

3.11.1 Environmental Management Systems

The comprehensive Environmental Management Systems (EMS) was implemented. Under EO 13148, "Greening the Government through Leadership in Environmental Management," PPPL developed an action plan to implement a formal EMS program. Many of the elements of an EMS had existed in PPPL's plans, policies, and procedures [DOE99a]. A more fully integrated approach to include PPPL's ISM within the EMS framework was performed to fully comply with EO13148.

3.12 Summary of Environmental Permits

The following table (Exhibit 3-27) 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 applicable environmental regulations, the 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 Program Information" and "Non-Radiological Program Information," respectively.

Exhibit 3-27. 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)	Data are no longer required Precipitation reported in ASER
		Rain gauge	
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	PPPL designated minor facility – no DPCC or DCR required;	SPCC Plan required; Inspections, records, procedures
	40 CFR 110 – Discharge of Oil 40 CFR 112 – Oil Pollution Prevention	Spill Prevention, Control, and Countermeasure Plan (SPCC) required	
TSCA	40 CFR 761- Polychlorinated Biphenyls (PCBs)	Label, inspect, records of polychlorinated biphenyls (PCBs) in capacitors	Inventory; Disposal records; Also reported in ASER

Exhibit 3-27. 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 & 003; annual chronic toxicity test @ DSN 001; once-a-permit cycle acute toxicity test @ DSN003;(WCR) waste characterization reporting	Monthly discharge monitoring reports to NJDEP; annual chronic toxicity test report to NJDEP; annual WCR Also, reported in ASER

ENVIRONMENTAL PROGRAM INFORMATION

4.1 Environmental Management System and Environmental Protection Programs

4.1.1 Environmental Management System (EMS)

In the Executive Order (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. PPPL's timeline is shown in Exhibit 4-1.

At PPPL's Earth Day celebration in April 2005, Deputy Director, Dr. R. Hawryluk summarized the Laboratory's

vision of its Environmental Management System:

"To create the innovations which will make fusion power a practical reality. On our path to attaining this vision, we must also strive to have the best environmental record possible. At PPPL, we celebrate Earth Day every day through our recycling, energy conservation and environmental management activities, as well as by the research we do."

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

Exhibit 4.1 2005 Timeline for

In December 2005, PPPL submitted to the Department of Energy-Princeton Site Office a self-declaration notice that an EMS program was created and implemented. The program was documented on PPPL's local homepage. During 2005, PPPL conducted an independent peer review of its EMS program development. Resulting from this audit, PPPL defined aspects and impacts of all activities occurring on-site by conducting a building-by-building (including grounds) assessment. PPPL determined what actions were taken and what actions needed to be taken to reduce impacts to the environment and to reach the goals established by the EMS program.

In 2006, EMS activities included a spring office and support facilities clean-up, beneficial landscaping with perennial plants and trees maintenance, EMS inclusion into the General Employee Training program, EMS website, and EMS program assessment with the establishment of environmental performance goals and targets for 2007.

The 2005-2006 performance targets were met or exceed by PPPL (Exhibit 3-17). In the Pollution Prevention category P²:

- Hazardous waste generated 3.16 and 4.06 metric tons (MT) with the goal of 2.9 MT (2005 and 2006, respectively)
- Municipal solid waste (MSW) recycling rate at 50.7% and 47.48% of the total MSW with the goal of 45%
- Purchase of Environmentally Preferred Products (EPP) 87.8% and 74.9% with the goal of 100%

For the Energy Efficiency (E²) category:

- House Unit Energy consumption 159,924 and 126,937 BTUs per ft²

with the goal of 174,305 BTUs/ft²)

- Purchase Green Energy Jan.-Jun. 2005 at 5.5% of total energy purchases (FY 2007 at 3%)

For Transportation, the following activities were accomplished:

- Alternative Fuel Vehicles and Usage rate 100% of goal
- Petroleum consumption of 7,920 and 6,667 gallons with the goal of 6,535 gallons

Areas for improvement that were identified were reusing materials and equipment instead of recycling or disposal, maintaining and improving recycling performance by 5% or 55% recycling all MSW, and increasing purchasing of EPP by expanding into new and different purchase areas.

4.1.2 Environmental Protection Program

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 announcement of the New Jersey Clean Water Action Plan in 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 (NJPDDES) regulations with monthly monitoring occurring at both outfalls since 1992. Improvements include the following actions taken by PPPL for the

detention basin: annual maintenance and triennial liner inspection in 2006, new aeration/bubbler equipment, new oil-detection units and instrumentation, and an ultrasonic unit to reduce algal growth.

To improve storm water quality, PPPL conducts site-wide grounds clean-ups, landscaping of disturbed areas to reduce pollutants and eliminate runoff, and swale maintenance to improve drainage. For water conservation, PPPL has replaced many original water lines and installed water-saving fixtures.

At annual briefings, PPPL representatives meet with local officials to provide updates on the current status of experimental projects at the Laboratory and also to provide the opportunity to discuss environmental topics or other concerns.

Exhibit 4-2. Radiological Air Monitoring Stations

Station Name	Number/Description	Exhibit #
Remote Environmental Air Monitoring (REAM)-off site	Stations <i>R 1- 6</i> ; Tritium	4-4
Radiological monitoring system (RMS) on D site	Passive tritium monitors at <i>T 1-4</i> :	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	On-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 and Non-Radiological Monitoring Locations

Exhibit 4-5. Off-site Monitoring Locations

4.2 Summary of Radiological Monitoring Program

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 2005 and 2006.

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 a 50-mile 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 0.003 mrem (0.03 μ Sv) for 2005 and 0.004 mrem (0.043 μ Sv) for 2006 (Exhibits 5-1

and 5-2) [Lev06a, 07a]. 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 2005-2006, PPPL operated under New Jersey Pollutant Discharge Elimination System (NJPDES) surface water permit, number NJ0023922, was renewed effective February 2006. 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
- 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 to test the DSN001 effluent with the fathead minnow (*Pimephales promelas*) as the test

organism [NJDEP95a]. The annual study results were submitted for the September 2005 and July 2006 tests [PPPL05c, 06c]. PPPL's discharge water and the control tests were the same – no mortality to the test specimens.

Ground water monitoring conducted for the Environmental Restoration program is discussed in Chapters 6 and 7.

4.4 Environmental Requirements

Environmental requirements, for which DOE and PPPL are held accountable, are listed in Exhibit 3-27 and are discussed in Chapters 3.0, "Environmental Compliance Summary" and 6.0, "Environmental Non-Radiological Program Information."

4.5 Environmental Impact Statements and Environmental Assessments

No Environmental Impact Statements or Environmental Assessments were prepared in 2005 or 2006.

4.6 Summary of Significant Environmental Activities at PPPL

4.6.1 Regulatory Inspections/Audits

In November 2005 and September 2006, the NJDEP Enforcement Inspector conducted the annual inspection of the Surface Water Permit Discharge (NJPDES NJ0023922) [NJDEP05, 06b]. After reviewing the records and visually inspecting the two permitted outfalls, an acceptable rating resulted. During 2005, no permit limits were exceeded. In 2006, the COD concentration at DSN001 twice exceeded the permit limit of 50 mg/L (see Exhibit 3-21). The monthly COD average was below the permit limit of 50 mg/L and therefore, it did not result in a serious violation.

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, cooling towers blowdown, non-contact cooling water, ground water from basement sumps, and storm water) and D-site (ground water from basement sumps and storm water).

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.

Prior to the 2005 basin cleaning, large algal blooms grew in the basin (Exhibit 4-6). PPPL cleaned the basin in July 2005 and installed new equipment for oil detection (Exhibits 4-7 & 4-8).

Exhibit 4-6. Algal Bloom Prior to Cleaning

As shown in the next two exhibits, cleaning the basin noticeably improves the water quality by eliminating nutrients.

Exhibit 4-7. New Oil Sensor in Front of D-site Outfall

Exhibit 4-8. New Oil sensor in Foreground Bubbler Shown in Background

In April 2006, the basin was cleaned and the liner was inspected (Exhibit 4-9). In August 2006, an ultrasonic device was installed to further limit the algal blooms; the ultrasonic waves disrupt only the algae cell membrane allowing other organisms in the basin to be unaffected.

Exhibit 4-9. 2006 Liner Inspection

Exhibit 4-10. 2005 Highest Tritium Concentrations in Environmental Samples

(see Tables 3-A to 8-A)

Media	Location	Highest HTO	Stack Data (Date)
Air	T3(SE D-site)	3.11 pCi/m ³	Jan. 12
	R6 (S of PPPL)	6.60 pCi/m ³	
	D-site Stack	0.25 Ci	
Well	TW-8	365 pCi/L	0.104 Ci HTO (Sept. 7)
Rain water	R1E	623 pCi/L	

Ci = Curie

pCi/L = picoCuries per Liter

HTO = tritiated water

Exhibit 4-11. 2006 Highest Tritium Concentrations in Environmental Samples

(see Tables 3-B to 8-B)

Media	Location	Highest HTO	Stack Data (Date)
Air	T1 (NE D-site)	0.882 pCi/m ³	Oct. 11
	R5 (SE of PPPL)	0.401 pCi/m ³	
	D-site Stack	0.264 Ci	
Well	TW-8	236 pCi/L	0.197-0.128 Ci HTO (July 4-26)
Rain water	R1S	3,600 pCi/L	

Ci = Curie

pCi/L = picoCuries per Liter

HTO = tritiated water

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 2006 (Exhibits 4-10 & 4-11) [Lev06c, 07c].

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 4-12).

Exhibit 4-12. NCSX Plasma and Magnetic Coil Configuration (artist rendition)

4.6.4 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

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 began in 2005 and continued in 2006.

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.

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 2005, 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. Exhibit 5-2

summarizes the 2006 emissions and doses from D-site operations. The calculated EDEs at the site boundary are one-hundredths and two-hundredths of one mrem for 2005 and 2006, far below the annual limit of 10 mrem per year [Lev06a, 07a].

Exhibit 5-1. Summary of 2005 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 4.392 (1.63×10^{11}) HT 0.800 (2.96×10^{10})	0.0114 (1.14×10^{-4})	91.76	0.104886 (1.05×10^{-3})
Tritium (water)	LEC tank	0.0437 (HTO) (1.62×10^9)	0.000874 (8.74×10^{-6})	7.03	0.001197 (1.20×10^{-5})
Tritium (water)	Surface Ground	219 pCi/L (basin outfall) 365 pCi/L (Test Well (TW) 8)	0.000068 (6.80×10^{-7})	0.55	0.000093 (9.30×10^{-7})
Direct/Scattered neutron & Gamma Radiation	NSTX	6.4×10^{16} DD neutrons + 1.3×10^{15} DT neutrons	0.0000743 (7.43×10^{-7})	0.60	Negligible
Argon-41 (Air)	NSTX	0.000575 (3.60×10^7)	0.0000069 (6.90×10^{-8})	0.06	0.000013 (1.30×10^{-7})
Total			0.0124232 (1.24×10^{-4})		0.106189 (1.06×10^{-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 **0.00321 mrem (3.21×10^{-5} 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 0.0068 mrem/yr (6.80×10^{-5} 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.

Exhibit 5-2. Summary of 2006 Emissions and Doses from D Site Operations

Radionuclide & Pathway	Source	Source Term Curies (Bq)	EDE in mrem/yr (mSv/yr) at Site Boundary	Perce nt of Total	Collective EDE w/in 80 km in person-rem (person-Sv)
Tritium (air)	D-site stack	HTO 5.547 (2.052 x 10 ¹²) HT 0.591 (2.187 x 10 ¹¹)	0.0144 (1.44 x 10 ⁻⁴)	91.23	0.123978 (1.24 x 10 ⁻³)
Tritium (water)	LEC tank	0.0149 (HTO) (5.513 x 10 ⁹)	0.000297 (2.97 x 10 ⁻⁶)	1.88	0.000407 (4.07 x 10 ⁻⁶)
Tritium (water)	Surface Ground	514 pCi/L (Bee Brook) 236 pCi/L (Test Well (TW) 1)	0.001010 (1.01 x 10 ⁻⁶)	6.40	0.001384 (1.38 x 10 ⁻⁵)
Direct/Scattered neutron & Gamma Radiation	NSTX	6.97 X10 ¹⁶ DD neutrons	0.000070 (7.00 x 10 ⁻⁷)	0.44	Negligible
Argon-41 (Air)	NSTX	0.000615 (2.28x 10 ⁸)	0.000007 (7.0 x 10 ⁻⁸)	0.05	0.000014 (1.4 x 10 ⁻⁷)
Total			0.015784 (1.578 x 10 ⁻⁴)		0.125783 (1.258 x 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 NSTX = National Spherical Torus Experiment

Estimated dose equivalent at the nearest business is **0.00405 mrem (4.05 x 10⁻⁵ 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 **0.0068 mrem/yr (6.80 x 10⁻⁵ 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

During 2005, NSTX conducted experiments generating neutron and gamma radiation. Experimental shots conducted using neutral beam injection generated deuterium-deuterium (D-D) (MeV) neutrons. Approximately 2% of these shots are assumed also to 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 2005 and 2006 total penetrating radiation dose at the site boundary of 6.38×10^{-5} mrem from D-D neutrons and 1.05×10^{-5} mrem from D-T neutrons and 6.97×10^{-5} mrem from D-D neutrons, respectively [Lev06a, 07a].

5.1.2 Sanitary Sewage

Drainage from D-site sumps in radiological areas is collected in the one of the three Liquid Effluent Collection (LEC) tanks; each tank has a 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 2005 and 2006 samples showed effluent quantity and concentrations of radionuclides (tritium) to be within allowable limits established in New Jersey (1 Ci/y for all radionuclides), the National Safe Drinking Water regulations (40 CFR 141.16 limit of 20,000 pCi/L) and DOE Order 5400.5 (2×10^6 pCi/liter for tritium).

As shown in Exhibits 5-3 and 5-4, the 2005 and 2006 total amount of tritium released to the sanitary sewer were 0.044 and 0.015 Curies, respectively, about 4 to 1.5 percent of the allowable 1.0-Curie per year limit. In Table 10-A and 10-B, the gross beta activity is reported; the gross beta activity ranges from <195 to 357 pCi/L for 2005 and <195 pCi/L for 2006.

Exhibit 5-3. Total Annual Releases to Sanitary System from 1994 to 2006

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
2005	247,950	0.044
2006	183,657	0.015

Exhibit 5-4. Total Annual Releases to Sanitary System from the Liquid Effluent Collection Tanks 1994-2006

5.1.3 Radioactive and Mixed Waste

In 2005-2006, low-level radioactive wastes were stored on-site prior to off-site disposal in the Radioactive Waste Handling Facility (RWHF) (Exhibit 5-5). Each year one shipment of low-level radioactive shipments was made in 2005-2006. [BeJ09]. No low-level radioactive mixed waste was generated in 2005-2006.

Exhibit 5-5. Total Low-Level Radioactive Waste 1997-2006

Year	Cubic feet (ft ³) or Cubic meters (m ³) Kilograms (kg)	Total Activity in Curies (Bq)
1997	1,997.7 ft ³	31,903.0 (1.18 x 10 ¹⁵)
1998	533.74 ft ³	204.80 (7.58 x 10 ¹²)
1999	1188 ft ³	213.76 (7.91 x 10 ¹²)
2000	4,235.7 ft ³	50.0 (1.85 x 10 ¹²)
2001	19,949.8 ft ³	1,288.43 (4.77 x 10 ¹³)
2002	858,568 kgs	4,950.14 (1.83 x 10 ¹⁴)
2003	8,208 kgs	0.03 (1.11 x 10 ⁹)
2004	4,467 kgs	0.0202 (7.48 x 10 ⁸)
2005	30.29m ³ (3,997 kgs)	0.01997 (7.389 x 10 ⁸)
2006	11.12m ³ (4,705 kgs)	2.3543 (8.711 x 10 ¹⁰)

In CY 2005 and 2006, PPPL made two shipments to Nevada 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 (Exhibit 5-6). 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 radiological waste program, which 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 (HT) and oxide tritium (HTO) at the D site stack.

Exhibit 5-6. B-box with Liner in RWHF for Shipping Radioactive Waste to NTS

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 (R1 to R6) (Tables 4-A and 4-B). The baseline location was located in Roebing, N.J. (Burlington County). All of the aforementioned monitoring is performed on a continuous basis.

Tritium (HTO and HT) was released and monitored at the D-site stack (Tables 3-A, 3-B, and Exhibit 3-4). Projected dose equivalent at the nearest off-site business from airborne emissions of tritium was 0.003 mrem/year (0.03 μ Sv/year) in 2005 and 0.004 mrem/year (0.04 μ Sv/year) in 2006. Measurements at the D-site facility boundary (T1 to T4) have measured concentrations in the range

from 0.069 to 7.60 pCi/m³ elemental tritium (HT) and from 0.069 to 3.11 pCi/m³ oxide tritium (HTO) in 2005 and 0 to 5.77 pCi/m³ elemental tritium (HT) and from 0 to 0.882 pCi/m³ oxide tritium (HTO) in 2006 (Tables 4-A and 4-B). Measurements from off-site monitoring stations (R1 to R6) are shown in Tables 4-A and 4-B, "Ranges of Air Tritium Concentrations Collected On-site and Off-site in 2005/2006," and are less than the on-site measurements [Lev06a, 07a].

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 2005 and 2006 (Exhibits 5-1 & 5-2).

5.2 Release of Property Containing Residual Radioactive Material

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 cm². No active or contaminated materials were free-released in 2005 or 2006. All materials were either reused in controlled environments or properly disposed.

5.3 Protection of Biota

The highest measured concentrations of tritium in surface, ground, or rainwater in 2005 was 623 pCi/L (Rain water R1E Sept. 15, 2005 on Table 6-A) and 3600 pCi/L (Rain water R1S July 31, 2006 on Table 6-B). This concentration is a small fraction of the water biota concentration guide (BCG) (for HTO) of 3×10^8 pCi/L for aquatic system evaluations, and the water BCG (for HTO) of 2×10^8 pCi/L for terrestrial system evaluations, per DOE Standard STD-1153-2002, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" [Lev06c, 07c].

5.4 Unplanned Releases

There were no unplanned radiological releases in 2005 or 2006.

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 (Table 5-A). Locations are shown in Exhibits 4-3 (on-site) and 4-4 (off-site locations).

In July 2005, at on-site location, DSN001 basin outfall, the tritium concentration was detected at 219 pCi/L, which was the highest for surface water samples (Table 5-A). In 2006, at Bee Brook (B2) the tritium concentration was 514 pCi/L, which was the highest surface water HTO concentration (Table 5-B).

Rain water samples, which will eventually reach surface waters, were collected and analyzed and ranged from below detection to 623 pCi/liter in 2005 (Table 7-A) and 3600 pCi/L in 2006 (Table 7-B), 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 have mirrored the decreased tritium emissions measured at the D-site stack [Lev06c, 07c].

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 comparison of dry and wet years based on the 45-inch average (Tables 2-A & 2-B) [Ch06]. Total precipitation in 2005 and 2006 were above the mean 48.4, and 48.1 inches respectively, versus 45.6 average inches (123 cm, 122.2 cm, and 115.8 cm).

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 2006

In 2005, the highest concentration of tritium was found in well TW-8 (365 pCi/L). In 2006, well TW-1 had the highest concentration of tritium at 236 pCi/L. These tritium concentrations are well below the Drinking Water Standard of 20,000 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, New Jersey American Water Company, formerly 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 2005 and 2006, tritium concentrations at this location were less than the lower limit of detection (Table 5-A).

5.5.2 Foodstuffs, Soil, and Vegetation

There were no foodstuffs, soil, or vegetation samples gathered for analysis in 2005 or 2006. 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 and DOE-PSO submitted to NJDEP monthly discharge monitoring reports (DMRs) for Discharge Serial Number (DSN)—DSN001 and DSN003 (Tables 18-A, 19-A, 18-B, 19-B & 23-B). During 2005-2006, PPPL's discharges were within allowable limits for all tested parameters with the exception of chemical oxygen demand, which was believed to be due to laboratory error.

In December 2003, PPPL submitted the renewal application for the NJPDES permit; in 2006, PPPL received the final NJPDES permit with the effective date of February 1, 2006. New permit requirements for DSN001 included:

- Monthly reporting of the loading calculations for Total phosphorus, Tetrachloroethylene, and Chlorine-produced oxidants
- An annual Waste Characterization Report (WCR)
- A Phosphorus Evaluation Study to determine impacts of PPPL's impact on the Total Maximum

Daily Loading (TMDL) for the Raritan watershed

- A Remediation Plan for Tetrachloroethylene found in ground water and monitored at DSN001

New requirements for DSN003 were WCR and acute toxicity test using *Ceriodaphnia dubia* conducted between 4 and 4.5 years after the effective date of the permit (February 1, 2010 and July 31, 2010).

Changes to the basin include the annual basin cleanup that occurred in 2005 and 2006 (Exhibits 4-7 to 4-9), installation of oil sensors at the basin inflows and near the outfall, upgrade of the ultrasonic flow meter in the basin outfall, and an ultrasonic device that inhibits algal growth (Exhibit 6-1).

Exhibit 6-1. 2006 Ultrasonic Unit in Foreground

6.1.2 Chronic Toxicity Characterization Study

In 2005 and 2006, annual chronic toxicity testing for DSN001 effluent continued. In all chronic toxicity tests, *Pimephales*

promelas (fathead minnow) was the only test species required [NJDEP06a]. 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, as defined by the NJ Surface Water Quality Standards, was >100 percent (statistically possible) no observable effect concentration (NOEC) [PPPL06c]. 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))
[PPPL05c, 06c]

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
2005				September
2006				July

6.1.3 Ground Water

In 1985, the US Geological Survey (USGS) in co-operation with PPPL and DOE, installed ten monitoring wells north of the former 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 2005 and 2006, three of these

wells were used to collect ground water samples that were analyzed for tritium (Tables 6-A and 6-B). The tritium concentrations are compared over time.

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

A. NJPDES Ground Water Program in 2005 and 2006

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 will be 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 total of 70.2 and 88.9 million gallons of water were discharged from the detention basin in 2005 and 2006, respectively. Installed in December 2000 and with a meter upgrade in 2005, an ultrasonic flow transducer measured flow from the basin; data are downloaded to a data spreadsheet from which total flow, maximum and daily average flows were calculated. The lined retention basin operates with a permanent oil boom and new oil detection system capable of sending an alarm signal to Site

Protection Office and automatically closing the discharge valve. Normally the retention basin operates in a flow-through mode. A gated and locked, chain-link fence surrounds the perimeter of the basin.

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 PPPL in May 2000 and conditionally approved by NJDEP in June 2000 [PPPL00b].

Exhibit 6-3. Ground Water Monitoring Equipment with Backpack Air Compressor

In 2005 and 2006, 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, Tables 20-A & 20-B) [Sh07]. Samples were collected from twelve wells,

two sumps, and one surface water location.

PPPL detected volatile organic compounds (VOCs from degreasing solvents) above the NJ Ground Water Standard ($1.0 \mu\text{g/L}$) in 5 of the 12 wells/sumps sampled. The highest tetrachloroethylene concentrations (PCE) in 2005 and 2006 were measured in well MW-19S ($190, 158 \mu\text{g/L}$), slightly higher than in 2004 ($154 \mu\text{g/L}$). PCE concentrations in D-site MG sump (2005 - $32.9 \mu\text{g/L}$, 2006 - $43.2 \mu\text{g/L}$) were lower than in 2004 ($65.4 \mu\text{g/L}$). The natural attenuation by the indigenous bacteria and other in-situ processes appear to be degrading PCE to its daughter species. The de-watering sumps located in the D-site MG and air shaft (formerly TFTR) basements draw ground water from the shallow aquifer, controlling ground water flow and preventing off-site contaminant migration. The probable source of the PCE is from the former Annex building that housed hazardous waste activities in the mid-1980's.

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, waste water, 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 boilers were part of NJDEP's

inspection of the facility; in 2005, NJDEP determined PPPL complied of the air permit requirements (Exhibit 6-4).

Though actual boiler emissions measurements are not required, PPPL utilizes an outside contractor to test and adjust the boilers on an annual basis. The contractor is required to follow DOE Order 4330.2D, "In-House Energy Management," [DOE88] to optimize boiler efficiency and to reduce fuel cost. The contractor reports boiler efficiency, oxygen content, flue-gas temperature and carbon dioxide content of the stack gas for both oil and natural gas fuels. The Boiler Operations Chief Engineer maintains these records [Ne 06, Ne 07]. PPPL operates the following equipment that requires air permits:

Exhibit 6-4. PPPL's Air-Permitted Equipment

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

B. Drinking (Potable) Water

Potable water is supplied by the public utility, New Jersey American Water Company, formerly Elizabethtown Water Co. PPPL used ~30.88 and ~20.01 million gallons in 2005-2006 (Exhibits 6-5 & 6-6) [Kir06, Kir07]. A cross-connection installed beneath the water tower provides back-up potable water to the tower for the fire-protection and other systems.

Exhibit 6-5. PPPL Potable Water Use From NJ American Water Co. [Kir06, 07]

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	30.88
2005	20.01
2006	13.35

Exhibit 6-6. PPPL's Potable and Non-Potable Water Use from 1995 to 2006

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) [Kir06, Kir07].

Exhibit 6-7. PPPL Non-Potable Water Use from D&R Canal
[Kir06, 07]

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	13.02
2005	14.65
2006	7.9

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 (Tables 19-A & 19-B). 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. Tables 12-A and 13-B summarize 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 (Tables 11-A to 17-A and 11-B to 17-B)—are not required by regulation, but are a part of PPPL's environmental surveillance program (Exhibit 6-8).

Exhibit 6-8. Collecting Water Samples at (B1), Bee Brook in February 2005

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 2005-2006, PPPL estimates a total annual discharge of 4.4 million gallons of sanitary sewage to the

South Brunswick sewerage treatment plant [Kir06, Kir07].

Beginning in 1996, 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 in 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 2004, PPPL continued monthly radiological and non-radiological analyses to meet the license requirements (Tables 10-A & 10-B). PPPL continued to periodically collect samples during the remainder of CY2005 and 2006.

F. Spill Prevention Control and Counter-measure

PPPL maintains a Spill Prevention Control and Countermeasure Plan (SPCC), which was last updated in 2004 and certified by a Professional Engineer who works within the PPPL Materiel & Environmental Services Division (M&ES). The SPCC was reviewed internally by organizations responsible for equipment covered by the SPCC. The current SPCC is approved by the Heads, M&ES and ES&H and Infrastructure Support [PPPL04a].

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 2005 and 2006, PPPL's 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 2005 were as follows: herbicides - Roundup (2.5 gals.), and fertilizer - NPK (480 lbs.) [Kin06b]. In 2006, herbicides, Chaser (3 qts.), Roundup (2 gals.), and Dimension (4.5 gals.) were applied; the insecticide, Sevin Carbaryl (1 pt.) was applied; and no fertilizer was used [Kin07b]. 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 2005 and 2005, PPPL's inventory of equipment included five-polychlorinated biphenyl (PCB)-regulated capacitors [MP07a].

I. Hazardous Wastes

PPPL submitted the Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) to the NJDEP for 2005-2006. A description of Resource Conservation and Recovery Act (RCRA) compliance is found in Section 3.1.2 of this report.

PPPL investigates opportunities to remove hazardous materials from the workplace that have the potential to become hazardous wastes by substituting them with non-hazardous materials that has the added benefit of reducing employee exposure. PPPL M&O Division replaced its petroleum-based cleaning fluids with all bio-based cleaning products.

The elimination of ethylene glycol in vehicles and other equipment at PPPL is one example (Exhibit 6-9). Another example is replacing the petroleum-based hydraulic fluids that leaked in elevator shaft with a bio-based fluid that is non-hazardous (Exhibit 6-10). This substitution program was recognized by DOE, who honored PPPL with the Pollution Prevention and Environmental Stewardship award in 2006.

Exhibit 6-9. Removing Ethylene Glycol and Replacing it with Propylene Glycol

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.

Exhibit 6-10. Hydraulic Fluid Leak in Elevator Shaft Prior to Replacing with Bio-based Fluids

6.2.3 Environmental Occurrences

One unplanned release of petroleum substances in 2005 and two in 2006 occurred. In July 2005, PPPL reported to the NJDEP Hotline that mineral oil (~1 qt.) from the transformer filter skid spilled onto gravel and was cleaned up by PPPL. A spill from the fuel tank of a tractor trailer making a delivery to the warehouse was not reported to the NJDEP Hotline, because it was contained on the impervious paving. PPPL personnel drained the remaining fuel from the tank and cleaned up the spilled fuel (Exhibit 6-11).

Exhibit 6-11. Cleaning Up Fuel from Leaking Tank – December 2005

Two spills were reported *via* the NJDEP Hotline in 2006: in July, a small hydraulic spill occurred when a drip pan under a crane overflowed onto gravel and was cleaned up by PPPL and the second largere spill occurred in December. Approximately 30 gallons of diesel fuel spilled from the diesel generator onto the gravel. PPPL recovered approximately 20 gallons of the fuel that spilled. The remaining fuel contaminated soil was then excavated and removed; soil beneath was tested for petroleum and backfilled with clean soil (Exhibits 6-12 & 6-13).

Exhibit 6-12. Testing for Oil in Soil Sample
December 2006

Exhibit 6-13. Fencing Surrounding Spill Site

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 2005 and 2006 [PPPL06a, 07a]. 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 2005 or 2006. *

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 Sassafra 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 (Exhibits 3-13, 3-14 & 3-18) [SE96].

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

Also, the 500-year flood plain elevation (85 ft above msl) 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 (Exhibit 7-2).

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 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.

Exhibit 7-3. Ground Water Monitoring Equipment- Probe and Meter

Beginning in 2003, each fall - usually in September, PPPL monitors the groundwater wells. The type of equipment used by PPPL to sample the ground water is shown in Exhibits 7-3 and 7-4. Air from either a compressed gas (carbon dioxide) cylinders or generated by a gasoline-powered air compressor is pumped down into the

well via a Teflon-lined polyethylene tube into the dedicated bladder pump. The air pushes the water up through the exit tube and water flows through a chamber containing probes for pH, conductivity, dissolved oxygen, temperature, and turbidity. The water then flows into a bucket that measures the volume discharged. A water level gauge is used to determine the rate of water recharging back into the well, in order that the well does not go “dry” and to ensure the sample will be representative of the groundwater.

Exhibit 7-4. Well Monitoring Setup - Compressed Air, Water Depth Meter, Discharge Collection Bucket, and Probe

Ground water monitoring results show that tetrachloroethylene, trichloroethylene (PCE, TCE), and their natural degradation products are present in a number of shallow and intermediate-depth wells on C-site (Exhibits 7-6 & 7-8). These VOCs are commonly contained in solvents or metal degreasing agents.

Foundation de-watering sumps located on D-site influence ground water flow across

the site (Exhibits 7-5 & 7-7). 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 FABA was conducted during 1997 and 1998 [HLA98].

Phase 3 activities were conducted to:

- Baseline Ecological Evaluation
- Investigate soil and ground water quality at 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 currently 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 2005 and 2006, RAWP activities accomplished the following:

- Annual ground water monitoring activities were conducted in November 2005, due to low water levels in the monitoring wells and September 2006, which is the month selected to conduct the annual monitoring.
- Examination of analytical data and water level measurements indicates an inverse relationship between ground water level and VOC concentration.
- Natural attenuation (anaerobic biodegradation) occurs in the wetlands adjacent to CAS/RESA.
- Contaminated ground water is captured by building sumps and is not migrating off-site.
- 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 cis-1,2-dichloroethylene (c-1,2-DCE), and the presence of dissolved methane, reduced dissolved oxygen levels and negative oxidation-reduction potential (redox) values also provides definitive evidence of on-going biological degradation (Tables 38-A to 39-A and 38-B to 39-B) [Sh06, Sh07].

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). 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, rain water-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 unpublished 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.

The highest concentrations of tritium in the ground water were detected at well TW-8 in May 2005 (365 pCi/L) and at well TW-1 in November 2006 (236 pCi/L). For both 2005 and 2006, the tritium results are less than 2% of the National Drinking Water Standard of 20,000 pCi/L.

Results of twelve 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.

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QUALITY ASSURANCE

In 2005-2006, analyses of environmental samples for radioactivity and other parameters were conducted by PPPL's on-site analytical laboratory (Exhibits 8-1 & 8-2).

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

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 a NIST NVLAP accredited radiochemistry proficiency testing 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 Samples for Tritium Analysis
Performed at PEARL

Results are supplied to PPPL and NJDEP to confirm a laboratories' ability to correctly analyze those parameters being tested (Tables 22-A and 22-B).

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.

In Tables 22-A and 22-B, the non-radiological proficiency testing results show that all PEARL's results were in the acceptable range except for chemical oxygen demand in April 2005 (PPPL's voluntary QA program). In July 2005, COD was in the acceptance range.

Gamma spectroscopy instruments were operational in 2005-2006.

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.

Once during the 3-year subcontract period, PPPL conducts an audit of its subcontractor analytical laboratories. As audits were performed in 2004 of Accredited Laboratory, Carteret, NJ and QC Laboratory, Southampton, PA, none were audited by PPPL in 2005-2006.

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TABLES for 2005

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Table 1-A. PPPL Radiological Design Objectives and Regulatory Limits^(a)

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

P = Probability of occurrence in a year.

(a) All operations must be planned to incorporate 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-A. Annual Precipitation Data for 2005

START DATE	WEEK	INCH	INCH/MONTH	MONTH	ACCUMULATION
3-Jan-05	1	1.3500			1.3500
10-Jan-05	2	1.5500			2.9000
17-Jan-05	3	0.0000			2.9000
24-Jan-05	4	0.0000			2.9000
31-Jan-05	5	0.2000	3.1000	January	3.1000
7-Feb-05	6	0.1500			3.2500
14-Feb-05	7	1.6500			4.9000
21-Feb-05	8	0.2500			5.1500
28-Feb-05	9	0.5000	2.5500	February	5.6500
7-Mar-05	10	0.6000			6.2500
14-Mar-05	11	0.6000			6.8500
21-Mar-05	12	1.6500			8.5000
28-Mar-05	13	3.3000	6.1500	March	11.8000
4-Apr-05	14	1.2500			13.0500
11-Apr-05	15	0.0000			13.0500
18-Apr-05	16	0.2000			13.2500
25-Apr-05	17	1.4500	2.9000	April	14.7000
2-May-05	18	0.0000			14.7000
9-May-05	19	0.0000			14.7000
16-May-05	20	1.0000			15.7000
23-May-05	21	0.9000			16.6000
30-May-05	22	1.0500	2.9500	May	17.6500
6-Jun-05	23	0.4500			18.1000
13-Jun-05	24	0.0000			18.1000
20-Jun-05	25	0.0000			18.1000
27-Jun-05	26	4.2000	4.6500	June	22.3000
4-Jul-05	27	1.9500			24.2500
11-Jul-05	28	0.7500			25.0000
18-Jul-05	29	0.0000			25.0000
25-Jul-05	30	0.3500	3.0500	July	25.3500
1-Aug-05	31	0.0000			25.3500
8-Aug-05	32	0.2000			25.5500
15-Aug-05	33	0.0000			25.5500
22-Aug-05	34	0.0000			25.5500
29-Aug-05	35	0.0000	0.2000	August	25.5500
5-Sep-05	36	0.0000			25.5500
12-Sep-05	37	1.5000			27.0500
19-Sep-05	38	0.0000			27.0500
26-Sep-05	39	0.3000	1.8000	September	27.3500
3-Oct-05	40	5.0000			32.3500
10-Oct-05	41	6.8500			39.2000
17-Oct-05	42	0.9500			40.1500
24-Oct-05	43	1.6500			41.8000
31-Oct-05	44	0.0000	14.4500	October	41.8000
7-Nov-05	45	0.2000			42.0000
14-Nov-05	46	0.7500			42.7500
21-Nov-05	47	1.4000			44.1500
28-Nov-05	48	1.5500	3.9000	November	45.7000
5-Dec-05	49	0.6000			46.3000
12-Dec-05	50	1.1500			47.4500
19-Dec-05	51	0.6000			48.0500
26-Dec-05	52	0.3500	2.7000	December	48.4000

Table 3-A. D-Site Tritium Stack Releases in Curies in 2005

Week Ending	HTO (Ci)	HT (Ci)	Weekly total (Ci)	Month	Annual Total (Ci)
Baseline 1/2/02	0	0	0	0	0
12-Jan-05	0.250	0.019	0.269		0.269
19-Jan-05	0.146	0.015	0.161		0.430
26-Jan-05	0.140	0.014	0.154	January	0.584
2-Feb-05	0.162	0.021	0.183		0.766
9-Feb-05	0.237	0.024	0.261		1.027
16-Feb-05	0.220	0.020	0.240		1.267
23-Feb-05	0.028	0.015	0.043	February	1.310
2-Mar-05	0.026	0.020	0.046		1.356
9-Mar-05	0.031	0.016	0.046		1.402
16-Mar-05	0.033	0.027	0.060		1.461
23-Mar-05	0.027	0.016	0.042		1.504
30-Mar-05	0.030	0.011	0.040	March	1.544
6-Apr-05	0.037	0.021	0.058		1.602
13-Apr-05	0.043	0.015	0.058		1.660
20-Apr-05	0.029	0.030	0.059		1.719
27-Apr-05	0.017	0.014	0.031	April	1.749
4-May-05	0.039	0.024	0.063		1.812
11-May-05	0.033	0.029	0.063		1.875
18-May-05	0.039	0.021	0.059		1.934
25-May-05	0.021	0.014	0.035	May	1.969
1-Jun-05	0.021	0.013	0.035		2.003
8-Jun-05	0.044	0.024	0.067		2.071
15-Jun-05	0.035	0.023	0.058		2.129
22-Jun-05	0.040	0.023	0.063		2.192
29-Jun-05	0.035	0.022	0.057	June	2.249
6-Jul-05	0.043	0.030	0.073		2.322
13-Jul-05	0.055	0.039	0.094		2.416
20-Jul-05	0.096	0.033	0.129		2.545
27-Jul-05	0.125	0.033	0.158	July	2.702
3-Aug-05	0.125	0.017	0.142		2.844
10-Aug-05	0.102	0.005	0.107		2.951
17-Aug-05	0.116	0.021	0.137		3.088
24-Aug-05	0.122	0.025	0.147		3.234
31-Aug-05	0.114	0.012	0.126	August	3.360
7-Sep-05	0.104	0.007	0.111		3.471
21-Sep-05	0.122	0.005	0.127	September	3.598
12-Oct-05	0.155	0.010	0.165		3.763
19-Oct-05	0.110	0.005	0.115		3.878
26-Oct-05	0.095	0.007	0.102	October	3.980
2-Nov-05	0.068	0.004	0.073		4.053
9-Nov-05	0.082	0.009	0.090		4.143
16-Nov-05	0.178	0.008	0.186		4.477
23-Nov-05	0.141	0.008	0.149		4.477
30-Nov-05	0.063	0.003	0.066	November	4.543
7-Dec-05	0.141	0.008	0.149		4.692
14-Dec-05	0.131	0.007	0.138		4.830
21-Dec-05	0.150	0.009	0.159		4.989
28-Dec-05	0.194	0.010	0.204	December	5.192
	4.392	0.800	5.192	Total 2005	

Table 4-A. Ranges of Air Tritium Concentrations (in pCi/m³) Collected On-Site (T1-T4) and Off-Site (R1-R6 & BM1) in 2005

Station	HTO pCi/m ³	HT pCi/m ³
T1	0.098 - 2.00	0.098 – 2.92
T2	0.071 – 2.32	0.071 – 4.10
T3	0.613 – 3.11	0.887 – 7.60
T4	0.069 – 1.05	0.069 – 3.06
R1	0.056 – 0.265	0.079 – 1.42
R2	0.009 – 0.510	0.022 – 1.08
R3	0.080 – 0.471	0.507 – 4.56
R4	0.017 – 0.792	0.017 – 1.61
R5	0.072 – 0.542	0.072 – 2.30
R6	0.097 – 6.60	0.873 – 19.2
BM1	0.037 – 1.33	0.037 – 1.42

Table 5-A. Surface Water Tritium Concentrations for 2005 (in picoCuries/Liter)

BOLD indicates above the level of detection. Bkg = background

Sample Location	Bee Brook (B1)	Bee Brook (B2)	Basin (DSN001)	D&R Canal (C1)	D&R Canal (DSN003)
January			145		<107
February	59.5		<110, 44	<110	<40
March			<42		<42
April			<373		≤Bkg
May	<91	<97	113	≤Bkg.	<97
June			<127		≤Bkg
July			219		≤Bkg
August	≤Bkg	≤Bkg	<337	≤Bkg	<118
September			<104		172
October			<103		≤Bkg
November	≤Bkg		<729	≤Bkg	≤Bkg
December			<146		≤Bkg

Sample Location	Potable Water (E1)	Millstone River (M1)	Cranbury Brook (P1)	Devil's Brook (P2)
January				
February	<110	<110	<40	<40
March				
April				
May	<91	<91	<97	<97
June				
July				
August	≤Bkg	≤Bkg	≤Bkg	≤Bkg
September				
October				
November	≤Bkg	≤Bkg	≤Bkg	≤Bkg
December				

Table 6-A. Ground Water Tritium Concentrations for 2005 (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						150	177
February	364	227	291	<40	<40	<110	176
March						55	94
April						<373	<373
May	329	297	365		<97		
June						<127	<127
July						<337	<337
August	344	226	262	<118	<118	241	146
September						132	168
October						<103	183
November	289	148	251	<122	≤Bkg	<122	<122
December							<146

BOLD indicates highest concentrations above background levels.
Bkg = background

Table 7-A. Rain Water Tritium Concentrations (in picoCuries/liter) Collected On-Site in 2005

~250 feet from Stack	R1E (East)	R1W (West)	R1S (South)	R1N (North)	R1ND (Duplicate)
January 13	141	<110	<110	127	<110
March 30	<42	85	184	<42	<42
April 27	≤Bkg	306	266	<373	<37
June 16	275	166	<127	<127	<127
July 19	130	<129	<108	175	
September 15	623	<103	177	<104	127
October 17	<132	<132	<132	172	214
November 23	359	≤Bkg	288	≤Bkg	<146

~500 feet from Stack	R2E (East)	R2W (West)	R2S (South)	R2N (North)
January 13	176	166	<107	<107
March 30	91	≤Bkg	≤Bkg	≤Bkg
April 27	126	135	<91	91
June 16	<127	134	<108	<108
July 19	<129	<127	<129	<129
September 15	189	<103	<103	<103
October 17	≤Bkg	≤Bkg	<132	<132
November 23	<146	<146	<146	<146

BOLD indicates highest concentrations above background levels.
Bkg = background

Table 8-A. Rain Water Tritium Concentrations (in picoCuries/liter) Collected Off-Site in 2005

	REAM 1	REAM 2	REAM 4	REAM 5	REAM 6
June 20					<108
June 21				<108	
July 22	≤Bkg	<129	≤Bkg	<129	
August 06					
August 10				<118	
August 25				<104	
September 28				≤Bkg	
October 18			<792		
October 31	≤Bkg			≤Bkg	

Bkg = background

Table 9-A. Annual Range of Tritium Concentration at PPPL in Precipitation from 1985 to 2005

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	+0.8
		(38.7 w/out Floyd)	(-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
2005	Below Bkg to 623	48.4	+1.9

Bkg = background

Table 10-A. Liquid Effluent Collection Tank Release Data for 2005

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)
2/22/2005	10,800	10	263	12,400	0.000507	0.000507	196	<LLD
4/11/2005	6,600	32.37	215	5,580	0.000139	0.000646	195	<LLD
4/11/2005	12,600	32.96	213	5,090	0.000243	0.000889	195	<LLD
6/8/2005	12,750	10	213	56,900	0.00274	0.00363	195	59 (<LLD)
6/15/2005	12,750	NS	212	45,500	0.0022	0.00583	195	0 (<LLD)
6/27/2005	12,750	NS	177	26,700	0.00129	0.00712	195	<LLD
7/5/2005	12,750	10	213	33,900	0.00164	0.00875	196	0 (<LLD)
7/18/2005	12,900	NS	221	31,000	0.00151	0.0103	195	<LLD
7/21/2005	12,750	NS	227	25,800	0.00124	0.0115	195	<LLD
7/29/2005	12,750	603.226	198	74,600	0.00356	0.0151	195	118 (<LLD)
8/4/2005	12,750	NS	212	49,800	0.0024	0.0175	195	0 (<LLD)
	14,250	NS	212	37,100	0.002	0.0195	195	0 (<LLD)
	13,500	NS	212	11,200	0.000572	0.02	195	<LLD
8/12/2005	12,750	NS	217	47,200	0.00228	0.0223	195	59.3 (<LLD)
8/18/2005	12,750	NS	235	67,400	0.00325	0.0256	196	<LLD
8/29/2005	12,750	1292.417	204	72,500	0.0035	0.0291	195	59.2 (<LLD)
9/2/2005	12,750	1464.238	219	111,500	0.00555	0.0346	196	357
9/16/2005	12,750	1355.32	201	113,000	0.00544	0.0401	195	296
10/5/2005	11,550	84.84	164	43,600	0.00191	0.042	195	<LLD
10/24/2005	12,750	34.219	213	34,900	0.00168	0.0437	196	<LLD
Total gals. released in 2005	247,950							

NS = No sample collected

Table 11-A. Surface Water Analysis for Bee Brook, B1, in 2005

Sample Date	2/3/05	5/5/05	8/3/05	11/1/05
Ammonia nitrogen as N, mg/L		0.19		
Biological Oxygen Demand, mg/L		<2.0	<2.4	
Chemical Oxygen Demand, mg/L	6.845, <10	<5.0	9.3	
Nitrogen, total inorganic, mg/L			<0.05	<0.05
Oxidation-Reduction Potential, mV	32	24	-1.1	36.9
pH, standard units	6.15	6.27	6.78	6.04
Ortho-phosphate, mg/L			0.078	<0.05
Phosphorus, dissolved reactive, mg/L			0.063	<0.05
Phosphorus, total, mg/L	<0.05	<0.05	0.092	0.20
Temperature, °C	0	10.9	22.4	9.1
Total Suspended Solids, mg/L	2.3	2.3	22	4
Total Organic Carbon, mg/L	1.72	4.89	4.61	3.95
Total Dissolved Solids, mg/L		209	377	

Location B1 = Bee Brook upstream of PPPL basin discharge

See Exhibit 4-3 for location.

Table12-A. Surface Water Analysis for Bee Brook, B2, in 2005

Sample Date	2/3/05	5/5/05	8/3/05	11/1/05
Ammonia nitrogen as N, mg/L		<0.10		
Biological Oxygen Demand, mg/L		<2.0		<1.2
Chemical Oxygen Demand, mg/L	<10, <5	<5.0	32.2	
Nitrogen, total inorganic, mg/L			<0.05	<0.05
Oxidation-Reduction Potential, mV	-21	-9	-56.3	-47.5
pH, standard units	7.16	7.27	7.74	7.57
Ortho-phosphate, mg/L			0.074	<0.05
Phosphorus, dissolved reactive, mg/L			0.069	<0.05
Phosphorus, total, mg/L	0.177	0.075	0.10	0.18
Temperature, °C	5.7	12.9	23.6	11.6
Total Suspended Solids, mg/L	3.70	<2.0	4.7	3.0
Total Organic Carbon, mg/L	2.15	3.21	2.82	2.47
Total Dissolved Solids, mg/L		306	220	

Location B2 = Bee Brook downstream of PPPL basin discharge

Table 13-A. Surface Water Analysis for Delaware & Raritan Canal, C1, in 2005

Sample Date	2/3/05	5/5/05	8/3/05	11/1/05
Ammonia nitrogen as N, mg/L		<0.5		
Biological Oxygen Demand, mg/L		<2.2	6.9	
Chemical Oxygen Demand, mg/L	<10, <5.0	<5.00	<5.00	
Nitrogen, total inorganic, mg/L			0.025	0.025
Oxidation-Reduction Potential, mV	-1	-9	-17.4	9.5
pH, standard units	6.76	6.92	7.07	6.54
Ortho-phosphate, mg/L			<0.05	<0.05
Phosphorus, dissolved reactive, mg/L			<0.05	<0.05
Phosphorus, total, mg/L	0.06	0.126	1.0	0.09
Temperature, °C	2.2	15.4	28.9	11.2
Total Suspended Solids, mg/L	4	2.3	12.3	2.00
Total Organic Carbon, mg/L	1.59	2.98	6.17	4.07
Total Dissolved Solids, mg/L		123	220	

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

Table 14-A. Surface Water Analysis for Elizabethtown Water, E1, in 2005

Sample Date	2/3/05	5/5/05	8/3/05	11/1/05
Ammonia nitrogen as N, mg/L		0.27		
Biological Oxygen Demand, mg/L		<2.0	<2.4	
Chemical Oxygen Demand, mg/L	<10, <5.0	<5.0	<5.0	<10
Nitrogen, total inorganic, mg/L			<0.05	<0.05
Oxidation-Reduction Potential, mV	-1	-15	-11.6	-34
pH, standard units	6.79	7.28	6.97	7.31
Ortho-phosphate, mg/L			<0.05	<0.05
Phosphorus, dissolved reactive, mg/L			<0.05	<0.05
Phosphorus, total, mg/L	<0.05	<0.05	<0.05	0.08
Temperature, °C	NS	NS	NS	NS
Total Suspended Solids, mg/L	<2.00	<2.00	<2.00	<2.00
Total Organic Carbon, mg/L	0.5	1.34	1.67	1.79
Total Dissolved Solids, mg/L		229	240	

Location E1 = Elizabethtown Water (potable) collected at Main Gate Security Booth
See Exhibit 4-3 for location.

Table 15-A. Surface Water Analysis for Millstone River, M1, in 2005

Sample Date	2/3/05	5/5/05	8/3/05	11/1/05
Ammonia nitrogen as N, mg/L		0.29		
Biological Oxygen Demand, mg/L		<2.0	<2.4	
Chemical Oxygen Demand, mg/L	<10, <5.0	<5.0	9.3	
Nitrogen, total inorganic, mg/L			<0.05	<0.05
Oxidation-Reduction Potential, mV	11	23	-16.5	24.8
pH, standard units	6.56	6.34	7.05	6.27
Ortho-phosphate, mg/L			0.074	<0.05
Phosphorus, dissolved reactive, mg/L			0.063	<0.05
Phosphorus, total, mg/L	0.078	0.067	0.083	0.20
Temperature, °C	3.8	17.6	29.7	12.7
Total Suspended Solids, mg/L	8	5.7	<2	4
Total Organic Carbon, mg/L	2.11	5.53	2.59	4.76
Total Dissolved Solids, mg/L		149	166	

Location M1 = Millstone River at Delaware & Raritan Canal State Park at Mapleton Road

NS = Not sampled

Table 16-A. Surface Water Analysis for Cranbury Brook (Plainsboro), P1, in 2005

Sample Date	2/3/05	5/5/05	8/3/05	11/1/05
Ammonia nitrogen as N, mg/L		0.05		
Biological Oxygen Demand, mg/L		2.2	<2.4	
Chemical Oxygen Demand, mg/L	<10, <5.0	<5.0	<5.0	
Nitrogen, total inorganic, mg/L			<0.05	<0.05
Oxidation-Reduction Potential, mV	34	29	22.8	23.2
pH, standard units	5.99	6.24	6.38	6.30
Ortho-phosphate, mg/L			<0.05	0.102
Phosphorus, dissolved reactive, mg/L			<0.05	<0.05
Phosphorus, total, mg/L	0.094	0.075	0.092	0.25
Temperature, °C	3.7	16.7	28.9	14.1
Total Suspended Solids, mg/L	6	10.7	9.3	38
Total Organic Carbon, mg/L	2.08	5.87	4.85	4.29
Total Dissolved Solids, mg/L		140	149	

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

Table 17-A. Surface Water Analysis for Devil's Brook (Plainsboro), P2, in 2005

Sample Date	2/3/05	5/5/05	8/3/05	11/1/05
Ammonia nitrogen as N, mg/L		0.05		
Biological Oxygen Demand, mg/L		<2.0	7.2	
Chemical Oxygen Demand, mg/L	<10, 15.119	8.49	<5.0	
Nitrogen, total inorganic, mg/L			<0.05	<0.05
Oxidation-Reduction Potential, mV	30	42	38.7	6.08
pH, standard units	6.22	6.08	6.10	6.08
Ortho-phosphate, mg/L			<0.05	<0.05
Phosphorus, dissolved reactive, mg/L			<0.05	<0.05
Phosphorus, total, mg/L	0.069	<0.05	0.075	0.21
Temperature, °C	2.8	15.6	26.1	11.7
Total Suspended Solids, mg/L	27	3	45	12.3
Total Organic Carbon, mg/L	4.12	9.63	5.84	13.1
Total Dissolved Solids, mg/L		97	134	

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

**Table 18-A. DSN001 - Detention Basin Outfall
Surface Water Analysis (NJPDES NJ0023922) in 2005**

Permit Limit	Units	Parameters	1/5/05	2/3/05	3/7/05	4/5/05	5/5/05	6/8/05
	NA	Ammonia-N mg/L					0.16	
	mg/L	Biological Oxygen Demand					<2.0	
50 mg/L	mg/L	Chemical Oxygen Demand	<10 35.506	2.5, 2.5 5, 5	<5.0	11.923	<5.0	9.274 <10
NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	mgd	Flow, Avg. Monthly	0.275	0.254	0.249	0.276	0.128	0.142
NA	mV	Oxidation-Reduction Potential		-40	-23	-27	-36	
10 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	0.500	0.71	0.95	<0.500	0.56
6.0-9.0	S.U.	pH	7.19	7.44	7.02 7.06	7.24	7.21 7.36	7.67 7.68
	mg/L	Phosphorus, Total		3.22, 0.301			0.126	
	µg/L	Tetrachloroethylene		0.67			1.18	
30 °C max.	°C	Temperature	11.8	9.9	12.8	15.7	15	23.1
NA	mg/L	Total Dissolved Solids	1.62				423	
	mg/L	Total Organic Carbon		2.09, 2.14	1.31	1.25	1.43	2.21
50 mg/L	mg/L	Total Suspended Solids	2.7	<2, <2	3	<2.0	<2.0	3.7

Permit Limit	Units	Parameters	7/6/05	8/3/05	9/12/05	9/16/05	10/7/05	11/1/05	12/6/05
NA	mg/L	Ammonia-N							
	mg/L	Biological Oxygen Demand		1.2 1.2					
50 mg/L	mg/L	Chemical Oxygen Demand	11.477	9.278	24.473		16.9	5 12.2	42.88 <10
0.016	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1
100	%	Chronic Toxicity Test NOEC (% effluent) <i>Pimephales promelas</i>				>100			
NA	Mgd	Flow, Avg. Monthly	0.096	0.087	0.077		0.168	0.228 0.228	
NA	mg/L	Nitrogen, total inorganic		0.05 0.05	<0.05			<0.05 <0.05	<0.05
NL	mV	Oxidation-Reduction Potential	-33.1	12.4	-98	-40.1	-84.6	-62.6 -57.2	-32.8
10 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500		<0.500	0.53	<0.500
6.0-9.0	S.U.	pH	7.3	6.55	8.28 8.52	7.93	8.18	7.83, 7.93 7.73	7.32
	mg/L	Ortho-phosphate		0.053 0.55	<0.05			<0.05 <0.05	<0.05
	mg/L	Phosphorus, dissolved reactive		<0.05 0.05	<0.05			<0.05 <0.05	
	mg/L	Phosphorus, Total		0.075 0.067	0.07		0.63	<0.05 0.09	
	µg/L	Tetrachloroethylene		<0.50				0.60 0.62	
30 °C max.	°C	Temperature	27.7	20.5 21.4	21.3	23.8	22	14.3, 15.8	11.2
	mg/L	Total Dissolved Solids		397 406					
NA	mg/L	Total Organic Carbon	2.45	2.64 2.43	1.72			1.25 1.12	<1.00
50 mg/L	mg/L	Total Suspended Solids	6.3	4.3, 3	3.7		5.7	2.7, 2.7	2.0

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

Table 19-A. D&R Canal Pump House - DSN003
Monthly Surface Water Analysis (NJPDES NJ0023922) in 2005

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	1/5/05	2/3/05	3/8/05	4/5/05	5/5/05	6/8/05	7/6/05
NA	NA	mg/L	Ammonia-N					<0.1		
		mg/L	Biological Oxygen Demand					1, 1		
NA	NA	mg/L	Chemical Oxygen Demand	19.63 5	5 2.5	2.5	21.7	2.5	2.5	6.563
NL	NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NL	NL	mV	Oxidation-Reduction Potential	19 18	-1	-2	23	-1		35.5
10	15	mg/L	Petroleum Hydrocarbons	0.25	0.53	0.54	1.3	0.25	0.62	0.25
NA	6.0-9.0	S.U.	pH	6.31 6.4	6.96	6.89 6.9	6.35 6.37	6.76 6.77	6.78	6.08
NA		mg/L	Phosphorus, Total		0.111			0.05		
NA	NA	°C	Temperature	7	2.8	5.6	12	14	24.2	19.2
		mg/L	Total Dissolved Solids					129, 117		
NA	NA	mg/L	Total Organic Carbon	2.28	1.4	1.92	6.71	3.09	3.41	3.08
20	60	mg/L	Total Suspended Solids		3.7			3.7, 3.3		

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	8/3/05	9/8/05	9/16/05	10/6/05	11/1/05	12/6/05
NA	NA	mg/L	Ammonia-N						
		mg/L	Biological Oxygen Demand	1.2					
NA	NA	mg/L	Chemical Oxygen Demand	2.5	56.77			12.031	14.1 25.439
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	-24.55	-33.65	-22.1	-34.3	-20.6	28.2
10	15	mg/L	Petroleum Hydrocarbons	0.25	0.25			0.83	1.3
NA	6.0-9.0	S.U.	pH	7.19	7.13 7.35	7.12	7.32	7.3	6.22
NA	NA	mg/L	Phosphorus, Total	0.075				0.06	0.06
NA	NA	°C	Temperature	29	24	24.45	19.6	11.5	7.9
NA	NA	mg/L	Total Dissolved Solids	174					
NA	NA	mg/L	Total Organic Carbon	2.43				3.09	6
20	60	mg/L	Total Suspended Solids	2.7				100	

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-A. Summary of Ground Water Sampling Results – 2002 to 2005
Target Chlorinated Volatile Organic Compounds

Location	Date	PCE (µg/L)	TCE (µg/L)	c-1,2-DCE (µg/L)	1,1-DCE (µg/L)	1,1,1-TCA (µg/L)
NJ GWQS		1.0	1.0	70.0	2.0	30.0
D-12	10/20/2003	2.38	1.15	<1.0	1.22	<0.9
	9/22/2004	2.66	1.36	<0.50	<1.2	<0.9
	11/02/2005	2.35	1.47	<0.70	<0.70	<0.80
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
	9/22/2004	34.8	<0.9	<0.5	<1.2	2.72
	11/02/2005	34.2	1.03	<0.70	0.8 J	2.04
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
	11/02/2005	39.2	292	<0.70	<1.00	<1.40
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
	11/02/2005	<0.5	<0.5	<0.70	<0.70	<0.80
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
	11/03/2005	<0.5	<0.5	<0.70	<0.70	<0.80
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
	11/03/2005	190	9.1	0.8	0.6	<0.80
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
	11/03/2005	<0.5	<0.5	<0.70	<0.70	<0.80
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
	11/03/2005	<0.5	<0.5	<0.70	<0.70	<0.80
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
	11/03/2005	<0.5	<0.5	<0.70	<0.70	<0.8
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
	9/22/2004	0.79	<0.5	5.21 NJ	<1.2	<0.9
	11/02/2005	0.74J	<0.5	<0.70	<0.70	<0.8
D-Site MG Building Sump	7/29/2002	88.6	6.31	3.61 NJ	2.01 J	1.36 J
	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
	11/02/2005	32.9	3.08	<0.70	<0.70	<0.80
D-site Air Shaft Building Sump	7/29/2002	2.88 J	< 0.8	< 0.8	< 0.8	< 0.8
	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
	11/02/2005	2.27	<0.5	<0.70	<0.70	<0.80

**Table 20-A. Summary of Ground Water Sampling Results – 2002 to 2005
Target Chlorinated Volatile Organic Compounds (continued)**

Location	Date	PCE (µg/L)	TCE (µg/L)	c-1,2-DCE (µg/L)	1,1-DCE (µg/L)	1,1,1-TCA (µg/L)
NJ GWQS		1.0	1.0	70.0	2.0	30.0
D-Site MG Building Sump	7/29/2002	88.6	6.31	3.61 NJ	2.01 J	1.36 J
	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
	11/02/2005	32.9	3.08	<0.70	<0.70	<0.80
D-site Air Shaft Building Sump	7/29/2002	2.88 J	< 0.8	< 0.8	< 0.8	< 0.8
	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
	11/02/2005	2.27	<0.5	<0.70	<0.70	<0.80
DSN001	6/20/2003	<0.8	<0.80	<0.80	<0.60	<0.70
	10/21/2003	<0.51J	0.15	<1.0	<1.2	<0.9
	9/22/2004	0.900J	<0.5	<0.5	<1.2	<0.9
	11/02/2005	0.62J	<0.50	<0.70	<0.70	<0.80

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-Dichloroethene

1,1-DCE – 1,1-Dichloroethene

1,1,1-TCA – 1,1,1-Trichloroethane

**Table 21-A. Summary of Ground Water Sampling Results – 2003 to 2005
Natural Attenuation Indicators (mg/L unless noted)**

Location	Date	Chloride 250 mg/L	Sulfate 250 mg/L	Alkalinity	Nitrate as N 10mg/L	Ferrous Iron	Dissolved Methane	Dissolved Ethane	pH 6.5-8.5 ORP
D-12	10/20/03	19.9	31.6	95	<0.5	<0.10	9.99		5.55, 16.3
	9/22/04	18.1	31.3	61.7	<0.5	<0.10	0.42	0.14	5.26, 234.7
	11/02/05	15.9	28.7	78.8	<0.50	<0.10	0.12	<0.10	5.00 , 85.1
MW-13I	6/03	<5.0, <5.0	15.8, 15.8	126,132	<5.0, <0.5	<0.10, <0.10	<0.10, <0.10		6.81,- 78
	10/20/003	6.60	22.5	90.9	<0.5	<0.10	<0.10		6.82, 55.8
	9/22/04	6.00	19.6	91.5	<0.5	<0.10	<0.10	<0.10	4.98, 166.9
	11/02/05	7.31	22.1	80.8	<0.50	<0.10	<0.10	<0.10	6.23 , 7.4
MW-13S	6/03	9.0	18.7	60.1	<0.50	<0.10 0.85,	9.71 30.4, 1.47		6.62, 6.2 6.02, 65.1
	10/20/03	10.7, 6.1	21.5, 29.2	51.5,20.2	<0.5, <0.5	<0.10			
	9/22/2004	11.7, 11.7	19.9, 20.3	47.8, 58.7	<0.5, <0.5	<0.10	21.5, 20.8	<0.10,	5.26, 63.9
	11/02/05	13.7, 13.8	13.8	52.2, 52.2	<0.5,<0.5	2.4, 2.4	25.1, 24.5	<0.10	5.72 , 36.2
MW-17	10/20/03	8.70	21.6	20.2	<0.5	0.98			5.60, 15
	9/22/04	7.5	19.2	20.9	<0.5	<0.10	0.25	<0.10	4.93, 101.3
	11/02/05	8.93	20.1	19.7	<0.5	<0.10	2.15	<0.10	4.72 , 66.5
MW-18	6/03	<5.0	27.7	20.4	0.18	<0.10	<0.10		5.42, -113
	10/20/03	8.00	24.4	25.3	<0.5	<0.10	2.09		5.74, 4.6
	9/22/04	6.70	22.4	21.9	<0.5	<0.10	0.48	<0.10	4.84, 75.7
	11/03/05	6.61	29.7	19.7	<0.5	<0.10	<0.10	<0.10	4.62 , 95.2

Table 21-A. Summary of Ground Water Sampling Results – 2003 to 2005
Natural Attenuation Indicators (mg/L unless noted) (continued)

Location	Date	Chloride 250 mg/L	Sulfate 250 mg/L	Alkalinity	Nitrate as N 10mg/L	Ferrous Iron	Dissolved Methane	Dissolved Ethane	pH 6.5-8.5 ORP
MW-19I	6/03	24.4		45.6	0.750	<0.10	<0.10		6.98, 104.1 5.73, 187.8
	10/21/03	27	13.7	44	0.900	<0.10	<0.10		
	9/22/04	28.9	12.3	45.8	0.87	<0.10	<0.10	<0.10	5.7, 180.2
	11/03/05	32.4	11.0	38.4	0.85	<0.10	<0.10	<0.10	5.46 , 69.8
MW-19S	6/03	5.72	30.9	19.4	<0.50	<0.10	<0.10		4.97, 42
	10/21/03	6.00	29.1	<2.0	<0.5	<0.10	1.97		4.9, 177.99
	9/22/04	5.99	19.0	23.9	<0.5	4.3	3.98	<0.10	4.47, 187.7
	11/03/05	5.65	27.3	21.7	<0.5	<0.10	<0.10	<0.10	5.46 , 69.8
MW-22S	6/03	25.0	24.7	30.1	<0.50	<0.10	<0.10		5.48, -32
	10/21/03	24.6	22.5	<2.0	1.00	<0.10	<0.10		5.32, 15.5
	9/22/04	23.5	21.9	11.9	0.84	<0.10	<0.10	<0.10	4.82, 148.2
	11/03/05	33.7	18.7	<2.0	0.97	<0.10	<0.10	<0.10	5.11 , 73.5
MW-23S	6/03	<5.0	57.8	4.4	<0.50	<0.10	<0.10		4.49, 8
	10/21/03	13.4	56.2	<2.0	<0.5	<0.10	<0.10		4.65, 201.1
	9/22/04	7.62	53.3	10.9	<0.5	0.75	<0.10	<0.10	4.53, 159.9
	11/03/05	6.98	57.2	<2.0	<0.50	<0.10	<0.10	<0.10	4.31 /104.8
MW-24S	6/03	<5.0	16.5	31	<0.50	<0.10	<0.10		6.72, 106.8
	10/21/03	<5.0	14.2	<2.0	<0.5	<0.10	<0.10		5.27, 21.2
	9/22/04	<5.0	13.5	7.96	<0.5	<0.10	<0.10	<0.10	4.55, 160.1
	11/02/05	<5.0	13.3	<2.0	<0.50	<0.10	<0.10	<0.10	5.2 , 73.6
MW-25	6/03	218	14.2	73.7	<0.50	0.46	6.48		6.32, -12.2
	10/21/03	197	16.1	74.7	<0.5	0.39	16.0		6.01, 50.6
	9/22/04	199	14.2	67.7	<0.5	<0.10	7.25	0.2	5.47, 2.8
	11/02/05	175	17	67	<0.50	<0.40	7.89	0.12	5.62 , 31.6
MW-9S	10/21/03	8.8	24	56.5	<0.5	<0.10	<0.10		5.28, 129.3
	9/22/04	14.4	27.8	79.6	<0.5	<0.10	<0.10	<0.10	5.48, 152.7
	11/02/05	8.73	21.0	25.6	<0.50	<0.10	<0.10	<0.10	5.32 , 57.8
D-Site MG Building Sump	6/03	95.1	21.7	109	1.00	<0.20	1.34		
	10/21/03	53.9	33.9	79.8	<0.5	0.46	3.62		
	9/22/04	99.5	18.9	112	<0.5	<0.10	5.99	<0.10	
	11/02/05	126	19.5	116	0.84	0.39	7.64		
D-site Air Shaft Building Sump	6/03	71.1	23.8	98.9	1.20	<0.20	0.20		
	6/18/03	53.8	31.2	99	1.2	<0.10	0.17		
	9/22/04	49.5	27.5	95.5	0.93	<0.10	0.16	<0.10	
	11/02/05	82.6	25.7	98.5	1.35	<0.10	0.18		
DSN001	6/03	19.4	6.8	33	<0.50	<0.20	3.44		
	10/21/03	53.9	29.2	79.8	1.00	<0.10	<0.10		
	9/22/04	46.4	37.7	91.5	0.770	<0.10	<0.10	<0.10	
	11/02/05	93.2	30.0	74.9	1.45	<0.10	0.41		

ORP – oxidation/reduction potential measured in mVe.

Table 22-A. Quality Assurance Data for Radiological and Non-Radiological Samples for 2005

Laboratory, Program, and Parameter	Reported Value	Actual Value	Acceptance Range
<i>ERA (picoCuries/Liter)</i>			
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
<i>June 2005 WP</i>			
Chemical oxygen demand (mg/L)	114.253	124	93.6-143
Specific conductance (µmhos/cm)	285.5	281	245-310
pH (S.U.)	9.22	9.22	9.02-9.42
Total residual chlorine (mg/L)	2.21	2.24	1.6-2.76
<i>July 2005 WP0204</i>			
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

Bold type indicates value outside of acceptance range.

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Table 1-B. PPPL Radiological Design Objectives and Regulatory Limits^(a)

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

P = Probability of occurrence in a year.

(a) All operations must be planned to incorporate 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-B. Annual Precipitation Data for 2006

START DATE	WEEK	INCH	INCH/MONTH	MONTH	ACCUMULATION
2-Jan-06	1	2.2500			2.2500
9-Jan-06	2	1.2500			3.5000
16-Jan-06	3	2.0500			5.5500
23-Jan-06	4	0.2000			5.7500
30-Jan-06	5	1.1000	6.8500	JANUARY	6.8500
6-Feb-06	6	0.9000			7.7500
13-Feb-06	7	0.0000			7.7500
20-Feb-06	8	0.0000			7.7500
27-Feb-06	9	0.4000	1.3000	FEBURARY	8.1500
6-Mar-06	10	0.6000			8.7500
13-Mar-06	11	0.0000			8.7500
20-Mar-06	12	0.1500			8.9000
27-Mar-06	13	0.0000	0.7500	MARCH	8.9000
3-Apr-06	14	1.2000			10.1000
10-Apr-06	15	0.0500			10.1500
17-Apr-06	16	2.3500			12.5000
24-Apr-06	17	0.0000	3.6000	APRIL	12.5000
1-May-06	18	0.0000			12.5000
8-May-06	19	2.4500			14.9500
15-May-06	20	0.4000			15.3500
22-May-06	21	0.3000			15.6500
29-May-06	22	1.5850	4.7350	MAY	17.2350
5-Jun-06	23	0.8500			18.0850
12-Jun-06	24	0.9500			19.0350
19-Jun-06	25	1.0500			20.0850
26-Jun-06	26	1.5500	4.4000	JUNE	21.6350
3-Jul-06	27	0.0500			21.6850
10-Jul-06	28	0.8000			22.4850
17-Jul-06	29	2.4000			24.8850
24-Jul-06	30	0.8000			25.6850
31-Jul-06	31	0.0000	4.0500	JULY	25.6850
7-Aug-06	32	0.2000			25.8850
14-Aug-06	33	0.0000			25.8850
21-Aug-06	34	0.8000			26.6850
28-Aug-06	35	3.2500	4.2500	AUGUST	29.9350
4-Sep-06	36	0.6000			30.5350
11-Sep-06	37	2.1500			32.6850
18-Sep-06	38	0.2000			32.8850
25-Sep-06	39	0.6500	3.6000	SEPTEMBER	33.5350
2-Oct-06	40	1.1000			34.6350
9-Oct-06	41	2.2000			36.8350
16-Oct-06	42	1.9000			38.7350
23-Oct-06	43	1.7000			40.4350
30-Oct-06	44	0.3500	7.2500	OCTOBER	40.7850
6-Nov-06	45	2.4500			43.2350
13-Nov-06	46	1.1000			44.3350
20-Nov-06	47	1.3000			45.6350
27-Nov-06	48	0.2500	5.1000	NOVEMBER	45.8850
4-Dec-06	49	0.0000			45.8850
11-Dec-06	50	0.2000			46.0850
18-Dec-06	51	1.2500			47.3350
25-Dec-06	52	0.7500	2.2000	DECEMBER	48.0850

Table 3-B. D-Site Tritium Stack Releases in Curies in 2006

Week Ending	HTO (Ci)	HT (Ci)	Weekly total (Ci)	Month	Annual Total (Ci)
Baseline 12/28/05	0.000	0.000	0.000		0.000
4-Jan	0.001	0.001	0.002		0.002
11-Jan	0.133	0.009	0.142		0.144
18-Jan	0.182	0.017	0.199		0.343
25-Jan	0.154	0.007	0.161	January	0.504
1-Feb	0.147	0.008	0.155		0.659
8-Feb	0.090	0.005	0.095		0.754
15-Feb	0.157	0.008	0.165		0.919
22-Feb	0.086	0.010	0.095	February	1.014
1-Mar	0.093	0.007	0.101		1.115
8-Mar	0.100	0.010	0.110		1.225
15-Mar	0.112	0.007	0.119		1.343
22-Mar	0.094	0.011	0.105		1.448
29-Mar	0.105	0.009	0.114	March	1.562
5-Apr	0.119	0.006	0.125		1.687
2-Apr	0.098	0.009	0.107		1.795
19-Apr	0.100	0.014	0.114		1.909
26-Apr	0.095	0.009	0.105	April	2.013
3-May	0.091	0.011	0.102		2.115
10-May	0.091	0.011	0.102		2.217
17-May	0.091	0.011	0.103		2.320
24-May	0.087	0.12	0.099		2.418
31-May	0.110	0.016	0.126	May	2.544
7-Jun	0.112	0.008	0.120		2.664
14-Jun	0.110	0.020	0.130		2.794
21-Jun	0.099	0.007	0.106		2.901
28-Jun	0.099	0.007	0.106	June	3.007
4-Jul	0.197	0.015	0.212		3.219
12-Jul	0.139	0.013	0.152		3.371
19-Jul	0.162	0.013	0.175		3.547
26-Jul	0.128	0.012	0.140	July	3.686
2-Aug	0.101	0.011	0.112		3.799
9-Aug	0.110	0.007	0.117		3.916
16-Aug	0.096	0.008	0.104		4.020
23-Aug	0.096	0.008	0.104		4.1233
30-Aug	0.097	0.008	0.105	August	4.228
6-Sept	0.090	0.011	0.100		4.329
13-Sept	0.103	0.010	0.113		4.442
20-Sept	0.092	0.011	0.103		4.545
27-Sept	0.074	0.010	0.084	September	4.628
4-Oct	0.179	0.010	0.189		4.817
11-Oct	0.264	0.019	0.283		5.101
18-Oct	0.053	0.004	0.057		5.158
25-Oct	0.109	0.005	0.114	October	5.271
1-Nov	0.117	0.004	0.121		5.392
8-Nov	0.060	0.013	0.073		5.465
15-Nov	0.020	0.017	0.037		5.502
22-Nov	0.021	0.017	0.038		5.540
29-Nov	0.040	0.020	0.060	November	5.600
6-Dec	0.070	0.034	0.104		5.704
13-Dec	0.081	0.013	0.093		5.798
20-Dec	0.109	0.016	0.125		5.922
27-Dec	0.110	0.011	0.121	December	6.043
2-Jan	0.079	0.009	0.088	Total	6.131

Table 4-B. Ranges of Air Tritium Concentrations (in pCi/m3) Collected On-Site (T1-T4) and Off-Site (R1-R6 & BM1) in 2006

Station	HTO pCi/m3	HT pCi/m3
T1	0 - 0.882	0 - 2.78
T2	0 - 0.814	0 - 3.49
T3	0 - 0.865	0 - 5.77
T4	0 - 0.692	0 - 2.75
R1	0 - 0.117	0 - 128
R2	0 - 0.125	0 - 0.398
R3	0 - 0.205	0 - 0.833
R4	0.024 - 0.183	0.503 - 2.82
R5	0 - 0.401	0 - 2.75
R6	0 - 0.306	0 - 2.23
BM1	0 - 0.400	0 - 2.15

Table 5-B. Surface Water Tritium Concentrations for 2006 (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			≤Bkg		≤Bkg
February	≤Bkg	≤Bkg	≤Bkg	≤Bkg	≤Bkg
March			≤Bkg	≤Bkg	≤Bkg
April			≤Bkg	≤Bkg	≤Bkg
May	≤Bkg	≤Bkg	63	≤Bkg	≤Bkg
June			123	≤Bkg	≤Bkg
July			90	≤Bkg	23
August	104	514	108	117	32
September			153	27	14
October			≤Bkg	≤Bkg	≤Bkg
November	41	5	86	≤Bkg	≤Bkg
December			≤Bkg	108	54

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	≤Bkg	≤Bkg	≤Bkg
June				
July				
August	≤Bkg	≤Bkg	≤Bkg	14
September				
October				
November	≤Bkg	≤Bkg	≤Bkg	≤Bkg
December				

Table 6-B. Ground Water Tritium Concentrations for 2006 (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						167	
February	225	108	140	≤Bkg	≤Bkg		
March						145	
April						≤Bkg	
May	131	50	189	≤Bkg	≤Bkg		
June						136	
July						108	
August	158	203	176	≤Bkg	90	90	
September						144	
October						50	
November	236	146	133	≤Bkg	50		
December						≤Bkg	

BOLD indicates highest concentrations above background levels.

**Table 7-B. Rain Water Tritium Concentrations (in picoCuries/liter)
Collected On-Site in 2006**

250 feet from Stack	R1E (East)	R1W (West)	R1S (South)	R1N (North)	R1ND (Duplicate)
January 5	104	≤Bkg	90	23	14
February 2	≤Bkg	≤Bkg	14	≤Bkg	18
April 27	117	32	230	81	54
June 2	252	≤Bkg	≤Bkg	99	135
June 27	213	144	176	26	125
July 31	95	≤Bkg	3600	≤Bkg	23
August 29	68	126	144	81	59
September 27	≤Bkg	77	≤Bkg	131	198
November 29	89	114	102	146	137
December 27		43	≤Bkg	50	79

500 feet from Stack	R2E (East)	R2W (West)	R2S (South)	R2N (North)
January	14	≤Bkg	≤Bkg	≤Bkg
February 2	≤Bkg	≤Bkg	≤Bkg	≤Bkg
April	167	68	140	45
June 2	217	≤Bkg	≤Bkg	91
June 27	149	50	171	865
July 31	≤Bkg	45	14	18
August 29	68	27	9	131
September 27	≤Bkg	36	≤Bkg	68
November 29	63	23	18	95
December 27	114	106	≤Bkg	29

BOLD indicates highest concentrations above background levels.

**Table 8-B. Rain Water Tritium Concentrations (in picoCuries/liter)
Collected Off-Site in 2006**

	REAM 1	REAM 2	REAM 4	REAM 5	REAM 6
July 24			≤Bkg	≤Bkg	
July 31		≤Bkg			
August 9				18	

**Table 9-B. Annual Range of Tritium Concentration at PPPL
in Precipitation from 1985 to 2006**

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
2005	<37 to 623	48.4	+1.9
2006	9 to 3,600	48.1	+1.6

Table 10-B. Liquid Effluent Collection Tank Release Data for 2006

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)
1/24/06	12,450	<20	235	32,600	0.00154	0.00154	196	<BKG
5/12/06	12,750	38.188	183	20,300	0.00098	0.00252	195	<BKG
6/7/06	12,750	29.919	213	24,300	0.00117	0.00369	196	<BKG
6/226/06	12,750	NS	217	32,400	0.00156	0.00525	196	<BKG
7/5/16	12,750	6.771	203	27,700	0.00133	0.00658	197	<BKG
7/13/06	12,750	NS	201	25,400	0.00122	0.00780	196	<BKG
7/24/06	12,657	NS	221	19,400	0.000936	0.00874	196	<BKG
7/27/06	12,750	NS	215	18,100	0.000874	0.00961	196	<BKG
8/10/06	12,750	NS	212	15,800	0.00076	0.01037	195	<BKG
8/10/06	12,750	13.929	211	16,300	0.000787	0.01116	195	<BKG
8/25/06	12,750	NS	224	21,100	0.00102	0.01218	195	<BKG
9/1/06	9,000	Ns	225	18,900	0.000645	0.01282	195	<BKG
9/20/06	12,300	<20	226	17,400	0.000829	0.01365	195	<BKG
10/6/06	10,500	84.778	257	18,000	0.000715	0.01437	196	59.4
4/16/06	12,000	NS	248	11,000	0.000502	0.01487	196	59.4
Totals released	183,657							

Table 11-B. Surface Water Analysis for Bee Brook, B1, in 2006

Sample Date	2/7/06	5/9/06	8/10/06	11/1/06
Ammonia nitrogen as N, mg/L		<0.100	0.110	
Biological Oxygen Demand, mg/L		<2.20	<1.65	
Chemical Oxygen Demand, mg/L	<10.0 31.508	<10 27.174	28.662	9.641
Nitrogen, total inorganic, mg/L		<0.050		
Oxidation-Reduction Potential, mV	10.7	-0.3	-14.3	4.5
pH, standard units	6.52	6.81	6.97	6.60
Phosphorus, total, mg/L	<0.050	<0.050	0.272	0.063
Temperature, °C	3.3	11.56	20.6	12.4
Total Suspended Solids, mg/L	2.00	10.70	23.70	<2.00
Total Organic Carbon, mg/L	5.67	3.25	5.77	8.54
Total Dissolved Solids, mg/L		126	583	

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

Table12-B. Surface Water Analysis for Bee Brook, B2, in 2006

Sample Date	2/7/06	5/9/06	8/10/06	11/1/06
Ammonia nitrogen as N, mg/L		<0.100	0.130	
Biological Oxygen Demand, mg/L		<2.20	<1.65	
Chemical Oxygen Demand, mg/L	<10.0, 26.629	17, 24.522	33.572	40.227
Nitrogen, total inorganic, mg/L		<0.050		
Oxidation-Reduction Potential, mV	-18.7	-18.8	-80.3	-21.1
pH, standard units	7.6	7.14	8.12	7.06
Phosphorus, total, mg/L	0.060	0.144	0.078	<0.050
Temperature, °C	6.7	14.07	21.7	14
Total Suspended Solids, mg/L	2.00	26.0	4.0	<2.0
Total Organic Carbon, mg/L	3.77	2.51	3.17	13.2
Total Dissolved Solids, mg/L		303	460	

Location B2 = Bee Brook downstream of PPPL basin discharge

Table 13-B. Surface Water Analysis for Delaware & Raritan Canal, C1, in 2006

Sample Date	2/7/06	5/9/06	8/10/06	11/1/06
Ammonia nitrogen as N, mg/L		0.130	0.110	
Biological Oxygen Demand, mg/L		<2.20	<1.65	
Chemical Oxygen Demand, mg/L	<10.0, 9.929	13.678	8.696	<5.0
Nitrogen, total inorganic, mg/L		<0.050		
Oxidation-Reduction Potential, mV	-15	-14.1	-33	5
pH, standard units	6.99	7.06	7.29	6.59
Phosphorus, total, mg/L	0.360	<0.050	<0.050	0.098
Temperature, °C	6.5	19.07	27.3	12.2
Total Suspended Solids, mg/L	<2.00	3.3	3.0	<2.0
Total Organic Carbon, mg/L	3.26	2.56	2.88	8.95
Total Dissolved Solids, mg/L		120	194	

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

Table 14-B. Surface Water Analysis for Elizabethtown Water, E1, in 2006

Sample Date	2/7/06	5/9/06	8/10/06	11/1/06
Ammonia nitrogen as N, mg/L		0.18	0.280	
Biological Oxygen Demand, mg/L		<2.20	<1.65	
Chemical Oxygen Demand, mg/L	<10.0	18.521	6.624	25.773
Nitrogen, total inorganic, mg/L		<0.050		
Oxidation-Reduction Potential, mV	-10.1	30.4	-16	2.1
pH, standard units	6.87	6.24	7.0	6.65
Phosphorus, total, mg/L	<0.050	<0.050	<0.050	<0.050
Temperature, °C	27.1	16.85	30	16.1
Total Suspended Solids, mg/L	<2.00	<2.00	<2.00	<2.00
Total Organic Carbon, mg/L	1.17	1.84	1.62	2.81
Total Dissolved Solids, mg/L		289	251	

*Location E1 = Elizabethtown Water (potable) collected at Main Gate Security Booth
See Exhibit 4-3 for location.*

Table 15-B. Surface Water Analysis for Millstone River, M1, in 2006

Sample Date	2/7/06	5/9/06	8/10/06	11/1/06
Ammonia nitrogen as N, mg/L		0.34	0.190	
Biological Oxygen Demand, mg/L		<2.20	18.7	
Chemical Oxygen Demand, mg/L	10.4	18.521	61.953	15.338
Nitrogen, total inorganic, mg/L		<0.050		
Oxidation-Reduction Potential, mV	6.8	10	1.5	10.5
pH, standard units	6.60	6.63	6.70	6.49
Phosphorus, total, mg/L	<0.050	<0.050	0.369	0.072
Temperature, °C	6.5	18.24	27.4	13.2
Total Suspended Solids, mg/L	5.00	6.7	80	2.0
Total Organic Carbon, mg/L	3.75	4.03	11.7	8.51
Total Dissolved Solids, mg/L		211	209	

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

Table 16-B. Surface Water Analysis for Cranbury Brook (Plainsboro), P1, in 2006

Sample Date	2/7/06	5/9/06	8/10/06	11/1/06
Ammonia nitrogen as N, mg/L		0.120	0.170	
Biological Oxygen Demand, mg/L		3.10	<2.2	
Chemical Oxygen Demand, mg/L	10.4	16, 34.003	18.207	12.996
Nitrogen, total inorganic, mg/L		<0.050		
Oxidation-Reduction Potential, mV	19.8	18.1	0.5	20.9
pH, standard units	6.36	6.49	6.72	6.31
Phosphorus, total, mg/L	0.100	0.117	0.061	0.063
Temperature, °C	7.7	18.07	27.7	12.0
Total Suspended Solids, mg/L	20.7	23	10.7	9
Total Organic Carbon, mg/L	3.63	3.89	5.29	6.74
Total Dissolved Solids, mg/L		174	137	

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

Table 17.-B. Surface Water Analysis for Devil's Brook (Plainsboro), P2, in 2006

Sample Date	2/7/06	5/9/06	8/10/06	11/1/06
Ammonia nitrogen as N, mg/L		0.100	0.180	
Biological Oxygen Demand, mg/L		<2.2	<2.2	
Chemical Oxygen Demand, mg/L	15.9	36.581	21.587	28.953
Nitrogen, total inorganic, mg/L		<0.050		
Oxidation-Reduction Potential, mV	25.9	42.9	12.4	25.9
pH, standard units	6.24	6.05	6.50	6.22
Phosphorus, total, mg/L	<0.050	<0.050	0.845	<0.050
Temperature, °C	5.7	18.07	22.5	12.3
Total Suspended Solids, mg/L	3.30	9.7	4.0	3.0
Total Organic Carbon, mg/L	6.89	10.6	5.78	13.5
Total Dissolved Solids, mg/L		100	154	

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

**Table 18- B. DSN001 - Detention Basin Outfall
Surface Water Analysis (NJPDES NJ0023922) in 2006**

Permit Limit	Units	Parameters	1/3/06	2/7/06	3/7/06	4/4/06	5/9/06	6/6/06
NA	mg/L	Ammonia-N					<0.100	
	mg/L	Biological Oxygen Demand					0.130	
	mg/L						2.20	
	mg/L						<2.20	
50 mg/L	mg/L	Chemical Oxygen Demand	<10.0	<10.0	<10.0	<10.0	<10.0	18.004
			9.072	16.867	19.2	18.576	157.64	
NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	MGD	Flow, Avg. Monthly	0.431	0.346	0.247	0.214	0.182	0.238
NA	mV	Oxidation-Reduction Potential	-7	-20.2				
10 mg/L	mg/L	Petroleum Hydrocarbons	0.850	<0.500	0.740	<0.500	<0.500	0.940
							<0.500	
6.0-9.0	S.U.	pH	7.08	7.37	7.62	7.37	7.92	7.50
	mg/L	Ortho Phosphate as P	0.0910					
	mg/L	Phosphorus, Reactive Dissolved	<0.0500					
	mg/L	Phosphorus, Total	0.0500	0.200	0.0500	0.0550	0.117	0.0990
				0.170			<0.050	
	µg/L	Tetrachloroethylene	0.830J	0.710J	0.580J	0.550J	0.390J	0.910J
30 °C max.	°C	Temperature	9.4	11.9	12.1	12.2	15.96	18.9
NA	mg/L	Total Dissolved Solids					409	
							131	
	mg/L	Total Organic Carbon	2.17	1.78		3.85	1.76	1.81
				1.59			2.72	
50 mg/L	mg/L	Total Suspended Solids	4.70	<2.00	2.70	11.3	3.00	3.00
				2.00			4.70	

Permit Limit	Units	Parameters	7/5/06	8/10/06	9/12/06	10/3/06	11/1/06	12/5/06
NA	mg/L	Ammonia-N		0.150				
				0.100				
	mg/L	Biological Oxygen Demand		2.47				
				2.83				
50 mg/L	mg/L	Chemical Oxygen Demand	21.749	20.74	19.891	<5.0	7.149	<5.0
			24.687	28.662	31.187		9.18	<5.0
							11.204	
0.016	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	MGD	Flow, Avg. Monthly	0.125	0.098	0.221	0.233	0.323	0.264
NL	mV	Oxidation-Reduction Potential	42.8,-50	-129.8	-95.6	-80.1	-51.9	-44.3
10 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
6.0-9.0	S.U.	pH	7.61,7.77	8.97	8.39	8.09	7.61	7.56
	mg/L	Phosphorus, Total	0.607	<0.050	<0.050	0.054	0.132	<0.050
				0.272			0.132	
	µg/L	Tetrachloroethylene	1.15	0.570J	0.410J	0.540J	0.640J	0.720J
30 °C max.	°C	Temperature	22.6	21.9	19.5	18.5	15.8	11.1
			24.6					
	mg/L	Total Dissolved Solids		371				
				366				
NA	mg/L	Total Organic Carbon	6.21	2.23	1.77	2.86	3.13	1.04
				2.31			3.30	
50 mg/L	mg/L	Total Suspended Solids	10.7	6.30	2.70	2.70	<2.00	<2.00
				8.30			<2.00	

Blank indicates no measurement

NA = not applicable

NL = no limit

Table 19-B. D&R Canal Pump House - DSN003
Monthly Surface Water Analysis (NJPDES NJ0023922) in 2006

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	1/3/06	2/7/06	3/7/06	4/4/06	5/9/06	6/6/06
NA	NA	mg/L	Ammonia-N					0.120	
		mg/L	Biological Oxygen Demand					<2.20	
NA	NA	mg/L	Chemical Oxygen Demand	<5.0	<10.0	<10.0 <5.0	<5.0	14.882	20.359
NL	NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	0.13	<0.1
NL	NL	mV	Oxidation-Reduction Potential	-13.1	2.6	-14.9	-51.6	-2.5	12.3
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	0.520	<0.500	<0.500	0.830
NA	6.0-9.0	S.U.	pH	6.95	6.64	6.97	7.57	6.85	6.54
NA		mg/L	Phosphorus, Total		<0.050	<0.050	0.0730	0.0550	0.188
NA	NA	° C	Temperature	5.7	6.0	5.7	14.1	18.7	21.1
		mg/L	Total Dissolved Solids					174	
NA	NA	mg/L	Total Organic Carbon		3.78		2.91	2.58	11.1
NL	NL	mg/L	Total Suspended Solids	6.30	3.00	2.00	3.30	6.30	5.70

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	7/5/06	8/10/06	9/12/06/	10/3/06	11/1/06	12/5/06
NA	NA	mg/L	Ammonia-N		0.110				
		mg/L	Biological Oxygen Demand		<1.65				
NA	NA	mg/L	Chemical Oxygen Demand	<5.0	14.814	<5.0	<5.0	94.024	<5.0
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	26.9	-28.4	-24.1	-24.1	-5.6	-14.5
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<5.00	<0.500
NA	6.0-9.0	S.U.	pH	6.32	7.21	7.14	7.11	6.78	7.02
NA	NA	mg/L	Phosphorus, Total	0.052	0.184	0.166	0.089	0.141	<0.050
NA	NA	° C	Temperature	25.6	26.1	20.8	18.5	12.1	7.7
		mg/L	Total Dissolved Solids		149				
NA	NA	mg/L	Total Organic Carbon	5.00	2.94	3.22	3.97	9.10	3.24
NL	NL	mg/L	Total Suspended Solids	7.00	3.70	5.00	5.30	<2.00	<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-B. Summary of Ground Water Sampling Results – 2002 to 2006
Target Chlorinated Volatile Organic Compounds (in µg/L)

Monitoring Locations	Date	PCE	TCE	c-1,2-DCE	1,1-DCE	1,1,1-TCA
NJ GWQS		1.0	1.0	70.0	2.0	30.0
D-12	10/21/2003	2.38	1.15	<1.0	1.22	<0.9
	9/22/2004	2.66	1.36	<0.5	<1.2	<0.9
	11/2/2005	2.35	1.47	<0.70	<0.70	<0.80
	9/25/2006	2.00	0.940 J	<0.50	0.780	<0.60
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	3.04 NJ	<1.2	2.9
	9/22/2004	34.8	<0.9	<0.5	<1.2	2.72
	11/02/2005	34.2	1.03	0.35	0.8	2.04
	9/26/2006	30.6	0.83	<0.70	0.790 J	0.86
MW-13S	7/29/2002	51.4	1.57 J	4.5 NJ	<0.4	1.72 J
	10/20/2003	75.5	315	10.4 NJ	<1.2	1.68
	9/22/2004	57.8	431	18	1.2J	1.35
	11/02/2005	39.2	292	15.9 NJ	<1.00	<1.40
	9/26/2006	50.6	179	26.7 NJ	1.09	0.86
MW-17	10/21/2003	39.9	1.33	<1.0	<1.1	0.55 J
	9/22/2004	45.9	1.85	4.28 NJ	<1.2	<0.9
	11/2/2005	32.2	1.97	<0.70	<0.70	<0.80
	9/25/2006	39.2	1.95	<0.50	<0.30	<0.60
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
	11/02/2005	0.5	0.25	0.35	0.35	0.4
	9/26/2006	0.670 J	0.540 J	<0.50	<0.3	<0.6
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
	11/03/2005	0.25	0.25	0.3	0.35	0.4
	9/26/2006	<0.30	<0.20	<0.50	<0.30	<0.60
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
	11/03/2005	190	9.1	0.8	0.6	0.8
	9/26/2006	158	8.12	16.4 NJ	<0.30	<0.60
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
	11/03/2005	0.25	0.25	0.3	0.35	0.4
	9/26/2006	<0.3	<0.2	<0.50	<0.3	<0.6
MW-23	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
	9/22/2004	<0.4	<0.5	<0.5	<1.2	<0.9
	11/03/2005	0.25	0.25	0.35	0.3	0.4
	9/26/2006	<0.30	<0.20	<0.50	<0.30	<0.60

**Table 20-B. Summary of Ground Water Sampling Results – 2002 to 2006
Target Chlorinated Volatile Organic Compounds (in µg/L) (continued)**

Monitoring Locations	Date	PCE	TCE	c-1,2-DCE	1,1-DCE	1,1,1-TCA
NJ GWQS		1.0	1.0	70.0	2.0	30.0
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
	11/03/2005	0.25	0.3	0.35	0.3	0.4
	9/26/2006	<0.3	<0.2	<0.50	<0.3	<0.6
MW-25	11/21/2002	0.90 J	< 0.6	4.21	< 0.6	< 0.7
	10/21/2003	0.90 J	0.5 0J	5.31NJ	0.6 J	< 0.7
	9/22/2004	0.79	<0.5	5.21 NJ	<1.2	<0.9
	11/02/2005	0.74	0.25	0.35	0.35	0.40
	9/26/2006	1.2	0.630 J	4.41 J	<0.30	<0.60
NJ GWQS		1.0	1.0	70.0	2.0	30.0
DSN001 - Basin Outfall	10/21/2003	0.51 J	0.15	<1.0	<1.2	<0.9
	9/22/2004	0.900 J	<0.5	<0.5	<1.2	<0.9
	11/02/2005	0.62 J	<0.50	<0.70	<0.70	<0.80
	9/26/2006	0.390 J	<0.20	<0.50	<0.30	<0.60
D-Site MG Building Sump	7/29/2002	88.6	6.31	3.61 NJ	2.01 J	1.36 J
	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
	11/02/2005	32.9	3.08	<0.70	<0.70	<0.80
	9/25/2006	43.2	4.36	3.13 NJ	0.76 J	<0.60
D-site Air Shaft Building Sump	7/29/2002	2.88 J	< 0.8	< 0.8	< 0.8	< 0.8
	6/18/2003	5.19	<0.8	<0.7	<0.6	<0.7
	10/21/2003	2.73	<0.3	<1.0	<1.2	<0.9
	9/22/2004	1.89	<0.5	<0.5	<1.2	<0.9
	11/02/2005	2.27	<0.50	<0.70	<0.70	<0.80
	9/25/2006	2.23	0.340 J	<0.50	<0.30	<0.60

Notes: "J" indicates a value that is greater than the MDL but lower than the lowest standard.
"N" indicates presumptive evidence of a compound.

c-1,2-DCE – cis-1,2-Dichloroethylene

1,1-DCE – 1,1-Dichloroethylene

PCE – Tetrachloroethylene

1,1,1-TCA – 1,1,1-Trichloroethane

TCE – Trichloroethene

Table 21.-B Summary of Ground Water Sampling Results – 2003 to 2006
Natural Attenuation Indicators (mg/L unless noted)

Monitoring Locations	Date	Chloride 250 mg/L	Sulfate 250 mg/L	Alka- linity	Nitrate as N 10mg/L	Ferrous Iron	Dissolved Methane	Dissolved Ethane	pH SU ORP mV
D-12	10/21/03	19.9	31.6	95	<0.5	<0.10	9.99		5.55, 16.3
	9/22/04	18.1	31.3	61.7	<0.5	<0.10	0.42	0.14	5.26, 234.7
	11/03/05	15.9	28.7	78.8	<0.5	<0.10	0.12	<0.10	5.00, 85.1
	9/26/06	18.3	31.2	64.1	<0.5	<0.10	7.00	<0.1	5.11, 51.7
MW-9S	10/21/03	8.8	24	56.5	<0.5	<0.10	<0.10		5.28, 129.3
	9/22/04	14.4	27.8	79.6	<0.5	<0.10	<0.10	<0.10	5.48, 152.7
	11/02/05	8.73	21.0	25.6	<0.50	<0.10	<0.10	<0.10	5.32, 57.8
	9/27/06	10.4	22.0	39.3	<0.50	<0.20	<0.10	<0.10	5.49, 36.1
MW-13S	10/20/03	10.7	21.5	51.5	<0.5	0.85	30.4		6.02, 65.1
	9/22/04	11.7	19.9	91.5	<0.5	<0.10	21.5	<0.10	5.26, 63.9
	11/02/05	13.7	20.5	52.2	<0.5	2.4	25.1	<0.10	5.72, 36.2
	9/26/06	19.3	21.6	55.2	<0.50	6.0	40.9	<0.10	5.34, 45.7
MW-13I	10/21/03	6.60	22.5	90.9	<0.5	<0.10	<0.10		6.82, 55.8
	9/22/04	6.00	19.6	91.5	<0.5	<0.10	<0.10	<0.10	4.98, 166.9
	11/03/05	7.31	22.1	80.8	<0.5	<0.10	<0.10	<0.10	6.23, 7.4
	9/26/06	9.43	21.8	91.9	<0.5	<0.20	<0.10	<0.10	5.82, -4.5
MW-17	10/21/03	8.70	21.6	20.2	<0.5	0.98	1.43		5.6, 15
	9/22/04	7.5	19.2	20.9	<0.50	<0.10	0.25	<0.10	4.93, 101.3
	11/03/05	8.93	20.1	19.7	<0.5	<0.10	2.15	,0.10	4.72, 66.5
	9/27/06	11.7	21.8	15.5	<0.50	<0.20	0.97	<0.10	4.54, 14.1
MW-18	10/21/03	8.00	24.4	25.3	<0.50	<0.10	2.09		5.74, 4.6
	9/22/04	6.70	22.4	21.9	<0.50	<0.10	0.48	<0.10	4.84, 75.7
	11/03/05	6.61	29.7	19.7	<0.5	<0.10	<0.10	<0.10	4.62, 95.2
	9/27/06	8.65	24	16.1	<0.50	<0.20	1.14	<0.10	4.53, 20.7
MW-19S	6/03	5.72	30.9	19.4	<0.50	<0.10	<0.10		4.97,42
	10/21/03	6.00	29.1	<2.0	<0.5	<0.10	1.97		4.9, 177.99
	9/22/04	5.99	19.0	23.9	<0.5	4.3	3.98	<0.10	4.47, 187.7
	11/03/05	5.65	27.3	21.7	<0.5	<0.10	<0.10	<0.10	5.46, 69.8
	9/26/06	7.39	27.8	21.6	<0.50	<0.20	10.2	<0.10	4.51, 28.5
MW-19I	6/03	24.4		45.6	0.750	<0.10	<0.10		6.98, 104.1
	10/21/03	27	13.7	44	0.900	<0.10	<0.10		5.73, 187.8
	9/22/04	28.9	12.3	45.8	0.87	<0.10	<0.10	<0.10	5.7, 180.2
	11/03/05	32.4	11.0	38.4	0.85	<0.10	<0.10	<0.10	5.46, 69.8
	9/26/06	41.5	11.8	34.6	1.05	<0.20	<0.10	<0.10	5.07, 14.6
MW-22S	6/03	25.0	24.7	30.1	<0.50	<0.10	<0.10		5.48,-32
	10/21/03	24.6	22.5	<2.0	1.00	<0.10	<0.10		5.32, 15.5
	9/22/04	23.5	21.9	11.9	0.84	<0.10	<0.10	<0.10	4.82, 148.2
	11/03/05	33.7	18.7	<2.0	0.97	<0.10	<0.10	<0.10	5.11, 73.5
	9/26/06	31.6	20.9	6.85	0.96	<0.20	<0.10	<0.10	4.81, 73.6

ORP – oxidation/reduction potential measured in mVe.

Table 21-A. Summary of Ground Water Sampling Results – 2003 to 2006
Natural Attenuation Indicators (mg/L unless noted) (continued)

Monitoring Locations	Date	Chloride 250 mg/L	Sulfate 250 mg/L	Alka- linity	Nitrate as N 10mg/L	Ferrous Iron	Dissolved Methane	Dissolved Ethane	pH SU ORP mV
MW-23S	6/03	<5.0	57.8	4.4	<0.50	<0.10	<0.10		4.49, 8
	10/21/03	13.4	56.2	<2.0	<0.5	<0.10	<0.10		4.65, 201.1
	9/22/04	7.62	53.3	10.9	<0.5	0.75	<0.10	<0.10	4.53, 159.9
	11/03/05	6.98	57.2	<2.0	<0.50	<0.10	<0.10	<0.10	4.31/104.8
	9/26/06	8.69	51.6	11.5	<0.50	<0.20	<0.10	<0.10	4.33, 22.2
MW-24S	6/03	<5.0	16.5	31	<0.50	<0.10	<0.10		6.72, 106.8
	10/21/03	<5.0	14.2	<2.0	<0.5	<0.10	<0.10		5.27, 21.2
	9/22/04	<5.0	13.5	7.96	<0.5	<0.10	<0.10	<0.10	4.55, 160.1
	11/02/05	<5.0	13.3	<2.0	<0.50	<0.10	<0.10	<0.10	5.2, 73.6
	9/26/06	5.49	14.1	9.53	<0.50	<0.20	<0.10	<0.10	4.96, 65.6
MW-25	6/03	218	14.2	73.7	<0.50	0.46	6.48		6.32, -12.2
	10/21/03	197	16.1	74.7	<0.5	0.39	16.0		6.01, 50.6
	9/22/04	199	14.2	67.7	<0.5	<0.10	7.25	0.2	5.47, 2.8
	11/02/05	175	17	67	<0.50	<0.40	7.89	0.12	5.62, 31.6
	9/26/06	171	19.5	73	<0.50	0.47	9.96	0.18	5.52,-10.2
D-Site MG Building Sump	6/03	95.1	21.7	109	1.00	<0.20	1.34		
	10/21/03	53.9	33.9	79.8	<0.5	0.46	3.62		
	9/22/04	99.5	18.9	112	<0.5	<0.10	5.99	<0.10	
	11/02/05	126	19.5	116	0.84	0.39	7.64		
	9/25/06	157	19.9	110	0.72	<0.10	0.2	<0.10	
D-site Air Shaft Building Sump	6/03	71.1	23.8	98.9	1.20	<0.20	0.20		
	6/18/03	53.8	31.2	99	1.2	<0.10	0.17		
	9/22/04	49.5	27.5	95.5	0.93	<0.10	0.16	<0.10	
	11/02/05	82.6	25.7	98.5	1.35	<0.10	0.18		
	9/25/06	97.5	22.3	113	1.21	<0.10	4.12	<0.10	
DSN001 – Basin Outfall	6/03	19.4	6.8	33	<0.50	<0.20	3.44		
	10/21/03	53.9	29.2	79.8	1.00	<0.10	<0.10		
	9/22/04	46.4	37.7	91.5	0.770	<0.10	<0.10	<0.10	
	11/02/05	93.2	30.0	74.9	1.45	<0.10	0.41		
	9/25/06	91.6	27.1	87.4	0.93	<0.10	0.21	<0.10	

Table 22-B. Quality Assurance Data for Radiological and Non-Radiological Samples for 2006

Laboratory, Program, and Parameter	Reported Value	Actual Value	Acceptance Range
<i>ERA (picoCuries/Liter)</i>			
RAD-64	14,100	16,700	13,800 – 19,600
RAD-66	3,270	4,050	3,300 – 4,750
<i>June 2006 WP</i>			
Chemical oxygen demand (mg/L)	223.064	204	158-231
Specific conductance (µmhos/cm)	495	492	439-541
pH (S.U.)	8.18	8.16	7.96-8.36
Total residual chlorine (mg/L)	1.74	1.9	1.36-2.34
Low level residual chlorine (µg/L)	85	91.1	82-100
<i>June 2006 WP0606 WP137</i>			
Chemical oxygen demand (mg/L)	52.177	45.3	29.8-57.3
Specific conductance (µmhos/cm)	397.0	393	365-421
pH (S.U.)	8.00	8.00	7.80-8.20
Total residual chlorine (mg/L)	1.74	1.77	1.27-2.03

Table 23-B. Toxic Pollution Data for DSN001 Surface Water Sampling in 2006

<i>Parameter</i>	Reported Value in µg/L	Reported in mg/L
Chloroform	1.45	
Tetrachloroethylene (PCE)	1.02	
Barium		0.166
Copper		0.0073
Manganese		0.0574
Nickel		0.0032
Zinc		0.0642

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