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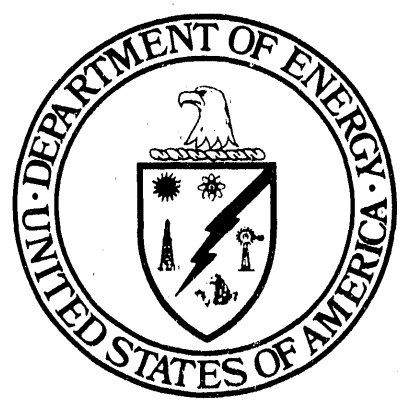

Environmental Survey
Preliminary Report

Princeton Plasma Physics Laboratory
Princeton, New Jersey

May 1989

PREFACE TO
THE DEPARTMENT OF ENERGY
PRINCETON PLASMA PHYSICS LABORATORY
ENVIRONMENTAL SURVEY PRELIMINARY REPORT

This report contains preliminary findings based on the first phase of an Environmental Survey at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL), located in Princeton, New Jersey. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The PPPL Survey is a portion of a larger, comprehensive DOE Environmental Survey encompassing all major operating facilities of DOE. The DOE Environmental Survey is one of a series of initiatives announced on September 18, 1985, by Secretary John S. Herrington to strengthen the environmental, safety, and health programs and activities within DOE. The purpose of the Environmental Survey is to identify, via a "no fault" baseline Survey of all the Department's major operating facilities, environmental problems and areas of environmental risk. The identified problem areas will be prioritized on a Department-wide basis in order of importance in 1989.

The preliminary findings in this report are subject to modification based on the results from the Sampling and Analysis phase of the Survey. Preliminary findings are also subject to modification based on comments from the DOE Princeton Area and Chicago Operations Offices concerning the technical accuracy of the findings. The modified findings will be incorporated into the Environmental Survey Summary Report.

April 1989
Washington, D.C.

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Introduction

This report presents the preliminary findings of the first phase of the Environmental Survey of the United States Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL), conducted June 13 through 17, 1988.

The Survey is being conducted by an interdisciplinary team of environmental specialists, led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. Team members are being provided by private contractors. The objective of the Survey is to identify environmental problems and areas of environmental risk associated with PPPL. The Survey covers all environmental media and all areas of environmental regulation. It is being performed in accordance with the DOE Environmental Survey Manual. This phase of the Survey involves the review of existing site environmental data, observations of the operations carried on at PPPL, and interviews with site personnel.

The Survey team developed a Sampling and Analysis (S&A) Plan to assist in further assessing certain of the environmental problems identified during its on-site activities. The S&A plan is being developed by the Idaho National Engineering Laboratory. When completed, the S&A results will be incorporated into the PPPL Survey findings for inclusion in the Environmental Survey Summary Report.

Site Description

PPPL occupies a 72-acre site in central New Jersey approximately midway between Philadelphia and New York City. Although the land is leased by the United States Government from Princeton University, the buildings are government-owned. The Laboratory also leases two office buildings approximately 1 mile north of the main site. PPPL is managed by DOE through the Princeton Area and Chicago Operations Offices, and is operated by Princeton University. Since the early 1950s, PPPL has been involved in fusion energy and, presently, it is the primary Federal facility devoted to research and development of magnetic fusion energy as a viable long-term method of generating electricity.

No substantive environmental concerns relevant to the Survey were raised in a meeting with Federal and state regulators.

Summary of Findings

The major preliminary finding of the Environmental Survey at PPPL is that the potential exists for spills of polychlorinated biphenyls (PCBs), mineral oil, and other hazardous substances. Should spills occur, they could result in the contamination of downgradient surface water, and the groundwater underlying and downgradient of the site.

Overall Conclusions

The Survey found no environmental problems at PPPL that represent an immediate threat to human life. The preliminary findings identified at PPPL indicate that there are several environmental problems which are the result of both current and past operational practices.

The environmental prob'ems described in this report vary in terms of magnitude and risk. Although the Survey-related S&A will assist in further identifying some suspected environmental problems at the site, a complete understanding of the significance of these and other identified environmental problems requires a level of study and characterization that is beyond the scope of this Survey. Actions currently under way or planned will contribute toward meeting this requirement.

Transmittal and Follow-Up of Findings

The preliminary findings of the Environmental Survey for PPPL were shared with the DOE Chicago Operations and Princeton Area Offices and the site contractor at the Survey closeout briefing held June 17, 1988. The Princeton Area Office has developed a draft action plan, dated August 1988, to address the Survey preliminary findings. A final action plan addressing all the Survey findings cited herein will be prepared by the Princeton Area Office within 45 days after receiving this Preliminary Report. Those problems that involve extended studies and multi-year budget commitments will be the subject of the Environmental Survey Summary Report and the DOE-wide prioritization.

Within the Office of the Assistant Secretary for Environment, the Office of Environmental Guidance and Compliance (OEG) has immediate responsibility for monitoring environmental compliance and the status of PPPL Survey findings. The Office of Environmental Audit will continue to assess the environmental problems through a program of systematic environmental audits that will be initiated toward the conclusion of the DOE Environmental Survey in 1989.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings made during the Environmental Survey, June 13 through 17, 1988, at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL), Princeton, New Jersey. As a Preliminary Report, the contents are subject to revision. Revisions to the preliminary findings based on technical accuracy review comments from the DOE Princeton Area and Chicago Operations Offices (PAO and CH) and the results from the Survey's Sampling and Analysis program at PPPL will be incorporated into the Environmental Survey Summary Report. The PAO and CH manage PPPL, which is operated by Princeton University.

The PPPL Survey is part of the larger DOE-wide Environmental Survey announced by Secretary John S. Herrington on September 18, 1985. The purpose of this effort is to identify, via "no-fault" baseline surveys, existing environmental problems and areas of environmental risk at DOE facilities, and to rank them on a DOE-wide basis. This ranking will enable DOE to more effectively establish priorities for addressing environmental problems and allocate the resources necessary to correct them. Because the Survey is "no-fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance or to analyze environmental management practices. Such incidents and/or management practices will, however, be used in the Survey as a means of identifying existing and potential environmental problems.

The PPPL Environmental Survey was conducted by a multidisciplinary team of technical specialists headed and managed by a Team Leader and Assistant Team Leader from DOE's Office of Environmental Audit. A complete list of the PPPL Survey participants and their affiliations is provided in Appendix A.

The Survey team focused on all environmental media, using Federal, state, and local environmental statutes and regulations, accepted industry practices, and professional judgment to make the preliminary findings included in this report. The team carried out its activities in accordance with the guidance and protocols of the DOE Environmental Survey Manual. Substantial use of existing information and of interviews with knowledgeable field-office and site-contractor personnel accounted for a large part of the on-site effort. A summary of the site-specific

Survey activities is presented in Appendix B, and the Survey Plan is presented in Appendix C.

Preliminary Survey findings, in the form of existing and potential environmental problems, are presented in Sections 3.0 and 4.0. Section 3.0 includes findings that pertain to a specific environmental medium (i.e., air, soil, surface water, and groundwater), whereas Section 4.0 includes those that are non-media-specific (i.e., waste management, toxic and chemical materials, direct radiation, quality assurance, and inactive waste sites and releases). A list defining the abbreviations, acronyms, and initialisms used throughout the report is provided in Appendix D. Because the findings are highly varied in magnitude, risk, and characterization, and consequently require different levels of management attention and response, they are further subdivided into four categories within Sections 3.0 and 4.0.

The criteria for placing a finding into one or more of the four categories are as follows:

- Category I includes only findings that, based on information available to the Team Leader, involve immediate threat to human life. Findings of this category shall be conveyed immediately to the Environment, Safety and Health personnel at the scene or in control of the facility or location in question for action. Category I findings are environmental problems with the highest potential risk, the strongest confidence in the finding, based on the information available, and the most restrictive appropriate response in terms of alternatives.

- Category II findings encompass one or more of the following situations:

  - Multiple or continuing exceedances, past or present, of a health-based environmental standard where there is immediate potential for human exposure, or a one-time exceedance where residual impacts pose an immediate potential for human exposure.

  - Evidence that a health-based environmental standard may be exceeded, as discussed in the preceding situation, within the time of the DOE-wide Survey.

- Evidence that the likelihood is high for an unplanned release due to, for example, the condition or design of pollution abatement or monitoring equipment or other environmental management practices.

- Noncompliance with significant regulatory procedures (i.e., substantive technical regulatory procedures designed to directly or indirectly minimize or prevent risks), such as inadequate monitoring or failure to obtain required permits.

Category II findings include environmental problems where the risk is high but where the definition of risk is broader than in Category I. The information available to the Team Leader is adequate to identify the problem but may be insufficient to fully characterize it. Finally, in this category, most discretion is available to the Area Offices, Operations Offices, and Program Offices as to appropriate response; however, the need for that response is such that management should not wait for the completion of the DOE-wide Survey to respond. Unlike Category I findings, a sufficient near-term response to Category II findings by the Project and Operations Offices may include further characterization before any action is taken to rectify the situation.

- Category III findings encompass one or both of the following criteria:

  - The existence of pollutants or hazardous materials in the air, water, groundwater, or soil resulting from DOE operations that pose or may pose a hazard to human health or the environment.

  - The existence of conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

Category III findings are environmental problems for which the broadest definition of risk is used. As in Category II, the information available to the Team Leader may not be sufficient to fully characterize the problems. Under this category, the range of alternatives available for response and

the corresponding time limits for response are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases, as well as multiyear budget commitments. These problems will be included in the DOE-wide prioritization to ensure that DOE's limited resources are used effectively.

In general, levels of pollutants or materials that constitute a hazard or potential for hazard are those that exceed some Federal, state, or local regulations for release of, contamination by, or exposure to such pollutants or materials. However, in some cases, the Survey may determine that the concentration of some nonregulated material is sufficient to be included as an environmental problem. Likewise, concentrations of regulated materials even though below limits established by regulatory authorities, that nevertheless present a potential for hazard or concern may be classified as an environmental problem. In general, however, conditions that meet regulatory or other requirements, where such exist, should not present a potential hazard and will not be identified as an environmental problem.

Conditions that pose or may pose a hazard are generally those that are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazard to human health and the environment and should be identified as an environmental problem. Additionally, potentially hazardous conditions are those where the likelihood of the occurrence of release is high.

The definition of the term "environmental problem" is broad and flexible to allow for the wide differences among the DOE sites and operations. Therefore, a good deal of professional judgment must be applied to the identification of environmental problems.

- Category IV findings include instances of administrative noncompliance and of management practices that are indirectly related to environmental risk but are not appropriate for inclusion in Categories I

through III. Such findings can be based on any level of information available to the Team Leader, including direct observations by the team members. Findings in this category are generally expected to lend themselves to relatively simple, straightforward resolution without further evaluation or analysis. These findings, although not part of the DOE-wide prioritization effort, will be passed along to the Area and Operations Offices and appropriate Program Office for action.

Based on the professional judgment of the Team Leader, the findings within categories are arranged in order of relative significance. Comparing the relative significance of one finding to another, either between categories within a section or within categories between sections, is neither appropriate nor valid. The categorization and listing of findings in order of significance within this report constitute only the first step in a multistep, iterative process to prioritize DOE's problems.

The next phase of the PPPL Survey will be Sampling and Analysis (S&A). The Idaho National Engineering Laboratory (INEL), the S&A team for PPPL , collected samples in late 1988. An S&A Plan was prepared by DOE and the INEL in accordance with the protocols in the DOE Environmental Survey Manual. The S&A Plan was designed to fill existing data gaps or weaknesses. Results generated by the S&A effort will be used to assist the Survey team in further defining the existence and extent of potential environmental problems identified during the Survey.

It is clear that certain of the findings and observations contained in this report are highly varied in magnitude, risk, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses will require careful planning to ensure appropriate and effective application. The information in this Preliminary Report will assist the PAO and CH in planning these near-term responses.

CH submitted a draft action plan in August 1988 in response to the preliminary findings presented at the conclusion of the on-site Survey activities and summarized in the PPPL Survey Status Report dated August 3, 1988. The draft action plan for the PPPL Survey has been reviewed by the Office of Environmental Guidance and Compliance (OEG), which has immediate responsibility for monitoring the status

and overseeing the adequacy of corrective actions taken by the Area and Operations Offices in response to the Survey findings.

As required in the December 2, 1987, memorandum from the Assistant Secretary for Environment, Safety and Health to the Operations Office Managers entitled, Follow-up of Environmental Survey Findings, CH will prepare and submit a final action plan to the Deputy Assistant Secretary (DAS) for Environment within 45 days after receiving this Preliminary Report. The final action plan for the PPPL Survey will address all of the preliminary findings cited herein and incorporate OEG's comments on the draft action plan.

2.0 GENERAL SITE INFORMATION

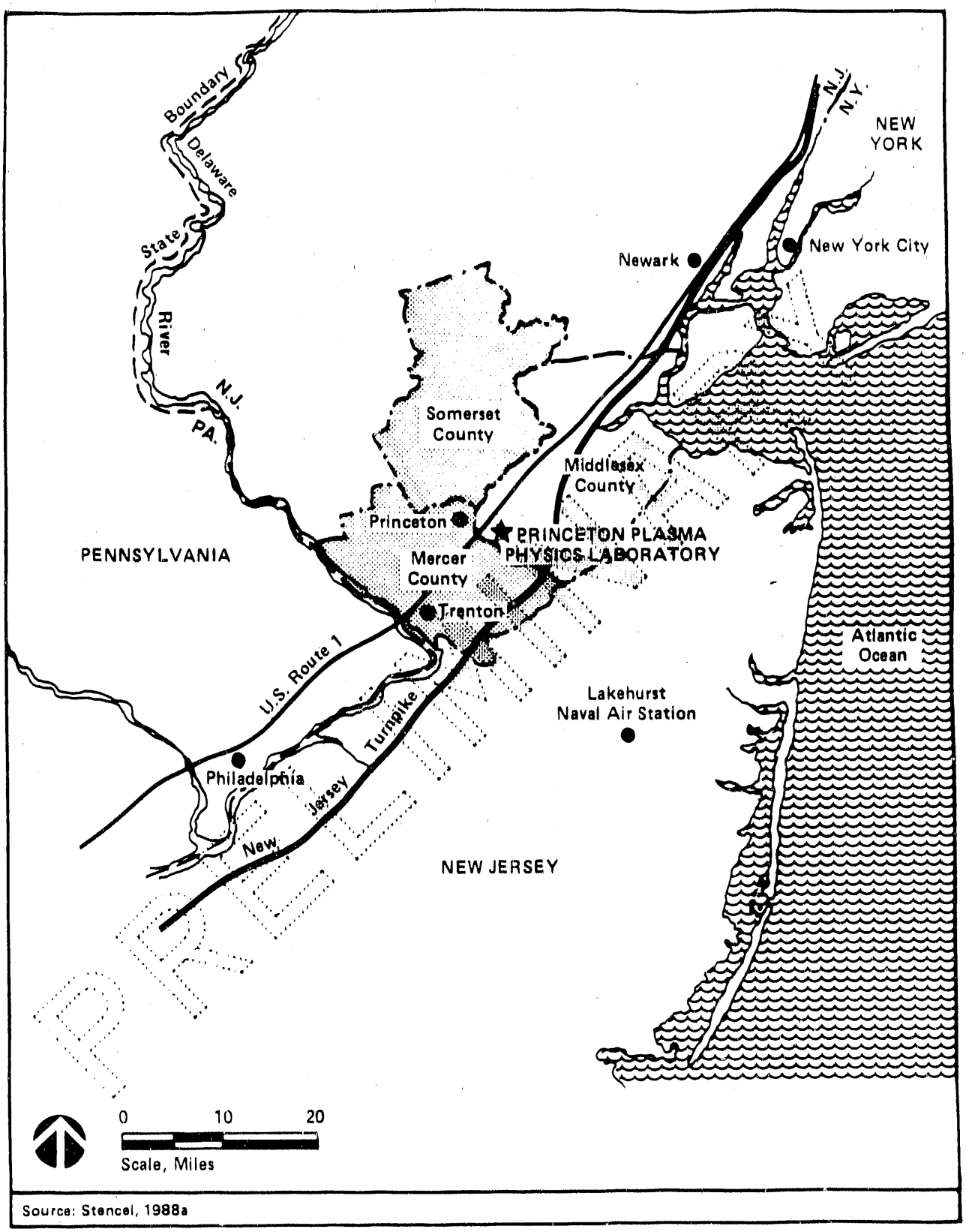
Much of the information in this section is summarized from the Environmental Assessment of the Princeton Plasma Physics Laboratory (PPPL) Compact Ignition Tokamak, Final Draft (DOE, 1988); the Environmental Monitoring Report for Calendar Year 1987 (Stencel, 1988a); the Site Development and Facility Utilization Plan, FY 1987-1992 (PPPL, 1987b); the Tokamak Fusion Test Reactor Facilities Final Safety Analysis Report (Ebasco Grumman, 1982), and PPPL: An Overview (PPPL, 1985a).

2.1 Site Setting

PPPL is located in central New Jersey approximately midway between Philadelphia and New York City. It is adjacent to U.S. Route 1 in the Township of Plainsboro in Middlesex County (Figures 2-1 and 2-2). PPPL is situated on a U.S. Government-leased 72-acre tract of land on the Princeton University Forrestal Campus, located approximately 1 mile east of Princeton Township (Figure 2-3). The Laboratory uses approximately 700,000 square feet of space in U.S. Government-owned buildings on the 72-acre tract that is composed of C- and D-Sites. Until 1987, PPPL also occupied U.S. Government-owned buildings at A-Site on the Forrestal Campus and university-owned buildings at both A- and B-Sites. A- and B-Sites are located approximately 1 mile southwest of the main C- and D-Site complex. The arrangement and identification of buildings on the C- and D-Sites are presented in Figure 2-4 and Table 2-1, respectively.

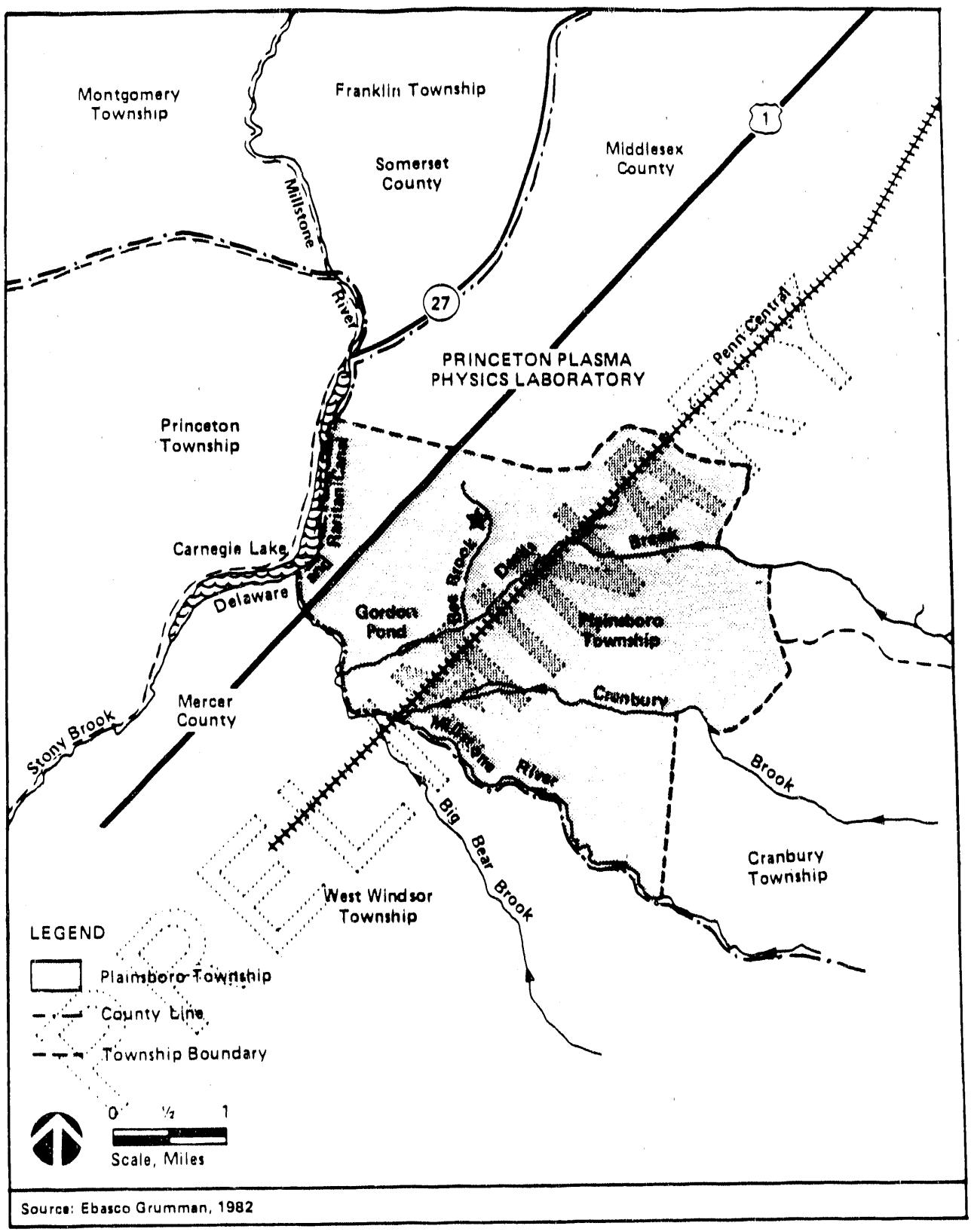
PPPL also leases two one-story office buildings with approximately 120,000 square feet of space in an office park at 305-307 College Road, approximately 1 mile north of the Forrestal Campus (Figure 2-3). These buildings are presently utilized as office space only.

The PPPL vicinity, including Mercer, Middlesex, and Somerset Counties, is characterized by a combination of suburban and rural land uses. The rural areas, however, are rapidly being developed for commercial, residential, and industrial uses. The heaviest concentration of development occurs along U.S. Route 1, which passes near the western border of PPPL. In fact, PPPL is surrounded by other



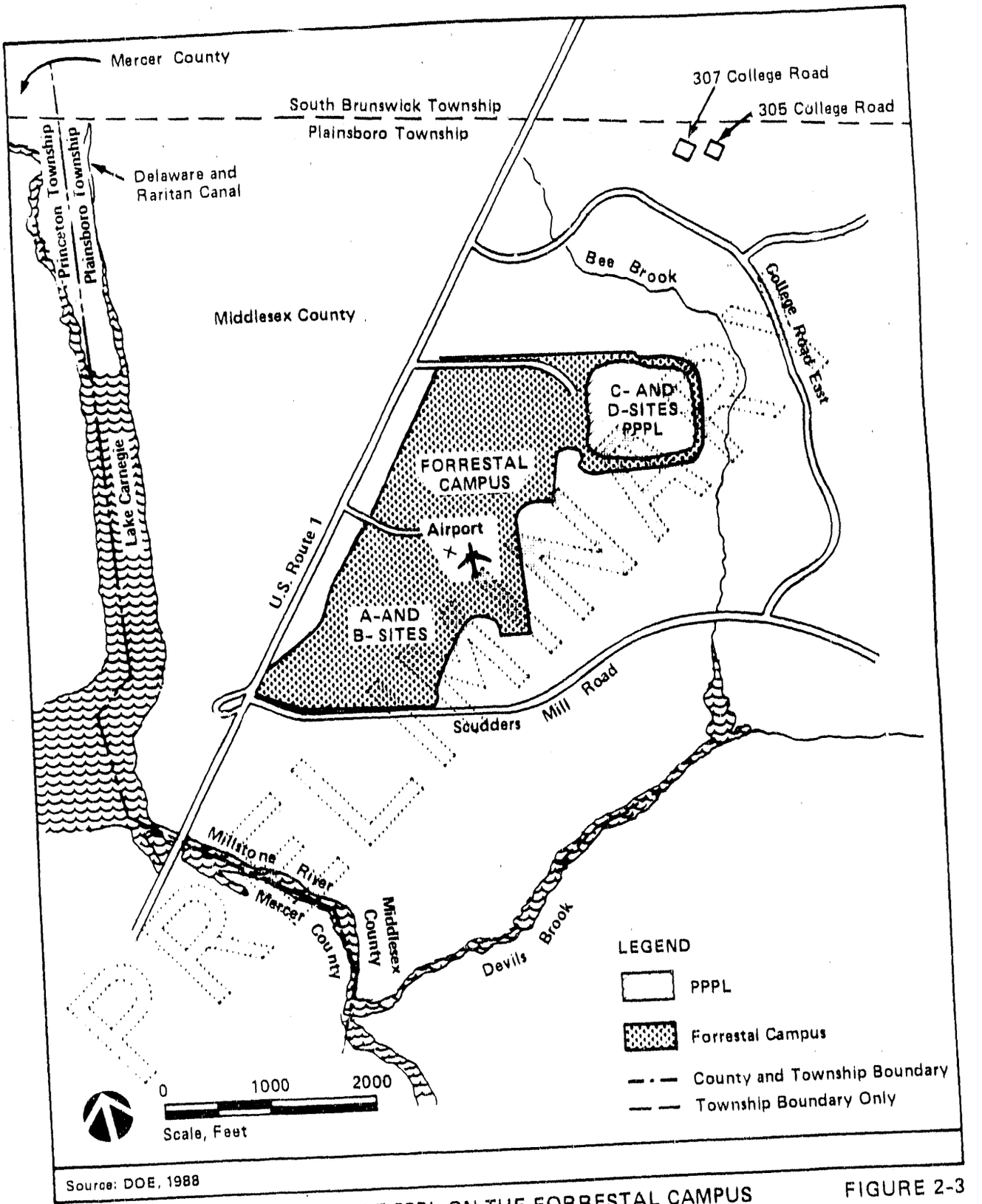
Source: Stencel, 1988a

LOCATION OF PPPL IN CENTRAL NEW JERSEY FIGURE 2-1



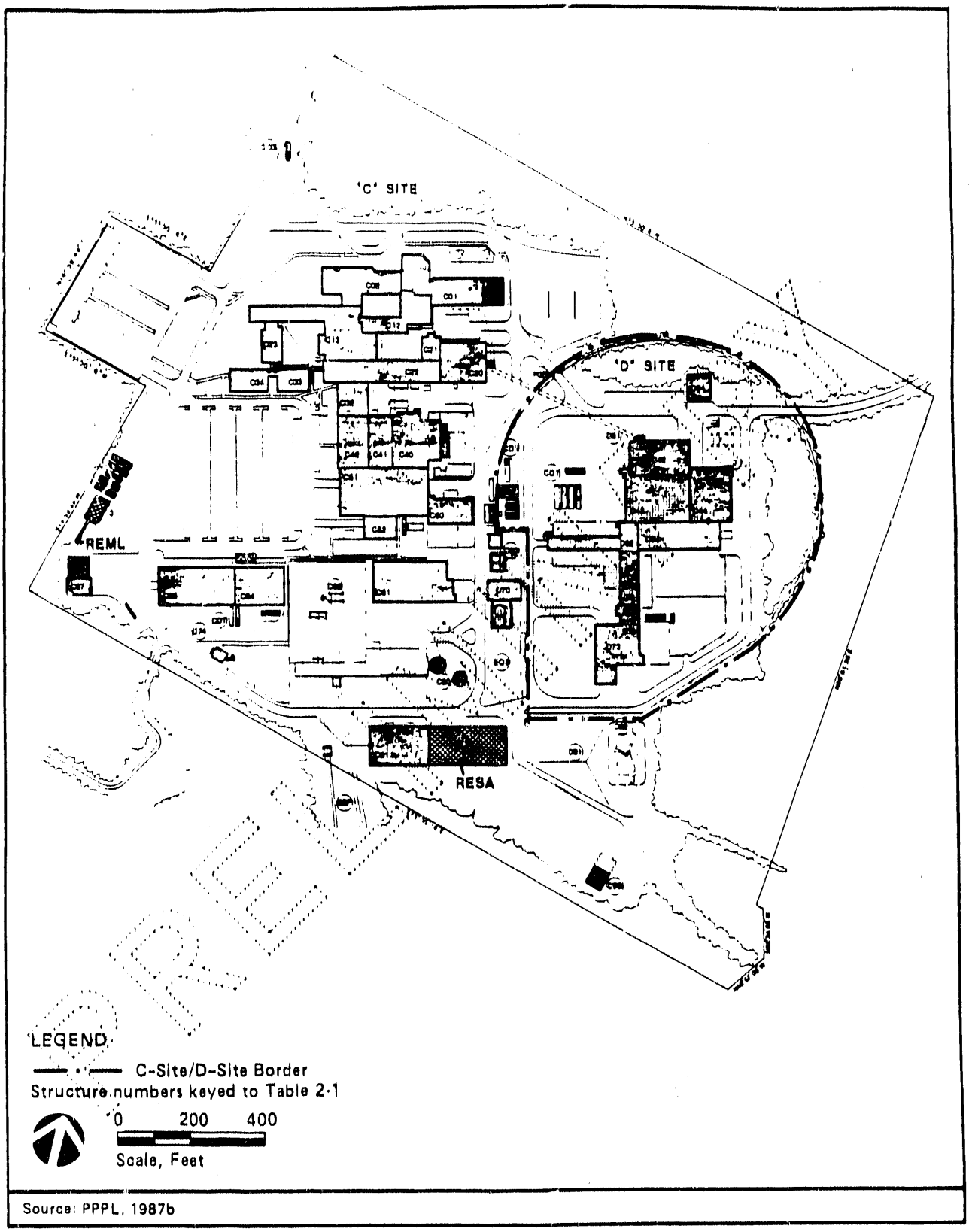
Source: Ebasco Grumman, 1982

LOCATION OF PPPL IN PLAINSBORO TOWNSHIP FIGURE 2-2



Source: DOE, 1988

LOCATION OF PPPL ON THE FORRESTAL CAMPUS FIGURE 2-3



Source: PPPL, 1987b

PPPL STRUCTURES ON C-SITE AND D-SITE FIGURE 2-4

TABLE 2-1

PRINCIPAL STRUCTURES ON PPPL C-SITE AND D-SITE

C-Site			
Structure Number	Name	Structure Number	Name
C01	LOB East Wing[1]	C51	C-Site MG Bldg.[5]
C02	LOB West Wing[1]	C52	PLT Power Bldg.[6]
C03	C-Site Guard Booth	C60	C-Site Cooling Tower Pump House
C12	Administration Wing/Cafeteria	C61	Maintenance Bldg.
C13	Administration Bldg.	C62	C-Site Switchyard
C20	Tech Shop	C64	Receiving #3
C21	L-Wing Addition	C65	Receiving #4
C22	Laboratory Bldg.	C67	Emergency Services Bldg.
C23	Theory Wing	C75	Gas Cylinder Storage Bldg.
C32	Shop Bldg.	C80	Water Towers
C33	Module I	C91	CAS Bldg.[7]
C34	Module II	C93	Hazardous Material Control Bldg.
C40	RF Bldg.[2]	CDT	Mobile Trailers (26 PPPL Occupied)
C41	CS Bldg.[3]	ESF	138/26 kV Elec. Service Feed
C42	COB Bldg.[4]	REML	Radiological Environmental Monitoring Laboratory
C50	System Test Bldg.	RESA	Research Equipment Storage and Assembly Building

TABLE 2-1

PRINCIPAL STRUCTURES ON PPPL C-SITE AND D-SITE (Continued)

D-Site			
Structure Number	Name	Structure Number	Name
D31	Tunnel	D53	NBPC Bldg.[12]
D34	LECT[8]	D70	TFTR Cooling Tower Pump House[9]
D42	Mock-Up Bldg.	D72	TFTR MG Bldg.[5,9]
D43	TFTR Test Cell[9]	D91	Meteorological Tower
D44	Hot Cell/NB[10] Test Cell	D92	Detention Basin
D52	FCPC Bldg.[11]	FGB	TFTR 125M Boundary Fence/Guard Booth[a]

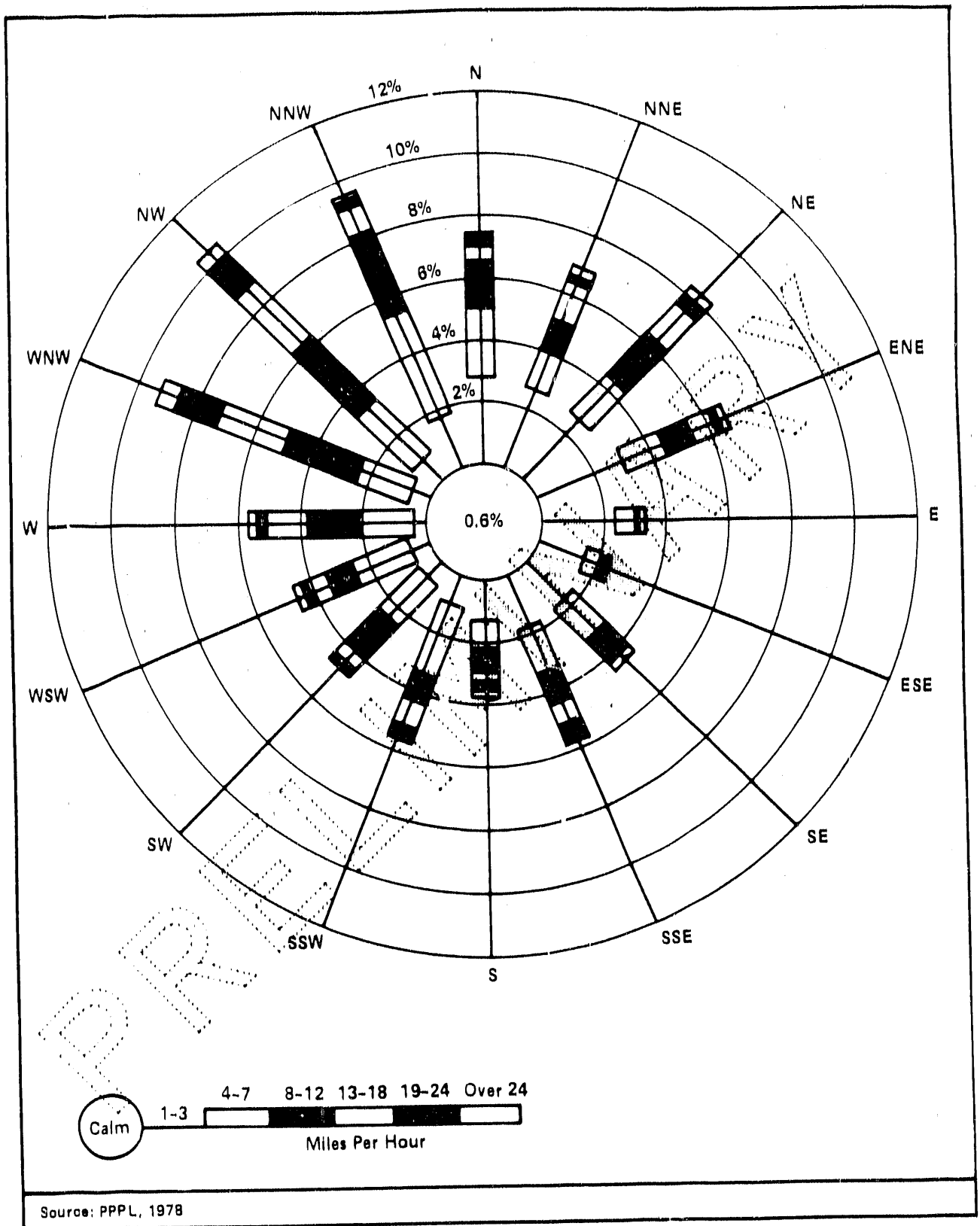
1 LOB = Laboratory/Office Building
2 RF = Radio Frequency
3 CS = C-Stellarator
4 COB = C-Stellarator Operating Board
5 MG = Motor Generator
6 PLT = Princeton Large Torus
7 CAS = Component Assembly Space
8 LECT = Liquid Effluent Collection Tanks
9 TFTR = Tokamak Fusion Test Reactor
10 NB = Neutral Beam
11 FCPC = Field Coil Power Converter
12 NBPC = Neutral Beam Power Converter

research and development and light-industrial facilities. The housing development closest to PPPL is approximately 3,200 feet to the east.

The Forrestal Campus has undisturbed areas with second-growth forest, open grass areas, an airplane runway, and a small brook (Bee Brook) running near its eastern boundary. Approximately 1 mile south of the PPPL site, Bee Brook empties into Devils Brook, which subsequently discharges to the Millstone River approximately 2 miles southeast of the site (Figure 2-3). The campus is relatively level with no pronounced hills and with the surface sloping downward generally from U.S. Route 1 (elevation 105 feet) to Bee Brook (elevation 80 feet). The airplane runway, which is used for gliders and small planes, has a benchmark elevation of 114 feet.

Winds at PPPL are predominantly from the west, being more northerly in the winter and more southerly and weaker in the summer. A one-year profile of on-site wind speed and wind direction measured at an on-site 10-meter meteorological tower is presented in a wind rose in Figure 2-5. The annual average temperature in the vicinity of PPPL is 54°F, with record low and high temperatures of 14°F and 106°F, respectively. The average daily minimum and maximum temperatures in January (the coldest month) are 25.3°F and 38.8°F, respectively, and in July (the warmest month) the average daily minimum and maximum are 66.8°F and 84.9°F, respectively. Average annual precipitation in the PPPL area is about 40 inches, with an average of 74 days per year with measurable precipitation greater than 0.10 inch. Total annual snowfall averages approximately 25 inches. August and February are the driest and wettest months, respectively, and approximately 20 percent of the precipitation occurring between December and March is in the form of snow.

The estimated 1985 population within 2 miles of PPPL was 8,700 and within 10 miles was 211,423. These populations are projected to increase to 13,908 and 282,807, respectively, by the year 1995. The closest urban centers are New Brunswick, 14 miles northeast, and Trenton, 12 miles southwest. The townships of Princeton, Plainsboro, Kingston, West Windsor, and Cranbury are in the immediate vicinity of the site. Also, the main campus of Princeton University, located primarily within the Borough of Princeton, is approximately 3 miles west of the site. Light-industrial businesses within 5 miles of the site employed approximately 10,000 people in 1975, but the area has developed considerably since that time.



Source: PPPL, 1978

WIND ROSE OF C- AND D-SITES
SEPTEMBER 1977 – AUGUST 1978

FIGURE 2-5

PPPL has a permanent full-time staff of approximately 1,040, including scientists, engineers, and administrative support personnel. Visiting staff, contract, temporary, and industrial subcontract personnel required for specific projects and programs bring the total workforce to a current level of approximately 1,100 people.

2.2 Overview of Major Site Operations

2.2.1 Site History

The Forrestal Campus was originally owned by the Rockefeller Medical Institute in the 1930s. After World War II, the land was purchased by the Forrestal Foundation, which subsequently donated the land to Princeton University.

Princeton developed portions of the Forrestal Campus in the A- and B-Site area for various administrative services and for use by various research centers associated with the university. One of these research centers involved the Princeton-Pennsylvania Accelerator (PPA) at the A-Site; the PPA was an early experimental device used to explore certain aspects of basic nuclear physics. Another was PPPL, whose sole mission was the research and development of fusion power; it was established at A- and B-Sites in the early 1950s. From that time until 1987, Princeton University and PPPL have shared the A- and B-Site area to different degrees depending on the nature of ongoing research for various programs. However, PPPL was the major user of the facilities.

The PPPL fusion effort began in the early 1950s when toroidal magnetic confinement was recognized for the potential generation of fusion power. At the time, two fundamental alternatives had been identified for the practical generation and control of fusion energy -- the steady-state stellarator and the pulsed-operated tokamak. PPPL initiated Project Matterhorn to research the stellarator alternative and the facilities now known as B-Site were expanded to provide office and high-bay space. The PPPL research program continued through the late 1950s with the construction of the Model C-Stellarator in the C-Site area.

During the 1950s and 1960s, PPPL contributed to the understanding of toroidal confinement and demonstrated several important principles, including the existence of quasi-steady-state stellarator equilibria, the practicality of plasma heating by radio-frequency waves, and plasma impurity control by a magnetic divertor.

In 1970, the PPPL Model C-Stellarator was converted to a tokamak, and PPPL embarked on a major research program to exploit the potential of the tokamak in reaching the reactor plasma regime. The Tokamak Fusion Test Reactor (TFTR), constructed at D-Site in 1982, is currently the major focus of the research program at PPPL. The basic TFTR mission is to achieve plasmas with actual reactor parameters and produce reactor-like deuterium-tritium fusion power densities under conditions of approximate energy breakeven (i.e., fusion output power comparable to plasma-heating input power).

2.2.2 Current Operations

PPPL is a single-purpose laboratory operated by Princeton University for the DOE. The laboratory is engaged in a broad range of research and educational activities in plasma physics. It conducts experimental and development programs in the field of fusion energy, which are sponsored by the DOE Office of Fusion Energy. PPPL is managed by the DOE Chicago Operations (CH) and Princeton Area Offices (PAO).

Major experimental devices at PPPL include the Princeton Beta Experiment (PBX), the Spheromak (S-1), the TFTR, and a proposed Compact Ignition Tokamak (CIT). Studies continue on other new toroidal devices. The Laboratory also conducts a program in theoretical research concentrating on the physics problems of toroidal magnetic confinement devices, and a graduate education program in plasma physics. Some of the PPPL research programs are discussed below.

2.2.2.1 Princeton Large Torus (PLT)

The PLT began operation in 1975. The machine, located in the CS Building (Figure 2-4), was designed to demonstrate the substantial increase in plasma confinement time that occurs when the thickness of the plasma "doughnut" is increased. The PLT also provided an experimental test-bed for the study of plasma

heating methods, including neutral-beam injection and radio-frequency heating. In 1986, the PLT was shut down and is presently mothballed.

2.2.2.2 Poloidal Divertor Experiment (PDX) / Princeton Beta Experiment (PBX)

The PDX, which is also located in the CS Building (Figure 2-4), began operation in the fall of 1979. During its lifetime, it was used to investigate the dependence of the basic plasma parameters (temperature, density, and confinement time) on machine tokamak plasmas; and to investigate the beta limit, which describes the maximum efficiency with which a tokamak magnetic configuration can contain plasma pressure. In 1983, the PDX was converted to the PBX to test the effectiveness of elongated and indented plasma cross-sections for increasing the limiting beta value. In 1987, the PBX underwent major coil modifications and is now called the PBX-M; this device is currently active.

2.2.2.3 S-1 Spheromak

The S-1 Spheromak, which began operation at PPPL in 1983, constituted the first large-scale test of the spheromak magnetic confinement concept. In a spheromak, the geometrical arrangement of the external toroidal field coils is expected to provide high beta values, as well as improved access to a reactor plasma for placement of thermal conversion blankets and for maintenance. The S-1, which is located in the C-Site RF Building (Figure 2-4), was shut down and mothballed in early 1988, although some instrumentation is being transferred for use on other fusion devices.

2.2.2.4 Tokamak Fusion Test Reactor

The TFTR, which is located in the D-Site TFTR Test Cell, is currently the major research device at PPPL (Figure 2-4). The TFTR began operation in December 1982 and is presently the largest operating fusion experiment in the United States. The objectives of TFTR are to obtain reactor plasma parameters [i.e., temperatures of 10 KeV (100 million degrees Centigrade), densities of 10^{14} particles/cm^3, and plasma breakeven confinement times of 0.3 second), and to demonstrate fusion energy breakeven using deuterium-tritium (D-T) plasmas. The TFTR is one of two tokamak facilities in the world capable of burning D-T fusion fuel. It is designed to produce

25 megawatts of fusion power for 0.5 second when the plasma is heated by a comparable amount of neutral-beam power.

2.3 State and Federal Concerns

The Survey team met on May 5, 1988, with representatives of the U.S. Environmental Protection Agency and the New Jersey Department of Environmental Protection (NJDEP) for the purpose of reviewing their concerns and issues regarding the operation of PPPL. The NJDEP indicated minor concerns with environmental monitoring for radiological parameters at PPPL. These concerns are contained in an NJDEP letter sent to PPPL in February 1988. The NJDEP had an additional concern regarding sampling of waste oils for tritium content in the future, when anticipated PPPL operations will experience a large increase in tritium use.

3.0 MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

The discussions in this section pertain to existing or potential environmental problems in the air, soil, surface water, and groundwater media. They include a summary of the available background environmental information related to each medium, a description of the sources of pollution and their control techniques, a review of the environmental monitoring program specific to each medium, and a categorization and explanation of the environmental problems found by the Survey team related to each medium.

3.1 Air

The air quality at and in the vicinity of PPPL is impacted by criteria, radioactive, and hazardous air pollutants. This section discusses ambient air quality for these pollutants, air emission sources and controls at PPPL, air monitoring, and findings and observations related to air. Meteorological data for the Princeton area are discussed in Section 2.1.

3.1.1 Background Environmental Information

PPPL is located in Middlesex County, in the Suburban Air Pollution Control District (APCD). The town of Princeton is located 3 miles west of PPPL in Mercer County, in the Central Delaware Valley APCD. The boundary between these two APCDs is U.S. Route 1, approximately 1/2 mile west of PPPL (Figure 2-3). The air quality in the Princeton area is better than Federal air quality standards for nitrogen oxides, sulfur dioxide, lead, carbon monoxide (CO), and total suspended particulate (TSP), and exceeds Federal or state standards for ozone (40 Code of Federal Regulations 50; New Jersey Administrative Code, Title 7, Chapter 27). Table 3-1 summarizes Federal and state ambient air quality standards for criteria pollutants. Both the Central Delaware Valley and Suburban APCDs are designated as non-attainment for ozone. PPPL does not emit volatile organic compounds (VOCs) in quantities that would impact ambient concentrations of ozone in the Princeton area. Elevated ozone concentrations in the two APCDs are attributed to emissions of hydrocarbons from mobile and industrial sources.

TABLE 3-1

SUMMARY OF AMBIENT AIR QUALITY STANDARDS (CRITERIA POLLUTANTS - NONRADIOACTIVE)

Parameter	Averaging Time	NAAQS	New Jersey AAQS
Total Suspended Particulate[a]	Annual Geometric Mean Primary[b]		75 µg/m^3
	Annual Geometric Mean Secondary[c]		60 µg/m^3
	24-Hour Primary[b,d]		260 µg/m^3
	24-Hour Secondary[c,d]		150 µg/m^3
PM-10 Particulate[e]	Annual Arithmetic Average, Primary and Secondary[b,c]	50 µg/m^3	-
	24-Hour Average, Primary and Secondary[b,c,f]	150 µg/m^3	-
Sulfur Dioxide	Annual Arithmetic Mean Primary[b]	0.30 ppm	-
	24-Hour Primary[b,d]	0.140 ppm	-
	3-Hour Secondary[c,d]	0.500 ppm	0.267 ppm
Carbon Monoxide	1-Hour Primary[b,d]	35 ppm	35 ppm
	8-Hour Primary[b,d]	9 ppm	9 ppm
Nitrogen Oxides	Annual Arithmetic Mean Primary[b]	0.05 ppm	0.05 ppm
Ozone	1-Hour Primary[b,f]	0.12 ppm	0.12 ppm
	1-Hour Secondary[c,d]	0.12 ppm	0.08 ppm
Lead	Calendar Quarter Primary[b]	1.5 µg/m^3	1.5 µg/m^3

Sources: NAAQS-40 CFR 50; New Jersey AAQS - New Jersey Administrative Code, Title 7, Chapter 27

a National Ambient Air Quality Standard (NAAQS) superseded in July 1987 by PM-10 Particulate Standards. New Jersey State Standards for PM-10 have not been promulgated.

b Primary NAAQS are intended to protect public health.

c Secondary NAAQS are intended to protect public welfare.

d Not to be exceeded more than once per year.

e PM-10 is the fraction of total particulates with a diameter of less than 10 micrometers.

f Statistically estimated number of days with concentrations in excess of the standards is not to be more than 1.0 per year.

Radiation is another source of air contamination. Background atmospheric radioactivity in the Princeton area is composed largely of fallout from past atmospheric nuclear weapons tests, natural radioactive constituents from the decay chains of thorium and uranium in soil, and materials resulting from interactions with cosmic radiation (e.g., natural tritiated water vapor produced by interactions of cosmic radiation and stable water). Since soil particulates carry most of the radioactive contamination, changing meteorological conditions often cause large daily and seasonal fluctuations in airborne radioactivity levels although all are very low. Windy, dry days can result in relatively high concentrations of airborne particulates, whereas precipitation (rain or snow) can wash out many particles from the atmosphere.

3.1.2 General Description of Air Pollution Sources and Controls

PPPL is a source of radioactive, criteria, and hazardous air pollutant emissions from both C- and D-Sites. In general, sources of criteria pollutant emissions resulting from PPPL operations do not fall within Federal regulations because they are below the minimum source size or are otherwise exempt, although air emissions from fuel combustion equipment, fuel storage tanks, and vapor degreasers at PPPL are regulated by the state. Air emissions from the C- and D-Site facilities are discussed in detail below.

3.1.2.1 D-Site TFTR Operations

TFTR Test Cell

The TFTR is a toroidal vacuum chamber in which a plasma is magnetically contained to study the characteristics of nuclear fusion reactions. The TFTR vacuum vessel is fabricated of stainless steel and lined with graphite tiles. In the present TFTR configuration, deuterium particles undergo a fusion reaction in the vacuum vessel to form helium molecules (helium-3), neutrons, and energy. The plasma is heated in part by injecting neutral deuterium particles into the vessel. When the plasma reaches a sufficient temperature and density, deuterium-deuterium (D-D) fusion reactions take place, releasing neutrons into the vacuum vessel and test cell. Although no tritium is introduced into the TFTR during D-D operations, tritium is produced as a by-product of the D-D reactions and deuterium-tritium (D-T)

reactions also occur during D-D operations. Approximately 3 percent of the reactions that occur are D-T reactions (Kolibal et al., 1986). Neutron production in the vessel and test cell is monitored by an array of neutron detectors. The PPPL monitoring program for neutron emissions is discussed in Section 4.3.

Radioactive air emissions from the TFTR are exhausted through eight exhaust ducts of varying diameters contained in a 19-meter-high rectangular air shaft. The air shaft is slightly higher than the TFTR building. The exhaust velocity is approximately 6.6 meters per second (m/sec). The TFTR is not ventilated continuously; exhaust fans are generally activated only between tests. Tests involving deuterium-tritium (D-T) reactions are scheduled to be conducted in 1992. The TFTR was being reconfigured to test systems involving tritium at the time of the Survey. These modifications included the addition of two 30-inch axial fans to the air shaft to increase the exhaust velocity to 20 m/sec. No emission control systems are employed on the TFTR exhaust.

The neutrons produced by the D-D reaction activate the constituents of the air and produce very small amounts of airborne radionuclides including argon-41, nitrogen-13, and nitrogen-16, in addition to the stable helium-3 produced by the fusion reaction. These are exhausted from the TFTR reaction vessel and test cell to the atmosphere. The neutrons impinging on the reactor vessel and other TFTR components produce activated metals, particularly isotopes of iron, nickel, and chromium (components of stainless steel), and also cobalt-60 and manganese-56. These activated metals are generally retained in the TFTR components, including the graphite tiles, and have not been detected in the ambient air outside the TFTR Test Cell, as discussed in Section 3.1.3. Activated metal parts and graphite tiles are occasionally removed from the TFTR during maintenance activities.

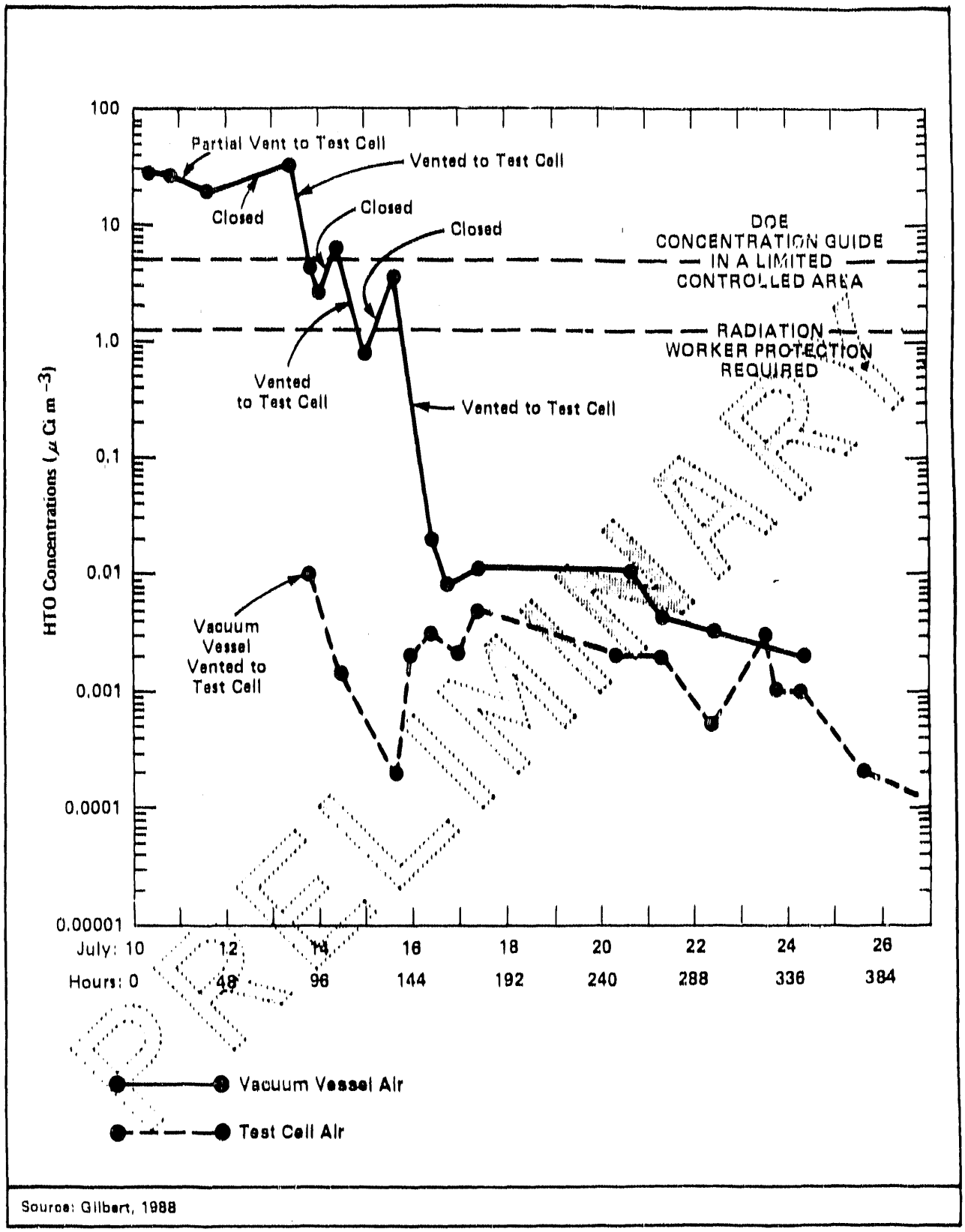
Small amounts of tritium, mostly in the form of tritium oxide (HTO), are also produced by the D-D reaction. Much of the HTO produced in the TFTR is initially retained on the graphite tiles that line the reaction vessel and is not released to the environment during TFTR operation. Some outgassing of tritium from the tiles occurred in July 1987, when a tritium monitor in the vessel showed a tritium concentration of 28 microcuries per cubic meter ($\mu Ci/m^3$) (about 6 times the present DOE concentration guide limit of 5 $\mu Ci/m^3$) in a controlled area. The vessel was vented to the atmosphere several times over a seven-day period to reduce the

tritium concentration in the vessel to below 1.25 μCi/m^3 to allow workers to enter the test cell and vessel without the use of Radiation Worker Protective equipment. Figure 3-1 shows the measured HTO concentrations inside the TFTR vessel and within the test cell during the 1987 vessel venting (Gilbert, 1988). These concentrations correspond approximately to the TFTR reaction vessel and test cell exhaust concentrations.

The majority of the HTO produced by the TFTR is released by outgassing and machining of the graphite tiles. According to PPPL, the small amount of tritium released from the TFTR during reaction vessel and test cell ventilation and outgassing, including the 1987 vessel venting discussed above, and machining of the graphite tiles, discussed below, does not elevate ambient tritium levels significantly above background, and is therefore not detectable in the environment (Stencel, 1988a). According to PPPL theoretical calculations, a total of approximately 300 millicuries (mCi) of tritium was produced from TFTR D-D operations from November 1985 to December 1987, of which approximately 145 mCi was produced in 1987 (Gilbert, 1988). The PPPL ambient monitoring system for tritium is discussed in Section 3.1.3.

Activated metals and HTO produced during TFTR operations are adsorbed onto the graphite tiles that line the vessel. These tiles were removed in 1987 and the adsorbed metals on them were removed by sanding and polishing. The machining operations were performed in a dedicated machine room in gloveboxes equipped with vacuum ventilation systems and portable HEPA filters. A small fraction of the HTO on the tiles desorbed and was released to the atmosphere by this operation. The remaining HTO remained adsorbed on the graphite and was collected with the graphite dust that was generated by the sanding and polishing operation (Gilbert, 1988). The graphite dust, containing activated metals, including iron, nickel, chromium, cobalt-60, manganese-56, and HTO, was being handled as a potentially hazardous mixed waste, as discussed in Section 4.1.2.

PPPL has estimated the total off-site radiation dose from TFTR D-D and proposed future D-T operations using both DOE XOQ/DOQ and AIRDOS-EPA dose models (Kolibal et al., 1986). Results of the DOE XOQ/DOQ and AIRDOS-EPA models were comparable (PPPL, 1988a). The isotopes considered in the dose calculations were tritium-3, nitrogen-16, argon-41, sulfur-37, and chlorine-40. Dose estimates for the



Source: Gilbert, 1988

TRITIUM AIR CONCENTRATION ANALYSIS FOR TFTR VACUUM VESSEL AND TEST CELL JULY 10 – 26, 1987

FIGURE 3-1

present D-D TFTR operations were obtained by scaling the results of the dose modeling performed for the proposed D-T operations.

The off-site dose from D-D operations is primarily due to emissions of activated air products, and the dose from proposed D-T operations is primarily due to HTO emissions. The maximum off-site dose resulting from TFTR operations in 1987 from all pathways is less than 1 millirem (Stencel, 1988a). This represents less than 1 percent of the DOE standard. The calculated dose is not significant with respect to the EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) standard of 25 millirem/year (air exposure pathway). Calculation of the total population dose resulting from TFTR operations was not performed in 1987, because past calculations showed that the value would be insignificant in comparison to the approximately 100 millirem each individual received from the natural background, exclusive of radon, in New Jersey (Stencel, 1988a). Radiation dose calculations are further discussed in Section 4.3.

EPA Region II conducted an inspection of the TFTR and determined that, as the TFTR was planned and in place prior to the date when the NESHAP for radioactive air emissions became effective, PPPL was not required to apply for a permit for the TFTR under the NESHAP regulations. New sources of radioactive air emissions or a major modification of existing source operations at PPPL are, however, required to be permitted under the NESHAP regulations.

3.1.2.2 D-Site Laboratory and Support Facility Operations

FCPC Building - Materials Preparation Room (Room 246)

Room 246 of the FCPC Building is used to prepare parts for installation in the TFTR. The room contains a hot water bath, an Alconox (aqueous aluminum cleaner) bath, and a vapor degreaser using Freon-113 (1,1,2-trichloro, 1,2,2-trifluoroethane). The baths and degreaser are used to clean newly fabricated parts. The vapor degreaser is used intermittently and is kept covered and locked when not in use. The degreaser has a surface area of about 10 square feet, and does not have local ventilation. However, the canopy hood over the Alconox bath is turned on when the degreaser is in use to provide additional room ventilation.

Cooling water is supplied to a once-through (non-recycle) cooling coil system, which is shut off when the machine is not in use. The degreaser is not emptied of solvent when not in use. Room 246 also contains a solvent distillation system. This system is not generally used, as most of the solvent used in the degreaser evaporates, leaving little for recovery. About two to three 55-gallon drums of solvent are used annually. State of New Jersey Regulation 7:27-8.2, Permits and Certificates Required, requires operators of open-top heated vapor degreasers with a surface area of greater than 6 square feet to obtain a permit and operating certificate. PPPL has not applied for a permit for the FCPC vapor degreaser.

FCPC Building - Mechanical Pump Maintenance (Room 229)

Vacuum pump parts degreased in Room 246 are assembled in Room 229. Some brazing and welding is also done in Room 229 to repair pumps. The welding/brazing area does not have local ventilation, and welding fumes containing metal oxides are exhausted through the general building ventilation system.

3.1.2.3 D-Site Electric Utilities and Fuel Storage Facilities

TFTR Emergency Diesel Engine

Emergency power to the TFTR is provided by a 2.6-megawatt diesel generator located outside the D-Site Test Cell. The total heat input rate to the diesel engine is approximately 2.6 million British thermal units per hour (Btu/hr), and the unit was installed in 1982. The unit is tested for a few hours each month and is otherwise used to provide power to critical TFTR systems in the event of a power outage. The generator has also been used for load shedding in the summer months. Diesel fuel for the engine is stored in a 15,000-gallon underground tank (tank E8) outside the TFTR MG Building (Figure 4-4). Fuel consumption was 3,846 gallons in 1987 and 1,879 gallons in the first two quarters of 1988.

Air emissions from the diesel engine and PPPL steam boilers are summarized in Table 3-2. The steam boilers are discussed in Section 3.1.2.5. Emissions from the diesel engine were estimated based on emission factors contained in EPA Publication AP-42 (EPA, 1986a). Emissions from the diesel engine do not significantly affect local air quality.

TABLE 3-2

AIR EMISSIONS FROM PPPL STEAM BOILERS
AND EMERGENCY DIESEL ENGINE

Pollutant	Maintenance Building Steam Boilers (tons/year)		TFTR Diesel Engine (tons/year)	
	1987	1988[a]	1987	1988[a]
Particulates	2.3	0.15	0.10	0.06
Nitrogen Oxides	15.3	1.19	0.96	0.61
Carbon Monoxide	1.5	0.20	0.25	0.16
Non-Methane VOC	0.32	0.04	0.03	0.02
Sulfur Dioxide	21.3	0.86	0.09	0.06

Sources: EPA, 1986a; Information provided to Survey team by PPPL personnel

[a] First and Second Quarter Emissions

[b] VOC - volatile organic compound

There are no emission standards for existing stationary diesel engines with the exception of standards for diesel fuel sulfur content. Facilities burning commercial fuel oil in the State of New Jersey are subject to Regulation 7:27-9.2, Sulfur Content Standards, limiting the sulfur content of fuel oil used in the state. Number 2 fuel oil used in the Princeton area is limited by this regulation to not more than 0.24 percent sulfur. PPPL purchasing records and contracts show that diesel fuel used by PPPL is in compliance with the regulation.

State of New Jersey Regulation 7:27-8.2(a)12, Permits and Certificates Required, requires operators of commercial fuel-burning equipment having a heat input rate of greater than 1,000,000 Btu/hr to obtain a permit and operating certificate. PPPL has not submitted an application for an operating permit for the emergency diesel engine.

State of New Jersey Regulation 7:27-8.2(a)8, Permits and Certificates Required, requires operators of storage tanks containing non-volatile liquids (e.g., diesel fuel, Number 4 fuel oil) having a capacity of greater than 10,000 gallons to obtain a permit and operating certificate. PPPL has not submitted an application for an operating permit for the emergency diesel engine fuel storage tank.

3.1.2.4 C-Site - Laboratory and Support Facility Operations

Shop Building

The Shop Building contains machine shops in which parts for the TFTR, PBX-M, and associated facilities are fabricated. The main machine shop, in Room S-109, contains saws, lathes, grinders, and other machine tools. Parts are fabricated primarily from steel or aluminum. A portable vacuum filter is used to collect dust when large machine tools are operated. The dust is disposed of as nonhazardous solid waste as discussed in Section 4.1.4. The machines do not have local ventilation, and ventilation is provided by ceiling fans when the portable filter is not used. Several gallons per month of ethyl alcohol, acetone, J-88 (a mixture of 90 percent 1,1,1-trichloroethane and 10 percent methylene chloride), and various cutting fluids and lubricants are used in the machine shop.

Particularly dusty machining operations and those involving skin irritants, such as fiberglass, are done in a separate room within the machine shop that is equipped with a canopy hood and a vacuum system and cloth filter to collect dust from the machines. Some machining of beryllium metal is planned to be performed in this area in late 1988. Plans for the control and removal of beryllium dust resulting from this operation have not been finalized.

The Shop Building also contains a small machine shop in Room S-111 used to fabricate parts for laser experiments at PPPL. The small machine shop contains saws, lathes, and a welding area. Parts are fabricated from both metals and phenolic resins. The machines are ventilated by flexible hoses and dust filters that exhaust into the room. Welding fumes from the welding area, containing metal oxides, are exhausted without controls. Small amounts of dust and organic compounds are also emitted from the Shop Building.

L-Wing Addition

The L-Wing Addition contains a machine shop used to fabricate parts for laser experiments. The shop contains lathes, drill presses, and other small machines, and parts are fabricated primarily from steel and aluminum. Some coating operations using commercial spray paints and thinners are performed in a laboratory hood. Several gallons per month of acetone, ethyl alcohol, 1,1,1-trichloroethane, and J-88 are used in the machine shop as cold solvents to clean machine tools and fabricated parts. No controls are applied to the hood or room exhausts. Small amounts of dust and organic compounds are emitted from the shop.

A chemical laboratory in Room L-111 of the L-Wing Addition is used to prepare metal samples. Small quantities of nitric, hydrofluoric, and phosphoric acids and a proprietary organic acid are used in the laboratory to polish metals. Approximately 15 gallons of the organic acid are used annually. Acids are used in laboratory hoods, and fumes are exhausted without controls.

CS Building

Room CS-121 of the CS Building contains a laser laboratory, including three Eximer lasers, one dye laser, and one experimental laser. The Eximer lasers use a mixture of

5 percent fluorine gas in helium. Inert gases including sulfur hexafluoride, neon, and krypton are also used. The lasers are purged with helium after use and are then exhausted through a polyethylene fan and halogen filter cartridge to the roof of the building. The halogen filter removes fluorine from the exhaust gas; the efficiency of the filter is not known. Approximately one 150-cubic-foot cylinder of the fluorine/helium gas mixture is used annually. The gas cylinder is stored in a ventilated cabinet, and the concentration of fluorine in the laboratory room air is monitored by a continuous air monitor. The monitor is equipped with an alarm to indicate any sudden release of fluorine into the laboratory.

Tech Shop

The Carpenter Shop in the Tech Shop contains saws, lathes, and other machines used to cut and fabricate wood. Some plastics and metal are cut in this area as well as wood. The machines are vented by flexible hoses and a vacuum system that exhausts to a bagfilter which is vented inside the building. Dust collected in the filter is removed as necessary and disposed of as nonhazardous solid waste.

Stainless steel and copper pipes are fabricated and welded in the Plumbing Shop in the Tech Shop. The shop does not have local ventilation, and welding fumes and metal dust generated from these operations are exhausted through ceiling fans without controls.

Parts are fabricated from steel, aluminum, and other metals in the Machine Shop in the Tech Shop. The machines in the shop do not have local ventilation, and exhaust is provided by ceiling fans. The welding area in the Machine Shop is ventilated by a flexible hose and duct to a wall vent. The soldering bench area is exhausted through a slot vent. Small amounts of dust, welding fumes, and VOCs are emitted from this area. No controls are applied to the exhausts.

RESA Building

Large vacuum chambers and other parts for the TFTR and PBX-M are fabricated from steel and other metals in the RESA Building. The building contains several large-scale (10- to 20-foot) boring machines and other smaller machines, and also a vacuum welding machine. Various cutting fluids and lubricants are used in

machining operations, and small amounts of metal dust and VOCs are emitted. The machines do not have local ventilation; ventilation is provided by ceiling fans.

CAS Building

Testing and assembly of high-voltage ion sources is conducted in the CAS Building. A clean room used for assembly of ion sources contains a phosphoric acid/alcohol bath, and an open-top vapor degreaser using Freon-113 (1,1,2-trichloro, 1,2,2-trifluoroethane). The vapor degreaser is covered and locked when not in use, and is equipped with a crane to move parts in and out of the machine. The degreaser has a surface area of about 10 square feet. About twelve 30-gallon drums of Freon-113 are used annually in the degreaser; most of the solvent used is emitted to the atmosphere. PPPL is presently preparing a permit application for the CAS Building vapor degreaser.

3.1.2.5 C-Site Electric Utilities and Fuel Storage Facilities

Maintenance Building

The Maintenance Building contains five steam boilers, one of which is permanently out of service. Boiler characteristics are summarized in Table 3-3. The boilers are presently operated using natural gas, with the capability of burning Number 4 fuel oil and Number 6 fuel oil as backup fuels. Both Number 4 and Number 6 fuel oil were burned in the boilers in 1987; use of Number 6 oil was discontinued in 1988. Normally one of the 350-horsepower (HP) boilers is operated in warm weather, and one 350-HP boiler and the 250-HP boiler are operated during cold weather. Number 4 fuel oil is stored in three 30,000-gallon underground tanks at the Utility Building. No Number 6 oil was being stored or used at PPPL at the time of the Survey. Emissions from the boilers and TFTR emergency diesel engine are summarized in Table 3-2. Emissions from the boilers were estimated based on emission factors contained in EPA Publication AP-42 (EPA, 1986a).

There are no emissions standards for existing boilers with the exception of standards for fuel sulfur content. Facilities burning commercial fuel oil in the State of New Jersey are subject to Regulation 7:27-9.2, Sulfur Content Standards, limiting the sulfur content of fuel oil used in the state. Number 4 fuel oil used in the

TABLE 3-3

CHARACTERISTICS OF PPPL STEAM BOILERS

Output	Estimated Fuel Use Capability Heat Input	Operating Status
250 HP	2.0 MMBtu/hr Natural Gas, #4 Oil, #6 Oil	In Service
250 HP	2.0 MMBtu/hr #4 Oil, #6 Oil	Permanently Shut Down
350 HP	2.7 MMBtu/hr Natural Gas, #4 Oil, #6 Oil	In Service
350 HP	2.7 MMBtu/hr Natural Gas, #4 Oil, #6 Oil	Maintenance Shut Down
400 HP	3.2 MMBtu/hr Natural Gas, #4 Oil, #6 Oil	In Service

Source: Information provided to Survey team by PPPL personnel

MMBtu/hr - million Btu/hr

Princeton area is limited by this regulation to not more than 0.3 percent sulfur. PPPL purchasing records and contracts show that PPPL is in compliance with the regulation. Emissions from the steam boilers have decreased substantially due to the use of natural gas instead of fuel oil as the primary boiler fuel. The emissions do not significantly affect local air quality.

State of New Jersey Regulation 7:27-8.2(a)3, Permits and Certificates Required, requires operators of commercial fuel-burning equipment having a heat input rate of greater than 1 million (MM) Btu/hr to obtain a permit and operating certificate. PPPL submitted an application for permit renewal for the boilers and received renewed operating permits in 1988. The expiration date of the renewed permits is 1992.

State of New Jersey Regulation 7:27-8.2(a)8, Permits and Certificates Required, requires operators of storage tanks containing non-volatile liquids having a capacity of greater than 10,000 gallons to obtain a permit and operating certificate. PPPL submitted an application for permit renewal for the three Number 4 fuel oil storage tanks and received renewed operating permits in 1988. The expiration date of the renewed permits is 1992.

Transportation and Construction Equipment Fuel Storage

Diesel fuel and gasoline for fueling PPPL fleet vehicles and construction equipment are stored in four underground tanks at C-Site. Two 8,000-gallon tanks, one containing diesel fuel (tank E4) and the other unleaded gasoline (tank E2), and one 1,000-gallon tank containing unleaded gasoline (tank E3), are located near the C-Site Maintenance Building (Figure 4-4). One 1,000-gallon tank containing diesel fuel (tank E5) is located near the C-Site MG Building (Figure 4-4). A detailed discussion of these underground storage tanks is given in Section 4.2.1.6.

State of New Jersey Regulation 7:27-8.2(a)9, Permits and Certificates Required, requires operators of storage tanks containing volatile liquids (e.g., gasoline) that have a capacity of greater than 2,000 gallons to obtain a permit and operating certificate. PPPL has not submitted an application for operating permits for the 8,000-gallon unleaded gasoline storage tank (tank E2).

3.1.3 Environmental Monitoring Program

Since emissions of nonradioactive air pollutants from PPPL are small, as confirmed by Survey team observation and discussed in Section 3.1.2, PPPL has not conducted stack or ambient air monitoring of criteria or hazardous air pollutants. Furthermore, there are no state or Federal air regulations applicable to PPPL that require monitoring. However, an exhaust gas monitoring system to monitor the tritium concentration in the TFTR exhaust was being installed at the time of the Survey, and is expected to be operational in late 1988.

PPPL installed a 60-meter meteorological tower in November 1983, and meteorological data have been collected at PPPL, using approved written protocols, since that time. Meteorological data are summarized in the 1987 PPPL Environmental Monitoring Report (Stencel, 1988a), and are discussed in Section 2.1.

In 1987, PPPL initiated on-site and off-site radiological air monitoring to determine ambient background concentrations of tritium and particulate gamma-emitting radionuclides in the vicinity of the TFTR, prior to initiation of tritium operations in 1992. Approved written protocols for the collection of these data have been developed by PPPL. The ambient monitoring system for tritium and particulate gamma-emitting radionuclides consists of four monitoring stations at the TFTR fenceline (located adjacent to the four direct radiation monitoring stations as illustrated in Figure 4-6), six stations situated in an approximate 1-kilometer radius around the site, and one baseline station 10 miles northwest of PPPL. The ten non-baseline monitors were located based on modeling using meteorological data collected at PPPL. The modeling indicated that the highest radionuclide concentrations resulting from operation of the TFTR with tritium would occur within 900 meters of the site (Levine, 1985).

The differential atmospheric tritium samplers (DATS) used for ambient monitoring at PPPL were designed by PPPL and installed in the field in mid-1987. On-site and off-site tests of the samplers were conducted in 1986 and 1987 (Stencel, 1987b; PPPL, 1988a). The tests demonstrated that tritium concentration data obtained by the monitors provide an accurate representation of actual ambient tritium concentrations.

The DATS consist of three molecular sieve moisture traps in series, the second and third traps separated by a palladium sponge catalyst. The first two traps collect HTO. Hydrogen gas is used to heat the catalyst, which converts molecular tritium HT in the sample gas to HTO. New catalyst beds have an HT - HTO conversion efficiency of 90 percent. The efficiency may decrease during use due to the effects of air contaminants. However the use of a carrier gas allows the efficiency to be determined and a correction factor to be applied. The HTO is subsequently collected by the third moisture trap. The DATS are operated continuously, and operating hours are monitored by an hour meter. The sample gas is pumped through the traps at approximately 0.1 liter/minute by a variable speed direct current pump. A mixture of 3 percent hydrogen in nitrogen is used as a carrier gas, and the gas flow rate is determined each week when the moisture traps are changed by using a rotameter. The rotameter is bypassed unless a flow reading is being taken.

The collected material is removed from the DATS and analyzed for tritium concentration in the PPPL Radiological Environmental Monitoring Laboratory. The percent sample recovery is approximately 95 percent, and the tritium monitoring system can detect ambient tritium concentrations near background levels. Analytical procedures used to determine ambient tritium concentrations are discussed in detail in Section 4.4.

According to PPPL theoretical calculations, as much as 300 mCi of tritium may have been released to the environment from TFTR operations between 1985 and 1987. According to PPPL, this amount of tritium is not measurable in the environment, and measurable concentrations of tritium above background in the vicinity of the site are not expected until initiation of TFTR tritium operations.

Ambient air tritium concentrations were not reported in the environmental monitoring report at the time of the Survey. However, according to PPPL, tritium concentrations in ambient air sampled at PPPL were less than 100 picocuries per liter (pCi/L), the minimum detection limit of the ambient monitoring system. Precipitation samples taken by PPPL in 1987 showed only background tritium concentrations (Gilbert, 1988). Precipitation has a normal variance of background tritium concentrations up to a concentration of 144 pCi/L due to atmospheric movement and seasonal effects.

Ambient concentrations of particulate radionuclides in the vicinity of PPPL are determined by particulate air samplers collocated with the tritium monitors. The collected particulate samples are analyzed for gamma-emitting radionuclides (e.g., activated metals such as cobalt-60 and manganese-56). The samplers were originally placed in the field in mid-1987.

The particulate air samplers consist of a glass filter and rotary vane pump with an hour meter. The particulate collection efficiency of the glass filters is certified to be 99.98 percent by dioctyl phthalate testing, and the installation of the filter in the filter cartridge is tested in the laboratory before being placed in the field. The gas flow rate is determined by attaching a rotameter to the pump each week when the glass filters are changed. The difference in flow rates between filter changes is generally less than 10 percent.

Particulate gamma-emitting radionuclide concentrations determined using the particulate air samplers installed in 1987 were not reported in the 1987 PPPL Environmental Monitoring Report available at the time of the Survey (Stencel, 1988a). According to PPPL, concentrations of particulate gamma-emitting radionuclides significantly above background are not expected until initiation of TFTR tritium operations. Concentrations of particulate gamma-emitting radionuclides determined at PPPL between 1982 and 1986 using a prototype monitor are comparable to background levels (Stencel, 1986).

PPPL monitors direct radiation resulting from operation of the TFTR and PBX-M as part of an ongoing program. Direct radiation monitoring is discussed in Section 4.3.3.

3.1.4 Findings and Observations

3.1.4.1 Category I

None

3.1.4.2 Category II

None

3.1.4.3 Category III

None

3.1.4.4 Category IV

1. Failure to apply for state air permits. PPPL has not applied for state air permits for the TFTR stationary diesel generator, two of the eight underground gasoline and diesel fuel storage tanks, and the two solvent degreasers in the CAS and FCPC Buildings.

   According to State of New Jersey Air Regulation 7:27-8.2, Permits and Certificates Required, operators of fuel-burning equipment having a heat input rate of 1 MMBtu/hr or greater, heated open-top surface cleaners (vapor degreasers) of greater than 6 square feet in surface area, diesel fuel storage tanks of greater than 10,000 gallons in capacity, and gasoline storage tanks of greater than 2,000 gallons in capacity are required to obtain operating permits. The TFTR emergency diesel engine (classified by the state as fuel-burning equipment), the two solvent degreasers in the CAS and FCPC Buildings, and the 8,000-gallon unleaded gasoline (tank E2) and the 15,000-gallon diesel fuel (tank E8) underground storage tanks at PPPL are subject to state permit requirements. However, PPPL has not applied for permits for any of the above-listed sources.

3.2 Soils

This section describes the soils at PPPL, pollution sources and controls of selected areas of soil contamination resulting from PPPL operations, and the soils monitoring program. Although the discussion in this section focuses on C- and D-Sites, which are the sites of current PPPL activities, the section also covers A- and B-Sites, which were used by PPPL in the past and which have some residual soil contamination as a result of PPPL operations. The soils at the College Road facility are not discussed since PPPL only rents office space at this location. Findings and observations related to soil contamination are discussed in Sections 4.2.2 (Toxic and Chemical Materials) and 4.5.2 (Inactive Waste Sites and Releases).

3.2.1 Background Environmental Information

In general, PPPL soils are of the Urban Land-Nixon-Nixon Variant Association. Soils of this association are on uplands and are nearly level to gently sloping, deep, well-drained and moderately well-drained, with a loamy subsoil and substratum. The specific soil types found at the A- and B-Sites and C- and D-Sites, along with some of their characteristics, are presented in Table 3.4.

Background soil concentrations in the vicinity of PPPL for radionuclides and nonradioactive chemicals used at PPPL have not been characterized by PPPL. Data on most of these parameters are also not available in literature. However, PPPL has recently established off-site sampling locations to establish baseline concentrations of tritium in the moisture of surface soils and vegetation and has found tritium concentrations to be at background levels, as discussed in Section 3.2.3.

DOE has established guidelines for determining acceptable residual radioactivity in soil at Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote Surplus Facilities Management Program (SFMP) sites (DOE, 1985; Gilbert et al., 1985). The soil concentration guidelines for radionuclides must be derived on a site-specific basis, from a basic dose limit of 100 mrem/year to an individual, from all pathways.

For nonradiological contaminant concentrations in soil, there are no regulatory standards. A determination of "safe" or "acceptable" levels in soils depends on

TABLE 3-4

CHARACTERISTICS OF PPPL SOIL TYPES

Location	Soil Type	Depth in Inches	USDA Texture	Permeability (inches/hour)	Soil Reaction pH
A- and B-Sites	Nixon	0-11	Loam	0.6-2.0	3.6-5.5
		11-30	Loam, sandy clay loam gravelly sandy loam	0.6-2.0	3.6-5.5
		30-40	Loamy sand, gravelly sandy loam	2.0-6.0	3.6-5.5
A- and B-Sites, C- and D-Sites	Urban land[a]	NA[b]	NA[b]	NA[b]	NA[b]

Source: Powley, 1987

[a]These are areas that have been disturbed by Man and include borrow areas, cut-and-fill areas, and areas where more than 80 percent of the surface is covered by industrial plants, business centers, and other structures.

[b]NA = Not applicable

contaminant migration pathways, potential human exposure routes and public tolerance. Therefore, acceptable levels must be determined on a site-specific and chemical-specific basis.

3.2.2 General Description of Pollution Sources and Controls

The major pathways for potential contamination of soil at PPPL are routine and accidental airborne releases, routine and accidental liquid releases, activities associated with waste disposal practices, and operation of the fusion energy research devices.

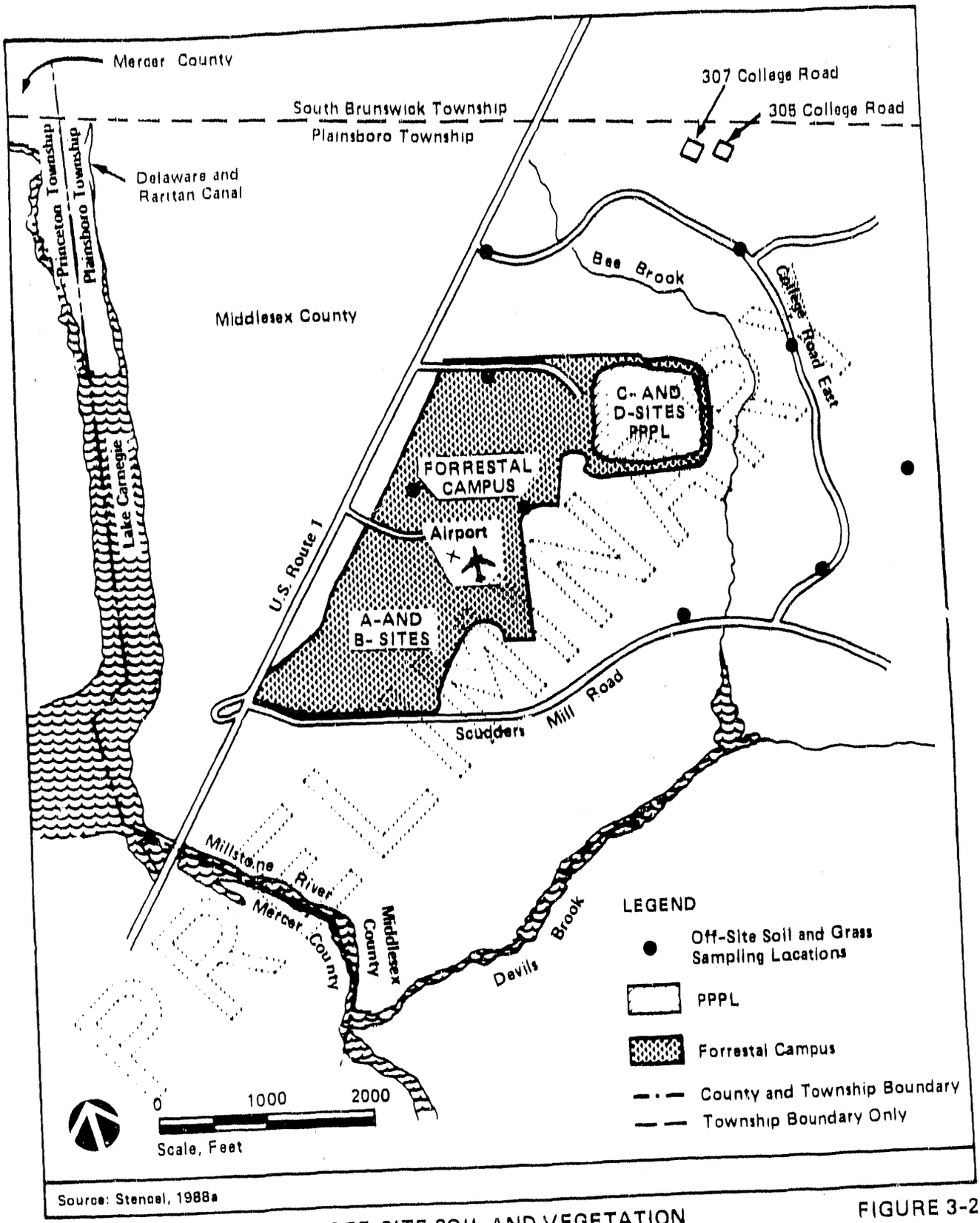
To reduce the potential for soil contamination, the site has established administrative and physical controls on handling radioactive and hazardous materials and wastes. The administrative controls include packaging, handling, storage, and disposal requirements, as discussed in Section 4.1. Physical controls consist of air filtration, water treatment systems, and shielding of the fusion energy devices, as discussed in Sections 3.1.2, 3.3.2, and 4.3.2, respectively.

Operations and activities at PPPL have resulted in soils contaminated or potentially contaminated with hazardous materials at various localized areas. These operations and activities include past spills, wastewater releases, material storage and handling practices, and cooling tower operations. With the exception of operation of the fusion energy research devices, discussed below, descriptions of these sources and incidents, along with existing controls, are contained in Sections 3.3.2, 4.2.1, and 4.5.1.

Operation of the fusion energy research devices at PPPL produces neutrons, which can radioactivate previously nonradioactive materials. Section 4.3.2.1 contains a more detailed discussion of this process. However, operations of the TFTR and the PBX-M using deuterium for both components of the plasma does not produce a high enough neutron flux for many neutrons to penetrate the shielding and measurably radioactivate the surrounding soil (Gilbert, 1988).

3.2.3 Environmental Monitoring Program

Off-site sample locations were established by PPPL in late 1985 (Figure 3-2) to



Source: Stenoel, 1988a

FIGURE 3-2

OFF-SITE SOIL AND VEGETATION SAMPLING LOCATIONS

establish baseline concentrations of tritium in the moisture of surface soils and vegetation. The locations were selected using the guidance in A Guide for Environmental Radiological Surveillance at U.S. Department of Energy Installations (Corley et al., 1982). These baseline levels of radionuclides are being established since surface soils and vegetation are among the best indicators of the presence of tritium after a release (Stencel, 1988a). Soil and grass samples collected off-site in 1987 had tritium levels in the moisture of less than 100 pCi/L. These levels are indicative of background concentrations of tritium in the environment (Stencel, 1988a). Results of the soil and grass baseline program are reported in the site's annual Environmental Monitoring Report.

Sampling procedures developed in 1984 are documented in the Radiological Environmental Monitoring Laboratory Handbook (PPPL, 1986c). The radiological analytical procedures are discussed in Section 4.4.

There is no PPPL sampling program for defining chemical concentrations in soil although a specific program was performed in 1985 to ascertain soil contamination resulting from former operations of the PPPL sewage treatment plant. The results of this effort showed background levels of chromium, mercury, and PCBs, as discussed in Section 4.5.1.2.

3.2.4 Findings and Observations

The findings that involve soil contamination are the result of past releases, spills, or disposal practices and are therefore discussed within the context of other findings in Sections 4.2.2 (Toxic and Chemical Materials) and 4.5.2 (Inactive Waste Sites and Releases).

3.2.4.1 Category I

None

3.2.4.2 Category II

None

3.2.4.3 Category III

None

3.2.4.4 Category IV

None

3.3 Surface Water

This section deals with surface-water features in the vicinity of PPPL, surface-water pollution sources and controls, surface-water and liquid waste monitoring programs at the Laboratory, and findings and observations related to surface water. Drinking water sources and uses are also addressed. The discussion focuses on the C- and D-Sites since these are the locations of most current PPPL operations. The A- and B-Sites are discussed only with respect to surface drainage, since PPPL no longer occupies these sites and only residual surface contamination from past PPPL operations may remain, as discussed in Section 4.5. The College Road facility is in a nearby office park and is only addressed as a sanitary wastewater source.

3.3.1 Background Environmental Information

3.3.1.1 Surface-Water Drainage

Both the A- and B-Sites and C- and D-Sites are located within the Millstone River basin, which drains an area of 283 square miles (Ebasco Grumman, 1982). The C- and D-Sites are located 1.4 miles east of the Millstone River, while the A- and B-Sites are located 0.8 mile east of the river (Figure 2-3). In the vicinity of PPPL, the Millstone River has been dammed to form Lake Carnegie. The maximum recorded discharge at Lake Carnegie was 13,200 cubic feet per second (ft^3/sec) in 1971. The Delaware and Raritan (D&R) Canal parallels the Millstone River but is separated from it by a levee. The Canal receives its water from the Delaware River at Trenton (Ebasco Grumman, 1982). The Millstone River and the Canal flow into the Raritan River, 16 miles north of Princeton. The Raritan River in turn flows into Raritan Bay, an estuary along the Atlantic Ocean, 18 miles downstream of its confluence with the Millstone River (Figure 2-1).

None of the four sites has natural surface-water features. However, Bee Brook, which flows from north to south, is immediately east of C- and D-Sites, and receives C- and D-Site runoff via two drainage systems, as discussed in Section 3.3.2.1. It has a drainage area of 806 acres and an average flow of 0.68 ft^3/sec (Ebasco Grumman, 1982). Bee Brook discharges into Devils Brook, 0.8 mile downstream of C- and D-Sites (Figure 2-2). Devils Brook flows into the Millstone River 1.2 miles downstream

of its confluence with Bee Brook. A- and B-Site runoff flows into the Millstone River, as discussed in Section 3.3.2.1.

There are no flood-prone areas at PPPL. Two small areas (less than 1 acre total) of temporarily flooded palustrine forested wetlands are situated on the eastern and northern edges, respectively, of D-Site.

3.3.1.2 Water Supply and Uses

Potable water is provided to PPPL by the Elizabethtown Water Company. The major sources of water are the D&R Canal and the Raritan River, upstream of the confluence with the Millstone River. The Millstone River has been used infrequently as an emergency water source. Potable water is treated at the publicly-owned Raritan-Millstone Treatment Plant; unit processes there include coagulation and flocculation, settling, potassium permanganate/activated charcoal treatment, mixed media filtering, and chlorination. The plant produces approximately 120 million gallons per day (mgd). Potable water enters PPPL through an Elizabethtown Water Company 12-inch main on the northwest corner of C-Site. The water is distributed throughout C- and D-Sites in an underground piped network and is used for domestic purposes, boiler makeup, C-Site Cooling Tower makeup, and secondary fire protection. Approximately 15 million gallons of potable water were consumed at PPPL in 1987; this was significantly less than previous years due to the changeover to D&R Canal water for some cooling water systems, as discussed below (Stencel, 1988a).

PPPL has an agreement with the New Jersey Water Supply Authority to withdraw up to 1 mgd from the D&R Canal. Canal water is routed from a PPPL pumping station at the Canal, where it is strained and chlorinated, to an elevated water tank on-site. From there it is distributed for use through a network of underground piping separate from the potable water system. Uses include primary fire protection, D-Site Cooling Tower makeup, and equipment cooling water. However, makeup and equipment cooling water is first treated in a multimedia sand filter system in the D-Site Cooling Tower Pump House. PPPL consumed 81 million gallons of canal water in 1987, the first full year that the Laboratory used canal water for cooling tower makeup (Stencel, 1988a).

3.3.2 General Description of Pollution Sources and Controls

Three types of wastewater are generated as a result of laboratory operations at PPPL -- sanitary wastewater, industrial wastewater, and stormwater. These wastewaters are collected or treated in one of three systems--the sanitary sewer system; stormwater management system, which includes storm sewers, drainage ditches, and a detention basin; or the liquid effluent collection tanks (LECTs). The sources of wastewater and the treatment and disposal methods used for each source are summarized in Table 3-5 and are discussed in the following two subsections.

3.3.2.1 Sources of Wastewater

Sanitary Wastewater

Sanitary wastewater is generated from nearly all active PPPL buildings at the C- and D-Sites and the office facility at 305-307 College Road. The major sources at these buildings are lavatory sinks, toilets, and showers; drinking water fountains; and, in the Administration Wing, the cafeteria sinks. The contents of the sanitary wastewater from these sources are presumed by the Survey team, based on piping diagrams and points of origin, to be predominantly water, human excreta, and foodstuff.

Industrial Wastewater

Sources of industrial wastewater at PPPL are C- and D-Site Cooling Tower blowdown, boiler blowdown, canal water filtration system backwash, TFTR process water, TFTR foundation dewatering, and water from laboratory and shop sinks and floor drains and transformer yard and switchyard sumps. The major contributor of industrial wastewater is blowdown from the C- and D-Site Cooling Towers. The C-Site towers provide cooling water to the process chillers and other equipment at the C-Site, including the C-Site motor generator sets. The D-Site tower provides cooling water to the heating, ventilation, and air conditioning chillers, which serve most C- and D-Site buildings, the TFTR process chillers, and other D-Site process equipment.

TABLE 3-5

WASTEWATER TYPES, SOURCES, AND COLLECTION/ TREATMENT SYSTEMS AT PPPL

Wastewater Types and Sources[a]	Collection/Treatment System[b]
Sanitary	Sanitary sewer
Industrial	
C-Site Cooling Tower blowdown	Sanitary sewer
D-Site Cooling Tower blowdown	Stormwater management system
Boiler blowdown	Stormwater management system
Canal water filtration system backwash	Stormwater management system
TFTR process water	LECTs/sanitary sewer
Laboratory and shop sink drains	Sanitary sewer
Building floor drains (except TFTR and Maintenance Building)	Sanitary sewer
TFTR floor drains	LECTs/sanitary sewer
Maintenance Building floor drains	Stormwater management system
TFTR foundation dewatering	Stormwater management system
Transformer yard sumps	Stormwater management system
C-Site Switchyard sump	Stormwater management system (west side)
Stormwater	
D-Site	Stormwater management system
C-Site (east side)	Stormwater management system
C-Site (west side)	Stormwater management system (west side)

[a]Described in Section 3.3.2.1
[b]Described in Section 3.3.2.2

The D-Site Cooling Tower is rated to blow down 2,040 gallons per hour. The blowdown from this tower is discharged to the stormwater management system. Blowdown volumes are not available for the C-Site Cooling Tower although the tower is designed to normally circulate approximately 60 percent of the amount of water that the D-Site Cooling Tower circulates. The C-Site Cooling Tower blowdown is discharged to the sanitary sewer (PPPL, 1987b).

Both cooling towers are treated with a Betz Dianodic II program to control corrosion, scale, and biofouling (Roy F. Weston, Inc., 1986). Specific products used in the cooling towers include Betz Entec 321, 356, and 365. Blowdown contents therefore include by-products of these treatment chemicals, such as corrosives, chlorine, and phosphates, and elevated dissolved and suspended solids from evaporative concentration. Limited chemical analyses performed in 1985, for alkalinity, hardness, total dissolved solids, specific conductance, and pH, have been reported on cooling tower water, from which blowdown is released. The resulting values are within manufacturer's recommended levels for cooling tower operations. In addition, the cooling tower treatments have been formulated so that phosphate concentrations are below 7 parts per million (ppm). According to product labeling, water treated with these chemicals can be sent to a sewage treatment plant, a permitted waste treatment facility, or National Pollutant Discharge Elimination System (NPDES)-permitted surface water discharge point.

The boilers are located in the Maintenance Building. Boiler feedwater is also treated with Betz products, including Betz Entec 721, 733, and 735, to control scale and corrosion. Blowdown contents therefore likely include by-products of these treatment chemicals, including corrosives, phosphates, and sulfites, although data on concentrations were not available. Approximately 50 to 380 gallons of boiler blowdown are discharged to the stormwater management system twice per day.

The canal water filtration system is located in the D-Site Cooling Tower Pump House and is used to filter D&R Canal water before it is used as makeup in the D-Site Cooling Tower. The backwash, which probably contains elevated dissolved and suspended solids, is discharged to the stormwater management system. Approximately 5,000 gallons of potable water are used 3 to 7 times per month to backwash the filter.

TFTR process water consists of water that may become radioactively contaminated, including machine cooling water. The main contaminant of concern is tritium. This water is discharged to the LECTs, which are located north of the TFTR complex. LECT operations and volumes and concentrations discharged are discussed in detail in Section 3.3.2.2. Approximately 82,000 gallons of TFTR process water containing 3.2×10^7 picocuries of radioactivity were discharged in 1988 through June 6.

Laboratory and shop sinks are located in most buildings at PPPL. The dominant component in the wastewater discharged through these sinks is used potable water. As discussed in Section 4.1, nearly all liquid hazardous wastes, which are generated in small amounts in laboratories and shops, are segregated in separate containers and are hauled off-site for disposal. However, a small portion of these wastes, mainly neutralized acids and bases, are discharged into the laboratory and shop sink drains during routine operations such as cleaning glassware. This waste stream is discharged to the sanitary sewer. Although volumes and concentrations of contaminants are unknown, they are small based on Survey team observations. These discharges are exempt from RCRA regulations in accordance with 40 CFR 261.3(a)(2)(iv), as discussed in Section 4.1.1.

Floor drains are present at buildings at PPPL for the removal of flood water, accidental spills, and floor cleaning solutions. A majority of this waste stream discharges to the sanitary sewer system, although volumes are not known. However, floor drains at the TFTR, which may receive radioactively contaminated wastewater from spills, discharge to the LECTs, and floor drains in the Maintenance Building, which houses the boilers, discharge to the stormwater management system. No spills of liquid chemicals within buildings that would flow to floor drains were reported by PPPL personnel. However, during the Survey, bulk liquid biocides and corrosion inhibitors were stored in proximity to floor drains in the C-Site and D-Site Cooling Tower Pump Houses and the Maintenance Building boiler room.

The foundation surrounding the TFTR is dewatered with the use of a pump. The pumped groundwater is then discharged at a rate of approximately 150 to 200 gallons per minute to the stormwater management system. The effect of this dewatering on groundwater is described in Section 3.4.1.2.

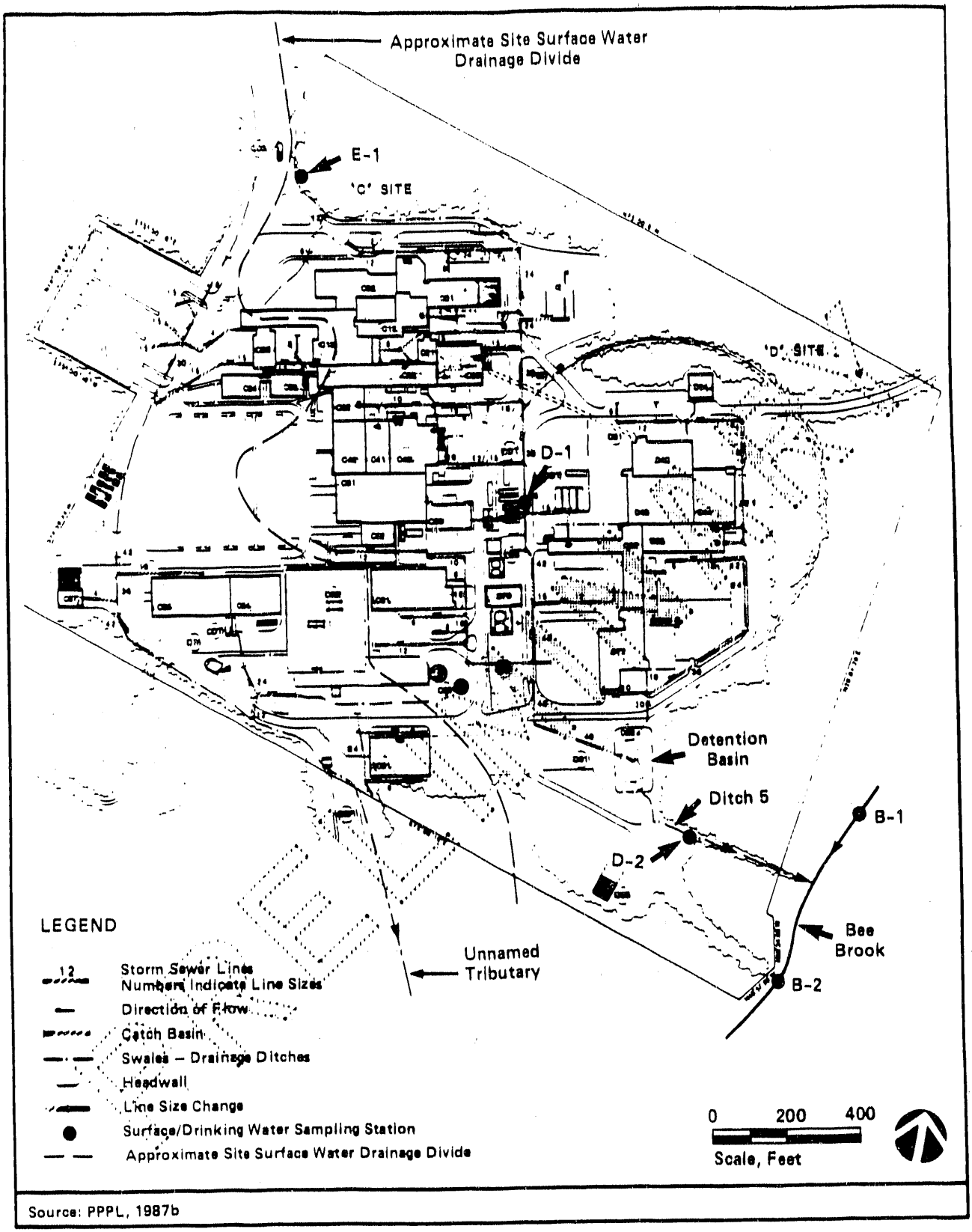
Transformer and capacitor yards and switchyards at PPPL are generally underlain by concrete or compacted clay containment. Precipitation that collects in the contained area is collected in sumps. With the exception of the C-Site Switchyard, the sump contents are discharged to the stormwater management system, which includes the Detention Basin. As discussed in Section 3.3.2.2, the Detention Basin releases into a ditch (Ditch 5) that flows into Bee Brook. The sump contents of the C-Site Switchyard are discharged to another ditch on the west side of the site, which flows through an unnamed tributary directly to Bee Brook. Spills and leaks of mineral and PCB-containing oils at both C- and D-Sites could collect in the sumps and eventually be discharged to Bee Brook. Although the sumps have hydrocarbon sensors to prevent oils from being pumped out, the sensors have been known to fail and transformer oils have been discharged to the stormwater management system, as described in Section 4.5.1.2.

Stormwater

Stormwater is generated by rainfall and snowmelt runoff from paved areas, rooftops, vegetated areas, and transformer yard and switchyard sumps. Stormwater can incorporate oils, grease, and lead and other metals from parking lots, driveways, and roads, and possibly oils and polychlorinated biphenyls (PCBs) from transformer yards and switchyards. In addition, spills on the paved areas, such as the Receiving driveway, could flow into the stormwater system.

There are two drainage basins on the C- and D-Sites, both of which flow into Bee Brook. Runoff from the eastern part of C-Site and all of D-Site flows into storm sewers that discharge into the Detention Basin on the southeast side of C- and D-Sites (Figure 3-3). The Detention Basin also receives process water from cooling tower and boiler blowdown and effluent from TFTR Test Cell foundation dewatering. The contents of the Detention Basin are released to a 600-foot-long ditch, called Ditch 5, which flows to the southeast and empties into Bee Brook (PPPL, 1987b). Flow into Ditch 5 from the Detention Basin is an NPDES-permitted discharge point for PPPL; in 1987, its measured flow ranged from 0.012 to 2.5 ft^3/sec.

Runoff from vegetated and paved areas on the west side of the C-Site, including the loading docks at Receiving No. 3 and No. 4, flows into a man-made ditch that runs



Source: PPPL, 1987b

STORMWATER SEWER SYSTEM AND SURFACE WATER DRAINAGE AND SAMPLING STATIONS AT C- AND D-SITES OF PPPL FIGURE 3-3

along the west side of the C-Site (Figure 3-3). Discharges from the C-Site Switchyard sumps also flow into this ditch. The ditch enters PPPL at the northwest corner of the site. It exits at the south-central boundary and empties into an unnamed tributary that flows through a wooded area to Bee Brook.

There are also isolated drainages at the C- and D-Sites. For example, runoff from the driveway of the Hazardous Material Control Building is directed to adjacent soil, where it percolates into the ground.

The west side of the A- and B-Sites has several inactive waste sites and releases, including the 1-L garage and spills at the scrapyard and in dumpsters west of the Princeton-Pennsylvania Accelerator Building, as discussed in Section 4.5.1. Runoff from these areas flows to a ditch west of A-Site, which, in turn, flows west under Route 1 and discharges into the Millstone River.

There has been no monitoring of stormwater to determine concentrations of contaminants. However, the NPDES-permitted discharge from the Detention Basin, which includes C- and D-Site stormwater runoff, as well as D-Site Cooling Tower blowdown, boiler blowdown, and transformer sump discharges, has been monitored for selected parameters including oil and grease, metals, nutrients, radioisotopes, and other physicochemical constituents. The results of this monitoring, which are discussed in detail in Section 3.3.3, indicate permitted parameters are within permit limits but that alkalinity, hardness, total phosphate, and total dissolved solids are elevated above background as a result of site operations.

3.3.2.2 Wastewater Treatment and Disposal

Sanitary System

As discussed in Section 3.3.2.1 and summarized in Table 3-5, flow to the sanitary sewer system at PPPL includes sanitary sewage; C-Site Cooling Tower blowdown; discharges from the LECTs, as described below; laboratory and shop sink drains; and most building floor drains. Most of the sanitary wastewater at C- and D-Sites is piped by gravity in the site's underground sanitary sewer lines to a lift station at D-Site, and then to the gravity system operated by the Stony Brook Regional Sewerage

Authority (SBRSA). However, sanitary wastewater from the LOB, the Theory Wing, and the Emergency Services Building bypasses the lift station and flows by gravity directly to the SBRSA system. Sewer lines at the C- and D-Sites are constructed of vitrified clay and cast iron. Lines were first installed in the late 1950s with the initial development of C-Site, and new lines have been installed as the facility has expanded. There have been no reports of unusual amounts of infiltration/exfiltration. Sanitary wastewater from the 305-307 College Road offices also flows directly to the SBRSA system.

The sanitary sewage in the SBRSA system is routed to the SBRSA's River Road Sewage Treatment Plant in Princeton. The plant has a capacity of 10 mgd and has tertiary treatment. Its liquid discharge is to the Millstone River and is NPDES-permitted. PPPL released 11.4 million gallons to the sanitary sewer system in 1987 (Stencel, 1988a). The Laboratory has no pretreatment requirements.

Before 1981, PPPL had its own sewage treatment plant (STP) on-site. In addition, the C-Site Cooling Tower blowdown, which flowed to the on-site STP, was pretreated in a pair of chromium reduction pits. The STP was abandoned in 1981 when the Laboratory was connected to the SBRSA system, and the chromium reduction pits were abandoned in 1983 when chromate use in the cooling towers was discontinued. These facilities are discussed in more detail in Section 4.5.1.

Stormwater Management System

As discussed in Section 3.3.2.1, stormwater from most of C-Site and all of D-Site, blowdown from the D-Site Cooling Tower and the boilers, backwash from the canal water filtration system, floor drains from the Maintenance Building, dewatering from the TFTR foundation, and discharges from transformer yard sumps (through hydrocarbon sensor-controlled pumps) flow into the stormwater management system. These sources first flow into a network of underground stormwater sewer piping that discharges into the Detention Basin for treatment (Figure 3-3), as discussed below. Stormwater from the west side of the C-Site, including the Receiving No. 3 and No. 4 loading docks and the C-Site Switchyard sumps, flows off-site in the unnamed tributary (Section 3.3.2.1) without treatment.

In an effort to minimize releases of spills into the stormwater management system at PPPL, the Laboratory has a document detailing environmental spill control procedures and responsibilities (Tompkins, 1987), as well as a Spill Prevention, Control, and Countermeasures (SPCC) Plan (Chmiel, 1984). The Detention Basin functions as an integral part of spill control and countermeasures activities. Although the basin was initially designed and built as a flood- and silt-control structure, an oil/water separator with a hydrocarbon sensor was added in 1986 for spill control. With this modification, the design of the Detention Basin fulfilled NJDEP directives against uncontrolled releases to surface waters as well as protection against oil spill releases to surface waters. However, the Detention Basin presently is not being operated as planned, as discussed below.

The Detention Basin is 95 feet by 150 feet at the top of the berm, sloping down 8 to 10 vertical feet to an area of 45 feet by 90 feet. The basin berm is earthen with the exception of a riprap spillway and a concrete outlet structure. The bottom of the basin is earthen except for two 6-foot-wide concrete channels which run from two stormwater sewer inlets on the north and west side of the basin to the basin outlet on the south side. The basin outlet consists of a grate, a 6-foot by 12-foot oil/water separator and a motorized shut-off gate. A hydrocarbon sensor is situated within the separator and is wired to operate the shut-off gate. PPPL submitted a treatment works approval application for the oil/water separator to NJDEP on October 9, 1986. The need for approval was waived by the state on December 5, 1986. In addition, PPPL has submitted an application for a Discharge to Groundwater Permit for operation of the Detention Basin, as required by NJDEP.

The discharge from the Detention Basin flows into the 600-foot-long man-made Ditch 5, which empties into Bee Brook. The discharge from the Detention Basin is NPDES-permitted by NJDEP. The permit became effective on November 1, 1984, and expires on October 31, 1989. It requires that the discharge be sampled monthly, as described in Section 3.3.3.1, and places maximum daily discharge limitations on temperature (30°C), total suspended solids [50 milligrams per liter (mg/L)], petroleum hydrocarbons (10 mg/L), and chemical oxygen demand (50 mg/L).

The Detention Basin was designed such that normal flows from the stormwater sewers would be directed along the concrete channels on the bottom of the basin, through the grate, oil/water separator, and shut-off gate, and be released

continuously through the outlet to Ditch 5 and Bee Brook. During storm events, the basin would store the runoff and gradually release the stormwater, thereby reducing peak discharge flows to Bee Brook.

In the event of a hydrocarbon spill to the stormwater management system, the spilled material, once in the Detention Basin, would be separated in the oil/water separator and detected by the hydrocarbon sensor. The shut-off gate would be actuated automatically and no liquids would be released from the basin. However, in January 1988, mineral oil from one of the transformer sumps discharged into the stormwater sewers and flowed into the Detention Basin. The hydrocarbon sensor in the basin oil/water separator did not detect this spill, the shut-off valve did not actuate, and mineral oil was released to Bee Brook. This incident is described in more detail in Section 4.5.1.2.

Since this spill control system was found to not work properly, the operation of the Detention Basin was changed and now functions in a flooded mode. The water level is kept above the basin outlet opening and the shut-off gate is left slightly open to allow for continuous release. The basin is inspected several times a day for evidence of spills and for observation of water level. If a spill which occurs on the site is observed as a sheen on the Detention Basin water, the gate is shut to confine the spill to the basin, and the spill is cleaned up with booms, absorbent pads, and other recovery devices. Depending on the water level, the opening of the gate is adjusted to raise or lower the water level in the basin to ensure that it remains above the top of the outlet but does not flow over the spillway. In 1987, the average flow from the Detention Basin was 0.1 mgd. The quality of the discharge is measured for a limited number of parameters at the NPDES monitoring station in Ditch 5, as discussed in Section 3.3.3.

LECTs

Process wastewater and floor drain effluents from the TFTR buildings are routed to three 15,000-gallon aboveground tanks, known as LECTs (Section 4.2.1.6). These wastewaters may contain trace amounts of tritium or trace concentrations of radioactive corrosion products. The purpose of the tanks is to retain the wastewaters until they can be analyzed for radioactivity. If the levels of radioactivity are below a PPPL maximum allowable limit of 3×10^5 pCi/L, the tank

contents are pumped to the sanitary sewer. This limit represents 10 percent of the appropriate Maximum Permissible Concentration, as given in DOE Order 5480.1A (Chapter XI, Requirements for Radiation Protection, Table II). If the $3x10^5$ pCi/L limit were exceeded, the water would be either allowed to decay until it was below $3x10^5$ pCi/L and then released to the sanitary sewer or would be solidified and packaged on-site by a contractor and disposed of with other solid radioactive waste generated on-site, as described in Section 4.1.3.

To date, radioactivity in the tanks has never exceeded the $3x10^5$ pCi/L limit based on PPPL records. In 1987, there were 30 releases from the three tanks. A total of $1.7x10^9$ pCi of radioactive constituents in 292,950 gallons of liquid was released to the sanitary sewer system. The maximum activity in any one release was $1x10^4$ pCi/L. In 1988, through June 6, there were nine releases totaling $3.2x10^7$ pCi in approximately 82,000 gallons. The maximum activity in any one release was $4x10^2$ pCi/L. Assuming the maximum releases for each year consisted entirely of tritium, these maximum activities represent 11.1 and 0.4 percent, respectively, of the proposed EPA drinking water standard for community water supply for tritium (90,000 pCi/L) (Federal Register, 1986, Volume 51, pages 34836-34862).

3.3.3 Environmental Monitoring Program

3.3.3.1 Sampling Locations, Parameters, and Frequency

Surface water is sampled from eight locations, four on-site and four off-site. The four on-site stations are located (Figure 3-3) in a storm sewer that flows to the Detention Basin (Station D-1); in Ditch 5, which is the outlet for the Detention Basin (Station D-2, the NPDES permit monitoring point); on Bee Brook upstream of the Ditch 5 confluence (Station B-1); and on Bee Brook downstream of the Ditch 5 confluence and mixing zone (Station B-2). The four off-site locations are Devils Brook upstream of the Bee Brook confluence (Station P-1); the Millstone River downstream of the Devils Brook confluence (Station M-1); Cranbury Brook, a tributary to the Millstone River upstream of the Devils Brook confluence (Station P-2), and the D&R Canal near the point where PPPL withdraws its process water (Figure 2-2). The latter station is sampled to provide baseline data on the process water used on-site, and is not used to assess site impacts. In addition, potable water supplied by the Elizabethtown Water Company is sampled at the PPPL water meter

on the northwest side of C-Site (Station E-1) (Figure 3-3), and is used as baseline data for the site's drinking water supply.

The parameters analyzed at the four on-site and four off-site locations, as well as at the potable water station, are shown in Table 3-6. All samples are taken monthly as grabs. The PPPL NPDES permit requires that flow, temperature, total suspended solids (TSS), petroleum hydrocarbons (as oil and grease), chemical oxygen demand (COD), and pH be grab-sampled monthly at Station D-2.

3.3.3.2 Sampling Procedures

Nonradiological surface-water sampling and analysis are performed by an outside contractor. During the Survey, sampling was observed at Stations D-2, B-1, and B-2. No site-specific written sampling protocols were available during sampling although a copy of Standard Methods for the Examination of Water and Wastewater was present. In the laboratory before sampling, sample bottles were washed with detergent and rinsed with deionized water, coliform sample containers were sterilized, and some of the COD sample bottles were rinsed with acetone. In general, water was first collected in a plastic container from the middle of the stream and then transferred to sample bottles. The plastic container was rinsed several times in the water at the station before the sample was taken. In some cases, such as oil and grease at Station B-2 and dissolved oxygen at B-1, the sample bottles were immersed directly into the surface water. Dissolved oxygen samples were fixed shortly after sampling, and all samples were placed on ice in a cooler.

Flow was determined by measuring stream cross-section and water velocity. Stream depth was measured at 1-foot intervals and velocity was measured with a flow meter at the mid-point of each interval. The flow meter was last calibrated approximately 2 years before the observed sampling event. Temperature was measured by inserting a thermometer into the stream.

Radiological sampling is performed by PPPL personnel using developed protocols as described in Section 4.4.2. Sampling was not observed during the Survey but the following method was described. A collection container is rinsed in the surface

TABLE 3-6

PARAMETERS ANALYZED IN PPPL SURFACE-WATER SAMPLES

Parameter	On-Site Stations (D-1, D-2, B-1, B-2)	Off-Site Stations (P-1, P-2, M-1, C-1)	Potable Water from Elizabethtown Water Company
Physical/Chemical			
Alkalinity	X	X	X
BOD-5 day[a]	X		
Calcium hardness	X	X	X
Chloride			X
Chromium-total	X	X	
Chromium-hexavalent	X	X	
Clarity	X	X	
COD[b,c]	X		
Coliform-total	X		X
Copper	X	X	X
Dissolved oxygen	X		
EDTA[d]	X	X	
Flow[c]	X		
Iron	X	X	X
Manganese			X
Nitrogen-total Kjeldahl	X		X
Nitrogen-nitrate	X	X	X
Oil and grease[c]	X	X	
pH[c]	X	X	X
Phosphate-total	X	X	X
Phosphate-ortho	X	X	X
Solids-total dissolved	X	X	X
Solids-total suspended[c]	X	X	
Sulfate	X	X	X
Temperature[c]	X		X
Turbidity	X	X	X
Zinc	X	X	
Radiological			
Gamma spectroscopy	X	X	X
Tritium	X	X	X

[a]BOD - biochemical oxygen demand
[b]COD - chemical oxygen demand
[c]Monitoring required by the PPPL NPDES permit
[d]EDTA - ethylenediamine tetraacetic acid (used to measure copper equivalent)

water several times before a sample is taken in the center of the stream. The sample is then transferred to the sample bottles and brought to the REML for analysis.

3.3.3.3 Results

Results from the surface water program are reported in the PPPL annual Environmental Monitoring Reports. Constituents analyzed from the NPDES discharge monitoring station (Station D-2) have always been within permitted limits except during three sampling periods between November 1984 and April 1985 when the limit for TSS of 50 mg/L was exceeded. This was due to high runoff from, and dewatering of, a construction excavation.

Impacts of site operations on surface water are discernable when data from Bee Brook upstream of the confluence of Ditch 5 (Station B-1) are compared with data from Bee Brook downstream of the Ditch 5 confluence (Station B-2). Ditch 5, which is sampled at Station D-2, carries most PPPL stormwater as well as certain industrial wastewater streams, as described in Section 3.3.2.2. A comparison of data from these three stations indicates that, of the parameters listed in Table 3-6, PPPL affects the quality of Bee Brook for the following parameters -- alkalinity, hardness, total phosphate, and total dissolved solids (TDS) (Table 3-7). None of these parameters is included in the NPDES permit. Elevation of alkalinity, hardness, and TDS is expected since cooling towers concentrate ions, and the discharge of cooling tower blowdown to the stormwater management system and eventually to Bee Brook increases the levels of these parameters in Bee Brook. Total phosphate is increased since phosphate-based corrosion inhibitors are used in the cooling tower. These parameters are also elevated in surface water from an on-site drainage ditch (Station D-1), which carries cooling tower blowdown as well as stormwater. Discharge from the site also increases the flow of Bee Brook by two to four times (Table 3-7).

Although concentrations of these parameters are elevated in Bee Brook due to PPPL operations, alkalinity levels are in conformance with the EPA water quality criterion (EPA, 1986b), and hardness and TDS levels, for which there are no standards, are normal for freshwater streams. However, total phosphate contributed by the site has increased concentrations in Bee Brook to levels that are indicative of nutrient-rich waters.

TABLE 3-7

1986 AND 1987 SURFACE WATER QUALITY DATA FOR SELECTED PARAMETERS AT THREE STATIONS AT PPPL

	1/86	2/86	3/86	4/86	5/86	6/86	7/86	8/86	9/86	10/86	11/86	12/86	1/87	2/87	3/87	4/87	5/87	6/87	7/87	8/87	9/87	10/87	11/87	12/87
Station B-1 (Bee Brook upstream of Ditch 5 confluence)																								
Alkalinity (mg/L $CaCO_3$ eq[a])	4	8	8	12	14	66	30	50	48	60	22	10	30	16	12	16	44	44	14	24	32	58	32	28
Hardness (mg/L $CaCO_3$ eq)	12	16	24	8	8	60	32	44	40	36	40	32	16	40	24	24	38	–	36	28	56	36	52	16
Total Phosphate (mg/L P[b])	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.5	<0.2	<0.2	<0.2	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total dissolved solids (mg/L)	121	129	88	75	114	186	191	175	113	168	96	73	103	234	98	101	95	119	91	101	110	165	0.08	87
Flow (ft^3/sec)	0.13	0.19	0.16	0.24	0.11	0.07	0.067	0.055	0.065	0.05	0.07	0.16	–	0.21	0.16	0.18	0.9	0.08	0.08	0.06	0.02	0.01	0.02	0.11
Station B-2 (Bee Brook downstream of Ditch 5 confluence)																								
Alkalinity (mg/L $CaCO_3$ eq)	12	48	44	50	52	66	60	60	100	76	48	44	54	36	42	36	32	36	54	64	54	50	24	22
Hardness (mg/L $CaCO_3$ eq)	72	52	64	72	36	52	56	96	60	48	80	68	52	56	28	28	44	48	40	60	100	24	56	48
Total Phosphate (mg/L P)	0.3	<0.2	0.25	0.3	0.3	0.3	0.5	0.7	0.9	0.4	0.5	<0.2	0.2	0.25	0.2	0.2	0.4	1.6	0.75	0.4	0.65	0.7	1.2	0.3

TABLE 3-7

1986 AND 1987 SURFACE WATER QUALITY DATA FOR SELECTED PARAMETERS AT THREE STATIONS AT PPPL (Continued)

	1/86	2/86	3/86	4/86	5/86	6/86	7/86	8/86	9/86	10/86	11/86	12/86	1/87	2/87	3/87	4/87	5/87	6/87	7/87	8/87	9/87	10/87	11/87	12/87
Total dissolved solids (mg/L)	177	168	141	147	143	178	165	254	155	149	122	128	178	219	139	147	161	326	157	152	175	160	220	137
Flow (ft^3/sec)	0 30	0 37	0 38	0.58	0.31	0.28	0.423	0.204	0.358	0.23	0.33	0.35	2.7	0 42	0.39	0 44	3 5	2.6	0 25	0 19	0 25	0 14	0 25	0 23
Station D-2 (Ditch 5 downstream of Detention Basin Outlet)																								
Alkalinity (mg/L $CaCO_3$ eq)	18	66	66	64	60	64	46	58	48	52	48	56	70	54	54	48	30	44	70	60	60	36	16	14
Hardness (mg/L $CaCO_3$ eq)	92	44	88	68	44	64	44	56	56	40	76	76	72	68	24	28	36	44	48	70	100	84	52	36
Total Phosphate (mg/L P)	0.4	<0.2	0.3	0.5	0.4	0.4	0.3	0.3	0.7	0.4	0.5	0.2	0.3	0.35	0 3	0.3	0.5	0.95	0 6	0.6	0.8	0 8	1	0 65
Total dissolved solids (mg/L)	195	210	189	163	166	176	151	149	151	142	124	143	213	170	182	144	181	172	167	149	123	140	276	161
Flow (ft^3/sec)	0.18	0.21	0.31	0 23	0.15	0.14	0.164	0.131	0.307	0.18	0.24	0.28	1.6	0 15	0.12	0.19	2.5	0.1	0.17	0.13	0 16	0 15	0.15	0 012

Source: Stencel, 1987b; 1988a
[a]Calcium carbonate equivalent
[b]phosphorus

The flow at Station M-1 on the Millstone River, downstream of PPPL, is several orders of magnitude higher than Bee Brook. Therefore, any site effects on surface water would be diluted at that station or would be masked by other sources. Nonetheless, the data indicate some nitrogen and phosphorus enrichment in the Millstone River, which may be the result of agricultural runoff.

Stations P-1 and P-2 are in the Millstone River basin upstream of the site. They were located to assess effects of deposition of airborne contaminants, rather than of discharges to surface water. Presently, PPPL is not emitting significant amounts of constituents to the atmosphere and will not until initiation of D-T experiments at the TFTR (Section 3.1). Therefore, data from these stations are currently considered baseline.

3.3.4 Findings and Observations

3.3.4.1 Category I

None

3.3.4.2 Category II

None

3.3.4.3 Category III

1. Contamination from Detention Basin water. The PPPL Detention Basin is constructed and operated in a manner such that contaminants entering the basin could be released and degrade surface water, sediment, and groundwater.

   The Detention Basin receives runoff from much of the C-Site and all of D-Site. If surface spills and releases of petroleum and chemical products used at PPPL (Section 4.2.1) were to occur, contaminated runoff water could enter the Detention Basin.

In addition, spills and accidental releases of mineral oil and PCBs from transformers and capacitors (Section 4.2.1.1) may also enter the Detention Basin. Most transformers and capacitors are located within outdoor transformer/capacitor yards. The transformer/capacitor yards are generally located on gravel-filled, concrete- or clay-lined basins that slope toward collection sumps. When liquids in the sumps reach a certain level, pumps may be activated to pump the liquids from the sumps into the storm sewer, which then leads to the Detention Basin. Since the sump pumps are controlled by hydrocarbon-sensitive floats, the pumps are not supposed to activate if hydrocarbons are detected. However, experience with some sumps at PPPL indicates that the floats are not completely sensitive to hydrocarbons in water. Therefore, PCBs and mineral oils released from transformers/capacitors may be discharged into the Detention Basin.

The Detention Basin is not lined, although there are two 6-foot-wide concrete low-flow channels. Presently, the basin is operated in the flooded mode in which water is always in the basin at a level above the top of the outlet (approximately 4 feet deep). In this mode, the basin contents are slowly and continuously released to an unlined ditch (Ditch 5), which flows to Bee Brook. Manually initiated batch releases also periodically occur when the basin's capacity is approached.

Although visual inspections of the basin for the detection of spills are made several times a day, releases of contaminants to Ditch 5, and subsequently to Bee Brook, may still occur since some contaminants are not readily visible, and since the basin does not have the capacity to indefinitely contain contaminated water. These releases could result in degradation of surface water and sediment in downstream water bodies such as Bee Brook. In addition, since the basin is mostly unlined and operates in the flooded mode, undetected contaminants within the basin and contaminants which have been released to Ditch 5, could percolate toward and potentially degrade the groundwater. Water within the Detention Basin and Ditch 5 would provide a driving force to move contaminants downward.

To determine whether contamination of the Detention Basin has occurred, sediments from the basin will be collected and analyzed for semivolatile

organic compounds including PCBs and heavy hydrocarbons during the Sampling and Analysis (S&A) phase of the Survey.

2. Contamination from C-Site Switchyard sump releases. Potential contamination of the surface water and sediment in an unnamed tributary south of C-Site and Bee Brook may occur from periodic C-Site Switchyard sump releases that could contain PCBs and mineral oils.

The C-Site Switchyard, which has PCB and mineral oil transformers, is reported by PPPL personnel to be constructed with a clay liner that slopes toward collection sumps. When liquids in the sump reach a certain level, a sump pump is activated and the liquids are pumped into a storm sewer. The storm sewer discharges directly to a surface ditch and stream that flow into Bee Brook. However, the sump pumps are controlled by hydrocarbon-sensitive floats. Thus, if hydrocarbons are detected, the pumps are not supposed to actuate. However, experience at other sumps at PPPL indicates that the floats are not completely sensitive to hydrocarbons in water. Therefore, PCBs and mineral oils may be discharged, resulting in surface-water and sediment contamination. These types of discharges may require an NPDES permit.

To determine whether contamination of the ditch has occurred, during the S&A phase of the Survey, sediments from the ditch will be collected and analyzed for semivolatile organic compounds including PCBs and heavy hydrocarbons.

3.3.4.4 Category IV

1. Improper surface-water sampling procedures. Some surface-water sampling procedures used at PPPL may result in data of questionable validity.

Surface water is sampled at PPPL by a sampling contractor to comply with the Laboratory's NPDES permit and to support its environmental monitoring program. Several improper procedures were noted during field sampling that may affect the validity of the resulting data, as follows:

- Site-specific written sampling protocols were not available;

- Only some bottles used for oil and grease samples are prepared, and acetone is used for rinsing. Standard Methods for the Examination of Water and Wastewater, which contains the procedure used by the contractor, specifies that all sample bottles shall be rinsed with trichlorotrifluoroethane;

- During dissolved oxygen sampling, the samples may have been aerated because of the procedures used to fill the sample bottles. Also, an air bubble was present in one of the sample bottles;

- Fecal coliform samples were collected in an unsterilized container before being transferred to the sterile sample container; and

- The flow meter had not been calibrated in 2 years.

3.4 Hydrogeology

This section discusses regional geologic conditions, groundwater characteristics, groundwater pollution sources and controls, the groundwater monitoring program, and the effect of PPPL operations on the subsurface environment.

3.4.1 Background Environmental Information

Most of the information in this section has been adapted, based on the Survey team's analysis, from a United States Geological Survey (USGS) water resources investigation performed in 1985 and 1986 (Lewis and Spitz, 1987). Much of the data generated in that study focused on the area between the TFTR Test Cell and Bee Brook (i.e., D-Site); however, in view of the observed lithologic homogeneity of the formations, similar subsurface conditions can be inferred for C-Site.

3.4.1.1 Geology

PPPL lies in the Piedmont physiographic province, approximately 4,000 feet northwest of the Fall Line. This natural boundary separates the sedimentary and crystalline rocks of the Piedmont physiographic province from the alluvium of the Coastal Plain physiographic province in the eastern United States.

In New Jersey, the Piedmont physiographic province consists entirely of sedimentary rock within the Newark Basin, which was formed, along with several other Triassic and Jurassic basins in the eastern part of the United States, as the result of infilling of a rift basin before continental breakup. Sediments deposited in the basin formed sandstone, siltstone, mudstone, and shale. In some places within the Newark Basin, basaltic lava flows are interbedded with these rocks. After deposition and consolidation, the rocks were tilted; in places, they faulted and were intruded with diabase dikes. The Newark Basin rocks are part of the Newark Supergroup, which in New Jersey includes, in ascending order, the Stockton and Lockatong Formations; the Passaic Formation; the Feltville, Towaco, and Boonton Formations; and the interbedded Orange Mountain, Preakness, and Hook Mountain Basalts.

PPPL is underlain by three layers, as depicted in Figure 3-4. The deepest layer is the Stockton Formation, which is the oldest of the above-mentioned formations and is

HYDROGEOLOGIC UNIT	DESCRIPTION	THICKNESS[a] (Feet)	DEPTH TO BOTTOM OF CORED INTERVAL BELOW LAND SURFACE[a] (Feet)
OVERBURDEN (Fill)	Silt, sand, and gravel, clayey.	2.0	2.0
RESIDUAL SOIL AND WEATHERED BEDROCK	Sand, fine- to coarse-grained, grading to moderate clayey silt and fine sand.	5.2	7.2[b]
	Sandstone, fine-grained. Closely spaced horizontal fractures.	3.0	12.0
	Siltstone, clayey.	1.0	13.0
	Sandstone, very fine- to fine-grained. Near-horizontal fractures spaced 1 to 8 inches apart.	7.0	20.0
STOCKTON FORMATION (Bedrock)	Same as overlying 7 feet, but with one near-vertical fracture with oxidized surface.	5.0	25.0
	Sandstone, same as overlying 12 feet, but very weathered, oxidized, and somewhat clayey.	1.0	26.0
	Siltstone and fine-grained sandstone. Horizontal fractures spaced 0.5 to 27 inches apart; most have oxidized surfaces.	29.0	55.0
	Clay, pale reddish-brown.	2.0	57.0
	Siltstone and fine-grained sandstone, clayey. Horizontal fractures spaced 5 to 6 inches apart; one vertical fracture.	2.0	59.0
	Clay, pale reddish-brown.	0.5	59.5
	Sandstone, fine- to medium-grained. Horizontal fractures spaced 4 to 18 inches apart; two near vertical fractures.	8.0	67.5
	Siltstone and fine-grained sandstone. Three near-vertical fractures with white (clay?) coating. Horizontal fractures spaced 0.5 to 14 inches apart.	16.5	84.0
	Alternate layers of: Sandstone, fine- to medium-grained, and Siltstone and fine-grained sandstone. Horizontal fractures spaced 1 to 21 inches apart.	10.0	94.0
	Sandstone, fine- to medium-grained. Horizontal fractures spaced 2 to 25 inches apart; one near-vertical fracture at depth of 100 to 104 feet coated with white (clay?) mineral.	26.0	120.0

[a] Thickness and depth based on measurements of D-Site Corehole, CH (Figure 3-5).
[b] No sample between 7.2 and 9.0 feet.

Source: Adapted from Lewis and Spitz, 1987

SHALLOW STRATIGRAPHY BENEATH D-SITE FIGURE 3-4

more than 500 feet thick. The Stockton Formation consists of olive-gray siltstone, light gray and red siltstone, and fine to medium-grained yellowish-brown to orange sandstone with minor amounts of shale and clay. Near-vertical joints are common, some coated with secondary minerals. No large faults have been reported in or near the PPPL, and no lineaments are revealed by aerial photographs. The Stockton Formation's relict bedding strikes approximately 65 degrees northeast and dips approximately 8 degrees northwest in the vicinity of the site.

Overlying the Stockton Formation is a 6- to 39-foot layer of weathered Stockton Formation rock and residual soil, composed of clayey silts and sands. A layer of fill, consisting of clayey sand, silt, and gravel, has been placed above the residual soil.

There are no bedrock outcrops in the site area, and no significant bedrock structural features are known to occur in the region. The area has a mature topography with low relief (maximum of 30 feet), ranging in elevation from approximately 71 feet to 110 feet above sea level, averaging less than 15 feet of relief regionally.

There has been no significant earthquake activity nor are there active faults in the region. In addition, there are no known mineral deposits underlying the site that would represent a viable extractable resource, and no historical mining activity is recorded.

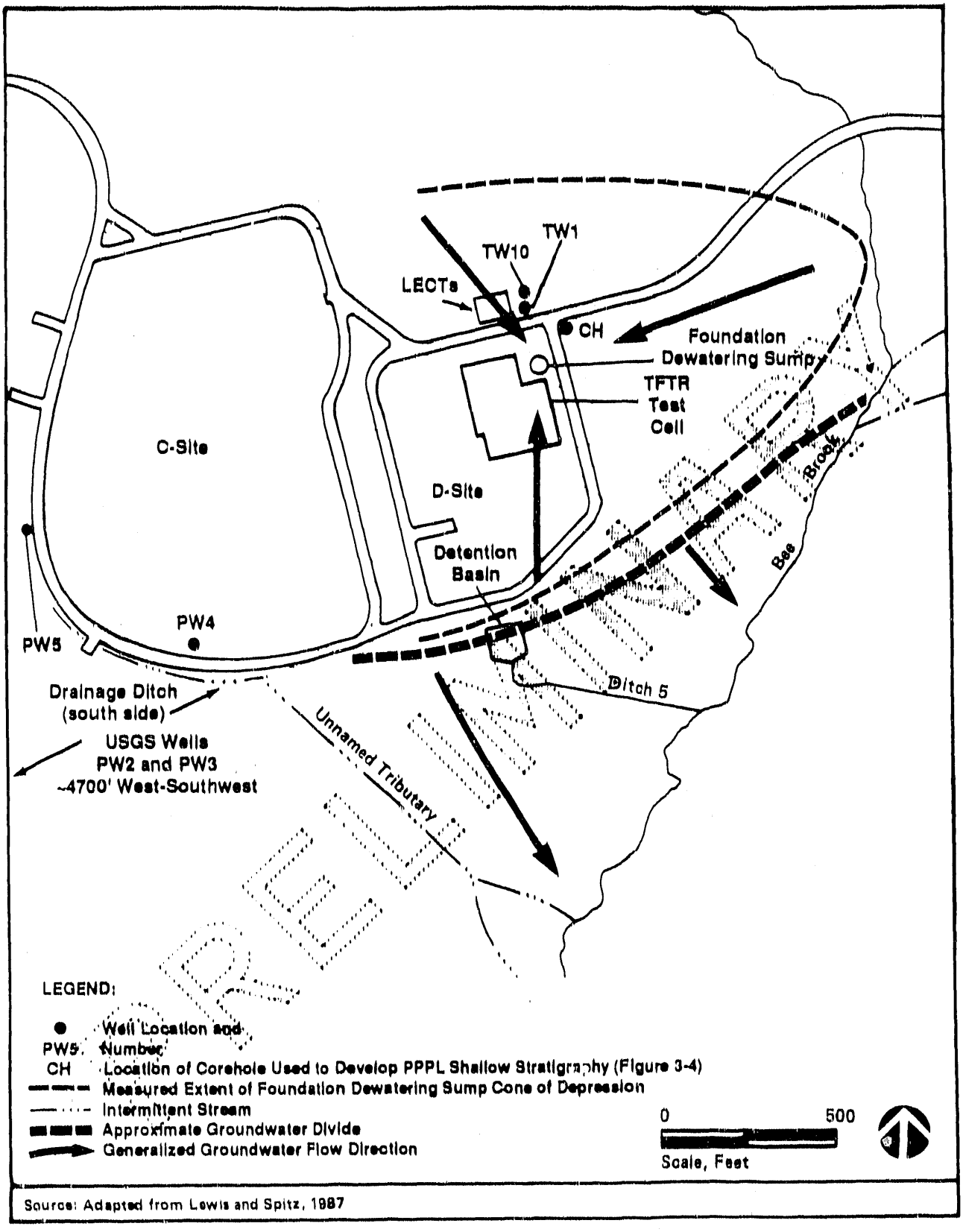
3.4.1.2 Groundwater Regime

As interpreted from the USGS study (Lewis and Spitz, 1987), groundwater beneath C- and D-Sites occurs both in the fractured and jointed sedimentary bedrock of the Stockton Formation (primarily siltstone and sandstone) and in its overlying unconsolidated residual soil and weathered bedrock layer (Figure 3-4). The groundwater which is present in these two layers acts as one aquifer, although its hydraulic and restrictive properties vary with the physical properties of each of the layers. The portion of the aquifer which is considered to be sufficiently jointed and fractured to allow for significant groundwater flow is the upper 500 feet of the Stockton Formation. Transmissivities average 1,740 square feet per day as determined by aquifer testing. Average effective porosity of the aquifer is 11 percent based on primary and secondary estimates. No large faults are known to occur that would cause preferential or heterogeneous flow in or near PPPL.

Recharge to the Stockton Formation aquifer at C- and D-Sites is assumed to be primarily by lateral flow; a lesser degree of recharge occurs by vertical infiltration of precipitation through the residual soil and weathered bedrock since the increased content of clay and silt may restrict downward flow (Lewis and Spitz, 1987). Additionally, stream infiltration from the losing reaches of Bee Brook east of the site, and the water contained within the Detention Basin and Ditch 5, as discussed in Section 3.3.2, may contribute to the aquifer recharge.

Discharge of groundwater in the vicinity of PPPL is primarily by on-site pumpage and natural subsurface lateral flow off the site. The extent of lateral flow is not known but some of this flow discharges to Bee Brook immediately southeast of D-Site. The natural average linear velocity of the groundwater is approximately 100 feet per year in a southeasterly direction. However, on-site pumpage from a foundation dewatering sump located near the northeast corner of the TFTR Test Cell creates a localized gradient reversal which affects the groundwater flow direction and linear velocity. The average linear velocity under this condition is estimated to be between 170 and 270 feet per year toward the sump (Figure 3-5) (Lewis and Spitz, 1987). The pumped water is discharged to the stormwater management system (Section 3.3.2) at approximately 150 to 200 gallons per minute.

The measured cone of depression on the potentiometric surface around the sump is estimated to extend from beneath the Detention Basin on the south to approximately 200 feet north of the LECTs on the northern edge of the site, to Bee Brook on the east. The western edge of the cone of depression, located somewhere beneath C-Site, is not known (Lewis and Spitz, 1987). Beneath the southern half of D-Site, the groundwater divide separating the normal southeasterly flow from the reversed flow toward the sump pump occurs beneath the drainage ditch on the south side of the site and the Detention Basin and continues in a northeasterly direction toward Bee Brook (Figure 3-5). However, the location of this divide is estimated based on limited data and therefore is only an approximation. Furthermore, the divide may move either toward or away from the sump during seasonal fluctuations of the water table.



Source: Adapted from Lewis and Spitz, 1987

LOCATION OF USGS AND PPPL MONITORING WELLS AND REACTOR BUILDING SUMP PUMP

FIGURE 3-5

The depth to the water table beneath C- and D-Sites ranges between 0 feet at Bee Brook and approximately 24 feet at the TFTR Test Cell. The greater depth to the water table around the TFTR Test Cell is caused by the TFTR foundation dewatering.

3.4.1.3 Groundwater Quality and Usage

One objective of the 1985/1986 USGS water resources investigation (Lewis and Spitz, 1987), described in Section 3.4.1.2, was to establish the ambient groundwater quality before the commencement of projected future fusion research operations at the Laboratory. Groundwater samples were taken from five wells (TW1, TW10, PW2, PW3, and PW5), all of which are completed in the bedrock of the Stockton Formation (Figure 3-5). The samples were analyzed to provide background water quality data for 14 common ions and nutrients, 16 trace metals, 5 physical parameters, and tritium.

Wells TW1 and TW10 were each sampled four times at three-month intervals during 1986. Wells PW2, PW3, and PW5 were each sampled one time. Additionally, USGS continued sampling wells TW1 and TW10 in 1987 at three-month intervals. All samples from USGS wells were collected by USGS staff. Nonradiological analyses for samples from these wells were performed by a USGS laboratory in Aravada, Colorado. USGS samples for tritium analyses were split with PPPL; the USGS performed analyses for tritium at a radiological laboratory at the University of Miami. In general, no unusually high levels of any chemical or physical parameters were detected, based on drinking water standards and concentrations measured in other wells in the area. Tritium concentrations ranged from 60 to 112 pCi/L, which is background for this region and is not indicative of any on-site source (Lewis and Spitz, 1987; Stencel, 1988a).

There is no significant use of groundwater from off-site wells in the immediate vicinity of PPPL, but there are at least 100 industrial and domestic use wells within 5 miles. However, no additional information is available for these wells, including the formations into which they are completed. Since the advent of surface-water-supplied public potable water supply systems, most of the wells, which are clustered south and west of the site (generally perpendicular to the direction of groundwater flow from the site), are either not used or are only sporadically used for irrigation,

process water, or emergency purposes. Groundwater from these wells is not known to be used for drinking water.

3.4.2 General Description of Pollution Sources and Controls

PPPL has three potential sources of groundwater contamination associated with its current activities -- the partially lined Detention Basin located at the southern end of D-Site, the unnamed tributary located south of C- and D-Sites, and Ditch 5 (Figure 3-5). The Detention Basin and Ditch 5 receive surface water runoff from all of D-Site and most of C-Site, as well as discharges from PCB and mineral oil transformer pad sumps. The unnamed tributary, a losing stream, receives surface water runoff from part of C-Site, including that from the Receiving No. 3 and No. 4 loading dock area and discharges from the C-Site switchyard sump. In both cases, this runoff has the potential to contain hazardous materials from any surface spills and releases and PCB and mineral oils from any uncontained, leaking transformers and capacitors. Seepage from these three sources may migrate to the groundwater beneath the site. This potential contamination is further discussed in Sections 3.3.2 and 4.2.

PPPL also has two potential sources of groundwater pollution associated with its past activities. These consist of the C-Site Cooling Tower and the chromium reduction pits, and are further discussed in Section 4.5.1.2.

The potentially contaminated groundwater from these sources may discharge to Bee Brook and other streams southeast of the site, or may be recirculated through the TFTR foundation dewatering sump to the stormwater management system, including the Detention Basin, depending of seasonal water table fluctuations.

To reduce the potential for groundwater contamination, PPPL has instituted several physical and administrative controls. These include a comprehensive SPCC Plan, as described in Section 4.2.1; routine inspections of the Detention Basin for spills, as described in Section 3.3.2.2; liners, sumps, and hydrocarbon sensors in several transformer yards, as described in Section 3.3.2.1; an underground storage tank leak testing program in 1983, as described in Section 4.2.1.6; and a hazardous and radioactive waste management program, as described in Section 4.1.

3.4.3 Environmental Monitoring Program

In addition to the USGS baseline monitoring program discussed in Section 3.4.1, PPPL initiated its own groundwater monitoring program in 1984. The program currently monitors for tritium; 39 halogenated and nonhalogenated organics; 15 metals; 11 ions and nutrients; and 8 physical parameters. Since 1984, a total of seven wells have been sampled for the nonradiological monitoring program, including four wells in the C- and D-Site area and three wells in the A- and B-Site area (Table 3-8). Two wells (PW4 and PW5) have been sampled for tritium since 1984. All these wells have been completed into the bedrock of the Stockton Formation; water within the shallower, residual soils is not monitored. The monitoring interval for each well has varied between one month and two years as the PPPL monitoring program has developed and as various wells have been added to or removed from the sampling regimen. Since 1985, PPPL has used monitoring data from the USGS investigation discussed in Section 3.4.1.3 to assist in defining the quality and characteristics of the groundwater. Table 3-8 presents the frequency of sampling and analysis of the PPPL groundwater monitoring program.

PPPL currently uses an outside contractor to collect and analyze its samples for nonradiological constituents. For field sampling procedures, the contractor follows guidelines in the Field Sampling Procedures Manual of the NJDEP Hazardous Waste Program. However, a set of site-specific field sampling protocols has not been developed for PPPL.

Samples for tritium analysis are collected from PPPL wells by PPPL personnel. The subsequent analyses are performed at the REML at PPPL, as discussed in Section 4.4.2. PPPL has no site-specific written protocols established for tritium sampling.

The Survey team interviewed the outside sampling contractor regarding sampling procedures at all wells, and observed groundwater sampling at Wells PW4 and PW5. As a result of the interview and sampling observations, the Survey noted that the submersible pump used to collect samples is not always decontaminated between sampling at wells TW1 and TW10, and that the pump used may aerate the samples during collection. Analytical results for dissolved oxygen and volatile and semivolatile organic compounds may be affected by aeration.

TABLE 3-8

GROUNDWATER MONITORING WELLS AND FREQUENCY AT PPPL

Well I.D.	Screened Interval (feet)	Annual Frequency of Sampling and Analysis				Comments
		1984	1985	1986	1987	
PW1	unknown	-	-	-	1	Located at B-Site; also known as 1
PW2	unknown to 297	-	1	-	1	Located at B-Site; also known as 2
PW3	30 to 406	-	1	-	3	Located at B-Site; also known as 3
PW4[a]	50 to 420	2	4	4	4	Also known as W4 and 4; formerly a production well; no well log was available during Survey
PW5[a]	45 to 250	2	4	4	5	Also known as W5 and 5; formerly a production well; no well log was available during Survey
TW1[a]	31 to 60	-	-	3	5	Well was constructed by USGS
TW10[a]	100 to 125	-	-	3	5	Well was constructed by USGS

Source: Lewis and Spitz, 1987; Stencel, 1985a; 1986, 1987b, 1988a

[a]Locations depicted in Figure 3-5

In general, concentrations of measured parameters in groundwater are below detection limits, applicable drinking water standards, or concentrations measured in other wells in the area. However, in 1987, tetrachloroethylene was detected in wells TW1 and TW10 at concentrations [1.8 micrograms per liter (µg/L) to 9.3 µg/L] above the New Jersey drinking water standard of 1 µg/L. Also in 1987, trichloroethylene was detected in well TW1 at 7.8 µg/L, which is above the New Jersey drinking water standard of 1 µg/L (Stencel, 1988a). The source of this contamination is not known; however since these constituents were detected only in wells generally upgradient of PPPL, the source may be off-site. It should be noted that these wells are not used as a drinking water source.

3.4.4 Findings and Observations

Findings that involve potential groundwater contamination are the result of current and past operations, releases, and disposal practices and are therefore discussed within the context of other findings in Sections 3.3.4 (Surface Water), 4.2.2 (Toxic and Chemical Materials), and 4.5.2 (Inactive Waste Sites and Releases).

3.4.4.1 Category I

None

3.4.4.2 Category II

None

3.4.4.3 Category III

None

3.4.4.4 Category IV

1. Improper groundwater sampling procedures. Some groundwater sampling procedures used at PPPL may result in data of questionable validity.

Groundwater is sampled at PPPL to support the Laboratory's environmental monitoring program. During interviews with the sampling contractor and observation of actual sample collection, the following improper procedures were identified that may affect the validity of data:

- Site-specific written sampling protocols for tritium and nonradiological parameters have not been developed;

- The groundwater submersible pump which is used for sampling tritium and nonradiological constituents is not decontaminated between sampling of wells TW1 and TW10; and

- The pump used to obtain samples for nonradiological parameter analysis aerates the samples during collection, thereby potentially impacting the data quality for dissolved oxygen and volatile and semivolatile organic compounds.

2. Insufficient groundwater monitoring program. The current PPPL groundwater monitoring program is ineffective in identifying the potential PPPL impacts on groundwater quality.

PPPL does not monitor for all contaminants which may reasonably be expected to be released to groundwater as a result of both current and past operations. Examples include PCBs, total petroleum hydrocarbons or oil and grease (measures of mineral oil), and chromium. PCBs and mineral oil are used in numerous transformers and capacitors at C- and D-Sites, and releases of these oils to the soil and surface water and subsequently to the groundwater may have occurred and may still be occurring, as described in Section 3.3.4.3, Findings 1 and 2 and Section 4.2.2.2, Finding 2. Additionally from the late 1950s to 1983, PPPL used chromium as a corrosion inhibitor in its C-Site Cooling Tower. Chromium reduction pits associated with the cooling tower were used to reduce hexavalent chromium to the trivalent state, as described in Section 4.5.2.3, Finding 1. Since chromium may have been released to the soil and surface water, it may have also contaminated the groundwater beneath PPPL.

3. Insufficient hydrogeologic and monitoring well construction data. PPPL groundwater data cannot be meaningfully interpreted because of insufficient site hydrogeologic and well construction information.

PPPL lacks site-specific information concerning the groundwater flow regime with respect to seasonal groundwater fluctuations, gradient, and flow direction. While observing actual sample collection procedures at wells PW4 and PW5, the Survey observed that static water levels are not measured to correlate with previously collected data and therefore allow more effective interpretation of the analytical results. In addition, at the time of the Survey, PPPL did not have "as built" construction data or well logs for wells PW4 and PW5. These logs can provide information to further aid in data interpretation, such as the portion of the aquifer being sampled and whether the annular space has been sealed to prevent surface infiltration. PPPL did acquire well log data for these wells after the Survey.

4.0 NON-MEDIA-SPECIFIC FINDINGS AND OBSERVATIONS

This section discusses findings and observations pertaining to waste management, toxic and chemical materials, radiation, quality assurance, and inactive waste sites and releases from PPPL operations at A-, B-, C-, and D-Sites and the College Road facility. These discussions do not include a background environmental information section because the areas addressed are not necessarily tied to one medium as was the case with the discussions in Section 3.0. The discussions include an environmental monitoring section where appropriate and where information was available.

4.1 Waste Management

PPPL generates and manages a variety of hazardous, radioactive, mixed, and nonhazardous wastes. These wastes are generated primarily at the C- and D-Sites, with relatively smaller quantities of hazardous and nonhazardous wastes being generated at the 305-307 College Road facility. The A- and B-Sites have been vacated by PPPL, as discussed in Section 4.5.1.1, and therefore are not discussed in this section. The following sections discuss the generation and on-site management of hazardous, radioactive, mixed, and nonhazardous wastes.

4.1.1 General Description of Pollution Sources and Controls - Hazardous Waste

NJDEP regulates the handling and disposal of hazardous waste in the State of New Jersey. The state regulations are in most aspects similar to those in the Resource Conservation and Recovery Act (RCRA) of 1980 as amended by the Hazardous and Solid Waste Amendments of 1984. The most significant exception which applies to PPPL is the recognition by the State of New Jersey that most types of waste oil are regulated as hazardous wastes.

The hazardous waste generation and management aspects of the two noncontiguous PPPL facilities (C- and D-Sites and the College Road facility) are regulated as separate and independent entities in accordance with both the New Jersey hazardous waste regulations and RCRA. The C- and D-Sites are categorized as a generator of hazardous waste (i.e., more than 1,000 kilograms per month are

generated there), and the 305-307 College Road facility is regulated as a small-quantity generator of hazardous waste (i.e., between 100 and 1,000 kilograms per month are operated there). PPPL has no facilities currently permitted as treatment, storage, and disposal (TSD) facilities for hazardous waste.

4.1.1.1 Characteristics and Sources of Hazardous Waste

General Waste Profile

The types of hazardous waste generated in the largest quantity at PPPL are waste oil and PCBs (Table 4-1). Several types and brand names of oil are used on-site, and the oils are used for several purposes, including cooling oils (some of which contain PCBs) for transformers, capacitors, and rectifiers, lubrication oils for large motors and other electrical devices, oils for cleaning, and hydraulic oils. The areas at PPPL that generate most of this oil are the C-Site MG Building, the TFTR MG Building, the transformer yards, and the east wing of the D-Site NBIC Building. These areas are identified on Figure 2-4.

Hazardous wastes generated in smaller quantities include degreasing solvents, acids and caustics, laboratory reagents, printing and photographic chemicals, and methanol/dye mixtures from lasers. The generation rates for each of the specific hazardous wastes are not precisely known; however, the PPPL hazardous waste generator annual reports do provide approximate quantities for these various waste types generated at PPPL (Table 4-1).

Waste degreasing solvents include acetone, 1,1,1-trichloroethane, Inhibisol, J-88, and Freon-113. Inhibisol, J-88 and Freon-113 contain various halogenated ethanes, methanes, and ethylenes. In some cases, such as in Freon-filled parts cleaners or in spray bottles of J-88, the solvents evaporate as they are used; however, in other applications, spent solvents are generated and are consequently disposed of as hazardous waste. These materials are used in many of the shops and laboratories at the C- and D- Sites.

Acids and caustics are used primarily for equipment cleaning. They include sulfuric, nitric, and muriatic acids and sodium hydroxide. Waste acids and caustics generally are generated only at C-Site.

TABLE 4-1

PPPL OFF-SITE HAZARDOUS WASTE DISPOSAL RECORDS, 1985-1987

Waste Types	New Jersey Waste Codes	1987			1986			1985		
		Pounds [a]	Gallons[a]	Cubic Yards[a]	Pounds [a]	Gallons[a]	Cubic Yards[a]	Pounds [a]	Gallons[a]	Cubic Yards[a]
Characteristic ignitable	D001	5,268	610	-	10,050	60	-	3,228	754	-
Characteristic corrosive	D002	5,019	205	-	5,200	220	-	-	77	-
Characteristic reactive	D003	642	-	-	-	55	-	-	-	-
EP Toxic - chromium	D007	350	-	-	650	-	-	-	-	-
EP Toxic - lead	D008	-	145	20	-	30	-	-	-	-
EP Toxic - silver	D011	-	65	-	-	20	-	-	-	-
EP Toxic - barium	D005	-	-	-	-	-	-	-	10	-
EP Toxic - mercury	D009	-	-	-	-	-	-	40	-	-
PCBs	X387	55,704	-	-	9,307	-	-	190,068	-	-
PCBs	B001	-	-	-	-	-	-	-	30	-
PCBs	B007	-	-	-	1,346	-	-	1,160	-	-
Waste oil	X722	-	4,850	-	-	-	-	-	-	-
Waste oil	X725	37,770	-	-	3,928	-	-	8,150	-	10
Waste oil	X726	-	2,611	-	-	2,400	18	-	1,600	-
Waste oil	X727	-	1,125	-	100	-	-	-	-	-
Non-RCRA hazardous[b]	X910	-	-	-	-	-	-	800	-	-
Miscellaneous	X850	11,842	-	-	20,550	350	-	2,450	-	-
Non-RCRA hazardous[b]	X900	-	-	-	-	35	-	-	555	-

TABLE 4-1

PPPL OFF-SITE HAZARDOUS WASTE DISPOSAL RECORDS, 1985-1987 (Continued)

Waste Types	New Jersey Waste Codes	1987			1986			1985		
		Pounds [a]	Gallons[a]	Cubic Yards[a]	Pounds [a]	Gallons[a]	Cubic Yards[a]	Pounds [a]	Gallons[a]	Cubic Yards[a]
Non-RCRA hazardous[b]	Other	-	-	-	-	585	-	-	-	-
Halogenated solvents	F001	85	280	-	-	495	-	-	-	-
Halogenated solvents	F002	-	50	-	-	515	-	-	-	-
Nonhalogenated solvents	F003	437	160	-	-	-	-	-	-	-
Nonhalogenated solvents	F005	39	110	-	-	-	-	-	-	-
Cyanides	P030	-	-	-	300	-	-	-	-	-
Potassium cyanide	P098	350	-	-	-	-	-	-	-	-
Sodium cyanide	P106	350	-	-	-	-	-	-	-	-
Silver cyanide	P104	-	-	-	300	-	-	-	-	-
Mercury	U151	6,800	-	-	4,100	-	-	-	-	-
1,2-Dichlorobenzene	U070	-	-	-	-	-	-	-	55	-
Acetone	U002	-	-	-	-	25	-	-	-	-
Dibutyl phthalate	U069	-	-	-	300	-	-	-	-	-
1,1,1-Trichloroethane	U226	-	-	-	600	-	-	900	-	-
	Totals[c]	111,034	9,751	20	35,431	4,025	18	206,796	3,081	10

Source: Lawson, 1986; Larson, 1987a; 1988a

[a] Pounds, gallons, and cubic yards are mutually exclusive.
[b] Nonhazardous wastes disposed of as hazardous.
[c] Totals do not correspond to the sum of reported waste quantities since some wastes reported are identified by two or more wastes cod

Waste laboratory reagents are occasionally generated in the research laboratories at C-Site. These wastes are generated sporadically in small quantities when researchers turn in unwanted chemicals or the Material Control (MC) staff periodically performs a "purge" to remove such chemicals from the work areas. The wastes include metal salts, organic acids, and solvents.

Waste printing and photographic chemicals are generated in the administrative buildings at C-Site and at the 307 College Road facility.

Methanol/dye mixtures are generated in small quantities from laser operations in laboratories at C-Site.

Other hazardous wastes are generated on a case-by-case basis, usually in association with major events at the site such as cleanup of a spill, cleaning of a fuel tank, or infrequent maintenance of a large piece of equipment. Such wastes have included oil-contaminated spill control absorbents and soil, metal-contaminated soil, waste oil (including PCBs), and oil- or solvent-contaminated wastewater. These major events have accounted for a large proportion of the hazardous waste generated at PPPL, but complete waste generation rates for these events are not available.

According to PPPL Annual Hazardous Waste Generator Reports, the quantity of hazardous waste disposed of off-site (and generated on-site) more than doubled from 1986 to 1987, from approximately 4,000 gallons, 35,000 pounds, and 18 cubic yards in 1986 to 9,700 gallons, 111,000 pounds, and 20 cubic yards in 1987 (Table 4-1). PPPL attributed the increase to the vacating of A- and B-Site, which occurred in 1987.

Hazardous Waste Generation Points

Various hazardous wastes are generated at numerous locations on both C- and D-Sites. The operations that generate hazardous waste include equipment maintenance and construction shops, laboratories, offices, and facilities maintenance and operations. The buildings or areas in which hazardous wastes are generated, as identified by the Survey, are listed on Table 4-2 and are discussed below.

TABLE 4-2

HAZARDOUS WASTE GENERATION AND SATELLITE ACCUMULATION AT PPPL

Site	Building or Area	Locations of Satellite Accumulation Areas	Description of Areas and Containers	Waste Types Generated and Accumulated						
				Waste Oil[a]	Degreasing Solvents	Acids and Caustics	Laboratory Reagents + Mercury	Printing and Photographic Chemicals	Methanol/ Laser Dye Mixtures	Janitorial Chemicals
C-Site	LOB West Wing	Room B345A	Metal safety cans on floor					X		
	Administration/Library	Room A118	Plastic product jugs in cabinet					X		
	Tech Shop	Main Machine Shop	Metal safety cans on floor	X	X					
	Laboratory Building	Various laboratories	Glass bottles, plastic jugs, metal safety cans on floor and in cabinets	X	X	X	X			
	L-Wing Addition	Various laboratories	Glass bottles, plastic jugs, metal safety cans on floor and in cabinets	X	X	X	X		X	
	Shop Building	Shops S109, S234	Metal safety cans on floor,	X	X					
	RF Building	Rooms R106, R107, R108, CS121, 3rd floor, 4th floor, SE corner	Glass bottles, plastic jugs, metal safety cans on floor and in cabinets	X	X	X	X		X	X
	CS Building	Various laboratories	Glass bottles, plastic jugs, metal safety cans on floor and in cabinets	X	X	X	X			
	COB Building	Various laboratories	Glass bottles, plastic jugs, metal safety cans on floor and in cabinets	X	X	X	X			
	System Test Building	Various workstations	Metal safety cans on floor	X	X					
	Maintenance Building	Outdoors, SE of Building	Drums on curbed concrete pad	X	X					
	C-Site MG Building	Various locations	Drums on pallets	X	X					

TABLE 4-2

HAZARDOUS WASTE GENERATION AND SATELLITE ACCUMULATION AT PPPL (Continued)

Site	Building or Area	Locations of Satellite Accumulation Areas	Description of Areas and Containers	Waste Types Generated and Accumulated						
				Waste Oil[a]	Degreasing Solvents	Acids and Caustics	Laboratory Reagents + Mercury	Printing and Photographic Chemicals	Methanol/ Laser Dye Mixtures	Janitorial Chemicals
C-Site	CAS Building	Various workstations	Drums on pallets, metal safety cans on floor	X	X					
	RESA Building	Various workstations	Drums on pallets, metal safety cans on floor	X	X					
	REML Building	Lab in West corner	Metal safety cans on shelf		X					
	Various maintenance activity locations	Various temporary locations	Drums on pallets	X						
D-Site	TFTR Mockup Building	Various locations	Drums on pallets							X
	NB Test Cell	Room 108	Various containers in cabinet	X	X					
	NBPC Building	Various locations	Drums on pallets, safety cans on floor	X	X					
	FCPC Building - East Wing	Various locations	Drums on pallets, safety cans on floor	X	X					
	FCPC Building - West Wing	Room 253	Drums on pallets, safety cans on floor	X	X					
	TFTR Test Cell	SE corner in basement	Drums and safety cans on floor	X	X					
	TFTR MG Building	Various locations	Drums on pallets	X						
	Various maintenance activity locations	Various temporary locations	Drums on pallets	X						
305-307 College Road	307 College Road	Cubicle 141	Plastic product jugs in cabinet					X		

[a] This category includes PCBs, PCB-contaminated oils, and non-PCB-contaminated oils.

In the west wing of the LOB, printing and development equipment in Room B345A generates waste hydroquinone ammonium thiosulfate developer and fixer.

In the Administration Building, printing equipment in Room A118 generates waste Versitech printing pigment chemicals.

In the Tech Shop, waste degreasing solvents and small amounts of lubricating oils are generated in the main machine shop.

In the Laboratory Building and L-Wing Addition, various research laboratories on both the first and second floors generate waste laboratory reagents and solvents, waste acids and bases, and small amounts of vacuum pump oil.

In the Shop Building, the machine shops in Rooms S109 and S234 generate waste degreasing solvents and lubrication oils.

In the RF Building, laser research laboratories in Rooms R106, R107, R108, and CS121 generate waste methanol/laser dye mixtures, cleaning solvents, laboratory reagents, acids and bases, and pump oil. Janitorial chemicals are stored on the fourth floor. Mercury switches are removed from the third floor of the RF Building and are either disposed of as hazardous waste or sold to a recycler.

In the CS and COB Buildings, various laboratories generate cleaning solvents, laboratory reagents, acids and bases, and pump oil.

In the System Test Building, the Maintenance Building, and the C-Site MG Building, waste solvents and lubrication oil, pump oil, and electrical cooling oils (some of which contain PCBs) are generated from oil changes on various pumps, motors, transformers, rectifiers, and capacitors which are located throughout these buildings.

In the CAS and RESA Buildings, waste degreasing solvents and oils are generated at various equipment maintenance and rebuilding stations which are located throughout these buildings. A heated Freon parts degreaser located on the west

end of the CAS Building generates relatively large (30-gallon) batch quantities of waste degreaser sludge.

In the REML, waste laboratory solvents and solvent/soil mixtures are generated.

In the TFTR Mockup Building, potentially hazardous waste janitorial chemicals are stored on pallets.

In the NB Test Cell Building, the NBPC Building, the east wing of the FCPC Building and the TFTR Test Cell basement, waste oil and waste degreasing solvents are generated from maintenance of various stationary pumps and electrical equipment located throughout the building. Room 253 in the west wing of the FCPC Building also generates waste degreaser sludge from a heated Freon parts degreaser. In the TFTR MG Building, waste oil is generated from maintenance of electrical equipment.

At the 307 College Road facility, waste Versitech printing pigment chemicals are generated by printing equipment used in the main office area in the center of the building.

At both the C-Site and D-Site, hazardous wastes are generated at various locations during maintenance activities, particularly during change-out of electrical equipment cooling oils in transformer, capacitor and rectifier yards.

4.1.1.2 Hazardous Waste Management Areas and Procedures

Once hazardous wastes are generated, PPPL has established facilities and procedures in place to manage these wastes. These include facilities for managing small quantities of waste at the point of generation (satellite accumulation areas), facilities for storing larger quantities of waste (90-day and 180-day accumulation areas), and management procedures for identifying, segregating, storing, transporting (on-site), and disposing of (off-site) hazardous waste, as discussed below.

Satellite Accumulation Areas

In general, hazardous waste generated at PPPL is accumulated and stored temporarily in small quantities at or near its point of generation. Waste containment at these locations, identified in Table 4-2, typically consists of 1- to 5-gallon red plastic or metal safety cans for waste solvents, 5- to 55-gallon cans and drums for waste oil, small (1 gallon or less) glass solvent and chemical reagent jugs and bottles for waste solvents and reagents, plastic 1- to 5-gallon jugs for waste acids and bases, and small (less than 1 gallon) plastic jugs for waste printing and photographic chemicals. All waste is segregated into the above-mentioned containers when initially disposed of. Containers are typically stored indoors either on the floor or in chemical storage cabinets. Spill control and cleanup materials are not typically immediately available at these locations.

Other locations, which are established on a case-by-case basis (Table 4-2), are also used temporarily as satellite accumulation areas. The areas usually are established when cooling oil is periodically changed in large transformers or groups of transformers, capacitors, or rectifiers, typically generating a few hundred gallons of waste oil. In these cases, the waste oil is temporarily stored in the vicinity of the electrical equipment where the oil is being changed. In some instances, the oil is stored outdoors, for example, at the C- and D-Site transformer yards and at the C-Site MG Building. Because of the great number of pieces of electrical equipment containing cooling oil at PPPL, the temporary satellite accumulation areas are established on average a few times a week, at differing locations throughout the site.

90-Day and 180-Day Accumulation Areas

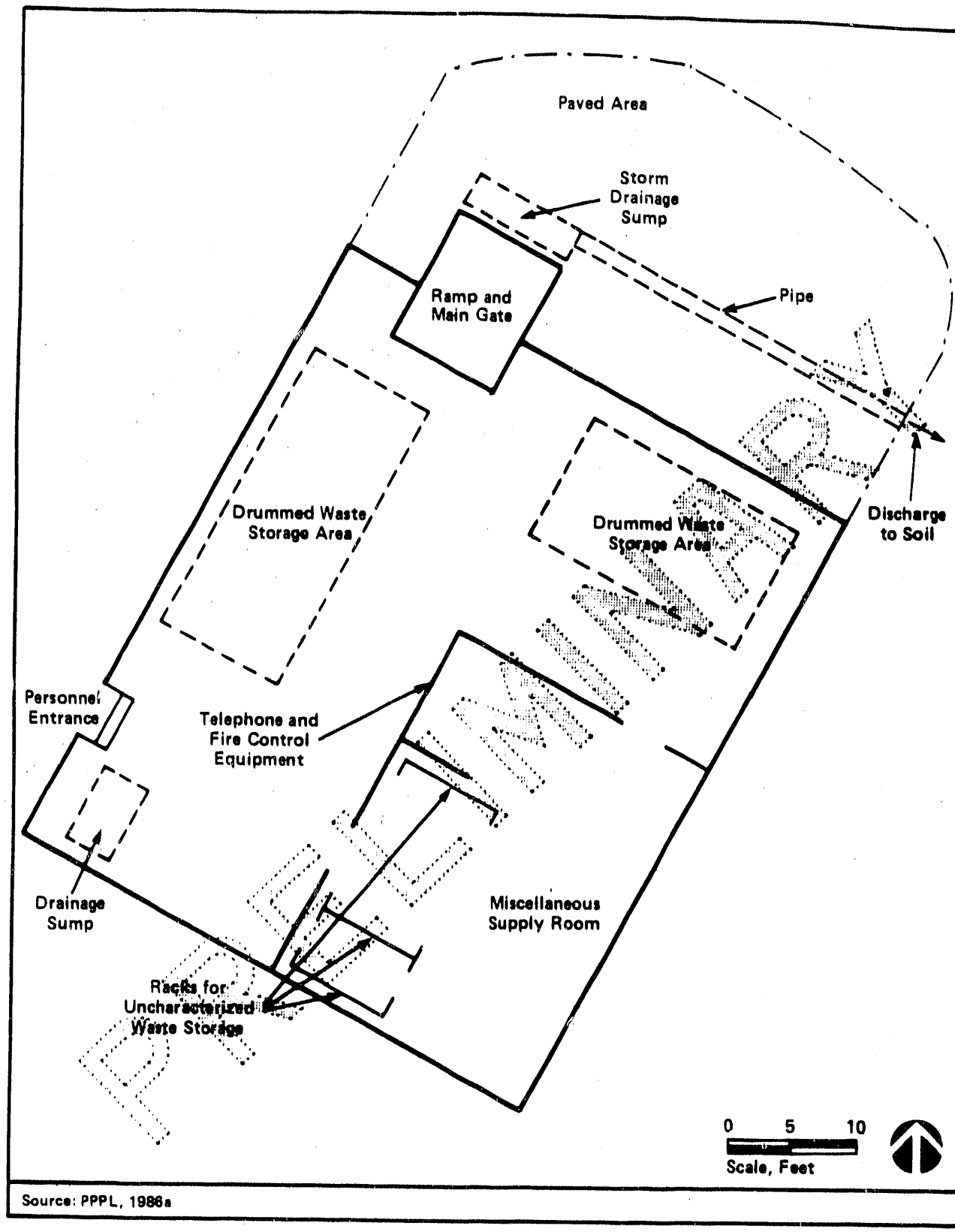
Once removed from the satellite accumulation areas at the C- and D-Sites, hazardous waste is transported to the Hazardous Material Control (HAZMAT) Building, a large fully-equipped area located near the southern tip of C- and D-Sites, which serves as a 90-day accumulation area (Structure C93 in Figure 2-4). Wastes generated at the 305-307 College Road facility are sent to a small-quantity generator 180-day accumulation area located in Room 193 at 307 College Road. All hazardous waste generated at PPPL is managed in these two facilities before it is disposed of off-site.

The HAZMAT Building has been in operation since November 1986. The facility includes a roofed, curbed, concrete pad with dimensions of 42 feet by 50 feet, surrounded by a chainlink fence and fiberglass panel walls (Figure 4-1) (PPPL,1986a). It has two entrances, including the ramped main entrance and a smaller personnel entrance. The main entrance, which is used to bring waste into the facility, has a steel grate and concrete storm drain underneath it which drains to the soil adjacent to the ramp. The entrances to the facility are normally kept locked. The facility is lighted and the Miscellaneous Supply Room is heated. The building is also equipped with fire control, spill control, and emergency communications equipment in accordance with RCRA standards for generators (40 CFR Part 262, Subpart C, and Part 265, Subpart C). The floor of the facility slopes downward to a 2-1/2 by 2-1/2 by 4-foot (approximately 190 gallons) closed sump in the western corner of the facility.

Most waste and empty containers are stored in a large L-shaped room that covers three-quarters of the facility. Hazardous waste is segregated into several categories, including acids, solvents, PCB-contaminated waste oils, other waste oils, unknown wastes, and mercury. The mercury is contained in high-voltage switches being stored for off-site reclamation. All other wastes in this room at the time of the Survey had been repackaged in fiber or steel drums, varying in size from 5 to 55 gallons. This room also contains spill control equipment, empty drums, and drum dollies.

The southern quadrant of the facility is a separate walled-off room used for administrative tasks associated with operation of the facility and storage of small amounts of equipment, some chemicals, and wastes. These materials include waste mercury being stored on shelves for off-site reclamation; unidentified wastes stored on shelves and awaiting results of analyses; suspected hazardous wastes identified only by trade name and stored on shelves and awaiting MSDS sheets; small containers of hazardous wastes awaiting recontainerization or labpacking; pumps; acids, bases, and solvents used to do crude analyses of unidentified wastes; cabinets and a refrigerator used to store these chemicals; drum covers; anticontamination clothing; other safety equipment; and miscellaneous supplies.

The small-quantity generator 180-day accumulation area at the 305-307 College Road facility is located in Room 193, by the rear loading dock at the northmost



Source: PPPL, 1986a

HAZARDOUS MATERIAL CONTROL BUILDING AT PPPL

FIGURE 4-1

northeast corner of the 307 College Road building. The accumulation area was temporary and had been in operation only a few months before the Survey. PPPL advised the Survey team that it was to be moved next door to Room 191 later in 1988. At the time of the Survey, no hazardous waste had yet been delivered to the accumulation area. PPPL expected that the facility would only receive potentially-hazardous-waste Versitech pigments. The facility consists of a flammable materials cabinet capable of holding two 55-gallon drums located in a concrete-floored room with approximate dimensions of 16 feet by 24 feet.

Hazardous Waste Management Procedures

Hazardous waste management at PPPL is described in two documents - Section 8.0 of the PPPL Health and Safety Manual (PPPL, 1982) and Policy and Procedure Number 1101.6 in Section 11.0 of the PPPL Policies and Procedures Manual (PPPL, 1985b). PPPL also produces an annual hazardous waste generator report, which is submitted to the NJDEP, that describes all regulated hazardous waste generated at PPPL.

All hazardous waste generated at PPPL is controlled by the generators and the MC staff. All hazardous wastes and suspected hazardous wastes are initially identified by the generators, which include laboratory supervisors, technicians, and scientists; shop supervisors; and facilities maintenance supervisors and staff. Once identified by the generator, the waste is segregated into its proper category [i.e., acid/aqueous, oil, solvents; mercury, listed wastes (typically unused or contaminated laboratory reagents), or printing/photographic chemicals] and is allowed to accumulate in the appropriate marked containers at satellite accumulation areas near the point of generation.

Hazardous waste accumulation containers are typically labeled as hazardous waste and are kept closed. Containers such as safety cans and drums of various sizes are provided by the MC Staff for hazardous waste accumulation.

Small quantities of potentially hazardous wastes (such as neutralized or diluted acids and bases that are generated in laboratories) are occasionally disposed of by generators by pouring them down laboratory sink drains. The potentially hazardous constituents present in these discharges are unknown. These discharges

are exempt from RCRA hazardous waste management regulations in accordance with 40 CFR 261.3(a)(2)(iv).

At the request of management, the MC staff, with the cooperation of other PPPL staff, occasionally performs a purge of certain laboratories or maintenance facilities to remove unused chemicals. The MC staff believed that cooperation of researchers and staff in rooting out such waste chemicals varied considerably. In particular, unidentified, old, or unusable potentially hazardous janitorial-type chemicals which are on-site reportedly are difficult for the MC staff to find and collect as waste.

As soon as the maximum allowable storage quantity (i.e., 55 gallons) has been exceeded at the satellite accumulation point, the generator fills out and attaches a Hazardous Waste Identification Card to each of the containers and calls the MC staff to schedule pickup of the waste. In many cases, the generator does this before the maximum allowable storage quantity is exceeded since storing a larger quantity of hazardous waste at the point of generation is considered inconvenient.

The Hazardous Waste Identification Card is a prenumbered, 3-copy card which has space for the generator to fill in his name, his supervisor's name, their phone numbers, a description of the waste, the type of container, the waste quantity, the location of the waste, and the hazard class of the waste (poison, flammable, corrosive, combustible, oxidizer, or reactive). One copy of the card remains with the waste, one copy is sent to the Hazardous Materials (i.e., Safety) Section, and the last copy is sent to another PPPL administrative office. The Survey noted that nowhere on the card is there space for the "accumulation start date," which corresponds to the date that the waste is removed from its point of generation.

Wastes will normally not be picked up without a Hazardous Waste Identification Card. However, occasionally the MC staff will fill out the card when an unknown waste is found and the generator is not known or is unavailable. The MC staff inputs all data on the cards into a computerized database that is used to track the waste while it is on-site and after it has been disposed of off-site.

At C- and D-Sites, the containers typically are picked up by a member of the MC staff within 48 hours of notification and are transported in a pickup truck to the

HAZMAT Building by the MC staff. Drum dollies and hoists are used to move drums to and from the truck.

The Survey observed two exceptions to the site-wide management of hazardous waste as described above. The first exception was a waste soil/cyclohexane mixture generated at the REML that is allowed to evaporate with the dry soil being disposed of on the ground behind the REML. The second exception was waste oily rags, which are generated at a number of locations on C- and D-Sites. At the time of the Survey, these rags were being managed and disposed of as nonhazardous solid waste.

At the HAZMAT Building, the waste containers are segregated into their appropriate categories. Small containers of solvents and oil are poured or pumped into drums. Spray cans of degreasing solvent are discharged into a solvent drum through a special drum cover designed to retain fumes. Listed wastes and acid wastes are accumulated on shelves until approximately one drum equivalent has been accumulated, at which time the wastes are lab packed in a drum. Full drums are stored both on pallets and directly on the floor of the facility. Inventories of the contents of each drum are maintained by the MC staff in the computerized database.

Unidentified wastes are sampled and analyzed by an off-site contractor, Inland Pollution Control Services, Incorporated (IPCS), so that they may be identified and appropriately segregated, packaged, and disposed of. IPCS visits PPPL at least once each week to perform this task. While awaiting sampling and analysis results, the unidentified wastes are stored on shelves. The MC staff also performs gross analyses of suspected hazardous wastes at the HAZMAT Building, including pH analyses and visual observations, in order to identify certain wastes or to help specify which analyses should be requested from IPCS.

Approximately two weeks before the Survey, the MC staff put into effect a policy of placing "accumulation start dates" on wastes only at the time that they were repackaged in the HAZMAT Building. Prior to that time, the policy was for accumulation start dates to be given to wastes as soon as they entered the building. The Survey team advised PPPL that the old policy, instead of the new one, corresponded to the generally accepted interpretations of New Jersey hazardous

waste regulations, and PPPL subsequently advised that they would immediately return to their old policy. PPPL did not store any wastes in excess of the 90-day limit as a result of the changed policy, according to the MC staff.

PPPL expects that the procedures used to manage hazardous wastes at the 305-307 College Road facility will be similar in most respects to those used at the C- and D-Sites. However, the 180-day accumulation area had not been put into operation and most procedures contained in the PPPL Health and Safety Manual (PPPL, 1982) and the PPPL Policies and Procedures Manual (PPPL, 1985b), although in effect, had not been implemented at the time of the Survey.

Off-Site Disposal

No hazardous waste is disposed of on-site at PPPL. All hazardous waste generated on-site at PPPL is eventually disposed of at RCRA-permitted TSD facilities or facilities approved by the NJDEP for treatment or disposal of hazardous waste oil.

At intervals that average once a month, all hazardous waste that has been drummed is prepared for shipment and is shipped off-site. Usually planning and preparations for the next shipment are underway only a few days after the previous shipment has left the site. The MC staff performs much of the packaging and paperwork associated with the off-site shipments, including labeling containers and preparing manifests. Labpacking is done by the hazardous waste shipment vendor.

Only RCRA-permitted hazardous waste transporters are used to transport waste from the site. The transporters and disposers used by PPPL between 1985 and 1987 are presented in Table 4-3. Table 4-1 presents the quantities of hazardous waste shipped off-site between 1985 and 1987, as discussed in Section 4.1.1.1. The MC Staff maintains file records of all PPPL waste generated and disposed of for at least 3 years.

TABLE 4-3

TRANSPORTERS AND DISPOSERS OF PPPL HAZARDOUS WASTE

Transporters	Years Used by PPPL		
	1987	1986	1985
NAPPI Trucking	X	X	
Waste Conversion, Inc.	X		
Disposal Systems, Inc.	X		X
D&J Transportation Specialists	X	X	X
Casie Enterprises/Protank	X	X	X
Hazardous Materials Environment Group	X		X
SCA Chemical Services, Inc.	X	X	X
Keystone Block Transportation	X		
S. D. Meyers, Inc.	X		
Inland Pollution Control Services, Inc.	X	X	X
Chicago Industrial Waste Haulers		X	
Applied Refinery Services		X	
S. J. Transportation			X
ABC Tank Co.			X
TSD Facilities			
Battery Disposal Technology, Clarence, NY	X		X
Waste Conversion, Inc., Hatfield, PA	X		
Environmental Waste Resources, Inc., Waterbury, CT	X	X	
Chemical Waste Management, Inc., Emelle, AL	X		X
Rezultz, Inc., Vineland, NJ	X	X	X
Environmental International Electrical Services, Inc., Kansas City, MO	X		
SCA Chemical Services, Inc., Model City, NY	X	X	X
S.D. Meyers, Inc., Tallmadge, OH	X		
Chemical Waste Management of New Jersey, Newark, NJ	X		
PCB, Inc., of Missouri, Kansas City, MO		X	X
Rollins Environmental Services, Inc., Bridgeport, NJ		X	X
SCA Chemical Services, Inc., Newark, NJ		X	X
Solvents Recovery Services, Linden, NJ			X
Ensco, El Dorado, AR			X
S & W Waste, Inc., South Kearny, NJ			X

Source: Lawson, 1986; Larson, 1987a; 1988a

4.1.2 General Description of Pollution Sources and Controls - Mixed Waste

4.1.2.1 Characteristics and Sources of Mixed Waste

PPPL currently generates mixed waste at two locations at C- and D-Site. No mixed waste is generated (and subsequently managed) at the 305-307 College Road facility.

At C-Site, the REML generates waste tritium-contaminated and suspect-tritium-contaminated scintillation fluids containing either xylene or toluene. Approximately 4,000 vials of these fluids have been generated in the last 2 years, each with a quantity of 15 to 25 milliliters.

At D-Site, an unspecified number of vacuum pumps, known as roughing pumps and turbomolecular pumps, generate waste pump oil that is potentially contaminated with tritium. Over the past 2 years, the pumps have generated several hundred gallons of waste oil, which has been analyzed for tritium; approximately 4 gallons of this oil has been found to be tritium-contaminated.

Another potentially hazardous mixed waste was generated at PPPL in 1987 during a one-time TFTR maintenance operation that included sanding and polishing graphite tiles from the TFTR. The resulting dust contained graphite and trace quantities of activated Extraction Procedure (EP) toxic metals (nickel and chromium). The dust was contained in the hood where the operation was performed and subsequently in a small vacuum and on rags. At the time of the Survey, the waste dust was being stored in a satellite accumulation area on the second floor of the D-Site PCPC Building. Since an EP toxicity test has not been performed on the dust, it is not known whether the levels of nickel and chromium are high enough to make the waste hazardous, or whether the waste should only be classified as nonhazardous radioactive waste.

From a radiological standpoint, all mixed waste generated at PPPL is classified as low-level. The above-mentioned wastes reportedly comprise the inventory of mixed waste generated at PPPL in its entire history.

4.1.2.2 Mixed Waste Management Procedures and Facilities

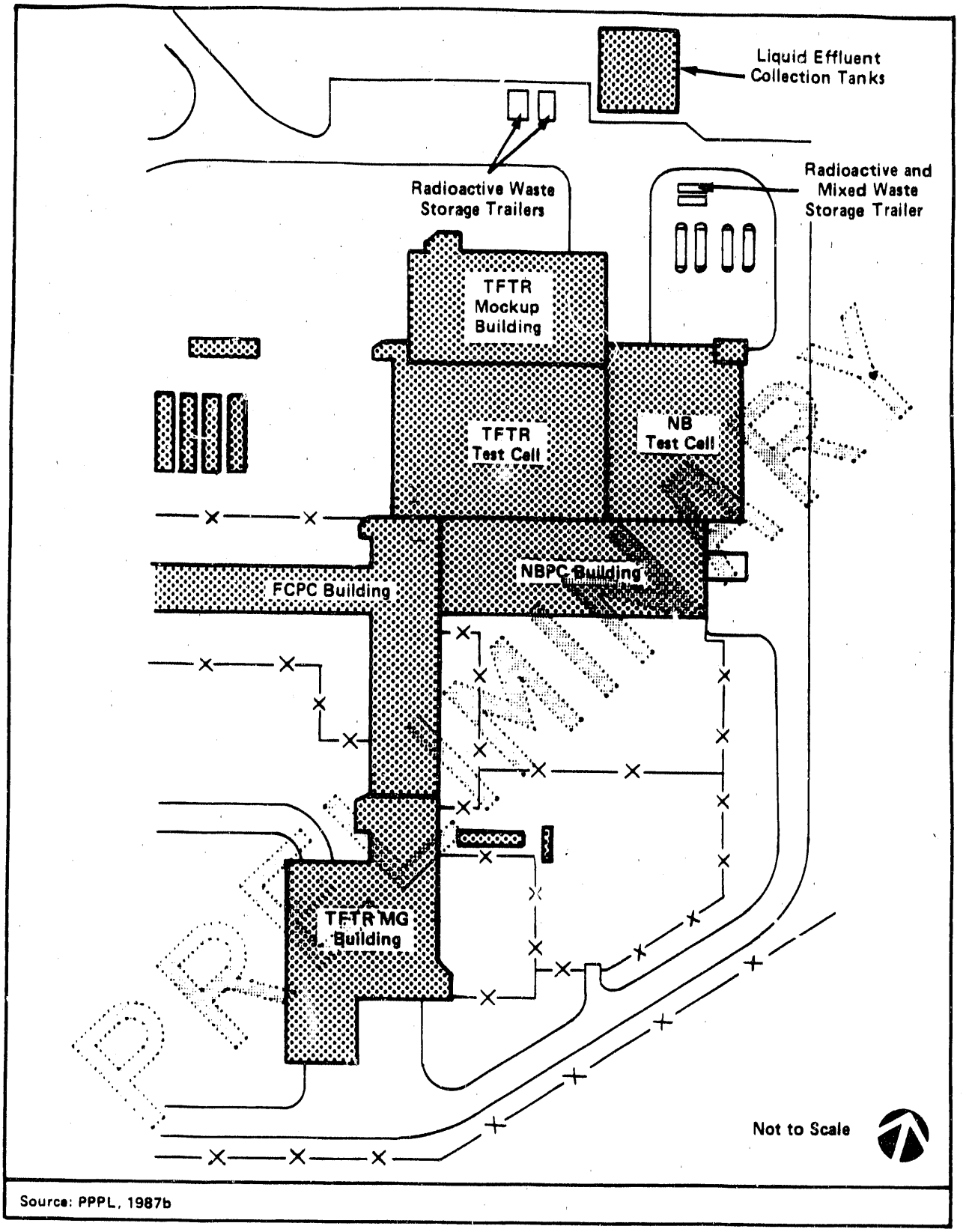
In general, mixed waste at PPPL is segregated from the hazardous waste stream. The policies and procedures used to manage mixed waste at PPPL are the same as those used to manage radioactive waste. These policies and procedures are stated in the PPPL Site Radioactive Waste Management Plan, found in Supplement 10.6 of the PPPL Health and Safety Manual (PPPL, 1984). The procedures and facilities used to manage hazardous waste, which are discussed in Section 4.1.1.2, are not routinely applied to the mixed waste stream. In particular, the MC staff, which controls and manages all PPPL hazardous waste, is not involved in the control and management of mixed waste, despite the hazardous component of the waste. Instead, the Health Physics (HP) staff manages all mixed waste.

At the REML on C-Site, the waste scintillation fluids are stored in their original vials on a countertop in one of the laboratory rooms. A few times each year, the vials are transported by the HP staff to a locked radioactive and mixed waste storage trailer located at D-Site north of the NB Test Cell (Figure 4-2). The trailer also contains non-waste radioactive materials and is not a RCRA-permitted storage facility.

At D-Site, the suspect-tritium-contaminated waste oil generated by the various pumps is collected in safety cans or drums by the HP staff and transported to the REML, where it is analyzed for tritium. If identified as nonradioactive, the oil is given a Hazardous Waste Identification Card and is managed as a hazardous waste; if identified as radioactively-contaminated, the oil is picked up by the HP staff and is transported to the above-mentioned radioactive and mixed waste storage trailer.

The contaminated scintillation fluids and waste pump oil have been stored for several months at the storage trailer north of the NB Test Cell. The vials and oil containers in the trailer have been labpacked in two drums which have been labeled as to their contents.

Although no mixed waste has ever been shipped from PPPL, PPPL was in the process of contracting a RCRA-permitted off-site disposal vendor to remove and properly dispose of the waste at the time of the Survey.



LOCATIONS OF RADIOACTIVE AND MIXED WASTE STORAGE TRAILERS AND LIQUID EFFLUENT COLLECTION TANKS

FIGURE 4-2

4.1.3 General Description of Pollution Sources and Controls - Radioactive Waste

4.1.3.1 Characteristics and Sources of Radioactive Waste

PPPL generates solid radioactive waste and suspected-radioactive liquid waste at the main C- and D-Sites only; no radioactive waste is generated and subsequently managed at the 305-307 College Road facility. Solid radioactive waste at PPPL consists of contaminated or internally activated equipment and suspect-contaminated trash including swipes, HEPA filters, gloves, anti-contamination clothing, and paper. The radioactive waste equipment is generated primarily at the TFTR where various equipment has been contaminated with tritium or has been activated from neutron radiation generated by the TFTR. The equipment is generated sporadically. The contaminated trash is generated in a constant stream both at the TFTR and at the REML. All radioactive waste currently generated on-site is classified as low-level waste. The isotopes of concern include radioactivated metals.

PPPL does not currently generate liquid radioactive waste other than the liquid mixed wastes described in Section 4.1.2. However, it does generate a quantity of suspect-contaminated wastewater. The water is generated from various process applications and from floor drains at the TFTR. The quantity of this wastewater generated is described in Section 3.3.2.2. To date, all suspect-contaminated wastewater has been confirmed to be below the PPPL-imposed limit of 3×10^5 pCi/L, which is 10 percent of the appropriate maximum permissible concentration for uncontrolled releases as stated in Chapter XI of DOE Order 5480.1A. The major isotope present is tritium, although various radioactivated corrosion products have a small potential of being created during deuterium-tritium operations, including chromium-51, copper-63, manganese-55, iron-54, nickel-58 and 60, and cobalt-60 as well as several others with shorter (less than 24 hours) half-lives (PPPL, 1984).

4.1.3.2 Radioactive Waste Management Procedures and Facilities

The policies and procedures for management of radioactive waste at PPPL are stated in the PPPL Site Radioactive Waste Management Plan, found in Supplement 10.6 of the PPPL Health and Safety Manual (PPPL, 1984).

Solid Radioactive Waste

Solid radioactive waste is controlled and managed by the HP staff and by the actual waste generators, who work closely with the HP staff. Radioactive and suspect-radioactive trash is stored at its point of generation in closed-top waste containers. Periodically, HP staff collects the waste in plastic bags and transports it to one of two radioactive waste storage trailers or to the previously described radioactive and mixed waste storage trailer (Figure 4-2). The bags are taped shut, labeled, and stored indefinitely in the trailers.

Radioactive equipment that is considered waste is transported by the HP staff to Room 110 in the TFTR Mockup Building, which serves as a radioactive waste staging area. Here it is sorted and labeled, and surface dose measurements are made. The measurements are recorded in a logbook that serves as an inventory of radioactive waste. If contaminated, the wastes are wrapped in plastic and are then stored temporarily in the room until it is convenient to transport them to one of the radioactive waste storage trailers north of the TFTR Mockup Building.

The only off-site shipment of solid radioactive waste consisted of 2 drums and 2 crates including approximately 52 cubic feet of waste containing 50 millicuries of activity. This shipment left the site on March 4, 1988, and was sent to the Hanford, Washington, low-level waste disposal site. The shipment included steel tiles, paper, cloth, plastic, glass, and ceramics (Couch, 1988). Isotopes of concern included cobalt-57 and 60, cesium-137 from a leaking calibration source, and natural thorium from a discarded iron gauge. Some of this waste was generated when PPPL vacated the A- and B-Sites in 1987. At that time, a boneyard at A-Site that contained radioactivated and contaminated scrap metal was cleared, as discussed in Section 4.5.1.2. Some of the scrap metal was determined by PPPL to be nonradioactive and was sold as scrap, as discussed in Section 4.3.2.3. PPPL made extensive measurements and calculations on these articles to determine that the levels of radioactivity were suitable for unrestricted release prior to selling it as scrap.

Liquid Suspect-Radioactive Waste

All liquid radioactive waste at PPPL is generated at the TFTR facility. The waste is piped through underground concrete-encased stainless steel pipes to the Liquid Effluent Collection Tanks (LECTs) located north of the TFTR Mockup Building, where it gradually accumulates. This facility, which is described in the Aboveground Tanks subsection of Section 4.2.1.6, includes three tanks with a total capacity of 45,000 gallons. Influent to the LECTs is periodically diverted from one tank to another at the discretion of the equipment operator. The tank contents are sampled and analyzed for radioactive content with a multi-channel analyzer and then, if below the $3x10^5$ pCi/L limit described in Section 4.1.3.1, are discharged to the sanitary sewer. Through the time of the Survey, all samples have been found to be below $3x10^5$ pCi/L and have been released. Should the limit be exceeded in the future, PPPL's contingency plans include temporarily storing the water to allow decay of short-lived radioactivated decay products until the levels are below the $3x10^5$ pCi/L limit, or if tank storage space is not available, to contract an off-site vendor to process and solidify the waste in drums.

4.1.4 General Description of Pollution Sources and Controls - Nonhazardous Waste

PPPL has performed no studies and keeps few records on most aspects of its nonhazardous waste; therefore the discussions in this section are based primarily on observations of the Survey team.

4.1.4.1 Characteristics and Sources of Nonhazardous Waste

Nonhazardous waste at PPPL is generated at both the main C- and D-Site facility and at the 305-307 College Road facility.

At 305-307 College Road, nonhazardous waste is generated in offices and in a printing shop. Wastes consist of paper, packing materials, and scrap wood. No information was available on the quantity of wastes generated; however, the quantity was extremely small in comparison to that generated at C- and D-Sites.

At C- and D-Sites, nonhazardous waste is generated in offices, machine and maintenance shops and facilities, and laboratories. Wastes consist of paper, packing materials, cafeteria waste, construction debris, scrap metal, glass bottles, and oily rags. No information was available on the quantity of waste generated, except as discussed in the following subsection.

4.1.4.2 Nonhazardous Waste Management Procedures and Facilities

At 305-307 College Road, nonhazardous waste is collected and disposed of off-site by an off-site contractor hired by the property manager. PPPL personnel typically have little involvement in management of the waste.

At C- and D-Sites, nonhazardous waste is accumulated in most generation locations in small open waste receptacles. PPPL Maintenance staff collects the waste either nightly or at longer intervals and transports it to any one of 30 small dumpsters located outdoors throughout the site. C-Site has fourteen 2-cubic-yard and ten 4-cubic-yard dumpsters, and D-Site has four 2-cubic-yard and two 4-cubic-yard dumpsters. Two of the dumpsters on C-Site are reserved for accumulation of recyclable scrap metal. In addition, PPPL maintains several larger (approximately 30 cubic yards) dumpsters throughout the site for accumulation of construction debris and large waste pieces (PPPL, 1987a).

All dumpsters are leased from off-site contractors who are responsible for removing the waste from the site and either disposing of it or recycling it. The 30 small dumpsters are leased from National Waste Disposal, Incorporated, of Trenton, New Jersey, who pick up the waste at least once each week. National Waste Disposal normally disposes of nonrecyclable wastes in either the Edgeboro Landfill in East Brunswick, New Jersey, or the G.R.O.W.S. Landfill in Morrisville, Pennsylvania. The larger 30-cubic yard dumpsters are owned and emptied off-site by another disposal contractor, Higgins, Incorporated.

4.1.5 Findings and Observations

4.1.5.1 Category I

None

4.1.5.2 Category II

1. Improper disposal of oily rags. Oily rags are disposed of at PPPL as a solid waste, which is not in accordance with the New Jersey hazardous waste regulations.

   Oily rags are generated at PPPL from various activities including metal working operations and automotive, fuel tank, motor, turbine, and transformer maintenance. Some of these rags are disposed of in the PPPL solid waste stream. This waste is then transported to a nonhazardous solid waste landfill. This practice does not conform to the New Jersey hazardous waste regulations [New Jersey Administrative Code, Title 7, Chapter 26, Sections 7.4(a), 8.1(a), and 8.13(b)], which define PPPL waste-oil-contaminated materials as hazardous wastes and which require that these materials be managed as a hazardous waste and treated or disposed of in a RCRA-permitted hazardous waste facility.

4.1.5.3 Category III

None

4.1.5.4 Category IV

1. Improper storage of mixed waste. Mixed waste generated at the REML and the TFTR is stored in an area which does not meet the requirements of a hazardous waste storage area as defined in the New Jersey hazardous waste regulations.

   The REML has generated approximately 60 liters of waste xylene-based, tritium-contaminated scintillation fluid, and the TFTR roughing and turbomolecular pumps have generated approximately 4 gallons of waste tritium-contaminated pump oil. These wastes have been removed from their points of generation and from the control of their generators and have been stored for longer than 90 days in the D-Site radioactive waste storage trailers. The trailers do not meet regulatory requirements for satellite storage areas,

90-day accumulation areas, or TSD facilities (New Jersey Administrative Code, Title 7, Chapter 26, Subchapter 9).

2. On-site treatment of hazardous waste without a permit. Small amounts of hazardous waste generated at the REML are treated on-site by evaporation without a RCRA treatment permit.

Over the last 2 years, the REML has generated 50 to 100 pounds of waste soil contaminated with approximately two gallons of cyclohexane. The soil/cyclohexane mixture is generated during an azeotropic distillation that removes moisture from environmental soil samples. After the distillation is complete and the mixture is allowed to cool in a laboratory hood, the soil/cyclohexane mixture is not disposed of within the site-wide hazardous waste management channels, but is instead evaporated in a hood in the REML, releasing the cyclohexane directly to the air. The remaining soil is disposed of on the ground northwest of the building. Evaporation of hazardous waste is a regulated treatment activity, and PPPL has not submitted a RCRA permit application for hazardous waste treatment to the NJDEP.

4.2 Toxic and Chemical Materials

This section discusses the usage, storage, disposal, and management of PCBs, mineral oil, asbestos, pesticides, herbicides, biocides, other toxic and chemical substances, and the possible environmental contamination resulting from release of these substances at PPPL. This section also discusses the storage of hazardous materials in aboveground tanks and underground storage tanks (USTs) and the possible environmental contamination associated with these tanks.

4.2.1 General Description of Pollution Sources and Controls

Because PPPL is primarily dedicated to the development of fusion power and laser research, most of the equipment is electrically, magnetically, or mechanically oriented. Solvents, oils, poisons, and corrosives are generally used in relatively small quantities in the laboratories, for cleaning and water treatment. Transformers and capacitors, which contain mineral oil and in some cases PCBs, comprise the largest use of hazardous materials at PPPL.

4.2.1.1 Polychlorinated Biphenyls and Mineral Oil

PPPL maintains several thousand pieces of equipment that contain PCB oil or mineral oil. PCB oil is a regulated toxic substance under the Toxic Substances Control Act (TSCA), whereas mineral oil is not. Therefore, this discussion is mainly oriented toward PCBs. Nonetheless, waste mineral oil as well as waste PCB oil and all other waste oils are recognized as hazardous by NJDEP; their management is discussed in Section 4.1.1.

The Survey counted 16 PCB transformers [PCB content greater than 500 parts per million (ppm)], 2 PCB-contaminated transformers (PCB content between 50 ppm and 500 ppm), and approximately 2400 PCB capacitors currently on-site and in use at PPPL. The PCB transformers and capacitors are listed in Table 4-4 and their locations are shown in Figure 4-3.

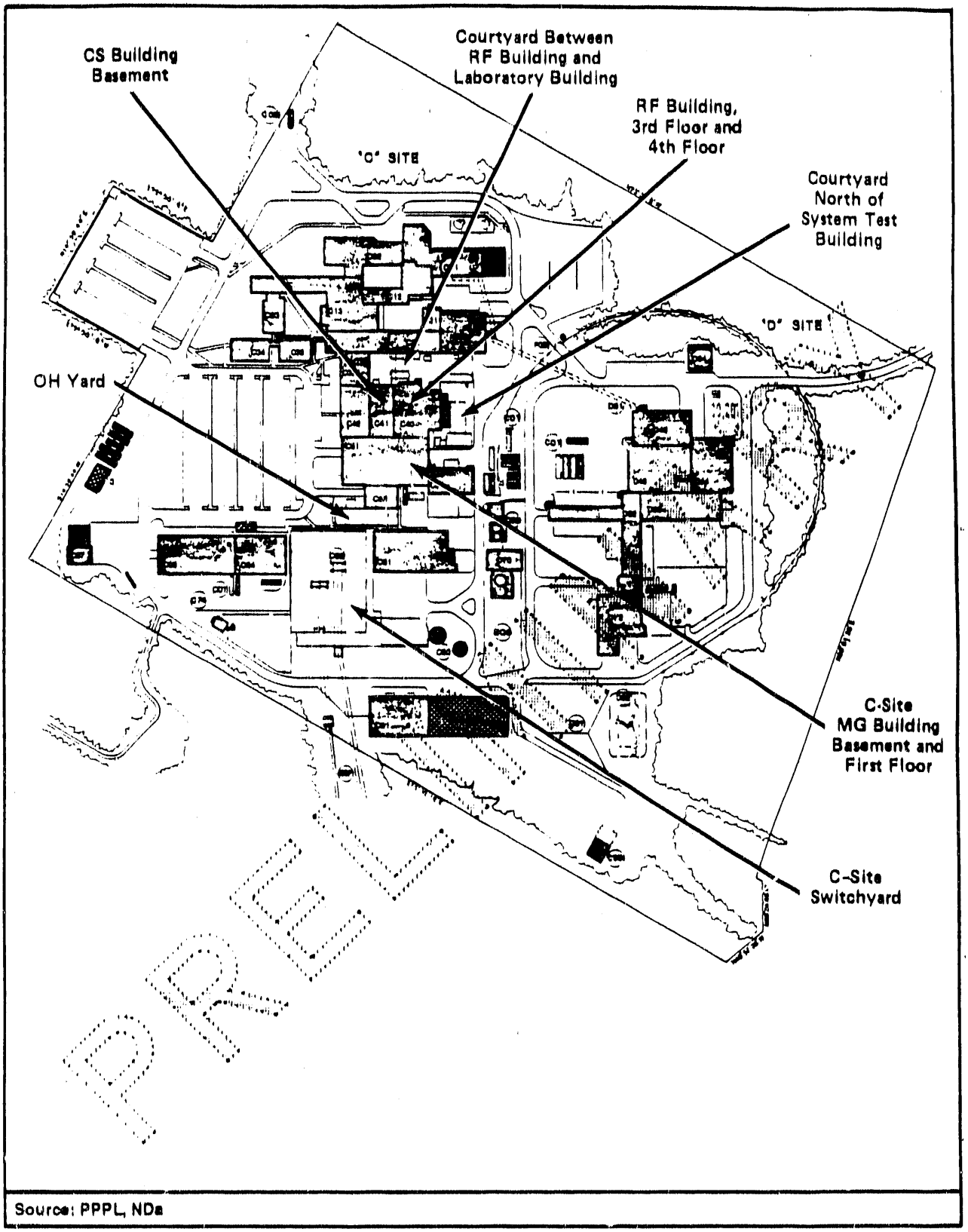
PPPL maintains an inventory of PCB equipment. However, the Survey identified PCB capacitors in the Rectifier Yard in the courtyard between the RF and Laboratory Buildings that were not listed on the inventory as well as a transformer on the

TABLE 4-4

PPPL PCB INVENTORY, JUNE 1988

Equipment Type	Location	Size (gallons)	PCB Concentration (ppm)	Comments
Transformers (3)	C-Site MG Bldg, basement	1080 (total)	100%	Not all access doors marked
Transformers (4)	C-Site MG Bldg, 1st floor	1331 (total)	100%	Not all access doors marked
Transformer	C-Site Switchyard, north end	unknown	50	No secondary containment
Transformer	C-Site Switchyard, north end	unknown	300	No secondary containment
Transformer	C-Site Switchyard, north end	unknown	800	No secondary containment
Transformer	C-Site Switchyard, north end	unknown	850	No secondary containment
Transformer	C-Site OH Yard, east end	345	100%	No secondary containment
Transformer	C-Site RF Bldg, 4th floor	360	100%	Removed 11/23/87 but still on current inventory during Survey (6/88)
Transformers (3)	C-Site, courtyard between RF Bldg and Laboratory Bldg	1129 (total)	100%	Not all access gates marked; transformer located adjacent to trash dumpster; combustibles stored within 5 meters
Transformers (3)	C-Site, courtyard north of System Test Bldg	987 (total)	100%	Not all access gates marked; combustibles stored within 5 meters
Capacitors (32)	C-Site MG Bldg, basement	96 (total)	100%	Not all access doors marked
Capacitor Bank	C-Site MG Bldg, 1st floor	10	100%	Not all access doors marked
Capacitor Bank	C-Site MG Bldg, 1st floor	5	100%	Not all access doors marked
Capacitors (2000)	C-Site OH Yard	6000 (total)	100%	No secondary containment; 2 capacitors weeping; not all capacitors marked
Capacitors (216)	C-Site Switchyard, east side	648 (total)	100%	No secondary containment
Capacitors (18)	C-Site Switchyard, east side	54 (total)	100%	No secondary containment
Capacitors (10)	C-Site RF Bldg, 3rd floor	30 (total)	100%	Not all access doors marked
Capacitors (38)	C-Site CS Bldg, basement	114 (total)	100%	
Capacitors (108)	C-Site, courtyard between RF Bldg and Laboratory Bldg	28 (total)	Not measured, but reportedly 100%	Inactive; not on current inventory; no secondary containment; capacitors and access gates not marked; combustibles stored within 5 meters.

Source: PPPL, NDa



LOCATIONS OF PCB AND PCB-CONTAMINATED EQUIPMENT AT PPPL

FIGURE 4-3

fourth floor of the RF Building and capacitors that were on the list but were no longer present at the site. Of the 108 capacitors in the Rectifier Yard, 24 contain an estimated 1 gallon each of PCB oil of unknown concentration; these 24 are to be disposed of. The remaining 84 capacitors (21 in each of 4 rectifiers) contain approximately 6 ounces of PCB oil and are on-line but not currently in service due to renovations required as a result of a fire in one of the rectifier windings. The fire did not affect the PCB capacitors. The PCB content of these capacitors has not been measured but site personnel indicated that they are probably 100 percent PCB.

PPPL uses an outside contractor, MET Electric, to perform quarterly inspections of all PCB transformers in accordance with TSCA requirements. Records of these inspections are maintained by the Occupational Safety Branch of the Health and Safety Office, and include information on unit location, date of inspection, name of inspector, and observations.

The PPPL PCB Interim Measures Program in the PPPL SPCC Plan (Section 4.2.1.7) for C- and D-Sites addresses the management of PCBs (Chimiel, 1984). The program described in the SPCC Plan addresses the inspection, repair of leaks, and recordkeeping of all regulated PCB equipment. Visual inspections are required at least once every three months; leaks resulting in any PCBs running off or about to run off the equipment must be serviced within 2 days of the leak being observed; and records are to include information on location, date of inspection, name of inspector, history of leaks and repairs, and disposition of all cleanup materials. The SPCC Plan also addresses spill control procedures as they relate to both PCB and mineral oil equipment.

PCB inventory and disposal are handled by the Material Control Group. Disposal of waste mineral oil also is handled by the Material Control Group. Both waste PCBs and waste mineral oil are disposed of off-site as hazardous wastes by permitted disposal contractors, as described in Section 4.1.1.

PPPL began a program to phase out PCBs in 1982. The program includes off-site disposal of PCB equipment in storage, refilling and reclassification of some large PCB transformers in use, and phased off-site disposal of other PCB equipment in use. Available records since 1984 indicate that PPPL had 15 PCB transformers, 6,005 large capacitors, and an unknown number of small capacitors (less than 3 pounds of fluid

each) at the beginning of 1984. Since that time, 2,172 large and small capacitors and 10 transformers have been either disposed of off-site or reclassified from PCB to non-PCB (PCB content less than 50 ppm) or PCB-contaminated (Stencel, 1985a, 1986, 1987b, 1988a). PPPL intends to have all PCB transformers either reclassified or disposed of by 1991 or 1992. However, other PCB equipment (e.g., capacitors) will remain on-site and in use for an indefinite period after that date.

As part of the Survey, all PCB transformers were inspected for compliance with TSCA requirements and good management practices, including labeling, placarding, secondary containment, clearance, and overall condition. Many mineral oil transformers and mineral oil and PCB capacitors also were inspected. Leaks and weeps were identified at two PCB capacitors in the OH Yard and nine mineral oil transformers, eight in the C-Site Switchyard and one in the courtyard north of the System Test Building. Some mineral oil transformers that were leaking persistently had been equipped with drip pans to capture the leaking oil. Other PCB and mineral oil transformers were not equipped with any secondary containment, including secondary containment, and some access doors and gates and some pieces of equipment containing PCBs were not marked in accordance with TSCA requirements (Table 4-4). Other observations included an operating PCB transformer and PCB capacitors surrounded by combustible materials, operating PCB and mineral oil transformers located next to a large trash dumpster, and improper storage of inactive PCB capacitors (Table 4-4). Additionally, operations of transformer yard and switchyard sump pumps may result in discharges of transformer oils to the site's stormwater management system, as described in Section 3.3.2.1.

4.2.1.2 Asbestos

Very little asbestos is currently used at PPPL, and historical usage was limited to some insulation on pipe elbows, tees, bends, and in transite building walls. The Survey noted no exposed friable asbestos on-site.

The only significant asbestos exposed to the environment is the transite on the outside walls of the C-Site CS Building. In 1985, these walls were sprayed with a silicone-based paint to seal and protect the transite from weathering. In addition, the C-Site MG and RF Buildings contain transite wall panels and other older C-Site

buildings have asbestos insulation on various pipe fixtures that is not friable, and asbestos-containing brake pads are used in generators in the TFTR MG Building.

All asbestos removal is subcontracted to private licensed removal firms. Their work is tracked to final burial in approved landfills out of state. The Industrial Hygiene Group maintains disposal records of all projects. The records indicated that 11 asbestos removal projects had been performed at PPPL during the 5 years preceding the Survey, all of which occurred after November 1986 (Stencel, 1988e). A description of these projects is presented in Table 4-5. No ongoing asbestos removal projects were occurring during the Survey.

Typically, asbestos removed from PPPL buildings has been stored temporarily in a wooden shed outside the Hazardous Material Control Building and then shipped to the Edgeboro landfill. However, that landfill, which is within the same county as PPPL, no longer accepts asbestos. New Jersey state law requires that asbestos waste be (1) disposed of in the county of origin or (2) shipped out of state. Therefore, future renovation will follow the guidelines in the Health and Safety Procedures section of "Asbestos Removal Practices and Procedures," and ultimate disposal will be directed to the IMS Landfill in Clarksville, West Virginia (PPPL, NDb).

4.2.1.3 Pesticides, Herbicides, and Biocides

All pesticides and herbicides at PPPL are applied by outside contractors designated by Princeton University. Because the land at the Forrestal Campus is leased by PPPL from Princeton University, outdoor pesticide and herbicide applications at the site have traditionally been the responsibility of the University. However, in late 1987, PPPL became responsible for outdoor applications although no applications have been made since then. PPPL indicated to the Survey that the same contractors previously used by the University will be contracted by PPPL. Table 4-6 presents the types and quantities of pesticides and herbicides applied at the Forrestal Campus, according to PPPL records. No large quantities of pesticides are currently stored at PPPL.

Algicides and similar biocides are used in low concentrations in the C- and D-Site Cooling Towers to control fouling and inhibit slime growth. The concentrated products are stored in the two pump houses serving the cooling towers. The Survey

TABLE 4-5

DEMOLITION OR RENOVATION PROJECTS INVOLVING FRIABLE ASBESTOS COMPLETED IN THE LAST 5 YEARS

5/3/88	Removal of 6' of 20"diameter transite pipe in excavation between C-Site MG and Maintenance Building. Project performed by private, state-licensed contractor. No PPPL employees involved
4/14/88	Vacuumed loose debris in Laboratory Equipment Room. Asbestos insulation present on overhead pipes
1/16/88	Removed 4' x 8' section of transite wall in C-Site MG Building
10/28/87	Cut 14" x 6" opening in transite wall, RF Building, Room 109
10/5/87	Removed one elbow, 2" pipe from C-Site shop equipment room
9/9/87	Removed four 2-1/2" OD elbows, LOB A121 Conference Room
7/10/87	Removed one pipe elbow, Receiving #3
7/10/87	Enlarged transite wall opening from 8" to 10" diam., C-Site MG Building, SW corner of Battery Room
6/10/87	Drilled three 1" diam. holes through transite wall, C-Site, RF Room 109
6/5/87	Removed approximately eight elbows, four valves 2-1/2" OD, LOB A101, 103, 105
11/14/86	Removed two 4' x 9' transite panels, C128, C129, LOB Wing

Source: Stencel, 1988e

TABLE 4-6

PESTICIDE AND HERBICIDE USE AT FPPL, 1984 - PRESENT

Year	Substance	Quantity	Location
1984	Pesticide: Sevin	600 gallons	B-Site
	Herbicide: Karmex	40 pounds	C- and D-Sites
	Herbicide: Pramitol 25EC	1357.5 gallons (diluted)	A-, B-, C-, and D-Sites
	Herbicide: Roundup & Betasan 4E	4 gallons	C- and D-Sites
	Herbicide: Embark	1.25 gallons	C- and D-Sites
	Herbicide: 2,4-D	3 gallons	C- and D-Sites
1985	Herbicide: Pendimethain	356 pounds	B-Site
	Herbicide: Trimec	3 gallons (concentrated)	B- and C-Sites
	Herbicide: Princep Caliber 98	40 pounds	C- and D-Sites
	Herbicide: Princep Caliber 90	40 pounds	C- and D-Sites
	Herbicide: Roundup	3 gallons	C- and D-Sites
	Herbicide: Hyvar XL	2 gallons (concentrated)	C- and D-Sites
	Herbicide: Pramitol 25EC	45 gallons (concentrated)	C- and D-Sites
	Herbicide: Amitrol 25E	2.5 ounces	B-Site
	Herbicide: Ammate, 2E	0.5 gallon	C- and D-Sites
1986	Herbicide: Balan	500 pounds	C-Site
	Herbicide: Arsenal	4.35 quarts (concentrated)	A-, B-, C-, and D-Sites
	Herbicide: Spike 80W	30 pounds	C- and D-Sites
	Herbicide: Roundup	2.25 gallons	C-Site
	Herbicide: Princep Caliber 90	10 pounds	C-Site
1987	Herbicide: Roundup & Surflan AS	2.5 gallons (concentrated)	A-, C-, and D-Sites
	Herbicide: Arsenal, (Cyanamid)	3 gallons (concentrated)	A-, B-, C-, and D-Sites
	Herbicide: Trimec	0.5 gallon (concentrated)	D-Site

Source: Stencel, 1985a, 1986, 1987b, 1988a

observed several drums of these caustic and toxic chemicals stored with various acids and solvents in the C- and D-Site Cooling Tower Pump Houses.

4.2.1.4 Toxic and Process Chemicals

Most of the laboratories at PPPL focus on electronic, magnetic, and laser experiments. As a result of these research activities, chemicals are typically used in small quantities.

All chemicals ordered for use at PPPL are required to be ordered through an internal PPPL procedure, Health and Safety Directive 5029, implemented in 1985 (PPPL, 1985c). The procedure requires the requisitioner to fill out a chemical material review sheet listing the specific hazards and protective measures pertinent to the intended use. The sheet is sent to Procurement, which logs in and assigns a sequential serial number to the order and processes the review sheet, forwarding it to the Occupational Safety Branch, which then must approve the order. When the product arrives at Receiving, a Material Safety Data Sheet (MSDS) is obtained from the vendor and follows the chemical through its storage and use cycle at PPPL. New products are not released from Receiving unless an MSDS accompanies the shipment or is already on file with the user. Both loading and unloading of chemicals at Receiving No. 3 and No. 4 take place on the asphalt loading dock on the south side of the building. Drainage from this area is to a storm drain that discharges to an unnamed tributary south of PPPL.

Reordering of chemicals requires the requisitioner to forward a copy of the previously approved Form 5029-1 to Procurement with the requisition marked "Re-Order-No Changes"; this includes quantity, use, and supplier information. If any of the conditions have changed from the initial order, a new Form 5029-1 must be processed.

This procedure was being observed primarily by the facility operations and maintenance staffs at PPPL. Chemicals such as degreasers and cooling tower corrosion inhibitors and biocides, which are used by these personnel, comprised the majority of chemicals listed (approximately 25 to 30 chemicals total) in the 5029 file. The file contained forms for chemicals which were ordered between mid-1986 and mid-1988.

Chemicals used directly in laboratory research, such as research-grade solvents and reagents, typically are not accounted for in the 5029 file. These chemicals usually are not purchased through PPPL procurement channels, but instead are purchased by researchers directly from outside chemical supply vendors, usually associated with Princeton University.

PPPL does not maintain a current chemical inventory list, but a file and a database of MSDSs are maintained by the Industrial Hygiene Group on all chemicals including both trade name and chemical name substances. The MSDS database contained approximately 1500 substances at the time of the Survey (PPPL, 1988d). The database includes both substances that are currently on-site and substances that have been on-site in the past. The MSDSs are provided by researchers and other staff when new chemicals are received.

When disposal of chemicals is required, the Material Control group is contacted. The chemicals are transported to the Hazardous Material Control Building and unloaded on the asphalt driveway. Runoff from the driveway is directed to adjacent soil. Once inside, the chemicals are stored before being labpacked and shipped by a licensed disposal contractor to a permitted disposal facility, as discussed in Section 4.1.1.

Most chemical reagents are stored in cabinets or shelves at their point of use. Process chemicals, solvents, lubricating oils, and water treatment chemicals are ordered continuously to minimize quantities stored on-site. The Survey noted some instances where incompatible chemicals are being stored together, including a 20-gallon drum of sulfuric acid stored next to several 20- and 30-gallon plastic drums of caustic corrosion inhibitors and solvents at the D-Site Cooling Tower Pump House; 15 gallons of acid stored with caustics, degreasers, and biocides at the C-Site Cooling Tower Pump House; and thirteen 20-gallon drums of hydrochloric acid stored with five 55-gallon drums of liquid caustic at the C-Site MG Building courtyard. Also, acids, biocides and corrosion inhibitors at the C- and D-Site Cooling Tower Pump Houses and the Maintenance Building Boiler Room, and solvents and oils behind the RESA Building were being stored without secondary containment.

4.2.1.5 Lead Bricks

PPPL uses and stores an unspecified number of lead bricks in several locations at C- and D-Sites. The bricks are used on-site for radioactive shielding. The Survey observed lead bricks being stored outdoors and exposed to the elements at the paved lot on the north side of the TFTR Mockup Building, the east side of the NBPC Building, and the storage yard south of the Receiving Buildings.

4.2.1.6 Petroleum Product and Hazardous Substance Storage Tanks

This section describes the locations, age, and design of all aboveground and underground tanks at PPPL, and UST leak testing and monitoring.

Aboveground Storage Tanks

PPPL has three active aboveground tanks, known as Liquid Effluent Collection Tanks (LECTs), situated in a covered, open-sided structure at the north end of D-Site (Figure 4-2). These tanks receive process wastewater and floor drain effluents from the TFTR buildings and release them to the sanitary sewer, as discussed in Sections 3.3.2.2 and 4.1.3. These wastewaters may contain trace tritium contamination or trace concentrations of radioactive corrosion products (PPPL, 1984).

Each of the three tanks holds 15,000 gallons, is constructed of stainless steel, is insulated, and is located on a curbed concrete pad constructed to retain the entire contents of all three tanks in the event of a leak or structural failure of the tanks. The underground piping leading to the tanks is concrete-encased. The aboveground piping in the vicinity of the tanks is contained within the curbed area and is either insulated or wrapped with electrical heat tape to help prevent freezing during cold weather. The tanks are equipped with a mixing pump and a valve and piping system to allow circulation of individual or collective tank contents and transfer of waste between tanks. Each of the tanks is equipped with a sampling valve. The tanks were installed in 1984. A summary of releases from the tanks to the sanitary sewer since 1986 is discussed in Section 3.3.2.2.

Underground Storage Tanks

PPPL currently has 11 USTs at C- and D-Sites. The identification number, size, age, status, contents, construction, and leak-testing history for each of these tanks are presented in Table 4-7. Figure 4-4 presents the locations of each of these tanks.

PPPL has submitted an Underground Storage Tank Registration Questionnaire and annual certifications of tank status to the NJDEP as required by the New Jersey Underground Storage Tanks Law of 1986 (Rossi, 1986; Mix, 1988).

The 11 tanks consist of:

- 3 active boiler fuel USTs;
- 3 active vehicle fuel USTs;
- 2 emergency diesel generator USTs;
- 1 emergency dump tank for the TFTR flywheel bearing lubrication oil; and
- 2 abandoned USTs.

The three 30,000-gallon boiler fuel USTs (E1, E6, and E7) are operated by the boiler staff. The tanks have internal floats to determine the fuel level. The float gauges are checked daily when the boiler is burning fuel oil from the tanks. The tanks were cleaned and changed over from number 6 heating oil to number 4 heating oil in November 1987 (Larson, 1987b). Since November 1987, the boilers have had the option of operating with natural gas instead of fuel oil, and when the boilers are burning gas, the tank float gauges are not regularly monitored. The fuel choice of oil or gas is determined by fuel costs, and the changeover between fuels has only occurred once, in November 1987. The primary purpose of monitoring the gauges is not for leak detection but for monitoring fuel oil usage. If the operator believes that a float reading is incorrect, the fuel level will be measured manually with a dipstick. This may occur if the float becomes stuck and may occur once a year at most. It is unlikely that this method of inventorying would be able to detect small leaks in the tanks.

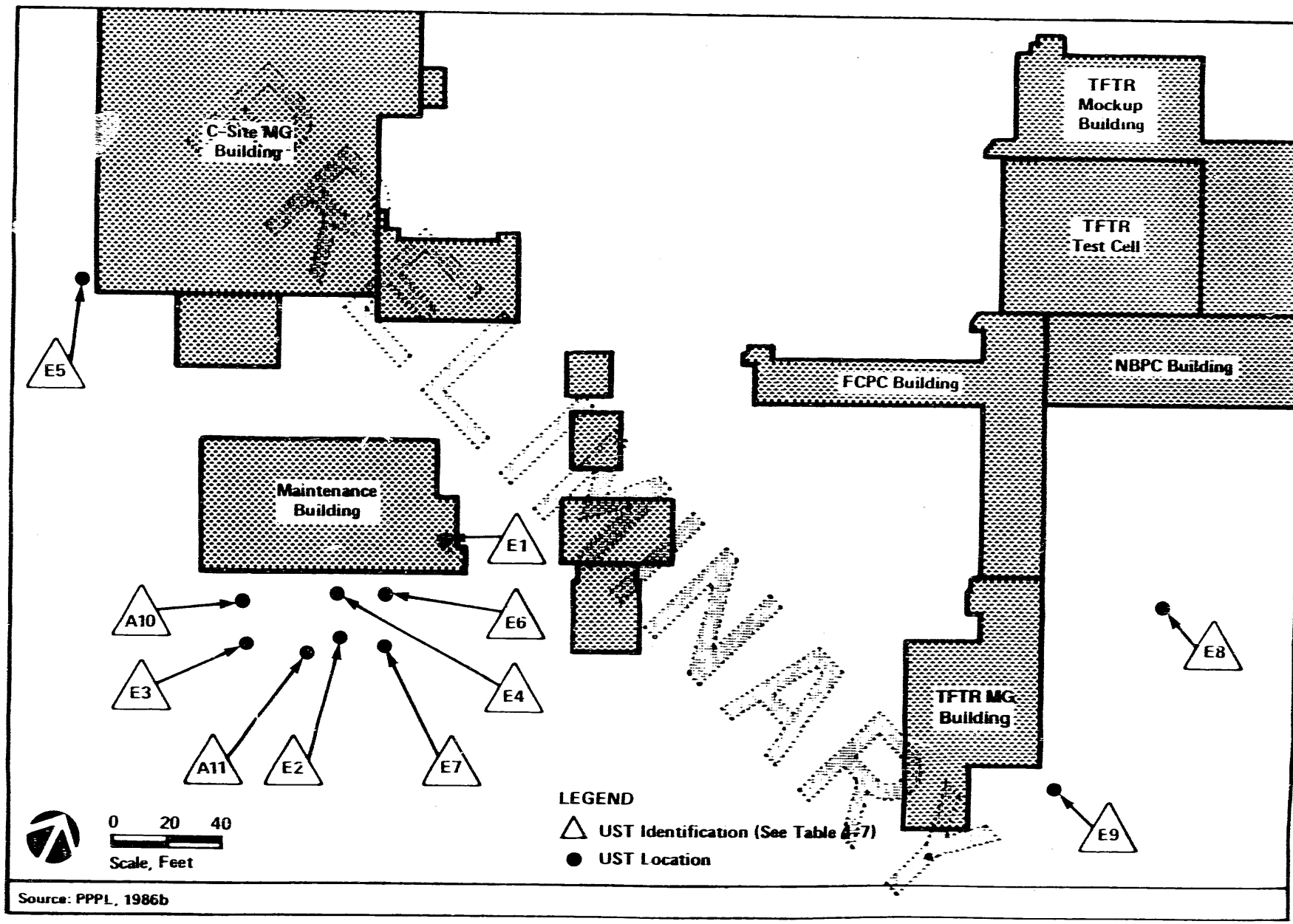
The three vehicle fuel USTs (E2, E3, and E4), which are operated by the maintenance staff, also are equipped with internal floats and gauges to determine fuel level. In

TABLE 4-7

UNDERGROUND STORAGE TANKS AT PPPL C- AND D-SITES

Tank Identification	Status	Reported Age (years in 1988)	Size (gallons)	Current Contents	Previous Contents	Construction		Internal Lining	Secondary Containment	Cathodic Protection		Comments
						Tank	Piping			Tank	Piping	
E1	operating	30	30,000	No. 4 diesel	No. 6 diesel	carbon steel	carbon steel	none	none	unknown	unknown	Failed leak test in 1983; leaking gasket replaced. Passed leak test in 1988.
E2	operating	7	8,000	unleaded gas	same	carbon steel	carbon steel	none	none	sacrificial anode	unknown	Passed leak test in 1983.
E3	operating	27	1,000	unleaded gas	same	carbon steel	carbon steel	none	none	unknown	unknown	Passed leak test in 1983.
E4	operating	7	8,000	No. 2 diesel	same	carbon steel	carbon steel	none	none	sacrificial anode	unknown	Passed leak test in 1983.
E5	operating	3	1,000	No. 2 diesel	same	fiberglass reinforced plastic	carbon steel	none	none	none	none	Never leak-tested. Replaced in 1984.
E6	operating	9	30,000	No. 4 diesel	No. 6 diesel	painted asphaltic steel	carbon steel	none	none	impressed current	unknown	E6 and E7 share some of the same fill piping. A single hydrostatic leak test of E6 and E7 was performed in 1983 using the shared piping. Test failure was attributed to a leaking gasket at the top of E6. E6 is currently operated at less than full to avoid leaks. Neither tank was ever retested.
E7	operating	9	30,000	No. 4 diesel	No. 6 diesel	painted asphaltic steel	carbon steel	none	none	impressed current	unknown	
E8	operating	9	15,000	No. 2 diesel	same	painted asphaltic steel	carbon steel	none	none	sacrificial anode	unknown	Never leak-tested.
E9	operating (emergency standby)	9	8,000	empty	waste oil & water	carbon steel	carbon steel	none	none	sacrificial anode	unknown	Never leak-tested.
A10	abandoned (filled and sealed)	unknown (less than 30)	4,000	none	No. 2 diesel	unknown	unknown	unknown	unknown	unknown	unknown	Cleaned and filled with concrete and sand, November 1984
A11	abandoned (filled and sealed)	27	1,000	none	No. 2 diesel	carbon steel	unknown	unknown	unknown	unknown	unknown	Cleaned and filled with concrete and sand, November 1984

Source: Semel, 1984; Hunter Environmental Services, 1988; Stecky and Fumia, 1983; Rossi, 1986



LOCATIONS OF UNDERGROUND STORAGE TANKS AT PPPL

FIGURE 4-4

addition, the tanks have effluent meters. Once each week, the readings from the effluent meter and float gauge on each tank are compared with manual dipstick readings. This inventorying is intended primarily to monitor fuel usage and not to detect potential leaks. At the time of the Survey, no measurement differences had been detected that had not been attributed by the operators to circumstances other than leakage (e.g., temperature fluctuations).

The C-Site and D-Site emergency diesel generator fuel USTs (E5 and E8, respectively) are operated by the C-Site and D-Site MG staffs, respectively. Since these tanks are drawn from only occasionally, such as during power outages, drills, and periodic maintenance, the fuel level does not change regularly. Both of the tanks are checked with a dipstick monthly, and the D-Site tank is equipped with an internal float and digital meter which is checked weekly. Up until the time of the Survey, no measurement differences had been detected that were attributable by the operator to a leak.

The TFTR flywheel emergency dump UST (E9) is currently kept empty and is available for emergency use only. However, in the past the tank also had additional uses. When the tank was installed in 1982, approximately 2,000 gallons of a waste water/oil (reportedly on the order of 99 percent water) mixture was generated in welding and brazing activities and these liquids were disposed of in the tank. In addition, small quantities (one-half to one gallon) of waste oil were regularly disposed of in the tank from regular maintenance of the flywheel bearing. This practice continued until 1987, when it was stopped in response to a DOE Environmental Appraisal advising that the tank was not permitted for waste oil storage. The tank was emptied and steam-cleaned in February 1988, generating approximately 2,200 gallons of waste which was subsequently handled within the normal sitewide hazardous waste management channels, described in Section 4.1.1. The tank has been empty since that time (Larson, 1988b; Guy, 1988).

Two USTs (A10 and A11) were abandoned in place in November 1984. Both are located southeast of the Maintenance Building and were used to store diesel fuel. During abandonment, all diesel fuel was vacuumed out and the tanks were thoroughly washed with water and a nonhazardous oil emulsifier-type cleaner. The 5,000 gallons of wash liquid was transported to a licensed TSD facility. The tanks

were then filled with a concrete/sand slurry mixture and fill spouts and caps were removed (Semel, 1984).

Underground Storage Tank Leak Testing and Monitoring

Of the 11 on-site USTs, PPPL leak-tested the 7 active USTs (E1, E2, E3, E4, E6, E7, and A10) located in the vicinity of the C-Site Maintenance Building in 1983 using Petro-Tite and Standpipe testing methods (Sisco, 1983; Stecky and Fumia, 1983). In response to the testing results, PPPL abandoned one tank (A10), repaired another (E1), and currently operates a third (E6) at less than full. Tank E1 passed a retest in January 1988 (Hunter Environmental Services, 1988).

The remaining four on-site USTs (E5, E8, E9, and A11) have never been leak-tested. However, in preparation for the 1983 testing, PPPL examined the C-Site emergency diesel tank (E5) and found it to be in poor condition. Because of its age, condition, and the cost of cleaning, which would have been necessary prior to testing, PPPL decided to replace this tank with the existing E5 tank rather than test it. No petroleum odor or stained soil were observed when the tank was excavated. PPPL has delayed any other leak testing until the release of new EPA regulations, which were expected to be promulgated during 1988.

No soil or groundwater monitoring has ever been performed in conjunction with any of the 11 on-site USTs.

4.2.1.7 Spill Prevention, Control, and Countermeasures

PPPL has an SPCC Plan (Chmiel, 1984), which includes information on operating and training procedures, requirements for liquid-containing equipment and vehicles, liquid transfer activities, and spill prevention and control equipment; and procedures and responsibilities for spill response. The Laboratory also has a formalized procedure (OP-EP-03) detailing environmental spill control procedures and responsibilities (Tompkins, 1987).

4.2.2 Findings and Observations

4.2.2.1 Category I

None

4.2.2.2 Category II

1. Improper storage of PCB transformer and capacitors. Combustible materials are stored within 5 meters of a PCB transformer and capacitors contrary to TSCA regulations, 40 CFR 761.30(a)(1)(viii), at Substation 13 in the courtyard north of the System Test Building and in the Rectifier Yard in the courtyard between the RF Building and the Laboratory Building.

   Wood boards, paper, and plastic trash are placed in dumpsters located less than 5 meters from a PCB transformer in Substation 13 in the courtyard north of the System Test Building. Also, wood boards and plywood panels are located next to PCB capacitors in the Rectifier Yard, and a pushcart filled with combustibles was found outside but within 5 meters of a PCB rectifier.

2. Leaks and weeps from several PCB capacitors and mineral oil transformers. Minor leaks and weeps were noted in two PCB capacitors and nine mineral oil transformers.

   During the Survey, the following minor leaks and weeps were noted:

   - At the OH Yard, two PCB capacitors are weeping at the seals; these units are scheduled for immediate removal;
   - In the C-Site Switchyard, four large mineral oil transformers have created small stains on their concrete pads;
   - In the same location, four additional mineral oil transformers have minor leaks at the sample valves as a result of recent maintenance and sampling; and

- At Substation 13 in the courtyard north of the System Test Building, an inactive mineral oil transformer is slowly leaking onto the asphalt and has created a 3-square-foot stained area.

As a result of inadequate secondary containment, as described in Section 4.2.2.3, Finding 1, and the operations of transformer yard and switchyard sump pumps, as described in Section 3.3.4.3, Findings 1 and 2, leaking fluid from these transformers may be carried by surface water runoff to various storm drains or pumped from the sumps. In both cases, the flow would lead to the Detention Basin or the unnamed tributary south of the site, potentially contaminating Bee Brook and the groundwater beneath PPPL, as also described in Section 3.3.4.3, Findings 1 and 2.

4.2.2.3 Category III

1. Lack of adequate spill containment of PCB and mineral oil-containing transformers, capacitors, and rectifiers. Some PCB and mineral oil-containing transformers, capacitors, and rectifiers do not have adequate spill containment and, in the event of a release, PCBs and mineral oil could contaminate the soil, surface water, sediment, and groundwater.

Units without adequate spill containment include the following:

- The C-Site Switchyard, which contains crushed limestone reportedly underlain with a clay liner of unknown design and permeability;
- The active PCB capacitors at the OH Capacitor Yard, which are surrounded by an 8-inch layer of stone riprap over soil;
- PCB capacitors at the Rectifier Yard in the courtyard between the RF Building and the Laboratory Building, situated on an asphalt driveway with no curbing;

- PCB capacitors and transformers at Substation 16 between the C-Site MG Building and the Maintenance Building, located on concrete pads surrounded by stone underlain by soil; and

- Mineral oil transformer at Substation 13 in the courtyard north of the System Test Building, which is set on an asphalt drive and surrounded by an asphalt dike of inadequate height.

As a result of inadequate containment, a PCB oil release may contaminate the soil around or underneath the transformers and capacitors. Contaminants could migrate down through the soil column toward the groundwater. Also, during storms, or in the event of a major release, contaminants could migrate to nearby storm drains which lead to the PPPL Detention Basin or the unnamed tributary south of the site. The basin and the tributary both discharge to Bee Brook and to the groundwater beneath the site. Therefore, uncontained releases could result in surface water, sediment, and groundwater contamination (Section 3.3.4.3, Findings 1 and 2 and Section 4.2.2.2, Finding 2).

4.2.2.4 Category IV

1. Storage of inactive PCB capacitors in violation of TSCA regulations. Inactive PCB capacitors awaiting disposal in the Rectifier Yard in the courtyard between the RF Building and the Laboratory Building are not being stored in compliance with TSCA regulations [40 CFR 761.65(b)].

   Twenty-four inactive PCB capacitors awaiting disposal, each containing an estimated 1 gallon of PCB oil, are being stored at the Rectifier Yard in the courtyard between the RF and Laboratory Buildings. The storage area does not have a containment curb, roof, or walls as required by TSCA regulations for storage of PCB equipment awaiting disposal.

2. Lack of proper marking of some PCB equipment and PCB transformer access ways. Some PCB transformer access ways and PCB capacitors and rectifiers are not labeled in accordance with TSCA regulations (40 CFR 761.40), and some

access ways to PCB capacitors and rectifiers are not marked in accordance with good management practice.

During the Survey, it was noted that PCB capacitors at the OH Yard and the Rectifier Yard were not labeled as containing PCBs. In addition, the following entrances leading to areas containing PCB transformers, capacitors, and rectifiers were not marked:

- The screened access door or enclosure adjacent to the capacitor bank and the secondary screened access door on the northwest inside area of the RF Building;
- The five doors leading to the TFTR MG Building;
- The access area to PCB Transformer Substations 14 and 15 in the courtyard north of the System Test Building. (Although an emergency action data sheet is posted at each of these substations, they do not conform to TSCA placarding requirements);
- The access area to Substation 16 between the C-Site MG Building and the Maintenance Building; and
- The entrance to and the fence surrounding the Rectifier Yard between the RF Building and the Laboratory Building.

TSCA regulations require that specific warning labels be posted on all means of access to an area containing PCB transformers, as well as on all PCB equipment. In addition, good management practice dictates that similar posting be provided on all means of access to all types of PCB equipment.

3. Potential accidental rupture of transformers. Operations associated with trash dumpsters located adjacent to PCB and mineral-oil containing transformers at Substation 13 in the courtyard north of the System Test Building may result in accidental rupture of a transformer and subsequent release of oil to the storm sewers.

Dumpsters are situated within 5 feet of PCB and mineral-oil transformers at Substation 13. During emptying, the dumpster could be set upon or dropped through the substation enclosure, rupturing the transformers and releasing oils into a storm sewer approximately 50 feet away. The storm sewer leads to the Detention Basin, which subsequently discharges to Bee Brook and the groundwater beneath PPPL. The transformers do not have secondary containment (Section 4.2.2.3, Finding 1). During the Survey, it appeared that the fence separating the transformers and dumpster had been damaged by a dumpster.

4. Incomplete PCB equipment inventory. The PCB equipment inventory list is not current as required by TSCA regulations [40 CFR 761.30(a)(1)(vii)].

   Discussions with PPPL personnel indicate that a transformer and some capacitors on the existing PCB equipment inventory list, which was prepared according to TSCA regulations, are no longer present at the Laboratory. Also, the Survey observed that PCB capacitors within the Rectifier Yard between the RF Building and the Laboratory Building are not on the list. The Laboratory is presently updating the list.

5. Improper storage of incompatible materials. Incompatible acids, bases, and organic solvents are being stored close together within the C-Site and D-Site Cooling Tower Pump Houses, and exterior to and east of the C-Site MG Building.

   Examples of incompatible materials storage observed during the Survey include:

   - At the D-Site Cooling Tower Pump House, a 20-gallon plastic drum of sulfuric acid is stored next to several 20- and 30-gallon plastic drums of caustic corrosion inhibitors and solvents such as methylene chloride;

   - At the C-Site Cooling Tower Pump House, 5 gallons of hydrochloric acid and approximately 10 gallons of sulfuric acid are stored with Betz Entec caustic corrosion inhibitors, degreasers, and biocides

including 35- and 55-gallon plastic drums and carboys of OTROL-W and X Betz 365, 321, 354, 735, 725, 356, 369, and 340; and

- At the C-Site MG Building courtyard, thirteen 140-pound net weight (20-gallon) drums of hydrochloric acid are stored with five 55-gallon plastic drums of liquid caustic in an outside chain-link fence enclosure. The area is unprotected from weather and has no containment.

In the unlikely event of a release, a mixture of the incompatible substances could release toxic or explosive gases.

6. Improper storage of acids, solvents, oils, biocides, and corrosion inhibitors. Improper storage of acids, solvents, oils, biocides, and corrosion inhibitors at the C-Site and D-Site Cooling Tower Pump Houses, the Maintenance Building Boiler Room, and behind the RESA Building may lead to soil, surface-water, and groundwater contamination.

   During the Survey, it was noted that bulk liquid chemicals within the Pump Houses and the boiler room were in proximity to floor drains leading to the sanitary and storm sewer systems, respectively, and had no secondary containment. Accidental release could result in indoor contamination and contamination of the sanitary sewer lines, the Detention Basin and subsequently Bee Brook and the groundwater beneath PPPL.

   During the Survey, 7 drums of solvents and oils were also found in an unprotected area behind the RESA Building. All drums were placed on the soil without spill containment. One 35-gallon drum of solvent was found venting as a result of heat expansion. Although the drums' integrity appeared good and there was no evidence of soil contamination in proximity to the drums, deterioration and accidental release could cause localized soil contamination.

7. Improper storage of lead bricks and plate shielding. Lead bricks and plate shielding at PPPL are being stored outside in various unprotected locations, and weathering of this material could result in localized soil contamination.

Notable examples of lead being stored unprotected and uncontained include the paved lot on the north side of the TFTR Mockup Building, the east side of the NBPC Building, and the storage yard south of the Receiving Buildings.

8. Inadequate spill containment at the Hazardous Material Control Building. There is inadequate containment on the driveway at the Hazardous Material Control Building and, in the event of a spill, adjacent soil may become contaminated.

   Hazardous material transfer operations occur on the asphalt driveway of the Hazardous Material Control Building. Drainage from this area flows directly to the soil on the east side of the driveway or indirectly through a drain to the same area of soil (Figure 4-1). There was no evidence of releases on the driveway or the adjacent soil. However, in the event of a spill, hazardous materials could follow these flow pathways, resulting in contamination of the soil. PPPL presently has plans to rectify this situation by constructing curbing around the driveway and placing a 600-gallon collection sump at the drain outlet and driveway low point.

9. Inadequate spill containment at Receiving No. 3. Inadequate spill containment at the loading dock of Receiving No. 3, where hazardous chemical products are loaded and unloaded, could result in surface-water and sediment contamination in the event of a release.

   Hazardous chemical products are delivered to and distributed from Receiving No. 3. Loading and unloading of these materials occur on the asphalt loading dock on the south side of the building. Drainage from this area flows to a storm drain approximately 100 feet from the loading dock. The storm drain discharges directly to a surface drainage that flows into Bee Brook. There was no evidence of releases in the loading dock area. However, in the event of a spill, hazardous materials could follow this flow pathway, resulting in contamination of surface water and sediment.

4.3 Radiation

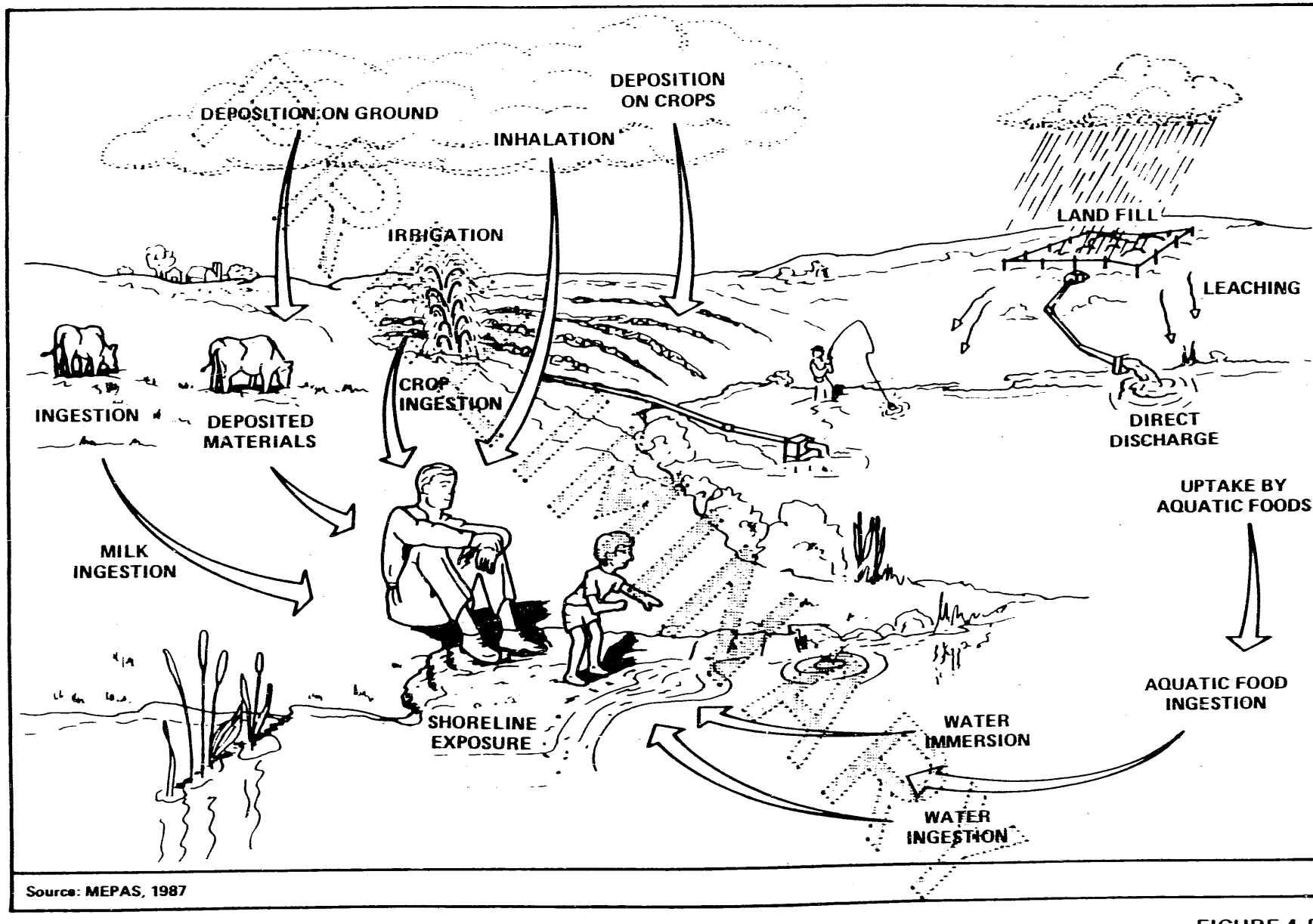
This section discusses the actual or potential radiological impacts to the environment from PPPL's past and present operations. Radionuclides can be transported via any or all of the primary media and result in contamination of ambient air, soils, drinking water, surface water, groundwater, vegetation, and food (Figure 4-5).

4.3.1 Background Environmental Information

Background radiation in the vicinity of PPPL is a consequence of both natural and man-made sources. These sources include natural cosmic radiation, both gamma and neutron; natural radioactive materials in soils and building materials; fallout from past global atmospheric weapons detonations; and releases of radioactive materials from nuclear power plants and other facilities handling radioactive materials worldwide. Human exposure to these sources is through the intake of natural and man-made radioactive materials in air, drinking water, and food. The most significant exposure is that to the lungs from background levels of radon. The annual average effective dose equivalent (EDE) from natural background radiation in the United States is approximately 189 millirem/year (mrem/yr) (Table 4-8). About one-half of the EDE is attributable to the inhalation of naturally occurring radon-222 and its decay products.

The data in Table 4-8 were derived in accordance with the approach recommended by the International Commission on Radiological Protection (ICRP) in ICRP Reports 26 and 30 (ICRP, 1977, 1978). This approach allows direct comparison of the effective dose for different organs by reflecting the distribution of and organ sensitivity to various radionuclides. This is accomplished by applying "weighting factors" to the effective doses received by individual organs. The weighting factors are expressed as the fraction of the total risk for the entire body attributable to the organ (e.g., EDE).

The U.S. Environmental Protection Agency (EPA) reports on a quarterly basis ambient gamma exposure rates, including those from natural cosmic radiation, for selected locations throughout the continental United States. These ambient gamma exposure rates do not measure the contribution attributable to the



Source: MEPAS, 1987

TRANSPORT/EXPOSURE SCENARIOS

FIGURE 4-5

TABLE 4-8

AVERAGE ANNUAL EFFECTIVE DOSE EQUIVALENT TO HUMANS FROM NATURAL BACKGROUND RADIATION

Organ	Annual Effective Dose Equivalent (mrem)
Gonads	24
Breast	14
Lung (Total)	100
Red Bone Marrow	13
Bone Surfaces	6
Thyroid	3
Other	29
Total	189

Source: Adapted from EPA, 1986c

inhalation of naturally occurring radon-222 and its decay products. The latest available data are for the 12-month period from April 1986 to March 1987. For this period, the EPA reported ambient gamma exposure rates equivalent to annual doses of between 136 ± 58 mrem dose equivalent (DE) in Denver, Colorado, and 58 ± 72 mrem DE in Berkeley, California. The annual dose for the same period was 110 ± 37 mrem DE in Trenton, New Jersey, the EPA monitoring location closest to PPPL. The average measured ambient gamma exposure rate equivalent to an annual dose at the 22 locations monitored throughout the continental United States was 89 ± 49 mrem DE (EPA, 1986d, 1987a, b, c).

DOE establishes radiation protection guidelines for its facilities. Radiation standards for the protection of the public in the vicinity of PPPL are given in DOE Order 5480.1A, Chapter XI, as amended on August 5, 1985 (Vaughan, 1985). These standards are based on the recommendations of the ICRP and the National Council on Radiation Protection and Measurements (NCRP). The amended order also includes the EPA limits for the atmospheric pathway radiation dose received from DOE facilities as contained in 40 CFR 61, Subpart H. The DOE dose limit is 100 mrem/yr EDE, excluding natural background and medical exposures, for all pathways to any member of the general public for a prolonged exposure from normal DOE operations. The previously recommended limit of 500 mrem/yr EDE is retained for non-continuous exposures. In addition, as stated in EPA regulations (40 CFR 61, Subpart H), any member of the general public shall not receive a radiation dose from the air pathway of greater than 25 mrem/yr DE to the whole body or 75 mrem/yr DE to any organ from normal DOE operations.

DOE Order 5484.1 requires its facilities to make an annual assessment of releases and potential dose to the public. The results are to be reported in an annual environmental summary or annual environmental monitoring report.

4.3.2 General Description of Pollution Sources and Controls

Direct penetrating radiation sources and controls and the release of radioactivated materials for unrestricted use are discussed in this section. The radioactive sources and controls in specific media that do not result in significant direct penetrating radiation measurements are discussed in Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2.

The major sources of direct penetrating radiation at PPPL can be divided into two categories. These categories are operation of the fusion energy research devices and use of calibration sources as discussed in Sections 4.3.2.1 and 4.3.2.2, respectively. Release of radioactivated material to the general public for unrestricted use is discussed in Section 4.3.2.3.

4.3.2.1 Operation of the Fusion Energy Research Devices

In a fusion reaction, the nuclei or central cores of light atoms combine or fuse together; when they do, energy is released. In a sense, fusion is the opposite of fission, the process utilized in existing nuclear power plants in which energy is released when a heavy nucleus splits into smaller pieces.

The lightest atom, hydrogen, is the easiest one to use for fusion. Hydrogen has three forms, or isotopes; two of them--deuterium (D) and tritium (T)--in combination work the best in fusion reactions, although D-D fusion reactions are also used. The fusion reaction produces a heavier nucleus (helium), other particles such as neutrons, and kinetic energy which can be converted to heat. The heat can, in turn, be used to make steam to drive a turbine to generate electricity.

But a fusion reaction cannot occur unless certain conditions are met. To fuse hydrogen nuclei together, the nuclei must be heated to approximately 100 million degrees Celsius (C). At these temperatures, matter exists as plasma, a state in which atoms are broken down into electrons and nuclei. Keeping a plasma hot enough for a long enough period of time, and effectively confining it, are crucial for generating fusion power. While no solid container can withstand the heat of a plasma, magnetic fields may be able to confine a plasma successfully.

The plasma confinement scheme initially studied by PPPL was one that used a toroidal, or donut-shaped, solenoid to produce the magnetic field. However, it was realized very early that a simple toroidal field would not work. The field had to be twisted so that the lines of magnetic force spiraled around the donut. At PPPL this was accomplished initially by twisting the solenoid into a "figure-eight" shape. In the Union of Soviet Socialist Republics (USSR) a system was developed in which the spiraling was accomplished with a toroidal solenoid by producing an electric current in the plasma itself. This device, first announced in 1968, is called the Tokamak, an

acronym formed from the Russian names standing for Toroidal Chamber Machine (Liverman, 1975).

PPPL currently utilizes two large tokamak devices for research in fusion energy, the Tokamak Fusion Test Reactor (TFTR) and the Princeton Beta Experiment-Modification (PBX-M) (Buildings D43 and C41, respectively, in Figure 2-4). Other devices utilized in the past but currently mothballed include the Princeton Large Torus (PLT) and the Spheromak (S-1). The PLT and S-1 are not discussed since they are no longer in operation.

TFTR

The TFTR currently utilizes deuterium (D) for both components of the plasma. The neutrons produced by the D-D reaction are of relatively low energy and tritium occurs only as a reaction product. The D-D reaction is being conducted to study effects of reaction products on the plasma and walls, neutron diagnostic techniques, the effectiveness of the device shielding, the effectiveness of the closed vacuum-tritium gathering system, and plasma heating techniques (Liverman, 1975). This information will aid in conversion to the D-T reaction operations, which are presently scheduled for 1992.

Operation of the TFTR produces two forms of direct penetrating radiation -- bremsstrahlung X-rays and neutrons. Bremsstrahlung X-rays are the results of the electrons in the plasma striking internal hardware at the end of a pulse. These X-rays, in the range of 0 to 20 Megaelectron volts (MeV), also produce photoneutrons. The neutrons are a product of the D-D reaction (Stencel, 1988a).

Controls employed at PPPL for this source of direct penetrating radiation are primarily shielding, monitoring, and distance of the TFTR from the site boundary. The other generally accepted direct penetrating radiation control method, reducing the time of exposure, is used to limit occupational and visitor exposures. Exposure time is controlled administratively, by posting radiation areas that exceed 2.5 milliroentgens per hour (mR/hr) and by prohibiting access in the TFTR test cell area during operation with interlocked key capture control systems.

Other radiation associated with TFTR operations is the release of tritium, produced by the D-D reaction, and/or the radioactivation of air, soil, TFTR component cooling water, and groundwater. Radioactivation occurs when neutrons interact with an isotope of an element and convert the isotope to one that is radioactive. However, operations of the TFTR using deuterium for both components of the plasma do not produce a high enough neutron flux for many neutrons to penetrate the shielding and measurably radioactivate surrounding soil or groundwater.

PBX-M

The PBX-M uses deuterium (D) for both components of the plasma and is used to study the effects of highly shaped plasmas on beta values, which is the ratio of plasma density to magnetic field pressure. Operation of the PBX-M also produces direct penetrating radiation in the forms of Bremsstrahlung X-rays and neutrons (Stencel and Parsells, 1988).

Controls employed at PPPL for this source of direct penetrating radiation are primarily shielding, monitoring, and distance of the PBX-M from the site boundary. The other generally accepted direct penetrating radiation control method, reducing the time of exposure, is used to limit occupational and visitor exposures. Exposure time is controlled administratively, by posting radiation areas that exceed 2.5 mR/hr and by prohibiting access in the PBX-M test cell area during operation with interlocked key capture control systems.

There are no other radiation concerns associated with PBX-M operations due to the low neutron and Bremsstrahlung X-ray radiation fluxes from the device. However, standard health physics procedures of radiation survey checks and wipe tests continue to be performed to verify that there are no radiation problems.

4.3.2.2 Use of Calibration Sources

The Health Physics Branch of Project and Operational Safety maintains an inventory of approximately 250 radioactive sources. These sources are used to calibrate radiation detection equipment. The largest are two 6-curie tritium sources; a 1-curie plutonium/beryllium (Pu/Be) and a 19.5-curie Pu/Be source; and a 130-curie cesium-137 source, with the remainder having activities in the nanocurie to

millicurie range. The sources are located in shielded, limited-access areas. Distance from the site boundary and shielding prevent off-site direct penetrating radiation resulting from the use of these calibration sources. Personnel exposure is administratively controlled by limiting access time when the calibration sources are in use.

4.3.2.3 Release of Radioactivated Material to the General Public for Unrestricted Use

PPPL releases materials to the general public via scrap dealers and other channels. According to interviews with site personnel, this practice occurred only once, after the July 1987 TFTR shutdown. Knowing that operations at PPPL can produce materials that are radioactivated (i.e., contain induced radioactivity), PPPL has a procedure and criteria for releasing material for unrestricted use. PPPL TFTR Operations Procedure OP-AD-7 states:

> *This procedure establishes the requirements for monitoring of potentially radioactivated material created by TFTR operations, preventing the spread of contamination, and the removal of the material to a storage location for safe keeping or disposal. This procedure is a general policy statement on minimum requirements for handling activated components resulting from machine operations. . .*
>
> *. . . Any material found to be contaminated will be appropriately contained before leaving the survey area to ensure that the spread of any contamination is minimized. As a minimum, the item should be placed in a plastic bag . . .*
>
> *. . . All radioactivated materials shall be placed in the radioactive materials storage area (hereinafter designated as RMSA) designated by the Test Cell Manager and approved by Health Physics. No materials can be removed from this area without the consent of the Test Cell Manager and Health Physics. An approved procedure will also be required by the individual removing the materials to ensure proper subsequent handling. The RMSA will be located within the D-site complex.*

To determine if a material is radioactive, PPPL uses Section 10.0 of the Health and Safety Manual (PPPL, 1986d), which states:

> *As a practical definition of radioactivity, materials shall be considered radioactive if the count rate on contact with any surface is greater than two times natural background as measured in a low background area with a Geiger-Mueller (GM) pancake survey meter.*
>
> *The radiation from some radioactive materials (e.g., tritium or alpha emitters) must be measured using special survey instruments or techniques.*
>
> *Except for the special cases in the above paragraph, material measured to be less than twice background on contact with any surface may be considered non-radioactive. Such material may be handled, used or disposed of without restriction.*

Review of PPPL's standard operation for releasing material for unrestricted use revealed the following:

1. There is no written procedure on how the radiation screening of the material is to be performed. Since there was no written procedure, a review of the procedure was performed by interviews with site personnel on how they conduct the radiation screening.

2. The procedures as described by interviews with site personnel and alluded to in TETR Operations Procedure OP-AD-7 and Section 10.0 of the Health and Safety Manual include the following:

   a. The entire surface of the material is screened.

   b. The probe is to be in contact with the surface of the material during the screening.

   c. The screening procedure can only be performed by Health Physics personnel.

d. If external contamination is a possibility, the material must also be smeared and counted for tritium and alpha activity.

e. Gamma spectroscopy is performed on geometry-specific material to obtain radioisotopic results.

f. Geometry-specific calculations are made using the screening and gamma spectroscopy results to determine the theoretical activity per gram of the material.

g. All results of the screening procedure are documented in logbooks, which were reviewed. Information included date, survey meter used, date the survey meter was last calibrated, results of the screening, disposition of the material, and person who performed the screening.

3. Training records are maintained, establishing that individuals who perform the screenings are qualified.

4. There is written documentation tracking the materials released through this procedure.

5. There is a quality assurance (QA) program covering this screening program.

6. Federal or state agency approval of the radiation screening procedures or release criteria has not been sought.

Interviews with site personnel indicated that the practice of releasing material that has been determined to be nonradioactive for unrestricted use, using the procedure described above, will continue in the future.

4.3.3 Environmental Monitoring Program

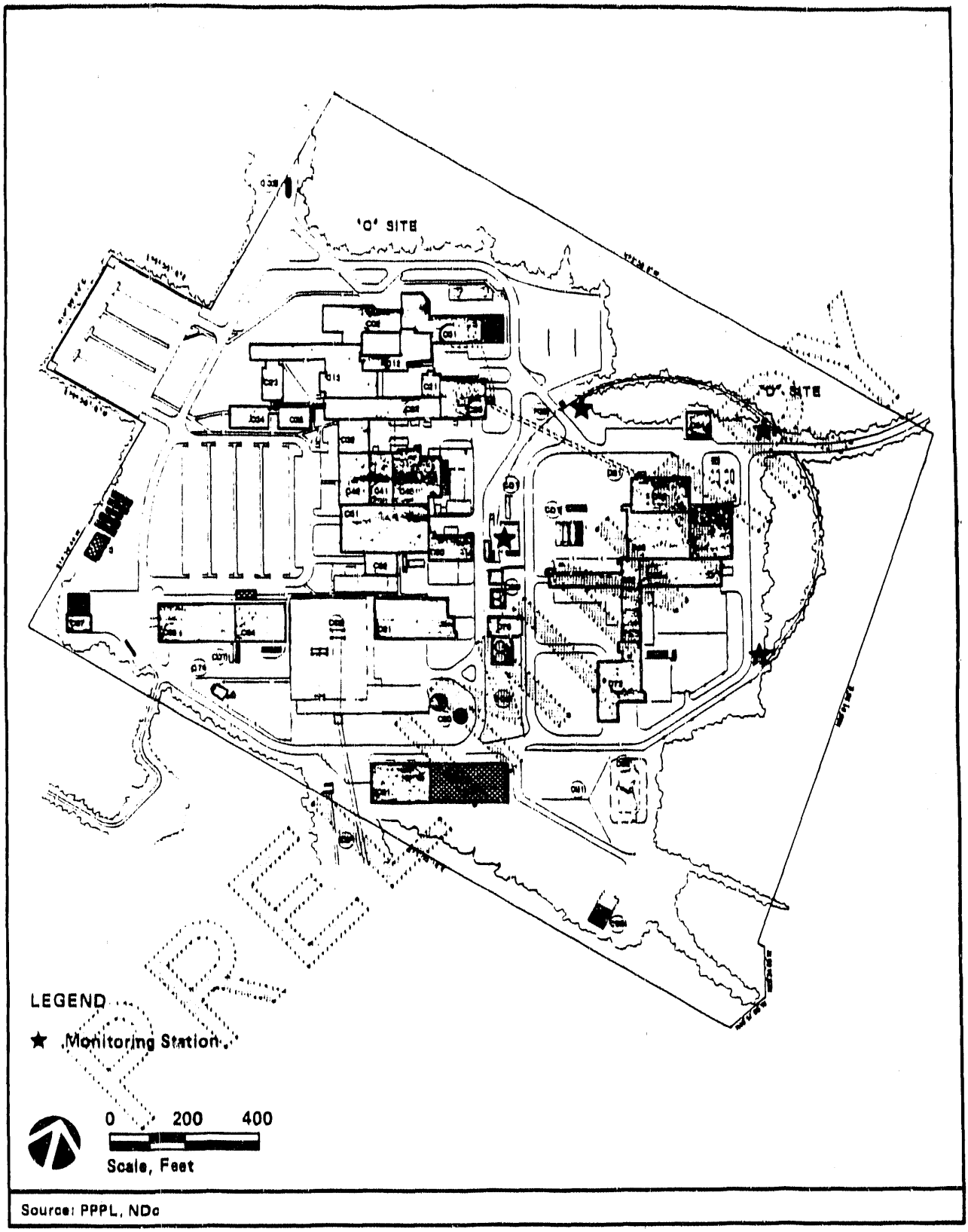
This section discusses PPPL's direct penetrating radiation monitoring (Section 4.3.3.1) and the reporting of the environmental impacts to DOE from facility

operations (Section 4.3.3.2). Environmental monitoring for radionuclides to individual media is discussed in sections for Air (3.1.3), Soil (3.2.3), Surface Water (3.3.3), and Groundwater (3.4.3). The sampling and analyses are performed by the Radiological Environmental Monitoring Laboratory (REML).

4.3.3.1 Direct Penetrating Radiation Environmental Monitoring Program

To determine the direct penetrating radiation impact of PPPL operations on the environment, four monitoring stations are located at the TFTR Exclusion Zone Boundary (EZB) (Figure 4-6). These monitoring stations consist of real-time monitors housed in environmentally controlled trailers. The monitors are Reuter-Stokes Sentri 1011 pressurized ionization chambers and helium-3-moderated neutron detectors. The electronics in the ionization chambers were modified to allow the integration of any prompt radiation resulting from a TFTR machine pulse which may be above natural background. These data are stored and processed using the Central Instrumentation Control and Data Acquisition (CICADA) computer system. An additional eight ionization chambers of lower sensitivity paired with neutron monitors are located nearer the TFTR device (i.e., four outside the test cell wall, three in the basement, and one on the roof). These eight detector locations are for personnel safety and are not considered environmental detectors. However, data collected from them are used to help correlate the environmental measurements. PPPL has written protocols for the direct penetrating radiation environmental monitoring they perform and operation/quality control (QC) protocols for the equipment used for the analyses.

The Environmental Monitoring Report (EMR) for Calendar Year 1987 (Stencel, 1988a) stated that monitoring of the EZB indicated that the annual neutron and gamma/X-ray dose was "background" for 1987. Background dose rates at the four EZB monitoring trailers were 6-9 microrem per hour (μrem/hr), gamma/X-ray, and 0.35-0.50 μrem/hr neutron. Additionally, the 10-mrem/yr design objective for dose rate elevation above background was easily met and the customary statement that "the dose from TFTR Operations during 1987 was less than one mrem at the EZB" is correct.



Source: PPPL, NDo

LOCATION OF THE
TFTR EZB TRITIUM AND DIRECT RADIATION
MONITORING STATIONS

FIGURE 4-6

4.3.3.2 Reporting of the Environmental Impacts to DOE from Facility Operations

PPPL submitted, in accordance with DOE Order 5484.1, an EMR for calendar year 1987. The EMR covered all aspects of PPPL operations, including radioactive and nonradioactive constituents, and an assessment of the environmental impacts.

4.3.4 Findings and Observations

4.3.4.1 Category I

None

4.3.4.2 Category II

None

4.3.4.3 Category III

None

4.3.4.4 Category IV

1. Incomplete documentation for release of potentially radioactivated material for unrestricted use. Procedures are not completely documented for the release of potentially radioactivated material to the general public for unrestricted use.

   While the procedures and criteria used by PPPL for release of potentially radioactivated material to the general public for unrestricted use are conservative, they are not documented. Deviations from the procedures described in Section 4.3.2.3 could result in an increased possibility of release of material which exceeds the intended radiation dose criteria of PPPL Health and Safety Manual Section 10.0 and TFTR Operations Procedure OP-AD-7. There are no written procedures stating when gamma spectroscopy and specific activity calculations are to be performed on material that has been determined to be non-radioactive and acceptable for release for unrestricted

use. There are no written procedures on how these analyses are to be performed or what records are required to document this program. Additionally, there is no provision for obtaining concurrence by DOE and regulatory agencies that the criteria and procedures used are adequate and acceptable. It should be noted that while the procedures and criteria used by PPPL are conservative, DOE has not established guidelines for the release of radioactivated material for unrestricted use.

4.4 Quality Assurance

This section references the quality assurance/quality control (QA/QC) aspects of environmental sampling at PPPL and discusses the PPPL analytical QA/QC program and data management system.

4.4.1 Environmental Sampling

Environmental samples are collected at PPPL for radiological and nonradiological parameters. The radiological samples are collected by PPPL's REML staff and consist of air, soil and vegetation, surface water, groundwater, and direct penetrating radiation measurements as discussed in Sections 3.1.3, 3.2.3, 3.3.3, 3.4.3, and 4.3.3, respectively. The nonradiological parameters are sampled for surface water and groundwater by an off-site contractor, the Princeton Testing Laboratory (PTL), as discussed in Sections 3.3.3 and 3.4.3, respectively. The USGS has also collected radiological and nonradiological groundwater samples from 5 wells as discussed in Section 3.4.1.3.

4.4.2 Analysis and Data Management

Radiological and nonradiological analyses of environmental samples are conducted and managed by the REML and PTL, respectively, as discussed below.

4.4.2.1 REML

The REML has written protocols for the radiological analysis of samples, reduction of data from the analysis, radiation screenings of areas and materials, and calibration and maintenance of measurement equipment and systems used for analysis. Additionally, logbooks and records are kept in the REML laboratories, documenting that the requirements of the written protocols are followed.

Analysis of samples for radioactivity is accomplished in-house. In general, in-house procedures follow the DOE Environmental Measurement Laboratory (EML) Procedures Manual (Volchok and de Planque, 1982). In-house procedures adopt accepted techniques and are documented in the REML manual (PPPL, 1986c). PPPL participates in the EPA Las Vegas cross-check program and has reinitiated its analysis

of samples provided by the DOE-EML in New York City. These programs provide blind samples for analysis and subsequent comparison to values obtained by other participants, as well as to known values.

In 1984, PPPL initiated a program to have its radiation counting laboratory certified by the State of New Jersey through the EPA QA program. In March 1986, the Laboratory facilities and procedures were reviewed and inspected by EPA Las Vegas and the NJDEP. The laboratory was certified for tritium analysis in urine and water and recertified in these areas in 1987. During 1988, PPPL had planned to extend this certification to gamma spectroscopy and all other procedures and techniques. Data from this program are incorporated in PPPL's Annual Environmental Monitoring Report.

4.4.2.2 PTL

PTL, a contract laboratory used by PPPL for nonradioactive analysis, participates in the State of New Jersey QA program and has a QA plan (Alinea, 1985). Blind split (field duplicate) samples were also submitted to PTL by PPPL for analysis in 1987 and the results showed good agreement between the results of the splits (Stencel, 1988a). Observations by Survey team members revealed that the contract between PPPL and PTL does not require PTL to apply its QA program to PPPL samples. However, PTL indicated during an interview that they apply their QA program to all clients.

In interviews, PTL personnel indicated they had written protocols for the analysis of samples, reduction of data from the analysis, and calibration and maintenance of measurement equipment and systems used for analyses. Currently, PTL is certified by the states of New Jersey, New York, and Pennsylvania; the EPA; and the American Industrial Hygiene Association for selected nonradioactive water quality analysis. Data from the PTL sampling program are incorporated in PPPL's Annual Environmental Monitoring Report.

4.4.3 Findings and Observations

4.4.3.1 Category I

None

4.4.3.2 Category II

None

4.4.3.3 Category III

None

4.4.3.4 Category IV

None

4.5 Inactive Waste Sites and Releases

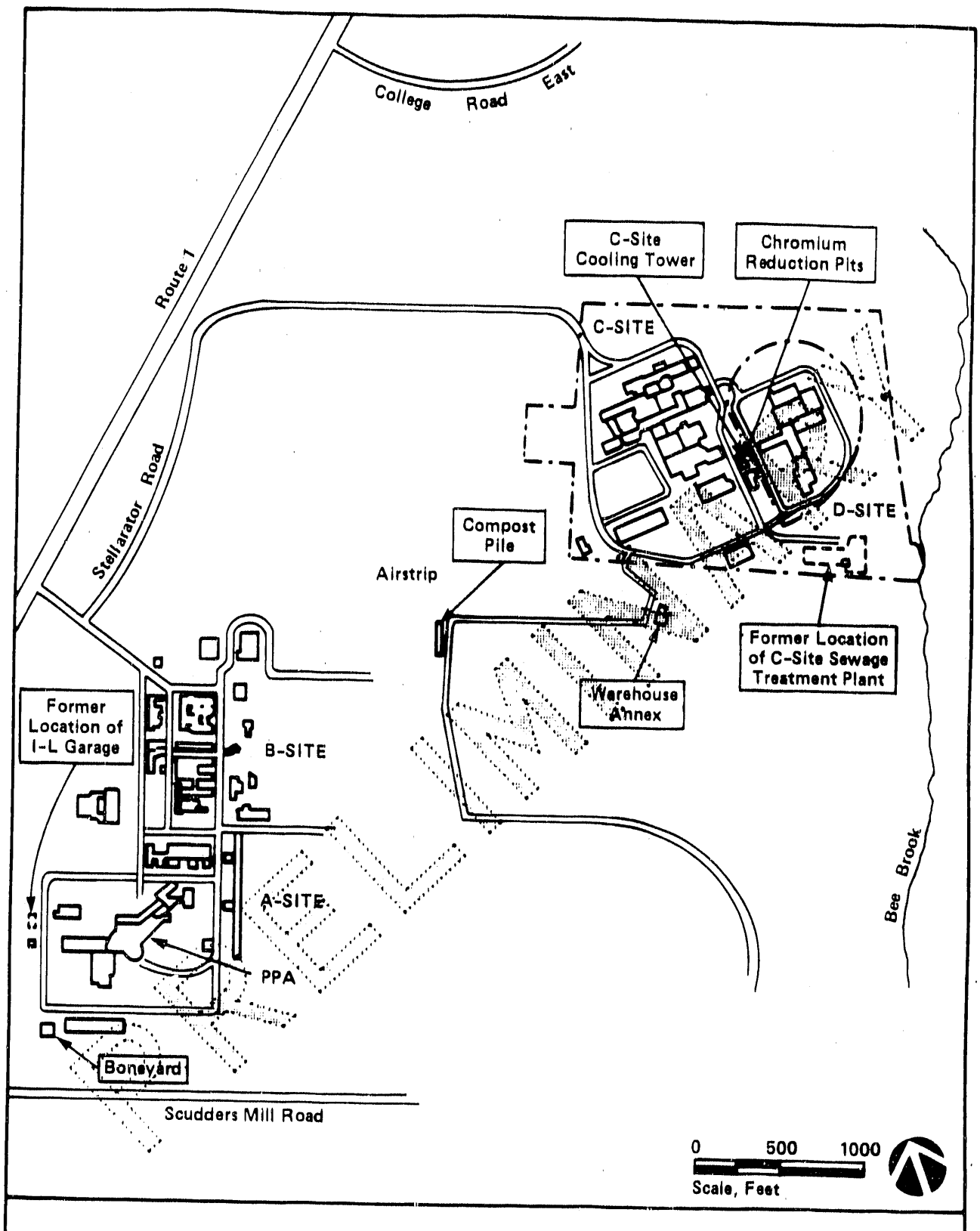
This section addresses inactive waste sites that may be present and spills and other types of releases that may have occurred at PPPL. The pollution sources, findings, and observations described below are based on on-site observations made during the Environmental Survey; on a review of historical photographs, engineering plans, spill cleanup reports, and monitoring data; and on interviews with PPPL personnel. Prelirminary Assessment forms and associated supporting documentation, submitted by PPPL to the EPA in accordance with Section 120(c) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), were also major sources of information used during the Survey.

4.5.1 General Description of Pollution Sources and Controls

4.5.1.1 Site History

PPPL had its inception in 1951 as Project Matterhorn, a U.S. Atomic Energy Commission (AEC) funded program to research and develop fusion as an energy source. Initially Project Matterhorn was located in the facilities at the B-Site (Figure 4-7), which had formerly been occupied by the Rockefeller Medical Institute. In the late 1950s, due to increased research activities, C-Site was constructed on forested land and farmland, and PPPL moved into these facilities. In the early 1960s, the Princeton-Pennsylvania Accelerator (PPA) and its support facilities were constructed with AEC funds; this area became known as A-Site. The PPA operated from 1962 to 1972 although in 1971, the AEC turned the accelerator and its operations over to Princeton University.

In the 1970s, as PPPL research activities continued to expand and the TFTR underwent development, the need for additional space increased. Thus, in 1975, PPPL occupied A- and B-Sites on a lease from Princeton University. The TFTR was constructed in the late 1970s and early 1980s at D-Site. However, as a result of negotiations between Princeton University and DOE, PPPL vacated all facilities at the A- and B-Sites by September 30, 1987.



LOCATIONS OF INACTIVE WASTE SITES AND RELEASES AT PPPL FIGURE 4-7

4.5.1.2 Potential Inactive Waste Sites and Releases

As a result of PPPL activities described in the preceding section, seven inactive waste sites and seven minor, recent releases were identified during the Survey. They are all described in this section; the former seven are organized based on their locations at C- and D-Sites and at A- and B-Sites, while the latter seven are described later in the section as Other Release Incidents.

C- and D-Sites

PPPL has occupied C-Site since 1959, when the area was first developed, and the adjacent D-Site since the late 1970s. As a result of activities during nearly 30 years of operation, three locations at the C- and D-Sites were identified by the Survey to be potentially contaminated with hazardous substances, and are discussed below. Two of these sites, the C-Site Cooling Tower and the chromium reduction pits, were newly identified during the Survey. The third site, the Sewage Treatment Plant (STP), has been included in the Preliminary Assessment that PPPL has provided to EPA pursuant to Section 120(c) of CERCLA/SARA.

C-Site Cooling Tower - The C-Site Cooling Tower is located on the eastern boundary of C-Site (Figure 4-7). It was constructed in the late 1950s when the C-Site was developed and is still operating. The tower provides process condenser water to the C-Site process chillers and other equipment including the C-Site motor generator sets. Two wood-filled cells compose the tower and total capacity is 15,000 gallons per minute (gpm). The tower is situated on a 40-foot by 45-foot concrete sump with three 5,000-gpm vertical pumps located in the adjacent pumphouse. Usual operating conditions require use of two pumps, or 10,000 gpm.

Chromium was used in the cooling tower until 1983. Therefore, surrounding areas may have been contaminated with chromium as a result of drift, seepage through the basin, and spillage over the basin wall. There are no records of the chromium concentrations maintained in the tower water, although one of the operators believes that the levels may have been 7 ppm. Drift from cooling towers ranges from 0.05 to 0.2 percent of the circulation rate (Schoor, DePalma & Gillen, Inc., 1982). Assuming a circulation rate of 10,000 gpm over 24 years of operation, a drift of 0.1 percent of the circulation rate, and a chromium concentration of 7 ppm,

approximately 7,000 pounds of chromium may have been deposited through settling of drift on the surrounding ground. This estimate is probably high since it is unlikely that the tower continually operated at 10,000 gpm. The area around the C-Site Cooling Tower consists of buildings, roads, driveways, and the chromium reduction pits as well as exposed soil. Thus only a portion of the chromium may have been deposited on soil; the remainder may have settled on impervious surfaces and been washed away in runoff through the site's stormwater collection system (Section 3.3.2). In addition, an unknown quantity of chromium may have seeped through the basin or spilled over the basin wall into the soil.

Chromium Reduction Pits - Two chromium reduction pits are located adjacent to one another immediately east of the C-Site Cooling Tower described above (Figure 4-7). They were constructed in the late 1950s with the development of the C-Site and were abandoned in 1983 when the use of chromium was terminated. Still in place, the pits are each 20-foot-wide by 28-foot-long by 6-foot-deep in-ground concrete basins.

The pits were used to precipitate chromium and to reduce the metal in the C-Site Cooling Tower blowdown from the toxic hexavalent state to the potentially less toxic trivalent state. Blowdown from the tower was released to one of the pits; the southern pit was a reserve tank and the northern pit, which had a mixer, was the main treatment tank; a weir separated the two. When the treatment tank was near capacity, sulfuric acid was added to lower the pH to below 2. Sulfur dioxide was then added to reduce the chromium and the pH was brought up to a neutral level with the addition of a caustic. The reduced water, along with precipitated solids resuspended by the mixer, was then released to the sanitary sewer. According to the operator, one tank's contents of approximately 20,000 to 25,000 gallons was treated every week in the summer and every three weeks in the winter.

During operation, chromium-contaminated water could have spilled over the side of the pits or leaked through the basin. The top of the basin is approximately 1 foot above surrounding grade. During the Survey, the basin did not appear to have any cracks, expansion joints, or other seepage routes. When the pits were abandoned, a water sample was taken; hexavalent chromium was less than 0.01 milligram per liter (mg/L) and trivalent chromium was 0.04 mg/L. The solids from the bottom of the pits were hauled to an unreported location.

C-Site Sewage Treatment Plant - The C-Site STP was put into service in 1959 to treat the sanitary wastes from the C-Site. It was located in the southeast corner of C-Site (Figure 4-7) and operated until December 1979 when the site was connected to the Stony Brook Regional Sewage Authority system (Section 3.3.2). Influent wastewater first passed through a comminutor and then to air injectors that transferred the influent to Imhoff tanks for primary settling and digestion. Two Imhoff tanks were used in a batch process; each was constructed in-ground of concrete and consisted of two compartments -- a settling chamber and a sludge compartment. Total size of each Imhoff tank was 5 feet by 30 feet by 17 feet deep.

Sludge was drawn off the Imhoff tanks to two sludge drying beds and liquids were piped through a 2,100-gallon dosing tank to two sand filter beds. The drying beds were 12 feet by 20 feet each and were underlain by 6 inches of sand, 3 inches of crushed stone, 6 inches (minimum) of gravel, and 4-inch-diameter tiles. The dry sludge cake was placed in a compost pile (discussed below) or used for general landscape requirements. The sand filter beds were each 50 feet by 50 feet. They consisted of 24 inches of sand underlain by 12 inches of gravel and 4-inch-diameter perforated underdrain pipes, 8 feet on center. Effluent from the sand filters passed through a 1,280-gallon chlorine contact chamber before being discharged to Bee Brook.

The design capacity of the plant was 35,000 gallons per day. Influent consisted predominantly of sanitary wastes from lavatories and the cafeteria, although laboratory and shop sink drains, floor drains, and blowdown from the C-Site Cooling Tower, after passing through the chromium reduction pits, as described above, were also discharged to the STP. Possibly 500,000 gallons per year of reduced cooling tower blowdown passed through the STP. Mercury was used in vacuum pumps, and PCBs were used in capacitors and transformers; chemical solvents were used in laboratories in limited quantities. Thus, potential contaminants of concern at the plant were chromium from cooling tower blowdown and other metals and chemicals that may have been discharged through laboratory and shop sink drains. However, individuals familiar with plant operations could not recall toxic spills that entered the plant or cessation of bacteriological activity associated with toxic materials (Stencel, 1985b).

After use of the plant was discontinued, above-grade concrete structures were demolished and the area was covered with crushed rock. The site is now used for general storage of equipment, shielding blocks, and vehicles. In 1985, samples were taken from the sand filter beds, from soil beneath the sand filter beds, from the location of the sludge beds, and from Bee Brook above and below the STP discharge, and were analyzed for PCBs, mercury, and total and hexavalent chromium; results are presented in Table 4-9. Although the metal concentrations are above mean values for eastern U.S. soils, they are generally at the lower end of the range of concentrations in eastern U.S. soils. Concentrations of PCBs were below the detection limit of 1 milligram per kilogram (mg/kg). In 1987, leachable metals were analyzed from the sand filters, using the EP Toxicity test. All values (Table 4-9) were below the limits established by RCRA for the classification of wastes as hazardous.

A- and B-Sites

B-Site was occupied by Project Matterhorn, under AEC funding, from 1951 to 1959. A-Site was subsequently occupied for the development and operation of the PPA from 1959 to 1971, once again under AEC funding. While these original activities at A- and B-Sites were examined by the Survey team, they are out of the scope of the Survey since they were not part of PPPL at the time. However, PPPL did occupy A- and B-Sites from 1975 to 1987. As a result of operations during these 12 years, four inactive waste sites have been identified at A- and B-Sites and are discussed below. Three of these sites, the compost pile, the I-L garage, and the Boneyard spill, have been included in the Preliminary Assessment that PPPL has provided to EPA pursuant to Section 120(c) of CERCLA/SARA. The remaining site, the Warehouse Annex, was newly identified during the Survey.

Compost Pile - As discussed above, dry sludge cake from the sludge drying beds at the C-Site STP was disposed of in a compost pile. Presumably, disposal was carried out from 1959, when the plant began operation, to 1979, when the plant was abandoned. The compost pile, which is still present though no longer used, is

TABLE 4-9

CHEMICAL DATA FROM THE PPPL C-SITE SEWAGE TREATMENT PLANT

CONCENTRATIONS IN SOIL (mg/kg) (SEPTEMBER 1985)[a]

Parameter	Within Sand Filter	Below Sand Filter	Sludge Drying Bed	Bee Brook above Outfall	Bee Brook below Outfall	Eastern U.S.[b]	
						Range	Mean
Mercury	0.30	0.58	0.61	0.58	0.51	0.01-3.4	0.12
Total chromium	98	68	60	6	32	1-1,000	52
Hexavalent chromium	8.0	0.5	<0.5	<0.5	<0.5	-	-
PCBs	BDL[c]	BDL[c]	BDL[c]	BDL[c]	BDL[c]	-	-

EP TOXICITY OF SOILS (mg/L) (OCTOBER 1987)[d]

Parameter	Sand Filter	RCRA Limit
Arsenic	<0.01	5.0
Barium	<0.10	100
Cadmium	0.12	1.0
Chromium	<0.02	5.0
Lead	<0.02	5.0
Mercury	<0.001	0.2
Selenium	<0.01	1.0
Silver	<0.01	5.0

[a]Source: Stencel, 1985b.
[b]Source: Shacklette and Boerngen, 1984
[c]BDL - Below detection limit of 1.0 mg/kg
[d]Source: Stencel, 1987a

located in a level grassy area at the B-Site, east of the runway (Figure 4-7). It is approximately 200 feet by 50 feet by 6 to 8 feet high. Chromium, mercury, and other metals, as well as PCBs, which may have flowed through the STP, could have adhered onto the sludge and been deposited at the compost pile.

In 1985, sludge from the compost pile was sampled for mercury, chromium, and PCB content. The metals values (Table 4-10), although above the mean for soils in the eastern U.S., are at the lower end of the range of concentrations in soil (Table 4-9). They are below the median and mean for typical metal concentrations in sewage sludge (Table 4-10). PCBs were below detectable limits of 1 mg/kg. In 1987, leachable metals were analyzed from the compost pile, using the EP Toxicity test. All values (Table 4-10) were below RCRA limits.

I-L Garage - A motor pool garage, located in Building I-L at the A-Site (Figure 4-7), was used by PPPL from 1973 through September 1987 for routine oil changes and other minor maintenance on government vehicles. The I-L Garage was demolished in 1988 and the area is presently under the control of Princeton University. It was primarily masonry block with dimensions of 80 feet by 36 feet. An 80-foot by 40-foot macadam driveway fronted the building on the east, an 80-foot by 30-foot crushed stone parking area flanked the building and its driveway to the south, and a 10-foot by 4-foot containment area was situated behind the building, on the west side. This latter area was used for the storage of 55-gallon drums that contained waste oil.

During PPPL's use of the I-L Garage, several oil spills occurred, although individual spills were probably not significant. Before remediation of the site in December 1987, the most notable evidence of a spill was an oil stain next to the waste oil containment area. Oil stains were also observed in the gravel parking area. In preparation for vacating the garage, soil samples were taken of oil stains at five locations and were analyzed for EP toxicity, petroleum hydrocarbons, and volatile organics. The EP toxicity and volatile organics levels were below detection limits. Petroleum hydrocarbons ranged from 220 to 99,000 mg/kg, with the highest level being measured at the containment area (Stencel, 1988c).

During remediation, soil containing petroleum hydrocarbon concentrations of greater than 100 mg/kg was removed. This is the standard contained within New

TABLE 4-10

CHEMICAL DATA FROM THE COMPOST PILE

CONCENTRATIONS IN COMPOST PILE (mg/kg) (SEPTEMBER 1985)[a]

Parameter	Compost Pile		Typical Sewage Sludge		
	East Side	West Side	Range	Median	Mean
Mercury	1.3	0.54	0.5-10,600	5	733
Total chromium	47	58	10-99,000	890	2,620
Hexavalent chromium	13.2	0.5	-	-	-
PCBs	BDL[b]	BDL[b]	-	-	-

EP TOXICITY OF COMPOST PILE (mg/L) (OCTOBER 1987)[c]

Parameter	Compost Pile	RCRA Limit
Arsenic	<0.01	5.0
Barium	<0.10	100
Cadmium	<0.01	1.0
Chromium	<0.02	5.0
Lead	<0.02	5.0
Mercury	<0.001	0.2
Selenium	<0.01	1.0
Silver	<0.01	5.0

[a]Source: Stencel, 1985b
[b]BDL - Below detection limit of 1.0 mg/kg
[c]Source: Stencel, 1987a

Jersey's Environmental Cleanup Responsibility Act (ECRA) that NJDEP has adopted for cleanup of petroleum hydrocarbon spills. Approximately 84 tons of soil were removed and disposed of at an off-siteTSD facility. Most was from a 12-foot-deep excavation around the containment area; the remainder was from other holes and surface scraping of the stone parking area. Excavations were filled in with clean soil (Stencel, 1988c).

Boneyard Spill - The A-Site radioactive storage yard, commonly known as the Boneyard, is located on the southwest side of the A-Site (Figure 4-7). It is a storage area for various low-activated equipment remaining from the PPA project. These items were stored in the yard when PPPL took control of it from Princeton University in 1979. PPPL stored a minimal amount of materials in this area during the subsequent 9 years. The largest-volume items from PPPL were bellows cover plates removed from the TFTR in 1985. These plates have since been removed and have been shipped to a DOE disposal site (Stencel, 1988b).

While preparations were being made for vacating the A- and B-Sites in 1987, an oil stain was observed in the Boneyard. The apparent source was a tank from PPA that had rusted and spilled its contents, believed to be transformer or hydraulic fluid, to the ground. Although the tank did not belong to PPPL, the Laboratory agreed to clean up the spill. An oil sample was analyzed for radioactivity and a surface soil sample was analyzed for PCBs; results of both tests were negative. Excavation began in September 1987 and, at the surface, covered a circular area approximately 6 feet in diameter. Petroleum hydrocarbons were analyzed in soils at 3 feet, 6 feet, and 12 feet; the results were 92,000 mg/kg, 2,700 mg/kg, and 91 mg/kg, respectively. Excavation was discontinued in December 1987 at 12 feet since concentrations at that depth were below the 100 mg/kg NJDEP ECRA limits for petroleum hydrocarbons. Approximately 300 cubic feet of material were disposed of at an off-site TSD facility. Clean soil was backfilled into the excavations. Presently, the Boneyard is under the control of Princeton University and still contains scrap equipment (Stencel, 1988b).

Warehouse Annex - The Warehouse Annex is located on the B-Site, 300 feet southwest of the southwest boundary of the C- and D-Sites (Figure 4-7). This L-shaped building, consisting of approximately 3,000 square feet, was reportedly used by the Rockefeller Medical Institute in the 1930s for animal experiments. It is

located in a wooded area and is immediately surrounded by an asphalt driveway. From 1982 to November 1986, PPPL used the building as its hazardous waste storage facility.

Two rooms within the building, both with concrete flooring, were used for hazardous waste storage and handling operations. One, which was completely diked, was used for storage of approximately 20 to 40 55-gallon drums at any one time. The drums contained any waste type generated at the site including solvents, PCBs, and laboratory wastes. The other room was used for waste transfer and packaging. Waste oil in drums was stored uncovered on the asphalt driveway, immediately outside the building. Usually 20 to 30 55-gallon drums were stored there at any one time. The building and driveway were inspected daily for leaking drums and containers, and although small drips were detected within the building, spills never left the building; no spills were reported on the driveway. The facility handled 3,000 to 4,000 gallons of wastes annually; disposal shipments were made quarterly.

In December 1986, after PPPL vacated the Warehouse Annex, soil samples were taken from six locations surrounding the building and its driveway and were analyzed for total hydrocarbons. All samples were below the detection limit of 0.04 milligram per gram (mg/g) (Vora, 1987).

Other Release Incidents

In 1986, PPPL drafted a spill reporting and response procedure, finalized in 1987 (Tompkins, 1987), that includes a requirement for the writing of spill reports. As a result, since late 1986, spill incidents at PPPL have been well documented. Several of these have affected the environment and are summarized in Table 4-11. The spills have ranged from 8 ounces to possibly 55 gallons, and have involved oils, Freon, sulfuric acid, and unidentified petroleum hydrocarbons. Several spills have occurred on asphalt or small areas of soil, but some have entered surface waters. In all cases, remedial activities have been undertaken.

The most notable of these spills occurred at the Neutral Beam Transformer Yard, immediately south of the NBPC Building at D-Site. On January 19, 1988, a PPPL employee noticed an oil sheen on water in the Detention Basin. An attempt was

TABLE 4-11

SPILL INCIDENTS AT PPPL

Date of Occurrence	Location	Material Spilled	Volume Spilled	Area/Depth Affected	Environment Affected	Cause	Remediation
10/2/86	SW of CAS Building[a]	Freon-113	<55 gallons	~10 ft x 20 ft	Asphalt, soil	Punctured drum	18 yd^3 of material removed; analysis after cleanup: Freon-not detected, petroleum hydrocarbons -40 mg/kg
3/2/87	East of C-Site Cooling Tower Pump House[a]	Sulfuric acid	8 ounces	Unknown but small	Wetness on concrete; small puddle on soil	Leaking carboy	Neutralized and washed with water
8/15/87	West of PPA at A-Site[b]	Waste motor oil	20 gallons	4 ft x 7 ft	Asphalt parking lot	Unauthorized disposal into dumpster; dumpster leaked	Absorbent applied; oil-contaminated materials in dumpster disposed of
8/29/87	East of I-L Garage at A-Site[b]	Oil	<5 gallons	7 ft^2	Asphalt	Unauthorized disposal into dumpster; dumpster leaked	Absorbent applied; oil-contaminated materials in dumpster were not segregated
10/29/87	Detention Basin[a]	Motor oil	Several quarts	~70 ft x 120 ft	Water in Detention Basin, soil and grass on basin berm	Intentional dumping into storm sewer	Spill contained to basin; storm sewer flushed; booms and filter fence used for cleanup

TABLE 4-11

SPILL INCIDENTS AT PPPL (Continued)

Date of Occurrence	Location	Material Spilled	Volume Spilled	Area/Depth Affected	Environment Affected	Cause	Remediation
1/19/88	Neutral Beam Transformer Yard (south of NBPC Building at D-Site)[a]	Mineral oil	<55 gallons	3,000 linear feet of drainage	Sanitary sewer, Detention Basin, Ditch 5, Bee Brook	Mineral oil leaking from a tranformer bleed line to sump in diked area; discharged to storm sewer	Booms, filter fences, spill pillows deployed on creek; storm sewer and dike flushed
5/88	South of CAS Building[a]	Petroleum hydrocarbons	Unknown	~50 ft^2	Surface drainage ditch and pool	Open-ended discharge pipe from sink drain	Removed contaminated soil and water

[a]Refer to Figure 2-4 for location

[b]Refer to Figure 4-7 for location

made to close the Detention Basin outlet gate but it was stuck open. Once repaired, however, the gate was not immediately closed so as to minimize the volume of liquid in the basin and the amount of oil adhering to the grass on the basin wall. Oil bypassed the oil-water separator at the Detention Basin outlet and entered Ditch 5 and Bee Brook (Stencel, 1988d).

After initial cleanup, it was determined that a maximum of 55 gallons of mineral oil had drained through a partially opened valve on a TFTR neutral beam transformer bleed line. The transformer sits within a concrete diked area which is filled with coarse crushed rock. Water or any oil within the diked area flow into a sump that has a liquid level sensor. Sump contents are discharged to the stormwater management system and flow to the Detention Basin (Section 3.3.2). Apparently, this is the route that the leaked oil followed.

The rock area around the transformer was flushed with 300 gallons of solvent-free degreaser and water solution, and the resulting product was pumped from the sump into barrels for disposal. The sump is continually monitored for additional mineral oil and pumped out as necessary. Oil booms, filter fences, and spill pillows were deployed in the Detention Basin, Ditch 5, and Bee Brook to collect spilled oil. It is believed that less than 1 quart of mineral oil was not recovered (Stencel, 1988d).

4.5.2 Findings and Observations

4.5.2.1 Category I

None

4.5.2.2 Category II

None

4.5.2.3 Category III

1. Contamination from cooling tower and chromium reduction pits. Release of chromium from the C-Site Cooling Tower and chromium reduction pits at PPPL

may have resulted in contamination of groundwater and soils surrounding these structures.

Chromium-containing compounds were used as corrosion inhibitors in the C-Site Cooling Tower from approximately 1959 to 1983. There are no records as to the chromium concentrations maintained in the tower water, although one of the operators recalls that the levels may have been 7 ppm. Blowdown from the cooling tower was routed to the adjacent set of two chromium reduction pits, where the chromium was reduced from the toxic hexavalent state to the potentially less toxic trivalent state. Two wood-filled cells compose the tower, which is set on a 40-foot by 45-foot sump, and total capacity is 15,000 gpm. The reduction pits are each 20-foot-wide by 28-foot-long by 6-foot-deep in-ground concrete basins. The cooling tower is still in use and the reduction pits are abandoned in place.

During operation, chromium-contaminated water could have spilled over the sides of the tower sump or pits or leaked through their walls. Although the basins of the tower sumps and pits did not appear to have any cracks, expansion joints, or other seepage routes, no determination has been made as to whether the cooling tower sump or the chromium reduction pits have ever leaked. Also, drift occurs during normal tower operations, and it is possible that a maximum of 7,000 pounds of chromium could have been deposited on surrounding ground, although the actual amount is probably much less. Thus, chromium contamination of the surrounding soil and groundwater may have resulted from spills, leaks, or drift.

During the Sampling and Analysis phase of the Survey, soils surrounding the C-Site Cooling Tower and chromium reduction pits will be sampled and analyzed for chromium to determine whether soil contamination resulted from use of chromium in these structures.

4.5.2.4 Category IV

1. Incomplete identification of inactive waste sites. Not all potential inactive waste sites resulting from PPPL operations have been identified and reported to the EPA in accordance with CERCLA, as amended by SARA.

Information obtained during the Survey indicates the existence of three inactive waste sites and releases that have not been included in Preliminary Assessments submitted to the EPA in accordance with Section 120(c) of CERCLA, as amended by SARA. These sites are: the C-Site Cooling Tower, in which chromium was used as a corrosion inhibitor from the late 1950s until 1983; a set of two adjacent chromium reduction pits, which are in-ground concrete pits used from the late 1950s to 1983 for reduction of hexavalent chromium to trivalent chromium; and the Warehouse Annex, which is owned and presently under the control of Princeton University but was used by PPPL from 1982 to 1986 as a hazardous waste storage area.

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APPENDIX A
SURVEY PARTICIPANTS

PRINCETON PLASMA PHYSICS LABORATORY
SURVEY PARTICIPANTS
JUNE 13 - 17, 1988

DOE

Team Leader	Joseph Boda
Assistant Team Leader	Lee Stevens
Chicago Operations Office Representative	Barrett Fritz

Technical Specialists

Air	Robert Lanza (ICF)
Surface Water	William Levitan * (NUS)
Hydrogeology	Wayne Downey (NUS)
Waste Management/Tanks	Donald Habib (NUS)
Toxic and Chemical Materials	Wayne Downey (NUS)
Direct Radiation/Soil	Ernest Harr (NUS)
Quality Assurance	Ernest Harr (NUS)
Inactive Waste Sites and Releases	William Levitan (NUS)

* Contractor Coordinator

APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

B.1 Pre-Survey Preparation

The DOE Office of Environmental Audit, Assistant Secretary for Environment, Safety and Health, selected a Survey team for the Princeton Plasma Physics Laboratory (PPPL) in the winter of 1987. PPPL is managed by the DOE Chicago Operations Office (CH) and Princeton Area Office (PAO), and is operated for DOE by Princeton University. Mr. Joseph Boda was designated the DOE Team Leader, Mr. Lee Stevens the Assistant Team Leader, and Mr. Barrett Fritz was designated the Survey team DOE CH Representative. The remainder of the team was composed of contractor specialists from the NUS Corporation and ICF, Incorporated (Appendix A).

Survey team members began reviewing PPPL general environmental documents and reports in April 1988. Messrs. Boda and Stevens, along with two members of the NUS Corporation, conducted a pre-Survey site visit on May 9 to 11, 1988, to become familiar with key DOE and PPPL personnel. They toured the site and completed a cursory review of the documents assembled in response to an information request submitted on March 17, 1988. The request listed environmental documents and reports required by the Survey team for Survey planning purposes. On May 11, 1988, during the pre-Survey visit, Messrs. Boda, Stevens, and Fritz, the two NUS specialists, and representatives of PAO and PPPL met with officials from the U.S. Environmental Protection Agency and the New Jersey Department of Environmental Protection to review environmental issues of concern to them and to explain the scope of the Survey.

The Survey team reviewed the information received during the pre-Survey visit and prepared a Survey Plan (Appendix C). This plan described the specific approach to the PPPL Survey for each of the technical disciplines and included a proposed schedule for the on-site activities. A Health and Safety Plan was also prepared for use by the Survey team.

B.2 On-Site Activities

The on-site phase of the Survey was conducted during the period of June 13 to 17, 1988. The opening meeting was held on June 13, 1988, at PPPL and was attended by representatives from CH, PAO, and PPPL, and the Survey team members.

Discussions during this meeting primarily concerned the purpose of the Survey, logistics at PPPL, and an introduction of the key personnel involved in the Survey.

During the Survey, team members reviewed pertinent file documents including permits and applications, background studies, engineering drawings, accident reports, chemical release and spill reports, as well as various operating logbooks. The site activities and associated processes were carefully analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed, where possible. Extensive interviews were held with PPPL personnel concerning environmental controls, operations, monitoring and analysis, regulatory permits, and waste management.

The Survey team members met daily to report observations, discuss findings, and evaluate progress. These meetings were also useful for planning schedule changes, if required, to meet the overall objectives of the Survey. The Survey team developed Sampling and Analysis (S&A) requests to better define Survey observations that had few or no supporting data. The S&A requests were presented to the Idaho National Engineering Laboratory (INEL) representatives who were designated to perform the required S&A.

A site closeout briefing was held on June 17, 1988, at which the DOE Team Leader and Assistant Team Leader presented the Survey team's preliminary findings and observations. The findings were considered preliminary pending additional research and review, and, in some cases, field S&A to better define the Survey team observations.

B.3 Sampling and Analysis

The INEL will perform the S&A portion of the Survey. The INEL evaluated the S&A requests made by the Survey team for PPPL to determine logistics, costs, and schedules and to prepare an S&A Plan. The S&A Plan prepared by the INEL included a quality assurance plan and a health and safety plan. It was completed during the fall of 1988, and the sampling team began work at the site in December 1988.

B.4 Report Preparation

The Environmental Survey Preliminary Report for PPPL has been prepared for DOE review. The preliminary findings are subject to modification based on comments from PAO and CH concerning the technical accuracy of the findings and the results of the S&A. The modified findings will be incorporated into the Environmental Survey Summary Report.

APPENDIX C

SURVEY PLAN

DOE ENVIRONMENTAL SURVEY
PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON, NEW JERSEY
June 13 through 17, 1988

1.0 INTRODUCTION

The Environmental Survey is a one-time baseline inventory of existing environmental information and environmental problems and risks at DOE operating facilities. The Survey will be conducted in accordance with the principles and procedures contained in the DOE Environmental Survey Manual.

The Survey is an internal management tool to aid the Secretary and Under Secretary in allocating resources for maintaining aggressive environmental programs and for mitigating environmental problems at DOE facilities.

2.0 SURVEY IMPLEMENTATION

The Environmental Survey at the Princeton Plasma Physics Laboratory (PPPL) will be managed by the DOE Team Leader, Joseph Boda, and the Assistant Team Leader, Lee Stevens. Barry Fritz will serve as the Chicago Operations Office (CH) representative on the Survey team. Technical support will be provided by contractor personnel as follows:

Radiation/Soils:	Ernest Harr, NUS Corporation
Surface/Drinking Water:	William Levitan, NUS Corporation*
Waste Management/Storage Tanks:	Donald Habib, NUS Corporation
Inactive Waste Sites/Releases:	William Levitan, NUS Corporation
Hydrogeology:	Wayne Downey, NUS Corporation
Toxic and Chemical Materials:	Wayne Downey, NUS Corporation
Air:	Robert Lanza, ICF Technology, Inc.
Quality Assurance:	Ernest Harr, NUS Corporation

*Team Coordinator

2.1 Pre-Survey Activities

Members of the Survey team began reviewing PPPL environmental documentation available at the DOE Office of Environmental Audit in February 1988. From that review, a memorandum dated March 17, 1988, was sent to CH requesting additional information. Messrs. Boda, Stevens, Habib, and Levitan conducted a pre-Survey site visit on May 9 to 11, 1988, to become familiar with the site, to identify any potential environmental problems, and to coordinate plans for the upcoming Survey with CH, DOE Princeton Area Office (PAO), and PPPL personnel. During the pre-Survey visit, the team met with representatives of CH, PAO, and PPPL and representatives of Federal and state government agencies. In addition, the team toured the facilities and gathered documents assembled by site personnel in response to the information request memorandum. Additional information was requested and received from PPPL personnel during the pre-Survey visit, based upon the review of available data on-site.

2.2 On-Site Activities and Reports

The Environmental Survey of the PPPL site will be conducted from June 13 through 17, 1988. The Survey will include the facilities presently and formerly leased by DOE from Princeton University, other DOE-leased space, and inactive waste sites historically associated with the Laboratory. The agenda for this Survey can be found in the attached Table 1. Modifications to this plan may be made during the course of the Survey. All modifications will be coordinated with the site officials designated as Survey contacts. The on-site activities of the Survey team will consist of interviews and consultations with, among others, environmental safety, operations, waste management, purchasing, and warehousing personnel; a review of files and documents unavailable prior to the on-site portion of the Survey; and project-specific and area-specific tours of the facility. Table 2 indicates specific areas of interest for each of the technical specialists.

A closeout meeting will be conducted on Friday, June 17, to describe observations and initial findings of the on-site activities. A status report stating the findings identified at the closeout meeting will be sent to CH within 4 weeks of the conclusion of the Survey. A Survey Preliminary Report will be prepared within approximately 4 months of the conclusion of the on-site effort. Subsequently,

sampling and analysis (S&A) may be conducted at the site to strengthen the Survey findings and fill important data gaps. The results of the S&A effort, if implemented, will then be used along with CH, PAO, and PPPL comments on the Survey Preliminary Report in the preparation of a Survey Interim Report. The findings of each of the Interim Reports from all scheduled Surveys will be updated as appropriate and included in the Survey Summary Report to the Secretary, which is scheduled for completion in 1989.

2.3 Sampling and Analysis

Based upon the results of the on-site portion of the Survey, the Survey team will identify S&A needs, if required. A sampling team under contract to DOE will draft an S&A Plan based upon these needs. The Assistant Team Leader, Lee Stevens, will coordinate the review of this S&A Plan with CH, PAO, and PPPL, and EPA's Environmental Monitoring Systems Laboratory at Las Vegas, which has quality assurance responsibility for the Survey's S&A efforts. Results of the S&A effort, if conducted, will be transmitted to the Survey Team Leader for incorporation into the Interim Report. The Interim Report should be available in 1989.

3.0 AIR EMISSIONS

3.1 Issue Identification

The radioactive and regulated/hazardous air-related Survey activities will involve an assessment of the laboratory-wide air emission sources, emissions controls and sampling/monitoring data. Areas of investigation will include laboratory emissions of radionuclides, acid fumes, toxic metals, organics, nitrogen and sulfur oxides, and volatile hydrocarbons (VOCs), as well as the emissions of carbon monoxide, nitrogen and sulfur oxides, and VOCs from fuel burning equipment. Operational and procedural practices associated with emission controls will also be evaluated. Fugitive sources of radioactive and regulated/hazardous particulate and gaseous emissions, including emissions from chemical and waste storage/handling areas, will be investigated.

The general approach to the Survey will involve a review of existing environmental reports, chemical inventories, operating procedures, ventilation diagrams, stack

monitoring reports, radioactive effluent reports, and other relevant documents to identify significant sources of air emissions. Following the document review will be the physical inspection of significant processes and control and monitoring equipment, and potential fugitive sources. The Survey will identify air contaminants from significant emissions sources and fugitive sources, identify and evaluate existing control and monitoring equipment for the air contaminants, and assess the potential for environmental problems from the emissions.

The radiological air monitoring system assessment will involve inspection of any ambient air samplers and review of data acquisition documentation and procedures, calibration procedures, data validation, and processing. The primary emphasis of the monitoring program review will be to determine the environmental impact of operations and evaluate the quality of the reported data.

3.2 Records Required

- Descriptive documentation on existing and proposed add-on air emission control equipment;
- Emissions calculations for laboratories;
- Ventilation system drawings and hood inventory; and
- Operating, testing and maintenance procedures for air emission control and monitoring equipment.

4.0 RADIATION

4.1 Issue Identification

The radiological portions of the Environmental Survey will involve an assessment of the site-wide radioactive material and effluent control, on-site and off-site monitoring equipment, and the associated impact on the environment and general off-site population. The radiological assessment will encompass three major areas: (1) airborne radioactive emissions; (2) liquid radioactive effluents; and (3) liquid and solid radioactive waste management. Because of overlaps, the radiological

assessment will be coordinated with the air, surface water, waste management, hydrogeology, and quality assurance activities.

The assessment will determine whether radioactive materials maintained on-site or released to the environment (or potentially released) create any actual or potential environmental problems. Existing environmental standards, regulations, and guidelines will be used for comparison to assess the potential magnitude of these problems. The review will also determine if appropriate actions are being taken or planned to minimize accidental releases and/or mitigate the consequences of such releases, and whether there are conditions that may lead to environmental problems.

During facility visits, the team will work with appropriate PPPL staff to understand the processes involved, and review radioactive material and airborne and liquid effluent controls, airborne and liquid effluent monitoring, historical records of releases, and laboratory practices associated with effluent monitoring.

In addition, the radiological environmental monitoring program will be assessed through review of documents and records, observation of field activities, and review of related laboratory practices. Finally, dose assessments conducted by the site staff for various purposes, including the annual environmental report, will be reviewed.

4.2 Records Required

- A Report on the Radiation Levels Remaining after the D&D of the PPA, August 25, 1980 (Pages ii, 1 and 2 only; they were missing from the copy that was provided).

5.0 SURFACE/DRINKING WATER

5.1 Issue Identification

A number of documents provided in response to the information request have been reviewed with regard to the surface water technical specialty area. The PPPL activities that generate wastewaters will be reviewed through a detailed field

evaluation. Discrete liquid discharge points will be identified and evaluated to develop an inventory of wastewater sources. A review of the present condition of the wastewater collection and treatment systems will be made. Liquid waste treatment, processing, collection, and handling equipment will be examined and records of operations will be reviewed. The objective of the review is to build a Survey information data base for the identification of physical evidence of existing or potential environmental contamination. Additionally, drinking water sources, treatment and distribution systems, and drinking water quality data will be reviewed.

The Survey will concentrate on areas of potential concern, including the discharge of contaminants into surface waters. The Survey will also include an identification of potential cross-contamination between chemical/radiological, potable, sanitary, and stormwater sewer systems. Specific attention will be paid to unknown or potential discharges into an inappropriate sewer system, which might cause a particular contaminant to be undetected or untreated. This will be accomplished by a thorough review of site facilities in conjunction with a review of standard operating procedures (SOPs) for the operation and maintenance of wastewater discharge equipment, followed by record review, interviews with site personnel, and observation of procedures.

A review of past water and wastewater conveyance, treatment, and disposal systems will also be accomplished during the Survey to evaluate what environmental problems, if any, may exist as a result of past practices. Site surface drainage features, including channels, swales, culverts and catch basins, will also be reviewed and surface water sampling techniques will be observed.

5.2 Records Required

- Discharge monitoring reports to New Jersey Department of Environmental Protection;
- 1986 CH Environmental Appraisal Report; and
- 1987 CH Environmental Appraisal Report (pages 1 and 2 only; they were missing from the copy that was provided).

6.0 WASTE MANAGEMENT

6.1 Issue Identification

The Survey procedure for activities related to waste management is to review known sources or activities and identify any additional sources or activities that have the potential to result in contamination of environmental media.

Hazardous/radioactive/solid wastes will be tracked through the system and waste-related site activities and records will be reviewed to develop an inventory and assess PPPL's waste management practices.

During the hazardous waste portion of the Survey, the team will devote a significant portion of the time on-site to a detailed facility investigation of hazardous waste generation, storage, and disposal practices. Areas for specific inspection will include hazardous waste identification and documentation, solid waste management procedures, waste segregation practices, storage and disposal of scrap/salvage materials, and waste oil management practices. In addition, hazardous waste transfer and storage areas will be examined.

The review of radioactive and nonhazardous solid waste will be similar to that for hazardous wastes. Procedures will be evaluated to determine the PPPL waste classification practices. The detailed investigation described above will produce information on radioactive and nonhazardous solid wastes so as to delineate any previously unidentified sources of waste that have the potential to result in environmental contamination.

Discussions will be held with individuals knowledgeable on current and past waste management practices. This will be accomplished during the investigation and in the process of reviewing facility records and documentation. The objective is to develop an understanding of past and existing waste management activities that may serve as the basis for problem identification by the Survey team.

With regard to storage tanks, several areas for specific investigation were identified during a review of available documentation including underground storage tank

leak testing, age, construction material, content, and location; and aboveground storage tank spill containment.

The review of activities related to waste management will be coordinated closely with the inactive waste site, hydrogeologic, toxic and chemical materials, and surface/drinking water discipline activities to identify any possible releases that may pose a threat to the environment.

6.2 Records Required

Documentation, procedures, and internal and external correspondences, not already submitted, associated with the following topics:

- Records of radioactive waste off-site shipments including inventories and manifests for the past three years;
- The responsibilities and activities of lab personnel in identifying, segregating, storing, and handling (1) nonhazardous solid waste; (2) hazardous waste; (3) radioactive waste; (4) hazardous and nonhazardous biological waste, if any; (5) mixed waste; and (6) waste oil; and
- The current Hazardous Waste Management Report.

7.0 INACTIVE WASTE SITES/RELEASES

7.1 Issue Identification

The inactive waste sites/releases specialty area review will identify environmental problems associated with the historical handling, storage, and disposal of hazardous substances at the site. The review will involve the evaluation of information developed in response to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Superfund Amendments and Reauthorization Act (SARA) regulations. The Survey will focus on current and future environmental problems related to past land disposal practices and past spills/releases.

Preliminary Assessments (PAs), prepared for the United States Environmental Protection Agency in response to CERCLA/SARA, identified 3 inactive sites at PPPL that could potentially result in a risk to public health or the environment. As part of the Survey, the background information sources used in developing the PAs will be reviewed, including the material gathered through interviews. As part of the Survey, records indicating the types and quantities of materials disposed of in inactive waste sites will be evaluated, as will the facility designs and methods of waste containment. Information available through historical photography, interviews, and site documents, such as Incident Reports, will be assessed to identify inactive waste sites and releases, disturbed land areas, and to further define site locations and associated changes in appearance over time. Visual inspections will be conducted for inactive sites and releases to note surface features and to locate potential monitoring points. Several areas of concern were identified during a review of available documentation, including the former sewage treatment plant and the 1-L garage.

Inactive waste sites that have undergone remediation will also be addressed. Records and analytical data in support of site cleanup will be obtained for review. Inactive tanks or containers that may have held hazardous substances will be located and their status assessed. Former storage areas and staging locations will be included in this effort. Each of these facilities will be evaluated in terms of the potential to cause a present or future risk to workers, the neighboring population, or the environment.

7.2 Records Required

- Documentation of 1-L garage sampling and remediation.

8.0 HYDROGEOLOGY

8.1 Issue Identification

A major concern for the Survey is the potential sources of groundwater contamination. In addition, the potential impacts of any existing contamination on aquifers and the impacts of off-site movement of contaminated groundwater will be assessed by the Survey team.

A general review of existing data will be required to determine the usefulness of this information for the purposes of the Survey. Interviews with site personnel will be conducted to define local groundwater conditions. Information on regional and local geological and groundwater characteristics, including flows and quality, will be collected. In addition, well sampling techniques will be observed.

Factors potentially affecting groundwater, including underground tanks, spills, inactive waste sites, bulk chemical storage, and solid and liquid waste management operations will also be investigated in concert with the other technical specialists.

8.2 Records Required

No additional records related to hydrogeology are required at this time.

9.0 TOXIC AND CHEMICAL MATERIALS

9.1 Issue Identification

The toxic and chemical materials review will address the raw materials and handling of chemical and petroleum products used at PPPL. The use, handling, and disposal of PCBs, asbestos, pesticides, and herbicides will also be within the scope of this effort.

All toxic and hazardous substances purchased, stored, used, or manufactured on-site will be evaluated to determine if these practices result in environmental problems. The tracking, control, and management of these substances will be reviewed. Records of usage will be evaluated to determine the potential for environmental contamination.

The inventory of PCBs and PCB-contaminated electrical equipment in use at the facility will be reviewed for completeness. The condition of this equipment, its potential for leakage, and the quantity of contaminated fluids will be identified. Disposal practices will be reviewed for current and past inventories to determine the methods of disposal and the locations of disposal sites. Procedures for PCB analysis, removal, handling, and disposal will be reviewed. Inspection and reporting

requirements for PCB transformers will be evaluated in an effort to focus the Survey team's attention on potential problem areas.

The use of asbestos at PPPL will be reviewed to identify pathways of environmental contamination. Also, asbestos removal and disposal practices will be evaluated to define potential areas of concern.

Pesticide/herbicide usage on the site will be reviewed to determine the risks of environmental contamination. The review will focus on application records, storage and disposal practices, and environmental monitoring procedures.

Several areas for specific investigation were identified during a review of available documentation including chemical procurement and material QA procedures; toxic and hazardous materials inventory; operator and technician training; decontamination/disposal manifests and records; maintenance/inspection logbooks; and chemical and petroleum storage.

9.2 Records Required

- Record of pesticide usage;
- Yearly chemical usage inventory; and
- Description of any asbestos removal projects.

10.0 QUALITY ASSURANCE

10.1 Issue Identification

The quality assurance (QA) review of the environmental program will examine the site sampling and analysis (S&A) capabilities. The intent of this review will be to assess the accuracy of the environmental monitoring data. All aspects of the QA program relating to the PPPL environmental S&A effort will be reviewed.

The environmental sampling performed by PPPL personnel and its subcontractors (e.g., Princeton Testing Laboratory) will be evaluated by reviewing protocols,

procedures, data handling, records, and logbooks. Field techniques will be observed to determine actual sampling practices.

The on-site environmental analytical laboratory will be evaluated through the review of procedures and records and the observation of laboratory operations. No visits to off-site laboratories are anticipated for these operations; however, all available QA manuals and procedures will be reviewed.

Several areas for specific investigations were identified during a review of available documentation. For field sampling, these include field technician training, sampling procedures, equipment and instrument calibration/maintenance, sample handling, chain-of-custody procedures, and field notebook maintenance. For laboratory analysis, areas for specific investigation include laboratory technician training; instrument calibration and maintenance; blank, split, and spiked sample analyses; precision and accuracy studies; data reduction and validation; data reporting and documentation; and calculation and logbook maintenance procedures.

10.2 Records Required

No additional records related to QA are required at this time.

TABLE 1

PRINCETON PLASMA PHYSICS LABORATORY ENVIRONMENTAL SURVEY AGENDA

	Air (R. Lanza)	RCRA/Tanks (D. Habib)	Radiation/Quality Assurance (E. Harr)	Toxic and Chemical Materials/Hydrogeology (W. Downey)	Surface Water/Inactive Waste Sites (W. Levitan)
Monday, June 13					
AM	Orientation Document review - permits, emissions calculations, ventilation diagrams, dose calculations	Orientation Interview with Scott Larson, tour of C Site (Hazmat Bldg, hazardous waste generation and accumulation areas, degreasers, waste oil and spent solvent generation points)	Orientation Interviews regarding source inventory, AIRDOS calculations, PTL sampling (w/Hydrogeology and Surface Water)	Orientation Laboratories in C32, interview regarding PTL sampling (w/Rad and Surface Water)	Orientation Tour water treatment area and cooling towers, interview regarding PTL sampling (w/Rad and Hydrogeology)
PM	TFTR Test Cell, D42 (w/Rad and TSCA)	AM tour continued, 307 College Road, C91 degreaser	TFTR Test Cell, D42 (w/Air and TSCA)	TFTR Test Cell, D42 (w/Air and Rad)	Tour surface water sampling locations and observe chemical sampling of surface water; review of historical photographs
Tuesday, June 14					
AM	C21, 22 (w/TSCA), 32, 40, 41, 42 shops; C Site laser labs (w/RCRA)	C Site laser labs (w/Air), interview with radioactive waste handling personnel	Interview regarding past use of A and B Sites, tour of A and B Sites (PPA, boneyard, I-L garage) (w/Inactive Waste Sites)	C20, 22 (w/Air), 50	Interview regarding past use of A and B Sites, tour of A and B Sites (PPA, boneyard, I-L garage) (w/Rad)
PM	C20 shop (w/TSCA), C41 steam boilers, C90 and 92 shops	Tour of D Site radioactive waste areas - radwaste trailers, LECTs, D52 glovebox, TFTR test cell radwaste staging areas	Observe rad surface water sampling (w/Surface Water), observe groundwater sampling (w/Hydrogeology)	A Site wells, C Site wells (4 and 5), D Site wells (1 and 10); observe groundwater sampling (w/Rad); tour C64 and 65	Interviews with Maintenance personnel regarding stormwater, water treatment, cooling towers, observe rad surface water sampling event (w/Rad)
Wednesday, June 15					
AM	D52, D Site laser labs, D Site solvent labs	Visit scintillation counters, interview regarding history and current disposition of storage tanks, visit tanks	Tour outside TLD locations	Transformer yard south of D53; C91 capacitor yard south of C52	Tour of C and D Sites - former spill locations, detention basin, stormwater routing, former sewage treatment plant, compost pile, LECTs
PM	REML, ambient air monitoring stations, observe air sampling (w/Rad)	Continue tank tour, tour D Site hazardous waste generation and accumulation areas and waste oil and spent solvent generation points	REML, ambient air monitoring stations, observe air sampling (w/Air)	Detention basin	AM tour continued
Thursday, June 16					
AM	Revisits	Revisits	Revisits	Interview regarding pesticide usage; revisits	Revisits
PM	Findings development	Findings development	Findings development	Findings development	Findings development
Friday, June 17					
AM	Close-out meeting	Close-out meeting	Close-out meeting	Close-out meeting	Close-out meeting

TABLE 2

THE PRINCETON PLASMA PHYSICS LABORATORY ENVIRONMENTAL SURVEY

AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

WASTE MANAGEMENT/STORAGE TANKS D. Habib	-	Hazardous Waste Non-Hazardous Waste RCRA/Solid Waste Permits Mixed Waste Radioactive Waste Underground and Aboveground Storage Tanks
RADIATION/SOILS E. Harr	-	Radioactive Emissions and Effluents Source Controls and Monitoring Radioactive Waste Environmental Monitoring - Radiation Soil Types Soil Contamination
AIR R. Lanza	-	Meteorology Local Air Quality Data Emission Sources, Control and Monitoring Environmental Monitoring - Air Air Permits and Air Emissions Inventory
SURFACE/DRINKING WATER W. Levitan	-	Effluent Sources Wastewater (Process and Sanitary Treatment) Facilities Cooling Water System Drinking Water Distribution Stormwater Management Spill Prevention, Control and Counter-measure Plan
HYDROGEOLOGY W. Downey	-	Waste Storage and Disposal Sites (Past and Active) Spill/Accident Locations Regional Geology and Groundwater Well Inventory and Construction Groundwater Monitoring Program and Studies

TABLE 2

THE PRINCETON PLASMA PHYSICS LABORATORY ENVIRONMENTAL SURVEY

AREAS OF INTEREST FOR TECHNICAL SPECIALISTS (Continued)

INACTIVE WASTE SITES/ RELEASES W. Levitan	- Past Waste Site Locations Characterization Studies Spill/Accident Locations Remediation Work Former Production Locations
QUALITY ASSURANCE E. Harr	- Environmental Sampling Program Environmental Analytical Program Data Management and Handling QA Program Overview
TOXIC AND CHEMICAL MATERIALS-TSCA W. Downey	- Process Chemicals and Substances Inventory Asbestos Use Evaluation Asbestos Removal and Disposal PCBs In-Service, Storage, and Disposal Pesticide Use, Storage, and Disposal Warehousing and Storage Tanks for Process Chemicals

APPENDIX D

LIST OF ABBREVIATIONS, ACRONYMS, AND INITIALISMS

LIST OF ABBREVIATIONS, ACRONYMS, AND INITIALISMS

AAQS	-	Ambient Air Quality Standard
AEC	-	United States Atomic Energy Commission
APCD	-	Air Pollution Control District
BDL	-	below detection limit
BOD	-	biochemical oxygen demand
Btu/hr	-	British thermal unit(s) per hour
°C	-	degree celsius (centigrade)
$CaCO_3$	-	calcium carbonate
CAS	-	Component Assembly Space
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act
CH	-	Chicago Operations Office (DOE)
CICADA	-	Central Instrumentation Control and Data Acquisition
CIT	-	Compact Ignition Tokamak
CO	-	carbon monoxide
COB	-	C-Stellarator Operating Board
COD	-	chemical oxygen demand
CS	-	C-Stellarator
D	-	deuterium (also designated as H^2)
DAS	-	Deputy Assistant Secretary
DATS	-	differential atmospheric tritium samplers
DE	-	dose equivalent
DOE	-	United States Department of Energy
D&R	-	Delaware and Raritan
ECRA	-	Environmental Cleanup Responsibility Act (New Jersey)
EDE	-	effective dose equivalent
EDTA	-	ethylenediaminetetraacetic acid
EML	-	DOE Environmental Measurement Laboratory
EMR	-	Environmental Monitoring Report
EP	-	Extraction Procedure
EPA	-	United States Environmental Protection Agency
eq	-	equivalent
EZB	-	exclusion zone boundary
FCPC	-	Field Coil Power Converter
ft^3/sec	-	cubic feet per second
FUSRAP	-	Formerly Utilized Sites Remedial Action Program
GM	-	Geiger - Mueller
gpm	-	gallon(s) per minute
H^2	-	deuterium (also designated as D)
H^3	-	tritium (also designated as T and HT)
HAZMAT	-	Hazardous Material Control (Building)
HP	-	Health Physics
HP	-	horsepower
HT	-	tritium (also designated as H^3 and T)

HTO	-	tritium oxide
ICRP	-	International Commission on Radiological Protection
INEL	-	Idaho National Engineering Laboratory
IPCS	-	Inland Pollution Control Services
keV	-	kiloelectronvolt(s)
kV	-	kilovolt
LECTs	-	Liquid Effluent Collection Tanks
LOB	-	Laboratory/Office Building
MC	-	Material Control
mCi	-	millicurie(s)
MeV	-	megaelectronvolt(s)
MG	-	Motor Generator
mgd	-	million gallons per day
mg/g	-	milligram(s) per gram
mg/kg	-	milligram(s) per kilogram
mg/L	-	milligram(s) per liter
MM	-	million
mrem	-	millirem
mrem/yr	-	millirem per year
mR/hr	-	milliroentgens per hour
MSDS	-	Material Safety Data Sheet
m/sec	-	meter(s) per second
NAAQS	-	National Ambient Air Quality Standard
NB	-	Neutral Beam
NESHAP	-	National Emission Standards for Hazardous Air Pollutants
NBPC	-	Neutral Beam Power Converter
NCRP	-	National Council on Radiation Protection and Measurements
NJDEP	-	New Jersey Department of Environmental Protection
NPDES	-	National Pollutant Discharge Elimination System
OEG	-	Office of Environmental Guidance and Compliance (DOE)
P	-	phosphorus
PAO	-	Princeton Area Office (DOE)
PBX-M	-	Princeton Beta Experiment-Modification
PCB	-	polychlorinated biphenyl
pCi/L	-	picocurie(s) per liter
PLT	-	Princeton Large Torus
PPA	-	Princeton-Pennsylvania Accelerator
ppm	-	part(s) per million
PPPL	-	Princeton Plasma Physics Laboratory
PTL	-	Princeton Testing Laboratory
Pu/Be	-	plutonium/beryllium
QA	-	quality assurance
QC	-	quality control
RCRA	-	Resource Conservation and Recovery Act
REML	-	Radiological Environmental Monitoring Laboratory

RESA	-	Research Equipment Storage and Assembly
RF	-	Radio Frequency
RMSA	-	radioactive materials storage area
S-1	-	Spheromak
S&A	-	sampling and analysis
SARA	-	Superfund Amendments and Reauthorization Act
SBRSA	-	Stony Brook Regional Sewerage Authority
SFMP	-	Surplus Facilities Management Program
SPCC	-	Spill Prevention, Control, and Countermeasures
STP	-	sewage treatment plant
T	-	tritium (also designated as HT and H^3)
TDS	-	total dissolved solids
TFTR	-	Tokamak Fusion Test Reactor
TSCA	-	Toxic Substances Control Act
TSD	-	treatment, storage, and disposal
TSP	-	total suspended particulates
TSS	-	total suspended solids
$\mu Ci/m^3$	-	microcurie(s) per cubic meter
µg/L	-	microgram(s) per liter
µrem/hr	-	microrem per hour
USDA	-	United States Department of Agriculture
USSR	-	Union of Soviet Socialist Republics
USGS	-	United States Geological Survey
UST	-	underground storage tank
VOC	-	volatile organic compound

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