1 Introduction

Each year, Brookhaven National Laboratory, a U.S. Department of Energy national laboratory, prepares an annual Site Environmental Report summarizing the status of its environmental programs and performance, as well as any impacts, both past and present, that Laboratory operations have had on the environment. Located in the center of the unique Pine Barrens ecosystem of Long Island, New York, Brookhaven National Laboratory is committed to conducting its mission of research and education in a safe and environmentally responsible manner. Chapter 1 describes the site's facilities, ecological resources, demographics, and history. It also discusses local characteristics in terms of geology, hydrology, and climate, providing background material for the technical information in the chapters that follow.

1.1 SITE ENVIRONMENTAL REPORT PURPOSE

Brookhaven National Laboratory (BNL) prepares an annual Site Environmental Report (SER) in accordance with the U.S. Department of Energy's (DOE) Order 231.1, "Environment, Safety and Health Reporting." The SER summarizes BNL's on-site environmental data; environmental management performance; compliance with applicable Environmental Protection Agency (EPA), DOE, state, and local regulations; and environmental, restoration, and surveillance monitoring programs. The report is written to meet DOE requirements and guidelines and to inform BNL employees, outside regulators, and the general public of BNL's environmental performance during the year in review.

BNL has been preparing annual SERs since 1971. In June 2001, BNL published *Radiological Emissions and Environmental Monitoring for Brookhaven National Laboratory, 1947–1961* (Meinhold and Meinhold 2001). That report, combined with *Radiological Environmental Monitoring Report for Brookhaven National Laboratory, 1967–1970* (Meinhold and Hull 1998), as well as other individual reports written from 1962 through 1966, has enabled BNL to compile and record nearly all of its environmental history since the Laboratory's inception in 1947.

The 2002 SER describes the status and results of BNL's environmental protection programs for the calendar year and is intended to be a technical document. It is available in hard copy and as a downloadable file on the BNL web page at http://www.bnl.gov/esd/ser.htm. A summary of the SER is also prepared as a separate document to provide a general overview and includes a CD version of the SER (see inside front cover for ordering information). The SER Summary provides environmental information to BNL's employees, stakeholders, visitors, students, and members of the public, in support of BNL's educational and community outreach program.

1.2 MISSION

BNL's broad mission is to produce excellent science in a safe, environmentally responsible manner with the cooperation, support, and appropriate involvement of the scientific and local communities. The Laboratory plays a lead role in the DOE Science and Technology mission and contributes to the DOE missions in Energy Resources, Environmental Quality, and National Security. The fundamental elements of BNL's role in support of these key DOE missions are:

- To conceive, design, construct, and operate complex, leading-edge, user-oriented

research facilities in response to the needs of DOE and the international community of users.
- To carry out basic and applied research in long-term, high-risk programs at the frontier of science.
- To develop advanced technologies that address national needs and to transfer them to other organizations and to the commercial sector.
- To disseminate technical knowledge, to educate new generations of scientists and engineers, to maintain technical capabilities in the nation's workforce, and to encourage scientific awareness in the general public.

It is BNL's policy to integrate environmental stewardship into all facets of its missions and operations. BNL's Environmental Stewardship Policy, which is posted throughout the site, represents the highest level of commitment to conducting research and operational activities in a manner that protects the ecosystem and the health of employees on site and of the general public.

1.3 OPERATIONS

Established in 1947, BNL is a multi-program national laboratory operated for DOE by Brookhaven Science Associates (BSA), a not-for-profit partnership between Battelle Memorial Institute and the Research Foundation of the State University of New York on behalf of the State University of New York at Stony Brook. BSA began operating the Laboratory on March 1, 1998 under DOE Contract No. DE-AC02-98CH10886. From 1947 to 1998, BNL was operated by Associated Universities Incorporated. Prior to 1947, the site was operated as Camp Upton, a U.S. Army training camp, which was active from 1917 to 1920 during World War I and from 1940 to 1946 during World War II. Many of the cultural resources from this era are preserved in the Camp Upton Museum (see Chapter 6 for details).

BNL conducts research in physics and in chemical, biological, biomedical, and environmental sciences, as well as energy technologies. BNL also builds and operates major world-class research facilities available to university, industrial, and government scientists. Approximately 3,000 scientists, engineers, technicians, and support staff work at BNL, and more than 4,000 guest researchers from all over the world visit the site each year to participate in scientific collaborations. Some important scientific discoveries and research at BNL include major discoveries in particle physics; the use of L-dopa to treat Parkinson's disease; work on magnetically levitated (Maglev) trains; the radionuclide thallium-201, used in millions of heart stress tests each year; pollution-eating bacteria; structural studies of the Lyme disease protein for new vaccines; asbestos-digesting foam; quiet jackhammers; promising cocaine addiction treatments; and cleaner, more efficient oil burners. In 2001, BNL was ranked by *Environmental Protection* magazine as one of the top five major institutions worldwide for its impact in environmental research and received three Energy 100 Awards from DOE for scientific and technological achievements. The recognized research included studies of drug addiction and drug action using the Positron Emission Tomography (PET) imaging technique; invention of the Flame Quality Indicator, a device that measures flame brightness in oil burners; and development of techniques for preventing and diagnosing Lyme disease. In 2002, BNL chemist Raymond Davis, Jr. and two colleagues won the 2002 Nobel Prize in Physics for detecting solar neutrinos, which are ghostlike particles produced in the nuclear reactions that power the sun. Also in 2002, a BNL atmospheric chemist was one of four recipients of Southampton College's first annual environmental leadership awards for research on strategies to control the nation's air quality problems.

BNL is the largest employer on eastern Long Island, with an annual budget of over $450 million. Most of this budget directly supports the local economy through wages and purchases of materials and services. In fiscal year 2002, BNL purchased more than $31 million worth of supplies and services from Long Island businesses. Construction of new buildings, repair of the Laboratory's aging infrastructure, and environmental cleanup accounted for a large part of the local expenditures. Employee salaries, wages, and fringe benefits accounted for 58

percent, or almost $269 million, of BNL's total budget of $463 million in 2002. Additionally, most of the Laboratory's employees live and shop locally in Suffolk County and throughout Long Island. An independent Suffolk County Planning Commission report concluded that BNL's spending for operations, procurement, payroll, construction, medical benefits, and technology transfer spreads throughout Long Island's economy, making BNL vital to Long Island's economic health (Kamer 1995).

1.4 HISTORY

BNL was founded in 1947 by the Atomic Energy Commission. The objective was to build a regional laboratory that could provide researchers with powerful tools too costly for their home institutions to build and maintain. Although BNL no longer operates any research reactors, the Laboratory's first major scientific facility was the Brookhaven Graphite Research Reactor (BGRR), which operated from 1950 to 1969 and is now being decommissioned. The BGRR was used for peaceful scientific exploration in the fields of medicine, biology, chemistry, physics, and nuclear engineering. The BGRR's capacity was replaced and surpassed in 1965 by the High Flux Beam Reactor (HFBR), which provided neutrons to researchers in diverse subjects ranging from solid state physics to art history. During a scheduled maintenance shutdown in 1997, workers discovered a leak in the HFBR's spent fuel storage pool; in November 1999, the Secretary of Energy decided that the HFBR would be permanently closed. All spent fuel has been transported to DOE's Savannah River Site.

Medical research at BNL began in 1950 with the opening of one of the first hospitals devoted to nuclear medicine. It was followed by the Medical Research Center in 1958, the Brookhaven Medical Research Reactor (BMRR) in 1959, and the Brookhaven Linac Isotope Producer (BLIP) in 1973. Chemists and physicians could view the inner workings of the brain in 1977 with the advent of PET cameras. Two more imaging techniques were added to the PET research efforts to form the Center for Imaging and Neuroscience in 1996. Except for the BMRR, all of these medical facilities are currently operating. Due to a reduction of research funding, the BMRR shut down on December 20, 2000. All spent fuel has been transported to DOE's Savannah River Site.

High-energy particle physics research at BNL began in 1952 with the Cosmotron, the first particle accelerator to achieve billion-electron-volt energies. Work at the Cosmotron resulted in a Noble Prize-winning discovery in 1957. In 1960, the Alternating Gradient Synchrotron (AGS), a much larger accelerator that surpassed the Cosmotron's capabilities, became operational. The AGS, still in operation, has yielded many discoveries of new particles and phenomena, for which BNL researchers were awarded three Nobel Prizes in Physics in 1976, 1980, and 1988. The Tandem Van de Graaff accelerator, also still in use, began operating in 1970 and is the starting point of the chain of accelerators that provide gold and other heavy ions for experiments at the Relativistic Heavy Ion Collider (RHIC), discussed below. In 1982, researchers began using the National Synchrotron Light Source (NSLS), which guides charged particles in orbit inside a donut-shaped electron storage ring for use in a wide range of physical and biological experiments.

The RHIC, the Laboratory's new two-ringed particle accelerator, began operation in 2002. The four RHIC detectors record full-energy collisions that recreate (on a microscopic scale) the hot, dense conditions that are thought to have existed when the universe first formed. This enables scientists to study the basic components of matter as they existed in their earliest forms. In August 1999, the RHIC became the first facility at BNL and also on Long Island to receive International Organization for Standardization (ISO) 14001 Environmental Management System certification (see Chapter 2 for details). The RHIC is an example of BNL's commitment to fully integrate today's world-class science with world-class protection of the environment.

Historical operations and past waste management practices at the Laboratory permitted the release of chemicals and radioactive materials that resulted in soil and groundwater contamination. In 1989, BNL was added to the federal Comprehensive Environmental Response,

Compensation and Liability Act (CERCLA) National Priorities List of environmentally contaminated sites identified for priority cleanup. Since then, BNL has made significant progress toward improving environmental operations and remediating past contamination. In 2002, BNL received an "Outstanding" performance rating from DOE for its environment, safety, and health performance. BNL also received an "Outstanding" performance rating in pollution prevention measures, which are a key component of the Laboratory's Environmental Management System.

1.5 LOCATION AND LOCAL POPULATION

BNL is located in Suffolk County on Long Island, New York, about 60 miles east of New York City. The Laboratory's 5,265-acre site is near Long Island's geographic center and is part of the Town of Brookhaven, the largest township (both in area and population) in Suffolk County. More than 75 percent of the Laboratory's approximately 3,000 employees live within a 15-mile radius of BNL. Approximately 150 people reside long-term in apartments and cottages on site, and many of the approximately 4,000 scientists and students who visit each year stay in the Laboratory's short-term housing. In addition to the resident staff and visiting scientists, more than 29,000 visitors participated in educational outreach activities conducted on site in 2002.

1.6 FACILITIES AND OPERATIONS

Most of BNL's principal facilities are located near the center of the site. The developed area is approximately 1,650 acres:

- 500 acres originally developed by the Army (as part of Camp Upton) and still used for offices and other operational buildings
- 200 acres occupied by large, specialized research facilities
- 550 acres occupied by outlying facilities, such as the Sewage Treatment Plant, research agricultural fields, housing facilities, and fire breaks
- 400 acres of roads, parking lots, and connecting areas.

The balance of the site, approximately 3,600 acres, is mostly wooded and represents the native Pine Barrens ecosystem. In November 2000, DOE set aside 530 acres of undeveloped land at BNL as the Upton Ecological and Research Reserve (Figure 1-1). Further details regarding the reserve and BNL's natural resources can be found in Section 1-9 of this chapter and in Chapter 6.

The major scientific facilities at BNL are pictured and briefly described in Figure 1-2. As described in Section 1.4, there are three nonoperational research reactors (the BGRR, the HFBR, and the BMRR). In addition to the scientific facilities, numerous other facilities (described below) support BNL's science and technology mission by providing basic utility and environmental services (Figure 1-3):

- *Water Treatment Plant*. The potable water treatment facility has a capacity of 5 million gallons per day. Potable water is obtained from six on-site wells. Three wells located along the western boundary of the site are treated with a lime softening process to remove naturally occurring iron. The plant is also equipped with dual air-stripping towers to ensure that volatile organic compounds (VOCs) are at or below New York State drinking water standards. Three wells located along the eastern section of the developed site are treated with carbon to ensure that VOC levels meet the standards.
- *Central Chilled Water Plant*. This facility provides chilled water sitewide for air conditioning and process refrigeration via underground piping. The plant has a large refrigeration capacity with once-through cooling, and reduces the need for local refrigeration plants.
- *Central Steam Facility (CSF)*. This dual-fuel-fired plant provides high-pressure steam for facility and process heating sitewide. Both natural gas and fuel oil can be used to produce the steam, which is conveyed to other facilities through underground piping. Condensate is collected and returned to the CSF for reuse, to conserve water and energy.
- *Major Petroleum Facility (MPF)*. This facility provides reserve fuel for the CSF during times of peak operation. With a total capacity of 2.3 million gallons, the MPF primarily stores No. 6 fuel oil. The 1997 conversion of the CSF boilers to burn natural gas as well as oil has significantly reduced

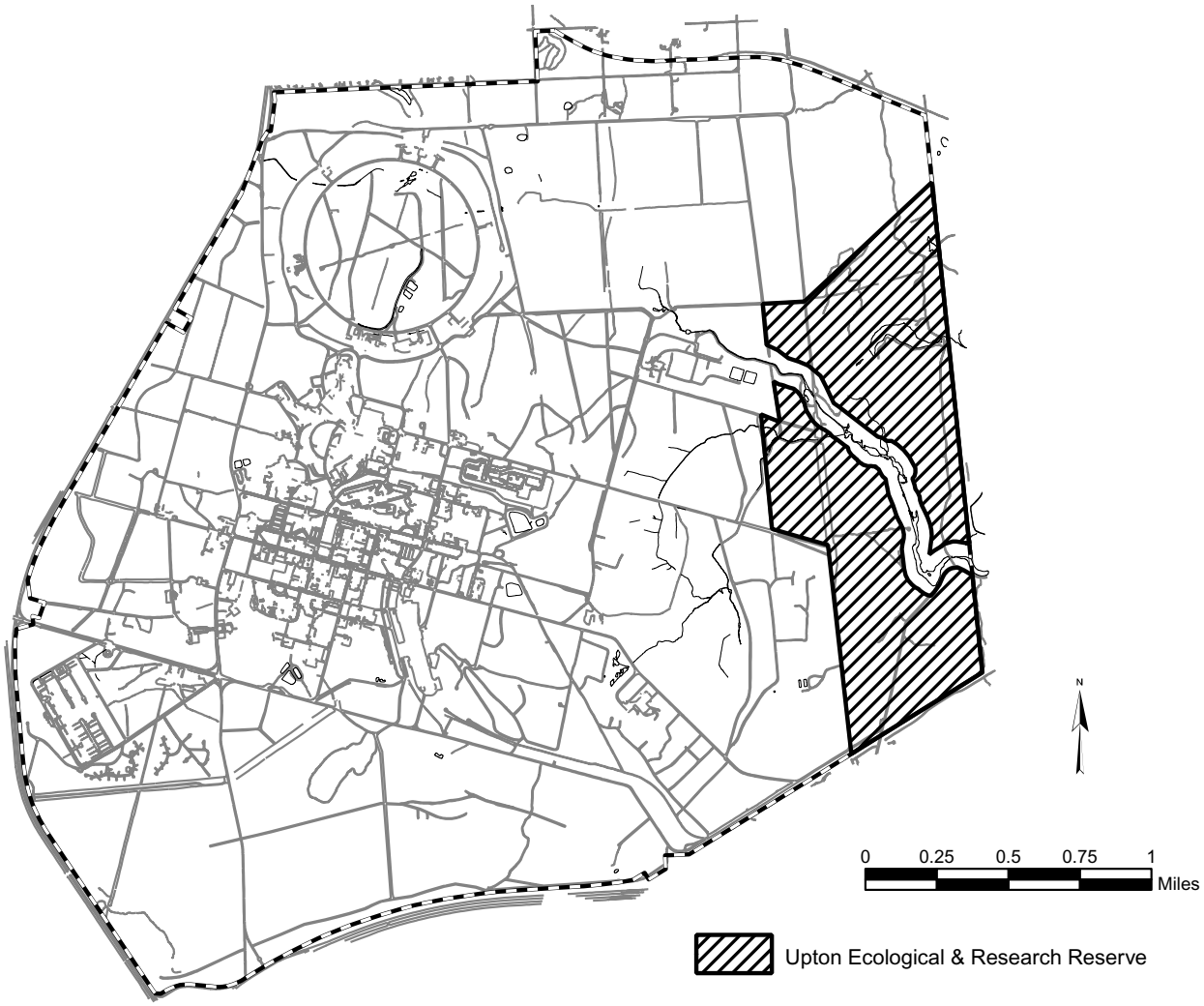
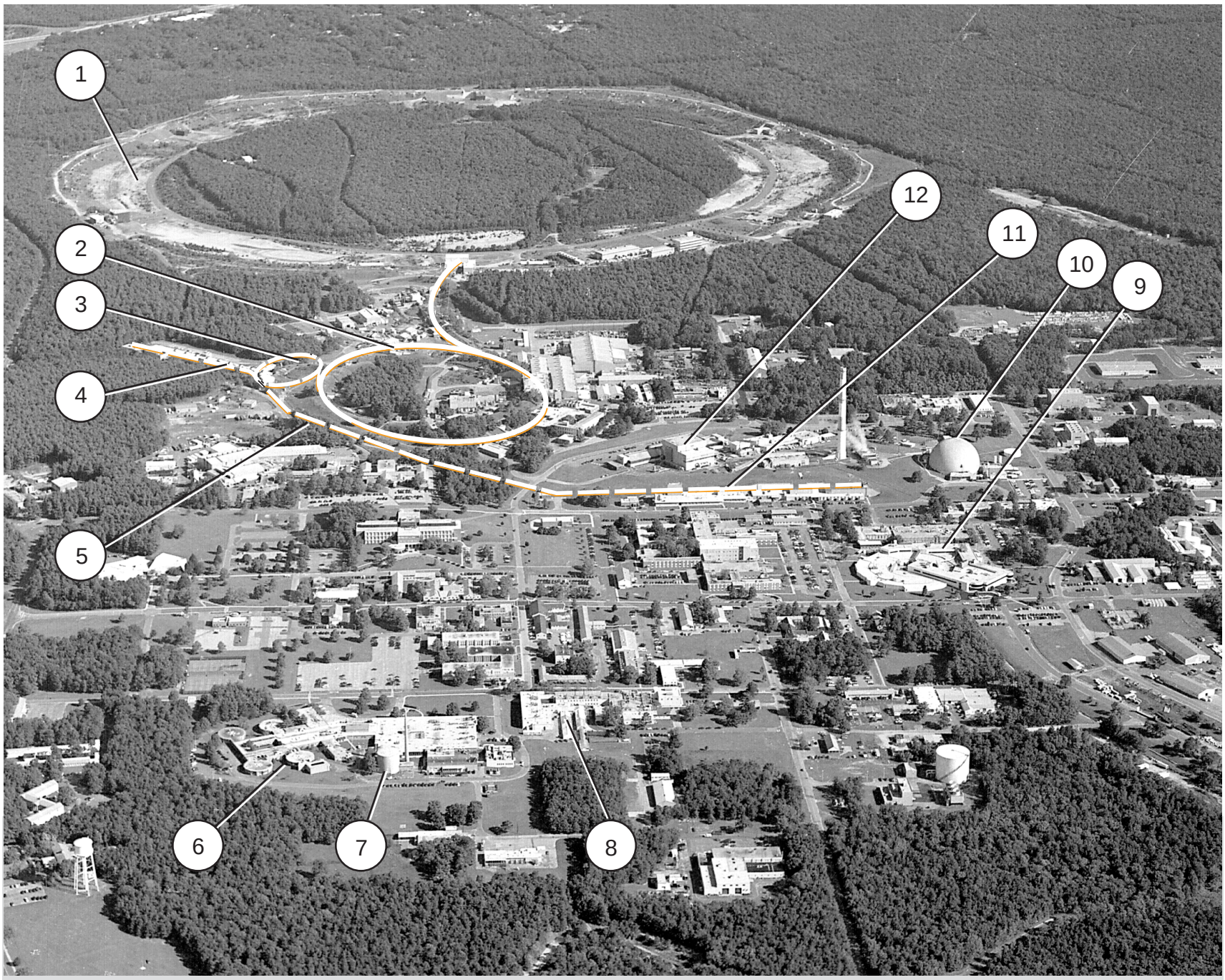


Figure 1-1. Upton Ecological and Research Reserve.

BNL's reliance on oil as a fuel source.

- *Sewage Treatment Plant*. This facility treats sanitary and certain process wastewater from BNL facilities prior to discharge into the Peconic River, similar to the operations of a municipal sewage treatment plant. The plant has a design capacity of 3 million gallons per day. Effluent is monitored and controlled under a permit issued by the New York State Department of Environmental Conservation (NYSDEC).
- *Waste Management Facility*. This facility is a state-of-the-art complex for managing the wastes generated from BNL's research and operations activities. The facility began operation in December 1997 and was built with advanced environmental protection systems and features. It houses two areas that have permits from NYSDEC for storing hazardous wastes prior to shipment for treatment and disposal at other permitted facilities.
- *Fire Station*. The BNL Fire Department provides on-site fire suppression, emergency medical services, hazardous material response, salvage, and damage control. The Fire Station houses six response vehicles. The fire rescue group responds within five minutes to any emergency in the core area of the Laboratory and within eight minutes to emergencies in the outer areas (RHIC and eastern portions of the site).



1. RELATIVISTIC HEAVY ION COLLIDER (RHIC)

RHIC is one of the world's largest and most powerful accelerators. RHIC's main physics mission is to study particles smaller than atoms.

2. ALTERNATING GRADIENT SYNCHROTRON (AGS)

The AGS is used for high-energy physics research and accelerates protons to energies up to 30 GeV, and heavy-ion beams to 15 GeV. A 200 MeV Linear Accelerator, described below, serves as a proton injector for the AGS booster and also supplies a continuous beam of protons for radionuclide production by spallation reactions in the Brookhaven Linac Isotope Producer (BLIP) facility.

3. AGS BOOSTER

The AGS Booster is a circular accelerator, 200 meters in circumference, that receives either a proton beam from the Linac, or heavy ions from the Tandem Van de Graaff. The AGS Booster accelerates proton particles and heavy ions before injecting them into the AGS ring. This facility became operational in 1992.

4. LINEAR ACCELERATOR (LINAC) AND BROOKHAVEN LINAC ISOTOPE PRODUCER (BLIP)

The Linac provides beams of polarized protons for the AGS and for the Relativistic Heavy Ion Collider. BLIP utilizes the excess beam capacity of the Linac to produce radioisotopes used in research and medical imaging. It is one of the key production facilities in the nation for radioisotopes which are crucial to clinical nuclear medicine. It also supports research on new diagnostic and therapeutic radiopharmaceuticals.

5. HEAVY ION TRANSFER LINE (HITL)

The HITL connects the Tandem Van de Graaff and the AGS Booster. This interconnection permits ions of intermediate mass to be injected into the AGS where they can be accelerated to an energy of 15 GeV. These ions then are extracted and sent to the AGS experimental area for physics research.

6. RADIATION THERAPY FACILITY (RTF)

Part of the Medical Research Center, the RTF is a high-energy dual x-ray mode linear accelerator for radiation therapy of cancer patients. This accelerator delivers therapeutically useful beams of x-rays and electrons for conventional and advanced medical radiotherapy techniques.

7. BROOKHAVEN MEDICAL RESEARCH REACTOR (BMRR)

The BMRR was the world's first nuclear reactor built exclusively for medical research applications and therapy. It produced neutrons in an optimal energy range for experimental treatment of a type of brain cancer known as glioblastoma multiforme. This reactor stopped operating in December 2000.

8. SCANNING TRANSMISSION ELECTRON MICROSCOPE (STEM)

This facility includes two microscopes, STEM 1 and STEM 3, used for biological research. Both devices allow scientists to see the intricate details of living things, from bacteria to human tissue.

9. NATIONAL SYNCHROTRON LIGHT SOURCE (NSLS)

The NSLS utilizes a linear accelerator and booster synchrotron as an injection system for two electron storage rings which operate at energies of 750 MeV vacuum ultraviolet (VUV) and 2.5 GeV (x-ray). The synchrotron radiation produced by the stored electrons is used for VUV spectroscopy and x-ray diffraction studies.

10. HIGH FLUX BEAM REACTOR (HFBR)

The HFBR was one of the premier neutron physics research facilities in the world. Neutron beams produced at the HFBR were used to investigate the molecular structure of materials, which aided in pharmaceutical design and materials development as well as expanded the knowledge base of physics, chemistry, and biology. A leak in the fuel storage pool was discovered in 1997. Since that time, the HFBR has not been in operation and was permanently shut down in November 1999.

11. TANDEM VAN DE GRAAFF AND CYCLOTRON

These two facilities are used in medium-energy physics investigations and for producing special nuclides. The heavy ions from the Tandem Van de Graaff also can be injected into the AGS Booster for physics experiments.

12. BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)

No longer in operation, the BGRR was used for scientific exploration in the fields of medicine, biology, chemistry, physics, and nuclear engineering.

Figure 1-2. Major Scientific Facilities at Brookhaven National Laboratory.

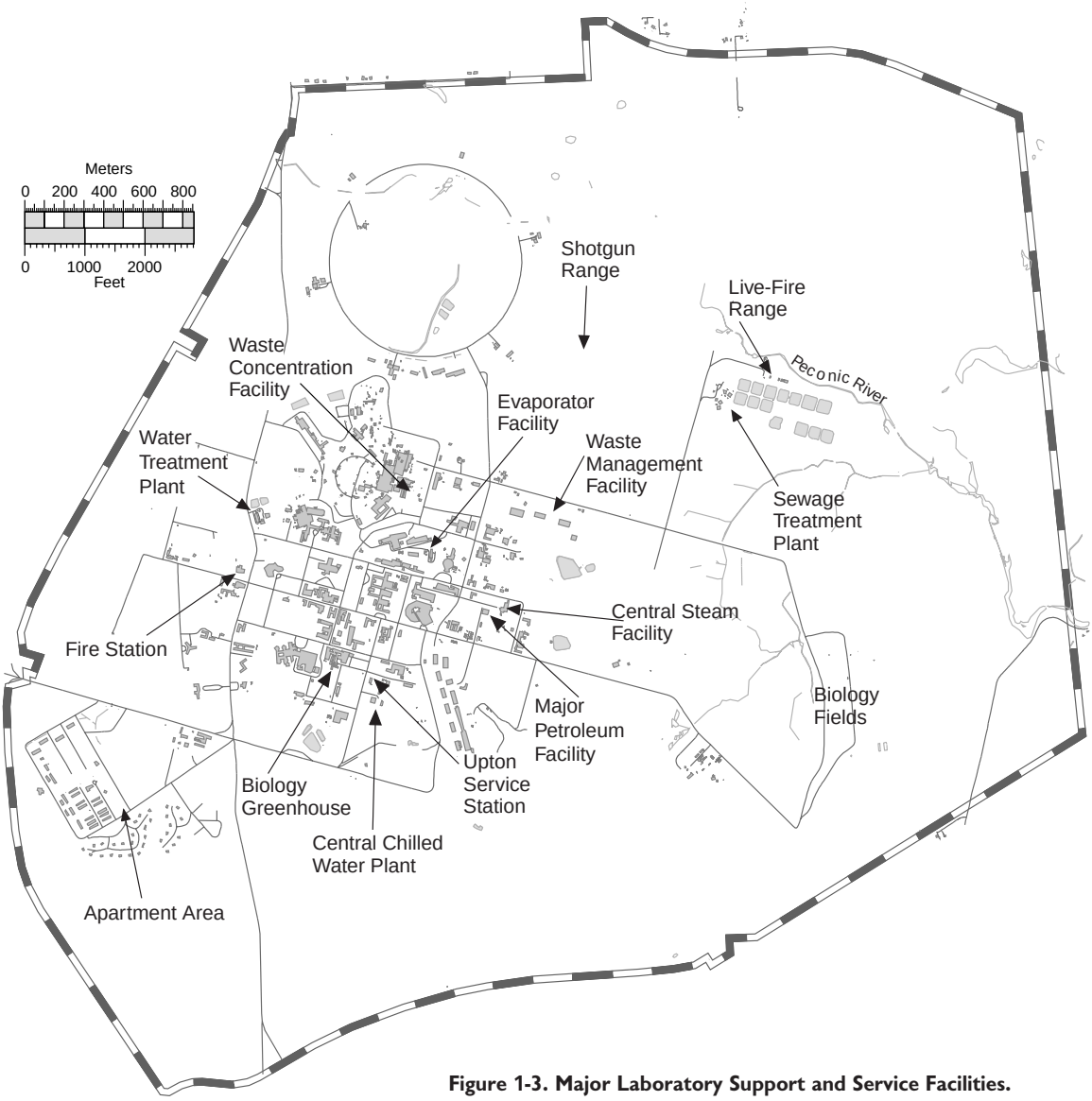


Figure 1-3. Major Laboratory Support and Service Facilities.

1.7 GEOLOGY AND HYDROLOGY

BNL is situated on the western rim of the shallow Peconic River watershed. The marshy areas in the northern and eastern sections of the site are part of the headwaters of the Peconic River. Depending on the height of the water table relative to the base of the riverbed, the Peconic River both recharges to, and receives water from, the sole source aquifer system beneath Long Island. In times of sustained drought, the river water typically recharges to the groundwater; with normal to above-normal precipitation, the river receives water from the aquifer. In 2002, there was no flow of the Peconic River off site due to drought conditions (see Chapter 5 for details on Peconic River sampling).

In general, the terrain of the BNL site is gently rolling, with elevations varying between 44 and 120 feet above mean sea level. Depth to groundwater from the surface of the land ranges from 5 feet near the Peconic River to about 80 feet in the higher elevations of the central and western portions of the site. The hydrology of the local area is well defined. Studies of Long Island hydrology and geology in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, composed of highly permeable glacial sands and gravel, are between 120 and 250 feet thick (Warren et al. 1968, Scorca et al.

1999). Water penetrates these deposits readily and there is little direct runoff into surface streams unless precipitation is intense. These sandy deposits store large quantities of water called the Upper Glacial aquifer. On average, about half of the annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates through the soil to recharge the groundwater (Koppelman 1978). The area has a high average recharge rate (22 inches per year) that varies seasonally.

The Long Island Regional Planning Board and Suffolk County have identified the BNL site as overlying a deep-flow recharge zone for Long Island groundwater (Koppelman 1978, Suffolk County Department of Health Services 1987). Precipitation and surface water that recharge within this zone have the potential to replenish the deep Magothy and Lloyd aquifer systems lying below the Upper Glacial aquifer. Experts estimate that up to two-fifths of the recharge from rainfall moves into the deeper aquifers. The extent to which groundwater at the BNL site contributes to deep flow recharge has been confirmed through the use of an extensive network of shallow and deep wells installed at BNL and surrounding areas (Geraghty and Miller 1996). This groundwater system is the primary source of drinking water for both on- and off-site private and public supply wells and, as such, has been designated a sole source aquifer system by EPA. BNL uses approximately 1.8 million gallons of groundwater per day to meet potable water needs and heating and cooling requirements. Approximately 60 percent of the water pumped from BNL supply wells is returned to the aquifer through on-site recharge basins. About 22 percent is discharged into the Peconic River. Human consumption, evaporation (cooling tower and wind losses), and sewer line losses account for the remaining 18 percent. An additional 3.6 million gallons of groundwater are pumped each day from remediation wells for treatment and then returned to the aquifer by way of recharge basins.

Groundwater flow direction across the BNL site is influenced by natural drainage systems moving eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River (Figure 1-4). Pumping from on-site supply wells affects the direction and speed of groundwater flow, especially in the central, developed areas of the site. The main groundwater divide on Long Island is aligned generally east–west, and lies approximately one-half mile north of BNL (Figure 1-4). Groundwater north of the divide flows northward and ultimately discharges to the Long Island Sound. Groundwater south of the divide flows southward and discharges to south shore streams, the Peconic River, Great South Bay, Peconic Bay, and the Atlantic Ocean. The regional groundwater flow system is discussed in greater detail in *Stratigraphy and Hydrologic Conditions* (Scorca et al. 1999).

In most areas at BNL, the horizontal velocity of groundwater is approximately 0.75 to 1.2 feet per day (Geraghty and Miller 1996). In general, this means that groundwater travels for approximately 20 to 22 years as it moves from the central, developed area of the site to the BNL southern boundary.

1.8 CLIMATE

The Meteorological Group at BNL has been collecting meteorological data on site since 1949. The prevailing ground-level winds at BNL are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall (Nagle 1975, 1978). Figure 1-5 shows the 2002 annual wind rose for BNL, which depicts the annual frequency distribution of wind speed and direction, measured at an on-site meteorological tower at heights of 33 feet (10 meters) and 300 feet (90 meters).

The average annual snowfall for BNL is 29.6 inches. The winter of 2002 was particularly mild, with a total of 5.5 inches of snowfall, the second lowest seasonal snowfall recorded on site. The average annual precipitation for BNL is 48.36 inches. Although the summer of 2002 was mostly dry, the total precipitation of 52.07 inches was above average. This was due to more rainfall than usual from September through December. Figures 1-6 and 1-7 show the 2002 monthly and the 54-year annual precipitation data.

The average yearly temperature on site is 50.0°F. In general, 2002 was a warm year, with

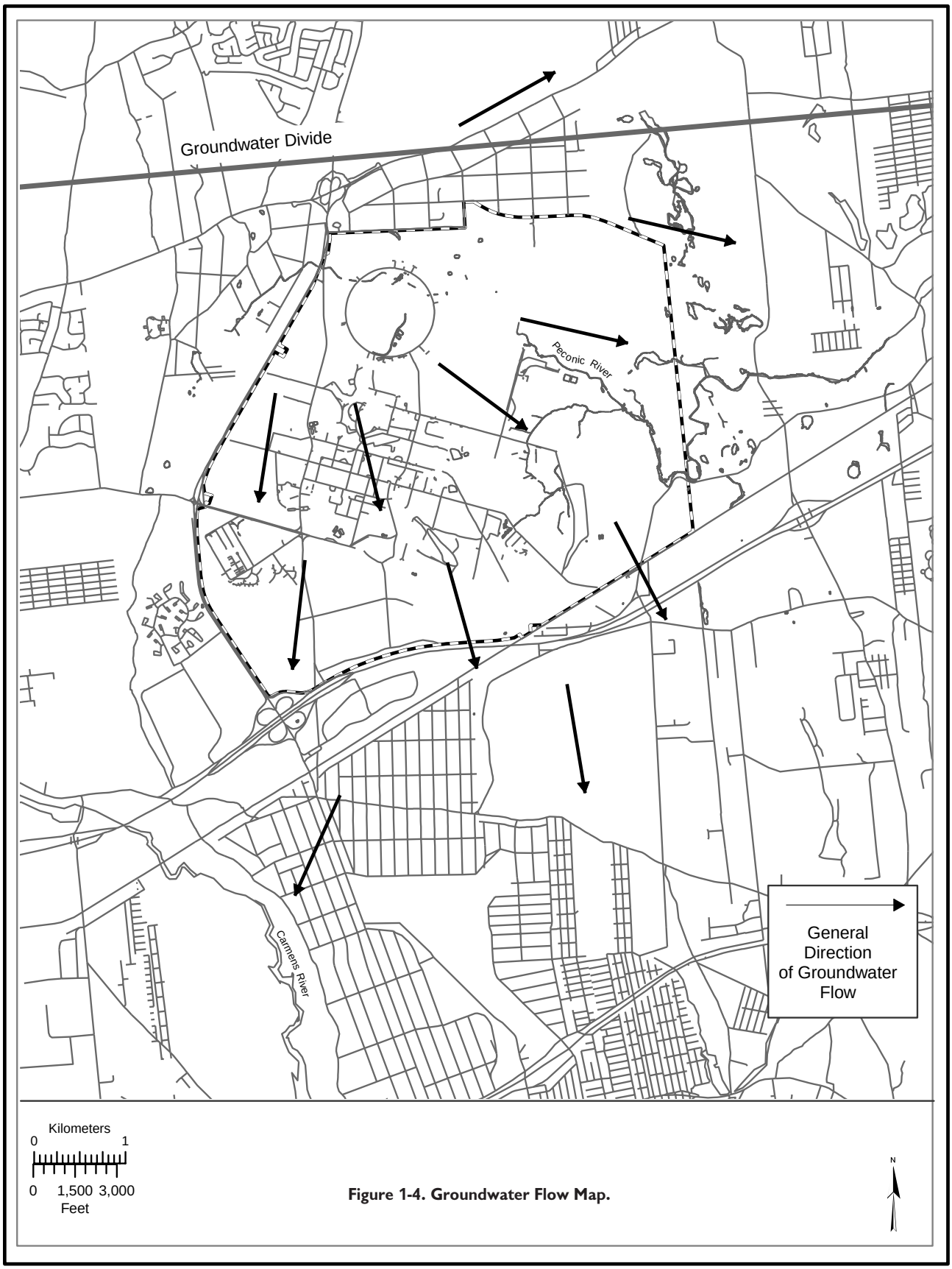
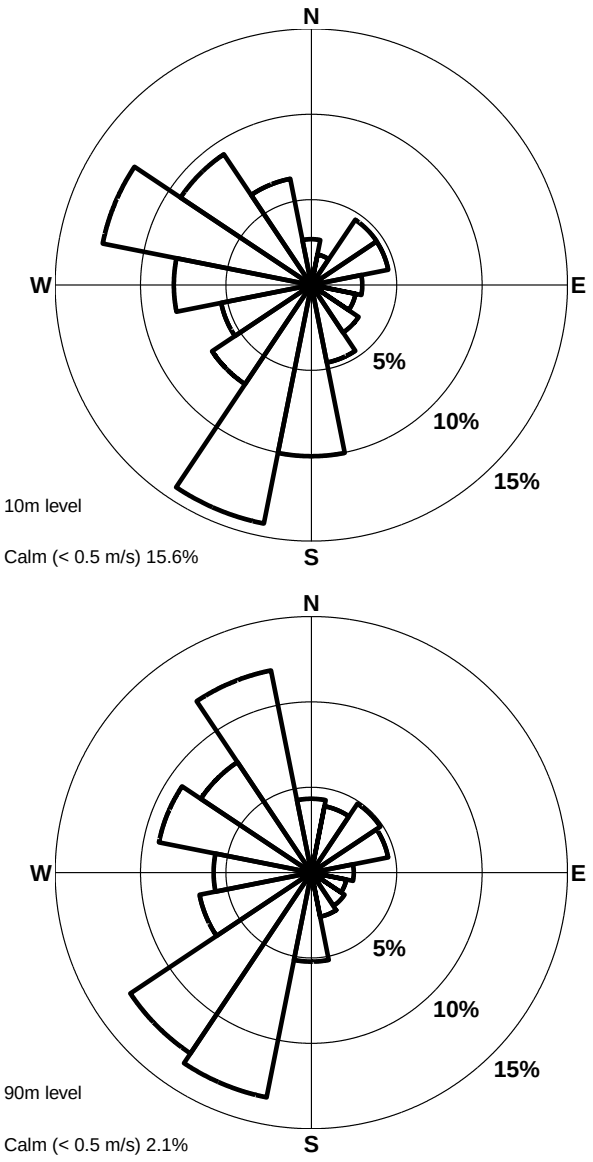


Figure 1-4. Groundwater Flow Map.



Explanation: The arrows formed by the wedges indicate wind direction. Each concentric circle represents a 5% frequency, that is, how often the wind came from that direction. The wind direction was measured at heights of 10 and 90 meters. This diagram indicates that the predominant wind direction was from the south-southwest, at both levels.

Figure 1-5. Annual Wind Rose (2002).

an average temperature of 52.7°F, almost three degrees above average. One record-low daily temperature and fifteen record-high daily temperatures were recorded. On May 19, the temperature dipped to the freezing point. The most dramatic high temperature occurred on January 29, when the temperature reached 69.5°F, which is 11.5°F higher than the previous record, set in 1974. On April 16, the temperature reached 89.5°F, also 11.5°F higher than the record, set in 1976. In general, using a linear average, temperatures at BNL have increased 2.05°F over the past 54 years, compared to a worldwide average surface temperature increase of 0.5°F over approximately the same time period (Jones et al. 1999). Figures 1-8 and 1-9 show the 2002 temperatures and the historical annual mean temperatures.

1.9 ECOLOGICAL RESOURCES

The BNL property is located in the oak/chestnut forest region of the Coastal Plain and constitutes about 5 percent of the 100,000-acre New York State-designated region known as the Central Pine Barrens. Part of the Peconic River, which runs through BNL, is designated "scenic" by the New York State Wild, Scenic, and Recreational River System Act (New York State 1972). As noted before, due to the general topography and porous soil, the land is very well drained and generally there is little surface runoff or open standing water. However, depressions form small, pocket wetlands with standing water on a seasonal basis (vernal pools), and there are six significant, regulated wetlands on site. Thus, a mosaic of wet and dry areas on the site correlates with variations in topography and depth to the water table.

Vegetation on site is in various stages of succession, which reflects a history of disturbances to the area. For example, when Camp Upton was constructed in 1917, the site was entirely cleared of its native pines and oaks. Portions were then cleared again in 1940 when Camp Upton was reactivated. Other past disturbances include fire, local flooding, and draining. Current operations minimize disturbances to the more natural areas of the site. More than 230 plant species have been identified on site, including the stiff goldenrod plant, a New York State threatened species.

The 15 mammal species identified at BNL include species common to mixed hardwood forests and open grassland habitats, and some New York State threatened, endangered, and species of special

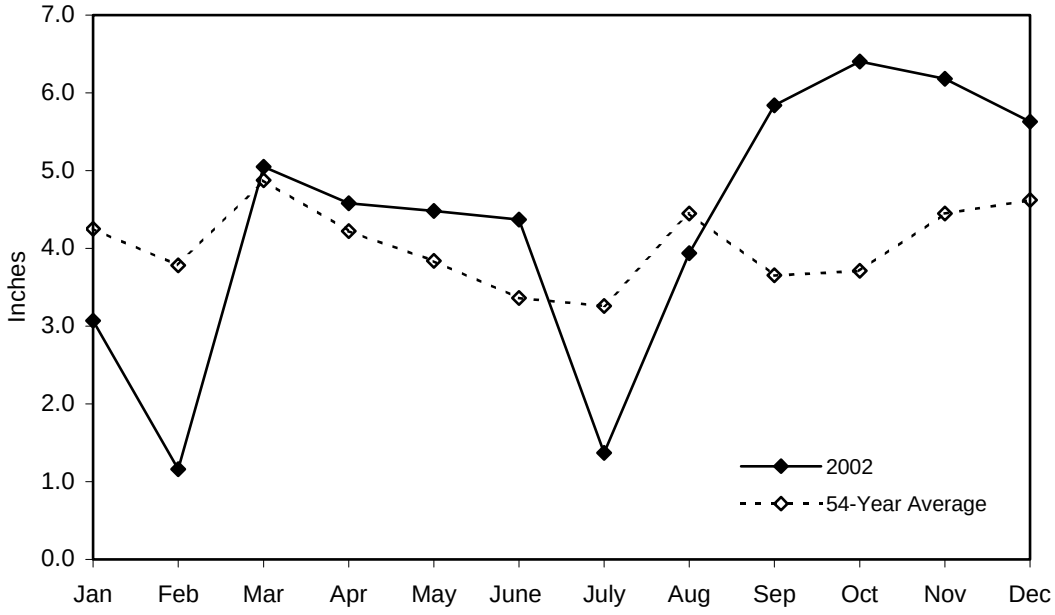


Figure 1-6. 2002 Monthly Precipitation Versus 54-Year Monthly Average.

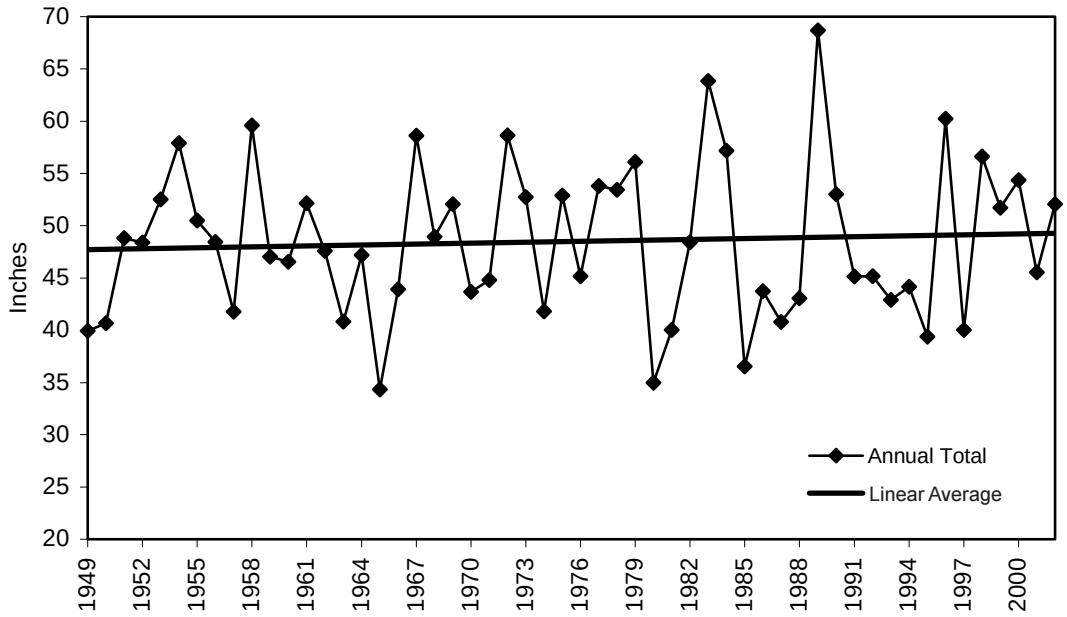


Figure 1-7. Annual Precipitation Trend (54 Years).

concern (see Chapter 6 for details). To eliminate or minimize any negative effects that Laboratory operations might cause, precautions are in place to protect the on-site habitat and natural resources. The white-tailed deer population changes from year to year, due to varying winter conditions and food supply. Estimates of the deer population began in 1966 and have fluctuated from a low of 85 deer per square mile in 1992 to a high of 236 per square mile in the winter of 2000–2001. In the winter of 2001–2002, the deer population was estimated at 135 per square mile. Other wildlife species of interest that inhabit the site include wild turkey, red fox, eastern box turtle, and red-tailed hawk. A

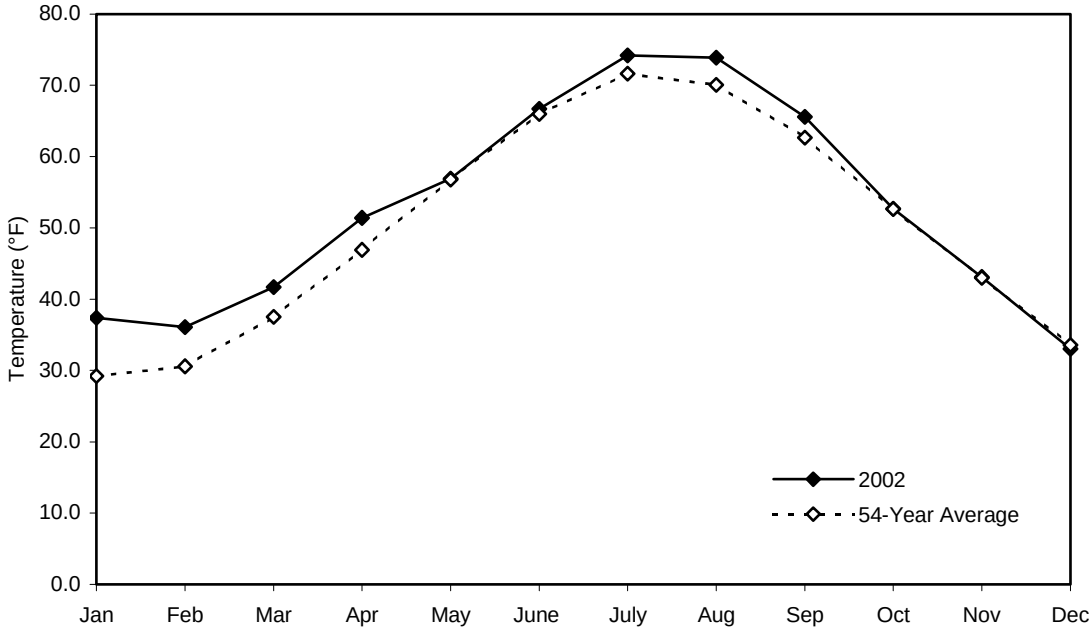


Figure 1-8. 2002 Monthly Mean Temperature Versus 54-Year Monthly Average.

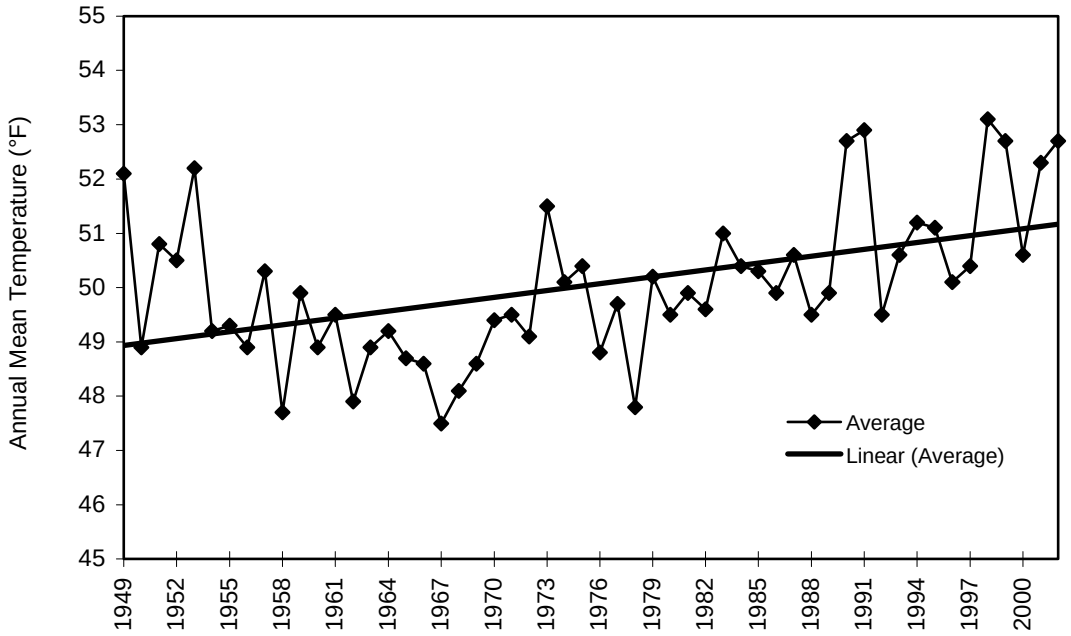


Figure 1-9. Annual Mean Temperature Trend (54 Years).

discussion of the Laboratory's natural resource program can be found in Chapter 6.

At least 85 species of birds are known to nest at BNL, and more than 130 species have been documented as visiting the site. These numbers can be attributed to BNL's location in the Atlantic Flyway and to the scrub/shrub habitats that offer food and rest to migratory songbirds. Open fields bordered by hardwood forests on site offer excellent hunting areas for birds such as hawks.

Permanently flooded retention basins and other watercourses support amphibians and aquatic reptiles. Nine amphibian and ten reptile

species have been identified on site, as well as nine species of fish. Ecological studies at BNL have confirmed 15 breeding sites for the New York State endangered eastern tiger salamander (*Ambystoma t. tigrinum*) in vernal pools and some recharge basins. In 1999, the New York State Department of Environmental Conservation listed the banded sunfish (*Eanneacanthus obesus*) as a threatened species. This species lives solely within the Peconic River system, including backwater areas of the river on site (Scheibel 1990). In 2000, the New York State threatened swamp darter fish (*Etheostoma fusiforme*) was positively identified on site in one of the larger ponds associated with the Peconic River.

A state threatened insect, the frosted elfin butterfly (*Callophrys irus*), was added to BNL's list of protected species in 2001due to the presence of appropriate on-site habitat and reports of previous sightings. This small butterfly lays its eggs on lupine, where the caterpillars feed. In 2002, ecologists tried to confirm this butterfly's presence during its breeding season, but the attempt was unsuccessful.

In November 2000, DOE established the Upton Ecological and Research Reserve (Upton Reserve) at BNL (see Figure 1-1). DOE then entered into an Inter-Agency Agreement with the U.S. Fish and Wildlife Services (FWS) to manage the Upton Reserve. A technical advisory group (TAG) made up of local land management agencies was then formed to assist BNL and FWS with technical expertise and to provide input into decision making. The 530-acre reserve makes up 10 percent of the Laboratory's property and is located on the eastern portion of the site, within the Core Preservation Area of the Pine Barrens. This land creates a unique ecosystem of forests and wetlands that provide a habitat for more than 220 species of plants and 162 species of mammals, birds, reptiles, and amphibians, some of which are endangered, threatened, or of special concern. As part of its commitment to protecting the environmental assets of its sites, DOE is providing FWS with $200,000 a year over a five-year period to conduct research and resource management programs for the conservation, enhancement, and restoration of wildlife and habitat in the reserve. In 2002, this funding helped support activities in outreach, conservation, and habitat protection. Four grants, selected by the TAG, were also awarded to support Pine Barrens-related research. Details regarding these activities and the research grants can be found at http://www.bnl.gov/esd/reserve/default.htm. DOE, BNL, and FWS continue to work with neighbors of the reserve, environmental organizations, regulatory agencies, and other stakeholders to develop a comprehensive, ecosystem-based Natural Resource Management Plan for BNL and the reserve (see Chapter 6 for details).

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