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Introduction

Established in 1947, Brookhaven National Laboratory (BNL) is a multi-program national laboratory operated by Brookhaven Science Associates (BSA) for the U.S. Department of Energy (DOE). BSA, a nonprofit, limited-liability company formed as a 50-50 partnership between Battelle Memorial Institute and The Research Foundation of State University of New York (SUNY) on behalf of SUNY-Stony Brook (USB), is the legal entity responsible for leading BNL successfully through the 21st century. Stony Brook University and Battelle have been managing and operating the Laboratory under a performance-based contract with DOE since 1998. From 1947 to 1998, BNL was operated by Associated Universities Incorporated. Prior to 1947, the site 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.

BNL is one of 10 national laboratories under DOE's Office of Science, which provides most of the Laboratory's research dollars and direction. BNL has a history of outstanding scientific achievements. For over 50 years, Laboratory researchers have successfully worked to visualize, construct, and operate large and unique scientific facilities and use the data generated to make advances in many fields. Under BSA's management, new programs in place at BNL emphasize improved environmental, safety, and health performance.

1.1 LABORATORY MISSION

BNL's broad mission is to produce excellent science and advanced technology in a safe and environmentally sound manner with the cooperation, support, and appropriate involvement of its scientific and local communities. The fundamental elements of the Laboratory's role in support of DOE's strategic missions in energy resources, environmental quality, and national security 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 future generations of scientists and engineers, to maintain technical currency in the nation's workforce, and to encourage scientific awareness in the general public.

BNL's Environmental, Safety, Security, and Health (ESSH) Policy is the Laboratory's commitment to continual improvement in ESSH performance. Under this policy, the Laboratory's goals are to provide a safe, secure, and healthy workplace, strive to prevent injuries and illnesses, promote healthy lifestyles, and encourage respect for the environment. The Laboratory has been registered under the prestigious International ISO 14001 environmental management standard since 2001. In addition, the Laboratory's Environmental and Waste Management Services Division was registered under the Occupational Health and Safety Assessment Series (OHSAS) 18001 standard in November 2005. These programs are described in detail in Chapter 2 of this report.

1.2 HISTORY

BNL was founded in 1947 by the Atomic Energy Commission (AEC), which was the predecessor to the present DOE. AEC provided the initial funding for BNL's research into the peaceful uses of the atom. The objective was to promote basic research in the physical, chemical, biological, and engineering aspects of the atomic sciences. The goal was to build a regional laboratory to design, construct, and operate large scientific machines that individual institutions could not afford to develop on their own.

Although BNL no longer operates any research reactors, the Laboratory's first major scientific facility was the Brookhaven Graphite Research Reactor (BGRR), which was the first peace-time reactor to be constructed in the United States following World War II. The reactor's primary mission was to produce neutrons for scientific experimentation in the fields of medicine, biology, chemistry, physics, and nuclear technology. The BGRR operated from 1950 to 1968 and is now being decommissioned. 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. For more than 30 years, the HFBR was one of the premier neutron beam reactors in the world. 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 shut down and decommissioned. All spent fuel from the HFBR has been removed and transported off 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 and the Brookhaven Medical Research Reactor (BMRR) in 1959. The BMRR was the first nuclear reactor in the nation to be constructed specifically for medical research. Due to a reduction of research funding, the BMRR was shut down in December 2000. All spent fuel from the BMRR has been removed and transported off site. The Brookhaven Linac Isotope Producer (BLIP) was built in 1973. The BLIP creates radioactive forms of ordinary chemical elements that can be used alone or incorporated into radiotracers for use in nuclear medicine research or for clinical diagnosis and treatment. BNL's Center for Translational Neuroimaging (CTN) uses brain-imaging tools, including Positron Emission Tomography (PET) and magnetic resonance imaging (MRI) equipment for research into treatments for brain diseases such as drug addiction, eating disorders, attention deficit disorder, and neurodegenerative disorders. The development of these powerful imaging methods has given scientists a unique opportunity to reveal the molecular mechanisms of human disease and to facilitate the development of new drugs for doctors worldwide to treat patients for cancer and heart disease. Except for the BMRR, all of the above medical facilities are currently operating.

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 in 1957. After 14 years of service, the Cosmotron ceased operation and was dismantled due to design limitations that restricted the energies that it could achieve. The Alternating Gradient Synchrotron (AGS), a much larger particle accelerator, became operational in 1960. The AGS allowed scientists to accelerate protons to energies that yielded many discoveries of new particles and phenomena, for which BNL researchers were awarded three Nobel Prizes in physics. The AGS receives protons from BNL's linear accelerator (Linac). The Linac was designed and built in the late 1960s as a major upgrade to the AGS complex. Its purpose is to provide accelerated protons for use at AGS facilities and BLIP. The AGS Booster, constructed in 1991, further enhanced the capabilities of the AGS, enabling it to accelerate protons and heavy ions to even higher energies. The Tandem Van de Graaff accelerator began operating in 1970 and is the starting point of the chain of accelerators that provide ions of gold, heavy metals, and protons for experiments at the Relativistic Heavy Ion Collider (RHIC).

RHIC began operation in 2000. Inside the two-ringed particle accelerator, two beams of gold ions, heavy metals, or protons circulating at nearly the speed of light collide head-on, releasing large amounts of energy. RHIC is used to study what the universe may have looked like in the first few moments after its creation, offering insights into the fundamental forces and properties of matter. Planned upgrades to RHIC will expand the facility's research. The first upgrade, RHIC II, will increase the collider's collision rate and improve the sensitivity of the large detectors it uses. Another planned upgrade, the eRHIC, would add a high-energy electron ring to create the world's only electron-heavy ion collider, which physicists expect will probe a new form of matter.

The NASA Space Radiation Laboratory (NSRL) became operational in 2003 and is jointly managed by DOE's Office of Science and NASA's Johnson Space Center. The NSRL uses heavy ions extracted from the AGS booster to produce beams of radiation similar to those that would be encountered by astronauts on long missions. Studies are conducted to help assess risks and test protective measures. The NSRL is one of the few facilities in the world that can simulate the harsh cosmic and solar radiation environment found in space.

The National Synchrotron Light Source (NSLS) uses a linear accelerator and booster synchrotron to guide charged particles in orbit inside two electron storage rings for use in a wide range of physical and biological experiments. The NSLS produces beams of very intense x-rays, ultraviolet, and infrared light. These beams allow scientists to study the structure of proteins, to investigate the properties of new materials, and to understand the fate of chemicals in our environment. Although the current NSLS has been continually updated since its commissioning in 1982, today the practical limits of its performance have been reached. A proposal is in place to build a new synchrotron, the NSLS-II. Producing x-rays 10,000 times brighter than the current NSLS, the NSLS-II would be the highest-resolution light source in the world. Planned research at the NSLS-II would focus on important challenges at the nanoscale, such as clean and affordable energy, molecular electronics, and high-temperature superconductors.

The Center for Functional Nanomaterials (CFN) began construction in 2005. The CFN will provide researchers the ability to fabricate and study materials on the order of billionths of a meter, with the potential to bring about and accelerate new technologies in energy distribution, drug delivery, sensors, and industrial processes. The possible benefits of nanoscience include faster computers, improved solar energy conversion, stronger and lighter materials, improved chemical and biological sensing, efficient and rapid detection and remediation of pollutants and pathogens in the environment, more efficient catalysts to speed chemical processes, molecular motors, as well as new drugs.

Past operations at the Laboratory have resulted in environmental contamination dating back to the early 1940s when it was Camp Upton. As a result, BNL was added to the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List of contaminated sites in 1989. One of 27 such sites on Long Island identified for priority cleanup, BNL has made significant progress toward improving environmental operations and remediating past contamination. DOE continues to fund cleanup projects and will until such time that the Laboratory is restored and removed from the National Priorities List.

1.3 RESEARCH AND DISCOVERIES

BNL conducts research in nuclear and high-energy physics, the physics and chemistry of materials, environmental and energy research, nonproliferation, neurosciences and medical imaging, and structural biology. Approximately 2,700 scientists, engineers, technicians, and support staff work at the Laboratory, and more than 4,000 guest researchers from around the world visit the site each year to participate in scientific collaborations. BNL's major world-class research facilities are also available to university, industrial, and government personnel.

To date, six Nobel Prizes have been awarded for discoveries made wholly or partly at BNL. Some important discoveries and developments made at the Laboratory include L-dopa, used to treat Parkinson's disease; magnetically-levitated (maglev) trains; the use of x-rays and neutrons to study biological specimens; the radionuclide thallium-201, used in millions of cardiac stress tests each year; the radionuclide technetium-99, also used to diagnose heart disease; x-ray angiography for noninvasive cardiac imaging; and research on solar neutrinos and how they change form on the way to earth.

Examples of current research being conducted at the Laboratory include the investigation of new nanostructures and nanoparticles; high-temperature superconductors; new state of matter being produced at RHIC; medical imaging techniques to investigate the brain mechanisms underlying drug addiction, psychiatric disorders, and metabolism; new methods of understanding the earth's climate; production of advanced radiation detectors for homeland security applications; and research into how infections begin. Further information regarding research and discoveries at BNL can be found at www.bnl.gov.

1.4 FACILITIES AND OPERATIONS

Most of the Laboratory'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 used for 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.

The major scientific facilities at BNL are briefly described in Figure 1-1. The three former research reactors, no longer operational, are discussed in Section 1.2. Additional facilities, shown in Figure 1-2 and briefly described below, support BNL's science and technology mission by providing basic utility and environmental services.

- *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 and reduces the need for local refrigeration plants and air conditioning.
- *Central Steam Facility (CSF)*. This plant provides high-pressure steam for facility and process heating sitewide. Either natural gas or 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.
- *Fire Station*. The Fire Station houses six response vehicles. The BNL Fire Rescue Group provides on-site fire suppression, emergency medical services, hazardous material response, salvage, and property protection. The Fire Rescue Group responds within 5 minutes to emergencies in the core area of the Laboratory and within 8 minutes to emergencies in the outer areas (RHIC and eastern portions of the site).
- *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 the Laboratory's reliance on oil as a sole fuel source when other fuels are more economical.
- *Sewage Treatment Plant (STP)*. 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.
- *Waste Concentration Facility (WCF)*. This facility was previously used for the receipt, processing, and volume reduction of aqueous radioactive waste. At present, the WCF houses equipment and auxiliary systems required for operation of the liquid low-

level radioactive waste storage and pump systems.

- *Waste Management Facility (WMF)*. This facility is a state-of-the-art complex for managing the wastes generated from BNL's research and operations activities. The facility was built with advanced environmental protection systems and features, and began operation in December 1997.
- *Water Treatment Plant (WTP)*. 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 drinking water standards. BNL's water met all drinking water standards in 2005.

1.5 LOCATION, LOCAL POPULATION, AND LOCAL ECONOMY

BNL is located on Long Island, 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. The Laboratory annually hosts an estimated 4,000 visiting scientists, more than 30 percent of whom are from New York State universities and businesses. The visiting scientists and their families, as well as students, reside in apartments and dormitories on site or in surrounding communities. More than 75 percent of BNL employees live in Suffolk County.

The Laboratory is one of five large, high-technology employers on Long Island. An independent Suffolk County Planning Commission 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 the local economic health (Kamer 1995). In addition, Laboratory employees do most of their shopping locally, further enhancing the local economy. Several of the Laboratory's currently planned projects, which include the Research Support Center and the Center for Functional Nanomaterials (both currently under construction) and the proposed building of a new synchrotron light source, are expected to significantly enhance BNL's economic value to Long Island and New York State.

In 2005, BNL's total procurement budget was approximately $465 million, of which $280 million was spent on employees' salaries, wages, and fringe benefits. In addition, BNL purchased $26.7 million worth of supplies and services from Long Island businesses. Out of that amount, approximately $22.4 million was spent on 3,000 purchases in Suffolk County and approximately $4.3 million went toward 507 purchases made in Nassau County.

1.6 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 recharges to the groundwater; with normal to above-normal precipitation, the river receives water from the aquifer.

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 land surface 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. 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

Figure 1-1. Major Scientific Facilities at BNL.

1. Relativistic Heavy Ion Collider (RHIC)
The RHIC is a world-class scientific research facility. The RHIC accelerator drives two intersecting beams of gold ions, other heavy metal ions, and protons head-on to form subatomic collisions. What physicists learn from these collisions may help us understand more about why the physical world works the way it does, from the smallest subatomic particles, to the largest stars. Current RHIC experiments include the Solenoidal Tracker at RHIC (STAR), a detector used to track particles produced by ion collisions; the PHENIX detector, used to record different particles emerging from collisions; the Broad Range Hadron Magnetic Spectrometer (BRAHMS), used to study particles as they pass through detectors; and PHOBOS, an experiment based on the premise that when new collisions occur, new physics will be readily identified.

2. Alternating Gradient Synchrotron (AGS)
The AGS is a particle accelerator used to propel protons and heavy ions to high energies for physics research. The AGS is capable of accelerating protons and heavy ions, such as gold and iron. The Linear Accelerator (Linac) serves as a proton injector for the AGS Booster.

3. AGS Booster
The AGS Booster is a circular accelerator used for physics research and radiobiology studies. It receives either a proton beam from the Linac or heavy ions from the Tandem Van de Graaff and accelerates these before injecting them into the AGS ring for further acceleration. The Booster also serves as the energetic heavy ion source for the NASA Space Radiation Laboratory. Construction is planned for spring 2005. This new facility will be used to simulate the harsh cosmic and solar radiation environment found in space.

4. Linear Accelerator (Linac) and Brookhaven Linac Isotope Producer (BLIP)
The Linac provides beams of polarized protons for the AGS and RHIC. The excess beam capacity is used to produce radioisotopes for research and medical imaging at the BLIP. The BLIP is one of the nation's key production facilities for radioisotopes, which are crucial to clinical nuclear medicine. The BLIP 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 enables the transport of ions of intermediate mass to the AGS Booster, where they are accelerated before injection into the AGS. The ions are then 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 used for radiation therapy for 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 and therapy. It produced neutrons in an optimal energy range for experimental treatment of a type of brain cancer known as glioblastoma multiforme. The BMRR was shut down in December 2000 due to a reduction in medical research funding.

8. Scanning Transmission Electron Microscope (STEM)
The STEM 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. The images provide a picture and data that are used in Mass Analysis.

9. National Synchrotron Light Source (NSLS)
The NSLS uses a linear accelerator and booster synchrotron as an injection system for two electron storage rings that provide intense light spanning the electromagnetic spectrum from the infrared through x-rays. The properties of this light and the 80 specially designed experimental stations, called beamlines, allow scientists to perform a large variety of experiments.

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 and expanded the knowledge base of physics, chemistry, and biology. The HFBR was permanently shut down in November 1999.

11. Tandem Van de Graaff and Cyclotron
These accelerators are used in medium energy physics investigations and for producing special nuclides. The Tandem Van de Graff accelerators are used to bombard materials with ions for manufacturing and testing purposes, and to supply RHIC with heavy ions. The cyclotrons, operated by the Chemistry Department, are used for the production of radiotracers for use in Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI) studies.

12. Brookhaven Graphite Research Reactor (BGRR)
The BGRR was the first peace-time reactor to be constructed in the United States following World War II. It was used for scientific exploration in the fields of medicine, biology, chemistry, physics, and nuclear engineering. The BGRR is currently being decommissioned under the Environmental Restoration Program.

sandy deposits store large quantities of water in 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 Long Island Regional Planning Board and Suffolk County have identified the Laboratory site as overlying a deep-flow recharge zone for Long Island groundwater (Koppelman 1978). 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 on 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 & Miller 1996). This groundwater system is the primary source of drinking water for both on- and off-site private and public supply wells and has been designated a sole source aquifer system by the Environmental Protection Agency (EPA).

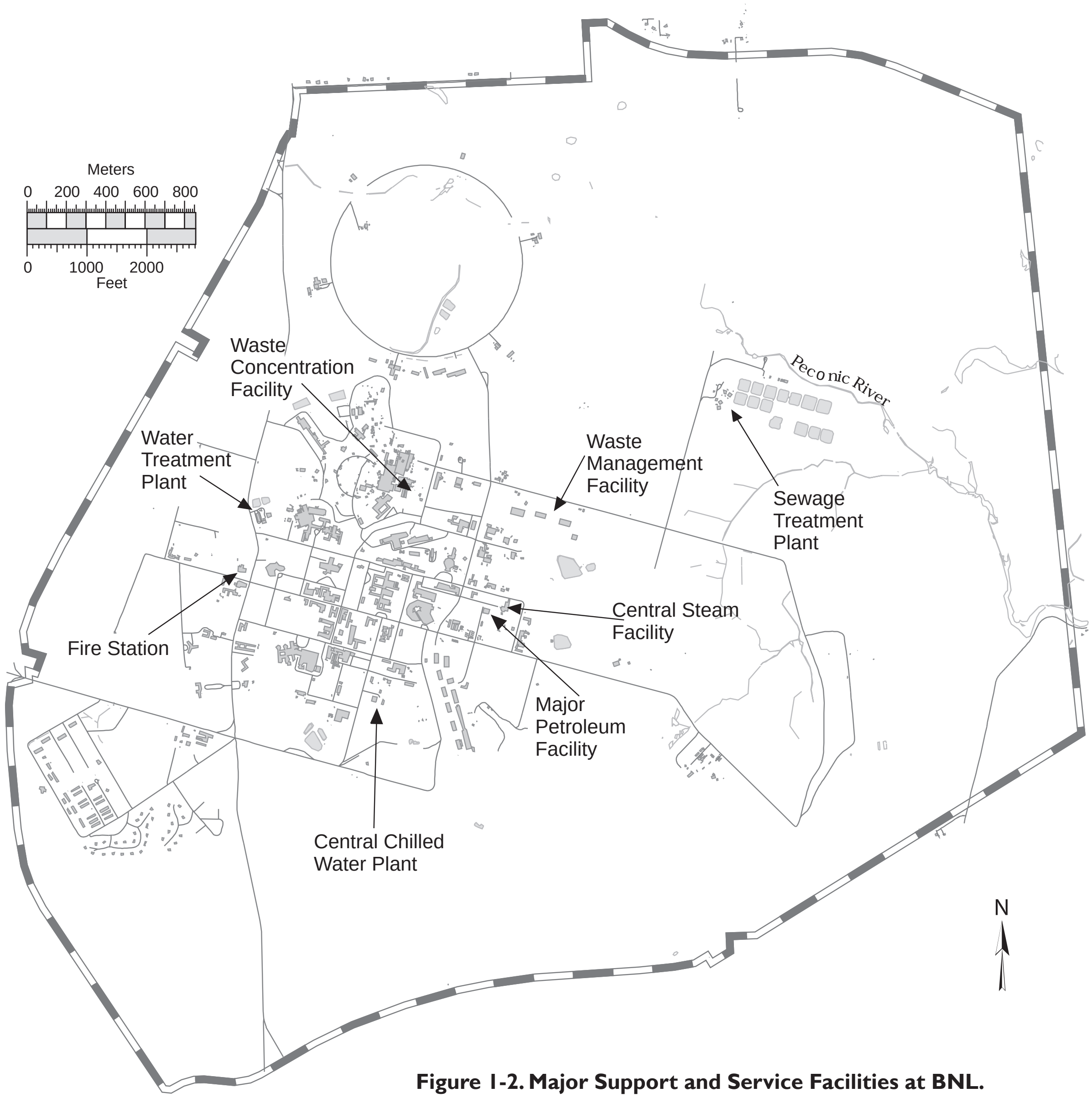


Figure 1-2. Major Support and Service Facilities at BNL.

During 2005, the Laboratory used approximately 1.4 million gallons of groundwater per day to meet potable water needs and heating and cooling requirements. Approximately 75 percent of the water pumped from BNL supply wells is returned to the aquifer through on-site recharge basins and permitted discharges to the Peconic River. Under normal hydrologic conditions, most of the water discharged to the river recharges to the Upper Glacial aquifer before leaving the BNL site. Human consumption, evaporation (cooling tower and wind losses), and sewer line losses account for the remaining 25 percent. An additional 4.4 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 flowing eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River (Figure 1-3). 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

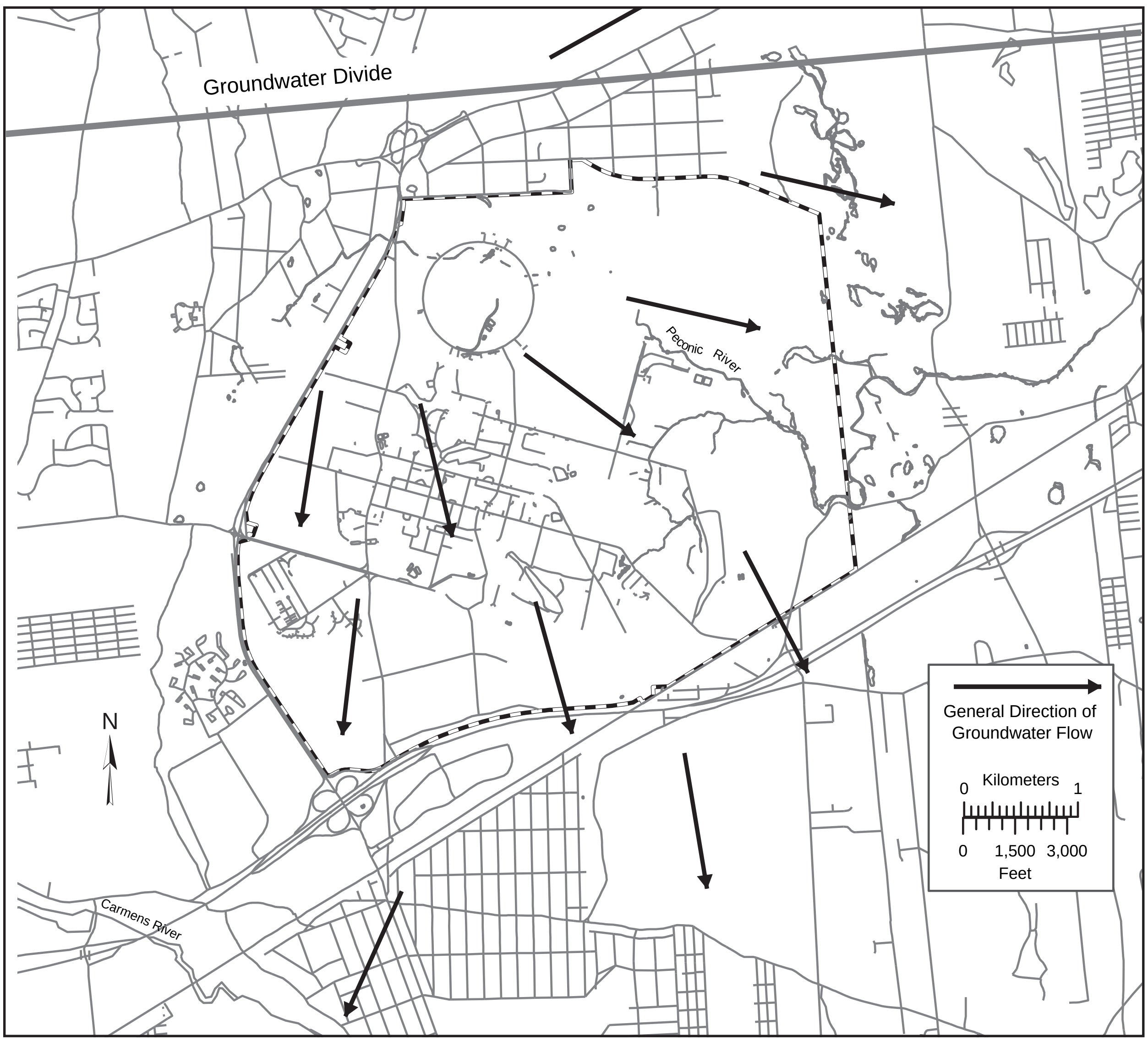
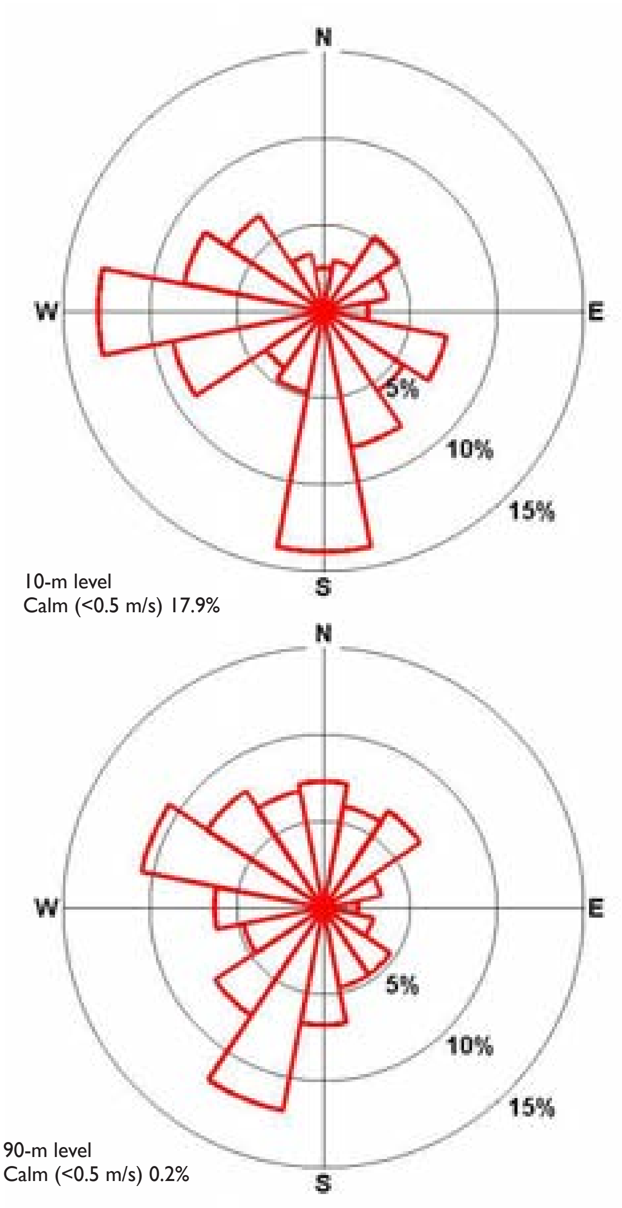


Figure 1-3. BNL Groundwater Flow Map.



Explanation: The arrows formed by the wedges indicate wind direction. Each concentric circle represents a 5 percent 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 at the 10-m level and south-southwest at the 90-m level.

Figure 1-4. BNL 2005 Wind Rose.

generally east–west and lies approximately one-half mile north of the Laboratory. Groundwater north of the divide flows northward and ultimately discharges to the Long Island Sound. Groundwater south of the divide flows east and south, discharging to the Peconic River, Peconic Bay, south shore streams, Great South Bay, and Atlantic Ocean. The regional groundwater flow system is discussed in greater detail in Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity (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 Laboratory's southern boundary.

1.7 CLIMATE

The Meteorological Group at BNL has been recording weather data on site since 1948. The Laboratory is broadly influenced by continental and maritime weather systems. Locally, the Long Island Sound, Atlantic Ocean, and associated bays influence wind directions and humidity and provide a moderating influence on extreme summer and winter temperatures. 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 1-4 shows the 2005 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 yearly snowfall in the area is 31.2 inches. The total snowfall in 2005 was 78.3 inches, the second snowiest season recorded at the Laboratory, with a record snowfall of 29 inches in January. The average yearly precipitation is 48.5 inches. The total annual precipitation for 2005 was 50.1 inches. October was the wettest month ever recorded since the Laboratory has been keeping weather statistics, with 22.14 inches of rain. Figures 1-5 and 1-6 show the 2005 monthly and the 57-year annual precipitation data.

The average monthy temperature for 2005 was 51.9°F. Eight new daily high temperatures were recorded during the months of January, July, August, and September. August beat a pre-

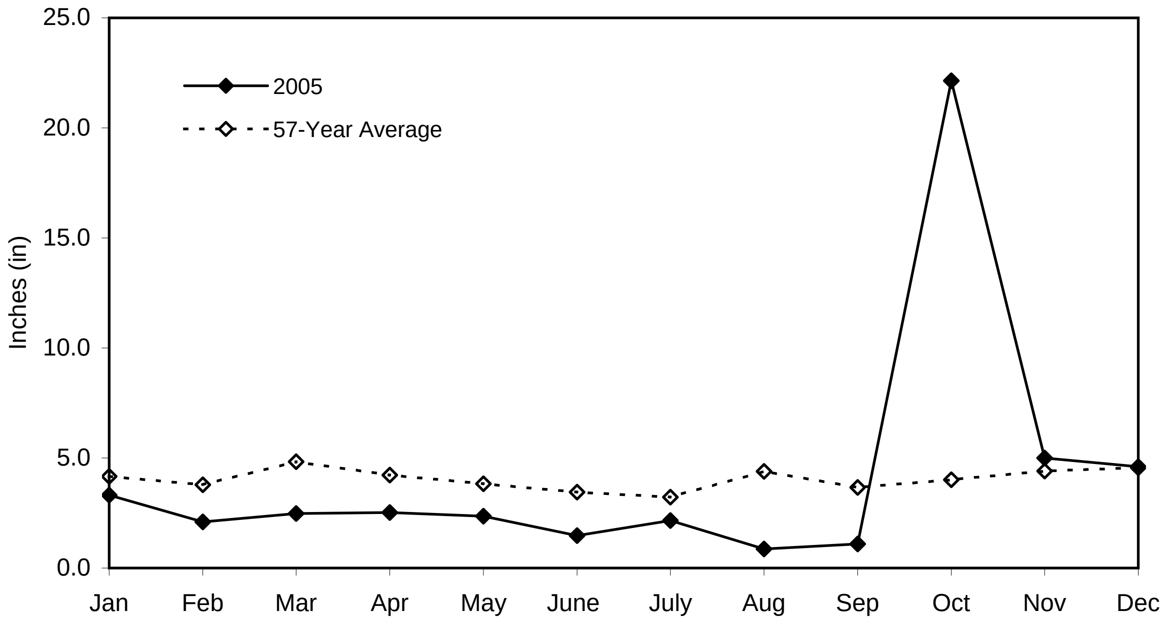


Figure 1-5. BNL 2005 Monthly Precipitation versus 57-Year Monthly Average.

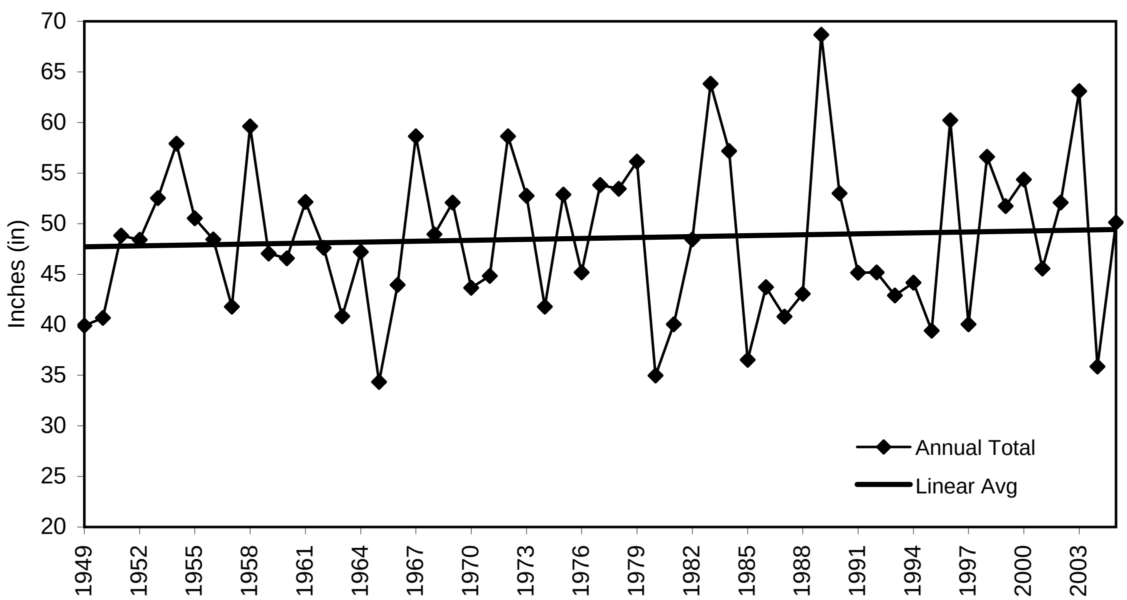


Figure 1-6. BNL Annual Precipitation Trend (57 Years).

vious record set in 2003 as the hottest month, with an average temperature of 76.2°F. Although January was the coldest month recorded, with an average temperature of 28.7°F, it also beat a record for warmest January day by one degree, when the temperature reached 57°F. Figures 1-7 and 1-8 show the 2005 monthly mean temperatures and the historical annual mean temperatures, respectively.

1.8 NATURAL RESOURCES

The Laboratory 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 on Long Island known as the Central Pine Barrens. The section of the Peconic River running through BNL is designated as "Scenic" under the New York State Wild, Scenic, and Recreational River System

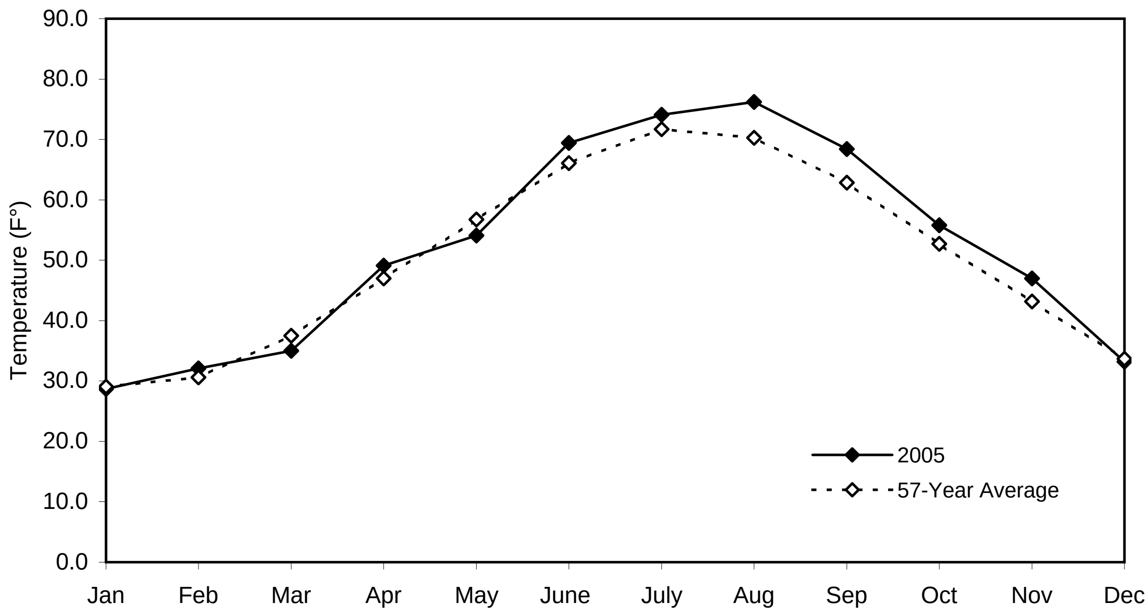


Figure 1-7. BNL 2005 Monthly Mean Temperature versus 57-Year Monthly Average.

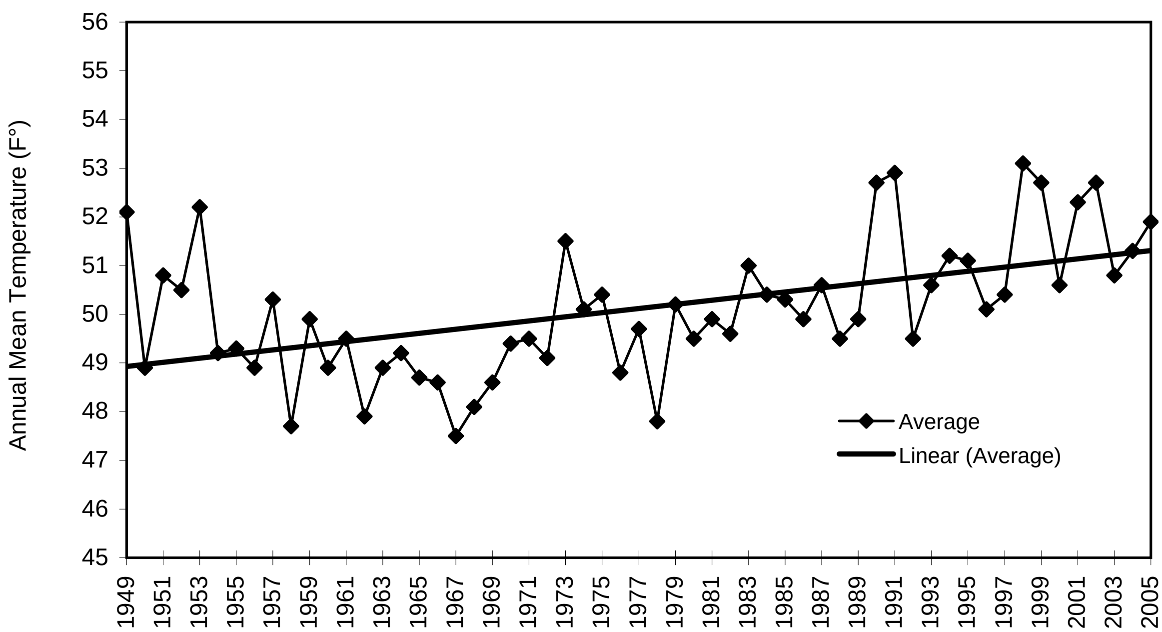


Figure 1-8. BNL Annual Mean Temperature Trend (57 Years).

Act of 1972. Due to the general topography and porous soil, the land is very well drained and there is little surface runoff or open standing water. However, depressions form numerous small, pocket wetlands with standing water on a seasonal basis (vernal pools), and there are six regulated wetlands on site. Thus, a mosaic of wet and dry areas 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 at the Laboratory, including two New York State threatened species and two that are rare. Fifteen animal species identified on site include a number that are protected in New York State, as well as species common to mixed hardwood forests and open grassland habitats. At least 85 species of birds have been observed nesting on site, and more than 200 transitory bird species have been documented visiting the site as a result of BNL's location within the Atlantic Flyway, and the scrub/shrub habitats that offer food and rest to migratory songbirds. Permanently flooded retention basins and other watercourses support amphibians and aquatic reptiles. Thirteen amphibian and 12 reptile species have been identified at BNL. Recent ecological studies have confirmed 26 breeding sites for the New York State endangered eastern tiger salamander in ponds and recharge basins. Ten species of fish have been identified as endemic to the site, including the banded sunfish and the swamp darter, both of which are New York State threatened species. Two types of butterflies that are protected in New York State are believed to breed on site due to preferred habitat and host plants, and a New York State threatened damselfly was found on site in 2005. To eliminate or minimize any negative effects that Laboratory operations might cause to these species, precautions are in place to protect the on-site habitat and natural resources.

In November 2000, DOE established the Upton Ecological and Research Reserve at BNL. The 530-acre Upton Reserve (10 percent of the Laboratory's property) is on the eastern portion of the site, in the Core Preservation Area of the Central Pine Barrens. The Upton Reserve creates a unique ecosystem of forests and wetlands that provides habitats for plants, mammals, birds, reptiles, and amphibians. Funding provided by DOE under an Inter-Agency Agreement between DOE and the U.S. Fish & Wildlife Services (FWS) expired in fiscal year 2004. FWS conducted resource management programs for the conservation, enhancement, and restoration of wildlife and habitat in the reserve through mid-year 2005, while transitioning research efforts to the Foundation for Ecological Research in the Northeast (FERN). FERN now coordinates research within the Central Pine Barrens and the Upton Reserve. The Laboratory continues to utilize the Upton Reserve Technical Advisory Group, made up of local land management agencies, to assist BNL and FWS with technical expertise and help determine natural resource management policy for the Laboratory and the Upton Reserve. Management of the Upton Reserve falls within the scope of BNL's Natural Resource Management Plan, and the area will continue to be managed for its key ecological values and as an area for ecological research. Additional information regarding the Upton Reserve and the Laboratory's natural resources can be found in Chapter 6 of this report.

1.9 CULTURAL RESOURCES

The Laboratory is responsible for ensuring compliance with historic preservation requirements. A *Cultural Resource Management Plan* was developed to identify, assess, and document BNL's historic and cultural resources. These resources include World War I trenches; Civilian Conservation Corps features; World War II buildings; and historic structures, programs, and discoveries associated with high energy physics, research reactors, and other science conducted at the Laboratory. BNL currently has three facilities that have been determined as eligible for listing on the National Register of Historic Places. These historical facilities include the Brookhaven Graphite Research Reactor complex, the High Flux Beam Reactor complex, and the World War I training trenches associated with Camp Upton.

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