BROOKHAVEN
NATIONAL LABORATORY

Environmental Stewardship Policy

It is Brookhaven National Laboratory's (BNL's) policy to integrate environmental stewardship into all facets of the Laboratory's missions. We will manage our programs in a manner that protects the ecosystem and public health.

In support of this policy,
BNL makes the following commitments:

♦

We are committed to achieving compliance with applicable environmental requirements.

♦

In consideration of the potential impacts of our activities on the environment, we will integrate pollution prevention/waste minimization, resource conservation, and compliance into all of our planning and decision-making. We will adopt cost-effective practices that eliminate, minimize or mitigate environmental impacts.

♦

We will define, prioritize, and aggressively correct and clean up existing environmental problems.

♦

We will work to continually improve our environmental management system and performance.
We will establish appropriate environmental objectives and performance indicators to guide these efforts and measure our progress.

♦

We will maintain a positive, proactive, and constructive relationship with our neighbors in the community, regulators, DOE, and our other stakeholders. We will openly communicate with stakeholders on our progress and performance.

In addition to my annual review of BNL's progress on environmental goals and adherence to this policy, I invite all interested parties to provide me with input on our performance relative to this policy, and the policy itself.

John H. Marburger

John H. Marburger, Laboratory Director

11/19/98

Date

CHAPTER 1

Introduction

Brookhaven National Laboratory (BNL) is a research facility situated on 21.3 square kilometers (5263 acres) in Brookhaven Township on Long Island, New York. BNL has a comprehensive environmental protection and monitoring program. The Site Environmental Report is prepared annually by BNL to summarize the Laboratory's environmental performance and to describe what impact, if any, BNL operations have on the environment. Key to evaluating the monitoring data used in determining what impact the Laboratory may be having on the environment is the understanding of local site characteristics in terms of human population, geology and hydrology, climatic data and ecological resources.

1.1. PURPOSE OF THE 1998 SITE ENVIRONMENTAL REPORT (SER)

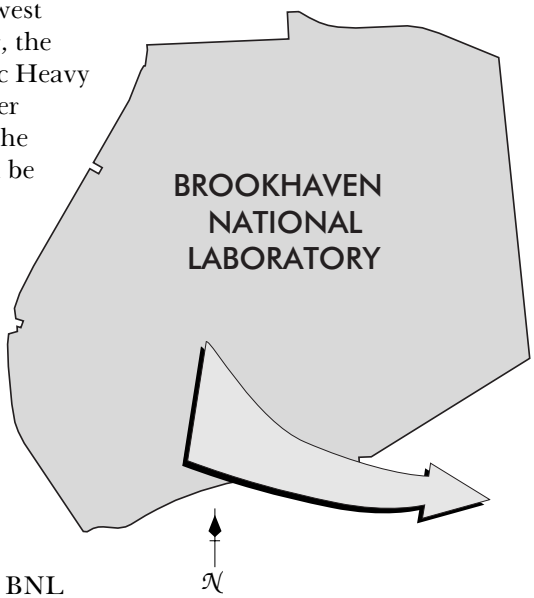
The SER summarizes the efforts, data, and status of BNL's environmental protection, compliance and monitoring programs for calendar year 1998. This report is prepared in accordance with the U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program." This order sets forth the requirements for environmental protection programs at DOE facilities to ensure that operations fully comply with applicable federal, state, and local environmental laws and regulations, executive orders, and with DOE policies. A condensed version of the SER, referred to as the Summary Report, is also available. The Summary Report, written with a minimum of technical terminology, is used to provide information to visitors, students, and members of the public in support of BNL's educational and community outreach programs.

1.2. THE HISTORY AND MISSION OF BROOKHAVEN NATIONAL LABORATORY

BNL is operated for DOE by Brookhaven Science Associates (BSA), a partnership of Battelle Memorial Institute and the State University of New York at Stony Brook (SUNY). BSA entered into an agreement with the DOE under contract DE-AC02-98CH10886 and began operating BNL on March 1, 1998. Prior to that, BNL was operated by Associated Universities, Incorporated (AUI).

BNL is a world class scientific research laboratory founded in 1947 on the site of the U.S. Army's former Camp Upton. BNL's main mission is basic and applied research in a variety of scientific fields from physics, chemistry and materials science to biology, medicine and forefront technology. In undertaking research, it is BNL's policy to integrate environmental stewardship into all facets of the Laboratory's missions, and to manage programs in a manner that protects the ecosystem and public health. The cover page to this chapter presents BNL's Environmental Stewardship Policy, and affirms this committment. The policy was signed by the Laboratory Director, John H. Marburger, on November 19, 1998.

At the heart of BNL are a number of large and unique research facilities. These sophisticated facilities allow thousands of BNL scientists and visiting researchers from academia and industry to extend the boundaries of knowledge and technology. BNL's scientific history began in 1950 with the operation of the Brookhaven Graphite Research Reactor (BGRR), the first of three research reactors used for peaceful scientific exploration. The BGRR was joined in 1952 by the Cosmotron, the first particle physics accelerator to achieve billion-electron-volt energies. Work at the Cosmotron resulted in a Nobel Prize-winning discovery in 1957. In 1960, the Alternating Gradient Synchrotron (AGS), a large accelerator, was built to surpass the Cosmotron's capabilities. It has yielded many discoveries on new particles and phenomena for which BNL researchers were awarded Nobel Prizes in physics in 1973, 1980, and 1988. Another accelerator, the Tandem Van de Graaff, began operating in 1970. Today, Brookhaven is looking forward to 1999 when physicists will begin to use the newest accelerator, the Relativistic Heavy Ion Collider (RHIC). The RHIC will be able to recreate a state of matter that was believed to be seen moments after the universe's formation.



Medical research at BNL began in 1950, with the opening of the first hospital devoted to nuclear medicine. It was fueled by a modern Medical Research Center (MRC) in 1958, the Brookhaven Medical Research Reactor (BMRR) in 1959, and the Brookhaven Linac Isotope Producer (BLIP) in 1973. Chemists and physicians teamed up to view the inner workings of the brain in 1977 with the advent of Positron Emission Tomography (PET) cameras. Two more imaging techniques were added to PET to form the Center for Imaging and Neuroscience in 1996.

A range of research from solid-state physics to art history was made possible starting in 1965, when the High Flux Beam Reactor (HFBR) began providing neutrons to researchers of all disciplines. In 1982, the National Synchrotron Light Source (NSLS) began operation. The NSLS guides charged particles in an orbit. As the electrons whirl around inside a hollow donut-shaped tube called an "electron storage ring," they give off light called "synchrotron light." This light, which can be detected by specialized instruments, is used to study the properties of matter.

The Laboratory's treatment of the environment did not measure up to its world class status in science. Historical waste management practices led to releases of chemicals and radioactive materials which resulted in soil and groundwater contamination. In 1989, BNL joined a number of Long Island sites added to the federal Superfund National Priorities List. Remediation of soil, groundwater and other waste disposal areas is proceeding. The year 1997 was an eventful one at BNL, with many environmental issues coming to light; the most noteworthy of which prompted the shut down of the HFBR (See Section 1.4 for more details). In the year the Laboratory celebrated its 50th anniversary, DOE terminated the AUI operating contract for poor environmental performance.

After a competitive bidding process that began in 1997, BSA was selected to succeed AUI in managing BNL. BSA is committed to guiding BNL into the 21st century, with a combination of excellent science, environmental protection and community involvement.

1.3. SITE LOCATION AND LOCAL POPULATION

Brookhaven National Laboratory is located near the geographical center of Suffolk County, Long Island, about 97 kilometers (km), or 60 miles (mi), east of New York City (Figure 1-1). About a third of the 1.36 million people that reside in Suffolk County live in Brookhaven Township where the Laboratory is situated (LIPA, 1998). Approximately eight

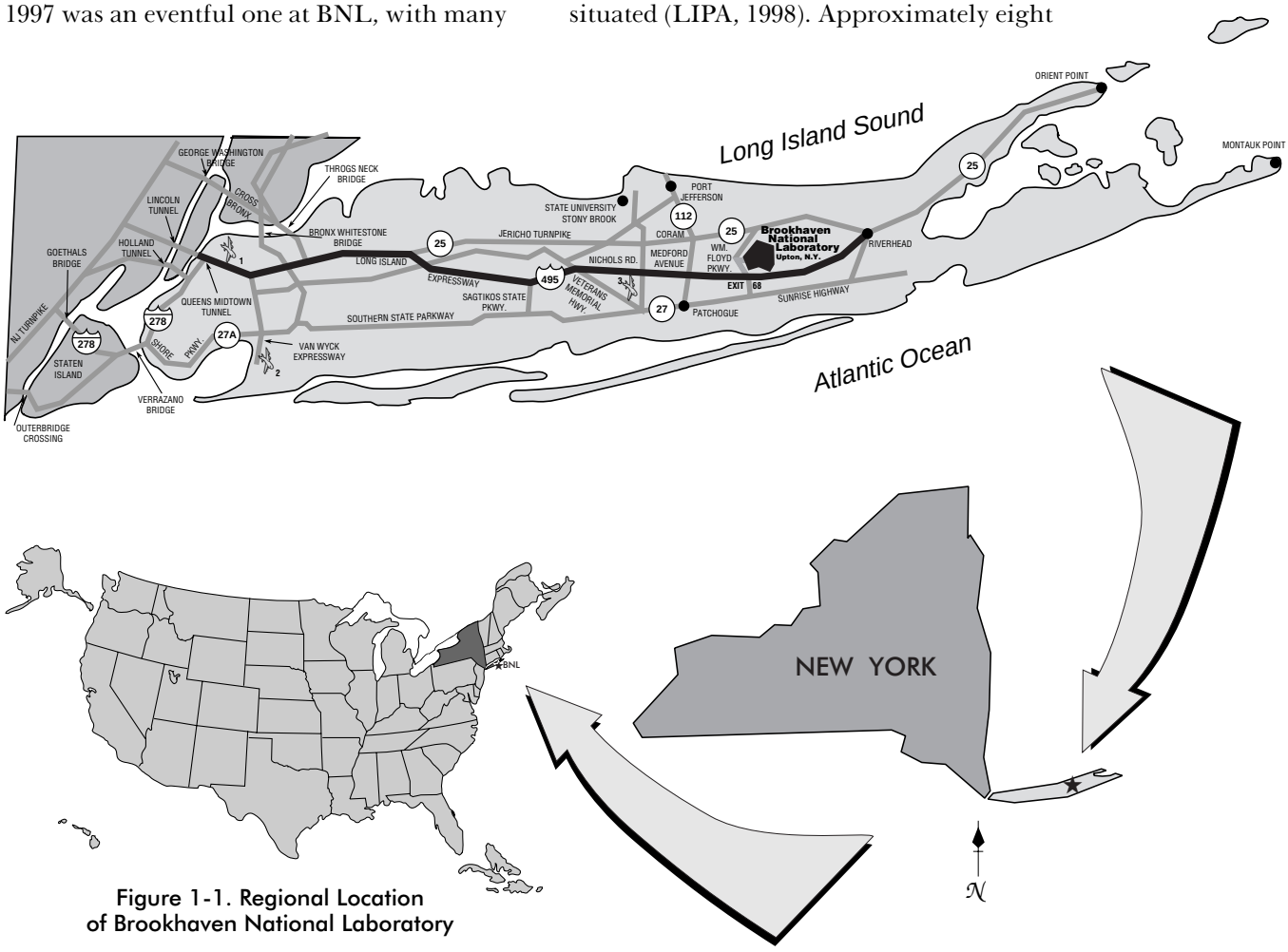
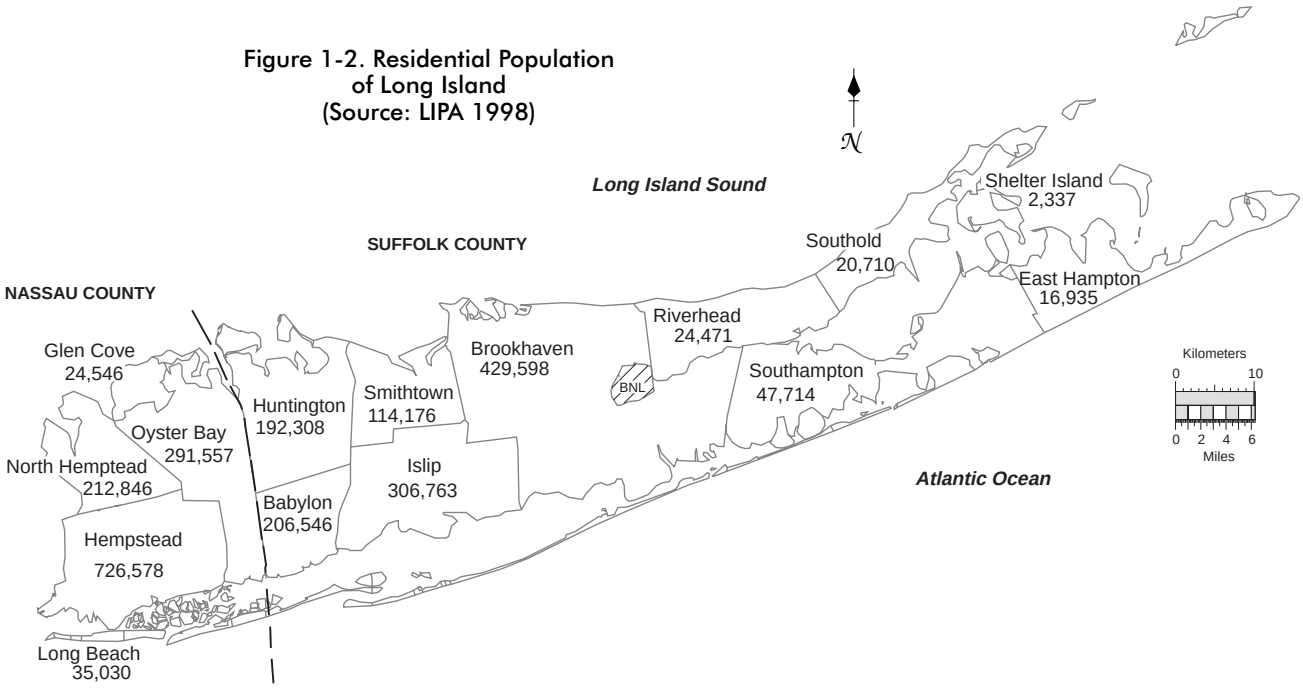


Figure 1-1. Regional Location of Brookhaven National Laboratory

Figure 1-2. Residential Population of Long Island (Source: LIPA 1998)



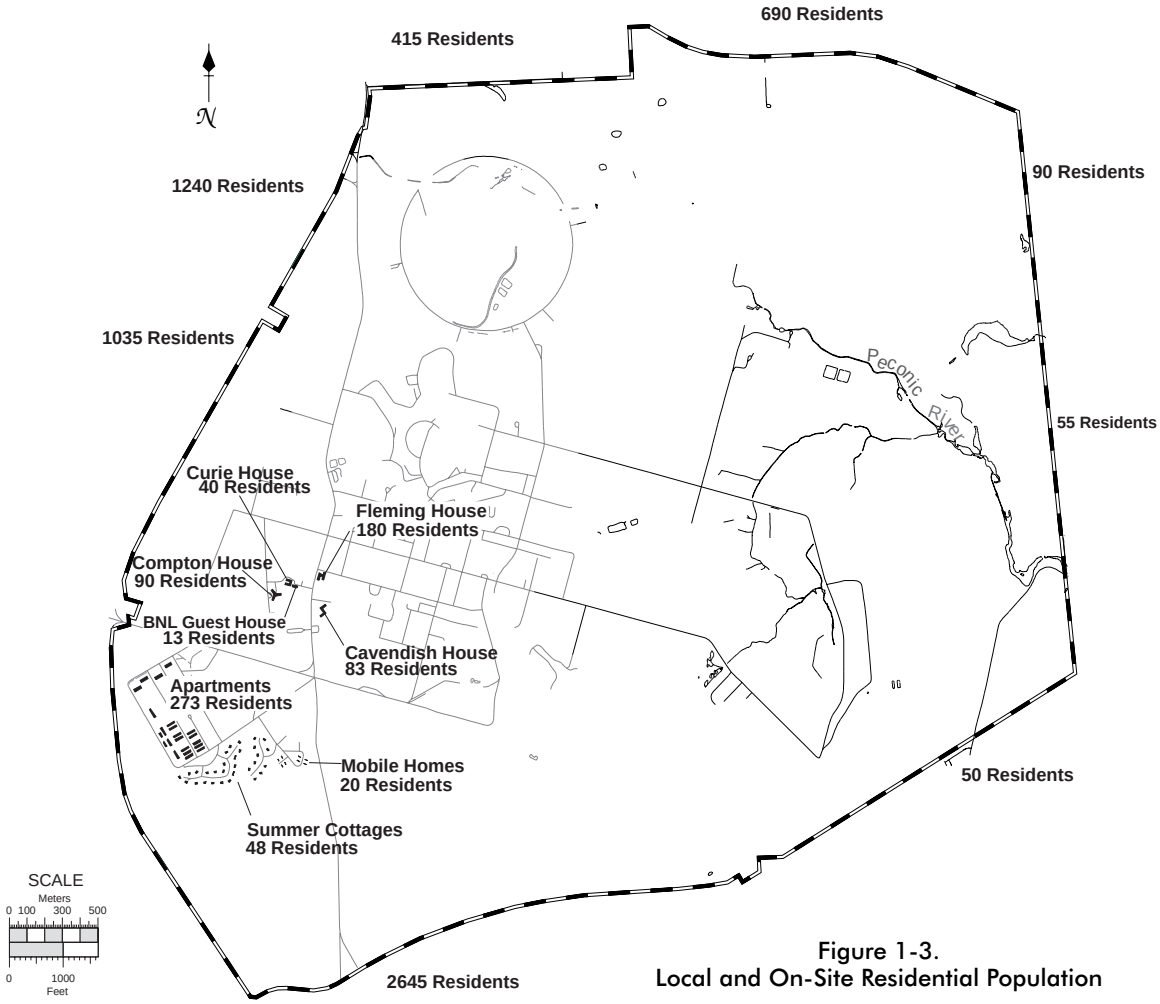


Figure 1-3. Local and On-Site Residential Population

thousand people live within a one-half km (0.3 mi) of the Laboratory's boundaries. Figure 1-2 shows the distribution of the resident population on Long Island. Figure 1-3 shows the onsite and resident population surrounding the site within a one-half km (0.3 mi). Although much of the land area within a 16 km (9.9 mi) radius of BNL is either forested or cultivated, there has been an increase in residential housing in recent years, a trend that is expected to continue.

BNL has over 3,000 employees. As shown in Figure 1-4, more than 75 percent of BNL's employees live within a 15-mile radius of the laboratory. In addition, more than 4,000 visiting scientists come from all over the world each year to conduct research at the laboratory. While conducting their research, these visiting scientists either live on or offsite. Adding to our onsite staff and visiting scientists, more than 10,000 student visitors and other members of the public visited the laboratory in 1998 to participate in education and public outreach activities. See Chapter 2 for more information.

1.4. FACILITY DESCRIPTION

BNL's site consists of 21.3 sq-km (5263 acres). Most principal facilities are located near the center of the site. The developed area is approximately 6.7 sq-km (1,656 acres), of which about 2.02 sq-km (500 acres) were originally developed by the Army (as part of Camp Upton), and about 0.81 sq-km (200 acres) are occupied by various large, specialized research facilities. Outlying facilities occupy about 2.22 sq-km (549 acres); these include the Sewage Treatment Plant (STP), research agricultural fields, housing, and fire breaks. The balance of the site is largely wooded.

The major scientific facilities are pictured and briefly described in Figure 1-5. The High Flux Beam Reactor is pictured in Figure 1-6.

Additional radiological programs for scientific investigations are carried out at other BNL facilities including those of the Medical Research Center, Biology, Chemistry, and Applied Technology programs.

In addition to the scientific facilities, there are numerous other major facilities, which provide support to BNL's science and technology mission. Among these are:

- Sewage Treatment Plant (STP) - The STP, shown in Figure 1-7, has a design capacity of 11.3 million liters per day (MLD) [3.0 million gallons per day (MGD)] and receives sanitary and certain process waste

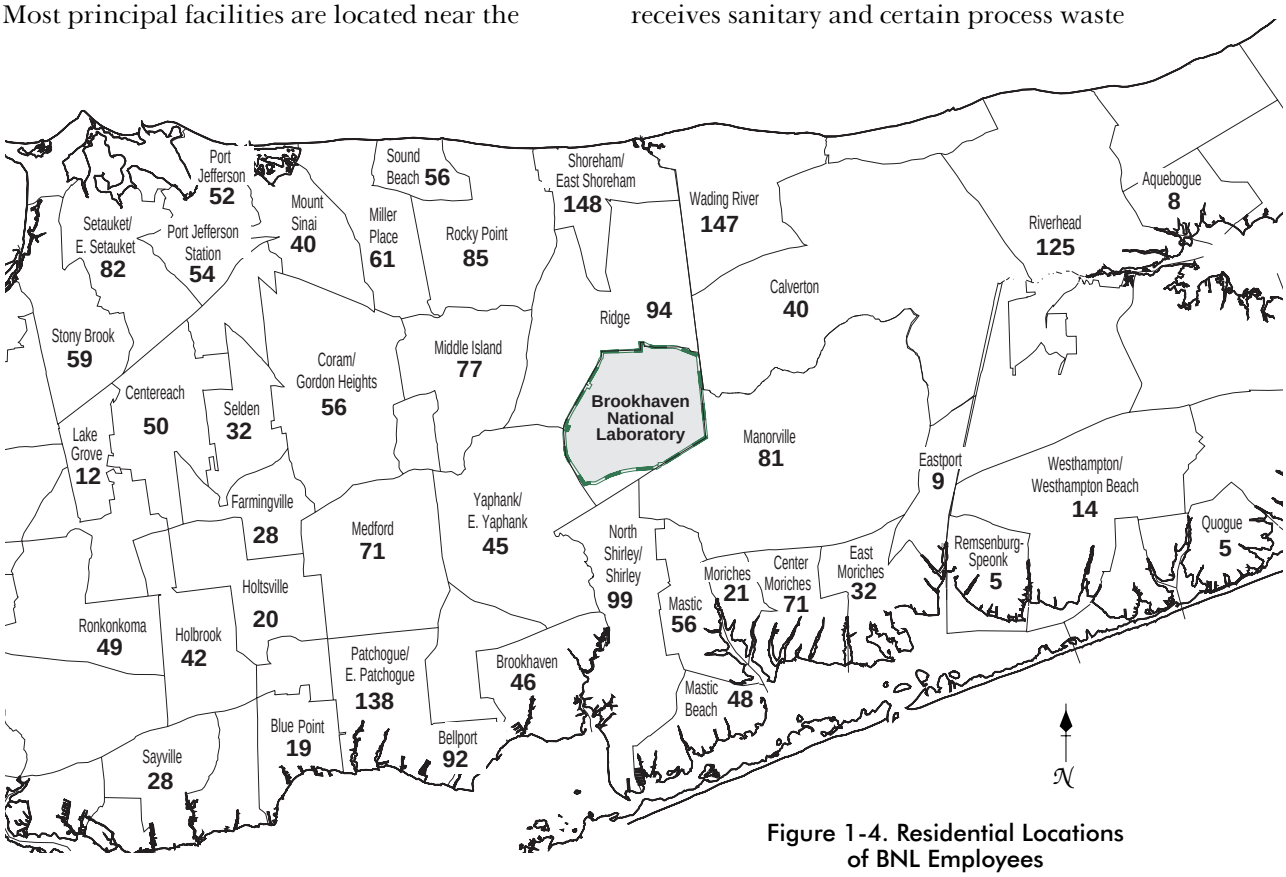


Figure 1-4. Residential Locations of BNL Employees

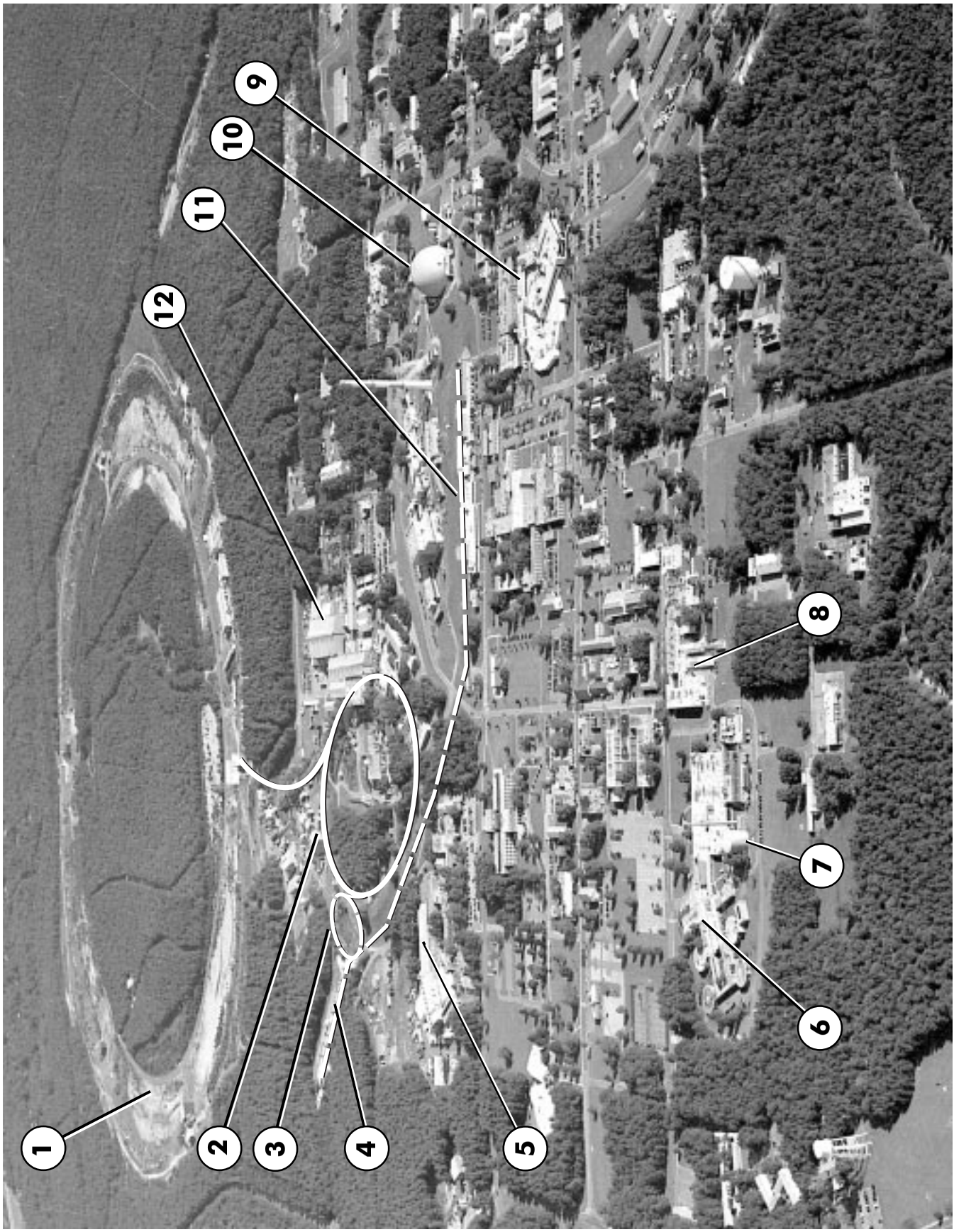

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Figure 1-5. Major Scientific Facilities

1. RELATIVISTIC HEAVY ION COLLIDER (RHIC)
Now under construction, RHIC will soon be 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 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 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 makes beams of polarized protons for the AGS and, when it becomes operational, for the Relativistic Heavy Ion Collider (RHIC). 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 at BNL on new diagnostic and therapeutic radiopharmaceuticals.

5. HEAVY ION TRANSFER LINE (HITL)
The HITL connects the Tandem Van de Graaff and the AGS. This interconnection permits ions of intermediate mass to be injected into the AGS where they can be accelerated to an energy of 15 GeV/amu. 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 (MRC), 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 Brookhaven Medical Research Reactor (BMRR) was the world's first nuclear reactor built exclusively for medical research applications. It produces neutrons in an optimal energy range for a promising experimental treatment for a type of brain cancer known as glioblastoma multiforme. The BMRR is an integral part of the MRC.

8. SCANNING TRANSMISSION ELECTRON MICROSCOPE (STEM)
This facility actually includes two microscopes, STEM 1 and STEM 3, used for biological research. Both powerful 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 for x-ray diffraction studies.

10. HIGH FLUX BEAM REACTOR (HFBR)
The High Flux Beam Reactor (HFBR) is one of the premier neutron physics research facilities in the world. Neutron beams produced at the HFBR are used to investigate the molecular structure of materials which aid in pharmaceutical design and materials development, as well as expanding the current knowledge base of physics, chemistry and biology. Due to a leak in the fuel storage pool which was discovered in 1997. Since that time, the HFBR has not been in operation.

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 for physics experiments.

12. BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)
No longer in operation, the BGRR was used to research cancer therapy methods, such as boron neutron capture therapy.

Figure 1-6.
High Flux Beam
Reactor. (HFBR)

Figure 1-7. Aerial photograph of
Sewage Treatment Plant

waters from BNL facilities for treatment prior to discharge into the Peconic River. The discharge, which is called effluent, is carefully monitored and controlled under a permit issued by the New York State Department of Environmental Conservation (NYSDEC). See Chapter 2 for additional information on this facility and environmental permits.

- Water Treatment Plant (WTP) - The WTP is a potable water treatment facility with a capacity of 19 MLD (5 MGD). During the treatment process, potable water obtained from three wells located along the western boundary of the developed site is treated with a lime-softening process to remove naturally occurring iron. The WTP is also equipped with dual air-stripping towers to ensure that volatile organic compounds are at or below New York State Drinking Water Standards.
- Central Steam Facility (CSF) - The CSF provides high-pressure steam used for both facility and process heating. Steam is conveyed to the user facilities through a series of underground piping. Condensate is collected and returned to the CSF for reuse as a water and energy conservation measure. See Chapter 2 for more information about Pollution Prevention initiatives at the CSF.
- Major Petroleum Facility (MPF) - The MPF provides the petroleum reserve needed for operating the CSF. This facility has a total capacity of 8.7 million liters (2.3 million gallons) for storing predominately fuel oil No. 6. The recent installation of a natural gas line has reduced BNL's reliance on oil as the primary source of fuel.
- Central Chilled Water Plant - This facility provides chilled water for ventilation and process cooling via a network of underground piping. The plant has a large refrigeration capacity, which reduces the necessity for local refrigeration plants, and once-through cooling.
- Waste Management Facility (WMF) - The WMF is a state-of-the-art complex of four buildings for managing the wastes generated during BNL's research and operation activities. This facility, which opened in December 1997, was built with advanced environmental protection systems and features. The WMF houses two areas permitted by the NYSDEC for storing and treating hazardous wastes, prior to shipment offsite for treatment and disposal at

other permitted Treatment, Storage, and Disposal Facilities.

1.5. GEOLOGY AND HYDROLOGY

The terrain of the site is gently rolling, with elevations varying between 13.3 and 36.6 meters (44 and 120 feet) above sea level. The land lies on the western rim of the shallow Peconic River watershed. The marshy areas in the north and eastern sections of the site are part of the headwaters of the Peconic River. The Peconic River both recharges to, and receives water from, the sole source aquifer system underneath Long Island, depending on the position of the water table relative to the base of the river bed. In times of sustained drought, the river water typically recharges to groundwater while with normal to above-normal precipitation, the river receives water from the aquifer.

BNL uses approximately 10 MLD (2.6 MGD) of groundwater to meet potable water needs in addition to heating and cooling requirements. Approximately 74 percent of the total water is returned to the aquifer through onsite recharge basins. About 19 percent is discharged into the Peconic River. Human consumption, evaporation (cooling-tower-and wind-losses) and sewer line losses account for the remaining seven percent. An additional 2.13 MLD (0.56 MGD) of groundwater are pumped from remediation wells for treatment, and then returned to the aquifer by the use of recharge basins. See Figure 1-8 for a graphical representation of groundwater usage at BNL.

Studies of Long Island hydrology and geology in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits (referred as the Upper Glacial Aquifer) are between 36 and 77 meters (120 and 250 feet) thick, and are generally composed of highly permeable glacial sands and gravel (Warren *et al.*, 1968). Water penetrates these deposits readily, and there is little direct run-off into surface streams unless precipitation is intense. 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 groundwater (Koppleman, 1978).

Many factors affect groundwater flow in the vicinity of BNL. An east-west groundwater divide is located approximately 0.8 km (0.5 miles) north of BNL (Scorca, *et. al.*, 1997). A second groundwater divide, which transects portions of the BNL site during periods of high water table position (i.e., during periods of inflow from the aquifer to the stream bed), defines the southern boundary of the area contributing groundwater to the Peconic River watershed. Groundwater flow direction across the BNL site is influenced by natural drainage systems varying between being eastward along the Peconic River, southeastward towards the Forge River, and southward toward the Carmans River. Figure 1-9 shows the typical ground water directional flow and elevation in terms of feet above mean sea level (AMSL). If depth to groundwater were measured from the surface of the land, it ranges from 1.52 meters (5 feet) near the Peconic River to about 24.38 meters (80 feet) in the higher elevation areas in the central and western portions of the site. In most areas at BNL, the horizontal velocity of groundwater is approximately 23 cm (0.75 feet) per day. In general terms, it takes approximately 20 to 22 years for groundwater to travel from the central, developed area of the site, to the BNL southern boundary.

BNL's site was identified by the Long Island Regional Planning Board and Suffolk County as being over a deep-flow recharge zone for Long Island (Koppleman, 1978). This finding indicates that precipitation and surface water which recharge within this zone have the

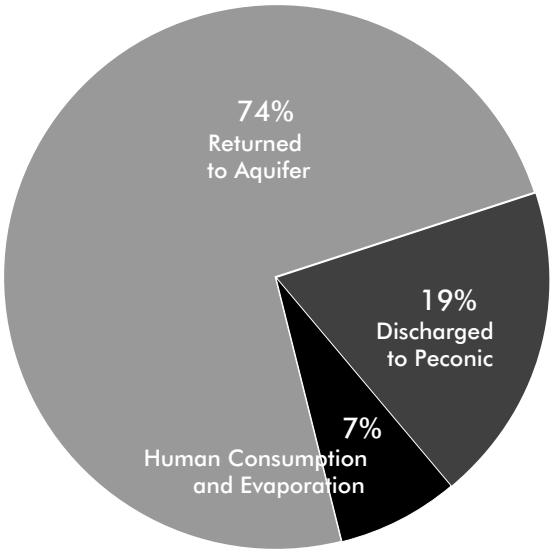


Figure 1-8. Use of Groundwater at BNL

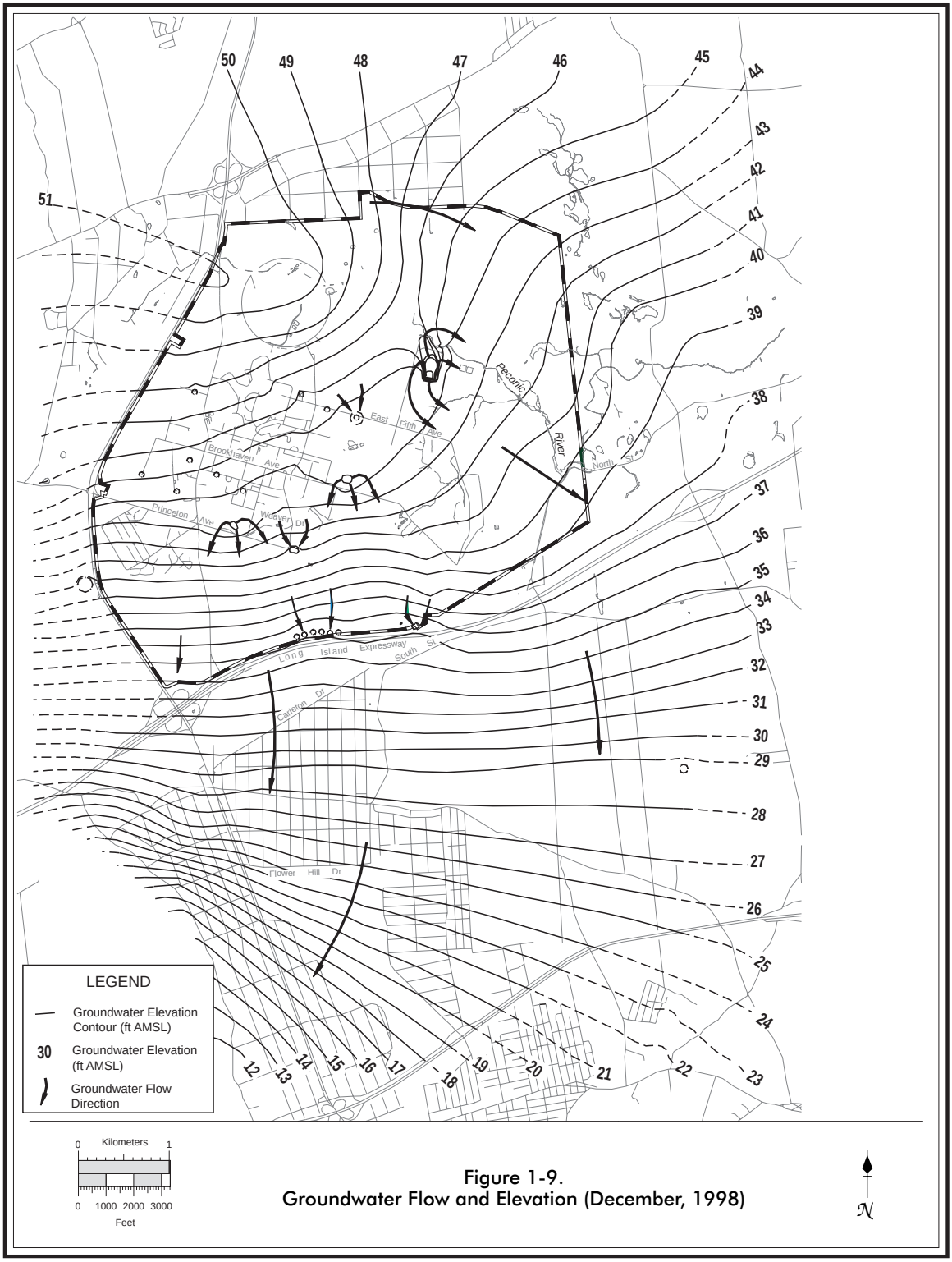


Figure 1-9.
Groundwater Flow and Elevation (December, 1998)

potential to replenish the lower aquifer systems lying below the Upper Glacial Aquifer. It is estimated 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). In coastal areas,

these lower aquifers discharge to the Atlantic Ocean or to the Long Island Sound.

1.6. CLIMATIC DATA

The Laboratory can be characterized as a breezy, well-ventilated site, like most of the eastern seaboard. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equal from these two directions during the spring and fall (Nagle, 1975; Nagle, 1978). "A Wind Rose" is a graphical depiction of the annual frequency distribution of wind speed and direction. Figure 1-10 shows the 1998 annual Wind Rose for BNL, measured at a height of 88 meters (288 feet).

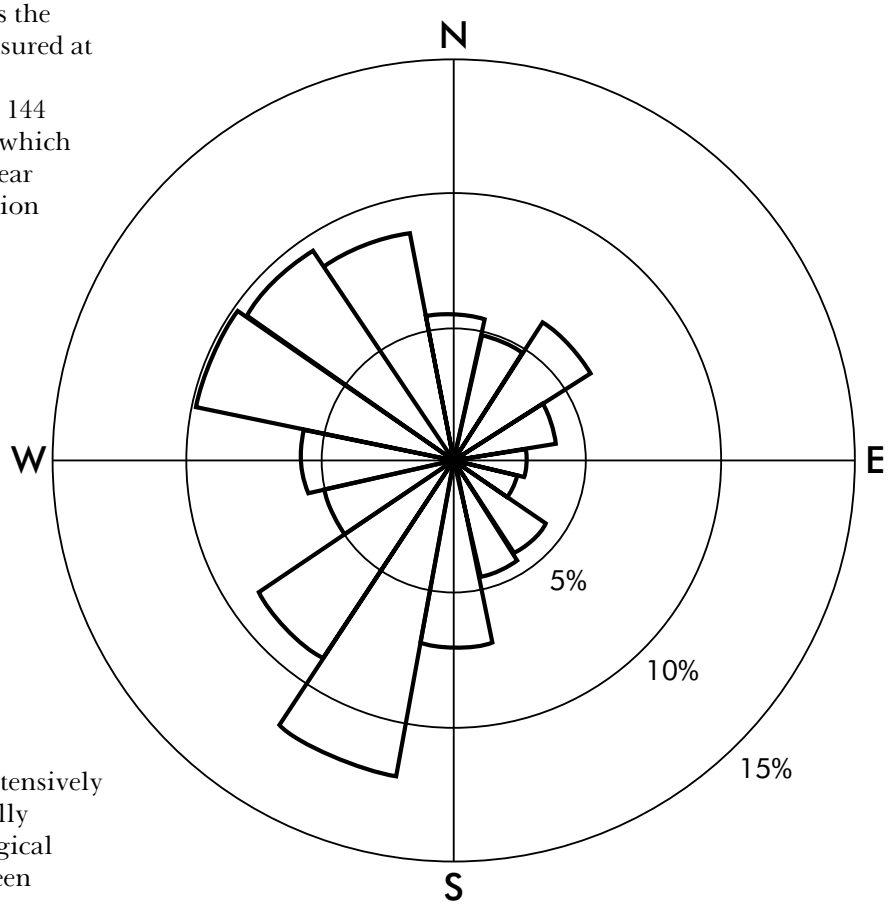
The total precipitation for 1998 was 144 centimeters (cm), or 56.61 inches (in), which is about 20.32 cm (8 in) above the 50-year annual average. Most of the precipitation was received from January through June. Precipitation for the months of July to December was below normal for 1998, leading to drier conditions on site at the end of 1998. Figures 1-11 and 1-12, respectively, present the 1998 monthly and historical precipitation data. The monthly mean temperature in 1998 was 11.7°C (53.1 °F), ranging from a monthly mean low temperature of -2.3°C (27.8 °F) to a monthly mean high temperature of 28.3°C (83 °F). Figure 1-13 shows the 1998 and historical monthly mean temperatures.

1.7. ECOLOGICAL RESOURCES

BNL natural resources have been extensively mapped to identify any environmentally sensitive areas, and to inventory biological species. Over 230 plant species have been identified onsite.

The Laboratory is located in a section of the Oak/Chestnut forest region of the Coastal Plain. BNL property constitutes five percent of 404.7 sq-km (100,000 acre) Pine Barrens on Long Island. Because of the general topography and porous soil, there is little surface runoff or open water. Upland soils tend to be very well drained, while depressions form small pocket wetlands with standing water on a seasonal basis. There are also six major regulated wetlands onsite. Hence, a mosaic of wet and dry areas on the site are correlated with variations in topography and depth to the water table. Without fires or other disturbances, the vegetation normally follows the moisture gradient closely. In actuality, vegetation onsite is in various stages of succession, reflecting the history of disturbances to the area, the most important having been land clearing, fire, local flooding, and draining.

The fifteen mammal species endemic to the site include species common to mixed hardwood forests and open grassland habitats. The white-tailed deer density is at least 100 per square mile according to a BNL deer popula-



Notes:
1. The arrows formed by the wedges indicate wind direction. This diagram indicates that the predominant wind direction in 1998 was towards the north-northeast.
2. Each concentric circle represents a 5 percent frequency, so wind blew towards the NNE 12% of the time in 1998.
3. Wind was calm 2.3% of the time in 1998
4. Wind directions were measured at a hieght of 88 meters.

Figure 1-10. Annual Wind Rose for 1998

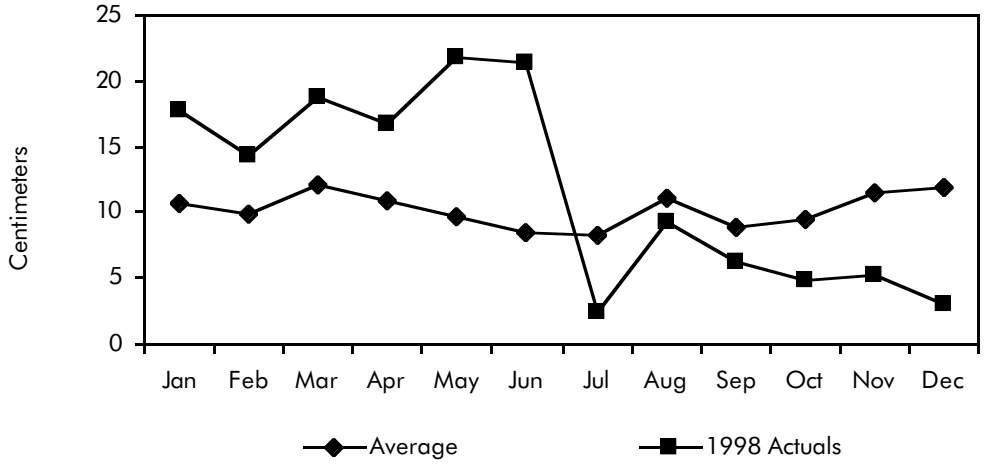


Figure 1-11. Monthly Precipitation Trends

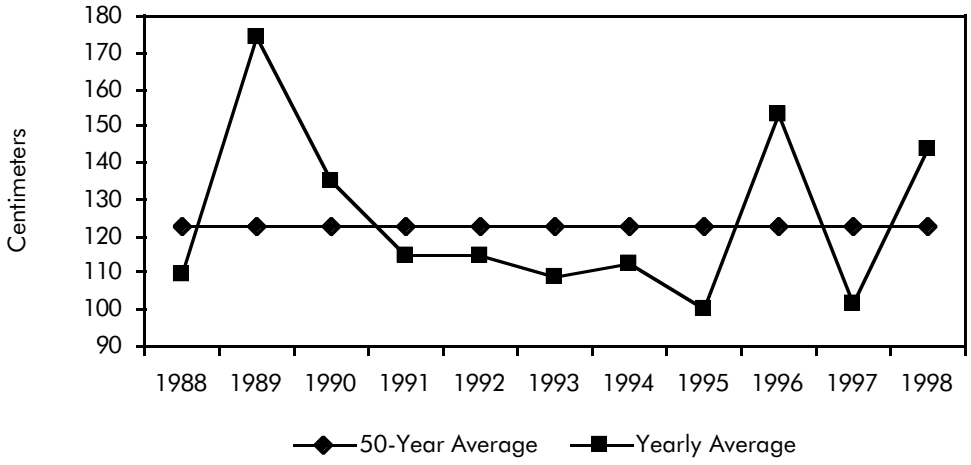


Figure 1-12. 10 Year Precipitation Trend

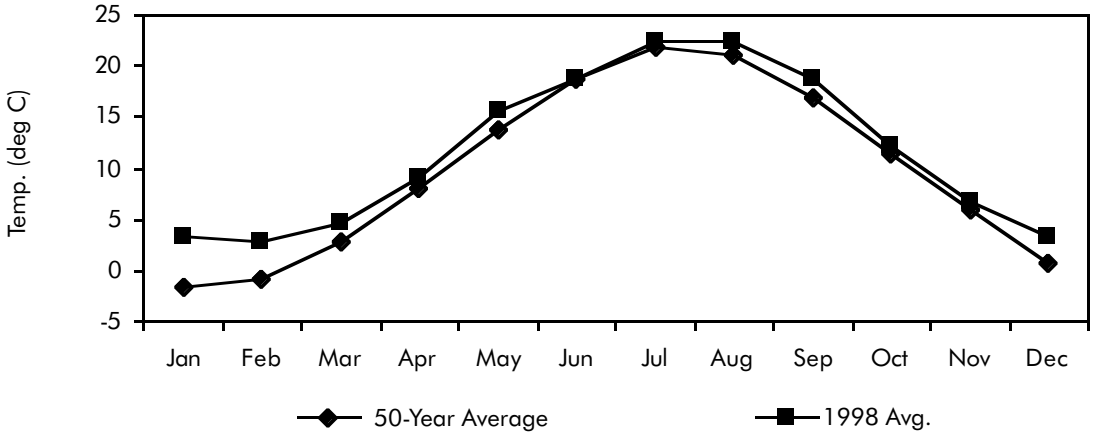


Figure 1-13. Monthly Mean Temperature Trend

tion study issued in 1993 (Thomlinson, 1993). At least 85 species of birds have been observed at BNL, a result of its location within the Atlantic Flyway, and the scrub/shrub habitats which offer food and rest to migratory songbirds. Open fields bordered by hardwood forests at the recreation complex are excellent hunting areas for hawks. Nine amphibian and ten reptile species have been identified. Permanently flooded retention basins and other watercourses support aquatic reptiles. Recent ecological studies at the BNL site have confirmed thirteen breeding sites for the NYS-endangered eastern tiger salamander *(Ambystoma Tigrinum)* in BNL's vernal ponds and some recharge basins. Figure 1-14 is a photograph of the spotted salamander *(Ambystoma Maculatum)*. Nine species of fish have also been identified. The banded sunfish *(Eanneacanthus Obesus)* is a NYS species of "special concern", as it occurs solely within the Peconic River system: it has been confirmed as inhabiting the Peconic River onsite (Scheibel, 1990; Corin, 1990). Part of the Peconic River running through BNL's property was designated "scenic" in accordance with the NYS's Wild, Scenic, and Recreational River Systems Act.

Figure 1-14. Spotted Salamander *(Ambystoma Maculatum)*

REFERENCES:

Corin, L.P. 1990. *Review of Federally Threatened or Endangered Species Potentially Impacted by Construction of the RHIC at Brookhaven National Laboratory*. Letter to Gerald C. Kinne, September 25, 1990.

Geragthy and Miller, Inc. 1996. *Regional Groundwater Model, Brookhaven National Laboratory, Upton, New York*. A report to Brookhaven National Laboratory, November 1996.

Koppelman, L. 1978. *Long Island Waste Treatment Management Plan, Vol. I and II*. July, 1978.

Long Island Power Authority (LIPA). 1998. *Population Survey 1998: Current Population Estimates for Nassau and Suffolk Counties and the Rockaway Peninsula*. September, 1998.

Nagle, C. M. 1975. *Climatology of Brookhaven National Laboratory: 1949-1973*. BNL Report No. 50466, November 1975.

Nagle, C. M. 1978. *Climatology of Brookhaven National Laboratory: 1974 through 1977*. BNL Report No. 50857, May, 1978.

Scheibel, M.S. 1990. *Review of New York State Endangered Species Potentially Impacted by Construction of the RHIC at Brookhaven National Laboratory*. Letter to Gerald C. Kinne, September 24, 1990.

Thomlinson, W. 1993. *Deer Population Estimate for the BNL Site*. Summer project Report, March, 1993.

Warren, M. A., W. de Laguna, and N.J. Lusczynski 1968. *Hydrology of Brookhaven National Laboratory and Vicinity*. U.S. Geological Survey Bulletin, 1156-C.