

2007 SITE ENVIRONMENTAL REPORT



SUMMARY

BROOKHAVEN NATIONAL LABORATORY



ABOUT THE COVER

A total of 216 species of birds have been identified at Brookhaven National Laboratory (BNL) since 1948. Approximately 85 species are known to nest on site, some of which are New York State threatened, endangered, or species of special concern. Chapter 6 of this report discusses habitat management and protection efforts of the laboratory's various bird populations.

The beautiful photo of a Red-tailed hawk (*Buteo jamaicensis*) on the cover of this report was taken by BNL photographer, Roger Stoutenburgh. The red-tailed hawk, a bird of prey, is one of nine species of *Buteo* inhabiting the United States and is protected by the migratory Bird Treaty Act.

The Brookhaven National Laboratory 2007 Site Environmental Report is a public document that is distributed to various U.S. Department of Energy sites, local libraries, and local regulators and stakeholders. The report is available to the general public on the internet at <http://www.bnl.gov/ewms/ser/>. A summary of the report is also available and is accompanied by a compact disk containing the full report. To obtain a copy of the summary and CD, please write or call:

Brookhaven National Laboratory
Environmental and Waste Management Services Division
Attention: SER Project Coordinator
Building 120
P.O. Box 5000
Upton, NY 11973-5000
(631) 344-3711



A MESSAGE FROM THE LABORATORY DIRECTOR

BNL's environmental performance in 2007 continued to be a success, and that performance is key in enabling us to accomplish our scientific goals. We were recognized with eight national or regional environmental awards, including the prestigious White House Closing the Circle Award for expanding our EMS by voluntary participation in environmental improvement programs and its first Silver Level Award from the Office of the Federal Environmental

Executive for electronics recycling. In addition, we received an Environmental Outreach Award from the National Environmental Performance Track Program, and a Long Island Transportation Management Inc., 2007 Commuter Choice Leadership Award. These accomplishments are proof that our commitment to environmentally responsible operations remains strong.

In 2007, BNL's Environmental Management System received recertification, with 24 examples of our continual improvement highlighted by the auditors. In addition, our nationally recognized Pollution Prevention Program continued to save the Laboratory money and helped reduce or reuse millions of pounds of waste.

As we address the remaining legacy issues under the Environmental Restoration Program, we will continue to openly communicate with the community, regulators, employees, and other interested parties on our environmental issues and cleanup progress. We know that the Laboratory's future as a world leader in science research depends in great part on the trust and cooperation of our neighbors.

Signature on file
Samuel Aronson, Laboratory Director

2007 SITE ENVIRONMENTAL REPORT SUMMARY

| | | | |
|--|----|---|----|
| Message from the Laboratory Director | 1 | EPA Performance Track..... | 14 |
| Preface | 2 | Energy Management and Conservation | 14 |
| BNL's Environmental, Safety, Security, and Health Policy | 3 | Water Conservation | 15 |
| About Brookhaven National Laboratory | 4 | Waste Management | 16 |
| Research and Discoveries at BNL..... | 5 | Compliance Status..... | 16 |
| BNL Facilities and Operations..... | 6 | Air Quality Monitoring and Surveillance | 17 |
| Major Scientific Facilities at BNL..... | 7 | Groundwater Protection | 18 |
| Hydrology and Geology of the BNL Site..... | 8 | Environmental Restoration Projects | 19 |
| Wildlife Programs at BNL..... | 10 | Water Quality Surveillance | 19 |
| Upton Ecological and Research Reserve | 11 | Radiological Dose Assessment | 20 |
| Cultural Resources at BNL..... | 12 | Natural Resource Monitoring | 21 |
| BNL's Environmental Management System | 13 | Quality Assurance | 23 |
| BNL's Environmental Management Programs ... | 14 | Communication and Community Involvement .. | 25 |
| Pollution Prevention | 14 | Reader Response Form | 27 |



Brookhaven National Laboratory

PREFACE

Each year, Brookhaven National Laboratory (BNL) prepares an annual Site Environmental Report (SER) in accordance with U.S. Department of Energy (DOE) Order 231.1A, Environment, Safety and Health Reporting. The report is written to inform the public, regulators, employees, and other stakeholders of the Laboratory's environmental performance during the calendar year in review. Volume I of the SER summarizes environmental data; environmental management performance; compliance with applicable DOE, federal, state, and local regulations; and performance in restoration and surveillance monitoring programs. BNL has prepared annual SERs since 1971 and has documented nearly all of its environmental history since the Laboratory's inception in 1947.

Volume II of the SER, the Groundwater Status Report, also is prepared annually to report on the status of and evaluate the performance of groundwater treatment systems at the Laboratory. Volume II includes detailed technical summaries of groundwater data and its interpretation, and is intended for internal BNL users, regulators, and other technically oriented stakeholders. A brief overview of the information contained in Volume II is included in this summary under Groundwater Protection Program.

Both reports are available in print and as downloadable files on the BNL web page at <http://www.bnl.gov/ewms/ser/>. An electronic version on compact disc is distributed with each printed report. This summary provides a general overview of Volume 1, and is distributed with a compact disc containing the full report.

Environmental, Safety, Security, and Health Policy

Brookhaven National Laboratory

This document is a statement of BNL's ESSH policy. BNL is a world leader in scientific research and strives to demonstrate excellence in protecting people, property, and the environment.

I expect every employee, contractor, and guest to take personal responsibility for adhering to the following principles:

- **Environment:** We protect the environment, conserve resources, and prevent pollution.
- **Safety:** We maintain a safe workplace and we plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers, and guests.
- **Security:** We protect people, property, information, computing systems, and facilities.
- **Health:** We protect human health within our boundaries and in the surrounding community.
- **Compliance:** We achieve and maintain compliance with applicable ESSH requirements.
- **Community:** We maintain open, proactive, and constructive relationships with our employees, neighbors, regulators, DOE, and our other stakeholders.
- **Continual Improvement:** We continually improve ESSH performance.

In addition to my annual review of BNL's progress on ESSH 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.

Signed: September 6, 2006
Sam Aronson, Director

ESSH Policy

The Laboratory's Environmental, Safety, Security, and Health (ESSH) Policy makes clear BNL's commitments to environmental stewardship, the safety of its employees, and the security of the site. Specific environmental commitments in the policy include compliance, pollution prevention, cleanup, community outreach, and continual improvement.

The ESSH Policy is posted throughout the site, on the BNL website at <http://www.bnl.gov/ESQH/ESSH.asp>, and is included in all training programs for new employees, guests, and contractors.



Satellite photo showing location of BNL. The small circle is the Relativistic Heavy Ion Collider, known as RHIC.

ABOUT BROOKHAVEN NATIONAL LABORATORY



Established in 1947, BNL is a multi-program national laboratory managed for DOE's Office of Science by Brookhaven Science Associates (BSA), a partnership formed by Stony Brook University and Battelle Memorial Institute. For more than 60 years, the Laboratory has played a lead role in the DOE Science and Technology mission. BNL manages its world-class scientific research with particular sensitivity to environmental issues and community concerns. The Laboratory's motto, "Exploring Life's Mysteries...Protecting its Future," and its Environmental, Safety, Security and Health Policy reflect the commitment of BNL's management to fully integrate environmental stewardship into all facets of its mission and operations.

BNL's broad mission is to carry out basic and applied research in long-term programs in a safe and environmentally sound manner with the cooperation, support, and 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 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 is one of the five largest, high-technology employers on Long Island, with approximately 2,700 employees that include scientists, engineers, technicians, and administrative personnel. More than 75 percent of BNL employees live in Suffolk County. In addition, BNL annually hosts an estimated 3,500 visiting scientists, more than 30 percent of whom are from New York State universities and businesses. The visiting scientists and sometimes their families, as well as visiting students, reside in apartments and dormitories on site or in nearby communities.

An independent Suffolk County Planning Commission report concluded that BNL's spending for operations, procurement, payroll, construction, medical benefits, and technology transfer spreads

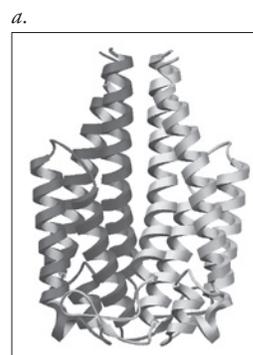
throughout Long Island's economy, making BNL vital to the local economic health, as well as to New York State. In 2007, the laboratory purchased \$40.2 million worth of supplies and services from Long Island businesses. Approximately \$13.8 million was spent on 467 purchases in Nassau County, and \$26.4 million was spent on 2,786 purchases in Suffolk County. BNL's total annual budget in 2007 was approximately \$510.2 million, of which approximately 55.6 percent, or \$283.8 million, was spent on employee salaries, wages, and fringe benefits.

RESEARCH AND DISCOVERIES AT BNL

The Laboratory is one of the nation's—and the world's—leading research institutions. Six Nobel Prize-winning discoveries have been made at BNL (<http://www.bnl.gov/bnlweb/history/nobel/>) and each year, visiting researchers from universities, industry, and other laboratories worldwide, use BNL's unique facilities to perform research. Listed below are some examples of current research and discoveries. Further information can be found at http://www.bnl.gov/bnlweb/research_list.asp.

Scientific Discoveries

- *Courant-Snyder strong focusing principle, critical to the design of all modern particle accelerators.*
- *Theories and experiments to determine the mechanisms underlying high-temperature superconductors.*
- *Study of the effects of radiation on biological systems, important to cancer treatment and prevention and to human space travel.*
- *A way to produce vast quantities of gene products, using a virus known as T7.*
- *Development of fluoro-2-deoxy-D-glucose, or FDG-18, now used in nearly every clinical positron emission tomography scan done in hospitals around the world.*
- *Important studies of the brain, including those uncovering the roots of psychiatric disorders, brain metabolism and drug addiction.*
- *Large-scale studies of the effect of increased carbon dioxide on ecosystems.*
- *The discovery of a perfect liquid – a type of matter thought by scientists to have existed microseconds after the Big Bang.*
- *The development of thallium-201, now used in hundreds of thousands of heart stress-tests each year.*
- *X-ray and neutron scattering facilities that have made possible countless studies of molecular structures important to disease.*
- *Use of L-dopa for the treatment of Parkinson's disease (the gold standard for treatment).*
- *X-ray angiography for non-invasive heart imaging.*
- *Important studies of the brain, including the roots of drug addiction (e.g. first image of cocaine in the brain, discovery of enzyme deficit in smokers' brains), psychiatric disorders, and brain metabolism.*



a. *A 3-D model of a Lyme disease protein, used in a new, effective vaccine.*

b. *The Positron Emission Tomography (PET) facility, used to conduct brain research, including how drugs, mental illness, nicotine, alcohol, and normal aging affect the brain.*

c. *The goal at the Center for Functional Nanomaterials (CFN) is to help solve energy problems in the U.S. by exploring materials that use energy efficiently and by researching practical alternatives to fossil fuels.*



Aerial photograph of the BNL site.

BNL 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, of which 530 of these acres are part of the Upton Ecological Reserve.

The major scientific facilities at BNL are briefly described on the following page. The three former research reactors (the Brookhaven Graphite Research Reactor, High Flux Beam Reactor, and Brookhaven Medical Research Reactor) are no longer operating. Other facilities, which are briefly described below, provide basic utility and environmental services. All of the research and support facilities must undergo periodic environmental reviews as part of BNL's Environmental Management Program.

- *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 facility provides high-pressure steam for building 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.
- *Major Petroleum Facility (MPF).* This facility provides reserve fuel for the Central Steam Facility 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 Central Steam Facility 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 transfer 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.
- *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 at the WTP to remove naturally occurring iron. The plant is also equipped with dual air-stripping towers to remove any volatile organic compounds that may be present.

Major Scientific Facilities at BNL

- **Alternating Gradient Synchrotron (AGS).** The AGS is a particle accelerator used to propel protons and heavy ions, such as gold or iron, to high energies for physics research. The Linear Accelerator (Linac) serves as a proton injector for the AGS Booster.
- **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, which is used to simulate the harsh cosmic and solar radiation environment found in space.
- **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.
- **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.
- **Center for Functional Nanomaterials (CFN).** The CFN provides state-of-the-art capabilities for the fabrication and study of nanoscale materials, with an emphasis on atomic-level tailoring to achieve desired properties and functions. The overarching scientific theme of the CFN is the development and understanding of nanoscale materials that address the nations' challenges in energy security.
- **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.
- **Linear Accelerator (Linac) and Brookhaven Linac Isotope Producer (BLIP).** The Linac provides beams of polarized protons for the AGS and RHIC. The beam is also 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.
- **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.
- **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/or 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.
- **Scanning Transmission Electron Microscope (STEM).** The STEM facility includes two microscopes that are used for biological research. Both devices allow scientists to see the intricate details of living things, from bacteria to human tissue.
- **Tandem Van de Graaff and Cyclotrons.** The Tandem Van de Graaff accelerators are used to bombard materials with ions for manufacturing and testing purposes, and to supply RHIC with heavy ions. The cyclotrons are used for the production of radiotracers for use in Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI) studies.

HYDROLOGY AND GEOLOGY OF THE BNL SITE

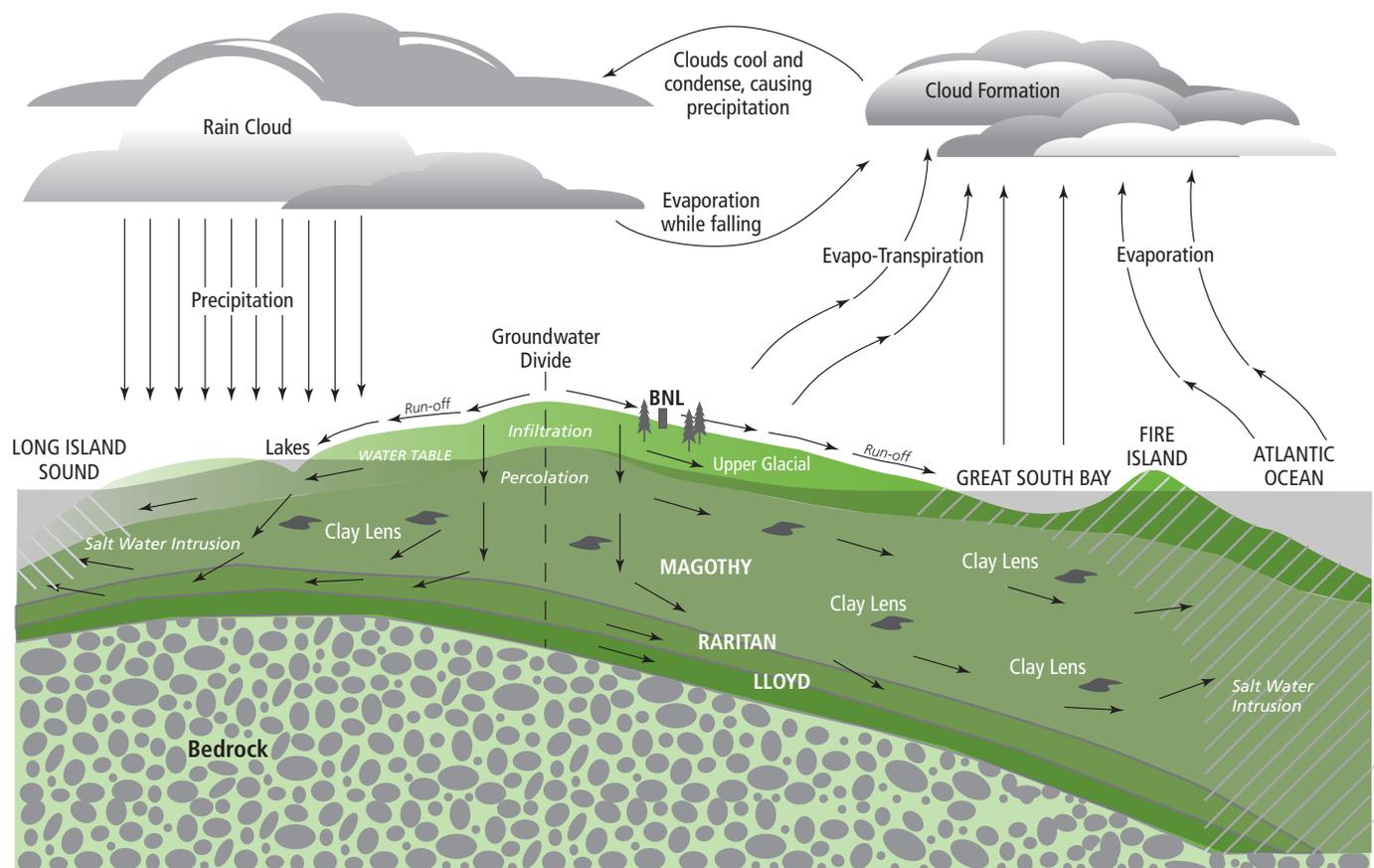
BNL is situated on the western rim of the shallow Peconic River watershed. The marshy areas in the northern and eastern sections of the site are part of the headwaters of the Peconic River. The Peconic River both recharges to, and receives water from, the underlying Upper Glacial aquifer. In times of sustained drought, the river water recharges to the groundwater; with normal to above-normal precipitation, the river receives water from the aquifer. Long Island's aquifer system is one of 72 sole source aquifers in the nation recognized under the aquifer protection program authorized by the U.S. Safe Drinking Water Act. This groundwater system is the primary source of drinking water for both on- and off-site private and public supply wells.

The terrain of the 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. Water penetrates these deposits readily, and there is little direct runoff into surface streams unless precipitation is intense. The 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.

The site is located within a defined deep-flow recharge zone for Long Island. Precipitation and surface water that recharge within this zone have the potential to replenish the Magothy and Lloyd aquifer systems lying below the Upper Glacial aquifer. It has been estimated 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.

During 2007, the Laboratory used approximately 1.15 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

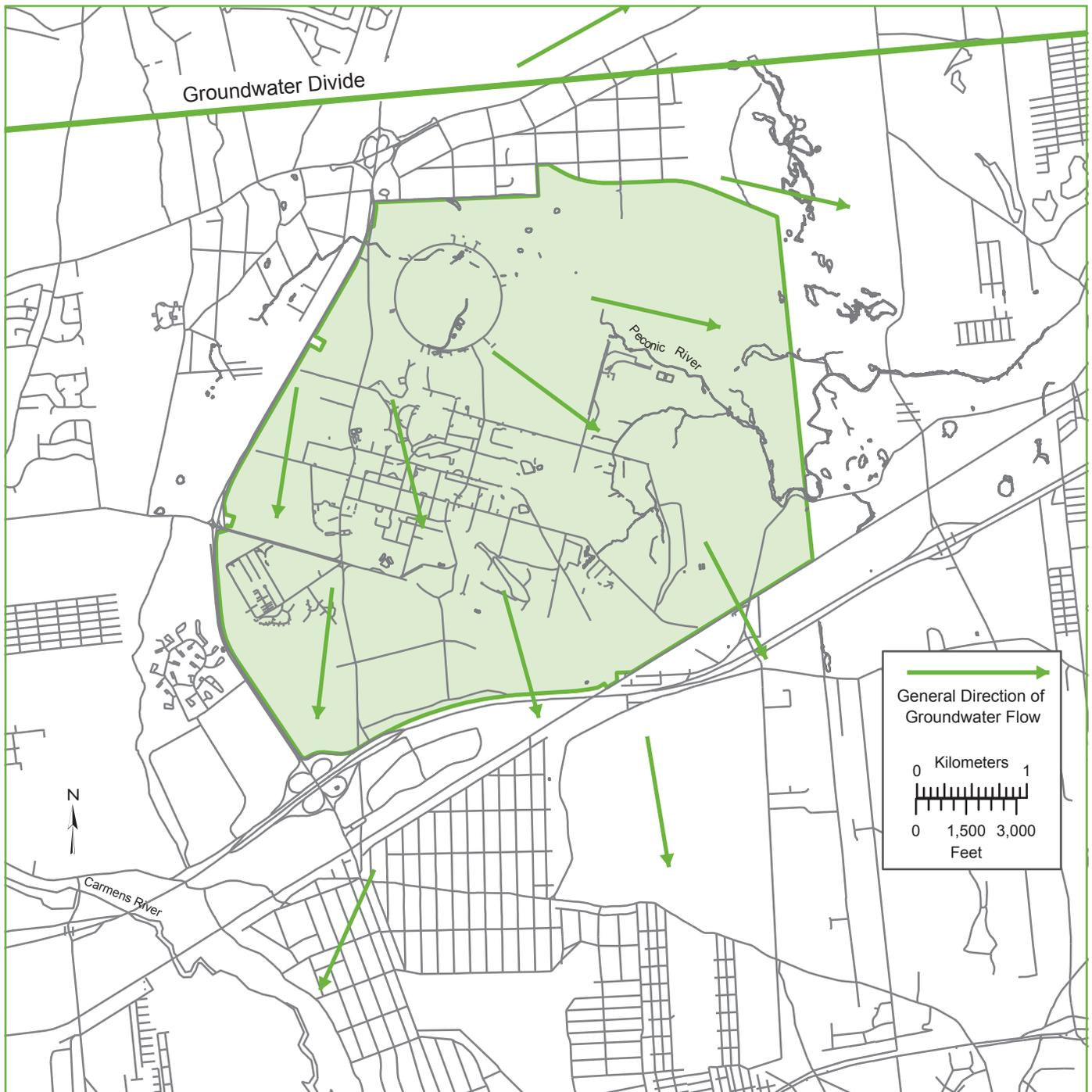
Precipitation Cycle in the Area of Brookhaven National Laboratory



3.4 million gallons of groundwater were pumped each day from remediation wells. The water was treated to remove contaminants and then returned to the aquifer by way of recharge basins or injection wells.

Groundwater flow directions across the site are influenced by natural drainage systems: eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River. 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 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. In most areas on site, the horizontal velocity of groundwater is approximately 0.75 to 1.2 feet per day. 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.

BNL Groundwater Flow Map



WILDLIFE PROGRAMS AT BNL

Eastern Hognose Snake (Heterodon platyrhinos).



Banded Sunfish (Enneacanthus obesus). This fish was released immediately after the photo was taken.



Eastern Tiger Salamander (Ambystoma t. tigrinum).



Under BNL's Natural Resource Management Program, the Laboratory focuses on protecting New York State threatened and endangered species on site, and continuing its leadership role within the greater Long Island Central Pine Barrens ecosystem.

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the site. Endangered, threatened, and species of special concern have been identified as having been resident at BNL during the past 30 years. The only New York State endangered species confirmed as now inhabiting the site is the eastern tiger salamander (*Ambystoma t. tigrinum*). Additionally, the New York State endangered Persius duskywing butterfly (*Erynnis p. persius*) and the crested fringed orchid (*Plantathera cristata*) have been identified on site in the past. Five New York State threatened species have been positively identified on site and two other species are considered likely to be present. The banded sunfish (*Enneacanthus obesus*), the swamp darter fish (*Etheostoma fusiforme*), and the stiff goldenrod plant (*Solidago rigida*) have been previously reported. The northern harrier (*Circus cyaneus*) was seen hunting over open fields in November 2003. In 2005, the Pine Barrens bluet (*Enallagma recurvatum*) damselfly was confirmed at one of the many coastal plain ponds located on site. The frosted elfin butterfly (*Callophrys irus*) has been identified as possibly being at BNL, based on historic documentation and the presence of its preferred habitat and host plant (wild lupine). In addition, stargrass (*Aletris farinosa*) was reconfirmed to exist at BNL. Several other species that inhabit the site, visit during migration, or have historically been identified, are listed as rare, species of special concern, or exploitably vulnerable by New York State.

To eliminate or minimize any negative effects that Laboratory operations might cause to these species, precautions are in place to protect the on-site habitats and natural resources. Activities to eliminate or minimize negative effects on sensitive or critical species are either incorporated into Laboratory procedures or into specific program or project plans. Environmental restoration projects remove pollutant sources that could contaminate habitats. Human access to critical habitats is limited. In some cases, habitats are enhanced to improve survival or increase populations. Even routine activities such as road maintenance are not performed until they have been evaluated and determined to be unlikely to affect habitat.

BNL sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants understand the ecosystem and to foster interest in science. Wildlife programs are conducted at the Laboratory in collaboration with DOE, local agencies, colleges, and high schools. Ecological research is also conducted on site to update the current natural resource inventory, gain a better understanding of the ecosystem, and guide management planning.

In 2007, the Environmental and Waste Management Services Division hosted 16 interns and one faculty member who worked on a variety of projects including: surveying drag-

onflies and damselflies, radio tracking turtles, analyzing the water chemistry of coastal plain ponds, investigating turtle and amphibian diseases, investigating the loss of the southern leopard frog on Long Island, genetics of resident gray and red fox, and population health of the banded sunfish. Teachers

conducted mark-recapture and distribution studies on tiger beetles and burying beetles. Teachers also participated in a week-long workshop in environmental monitoring under the Open Space Stewardship Program, which is managed by the BNL Office of Educational Programs.

Upton Ecological and Research Reserve

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. From 2000 to 2004, funding provided by DOE under an Inter-Agency Agreement between DOE and the U.S. Fish & Wildlife Services (FWS) was used to conduct resource management programs for the conservation, enhancement, and restoration of wildlife and habitat in the reserve.

In 2005, management was transitioned to the Foundation for Ecological Research in the Northeast (FERN). During that year, FERN initiated its first pine barrens-wide monitoring program to assess the health of the various forest types within the Pine Barrens, followed by a continuation of the effort in 2006. FERN established 91 permanent plots over the 2-year period of the monitoring program and is currently analyzing the data. One significant finding from the monitoring is the lack of forest regeneration. In virtually every forest type, there is a lack of survival of trees from seedlings through to saplings. This is likely a result of either the over-abundance of deer or lack of sunlight penetrating to the understory.

Research on oak tree defoliators that was initiated by FWS is continuing at the Laboratory. Much of the oak forest on site and

immediately east of BNL has been subject to repeated defoliation by gypsy moth and orange-striped oak moth. This double defoliation, if it occurs year after year, can kill large sections of oak forest. Beginning in 2003, death of tree oaks was documented. Due to continued defoliation, oak mortality is now estimated at greater than 25 percent in many areas in the northeast quadrant of the Laboratory. The amount of defoliation appeared to decrease in 2007, which was likely due to a reduced number of insect defoliators.

In 2007, FERN hosted two undergraduate interns who assisted in the development of Freshwater Wetland Health Monitoring Protocols for monitoring wetland health throughout the Pine Barrens. These protocols will likely be completed in 2008 and implemented sometime thereafter.

Research supported by FERN in 2007 included an investigation into the microbial world of soils located within a number of the Forest Health Plots. This investigation identified several new species of fungus and bacteria. Future work in the area of microbial diversity is expected to identify additional new species across the Pine Barrens. Additionally, approximately 30 ponds throughout eastern Long Island were surveyed for variations in water quality in ponds near roads versus ponds far from roads.

Further information on the forest health initiative, as well as other activities of FERN, is available on the FERN website at www.fern-li.org.



World War I Trenches

From 1917 through 1920, the site of what is now the Laboratory was the U.S. Army's Camp Upton. Named for Civil War General Emory Upton, Camp Upton was one of 16 U.S. Army training camps. Here, recruits mostly from the New York metropolitan area were trained for the famed 77th Infantry Division, also known as the Liberty Division, which began leaving Camp Upton for fighting in France in March 1918.

Training included marching, weapons-use and, among other techniques, trench warfare. Trench warfare was a form of combat in which armies dug zig-zagging lines of interconnected ditches. Within these trenches, troops lived in muddy water,



among rats and lice while defending their territory and combating their opponents.

The trenches shown here may be some of the only surviving examples of WWI earthworks in the U.S., and they have been determined to be eligible for listing on the National Register of Historic Places.



BNL employee Matthias Harrington graciously authorized the scanning of his grandfather's diary. The handwritten diary presents Matthias Harrington's thoughts and experiences during World War I (1918-1919). Starting in Camp Gordon, Georgia, then a brief stay at Camp Upton, through the war in Europe, and his return to America, his words offer a unique peek into the everyday life of an American soldier during World War I.

CULTURAL RESOURCES AT BNL

The BNL Cultural Resource Management (CRM) Program ensures that the Laboratory fully complies with the numerous cultural resource regulations. The Cultural Resource Management Plan for Brookhaven National Laboratory (BNL, 2005) guides the management of all of BNL's historical resources. Along with achieving compliance with applicable regulations, one of the major goals of the CRM program is to fully assess both known and potential cultural resources. The range of the Laboratory's cultural resources includes buildings and structures, World War I (WWI) earthwork features, the Camp Upton Historical Collection, scientific equipment, photo/audio/video archives, and institutional records. As various cultural resources are identified, plans for their long-term stewardship are developed and implemented. Achieving these goals ensures that the contributions BNL and the site have made to our history and culture are documented and available for interpretation. The Laboratory has three structures or sites that have been determined to be eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor (BGRR) complex, the High Flux Beam Reactor (HFBR) complex, and the WWI training trenches associated with Camp Upton.

Cultural resource management activities performed in 2007 include identifying additional equipment artifacts associated with the HFBR and BGRR, and electronically scanning the diary of a World War I soldier for website posting. Outreach activities consisted of providing presentations on Laboratory cultural resources and tours of the WWI trenches to several small groups, and participating in local fairs. Further information regarding BNL's history and cultural resources can be found at <http://www.bnl.gov/ewms/cresources/>.

One measure of an effective Environmental Management System (EMS) is recognition of good environmental performance. In 2007, BNL was recognized with eight national and regional awards:

- DOE Pollution Prevention and Environmental Stewardship Accomplishment awards for EMS, composting, and recycling efforts.
- Pollution Prevention Star Award and White House Closing the Circle Award for voluntary efforts in EMS, Performance Track, and the National Partnership for Environmental Priorities Program.
- Federal Environmental Executive Silver Award for Electronics Recycling.
- Environmental Outreach Award from the National Environmental Performance Track Program.
- Long Island Transportation Management Inc. 2007 Commuter Choice Leadership Award.

BNL'S ENVIRONMENTAL MANAGEMENT SYSTEM

The Laboratory's Integrated Safety Management System (ISMS) integrates management of environment (i.e., environmental protection and pollution prevention), safety, and health issues into all work planning. BNL's ISMS ensures that the Laboratory integrates DOE's five Core Functions and seven Guiding Principles into all work processes. These integrated safety processes contributed to BNL's achievement of registration under both the International Organization for Standardization (ISO) 14001 standard (for the Laboratory's Environmental Management System) and the Occupational Safety and Health Assessment Series (OHSAS) 18001 standard (for BNL's Safety and Health Program). Both standards require an organization to develop a policy, create plans to implement the policy, implement the plans, check progress and take correction actions, and review the system periodically to ensure its continuing suitability, adequacy, and effectiveness.

In 2001, an Environmental Management System (EMS) was established at BNL to ensure that environmental issues are systematically identified, controlled, and monitored. The EMS also provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual environmental improvement. The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized ISO 14001 Environmental Management Standard. BNL was the first laboratory under the DOE Office of Science to become officially registered to this standard. Annual independent audits, which are required in order to maintain the registration, are conducted to validate that the Laboratory's EMS is being maintained and to identify evidence of continual improvement. In 2007, an EMS surveillance audit determined that BNL continues to conform to the Standard. During the audit, 24 examples of BNL's continual improvement were highlighted, including the Laboratory's link between

institutional- and division-level objectives and targets, "very well done" internal audit records and documentation, and improved management reviews. The auditors identified one minor non-conformance in "Nonconformity, corrective action and preventative action" and four opportunities for improvement, one each in Emergency Preparedness and Response; Objectives, Targets and Programs; Control of Documents; and Operational Control. A corrective action plan was prepared to track the minor non-conformances to closure.



NSF International Strategic Registrations

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Certificate of Registration

This certifies that the Environmental Management System of

Brookhaven National Laboratory

Building 860
E. 5th Street
Upton L.I., New York, 11973-5000 USA

has been assessed by NSF-ISR and found to be in conformance to the following standard(s):

ISO 14001:2004

Scope of Registration:

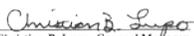
Facilities, experiments, and operations managed by Brookhaven Science Associates at Brookhaven National Laboratory in accordance with the Environmental Management System.

Industrial Classification:

IAF: 34
SIC: 8733
NACE:



Certificate Number: 69525-E4
 Certificate Issue Date: 10-Dec-2007
 Company Initial Date: 10-Jul-2001
 Registration Date: 18-Jun-2007
 Expiration Date*: 17-Jun-2010


 Christian B. Lupo, General Manager
 NSF-ISR, Ltd.

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BNL'S ENVIRONMENTAL MANAGEMENT PROGRAMS

BNL's Environmental Management Program consists of several Laboratory-wide and facility-specific environmental monitoring and surveillance programs. These programs identify potential pathways of public and environmental exposure and evaluate the impacts Laboratory activities may have on the environment. An overview of BNL's environmental programs and a summary of performance for 2007 follows.

POLLUTION PREVENTION

BNL's Pollution Prevention (P2) Program reflects the national and DOE pollution prevention goals and policies, and represents an ongoing effort to make pollution prevention and waste minimization an integral part of the Laboratory's operating philosophy. Pollution prevention and waste reduction goals have been incorporated as performance measures into the DOE contract with BSA and into BNL's ESSH Policy. The overall goal of the P2 Program is to create a systems approach that integrates pollution prevention and waste minimization, resource conservation, recycling, and affirmative procurement into all planning and decision making. In January 2007, Executive Order 13423 was signed, establishing federal requirements for: energy efficiency and conservation, renewable energy, fleet management, electronic stewardship, water conservation, toxic chemical use reduction, recycling, sustainable buildings, and purchasing environmentally preferred products. Although most of these requirements have already been incorporated within the Laboratory's P2 program, the new order will direct its future course.

Six P2 proposals, submitted by employees to BNL's P2 Council, were funded in 2007, for a combined investment of approximately \$10,000. The anticipated annual savings from these projects is estimated at \$38,000, for an average payback period of less than one year. Initiatives to reduce, recycle, and reuse 14.6 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program saved over \$2.9 million in 2007.

The implementation of pollution prevention opportunities, recycling programs, and conservation initiatives has significantly reduced both waste volumes and management costs. In 2007, these efforts resulted in more than \$2.9 million in cost avoidance or savings and approximately 14.6 million pounds of materials being reduced, recycled, or reused.

The Laboratory also has an active and successful solid waste recycling program, which involves all employees. In 2007, BNL collected more than 175 tons of office paper for recycling. Cardboard, bottles and cans, construction debris, motor oil, scrap metals, lead, automotive batteries, electronic scrap, fluorescent light bulbs, drill press machine coolant, and antifreeze were also recycled.

EPA'S PERFORMANCE TRACK

The Environmental Protection Agency Performance Track (PTrack) Program recognizes top environmental performance among participating U.S. facilities of all types and is

considered the "gold standard" for facility-based environmental performance. The program requires that facilities commit to several improvement goals for a 3-year period and report on the progress of these goals annually. In 2007, the Laboratory completed its first set of goals under the PTrack Program:

- BNL's land and habitat conservation was significantly increased. A total of 42 acres of land was recovered, surpassing the original goal to recover 30 acres.
- The Laboratory continued its efforts to reduce radioactive air emissions from the Brookhaven Linac Isotope Producer. In total, emissions were reduced by 34 percent, surpassing the original goal of 30 percent.
- BNL surpassed its original goal to remove more than 30 tons of ozone-depleting substances (ODS) by eliminating 35.5 tons of Class I ODS from 2003 through 2006.
- The Laboratory did not achieve its original goal of an 80 percent reduction in mercury inventory because the original inventory of mercury in storage was overestimated. By the end of 2006, 47 percent of the mercury inventory had been disposed. BNL continued to eliminate sources of mercury in 2007, achieving a 60 percent reduction by the end of the year.

In April 2007, BNL reapplied for continued membership to the PTrack Program. Four new goals were established: energy reduction, transportation energy reduction, toxic release reductions, and establishing an electronics procurement program.

ENERGY MANAGEMENT AND CONSERVATION

Since 1979, the Laboratory's Energy Management Group has been working to reduce energy use and costs by identifying cost-effective, energy-efficient projects, monitoring energy use and utility bills, and assisting in obtaining the least expensive energy sources possible. The group is responsible for developing, implementing, and coordinating BNL's Energy Management Plan and assisting DOE in meeting the energy goals in DOE Order 430.2B and the Secretary's Transformational Energy Action Management (TEAM) initiative.

The Laboratory has more than 4 million square feet of building space. Many BNL scientific experiments use particle beams generated and accelerated by electricity, with the particles controlled and aligned by large electromagnets. In 2007, the Laboratory used approximately 233 million kilowatt hours (kWh) of electricity, 3 million gallons of fuel oil, 36 thousand gallons of propane, and 163 million ft³ of natural gas. Fuel oil and natural gas produce steam at the Central Steam Facility.

Due to market conditions, fuel oil and natural gas were used whenever each respective fuel was least expensive.

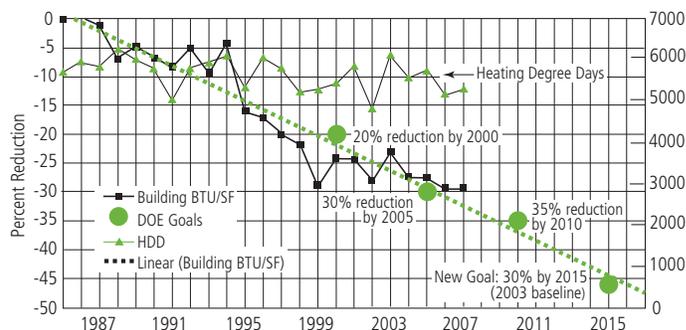
BNL is a participant in the New York Independent System Operator (NYISO) Special Case Resource (SCR) Program, which is an electric load reduction curtailment program. Through this program, the Laboratory has agreed to reduce electrical demand during critical days throughout the summer when NYISO expects customer demand to meet or exceed the available supply. In return, BNL receives a rebate for each megawatt reduced on each curtailment day. No curtailment days were requested in 2007, in part due to mild weather. However, participation in this program still produced a rebate of \$55,000. The Laboratory continues to keep electric loads at a minimum during the summer, by scheduling operations to avoid peak demand periods. This scheduling allowed BNL to save nearly \$4 million in electric costs in 2007 and greatly helps maintain the reliability of the Long Island Power Authority (LIPA) electric system to meet all of its users' needs.

BNL also maintains a contract with the New York Power Authority (NYPA) that resulted in an overall cost avoidance of \$20.4 million in 2007. The Laboratory will continue to seek alternative energy sources to meet its future energy needs, support federally required "green" initiatives, and reduce energy costs. In 2007, the Laboratory purchased a portion of "green energy" for the newly constructed Research Support Building, avoiding 265,000 lbs of CO₂. In addition, biofuels were used in several applications.

In 2007, a solar heating system for the BNL swimming pool began operation. This small project was the first step toward meeting the Laboratory's energy needs with renewable sources. To reduce energy use at non-research facilities, other activities also were undertaken in 2007. These activities included:

- The process was begun for a site-wide Energy Savings Performance Contract (ESPC) audit that will strive to reduce energy usage throughout the Laboratory. This is still in the preliminary evaluation stage, but BNL anticipates significant energy savings from this effort.
- 25 MW of demand was rescheduled to avoid coinciding with the utility summer peak, saving several million dollars in electricity charges.
- \$30,000 in Federal Energy Management Program funding was obtained to demonstrate a solar hot water combination system at the Brookhaven Center.
- Work continued in the replacement of aging, inefficient T-40 fluorescent lighting fixtures with new, efficient T-8 and T-5 units; two to three hundred fixtures are typically replaced annually, saving tens of thousands of kWhs and reducing costs by several thousand dollars.
- Due to aggressive conservation in various buildings, BNL's overall facilities energy usage for 2007 was approximately 8.3 percent less than in 2006, saving over \$1.2 million.
- Water consumption for 2007 was 53 million gallons less than in 2006, saving approximately \$20,000 in operational costs.

- Efficient fuel purchasing strategies (buying and storing oil and burning the least expensive fuel) saved \$420,000, compared to purchasing only oil.
- The Laboratory's Research Support Building was completed and received a Leadership in Energy and Environmental Design (LEED) silver certification.
- The Center for Functional Nanomaterials was completed, and has also received a LEED silver certification.
- Nearly 25,000 gasoline gallon equivalents of natural gas were used in place of gasoline for the Laboratory's vehicle fleet.



Building Energy Performance, 1985 - 2015

The National Energy Conservation Policy Act, as amended by the Federal Energy Management Improvement Act of 1988 and the Energy Policy Acts of 1992 and 2005, requires federal agencies to apply energy conservation measures and to improve federal building design to reduce energy consumption per square foot. Current goals are to reduce energy consumption per square foot, relative to 2003, by 2 percent per year from 2006 - 2015. In 2007, an Executive Order increased the target reduction to 3 percent per year, which is a 30 percent reduction by the end of 2015. Further, DOE Order 430.2B and the Secretary's TEAM initiative have set even more stringent requirements, including renewable energy and transportation fuels that go significantly beyond the previous goal of a 30 percent reduction by 2005, compared to 1985. BNL's energy use per square foot in 2007 was 29.4 percent less than in 1985 and 8.3 percent less than 2003. It is important to note that energy use for buildings and facilities at the Laboratory is largely weather dependent.

WATER CONSERVATION

BNL's water conservation program has achieved dramatic reductions in water use since the mid 1990s. The Laboratory continually evaluates water conservation as part of facility upgrades or new construction initiatives. These efforts include more efficient and expanded use of chilled water for cooling and heating/ventilation and air conditioning (HVAC) systems, and reuse of once-through cooling water for other systems such as cooling towers. The goal is to reduce the consumption of water and reduce the possible impact of clean water discharges on Sewage Treatment Plant operations. In 2007, BNL reduced its water use by more than 11 percent,



BNL Water Consumption Trend

compared to the previous year. In each of the past 4 years, the water consumption total was less than half the 1998 total—a reduction of nearly a half-billion gallons per year.

WASTE MANAGEMENT

As a byproduct of the research it conducts, BNL generates a large range of wastes. These wastes include materials common to many businesses and industries, such as aerosol cans, batteries, paints, and oils. However, the Laboratory’s unique scientific activities also generate waste streams that are subject to additional regulation and special handling, including radioactive, hazardous, and mixed waste.

Collecting, storing, transporting, and disposing of waste generated at the Laboratory is the responsibility of BNL’s Waste Management Facility. This modern facility was designed for handling hazardous, industrial, radioactive, and mixed waste and is comprised of three staging areas: a facility for hazardous waste, regulated by the Resource Conservation and Recovery Act (RCRA); a mixed-waste building for material that is both hazardous and radioactive; and a reclamation building for radioactive material. The RCRA and mixed-waste buildings are managed under a permit issued by the New York State Department of Environmental Conservation. These buildings are used for short-term storage of waste before it is packaged or consolidated for off-site shipment to permitted treatment and disposal facilities. In 2007, BNL generated the following types and quantities of waste from routine operations:

- Hazardous waste: 4.1 tons
- Mixed waste: 31 ft³
- Radioactive waste: 6796 ft³

Hazardous waste from routine operations in 2007 remained fairly steady with respect to 2006 generation rates. An increase in mixed waste generation is attributed to activities within the Collider-Accelerator Department. The radioactive waste quantity for routine operations also increased, but remained below quantities typically generated in previous years. This increase is attributed to increased funding and resulting operations within the high-energy nuclear physics program. Routine operations are defined as ongoing industrial and experimental operations. BNL is currently cleaning up facilities and areas containing radioactive and chemical contamination resulting from long-past operations. Waste recovered through restoration and decommissioning activities is managed by the

Environmental Restoration Project, with assistance from BNL’s Environmental and Waste Management Services Division.

COMPLIANCE MONITORING

The Laboratory must comply with more than 100 sets of federal, state, and local environmental regulations, numerous site-specific permits, equivalency permits for the operation of 14 groundwater remediation systems, and several other binding agreements. BNL is committed to maintaining full compliance with these requirements and agreements to help eliminate or minimize any impact Laboratory operations may have on the environment. Under this program, compliance monitoring is conducted to ensure that air emissions, wastewater effluents, and groundwater monitoring data comply with regulatory limits issued under the federal Clean Air Act, Clean Water Act, Oil Pollution Act, Safe Drinking Water Act, and associated New York State programs. In 2007, BNL complied with the majority of these requirements, and instances of noncompliance were reported to regulatory agencies and corrected expeditiously.

Ten external environmental audits were conducted in 2007. The New York State Department of Environmental Conservation (NYSDEC) conducted inspections of air compliance at the Central Steam Facility (CSF), several outfalls and the Sewage Treatment Plant regulated by the State Pollutant Discharge Elimination System (SPDES), the Major Petroleum Facility (MPF), and chemical bulk storage facilities. The Suffolk County Department of Health Services conducted inspections of the BNL potable water supply, a quarterly inspection of the Sewage Treatment Plant (STP), and several SPDES-regulated outfalls. No formal notices of violation or enforcement actions were issued as a result of these inspections.

The Laboratory took immediate corrective actions to address three conditions identified during the NYSDEC inspection of the MPF. The corrective actions included: the submission of design specifications/plans for the replacement of the secondary containment system for above ground oil storage tanks 5 and 6, repair of a malfunctioning alarm system, and the need for an additional cover stone on several secondary containment systems to prevent liner damage. In addition, an inspection of BNL’s diesel tank farm and underground gasoline storage facilities identified three conditions that needed corrective action. They included: application of the proper color coding for an underground storage tank, inspections and repair of two high-level alarms at the diesel tank farm, and noting both the design and working capabilities of each tank. All conditions were corrected in 2007.

Two issues that required corrective action were identified during an inspection by NYSDEC of BNL’s chemical bulk storage facilities. These included: peeling and blistering paint observed on a tank, and tank labels that did not include the working capacity of each tank. The issues were corrected in accordance with the NYSDEC directive.

Compliance monitoring in 2007 showed that emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the CSF were all within permit limits. Opacity excursions

were noted in the first and second quarters of 2007. The first excursions were due to soot blowing operations, which are performed to maintain boiler efficiency. The excursions were determined to be isolated events after an extended idle period which allowed excess soot to accumulate while nominal volumes of oil were burned to keep the boiler warm. Opacity excursions noted in the second quarter were caused by a mechanical malfunction of the calibration shutter in the transmissometer optical head assembly, which was subsequently replaced.

Approximately 1,168 pounds of ozone-depleting refrigerants were recovered from refrigeration equipment for recycling on site or made available for use by other DOE facilities or federal agencies. These reductions included the removal of forty-seven 17-pound Halon 1211 portable fire extinguishers as excess property due to changes in operations or through replacement.

Monitoring of the potable water supply showed that all drinking water quality requirements were met. Groundwater monitoring at the MPF continued to demonstrate that current oil storage and transfer operations are not affecting groundwater quality. With the exception of four minor permit excursions at the STP, liquid effluents discharged to surface water and groundwater met all applicable SPDES permit requirements. The four SPDES permit limit excursions reported were for nitrogen. Abnormally low flow conditions and decreased nutrients in the waste have been identified as the most likely causes of the increased nitrogen levels. Enzymes are now added at the plant to enhance denitrification of the effluent by the biological organisms during treatment.

The Laboratory continues to reduce the number and severity of spills on site. In 2007, the total number of spills was reduced by 22 percent, from 27 spills in 2006 to 21 spills in 2007. Twelve spills, most less than 5 gallons, were reportable because they reached the soil. The remaining nine spills were small-volume releases either to containment areas or to other impermeable surfaces. All releases were cleaned up or addressed to the satisfaction of NYSDEC. Measures employed to help reduce spills include: replacing petroleum-based lubricants and fluids with vegetable-based products, installing stainless steel-reinforced hydraulic lines on various pieces of equipment, and training staff in proper spill-response techniques.

AIR QUALITY MONITORING AND SURVEILLANCE

BNL monitors radioactive emissions at three facilities on site to ensure compliance with the requirements of the Clean Air Act (CAA). During 2007, Laboratory facilities released a total of 2,536 curies of radioactive gases. EPA regulations require continuous monitoring of all sources that have the potential to deliver an annual radiation dose greater than 0.1 mrem to a member of the public; all other facilities capable of delivering any radiation dose require periodic confirmatory sampling. Although the dose to the public is less than 0.1 mrem and monitoring is not required by EPA, the Brookhaven Linear Isotope Producer (BLIP) is continuously monitored. Oxygen-15 (half-life: 122 seconds) and carbon-11

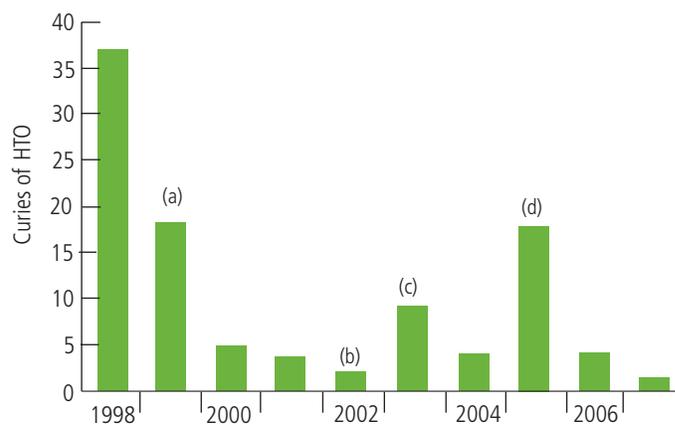
(half-life: 20.48 minutes) emitted from the BLIP constituted more than 99.9 percent of radiological air emissions on site in 2007. The combined emissions were approximately 43 percent lower than in 2006, primarily due to operation at lower power levels in 2007.

Monitoring was also conducted at one other active facility, the Target Processing Laboratory (TPL), and one inactive facility, the High Flux Beam Reactor (HFBR). Releases from the TPL in 2007 continued to be very small (0.038 μ Ci). Tritium releases from the HFBR in 2007 continued a downward trend, as emissions dropped to 1.33 Ci compared to releases in 2006 of 4.03 Ci.

The Laboratory conducts ambient radiological air monitoring to verify local air quality and assess possible environmental and health impacts from BNL operations. Air monitoring stations around the perimeter of the site measure tritium and gross alpha and beta airborne activity. Results for 2007 continued to demonstrate that on-site radiological air quality was consistent with off-site measurements and with results from locations in New York State that are not located near radiological facilities.

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The Central Steam Facility (CSF) is the only BNL facility that requires monitoring. Two of the four boilers at the CSF, specifically 6 and 7, are equipped with continuous emission monitors to measure opacity and nitrogen oxide (NO_x) emissions and opacity.

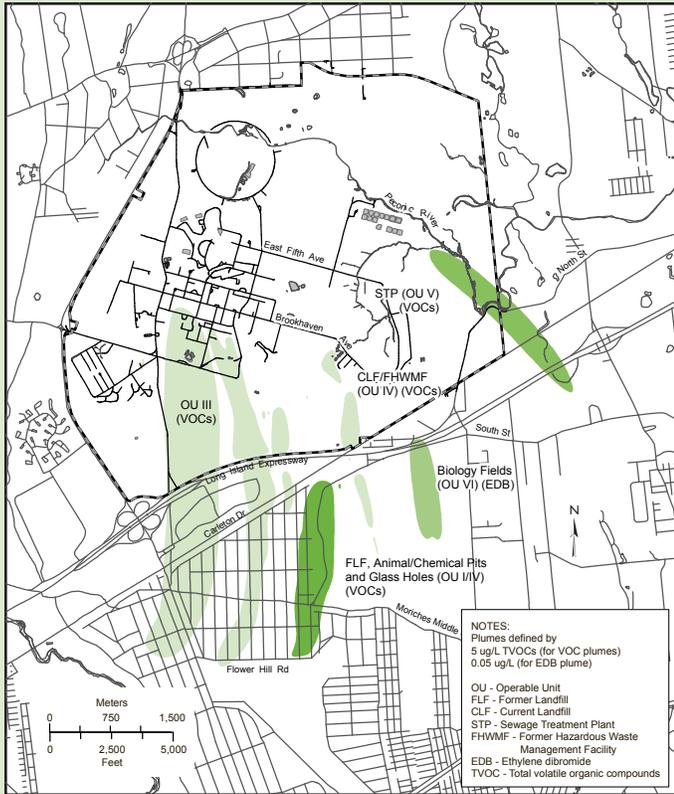
Because natural gas prices were lower than residual fuel oil prices from May through November 2007, BNL used natural gas for most heating and cooling needs during these months. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide were considerably lower than in years when residual fuel oil was predominantly used.



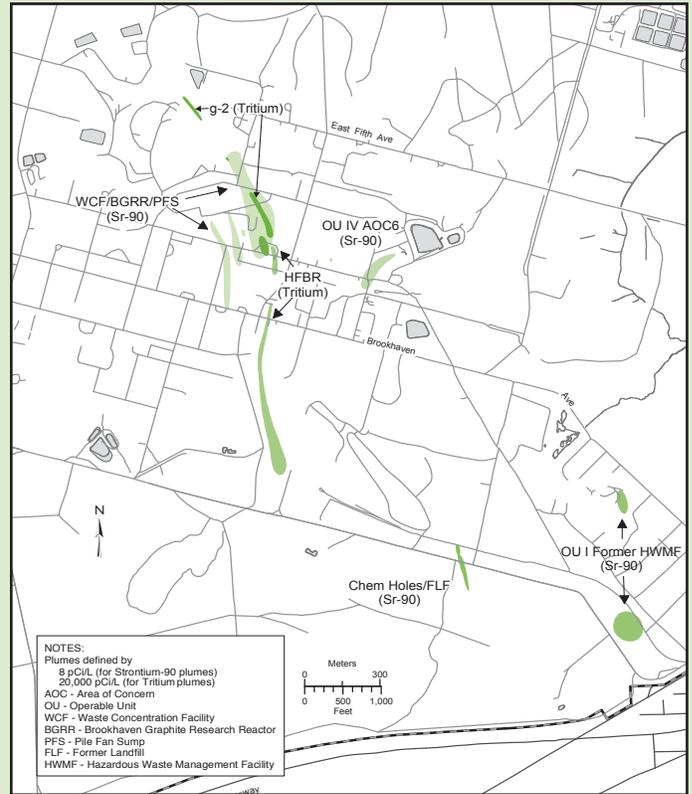
Notes:

- (a) Permanent shutdown of the HFBR announced in November 1999.
- (b) Frequency of sampling reduced to one week per month in 2002.
- (c) Temporary increase due to decommissioning activities.
- (d) Increase thought to be due to evaporation of residual heavy water from a drain-tank vent line.

High Flux Beam Reactor Tritium Emissions,
10-Year Trend, 1998 – 2007



Extent of Volatile Organic Compound Plumes.



Extent of Radionuclide Plumes On Site.

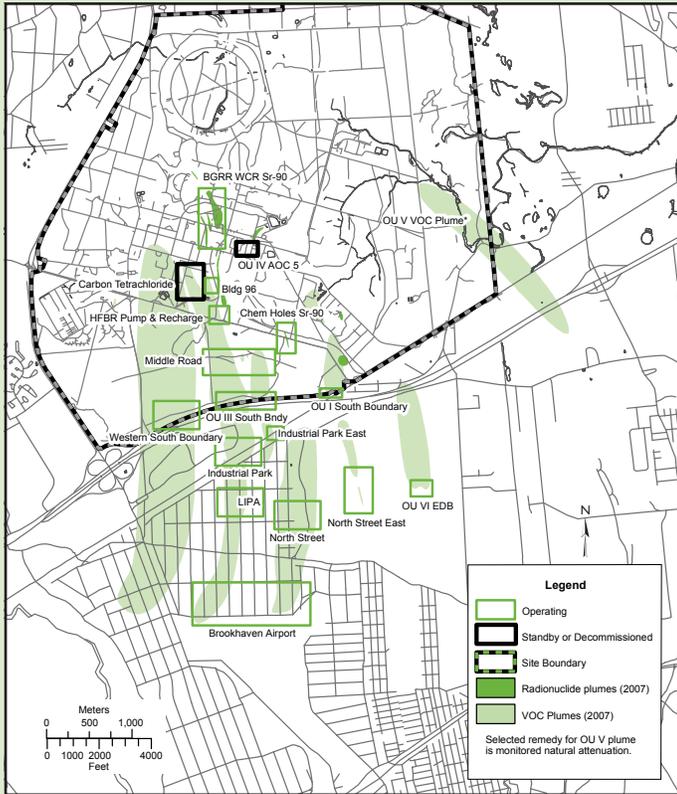
GROUNDWATER PROTECTION

The primary goal of BNL's Groundwater Protection Program is to ensure that plans for groundwater protection, management, monitoring, and restoration are fully defined, integrated, and managed in a manner that is consistent with federal, state, and local regulations. BNL's extensive groundwater monitoring well network is used to evaluate progress in restoring groundwater quality, to comply with regulatory permit requirements, to monitor active research and support facilities, and to assess the quality of groundwater that enters and exits the site. The Laboratory monitors research and support facilities where there is a potential for environmental impact, as well as areas where past waste handling practices or accidental spills have already degraded groundwater quality. In 2007, the Laboratory collected groundwater samples from 850 on- and off-site monitoring wells during 2,289 individual sampling events.

Under the environmental surveillance program, 10 active research and support facilities were monitored during 2007. Although no new impacts to groundwater quality have been discovered since 2001, groundwater quality continues to be impacted from past releases at two facilities: the former g-2 experiment within the Alternating Gradient Synchrotron facility, and the Upton service station facility. Tritium continues to be detected at concentrations above the 20,000 pCi/L drinking water standards (DWS) in wells monitoring the g-2 source area. Although tritium concentrations have shown a steady decline over the past four years, monitoring data sug-

gest that the continued release of tritium from the source area is due to residual tritium being flushed out of the unsaturated zone close to the water table by natural water table fluctuations. The amount of tritium entering the groundwater is expected to decrease over time, due to this flushing mechanism and by natural radioactive decay. Tritium levels in the groundwater at the Brookhaven Linear Isotope producer (BLIP) were less than the 20,000 pCi/L DWS during all of 2007. In early 2007, a Record of Decision (ROD) was signed by DOE and EPA for the g-2 and BLIP tritium source areas. The ROD requires continued routine inspection and maintenance of the impermeable caps at the source area, groundwater surveillance of the source areas, and monitoring the g-2 tritium plume until it attenuates to less than the 20,000 pCi/L DWS. Volatile organic compounds (VOCs) associated with historical petroleum and solvent spills continue to be detected in the groundwater at concentrations above the applicable DWS at the Upton service station facility. These low levels of VOCs are expected to decrease over time by means of natural attenuation.

The primary mission of the Laboratory's Long Term Response Actions (LTRA) program is to operate and maintain groundwater treatment systems and prevent additional groundwater contamination from migrating off site. BNL continues to make significant progress in restoring groundwater quality. During 2007, 198 pounds of VOCs and approximately 5.2 mCi of strontium-90 (Sr-90) were removed from the groundwater, and more than 1.2 billion gallons of treated



Locations of BNL Groundwater Remediation Systems.

groundwater were returned to the aquifer. Since the operation of the first treatment system in 1996, a cumulative total of approximately 5,900 pounds of solvents and 17 mCi of Sr-90 have been cleaned-up. Data from the groundwater monitoring networks and treatment systems is monitored and analyzed on a continuous basis. During 2007, it was determined that two groundwater treatment systems, the Chemical Holes Sr-90 System and the Airport System, required modifications in the form of additional extraction wells to ensure the complete capture of the plumes and the ability to achieve the cleanup goals. In addition, the HFBR Pump and Recharge System was reactivated and enhanced with an additional extraction well. The Laboratory's groundwater cleanup goals include minimizing plume growth and reducing contaminant concentrations in the Upper Glacial aquifer to below Maximum Contaminant Level (MCL) standards by 2030. For the Chemical/Animal Holes area, MCLs must be reached by 2040. VOC levels in the Magothy aquifer must meet MCLs by 2065. For the Sr-90 plumes associated with the BGRRR/WCF, MCLs must be reached by 2070. The cleanup objectives will be met by a combination of active treatment and natural attenuation. The LTRA program uses an extensive network of monitoring wells to track the progress that the groundwater treatment systems are making toward plume remediation.

The SER Volume I provides an overview of this program, and the SER Volume II, Groundwater Status Report, provides a detailed description, data, and maps relating to all groundwater monitoring performed in 2007.

ENVIRONMENTAL RESTORATION PROJECTS

The Environmental Restoration Projects group was established at the Laboratory to complete cleanup activities resulting from early operations at BNL.

In 2007, work planning continued for the Brookhaven Graphite Research Reactor (BGRR) decommissioning project. In accordance with the requirements of 10 CFR 830, BNL completed the development of the Documented Safety Analysis (DSA), which was approved by DOE. The DSA is a critical document for the BGRR pile removal. Other progress related to the BGRR project included finalizing the Remedial Design/Remedial Action (RD/RA) Work Plan for the graphite pile removal, the development and regulatory review of the RD/RA Work Plan for the removal of the biological shield, and the installation of an engineered cap.

Progress associated with the High Flux Beam Reactor (HFBR) decommissioning project in 2007 included: finalization of the HFBR Feasibility Study describing remedial alternatives and presenting a comparative analysis of the alternatives; working with regulators to finalize the Proposed Remedial Action Plan (PRAP); and preparations for the commencement of the public comment period for the PRAP, including two information sessions and a public meeting.

A final Action Memorandum was issued for the removal action involving the cleanup of the Waste Loading Area (WLA). The WLA is an area along the eastern boundary of the former Hazardous Waste Management Facility (HWMF). The remediation of this area (approximately two acres) was transferred to the HFBR project scope in 2005. Cleanup of the WLA using the dose-based cleanup goal and methodology specified for the former HWMF in the Operable Unit I ROD began in 2007.

WATER QUALITY SURVEILLANCE

BNL discharges treated wastewater into the headwaters of the Peconic River via the Sewage Treatment plant (STP), and non-contact cooling water and storm water runoff to groundwater via recharge basins. Some wastewater may contain very low levels of radiological, organic, or inorganic contaminants. Monitoring, pollution prevention, and careful operation of treatment facilities ensure that these discharges comply with all applicable requirements and that the public, employees, and the environment are protected.

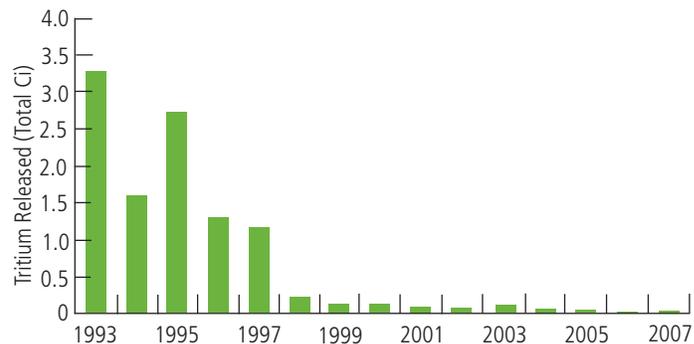
To assess the potential impact of discharges on the water quality of the Peconic River, surface water monitoring is conducted at several locations upstream and downstream of the STP point-source discharge. The Carmans River, located to the west of BNL, is monitored as a geographical control location for comparative purposes, as it is not affected by Laboratory operations. In 2007, the average gross alpha and beta activity levels in the STP discharge were well below drinking water standards (DWS). While the frequency of detectable levels of tritium declined in 2007, the average concentration was slightly higher than in 2006, resulting in an increase in releases to the Peconic River. The maximum concentration released was approximately 9.2 percent of the drinking water

standard and was only detected in the effluent. The average concentration was 57.4 pCi/L, which is less than 20 percent of the minimum detection limit (MDL). Throughout 2007, tritium was never detected in the influent to the STP, only the effluent. The only explanation for this observation is that tritium released to the STP in late 2006 continued to be released in early January. An investigation to ascertain the tritium source did not reveal any single source of high-concentration tritium, but did identify several low-concentration sources. The low-concentration releases are expected to continue, as facilities such as the High Flux Beam Reactor and Brookhaven Medical Research Reactor are placed into routine surveillance mode and piping and tank systems are drained and dried out. The STP effluent continued to show no detection of cesium-137 (Cs-137), strontium-90 (Sr-90), or other gamma-emitting nuclides attributable to BNL operations. Acetone was the only volatile organic compound (VOC) detected in the STP effluent at concentrations at or near the detection limit. The maximum concentration detected was 4.2 µg/L, which is less than 15 percent of the generic limit of 50 µg/L imposed by the New York State Department of Environmental Conservation. Nitrogen as nitrate was confirmed in the STP effluent through the environmental surveillance monitoring program at concentrations that exceeded the SPDES permit limits.

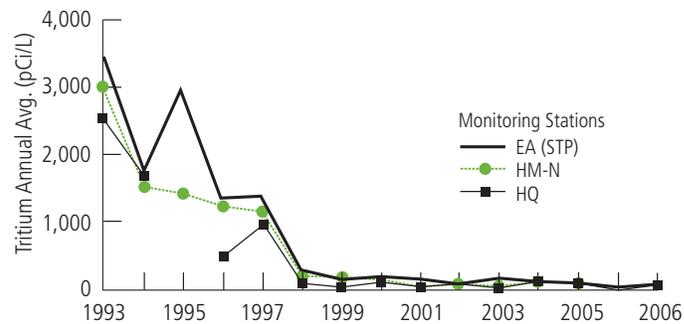
On-site recharge basins are used for the discharge of “clean” wastewater streams, including once-through cooling water, storm water runoff, and cooling tower blow-down, and are suitable for direct replenishment of the groundwater aquifer. Radiological analyses in 2007 showed that the low levels of gross alpha and beta activity detected in most of the basins were attributable to naturally occurring radionuclides, such as potassium-40, and not to BNL operations. Tritium was detected in a single sample collected at Basin HT-W at very low levels (430 pCi/L). Considering the low level of detection and analytical method uncertainties, positive identification of tritium in the sample was questionable.

In 2007, nonradiological analyses of the recharge basins showed low concentrations of VOCs, including disinfection byproducts generated by the use of chlorine for the control of bacteria and algae in cooling water systems. Acetone was also detected above the minimum detection level MDL for most recharge basins. Due to the common use of acetone in analytical laboratories and the finding of acetone in the contract analytical laboratory control samples, positive identification is suspect. Lead was detected in two samples and was likely due to the presence of suspended particulate in the samples. Remediation of the CSF outfall for lead contamination was completed and the site was restored in 2007 at a minimum detection limit of 0.2 µg/L.

Along the Peconic River, several locations are monitored for radiological and nonradiological parameters to assess overall water quality. Radiological data from Peconic River surface water sampling in 2007 showed very low concentrations of gross alpha and gross beta activity. The average concentrations from off-site and control locations were indistinguishable from BNL on-site levels, and all detected levels were below the applicable DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the STP. Tritium was detected in a single water sample collected downstream of the STP discharge in May, although the detection is questionable due to the fact that tritium was not detected in the STP discharge during this period. Aluminum, copper, iron, and zinc were present at some locations both upstream and downstream of the STP point-source discharge at concentrations that exceeded the NYS Ambient Water Quality Standards. Mercury was not detected in any water samples in 2007.



Tritium Released to the Peconic River, 15-Year Trend, 1993 – 2007



Notes:
 NYS Drinking Water Standard is 20,000 pCi/L.
 There were no samples collected at monitoring Station HQ in 2006.

Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations, 1993 – 2007

inguishable from BNL on-site levels, and all detected levels were below the applicable DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the STP. Tritium was detected in a single water sample collected downstream of the STP discharge in May, although the detection is questionable due to the fact that tritium was not detected in the STP discharge during this period. Aluminum, copper, iron, and zinc were present at some locations both upstream and downstream of the STP point-source discharge at concentrations that exceeded the NYS Ambient Water Quality Standards. Mercury was not detected in any water samples in 2007.

RADIOLOGICAL DOSE ASSESSMENT

BNL routinely assesses its operations to ensure that any potential radiological dose to members of the public, BNL workers, and the environment is “As Low As Reasonably Achievable”. The potential radiological dose is calculated as the largest possible dose to a hypothetical Maximally Exposed Individual (MEI) at the BNL site boundary. For dose assessment purposes, the pathways include direct radiation exposure, inhalation, ingestion, immersion, and skin absorption. Radiological dose assessments at the Laboratory have consistently shown that the “effective dose equivalent” from operations is well below the EPA and DOE regulatory dose limits for the public and the environment. The dose impact from all BNL activities in 2007 was found to be insignificant compared to natural background radiation levels.

To measure direct radiation from Laboratory operations, 49 thermoluminescent dosimeters (TLDs) are placed on site and 15 TLDs are placed in surrounding communities. In 2007, the average doses from all TLDs showed there was no additional contribution to dose from BNL operations above natural background radiation. The annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was 70 ± 12 mrem (700 ± 120 μ Sv), and the annual off-site external dose was 64 ± 10 mrem (640 ± 100 μ Sv). Both on- and off-site dose measurements include the contribution from natural terrestrial and cosmic background radiation.

The effective dose to the MEI from air emissions was $5.96E-2$ mrem (0.60 μ Sv). The ingestion pathway dose was estimated as 3.02 mrem (30 μ Sv) from consumption of deer meat and 0.08 mrem (0.7 μ Sv) from consumption of fish caught in the vicinity of the Laboratory. The total annual dose to the MEI from all pathways was estimated as 3.16 mrem (32 μ Sv). The dose from the air inhalation pathway attributable to BNL operations was less than 1 percent of EPA's annual regulatory dose limit of 10 mrem (100 μ Sv), and the

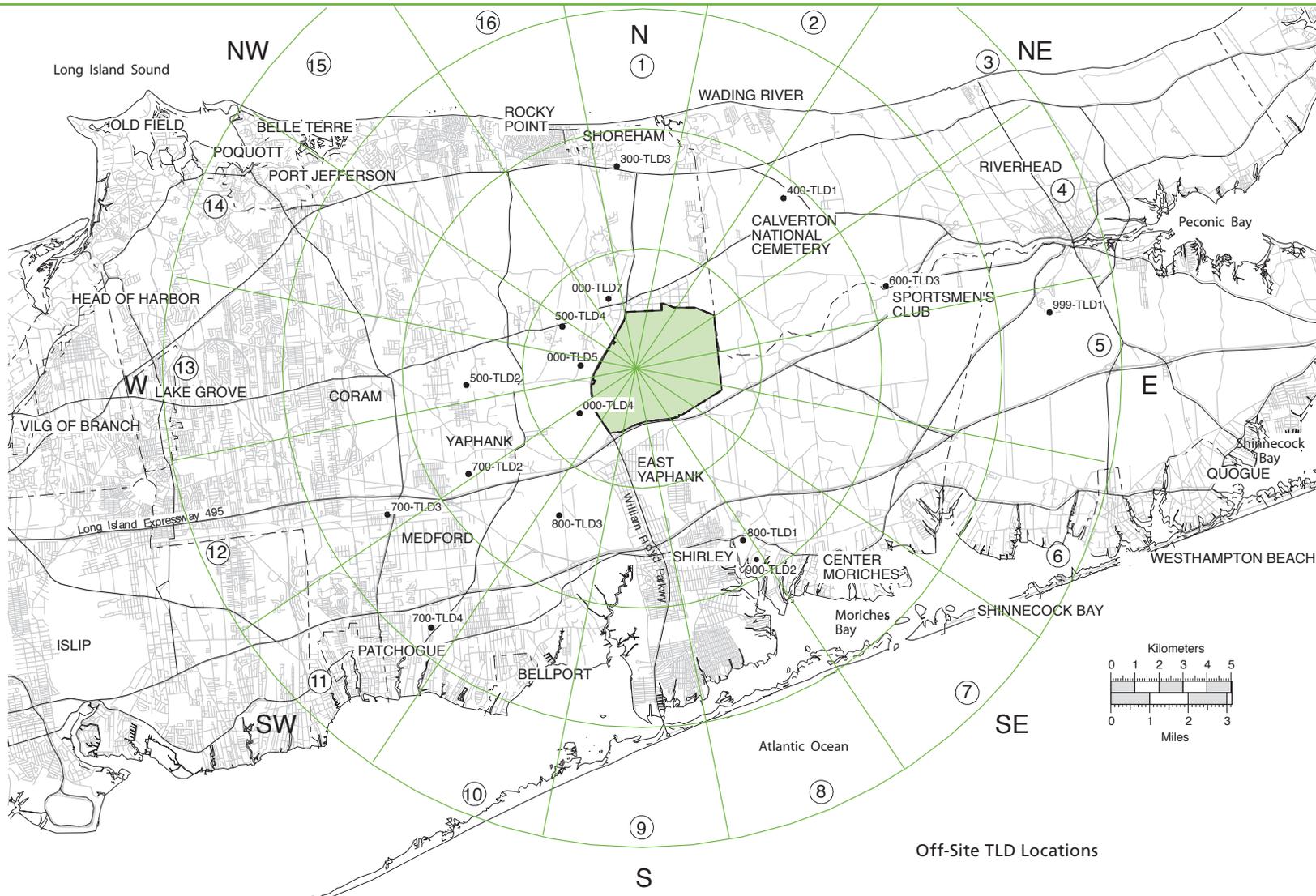
total dose was less than 4 percent of DOE's annual dose limit of 100 mrem (1,000 μ Sv) from all pathways. Doses to aquatic and terrestrial biota were also evaluated and found to be well below the regulatory limits.

As a part of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) review process at BNL, any source that has the potential to emit radioactive materials is evaluated for regulatory compliance. In 2007, two NESHAPs compliance reviews were performed: research using radiotracers in Room 9-830 in the Medical Department and remediation activities at the waste loading dock. Both assessments showed no significant dose impacts from these activities.

NATURAL RESOURCE MONITORING

BNL conducts routine monitoring of flora and fauna to assess the impact, if any, of past and present activities on the Laboratory's natural resources.

Generally, deer sampled within 1 mile of the Lab have cesium-137 (Cs-137) levels higher than greater than 1 mile



off site. This is likely due to deer feeding on site and then being struck by cars off site on William Floyd Parkway. The maximum on-site concentration in 2007 was 17 times lower than the highest level reported in 2006, and is much lower than the highest level ever reported (1996). The low levels in samples taken in 2007 indicate the effectiveness of cleanup actions across the site. The New York State Department of Health (NYSDOH) has reviewed the potential public health risk associated with the low levels of Cs-137 in on-site deer and determined that neither hunting restrictions or formal health advisories are warranted. Testing of deer bones for strontium-90 (Sr-90) indicated background levels. Sr-90 is present in the environment at background levels as a result of worldwide fall-out from nuclear weapons testing. BNL will continue to test for Sr-90 in bone to develop baseline information.

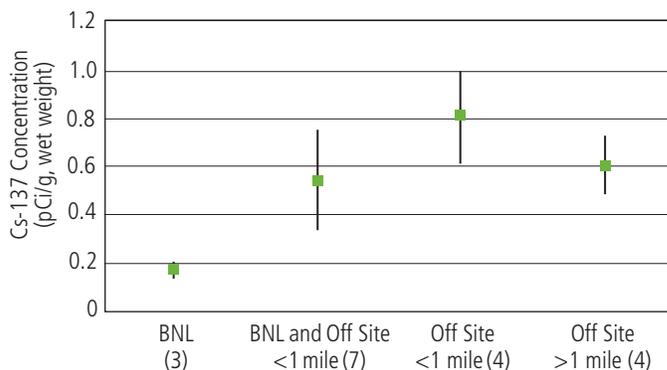
Routine annual on-site sampling of fish resumed in 2007, as populations had recovered sufficiently to allow collection of samples. Cs-137 was detected at low levels in all samples from the Peconic River system and appears to be declining compared with historic values. The cleanup of both on-and off-site portions of the Peconic River in 2004 and 2005 removed approximately 88 percent of Cs-137 in the sediment that was co-located with mercury. Natural decay and the removal of this contamination are expected to result in further decreases.

Non-radiological analysis of fish continued in 2007. Due to their small size, fish taken on site were analyzed for mercury only, due to its known health effects. The mercury in on-site samples ranged from 0.13 mg/kg in a brown bullhead to 1.35 mg/kg in a pumpkinseed. This compares to a range of 0.46 mg/kg to 0.62 mg/kg in fish taken in 2006. The larger range in the 2007 on-site data is due to a larger sample size and larger range in fish. Off-site Peconic River samples ranged from less than the MDL in a brown bullhead to 1.04 mg/kg in a largemouth bass. Mercury levels were less than the 1.0mg/kg consumption standard set by the U.S. Food and Drug Administration in all but a few fish. The average of all fish from the Peconic River was 0.32 mg/kg, which is slightly above the EPA criterion for freshwaters. Low levels of pesticides were also detected in off-site fish samples, but did not exceed any standards and do not pose any health impact to humans or animals that might consume the fish. PCBs have been found in fish and sediment at BNL and periodically at other locations in the Peconic River. However, the cleanup of the Peconic River, which was completed in 2005, removed most PCBs within the sediments. PCB testing will be discontinued in fish samples in 2008 except for fish taken on site, to continue to document the effectiveness of the Peconic River cleanup.

Annual sampling of sediment, vegetation, and freshwater in the Peconic River and a control location on the Carmans River was conducted in 2007. Low levels of Cs-137 were documented in sediment and vegetation. On- and off-site aquatic vegetation and sediments contained low levels of Cs-137, metals, pesticides, and PCBs, in amounts that were consistent with levels detected in previous years.

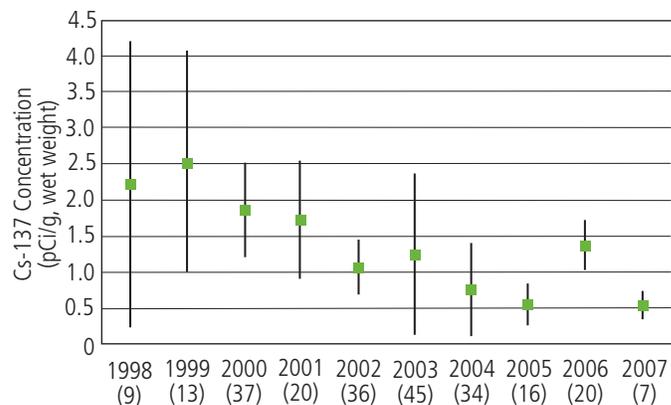
Under the Peconic River remediation project, sediment from the Peconic River was remediated to remove mercury and associated contaminants from the river. This project was completed in the summer of 2005. Sampling results for 2007 showed that 97 percent of samples analyzed at 16 on-site locations and 14 off-site locations met the cleanup goal of 2.0 mg/kg. One sample exceeded the goal in June and two samples exceeded the goal in August. Further evaluation will include additional sediment and surface water sampling in 2008.

Water column sampling for mercury and methylmercury was performed at 20 Peconic River sampling locations and one reference location on the Connetquot River in 2007. Concentrations of mercury were less than the respective 2003 Peconic River pre-cleanup concentrations. Mercury samples, collected from the Peconic River upstream and downstream of the STP and at the STP outfall, indicate that the STP effluent does add mercury to the Peconic River greater than concentrations above the STP outfall. Methylmercury concentrations detected in June 2007 were generally higher than the June 2003 Peconic River pre-cleanup concentrations, and



Notes: Averages are shown for samples collected at BNL, on site and off site within 1 mile, off site but within a 1-mile radius, and off site greater than a 1-mile radius. Numbers in parentheses indicate the number of samples in that data set. All values are shown with a 95% confidence interval.

Comparison of Cesium-137 Average Concentrations in Deer, 2007



Notes: Averages are shown for samples collected at BNL, and within 1 mile. Numbers in parentheses indicate the number of samples in that data set. All values are shown with a 95% confidence interval.

Five-Year Cesium-137 Concentration Trends in Deer Meat at BNL and within 1 Mile of BNL, 1998 – 2007

August 2007 concentrations were lower than values detected in August 2003. Methylmercury samples collected from the STP effluent indicate that the STP is not a significant contributing source.

Wetland monitoring results showed that vegetation restoration along the Peconic River was at 92 percent over 64 monitoring transects with less than 1 percent coverage of invasive species. Monitoring of invasive species will continue until 2008, at which time BNL will evaluate all wetland restoration and invasive species surveys and control operations since the completion of the Peconic River cleanup.

QUALITY ASSURANCE

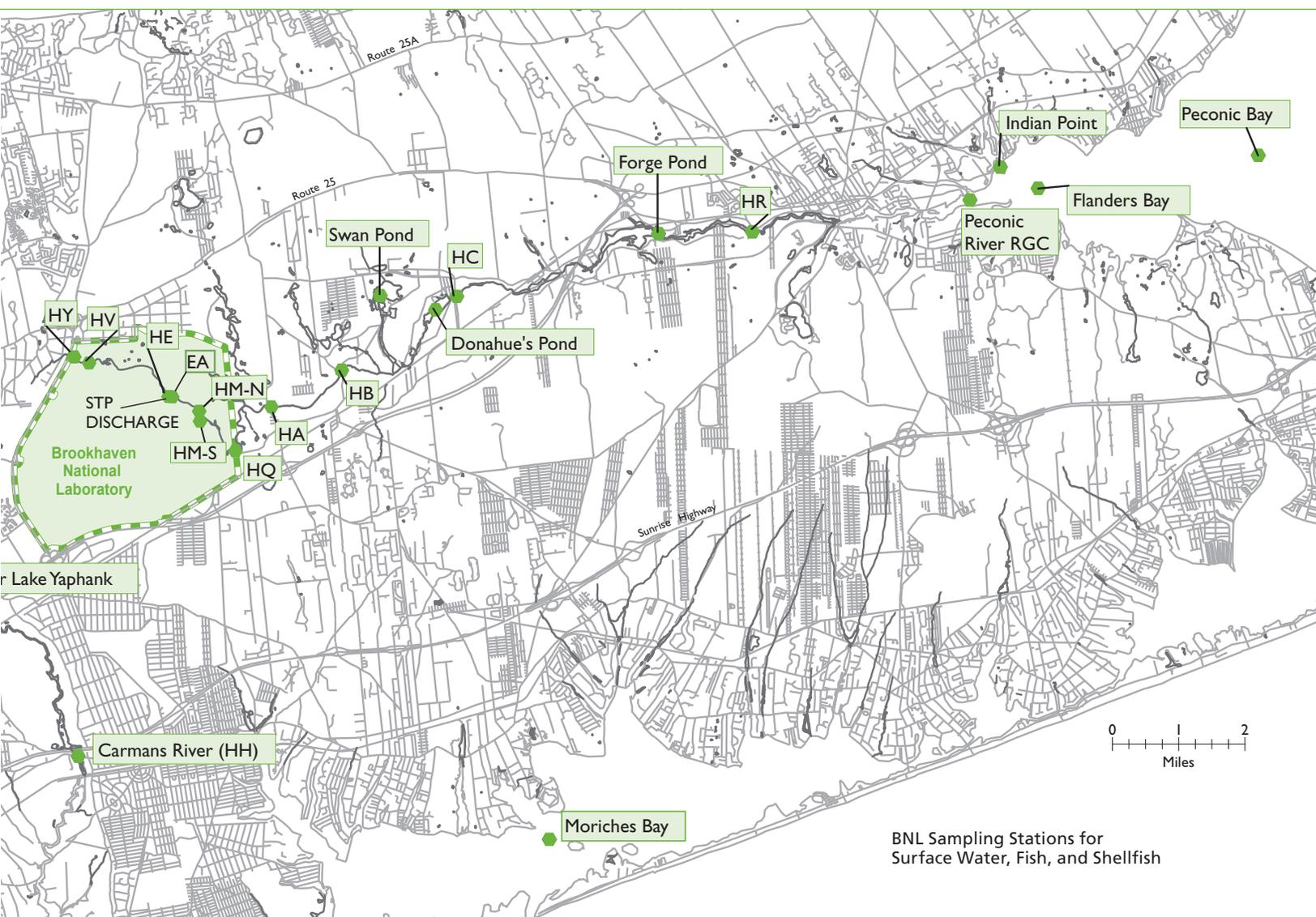
The multilayered components of the BNL Quality Assurance (QA) Program ensure that all environmental monitoring results are reliable and of high quality.

Samples are collected and analyzed in accordance with EPA methods and standard operating procedures that are designed to ensure samples are representative and the result-

ing data are reliable and defensible. Quality control in the analytical laboratories is maintained through daily instrument calibrations, efficiency and background checks, and testing for precision and accuracy. Data are verified and validated as required by project-specific quality objectives before being used to support decision making.

In 2007, the Laboratory used five off-site contract analytical laboratories to analyze environmental samples: General Engineering Lab (GEL), H2M Lab, Test American (TA), Chemtex Lab, and Brooks Rand. All analytical laboratories were certified by New York State for the tests they performed for BNL, and were subject to oversight that included state and national performance evaluation (PE) testing, review of QA programs, and audits.

Four of the contract analytical laboratories (GEL, TA, H2M, and Brooks Rand) participated in several national and state PE testing programs in 2007. The fifth contractor, Chemtex Laboratory, did not participate in PE testing because there is no testing program for the specific analytes Chemtex analyzed. Each of the participating laboratories took part in at



least one testing program, and several laboratories participated in multiple programs. Results of the tests provide information on the quality of a laboratory's analytical capabilities. The testing was conducted by Environmental Resource Associates (ERA), the National Voluntary Laboratory Accreditation Pro-

gram (NVLAP), the voluntary Mixed Analyte Performance Evaluation Program (MAPEP), and the NYSDOH Environmental Laboratory Accreditation Program (ELAP). In addition, TA and GEL were audited during 2007 as part of DOE's Integrated Contract Procurement Team Program.

COMMUNICATION AND COMMUNITY INVOLVEMENT

Communication and community involvement are commitments under BNL's EMS. The Laboratory maintains relationships with its employees, key stakeholders, neighbors, elected officials, regulators, and other community members. The goals are to provide an understanding of BNL's science and operations, including environmental stewardship and restoration activities, and to incorporate community input in the Laboratory's decision making.

BNL staff participates in on- and off-site meetings, which include discussions, talks, presentations, and roundtables; workshops; canvassing surrounding neighborhoods; Laboratory tours; and informal information sessions and formal public meetings held during public comment periods.

To facilitate effective dialogue between BNL and key stakeholders, several forums for communication and involvement have been established:

- The Brookhaven Executive Roundtable (BER), established in 1997 by DOE's Brookhaven Site Office, meets routinely to update local, state, and federal elected officials and regulatory agencies on environmental and operational issues, as well as on scientific discoveries and initiatives.
- The Community Advisory Council (CAC), established by BNL in 1998, advises the Laboratory Director on issues related to the Laboratory that are important to the community. The CAC is composed of approximately 30 member organizations representing business, civic, education, employee, community, environmental, and health organizations. The CAC meets monthly in sessions that are open to the public, and sets its own agenda in cooperation with the Laboratory.
- BNL's Envoy Program educates employee volunteers regarding Laboratory issues and provides a link to local community organizations. Feedback shared by envoys helps BNL gain a better understanding of local community concerns.
- The Speakers' Bureau provides speakers for educational and other organizations interested in the Laboratory.
- BNL's Summer Sunday tours enable the Laboratory to educate the public by featuring different facilities and program areas.
- The Laboratory participates in various annual events, such as a week-long celebration in honor of Earth Day,

the Heckscher State Park Spring Festival, and the Longwood Fair.

- Lunchtime tours are held once a month and offer employees the opportunity to learn about activities outside the scope of their jobs.
- The Laboratory's research, history, and natural environment, as well as cleanup projects, have all been topics covered under BNL's lunchtime jaunts. Periodically, bag lunch meetings are held with employees on specific topics of interest or concern, such as health benefits or wildlife management.
- BNL issues press releases; publishes *Laboratory Link*, a bi-monthly update on BNL science and events; and *the Bulletin*, a weekly employee newsletter.
- The Laboratory maintains an informative website at <http://www.bnl.gov>, where these publications, as well as extensive information about BNL's science and operations, past and present, are posted. In addition, employees and the community can subscribe to the Laboratory's e-mail update service at <http://lists.bnl.gov/mailman/listinfo/bnl-announce-1>.

BNL routinely involves the community in cleanup projects. In 2007, BNL stakeholders were updated on the progress of environmental cleanup projects through presentations given at monthly CAC and BER meetings, including:

- A presentation on the Laboratory's Annual Groundwater Report provided the CAC with information on the communication processes related to groundwater remediation, the protection and monitoring of the groundwater, and the remediation process including the operational status of treatment systems, the progress toward achieving cleanup goals, and proposed actions in response to monitoring data.
- The 2006 monitoring report on the Peconic River included data on sediment, surface water, fish, and wetlands



a.

a. Summer Sundays at BNL

b. Annual Environmental Stewardship Award

c. Annual "Your Environment" Art Contest

b.



c.



sampling. This report, which also included information on sampling, data evaluation, data transmission, and implementation of follow-up actions, was shared with the CAC in two detailed presentations.

- As a follow-up to the comments provided in 2006 by the CAC on the Proposed Remedial Action Plan for the g-2 Tritium Source area and plume, the Laboratory briefed the CAC on how their comments and those received from other stakeholders were incorporated into the Record of Decision.
- The CAC was updated periodically on the development of possible remedies for the decommissioning of the High Flux beam Reactor so that they would be prepared and have up-to-date information when the final Proposed Remedial Action Plan was released.
- A presentation on the activities at the Brookhaven Graphite Beam Reactor was given to the CAC. Work plans and schedules for removal of the pile, and preparatory activities including overhauling the overhead crane, removal of physical interferences, and identifying remote equipment, were explained. A detailed description of an inspection of the pile and its findings was also provided.

Working closely with elected officials, regulatory agency representatives, community members, and employees, DOE and BNL openly shares information and provides feedback on how input is used.

2007 SITE ENVIRONMENTAL REPORT TEAM



The SER Team

(Back row, left to right) John Burke, Robert Lee, Jason Remien, William Dorsch, Robert Howe, George Goode, Douglas Paquette, and Karen Ratel

(Front row, left to right) Arland Carsten, Patricia Yalden, John Selva, Timothy Green, and Jeffrey Williams

(Balwan Hooda and Kathleen Robinson not pictured)



The Environmental Information Management Services Group

(Back row, left to right)

Andrew Robkohl, and Frank Tramontano

(Front row, left to right)

John Burke, Susan Young, and Brian Foley



The Environmental and Waste Management Services Division Field Sampling Team

(From left to right) James Milligan, Lawrence Lettieri, and Robert Metz

(Richard Lagattolla not pictured)

2007 SITE ENVIRONMENTAL REPORT
READER RESPONSE FORM

The 2007 Site Environmental Report (SER) Summary provides highlights from the Brookhaven National Laboratory 2007 SER report. The report and summary are written to meet the requirements and guidelines of the U.S. Department of Energy and the informational needs of the public.

BNL welcomes your comments, suggestions for improvements, or any questions you may have. Please fill in the information below, and mail your response form to:

Brookhaven National Laboratory
Environmental and Waste Management Services Division
Attention: SER Project Coordinator
Building 120
P.O. Box 5000
Upton, NY 11973-5000

Name _____

Address _____

Phone _____

E-mail _____

Comments, Suggestions, or Questions

I would like to be added to your Environmental Issues mailing list.



SER Project Coordinator
Environmental & Waste Management Services Division
Building 120
Brookhaven National Laboratory
PO Box 5000
Upton, NY 11973-5000



One of many events BNL hosts each year for Earth Day includes the "Your Environment" art contest. Students from local schools in grades 3-5 were asked to create posters focusing on energy conservation. The winning students receive a certificate of participation award and a \$100 gift check.

The winning posters shown above were created by a) Tiana James, Grade 4, Ridge Elementary School, and b) Kyra Moosmueller, Grade 4, West Middle Island Elementary School.

