

## Executive Summary

*Each year, Brookhaven National Laboratory (BNL) prepares an annual Site Environmental Report (SER) in accordance with DOE Order 231.1A, Environment, Safety and Health Reporting of the U.S. Department of Energy (DOE). The SER is written to inform the public, regulators, Laboratory employees, and other stakeholders of BNL's environmental performance during the calendar year in review. The report summarizes BNL's environmental data; environmental management performance; compliance with applicable DOE, federal, state, and local regulations; and 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.*

*The SER is intended to be a technical document. It is available in print and as a downloadable file on the BNL web page at <http://www.bnl.gov/esd/SER.htm>. A summary of the SER is also prepared each year to provide a general overview of the report, and is distributed with a CD version of the full report. The summary supports BNL's educational and community outreach program.*

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BNL is operated and managed for DOE's Office of Science by Brookhaven Science Associates, a limited-liability company founded by Stony Brook University and Battelle Memorial Institute, a nonprofit, applied science and technology organization. For more than 50 years, BNL has played a lead role in the DOE Science and Technology mission and continues to contribute to the DOE missions in Energy Resources, Environmental Quality, and National Security. BNL manages its scientific research with particular sensitivity to environmental issues and community concerns. BNL's motto, "Exploring Life's Mysteries...Protecting its Future," reflects BNL's management philosophy to fully integrate environmental stewardship into all facets of its missions and operations.

Chapter 1 of this report discusses current and past research; facilities and operations; location, population, and economy; the geology, hydrology, and climate of the site; and a brief overview of BNL's natural and cultural resources.

### **BNL'S ENVIRONMENTAL MANAGEMENT SYSTEM**

One of BNL's highest priorities is ensuring that the Laboratory's environmental performance measures up to its world-class status in science. In 2001, an Environmental Management System (EMS) was established at BNL ensuring 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 cornerstone of an EMS is a Laboratory Environmental Stewardship Policy. In 2004, BNL incorporated the principles of this Laboratory-wide policy into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy as it works towards OHSAS 18001 certification. This policy makes clear BNL's commitments to environmental stewardship, the safety of its em-

employees, and the security of the site. Specific environmental commitments include compliance, pollution prevention, cleanup, community outreach, and continual improvement. The policy is posted throughout the Laboratory and on the BNL website at <http://www.bnl.gov/eshq/ESSH.asp> and is included in all training programs for new employees, guests, and contractors.

In 2004, BNL operations led to seven awards for environmental performance from diverse stakeholder groups. Also in 2004, BNL was accepted into the EPA Performance Track Program, which is EPA's "gold standard" for facility-based environmental performance—a standard that participating members strive to attain as they "meet or exceed their performance commitment."

The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard. BNL was the first DOE Office of Science Laboratory to become officially registered to this standard. Annual independent audits, which are required to maintain the registration, are conducted to validate that BNL's EMS is being maintained and to identify evidence of continual improvement. In 2004, an EMS recertification audit determined that BNL remains in full conformance with the standard. Audit findings included five minor nonconformances, three opportunities for improvement, and five examples of continual improvement.

A strong Pollution Prevention (P2) Program is an essential element of the successful completion of BNL's mission and EMS. The BNL 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 BNL operating philosophy. 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 at the Laboratory. To date, pollution prevention projects have saved more than \$1.6 million and have resulted in the reduction or reuse of

approximately 2.3 million pounds of waste. In 2004, eight new pollution prevention proposals were funded, investing approximately \$86,000, with an anticipated annual savings from these projects of \$60,500, for an average payback period of 1.3 years.

Chapter 2 of this report describes the elements and implementation of BNL's EMS in further detail.

## **BNL'S ENVIRONMENTAL MANAGEMENT PROGRAM**

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 exposures and evaluate the impacts BNL activities may be having on the environment. An overview of the Laboratory's environmental programs and a summary of performance for 2004 are discussed below.

### ***Compliance Monitoring Program***

BNL has an extensive program in place to ensure compliance with all applicable environmental regulatory requirements and permits. BNL must comply with more than 100 sets of federal, state, and local environmental regulations, numerous site-specific permits, equivalency permits for the operation of groundwater remediation systems, and several other binding agreements. In 2004, BNL operated in full compliance with most of these requirements, and programs are in place to address areas for continued improvement. In February, the New York State Department of Environmental Conservation (NYSDEC) approved a modified testing process. The change allowed stormwater runoff samples to be filtered, to remove sediment containing naturally-present metals, primarily aluminum and iron. The modified State Pollutant Discharge Elimination System (SPDES) permit also postponed chronic toxicity testing of the Sewage Treatment Plant (STP) because five quarters of routine testing had shown no impact. Testing will resume in 2005.

Twelve external environmental audits by regulatory agencies were conducted in 2004,

including inspections of petroleum and chemical storage, air emissions from the Central Steam Facility (CSF), Hazardous Waste Management facilities, STP operations, other regulated outfalls and recharge basins, and the potable water system. Minor administrative deficiencies found during two Resource Conservation and Recovery Act (RCRA)/hazardous waste compliance inspections were corrected before the inspectors left the site. Four conditions that required corrective action were identified during an annual inspection of the Major Petroleum Facility (MPF) and one issue was found during an inspection of the Chemical Bulk Storage Facilities; all five of these conditions are being corrected in accordance with NYSDEC directives.

Compliance monitoring in 2004 showed that emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide were all within permit limits; the potable water supply met all drinking water requirements; groundwater monitoring at the MPF continued to demonstrate that current oil storage and transfer operations are not impacting groundwater quality; and, with the exception of six permit excursions at the STP, liquid effluents discharged to surface water and groundwater met all applicable SPDES permit requirements. The six SPDES excursions included: two for the detection of methylene chloride in the discharge, which was determined to be the result of analytical contract laboratory cross-contamination; two for the detection of iron in the discharge; one for average suspended solids concentration; and one for suspended solids removal. The latter four excursions were attributed to poor placement of a sample collection probe. Each of these issues was investigated and reported to NYSDEC and the Suffolk County Department of Health Services.

There were 30 reportable spills of petroleum products or antifreeze in 2004. All releases were cleaned up or addressed to the satisfaction of NYSDEC. Nineteen spills were petroleum releases less than 5 gallons, four were small-volume antifreeze spills, two larger spills were discovered during tank removals, four spills resulted from failed equipment, and one spill was a release of oil from two transformers that were contaminated with polychlorinated biphenyls.

Chapter 3 of this report describes BNL's Compliance Program and status in further detail.

### *Air Quality Program*

BNL monitors radioactive emissions at several facilities on site to ensure compliance with the requirements of the Clean Air Act. During 2004, BNL facilities released a total of 2,711 curies of radioactive gases with short half-lives (less than 30 minutes). EPA regulations require continuous monitoring of all facilities that have the potential to deliver an annual radiation dose greater than 0.1 mrem to a member of the public. The Brookhaven Linac Isotope Producer (BLIP) is the only BNL facility in this category. Oxygen-15 (half-life: 122 seconds) and carbon-11 (half-life: 20.48 minutes) emitted from the BLIP constituted more than 99.8 percent of air emissions in 2004. Facilities capable of delivering radiation doses below 0.1 mrem require periodic, confirmatory monitoring. At BNL, this monitoring is conducted at one active facility, the Target Processing Laboratory, and two inactive facilities, the Brookhaven Medical Research Reactor (BMRR) and the High Flux Beam Reactor (HFBR). In 2004, BNL filed a petition with EPA to discontinue emission monitoring at the BMRR, because sampling has consistently shown no detectable emissions of radionuclides, even with building ventilation turned on.

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The CSF is the only BNL facility that requires this monitoring. Two of the four boilers at the CSF are equipped with continuous emission monitors to measure nitrogen oxides and opacity. In 2004, these boilers had no measured emission exceedances above the regulatory limits, for nitrogen oxides. Opacity exceedances were reported to NYSDEC; all but two occurred during boiler startup or soot blowing operations—times when opacity exceedances are most likely.

Since natural gas prices were higher than residual fuel prices throughout 2004, BNL used residual fuel for most heating and cooling. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide were

considerably higher than in years when natural gas was the primary fuel.

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 BNL site measure tritium and gross alpha and beta airborne activity. Results measured at BNL in 2004 demonstrated that on-site radiological air quality was consistent with results from locations in New York State that are not located near radiological facilities.

Chapter 4 of this report describes BNL's Air Quality Program and monitoring data in further detail.

#### ***Water Quality Surveillance Program***

BNL discharges treated wastewater into the headwaters of the Peconic River via the STP, and 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 helps ensure that wastewater discharges comply with all applicable requirements and that the public, employees, and the environment are protected.

To assess the impact of discharges on the quality of the Peconic River, surface water monitoring is conducted at several locations upstream and downstream of the STP effluent. 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 BNL operations. In 2004, the average gross alpha and beta activity levels of the STP discharge were within the typical range of historical levels and were well below drinking water standards. Tritium releases to the Peconic River fell below levels reported in 2002 and are expected to continue to decline, after a brief increase in 2003, following the preparatory steps for decommissioning and decontaminating the HFBR. There were no detections of cesium-137 (Cs-137) or strontium-90 (Sr-90) in the STP effluent. Traces of tritium were found, but in amounts below the minimum [measurable] detection limit. Nonradiological monitoring of the efflu-

ent showed that, with the exception of isolated incidents involving metals that occur naturally in local sediment, organic and inorganic parameters were within the SPDES effluent limitations or other applicable standards.

On-site recharge basins are used for the discharge of "clean" wastewater streams, including once-through cooling water, stormwater runoff, and cooling tower blowdown, and are suitable for direct replenishment of the groundwater aquifer. Radiological analyses in 2004 showed that the low levels of alpha and beta activity detected in all of the basins were not attributable to BNL operations but to natural terrestrial/geological or cosmic sources. A very low level of tritium, detected in a single sample, was attributed to inaccuracies of the analytical method. Nonradiological analyses showed low concentrations of volatile organic compounds (VOCs); when investigated, these were found to be due to cross-contamination of the samples at the analytical contract laboratory. Lead at the CSF outfall, attributed to accumulating sediment, continued to be monitored in 2004. The completed remedial plan previously in place was revised and resubmitted to the regulatory agencies in March. Their review is pending.

Chapter 5 of this report describes BNL's Water Quality Surveillance Program and monitoring data in further detail.

#### ***Natural and Cultural Resource Management Program***

The BNL Natural Resource Management Program was designed to promote stewardship of the natural resources found on site and to integrate natural resource management and protection with BNL's scientific mission. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with the public, stakeholders, and staff members regarding environmental issues. Precautions are taken to protect and enhance habitats and natural resources at the Laboratory. Activities to eliminate or minimize negative effects on sensitive or critical species (such as the eastern tiger salamander, eastern hognose snake, and banded sunfish) are incorporated into BNL procedures or into specific

program or project plans. Restoration efforts continue to remove pollutant sources that could contaminate habitats. In some cases, habitats are enhanced to improve survival or increase populations. BNL also monitors other wildlife populations, such as wild turkey and white-tailed deer, to ensure that they are sustained. In 2004, an infrared aerial survey indicated a much lower deer population than had been estimated using ground-based survey methods, which was subsequently reviewed and refined. The wild turkey population on site continues to grow; in March, the NYSDEC relocated 29 turkeys from BNL to the Easthampton area.

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. In 2004, deer and fish sampling results were consistent with previous years. Deer sampled on the BNL site contain higher concentrations of Cs-137 than deer sampled from greater than 1 mile from the BNL boundary off site. This is most likely the result of deer consuming contaminated soil and grazing on vegetation growing in soil where elevated Cs-137 levels are known to exist. Removal of areas of contaminated soil at BNL began in 2000, and will continue. Although hunting is restricted on site, the New York State Department of Health has reviewed the potential public health risk associated with elevated Cs-137 levels in on-site deer and determined that formal health advisories are warranted. On- and off-site sampling of fish found low levels of Cs-137, pesticides, and mercury. With completion of the Peconic River cleanup project, these levels are expected to drop.

Precipitation samples were collected quarterly at two air monitoring stations and analyzed for radiological content. Samples collected in 2004 showed gross alpha measurements at both stations above the minimum detection limit, although the values are within the range of those historically reported.

The Upton Ecological and Research Reserve (Reserve) was established on site by DOE. The 530-acre Reserve, managed by the U.S. Fish & Wildlife Service (FWS), is used to conduct resource management programs for the conser-

vation, enhancement, and restoration of wildlife and habitat. Completing the fourth year of managing the reserve, its technical advisory group approved funding for research projects that included the development of a research database, forest health monitoring protocols, mapping of vernal pools, educational and outreach activities, researcher access and training requirements, and conducting radio telemetry work on the eastern hognose snake and spotted turtle. Also in 2004, the Reserve conducted its first prescribed fire, treating approximately seven acres to improve germination and recruitment of oak seedlings. The fire also reduced fine-textured forest fuels that tend to increase the severity of wildfires. Post-fire monitoring will be conducted to determine whether the prescribed fire had the expected beneficial effects.

The goal of BNL's Cultural Resource Management Program (CRMP) is to ensure the proper stewardship of BNL and DOE historic resources. Additional goals include maintaining compliance with various historic preservation and archeological laws and regulations, and ensuring the availability of resources to BNL personnel and the public for research and interpretation. In December 2003, BNL submitted a draft Cultural Resource Management Plan to DOE for approval. This plan will be used to guide the management of all of the Laboratory's cultural resources. In 2004, two archeological projects were completed, including the survey and evaluation of the architectural significance of Berkner Hall and the Chemistry Building. The evaluation concluded that both buildings appear to be eligible for listing on the National Register of Historic Places. In addition, an archeological evaluation of two sites at BNL believed to date to the 1800s was performed; both sites may be eligible for listing on the National Register of Historic Places. Another goal of the CRMP is to formalize an oral history of the Laboratory. Four video interviews with long-time employees and three individuals associated with the early development and construction of the National Synchrotron Light Source were conducted.

Chapter 6 of this report describes BNL's Natural and Cultural Resource Management Programs in further detail.

### ***Groundwater Protection Management Program***

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 entering and leaving the BNL site. In 2004, BNL collected groundwater samples from 828 on-site and off-site monitoring wells during 2,207 individual sampling events. BNL has not detected any new impacts to groundwater quality since 2001.

Under the environmental surveillance program, 125 wells at ten active research and support facilities were monitored during 318 individual sampling events. Although no new impacts to groundwater quality were discovered in 2004, groundwater quality continues to be impacted from older releases at four facilities. Tritium continues to be detected at concentrations above the drinking water standard in wells immediately downgradient of the g-2/VQ-12 source area in the Alternating Gradient Synchrotron facility, and in one well immediately downgradient of the BLIP. However, the tritium concentrations are much lower than those observed in 2003. Monitoring data suggest that the continued release of tritium from these source areas is due to residual tritium being flushed out of the lower unsaturated zone close to the water table by natural water table fluctuations. As in previous years, VOCs associated with historical petroleum and solvent spills were detected in several monitoring wells directly downgradient of the Motor Pool and Service Station area, but at concentrations that were generally lower than those observed in 2003.

Under the Environmental Restoration program, 703 on-site and off-site wells were monitored during 1,889 individual sampling events. Monitoring data indicate that the restoration activities are effectively capturing and treating groundwater contamination. The construction of groundwater treatment systems was completed in 2004 with a total of 16 systems now complete. In the former Building 96

area, significant reductions in VOC concentrations allowed three of four treatment wells to be shut down and placed in standby mode in July 2004. In December 2004, BNL began to treat the remaining high levels of VOCs in the former Building 96 "silt zone" source area using an in situ method of chemical oxidation. The operation of the Operable Unit (OU) III Carbon Tetrachloride Treatment System has also significantly reduced VOC levels in groundwater near a former underground storage tank source area. As a result, the treatment system was shut down and placed in standby mode in August 2004. Construction of a Sr-90 groundwater treatment system for the Brookhaven Graphite Research Reactor and Waste Control Facility area was completed in December 2004, and startup testing will begin in January 2005. High levels of tritium were periodically detected in groundwater immediately downgradient of the HFBR during 2004. The continued release of tritium appears to be due to residual tritium that is being flushed out of the lower unsaturated zone by natural water table fluctuations.

During 2004, 12 groundwater remediation systems removed 652 pounds of VOCs, and one system removed approximately 0.4 mCi of Sr-90. The systems returned approximately 1.5 billion gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation activities in December 1996, BNL has removed 4,808 pounds of VOCs and 1.3 mCi of Sr-90 by treating nearly 8.4 billion gallons of groundwater.

Chapter 7 of this report provides an overview of the Groundwater Protection Management Program, and the SER Volume II, *Groundwater Status Report*, provides a detailed description, data, and maps relating to all groundwater monitoring.

### ***Radiological Dose Assessment Program***

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" (ALARA). The potential radiological dose is calculated as the largest possi-

ble 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 BNL have consistently shown that the “effective dose equivalent” from BNL 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 2004 was found to be insignificantly above natural background radiation levels.

To assess the impact of direct radiation from BNL operations, thermoluminescent dosimeters (TLDs) are deployed on the BNL site and in the surrounding communities. In 2004, the average doses from 56 on-site and 16 off-site 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  $66 \pm 11$  mrem, whereas the annual off-site external dose was  $62 \pm 10$  mrem.

The effective dose to the MEI from air emissions was calculated as  $4.40\text{E-}2$  mrem ( $0.44 \mu\text{Sv}$ ). The ingestion pathway dose was estimated as  $1.31$  mrem ( $13.1 \mu\text{Sv}$ ) from consumption of deer meat and  $0.37$  mrem ( $3.7 \mu\text{Sv}$ ) from consumption of fish caught on site. The total annual dose to the MEI from all pathways was estimated as  $1.72$  mrem ( $17.2 \mu\text{Sv}$ ). The BNL dose from the air inhalation pathway was 0.4 percent of EPA’s annual regulatory dose limit of 10 mrem ( $100 \mu\text{Sv}$ ), and less than 2 percent of DOE’s annual dose limit of 100 mrem ( $1,000 \mu\text{Sv}$ ) from all pathways. Doses to aquatic and terrestrial biota were also evaluated and found to be well below the regulatory limits.

Remediation and waste management projects conducted in 2004 were evaluated for radiological emissions and dose impact. There were no significant dose or radiological risks to the public, BNL workers, or the environmental from these activities.

Chapter 8 of this report describes the BNL Radiological Dose Assessment Program and monitoring data in further detail.

### *Quality Assurance Program*

The multilayered components of the BNL Quality Assurance (QA) Program ensure that all analytical data reported in this document are reliable and of high quality, and that all environmental monitoring data meet quality assurance and quality control objectives. Samples are collected and analyzed in accordance with EPA methods and standard operating procedures that are designed to ensure samples are representative and the resulting data are reliable and defensible. Quality control in the analytical contract 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 they are used to support decision making.

In 2004, BNL used the on-site Analytical Services Laboratory (ASL) and five off-site analytical contract laboratories to analyze environmental samples. 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. The ASL ceased performing analyses in January of 2004. For the remainder of the year, all samples were sent to off-site analytical contract laboratories.

Four of the analytical contract laboratories participated in several national and state PE testing programs in 2004. Results of the tests provide information on the quality of a laboratory’s analytical capabilities. The analytical contract laboratories performing radiological analyses had “average overall satisfactory” scores (as defined by the independent testing organizations) of 96 and 87 percent, respectively. The overall satisfactory scores for non-radiological testing ranged from 94.2 to 97.9 percent. The analytical contract laboratories received an “acceptable” rating for a combined average overall satisfactory score of 93.9 percent on the radiological and nonradiological PE tests performed.

Chapter 9 of this report describes the BNL Quality Assurance/Quality Control Program in further detail.