



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. The report is written to inform the public, regulators, employees, and other stakeholders of BNL's environmental performance during the calendar year in review. The SER summarizes environmental data; environmental management performance; compliance with applicable DOE, federal, state, and local regulations; and compliance, restoration, and surveillance monitoring program performance. BNL has prepared annual SERs since 1971 and has documented nearly all of its environmental history since the Laboratory's inception in 1947.

The report is available in print and as a downloadable file on the BNL web page at <http://www.bnl.gov/ewms/ser/>. A summary of the SER is also prepared each year to provide a general overview of the report, and is distributed with a CD of the full report.

BNL is operated and managed for DOE's Office of Science by Brookhaven Science Associates (BSA), a nonprofit limited-liability company formed as a 50–50 partnership between Battelle Memorial Institute and The Research Foundation of the State University of New York (SUNY) on behalf of Stony Brook University. For more than 60 years, the Laboratory 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 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 BNL's management philosophy to fully integrate environmental stewardship into all facets of its missions and operations.

BNL'S INTEGRATED SAFETY MANAGEMENT SYSTEM, ISO 14001, AND OHSAS 18001

The Laboratory's Integrated Safety Management System (ISMS) integrates environment, safety, and health management into all work planning. The integrated safety processes within ISMS contributed to BNL's Environmental Management System achieving the International Organization for Standardization (ISO) 14001 registration and the Laboratory's Safety and Health Program achieving Occupational Safety and Health Assessment Series (OHSAS) 18001 registration.

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 the Laboratory 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 cornerstone of BNL's EMS is the Laboratory's Environment, Safety, Security, and Health (ESSH) Policy. This 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 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.

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 to maintain the registration, are conducted to validate that BNL's EMS is being maintained and to identify evidence of continual improvement. In 2006, an EMS surveillance audit determined that the Laboratory continues to conform to the Standard. During the audit, eight examples of BNL's continual improvement were highlighted, including the Laboratory's commitment to fund pollution prevention and safety projects, improved methods for addressing corrective actions, the use of lessons learned, and management's response to comments and suggestions from employees. There were two minor nonconformances in document control and management review and two opportunities for improvement in "objectives, targets and programs," and "nonconformances." A corrective action plan was prepared to track the minor nonconformances to closure.

The Laboratory's strong Pollution Prevention (P2) Program is an essential element for the successful implementation of BNL's EMS. The 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. Pollution prevention and waste reduction goals have been incorporated into the DOE contract with BSA, into BNL's ESSH Policy, and into critical outcomes associated with the Laboratory's operating contract with DOE. 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. Eighteen P2 proposals were submitted by employees to BNL's P2 Council for funding in 2006. Seven proposals were funded, in addition to four special projects, for a combined investment of approximately \$37,200. The anticipated annual savings from these projects is estimated at \$74,200, for an average payback period of less than one year. The four special projects were jointly funded by the P2 Program and other BNL divisions, and significantly limit future environmental and worker safety risks. Initiatives to reduce, recycle, and reuse 13 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program saved over \$1.8 million in 2006.

BNL was accepted into the EPA's Performance Track Program in 2004. This 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 2006, the Laboratory made significant progress in: increasing BNL's land and habitat conservation, reducing radioactive air emissions, reducing the Laboratory's use of ozone-depleting substances and hazardous materials, and reducing its mercury inventory.

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 exposure and evaluate the impacts BNL activities may have on the environment. An overview of the Laboratory's environmental programs and a summary of performance for 2006 follows:

Compliance Monitoring Program

BNL has an extensive program in place to ensure compliance with all applicable environmental regulatory and permit requirements. 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 12 groundwater remediation systems, and several other binding agreements. In 2006, BNL fully 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 by regulatory agencies in 2006, including inspections of BNL's potable water system, Sewage Treatment Plant (STP) operations, several State Pollutant Discharge Elimination System (SPDES)-regulated outfalls, Major Petroleum Facility (MPF), Chemical Bulk Storage Facilities, and the hazardous waste program. No formal notices of violation or enforcement actions were issued as a result of these inspections. The Laboratory took immediate corrective actions to address two conditions identified during the New York State Department of Environmental Conservation (NYSDEC) inspection of the MPF. The two conditions that required corrective action included management of vegetative growth in the secondary containment berms at Building 610, and the need to further evaluate the secondary containment system for tanks 5 and 6, based on results of indepth integrity tests performed to ensure that the secondary containment systems will adequately impede the migration of oil in the event of a spill. Two Notices of Violation (NOV) were received in May for excursions of opacity standards reported in 2005. Since corrective actions addressed all future opacity problems, the NOV's were considered closed upon issuance.

Compliance monitoring in 2006 showed that emissions of nitrogen oxides, carbon monoxide, particulate, and sulfur dioxide were all within permit limits. Approximately 132 pounds of ozone-depleting refrigerants were recovered from refrigeration equipment for recycling on site or offered for use by other DOE or federal

facilities. In addition, one hundred sixteen 17-pound and four 13-pound Halon 1211 portable fire extinguishers were removed from service and have been made available to other DOE facilities.

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 three minor permit excursions at the STP and one at recharge basins, liquid effluents discharged to surface water and groundwater met all applicable SPDES permit requirements. The three SPDES excursions at the STP included two for total nitrogen, and one for iron. These excursions were investigated by BNL staff, corrected where possible, and reported to NYSDEC and the Suffolk County Department of Health Services (SCDHS). The final excursion at the recharge basin was for non-reporting of oil and grease data for Outfall 002B. The contract analytical laboratory conducting the analysis was unable to report a valid result due to quality control issues.

Efforts to reduce spills continue to be effective. The total number of spills was reduced by 21 percent, from 34 spills in 2005 to 27 in 2006. In addition, reportable spills were reduced by 50 percent, from 14 in 2005 to 7 in 2006. There were four reportable spills involving very small volumes of ethylene glycol spilled from employee- or Laboratory-owned vehicles, two releases from hydraulic systems on earth-moving equipment, and one spill of diesel fuel from a Fire-Rescue off-road vehicle. All releases were cleaned up or addressed to the satisfaction of NYSDEC.

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

Air Quality Program

BNL monitors radioactive emissions at three facilities on site to ensure compliance with the requirements of the Clean Air Act. During 2006, BNL facilities released a total of 4,410 curies of radioactive gases; all with short half-lives of less than 30 minutes. 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 Linac 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 2006. The combined emissions were approximately 35 percent higher than in 2005, primarily due to five additional weeks of operation. At BNL, monitoring is 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 2006 continued to be very small (0.0035 μ Ci). Tritium releases from the HFBR in 2006 decreased substantially from releases in 2005, from 17.9 Ci to 4.03 Ci, following the previous downward trend in 2004. An investigation determined that the probable source for the rise in 2005 was the evaporation of residual heavy water through an open drain-tank vent line, which was subsequently closed.

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 2006 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 are equipped with continuous emission monitors to measure nitrogen oxide emissions and opacity. In 2006, these monitors measured no periods of excess nitrogen oxide or opacity.

Because natural gas prices were lower than residual fuel oil prices from June through October in 2006, 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.

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 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 2006, the average gross alpha and beta activity levels in the STP discharge were well below drinking water standards. Tritium releases to the Peconic River continued to decline in 2006 and were the lowest ever recorded due to the continued decommissioning and decontaminating at the HFBR. Although tritium was not detected at the influent or effluent for most of 2006, low concentrations were detected in the STP discharge in December. Investigations did not reveal any single source, but did identify several low-concentration sources, which when combined, may have resulted in this slight increase. The maximum concentration of tritium released was approximately 7.5 percent of the drinking water standard. There were no detections of cesium-137 (Cs-137), strontium-90 (Sr-

90), or other gamma-emitting nuclides in the STP effluent.

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 2006 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. Very low levels of tritium were detected in a single sample collected at one of the recharge basins (430 pCi/L). Considering the low level of detection and analytical method uncertainties, positive identification of tritium in this sample is questionable.

In 2006, nonradiological analyses of the recharge basins showed low concentrations of volatile organic compounds (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 maximum 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, confirmation of acetone in waste water samples is questionable.

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 2006 showed that, with the exception of a single detection of gross alpha activity at one upstream station, all parameters were less than the detection limit. While single detections of gross beta activity were reported at two downstream stations, average gross beta measurements were indistinguishable from background measurements. 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 found at very low levels in water samples collected downstream of the STP. As part of the follow-up surveillance activi-

ties for the Peconic River remediation project, mercury concentrations in water samples are being evaluated to determine if the levels impact freshwater organisms. More discussion on mercury in water and sediment samples is found in Chapter 6.

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. The Laboratory also monitors and manages other wildlife populations, such as white-tailed deer and wild turkey, to ensure that they are sustained. The Laboratory 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.

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 on site contain higher concentrations of Cs-137 than deer sampled from more than 1 mile off site. This is most likely because on-site deer consume small amounts of contaminated soil and graze on vegetation growing in soil where elevated Cs-137

levels are known to exist. A nine-year trend of on-site and near off-site Cs-137 averages in deer meat showed a statistically significant increase in Cs-137 concentrations in deer meat samples in 2006. The unexplained increase was due to a single sample taken off site along the William Floyd Parkway. While the sample was high compared to samples taken within the recent past, it was still within the historic range of samples taken within the same geographic area. There are no known unremediated sources of Cs-137 in the area. Removal of areas of contaminated soil at BNL began in 2000, and all major areas were remediated by the end of 2005. The New York State Department of Health (NYS-DOH) 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. BNL will continue to test for Sr-90 in bone to develop baseline information.

In an effort to restore fish populations, the Laboratory suspended most on-site fish sampling in 2001. The reluctance to sample fish continued in 2006, due to impacts of the Peconic River cleanup project and drought conditions in 2005. However, four fish were sampled on site in 2006; although due to the size of the fish, only metals analyses could be performed. Off-site sampling of fish found low levels of Cs-137; all levels of Cs-137 appear to be declining, compared with historic values. 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, and further decreases in Cs-137, as well as mercury, are expected. Low levels of mercury and pesticides were also detected in off-site fish samples, but did not exceed any standards and do not present a health impact to consumers of such fish. 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 contami-

nants from the river. This project was completed in the summer of 2005. Sampling results for 2006 showed that 93 percent of samples analyzed at 16 on-site locations and 14 off-site locations met the cleanup goals of 2.0 mg/kg. Two samples exceeded the goal and another was close to exceeding the goal. Additional samples were collected at these locations which confirmed that mercury levels in this area of the Peconic River exceeded the clean-up goal. Additional sampling procedures to characterize the nature and extent of contamination were prepared for implementation in 2007.

Water column sampling for mercury and methyl mercury was performed at 20 Peconic River sampling locations and one reference location on the Connetquot River. Levels were less than 2005 values upstream of Schultz Road, but generally higher than 2004 values downstream of Schultz Road. Effluent from the STP is a potential low-level mercury source that may be contributing to elevated mercury concentrations in these locations. Additional surface water monitoring and monitoring of the STP effluent will be conducted to evaluate its potential contribution.

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.

In 2006, the Foundation for Ecological Research in the Northeast (FERN) conducted its second year of monitoring under the Forest Health Monitoring program established for the Long Island Pine Barrens. This program was developed to assess the health of the various forest types within the Pine Barrens. Planning for freshwater wetlands monitoring was also initiated.

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 Laboratory personnel and the public for research

and interpretation. In 2006, a National Historic Preservation Act (NHPA) Section 106 review determined that none of Camp Upton era structures remaining on site were eligible for listing on the National Register for Historic Places. A NHPA Section 106 Determination of Effects was performed to address decommissioning of the HFBR, and it was determined that the action would have "Adverse Effects" for its historical status. Also in 2006, an archaeological survey of the National Synchrotron Light Source-II was performed; no further investigations were recommended.

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, and to monitor active research and support facilities. In 2006, the Laboratory collected groundwater samples from 852 on- and off-site monitoring wells during 2,337 individual sampling events. BNL has not detected any new impacts to groundwater quality since 2001.

Under the environmental surveillance program, 125 groundwater wells at 10 active research and support facilities were monitored during 240 individual sampling events. Although no new impacts to groundwater quality were discovered in 2006, groundwater quality continues to be impacted from past releases at four facilities. Tritium continues to be routinely detected at concentrations above the 20,000 pCi/L drinking water standard (DWS) in wells immediately downgradient of the g-2 source area in the Alternating Gradient Synchrotron (AGS) facility, although tritium concentrations have shown a steady decline over the past three years. In January 2006, tritium concentrations exceeded the 20,000 pCi/L DWS in one well immediately downgradient of BLIP. However, tritium concentrations at BLIP declined to less than the DWS limit for the remainder of the year. Monitoring data suggest that the continued release of tritium from these areas 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

available to be flushed out of the deep soils appears to be declining.

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 areas. Monitoring of the leak detection systems at both vehicle maintenance facilities indicated that gasoline storage tanks and associated distribution lines were not leaking. Furthermore, BNL's ongoing evaluation of vehicle maintenance operations indicated that all waste oils and used solvents are being properly stored and recycled.

Under the Environmental Restoration Program, on- and off-site contaminant plumes are monitored to track the progress that the groundwater treatment systems are making toward plume remediation. In 2006, 727 groundwater wells were monitored during 2,097 individual sampling events. 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 Sr-90 plumes associated with the Brookhaven Graphite Research Reactor/Waste Concentration Facility MCLs must be reached within 70 years and for the Chemical/Animal Holes area MCLs must be reached within 40 years. VOC levels in the Magothy aquifer must meet MCLs within 65 years. The cleanup objectives will be met by a combination of active treatment and natural attenuation.

The Laboratory continues to make significant progress in restoring groundwater quality on site, with 13 groundwater remediation systems in active operation. During 2006, 372 pounds of VOCs and 5.3 mCi of Sr-90 were removed from the groundwater, and more than 1.5 billion gallons of treated groundwater were returned to the aquifer. To date, approximately 5,592 pounds of VOCs have been removed from the aquifer.

Significant issues associated with the restoration program during 2006 were:

- The Operable Unit (OU) III Record of Decision (ROD) contingency of 20,000 pCi/L for the HFBR Tritium Plume at Weaver Dive was triggered when tritium was de-

tected at 21,000 pCi/L in a temporary well. A new extraction well will be in operation to treat this area of the plume by the third quarter of 2007.

- Due to the continued presence of high levels of VOCs in the groundwater following three injections of potassium permanganate used to treat the Building 96 source area from December 3004 through January 2006, it appears that additional remedial action will be required in order to meet the cleanup goals. An engineering study to evaluate possible remedial alternatives will be completed by the end of 2007, and one of the existing extraction wells will be restarted to maintain hydraulic control of groundwater contamination in the source area.
- Continued characterization of the down-gradient portions of the Chemical/Animal Holes Sr-90 plume indicated that additional extraction wells are needed in order to achieve the cleanup goals specified in the OU III ROD. Two new wells will be operational by the end of 2007.
- Elevated levels of VOCs were observed in one of the western perimeter wells for the Airport treatment system. Based upon additional groundwater characterization of the plume in this area, an additional extraction well will be installed to allow for complete capture of the plume. The new extraction well will be operational by the third quarter of 2007.
- Two of the OU III South Boundary treatment system extraction wells will be placed in standby mode due to consistently low VOC concentrations in these wells. Combined with the two extraction wells previously placed in standby mode, only three of the seven South Boundary extraction wells remain in full-time operation. All wells placed in standby mode continue to be monitored on a quarterly basis and re-started should VOC concentrations rebound.
- Based upon consistently low VOC concentrations in the Industrial Park treatment system area (with concentrations less than the capture goal of 50 ug/L total VOCs [TVOCs]), pulse pumping of the system

will begin in 2007, and one of the treatment wells will be placed in standby mode. Only five of the seven Industrial Park treatment wells will remain in full-time operation.

- Based upon consistently low VOC concentrations in two of the Long Island Power Authority (LIPA) treatment system extraction wells and nearby monitoring wells (with concentrations less than the capture goal of 50 ug/L TVOCs), the two extraction wells will be placed in standby mode in 2007.

Chapter 7 of this report 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 2006.

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 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 2006 was found to be insignificantly above natural background radiation levels.

To measure direct radiation from Laboratory operations, thermoluminescent dosimeters (TLDs) are placed on site and in surrounding communities. In 2006, the average doses for 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 68 ± 11 mrem (680 ± 110 μ Sv), and the annual off-site external dose was 63 ± 9 mrem (630 ± 90 μ Sv).

The effective dose to the MEI from air emissions was $8.14E-2$ mrem (0.81 μ Sv). The ingestion pathway dose was estimated as 2.96 mrem (30 μ Sv) from consumption of deer meat and 0.07 mrem (0.7 μ Sv) from consumption of fish caught on site. The total annual dose to the MEI from all pathways was estimated as 3.11 mrem (31 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 2006, several NESHAPs compliance reviews were performed, including decontamination activities from removal of the Brookhaven Graphite Research Reactor (BGRR) belowground duct (BGD) liner; a dose assessment to evaluate the potential dose impact (in this case, a firefighter) in the event of an accidental fire at the former Hazardous Waste Management Facility (HWMF); continued decommissioning activities at the HFBR; and a pre-NESHAPS evaluation for emissions of radiological gases from the newly proposed National Synchrotron Light Source-II. All assessments showed there to be no significant dose impacts 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 proce-

dures that are designed to ensure samples are representative and the resulting 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 2006, the Laboratory used five off-site contract analytical laboratories to analyze environmental samples: General Engineering Lab (GEL), H2M Lab, Severn-Trent Lab (STL), 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 participated in several national and state PE testing programs in 2006. Results of the tests provide information on the quality of a laboratory's analytical capabilities. Testing was conducted by Environmental Resource Associates (ERA), the National Voluntary Laboratory Accreditation Program (NVLAP), the voluntary Mixed Analyte Performance Evaluation Program (MAPEP), and New York State Department of Health (NYSDOH) Environmental Laboratory Accreditation Program (ELAP). GEL and STL participated in the ERA radiological program; 95.7 percent of GEL's tests were in the acceptable range, and 92.9 percent of STL's tests were in the acceptable range. GEL also participated in the MAPEP evaluations; 88.1 percent of GEL's tests on radiological samples were in the acceptable range and 6.7 percent were in the warning (but acceptable) range.

H2M and GEL participated in the NYSDOH ELAP evaluations of performance on tests of nonpotable water, potable water, and solid wastes. NYSDOH found 98.1 percent of H2M's nonradiological tests to be in the acceptable range and 92.1 percent of GEL's nonradiological tests to be in the acceptable range.

Also in 2006, H2M, STL, and GEL voluntarily participated in the ERA water supply and water pollution studies, although this evaluation is not required for New York State certification. ERA found that 96.2 percent of H2M's tests were in the acceptable range, 94.7 percent of STL's tests were in the acceptable range, and 95.1 percent of GEL's tests were in the acceptable range. GEL also voluntarily participated in MAPEP evaluations. These evaluations showed that 98.8 percent of GEL's nonradiological tests were in the acceptable range. H2M also voluntarily participated in NIST-NVLAP evaluations. These evaluations showed that 98.0 percent of H2M's nonradiological tests were in the acceptable range.

STL and GEL were audited as part of DOE's Integrated Contract Procurement Team Program. There was no Priority I ("serious") findings for either laboratory. The STL audit resulted in 14 Priority II findings and the GEL audit resulted in seven Priority II findings. Priority II status indicates problems that do not result in unusable data and do not indicate that the contract analytical laboratory cannot adequately perform services for DOE. Corrective actions plans were submitted to DOE by the contract analytical laboratories to document that procedures were put in place to correct the findings.

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