

Executive Summary

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 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 summary of the information contained in Volume II is included in Chapter 7, Groundwater Protection, of this volume.

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. In addition, a summary of Volume I is prepared each year to provide a general overview of the report, and is distributed with a compact disc containing the full report.

BNL is operated and 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 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 the commitment of BNL's management to fully integrate environmental stewardship into all facets of its mission and operations.

INTEGRATED SAFETY MANAGEMENT SYSTEM, ISO 14001, AND OHSAS 18001

The Laboratory's Integrated Safety Management System (ISMS) incorporates 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 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 the Laboratory'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.

An Environmental Management System (EMS) was established at BNL in 2001 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 the Laboratory's EMS is BNL's Environment, Safety, Security, and Health (ESSH) Policy. This policy makes clear the Laboratory's commitments to environmental stewardship, the safety and health of its employees, and the security of the site. Specific environmental commitments in the policy include compliance, pollution prevention, conservation, 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>. It is also 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. BNL was also the first DOE Office of Science Laboratory to achieve registration under the OHSAS 18001 Standard. Each certification requires the Laboratory to undergo annual audits by an accredited registrar to assure that the systems are maintained and to identify evidence of continual improvement. In 2010, an EMS and OHSAS recertification audit determined that BNL remains in conformance with both standards. In their recommendation for continued certification, auditors from NSF-International Strategic Registrations, Ltd., highlighted 17 noteworthy practices and eight opportunities for improvement. There were also no non-conformances, marking the first time

BNL has achieved this level of success. Corrective actions have been prepared and are being tracked to closure.

Executive Order 13514, signed in 2009, sets sustainability goals for federal agencies and focuses on making improvements in environmental, energy, and economic performance. It requires federal agencies to set a greenhouse gas emissions reduction target, increase energy efficiency, reduce fleet petroleum consumption, conserve water, reduce waste, support sustainable communities, and leverage federal purchasing power to promote environmentally responsible products and technologies. The Laboratory's EMS objectives and targets have been established to mirror these requirements, and most have already been incorporated within the program.

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 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. Three of ten P2 proposals, submitted by employees to BNL's P2 Council, were funded in 2010, for a combined investment of approximately \$30,400. The anticipated annual savings from these projects is approximately \$20,800, for an average payback period of approximately 1.5 years. Initiatives to reduce, recycle, and reuse 9.1 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program resulted in more than \$1.9 million in cost avoidance or savings in 2010.

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 2010 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, 16 equivalency permits for the operation of 14 groundwater remediation systems, and several other binding agreements. In 2010, the Laboratory complied with the majority of these requirements, and instances of noncompliance were reported to regulatory agencies and corrected expeditiously. Routine inspections conducted during the year found no significant instances of noncompliance; however, the State of Utah issued BNL a Notice of Violation and a fine of \$5,000 in July for a shipment of mixed waste received at Energy Solutions in Utah that contained higher than expected levels of alpha-emitting isotopes, resulting in a violation of their license.

Twelve external environmental inspections were conducted in 2010 by federal, state, and local agencies that oversee BNL activities.

- Although the New York State Department of Environmental Conservation (NYSDEC) did not conduct a formal inspection of the Laboratory's air compliance program, a NYSDEC inspector was present during an annual relative accuracy test audit of the continuous emissions monitoring system at BNL's Central Steam Facility.
- NYSDEC conducted its annual inspection of the Major Oil Storage Facility. No issues were identified with any of the larger tanks at BNL's Central Steam Facility; however,

five conditions were identified at some of the smaller satellite fuel storage tanks. These included the need to properly prepare and paint a small section of piping, affixing the correct color coding at two waste oil storage tanks, ensuring that all satellite tanks had the required identification labeling at or near the gauge/fill port, repairing the remote high level and interstitial leak detector alarms for a tank, and the need to install a tank level gauge or alarm at the remote fill-port for another tank. Most conditions were corrected and the remaining conditions are being addressed.

- NYSDEC conducted an inspection of the Chemical Bulk Storage facilities; no issues were identified.
- NYSDEC and EPA conducted annual Resource Conservation and Recovery Act (RCRA) inspections; both inspections found BNL operations to be in compliance with requirements.
- NYSDEC performed an annual surveillance inspection of the Laboratory's Sewage Treatment Plant (STP); two recommendations for improved operations were noted.
- The Suffolk County Department of Health Services (SCDHS) collected samples and conducted its annual inspection of the BNL potable water system. Several maintenance items, such as painting, were noted as deficiencies. Also noted were requirements for standby power for Building 624, a ventilation fan in the chlorine storage room, and availability of safety equipment in the caustic storage room. All deficiencies are being addressed.
- SCDHS conducted quarterly inspections of the Laboratory's STP to evaluate operations and sample the effluent; no performance or operational issues were identified.
- SCDHS inspected several of the State Pollutant Discharge Elimination System (SPDES)-regulated outfalls and collected samples; minor issues were identified, including improved storm water controls for the National Synchrotron Light Source II (NSLS-II) construction site.

Each year, several DOE assessments and

inspections are performed at BNL. In 2010, the DOE Brookhaven Site Office (BHSO) and the DOE Chicago Office evaluated the Laboratory's Spill Prevention Control and Countermeasures plan and Environmentally Preferable Purchasing program. The assessment found BNL's documents to be in accordance with federal requirements. In addition, several recommendations for plan improvements were presented and will be addressed in the plan update in 2011.

Also in 2010, BNL conducted a programmatic self-assessment on several aspects of its environmental management program. The self-assessment focused on requirements related to energy and water conservation, pollution prevention, and pesticide management. Fourteen noteworthy practices and four minor non-conformances were noted. A causal analysis was performed and a corrective action plan was prepared to address the issues.

In 2010, emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the Central Steam Facility (CSF) were all within permit limits. There was one opacity excursion noted for Boiler 7, which occurred during boiler startup and is explained below under Air Quality Program.

Approximately 180 pounds of ozone-depleting refrigerants were recovered from refrigeration equipment for reuse on site or by other DOE facilities or federal agencies. These reductions included the disposition of Halon 1301 in tanks, Halon 1211 in cylinders, and portable extinguishers. These materials will be saved for on site reuse or transferred to storage for shipment to the Department of Defense Ozone Depleting Substances Reserve.

Monitoring of BNL's potable water supply showed that all drinking water quality requirements were met in 2010. Most of the liquid effluents discharged to surface water and groundwater met applicable SPDES permit requirements; however, three minor excursions occurred at the STP and were reported to NYSDEC and SCDHS. Groundwater monitoring at the Major Petroleum Facility continued to demonstrate that current oil storage and transfer operations are not affecting groundwater quality.

There were three excursions of permit lim-

its for waste water discharges in 2010. Two were for elevated levels of iron and one for the amount of nitrogen discharged to the Peconic River from the STP. Increased aeration and addition of lime to the STP process returned the levels of iron to less than permit limits. Total nitrogen (calculated in pounds per day) exceeded the daily maximum limit in June. Discharges in remaining months were within permit limits. The Laboratory completed the Quantification and Removal studies required under BNL's 2009 modified SPDES permit. The study results were shared with the community and regulatory agencies and a decision to proceed with diverting the STP effluent from the Peconic River to local recharge basins was finalized.

The Laboratory continues to reduce the number and severity of spills on site. In 2010, there were 15 reportable spills of petroleum products, antifreeze, or chemicals. While the total number of spills increased by three from 2009, the severity of releases were minor and cleaned up 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 2010, Laboratory facilities released a total of 6,066 curies of short-lived 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. The Brookhaven Linear Isotope Producer (BLIP) is the only BNL facility subject to EPA's continuous monitoring requirements. 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 2010. The combined emissions were approximately 3.4 times higher than 2009 levels due to BLIP operations at much higher energy levels.

Monitoring was also conducted at one other active facility, the Target Processing Labora-

tory (TPL), and one inactive facility, the High Flux Beam Reactor (HFBR). Releases from the TPL in 2010 continued to be very small (0.0101 μCi). Low levels of tritium from the HFBR in 2010 were primarily due to draining of residual heavy-tritiated water from tanks and piping components in preparation for long-term facility maintenance and surveillance. From 2002 through 2008, emissions from the HFBR facility were monitored via air sampling at a frequency of one week per month. In 2009, the monitoring frequency was increased to bi-weekly to better account for changes in tritium emissions during planned decontamination and decommissioning activities.

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 2010 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 emissions monitoring to demonstrate compliance with emission limits. The 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 nitrogen oxide (NO_x) emissions and opacity. NO_x emissions cannot exceed 0.30 lbs./MMBtu when No. 6 fuel oil is burned or 0.20 lbs./MMBtu when natural gas or No. 2 fuel oil is combusted. Opacity levels cannot exceed 20 percent, except for one 6-minute period per hour of not more than 27 percent opacity. In 2010, there were no exceedances of the NO_x emission standards for either boiler. There were no excess opacity measurements recorded for Boiler 6 and one excess opacity reading recorded for Boiler 7 in 2010. This isolated excess opacity reading was the result of an electrical anomaly that caused the air supply fan to trip during an unexpected start-up shutdown.

Because natural gas prices were lower than residual fuel oil prices from April through December 2010, BNL used natural gas to supply more than 99 percent of the heating and cooling needs of BNL's major facilities 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 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 2010, the average gross alpha and beta activity levels in the STP discharge were well below New York State Drinking Water Standards (NYS DWS). In 2010, tritium was detected once in the STP effluent at a concentration just above the minimum detectable activity (370 pCi/L vs. 310 pCi/L) and with high uncertainty (> 50 percent). The concentration detected is less than 2 percent of the NYS DWS. Analysis of the STP effluent and the Peconic River continued to show no detection of cesium-137 (Cs-137), strontium-90 (Sr-90), or other gamma-emitting nuclides attributable to BNL operations.

The STP is also monitored for nonradiological contaminants. In 2010, nonradiological monitoring of the STP effluent showed that,

except for isolated incidents of noncompliance, organic and inorganic parameters were within SPDES effluent limitations or other applicable standards, and no volatile organic compounds (VOCs) were detected above contract laboratory method detection limits.

Discharges to recharge basins are sampled throughout the year for analyses of gross alpha and beta activity, gamma-emitting radionuclides, and tritium. Each recharge basin is a permitted point-source discharge under the Laboratory's SPDES permit. In 2010, there were no reported gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins, and tritium was not detected above method detection limits in any of the surface water samples taken. Inorganics (i.e., metals) were detected; however, their presence is due primarily to sediment run-off in stormwater discharges.

Radiological data from Peconic River surface water sampling in 2010 shows that the average concentrations of gross alpha and gross beta activity from off-site locations and control locations were indistinguishable from BNL on-site levels, and all detected levels were below the applicable NYS DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the STP, and tritium was not detected above method detection limits in any of the surface water samples. Inorganic data from Peconic River samples collected upstream, downstream, and at control locations demonstrated that elevated amounts of aluminum and iron detected in the river are associated with natural sources.

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 the Laboratory's scientific mission. The goals of the program include protecting and monitoring the ecosystem on site, 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. 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 procedures or into specific programs 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 Canada geese.

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. The maximum on-site concentration in 2010 from a single deer found on site was 0.31 pCi/g, wet weight. The wet weight concentration is before a sample is dried for analysis, and is the form most likely to be consumed. The single sample was 9.6 times lower than the highest level reported in 2009. The New York State Department of Health (NYSDOH) has formally reviewed the potential public health risk associated with elevated levels of Cs-137 in on-site deer and determined that neither hunting restrictions nor formal health advisories are warranted. Testing of deer bones for Sr-90 indicated background levels. Sr-90 is present in the environment at background levels as a result of worldwide fallout from nuclear weapons testing. BNL continues to test for Sr-90 in bone to develop baseline information on this radionuclide and its presence in local white-tailed deer.

In collaboration with the NYSDEC Fisheries Division, BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater

bodies. In 2010, Cs-137 was detected at low levels in all but 13 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 have already removed approximately 88 percent of Cs-137 in the sediment that was co-located with mercury. Natural decay is expected to result in further decreases.

Nonradiological analysis of fish in 2010 showed that all concentrations for metals are considered safe and do not pose any health risks to humans or other animals that may consume fish. Due to its known health risk, mercury is the metal of most concern. In general, a trend of decreasing mercury content downstream from BNL's STP is evident. Polychlorinated biphenyl (PCB) analysis in fish was discontinued off site, but continued to be performed for fish on site. One fish sample tested positive for PCBs. Historically, PCBs have been found in both fish and sediment at BNL and periodically at other locations in the Peconic River. The cleanup of the Peconic River has removed most PCBs within the sediments on site.

Annual sampling of sediment and vegetation in the Peconic River and a control location on the Carmans River was also conducted in 2010. Cesium-137 was not detected in any on-site aquatic vegetation samples and was detected at levels near the detection level at off-site locations. Low levels of Cs-137 were detected in sediments at off-site locations. Metals analysis conducted indicated metals at background levels and many are common in the environment.

Under the Peconic River remediation project, sediment from the Peconic River was excavated to remove mercury and associated contaminants from the river. Sampling results identified three small areas with mercury concentrations greater than the cleanup goal of 2.0 mg/kg. Cleanup of these areas began in 2010 and the project was expected to be completed in 2011. Sediment sampling was also conducted. Twenty-nine of the 30 sediment samples collected met the cleanup goal, and one sample had a mercury concentration of 4.7 mg/kg. Five supplemental samples were then collected within the surrounding area and all were substantially lower

than the cleanup goal.

Water column sampling for mercury and methyl mercury was performed at 22 Peconic River sampling locations, the STP, and one reference location on the Connetquot River in 2010. The general trend of total mercury in water samples decreased with increasing distance downstream from the STP. Methyl mercury concentrations increased slightly from the STP to the BNL site border; then decreased gradually with increasing distance downstream of the site border until reaching the historic range of concentrations for the Connetquot River reference station.

The five-year periodic confirmatory sampling of local farm vegetables was completed in 2009. On-site sampling of garden vegetables in 2010 did not detect any Cs-137 in vegetables and grassy vegetation contained very low levels. Cs-137 was detected in associated soils at a very low level and is consistent with historical background levels.

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. Wildlife programs are conducted at BNL 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 2010, BNL's Environmental Protection Division hosted 16 interns and one faculty member who worked on a variety of projects, some of which include: soil microbial studies of Pine Barrens soils, insect folivory, insect pollinator distribution surveys on site in the area of the Long Island Solar Farm, soil chemistry, nitrogen in soils, microbial and vegetation surveys, and wetland health.

The goal of BNL's Cultural Resource Management Program 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 interpre-

tation. Cultural resource management activities performed in 2010 included identification and relocation of historic artifacts to storage and outreach activities.

Chapter 6 of this report describes BNL's natural and cultural resources 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 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 2010, the Laboratory collected groundwater samples from 789 on- and off-site monitoring wells during 1,732 individual sampling events.

Under the environmental surveillance program, ten active research and support facilities are monitored. During 2010, groundwater samples were collected from 119 wells during 207 sampling events. Over 20 temporary wells were also installed. 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 (AGS) facility, and the Upton service station.

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. Data indicate that tritium levels appear to be related to the flushing of residual tritium from the deep vadose zone following significant natural periodic fluctuations in the local water table. As a result of natural radioactive decay and dispersion in the aquifer, the g-2 tritium plume is breaking up into discrete segments. In 2010, the highest tritium concentration in the downgradient portion of the plume was 37,300 pCi/L. At the Upton service station, VOCs associated with historical petroleum and

solvent spills continue to be detected in the groundwater at concentrations above the applicable DWS. The levels of VOCs are expected to decrease over time by means of natural attenuation.

The primary mission of the Laboratory's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) groundwater program is to operate and maintain groundwater treatment systems and prevent additional groundwater contamination from migrating off site. During 2010, BNL continued to make significant progress in restoring groundwater quality with the removal of approximately 183 pounds of VOCs and approximately 1.4 mCi of Sr-90. With the treatment of approximately 18 billion gallons of groundwater to date, 6,553 pounds of VOCs have been removed from the aquifer, and noticeable improvements in groundwater quality are evident in the Operable Unit (OU) I South Boundary, OU III South Boundary, OU III Industrial Park, OU III Industrial Park East, OU III North Street, OU IV, Building 96, and Carbon Tetrachloride areas. Also to date, two of the treatment systems have removed approximately 23 mCi of Sr-90.

Chapter 7 of this report provides an overview of this program, and the SER Volume II, Groundwater Status Report, provides detailed descriptions, data, and maps relating to all groundwater monitoring performed in 2010.

Radiological Dose Assessment Program

BNL routinely assesses its operations to ensure that any potential radiological dose to members of the public, BNL workers, visitors, 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 2010 was comparable to natural background radiation levels.

To measure direct radiation from Laboratory operations, 49 thermoluminescent dosimeters (TLDs) are placed on site and 14 TLDs are placed in surrounding communities. An additional nine TLDs are placed in a lead-shielded container for use as reference and control TLDs for comparison purposes. In 2010, the average dose from all TLDs showed there was no additional contribution to on- and off-site locations from BNL operations.

The annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was estimated as 66 ± 12 mrem (660 ± 120 μ Sv) and the annual off-site external dose was estimated as 61 ± 11 mrem (610 ± 110 μ Sv). The effective dose to the MEI from air emissions was estimated as $9.20E-01$ mrem (9.2 μ Sv). The ingestion pathway dose was estimated as 4.9 mrem (49 μ Sv) from consumption of deer meat and 0.11 mrem (1.1 μ Sv) from consumption of fish caught in the vicinity of the Laboratory. The total dose to the MEI from all pathways was estimated as 5.93 mrem (59 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 6 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 2010, the following radiological sources were evaluated for potential contribution to the overall site dose:

- Remediation work at Buildings 704 and 802 included dismantling and removing structures, systems, components, ducts, filter house inlets, resin beds, plenums, pipes, asphalt, and the soil below the overall footprint of the two buildings. The effective dose equivalent to the MEI from this project

was estimated to be $1.68E-02$ mrem/year. Filter sample results showed no measurable activity above the natural background radiation.

- A NESHAP evaluation was completed for the demolition of the Building 705 stack once used to discharge effluents from the Brookhaven Graphite Research Reactor (BGRR) and to ventilate equipment and rooms in Building 801. The effective dose to the MEI was estimated to be $5.35E-05$ mrem/year. The stack remediation work was postponed by DOE until a later date, most likely prior to 2020, and a new method for the demolition will be proposed and reviewed under the NESHAP program at that time.
- The diffuse/fugitive losses due to forced circulation in the NSLS-II were evaluated to demonstrate compliance with the annual limit of 10 mrem to the members of the general public from DOE facility operations. The total dose to the MEI resulting from future NSLS-II operations was estimated to be $2.32E-04$ mrem/year. The potential dose is below the 10 mrem/yr. annual limit specified in 40 CFR 61, subpart H, and well below the EPA 0.1 mrem/year limit.
- In March 2010, the BLIP alarm sounded when irradiated targets were being removed from the hot cell and abnormally high radiation levels (40-70 μ R/hr.) were measured in the vicinity above the natural background radiation of 10-13 μ R/hr. It was determined that the alarm was caused by a negative lapse rate in air dispersion during early mornings and late evenings.
- The BLIP facility released 1,741 Ci of C-11 and 4,320 Ci of O-15 while operating over a period of 26 weeks in 2010. In addition, a small quantity ($3.31E-04$ Ci) of tritiated water vapor from activation of the targets' cooling water was also released. The effective dose equivalent to the MEI was estimated to be 0.92 mrem (9.2 μ Sv) in a year from BLIP operations.

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 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 2010, the Laboratory used six off-site contract analytical laboratories to analyze environmental samples: General Engineering Lab (GEL), Ecotest Lab, H2M Lab, Test America (TA), Chemtex Lab, Caltest Analytical, and American Radiation. All analytical laboratories were certified by NYSDOH 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.

Based on the data reviews, data validations, and results of the independent PE assessments, the chemical and radiological results reported in this 2010 SER are of acceptable quality.

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