

Executive Summary

Brookhaven National Laboratory (BNL) is managed on behalf of DOE by Brookhaven Science Associates (BSA), a partnership between the Research Foundation for the State University of New York on behalf of Stony Brook University and Battelle. For almost 70 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 Environmental, Safety, Security and Health (ESSH) Policy reflects the commitment of BNL's management to fully integrate environmental stewardship into all facets of its mission and operations.

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

Volume II of the SER, the Groundwater Status Report, also is prepared annually to report on the status of groundwater protection and restoration efforts. Volume II includes detailed technical summaries of groundwater data and treatment system operations, and is intended for 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 <https://www.bnl.gov/esh/env/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.

ENVIRONMENTAL MANAGEMENT SYSTEM

The Laboratory's Integrated Safety Management System (ISMS) incorporates management of Environment (i.e., environmental protection and pollution prevention), Safety, and Health (ES&H) 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 [EMS]) 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 EMS was fully 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 the ESSH Policy. The policy makes clear the Laboratory's commitments to environmental stewardship, the safety and health of 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. It also 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 DOE Office of Science Laboratory to become officially registered to this standard. BNL was also the first Office of Science Laboratory to achieve registration under the OHSAS 18001 (Occupational Health & Safety) 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 June 2015, an EMS and OHSAS surveillance audit determined that BNL remains in conformance with both standards. In recommending continued EMS certification, auditors from NSF-International Strategic Registrations, Ltd., identified two opportunities for improvement: 1) to consider simplifying documentation for Environmental/OSHAS-related management systems; and 2) to consider clarifying the process

employed for the graded approach of the "Effectiveness Review" as it applies to Environmental/OSHAS systematic nonconformities.

Executive Order 13639, *Planning for Federal Sustainability in the Next Decade*, establishes goals for federal agencies and focuses on greenhouse gas (GHG) reduction across the government. In addition to guidance, recommendations, and plans, which must be prepared by specific due dates, EO 13693 has set numerical targets for agencies. DOE Order 436.1, *Departmental Sustainability*, provides requirements and responsibilities for managing sustainability within DOE to ensure facilities are working towards sustainability goals established in its Strategic Sustainability Performance Plan (SSPP) pursuant to EO 13639. Each DOE facility is required to have a Site Sustainability Plan (SSP) in place detailing the strategy for achieving these long-term goals and due dates, and to provide an annual status. The requirements influence the future of the Laboratory's EMS program and have been incorporated into BNL's SSP.

The Laboratory's 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.

The implementation of pollution prevention opportunities, recycling programs, and conservation initiatives continues to reduce both waste volumes and management costs. In 2015, these efforts resulted in more than \$81.1 million in cost avoidance or savings and approximately 26.1 million pounds of materials being reduced, recycled, or reused annually. Two major pollution prevention projects in 2015 were major contributors to these high numbers and included the

National Synchrotron Light Source (NSLS) Stabilization and Hazard Removal Project and the Utility Energy Services Contract (UESC) project.

Chapter 2 of this report describes the elements and implementation of BNL's EMS and P2 Program.

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 2015 is provided below.

COMPLIANCE MONITORING PROGRAM

BNL has an extensive program in place to ensure compliance with all applicable regulatory and permit requirements. The Laboratory must comply with more than 100 sets of federal, state, and local environmental regulations; numerous site-specific permits; 12 equivalency permits for the operation of groundwater remediation systems; and several other binding agreements. In 2015, the Laboratory operated in compliance with most of the requirements, and any instance of noncompliance was reported to regulatory agencies and corrected expeditiously.

Routine inspections conducted in 2015 found no significant instances of non-compliance. Emissions of carbon monoxide and sulfur dioxide from the Central Steam Facility (CSF) are discussed in the Air Quality Program on the following page.

In 2015, there were no discharges of Halon 1211 from portable fire extinguishers or Halon 1301 from accidental or fire induced activation of fixed fire suppression systems. Halon portable fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as part of an ongoing program to phase out the use of chlorofluorocarbons as extinguishing agents.

Monitoring of BNL's potable water system indicated that all drinking water requirements were met during 2015. Most of the liquid effluents

discharged to surface water and groundwater also met applicable New York State Pollutant Discharge Elimination System (SPDES) permit requirements. Six permit excursions were reported for 2015. Four of these occurred at the Sewage Treatment Plant (STP) Outfall 001 and consisted of one exceedance of permit limits for total nitrogen, two for total iron, and one for ammonia. Non-compliance events were also reported for failure to collect samples at Outfalls 008 (HW) and 010 (CSF). The permit excursions were reported to the New York State Department of Environmental Compliance (NYSDEC) and the Suffolk County Department of Health Services (SCDHS) and corrective measures were taken.

Groundwater monitoring at the Laboratory's Major Petroleum Facility (MPF) continued to demonstrate that current oil storage and transfer operations are not affecting groundwater quality. Efforts to minimize impacts of spills of materials continued in 2015. There were 21 spills; a 25 percent reduction compared to 2014. Only three of the 21 spills met regulatory agency reporting criteria. The severity of releases was minor, and all releases were cleaned up to the satisfaction of NYSDEC.

BNL participated in 11 environmental inspections or reviews by external regulatory agencies in 2015. The inspections included Sewage Treatment Plant (STP) operations; waste water discharges to other regulated outfalls and recharge basins; hazardous waste management facilities; regulated Underground Storage Tank facilities; and the potable water system. Minor issues raised during some of the inspections were immediately addressed.

The DOE Brookhaven Site Office (BHSO) continued to provide oversight of BNL programs during 2015 and participated as an observer of the BSA Multi-Topic Assessment of BNL's environmental protection programs. The scope of the assessment focused on requirements related to BNL's Sustainability, Spill Response, and Best Management Programs. While the assessment evaluated a comprehensive range of safety and environmental topics, the focus was on institutional risk, DOE and regulatory agency expectations, and ensuring that key environmental requirements are being implemented.

The assessment of these programs identified

13 Noteworthy Practices, 2 Minor Nonconformances, and 14 Opportunities for Improvement. Except for the noted Minor Nonconformances, the assessed programs as a whole were found to be in conformance with applicable BNL Standards-Based Management System and external regulatory requirements. A causal analysis was performed and a corrective action plan was prepared for the identified nonconformances. Progress on the actions are being tracked to closure in BNL's Institutional Assessment Tracking System.

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. 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.

During 2015, Laboratory facilities released a total of 4,551 curies of short-lived radioactive gases. BNL's Brookhaven Linac Isotope Producer (BLIP) is the only facility subject to EPA's continuous monitoring requirements. Oxygen-15 (half-life: 122 seconds) and carbon-11 (half-life: 20.4 minutes) emitted from the BLIP constituted more than 99.8 percent of radiological air emissions on site.

The Laboratory conducts ambient radiological air monitoring to verify local air quality and to assess possible environmental and health impacts from BNL operations. Samples collected from air monitoring stations around the perimeter of the site were analyzed for tritium and gross alpha and beta airborne activity. Results for 2015 continued to demonstrate that on-site radiological air quality was consistent with air quality measured at 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 this monitoring.

In 2015, emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the CSF were all well within permit limits. The only recorded excess opacity measurement occurred during quarterly quality assurance tests of the opacity monitors for Boilers 6 and 7. All of the excursions were documented in quarterly Site-Wide Air Emissions and Monitoring Systems Performance Reports submitted to NYSDEC.

Because natural gas prices were lower than residual fuel oil prices throughout 2015, the CSF used natural gas to supply more than 99.8 percent of the heating and cooling needs of the Laboratory's major facilities. As a result, emissions of particulates, oxides of nitrogen, sulfur dioxide, and volatile organic compounds (VOCs) were well below the respective regulatory permit criteria pollutant limits.

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

WATER QUALITY SURVEILLANCE PROGRAM

Wastewater generated from BNL operations is treated at the STP before it is discharged to nearby groundwater recharge basins. Some wastewater may contain very low levels of radiological, organic, or inorganic contaminants. Monitoring, pollution prevention, and vigilant operation of treatment facilities ensure that these discharges comply with all applicable regulatory requirements and that the public, employees, and the environment are protected.

In 2015, the average gross alpha and beta activity levels in the STP discharge were within the typical range of historical levels and well below New York State Drinking Water Standards (NYS DWS). Tritium was not detected above method detection limits throughout the year. There was also no detection of cesium-137 (Cs-137), strontium-90 (Sr-90), or other gamma-emitting radionuclides attributable to BNL operations. The STP is also monitored for nonradiological contaminants. In 2015, monitoring of the STP effluent showed that organic and inorganic parameters were within SPDES effluent limitations and other applicable standards.

Stormwater and cooling water discharges to recharge basins are sampled throughout the year

and analyzed for 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 2015, the average concentrations of gross alpha and beta activity in stormwater and cooling water discharged to recharge basins were within typical ranges and no gamma-emitting radionuclides were detected. Tritium was detected in a single sample collected at Basin HO at a very low level (375 ± 229 pCi/L). Disinfection by-products continue to be detected in the discharges at concentrations just above the method detection limit due to the use of chlorine and bromine for the control of algae and bacteria in potable and cooling water systems. Inorganics (i.e., metals) were detected; however, their presence is due primarily to sediment runoff in stormwater discharges.

Radiological data from Peconic River surface water sampling show that the average concentrations of gross alpha and gross beta activity from on-site locations were indistinguishable from off-site and control locations, and all detected levels were below the applicable NYS DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected, and tritium was not detected above method detection limits in any of the samples. Samples collected upstream, downstream, and at control locations demonstrated that elevated amounts of aluminum and iron 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. 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 or within 1 mile of the Laboratory 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.

As a result of a deer cull conducted in 2015, BNL was able to obtain 52 representative deer meat samples from across the site. Cesium-137 concentrations in the deer meat samples ranged from 0.02 pCi/g, wet weight, to 1.92 pCi/g, wet weight, with an arithmetic average of 0.29 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. Dry weight concentrations are typically higher than wet weight values. The highest on-site sample in 2015 (1.92 pCi/g, wet weight) was about 33 percent higher than the highest on-site sample reported in 2014 (1.46 pCi/g, wet weight) and 6 times lower than the highest level ever reported in 1996 (11.74 pCi/g, wet weight). 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.

Cesium-137 concentrations in off-site deer meat samples taken within 1 mile ranged from 0.01 pCi/g, wet weight, to 0.22 pCi/g, wet weight, with an arithmetic average of 0.10 pCi/g, wet weight. Because deer on site may routinely travel up to 1 mile off site, the arithmetic average for deer taken on site and within 1 mile of the Laboratory is also calculated; for 2015, this was 0.28 pCi/g, wet weight. The single deer sampled from greater than 1 mile from BNL had non-detectable levels of Cs-137 present in the meat.

BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. Sampling is alternated each year either as part of BNL's routine surveillance monitoring program or sampling is performed as part of the post-cleanup monitoring for the Peconic River remediation project.

In 2015 (as part of the post-cleanup

monitoring), Cs-137 levels ranged from non-detected to 0.25 pCi/g, wet weight, from the Peconic River system, and all samples from the Carmans River had non-detectable levels. Detectable Cs-137 levels ranged from an estimated 0.06 pCi/g in brown bullhead taken from Donahue's Pond to 0.25 pCi/g, wet weight, in a largemouth bass taken from Area C on site. For comparison, the highest recent value of Cs-137 was 0.78 pCi/g, wet weight, in a composite sample of bluegill was taken from Forge Pond in 2011.

Mercury in fish taken from the Peconic River ranged from less than the method detection level (MDL) to 3.26 mg/kg in brown bullheads taken from Area C; concentrations in other species and locations were within this range. Mercury in control fish taken from Lower Lake on the Carmans River ranged from 0.04 mg/kg in brown bullhead to 0.19 mg/kg in a largemouth bass. Mercury values in on-site fish taken from Area A during 2015 were similar to those seen in 2014, but higher than those seen in 2011 and 2012. This increase was most likely due to low water flow conditions in the river since late summer 2011, with limited open water areas and little or no flow off site. Consequently, fish have been isolated to the BNL site and any methylated mercury was not diluted by flow. Mercury content in fish between on- and off-site locations indicate that concentrations decrease significantly once off site, and values at Donahue's Pond are similar to those from Lower Lake on the Carmans River.

Sediment was sampled in June 2015 at three Peconic River locations associated with the supplemental cleanup areas remediated during 2010 and 2011. Radiological analysis of sediments at all three locations indicate that low levels of Cs-137 are present, ranging from 0.67 pCi/g to 3.71 pCi/g, which are consistent with previous analyses of the river sediments. Analysis of sediment for mercury identified values ranging from 0.02 mg/kg to 0.77 mg/kg taken at the 2010/2011 cleanup sites. In 2014, the highest value (7.40 mg/kg) was from a sample taken at the PR-WC-06 area and was above the 2.0 mg/kg cleanup goal for post cleanup confirmatory sampling. This result, along with the fact that concentrations above 2.0 mg/kg were seen at this location in the past, resulted in an effort to determine the

extent of mercury in sediment around this point. Additional samples were collected in late 2014 through October 2015. Sampling results ranged from 0.10 to 23.0 mg/kg. By late 2015, BNL began to develop plans for removal of the contaminated sediment and communicated details on this effort with community stakeholders and regulators.

Water column sampling for mercury and methyl mercury was measured at three monitoring stations in 2015. In June, methyl mercury ranged from 2.7 ng/L at the station immediately upstream of the former STP outfall to 1.3 ng/L at the station approximately 2.1 miles downstream of the former STP outfall. In July, methyl mercury values ranged from 1.4 ng/L upstream of the former STP outfall down to 0.48 ng/L approximately 1.1 miles downstream of the former STP outfall.

Grassy vegetation samples collected from 12 locations around the Laboratory were analyzed for Cs-137. Cs-137 content in vegetation ranged from non-detectable to 0.43 pCi/g, wet weight. Five of the 12 samples had detectable levels of Cs-137. Soil sampling was conducted at the same 12 locations and analyzed for Cs-137. Concentrations in soils ranged from 0.05 pCi/g, dry weight, to 2.84 pCi/g, dry weight. These values were consistent with past soil monitoring results.

During 2015, precipitation samples were collected quarterly at air monitoring Stations P4 and S5 and analyzed for radiological content and total mercury. Gross beta activity was measured in samples collected during all four quarters at monitoring stations P4 and S5. Location P4 had a maximum gross beta activity level of 4.61 pCi/L in the third quarter of 2015. Location S5 had a maximum gross beta activity level of 5.72 pCi/L, also in the third quarter. Gross beta, gamma, and Sr-90 (not detected) activity values were within the range of historically observed values at these two locations. Mercury was detected in all of the precipitation samples collected at both sampling stations. Mercury ranged from 1.97 ng/L at station S5 in October to 18.2 ng/L at station P4 in July. This range is one twelfth to three fourths of the highest value measured in precipitation, 24.6 ng/L, recorded in 2013.

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 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 2015, the BNL Visiting Faculty Program (VFP) continued ongoing work on statistical analysis of migratory bird data and meteorological data to determine the potential for placing one or more wind turbines on site. Work associated with the Long Island Solar Farm (LISF) involved tracking 24 eastern box turtles outfitted with transmitters to determine home range sizes. Interns also conducted surveys in and around the LISF to study the relationship and impacts of this facility on the local ecosystems.

During summer 2015, a bat specialist captured bats on site using mist-netting. The results were compared to 2012-2014 surveillance efforts and confirmed that white-nosed syndrome has had a major impact on certain bat species, particularly the northern long-eared bat (*Myotis septentrionalis*), which showed a dramatic reduction in population at BNL based upon 15 captures in 2012, 1 in 2013, 2 ‘young of the year’ in 2014, and none in 2015. The northern long-eared bat was listed as a Threatened species in 2015.

In 2015, BNL continued to participate in several events in support of ecological education programs including: providing on-site ecology tours; hosting the Twentieth Annual Pine Barrens Research Forum for ecosystems researchers to share and discuss their results; participation in the Sixth Annual Pine Barrens Discovery Day held at the Wertheim National Wildlife Refuge; and assisting the Central Pine Barrens Commission on “A Day in the Life of the Rivers,” which allowed students from multiple school districts to acquire environmental and biological data about the Carmans, Peconic, and Nissequogue Rivers. On four separate days, over 30 partner organizations and agencies, 29 school districts, and over 1,500 students collected scientific information for analysis to be used to portray the status of the rivers and estuary systems. These events provide students

hands-on experience with field techniques in catching fish, invertebrate sampling, biodiversity inventory, and water chemistry.

In addition, BNL is in the 12th year of the Open Space Stewardship Program (OSSP) and worked with 30 schools and over 3,000 students in 2015. The OSSP enables students to engage in activities to solve problems within their local community through scientific discovery, conservation, and stewardship. The effort integrates outdoor research with school curricula in language arts, civics, community service, and media arts.

The Laboratory also hosts the annual New York Wildfire & Incident Management Academy, offered by NYSDEC and the Central Pine Barrens Commission. Using the Incident Command System of wildfire management, this academy trains firefighters in the methods of wildland fire suppression, prescribed fire, and fire analysis. BNL has developed and is implementing a Wildland Fire Management Plan. The Laboratory continues the use of prescribed fire for fuel and forest management and is working with NYSDEC to conduct growing season fires in northern and eastern sections of the BNL property. A growing season prescribed fire was planned to take place in June 2015; however, extended drought conditions prevented implementation.

Chapter 6 of this report describes BNL’s natural and cultural resources in further detail.

GROUNDWATER PROTECTION MANAGEMENT PROGRAM

BNL has made significant investments in environmental protection programs over the past 20 years and continues to make progress in achieving its goal of preventing new groundwater impacts and remediating previously contaminated groundwater. No new impacts to groundwater quality were discovered during 2015. The Laboratory’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 where there is a potential for environmental impact.

During 2015, BNL collected groundwater samples from 732 permanent monitoring wells and 76 temporary wells during 1,517 individual

sampling events. Nine groundwater remediation systems removed 94 pounds of VOCs and returned approximately 1.2 billion gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation in December 1996, the treatment systems have removed 7,370 pounds of VOCs by treating nearly 25 billion gallons of groundwater. Also during 2015, two groundwater treatment systems removed approximately 1 millicurie of Sr-90 while remediating approximately 24 million gallons of groundwater. Since 2003, BNL has removed approximately 31 millicuries of Sr-90 from the groundwater while remediating 167 million gallons of groundwater. As a result of the successful operation of these treatment systems, significant reductions in contaminant concentrations have been observed in a number of on- and off-site areas. To date, three VOC treatment systems have been decommissioned and two others have been placed in standby mode. Due to significant reductions in Freon-11 concentrations observed during 2015, it is anticipated that the Building 452 Freon-11 Treatment System will be placed in standby mode in early 2016.

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 and remediation performed in 2015.

RADIOLOGICAL DOSE ASSESSMENT PROGRAM

The Laboratory routinely reviews 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 to members of the public is calculated at an off-site location closest to an emission source as the maximum dose that could be received by an off-site individual, defined as the “maximally exposed off-site individual” (MEOSI). The dose to the MEOSI is the sum total from direct and indirect dose pathways via air immersion, inhalation of particulates and gases, and ingestion of local fish and deer meat.

In 2015, the total effective dose (TED) of 3.15 mrem (32 μ Sv) from Laboratory operations was well below the EPA and DOE regulatory dose

limits for the public, workers, and the environment. The effective dose equivalent (EDE) from air emissions in 2015 was estimated at 2.84E-01 mrem (2.8 μ Sv) to the MEOSI. The dose level from the inhalation pathway was less than 3 percent of EPA’s annual regulatory dose limit of 10 mrem (100 μ Sv). In addition, the dose from the ingestion pathway was estimated as 2.78 mrem (27.8 μ Sv) from the consumption of deer meat and 8.75E-2 mrem (0.88 μ Sv) from the consumption of fish caught in the vicinity of the Laboratory. In summary, the total annual dose to the MEOSI from all pathways was estimated at 3.15 mrem (32 μ Sv), which is less than 4 percent of DOE’s 100-mrem limit.

In 2015, to measure direct radiation from Laboratory operations, 58 environmental thermoluminescent dosimeters (TLDs) were deployed on site, of which 9 were placed in known radiation areas. Eighteen TLDs were deployed at off-site locations. Over the year, two off-site TLD locations were discontinued and five locations were added. An additional 30 TLDs were placed in a lead-shielded container for use as reference and control TLDs for comparison purposes. The average dose of all TLDs showed there was no additional contribution above the natural background radiation to on- and off-site locations from BNL operations.

The on-site average external doses for the first through fourth quarters were 16.6 ± 2.9 , 15.6 ± 2.8 , 14.7 ± 2.8 , and 16.6 ± 2.7 mrem, respectively. The on-site average annual external dose from all potential environmental sources, including cosmic and terrestrial radiation sources, was 64 ± 9 mrem (640 ± 90 μ Sv). The off-site average external doses for the first through fourth quarters were 15.4 ± 2.6 , 15.1 ± 3.0 , 14.0 ± 3.4 , and 15.4 ± 3.3 mrem, respectively. The off-site average annual ambient dose from all potential environmental sources, including cosmic and terrestrial radiation sources, was 59 ± 6 mrem (590 ± 60 μ Sv).

To determine the BNL contribution to the external direct radiation dose, a statistical t-test between the measured on- and off-site external dose averages was conducted. The t-test showed no significant difference between the off-site dose (59 ± 6 mrem) and on-site dose (64 ± 9 mrem) at the 95 percent confidence level. From the

measured TLD doses, it can be safely concluded that there was no measurable external dose contribution to on- and off-site locations from Laboratory operations in 2015.

During the summer of 2015, the project to decontaminate and demolish Building 811 was largely completed. As required by NESHAPs, this demolition project was evaluated for the potential to release radioactive contaminants to the environment. A detailed demolition plan was prepared and closely followed, which included the use of a water mist spray to prevent suspension of any possible soil- or dust-borne contaminants. Monitoring for airborne radioactive materials during the demolition activities did not detect any measurable releases.

Dose to aquatic and terrestrial biota were also evaluated and found to be well below DOE regulatory limits. In summary, the overall dose impact from all Laboratory activities in 2015 was comparable to that of natural background radiation levels.

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 report are reliable, of high quality, and meet quality assurance and quality control objectives. Samples are collected and analyzed in accordance with EPA methods and BNL 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 2015, the Laboratory used five off-site contract analytical laboratories to analyze environmental samples. 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 documented in this report are of acceptable quality.

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