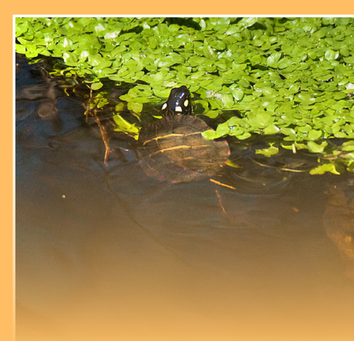
BROOKHAVEN NATIONAL LABORATORY

Site Environmental Report 2012

VOLUME 1

Brookhaven National Laboratory has one of the most diverse populations of reptiles and amphibians on Long Island. The photo on the front cover is of an eastern box turtle (*Terrapene c. carolina*) Other species present on the Laboratory site include the snapping turtle (*Chelydra serpentine*), the spotted turtle (*Clemmys guttata*), the painted turtle (*Chrysemys p. picta*), and the musk turtle (*Sternotherus odoratus*).

Interns at the Laboratory have been using radiotelemetry to gain a better understanding of habitat use and box turtle home range and reproductive success on site. BNL's Natural Resources staff are also interested in how much this species uses the Long Island Solar Farm on site. Tracking will continue for up to 6 years in order to gain long-term data.



New and ongoing research on snapping and painted turtles is being conducted by researchers from Hofstra University; specifically, sex determination hormones in developing eggs and the effect of fertilizers on turtle health. BNL serves as a location of low environmental nitrogen loading compared to more developed areas of Long Island with turtle populations.

The Brookhaven National Laboratory 2012 Site Environmental Report is a public document that is distributed to various U.S. Department of Energy sites, local libraries, and local regulators and stakeholders. The report is available to the general public on the internet at http://www.bnl.gov/ewms/ser/. A summary of the report is also available and is accompanied by a compact disk containing the full report. To obtain a copy of the report or summary, please write or call:

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2012
SITE ENVIRONMENTAL REPORT

BROOKHAVEN NATIONAL LABORATORY

Volume I

October 2012

Prepared by
Brookhaven Science Associates, LLC
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EXPLORING EARTH'S MYSTERIES
...PROTECTING ITS FUTURE

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Executive Summary

Brookhaven National Laboratory (BNL) prepares an annual Site Environmental Report (SER) in accordance with DOE Order 231.1B, Environment, Safety and Health Reporting of the U.S. Department of Energy (DOE). 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 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 personnel, 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.

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 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 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 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 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 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 (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 2012, an EMS and OHSAS surveillance audit determined that BNL remains in conformance with both standards. In recommended continued EMS certification, auditors from NSF-International Strategic Registrations, Ltd., found one Minor Nonconformance regarding the need for better document control to prevent unintended use of obsolete documents. Corrective actions will be 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.

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 Brookhaven Science Associates 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 eight P2 proposals, submitted by employees to BNL's P2 Council, were funded in 2012, for a combined investment of approximately $13,500. The anticipated annual savings from these projects is estimated at $170,000, for an average payback period of approximately 1 month. Initiatives to reduce, recycle, and reuse 13.1 million pounds of industrial, sanitary, hazardous, and radiological waste through the P2 program resulted in more than $3.0 million in cost avoidance or savings in 2012.

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 2012 follow.

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, 13 equivalency permits for the operation of groundwater remediation systems, and several other binding agreements. In 2012, the Laboratory complied fully with most requirements; all instances of noncompliance were reported to regulatory agencies and corrected expeditiously. Routine inspections conducted during the year found no significant instances of non-compliance.

The Laboratory received two Notices of Violation (NOV) from EnergySolutions of Utah and one Notice of Non-Compliance from the Environmental Protection Agency (EPA). The two NOVs from EnergySolutions were received in June and August and resulted in 600 points against BNL's Utah Generator Site Access Permit, but with no monetary fines. In July, EPA issued a Notice of Non-Compliance of Subpart H, 40 CFR 61, National Emissions Standards for Hazardous Pollutants–radionuclides (rad-NESHAP), as a result of some findings from an inspection in July 2012 and review of BNL's 2011 rad-NESHAPs Report. A revised annual report was submitted, which addressed the non-compliance findings.

In 2012, emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from BNL's Central Steam Facility (CSF) were all within permit limits. Nine unexpected opacity excursions occurred in January 2012 due to the sudden buildup of soot across the transmitter light path for Boiler 6, for which there was no apparent cause. Subsequent shutdown and cleaning of the light path brought opacity readings back to normal. Halon portable fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as they are encountered. The existing supply of Halon in storage was transferred to the Department of Defense Ozone Depleting Substances Reserve in 2012.

Monitoring of BNL's potable water system indicated that all drinking water requirements were met. During 2012, most of the liquid effluents discharged to surface water and groundwater met applicable New York State Pollutant Discharge Elimination (SPDES) permit requirements. Nine minor excursions above permit limits were reported for the year; three occurred at BNL's Sewage Treatment Plant (STP) (iron, total nitrogen, and total nitrogen load), five pH excursions were recorded for discharges to recharge basins (one at Outfall 007 and four at Outfall 008), and one oil and grease excursion at Recharge Basin 006B. The permit excursions were reported to the New York State Department of Environmental Conservation (NYSDEC) and the Suffolk County Department of Health Services (SCDHS). 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 reduce the number and minimize the severity of spills on site continued in 2012. There were 15 reportable spills of petroleum products, antifreeze, or chemicals, which was slightly less than in 2011. The severity of releases was minor and spills were promptly cleaned up to the satisfaction of NYSDEC.

Nine external environmental inspections or reviews were conducted in 2012 by federal, state, and local agencies that oversee BNL activities. These inspections included:

- *Air Compliance.* NYSDEC did not perform a formal inspection of the Laboratory's air compliance program in 2012; however, NYSDEC was present during a portion of the annual relative accuracy test audit of the continuous emissions monitoring system at the CSF. There were no issues identified during this inspection.

- *Potable Water.* In July, SCDHS collected samples and conducted its annual inspection of the BNL potable water system. Identified deficiencies are being addressed by the Laboratory's Energy and Utilities Division.
- *Sewage Treatment Plant.* SCDHS conducts quarterly inspections of the Laboratory's STP to evaluate operations and sample the effluent; no performance or operational issues were identified. NYSDEC performed an annual surveillance inspection in February; there were no issues identified.
- *Recharge Basins.* SCDHS inspected several on-site SPDES-regulated outfalls in 2012; there were no issues identified.
- *Major Petroleum Facility.* The annual NYSDEC inspection of the MPF was performed in February 2012. Three conditions required corrective action were identified. All conditions were corrected in 2012 in accordance with NYSDEC directives.
- *Chemical Bulk Storage (CBS) Facilities.* The CBS facilities are inspected periodically by NYSDEC. An inspection was conducted in February 2012. Two conditions were noted and corrected in 2012 in accordance with NYSDEC directives.

Each year, the DOE Brookhaven Site Office (BHSO) conducts several environmentally-related assessments, some of which are supported by the DOE Chicago Office. In May 2012, BHSO conducted a Readiness Assessment for Transition of BNL's Brookhaven Graphite Research Reactor (BGRR) and High Flux Beam Reactor (HFBR) Long-Term Surveillance and Maintenance (S&M) Program. The purpose of the assessment was to review BSA progress in implementing the BGRR and HFBR Long-Term S&M Transition Plan and to identify any issues or impediments to successfully transferring long-term stewardship responsibilities of the facilities to the Environmental Services Division (ESD), and to complete the Environmental Management Legacy Scope from the Laboratory's Environmental Restoration Projects to other organizations within BNL. The assessment consisted of verification of the completion of the required actions and development of an open action list, which will be monitored and tracked to completion through BNL's assessment tracking system (ATS).

In July 2012, BHSO performed a surveillance audit of BNL's Response to the Building 705 Stack Drain Tank High-Level Alarm during a severe rainstorm in July 2012. Rainwater that touches the interior surfaces of the stack becomes radioactively contaminated. This water is collected via a stack drain collection system and flows into a double-walled, underground storage tank. During the storm, the tank was overfilled and set off an alarm indicating that water entered the overfill containment sump and ultimately the interstitial space between the primary and secondary containment of the tank. Although there was no release of contaminated water to the environment as a result of this overfilling event, BHSO concluded that the alarm response was inadequate and recommended that BNL evaluate the event and consider potential vulnerabilities across the site where alarm response and notification procedures may be less than adequate. Following the assessment, the Laboratory identified several corrective actions to address the findings and tracked them to completion using BNL's ATS.

In June 2012, BHSO performed a surveillance audit of the Laboratory's SPDES Discharge Monitoring Report Preparation. The intent of the audit was to review BNL's process to track permit requirements, to ensure the correct wastewater samples are collected for analysis, the Laboratory's contract for laboratory analyses, conduct quality assurance reviews of sample results, and to transpose results for reporting to NYSDEC. No findings were identified.

In November 2012, BHSO, with assistance from the Chicago Integrated Support Center, conducted an assessment of BNL's Packaging and Transportation Program, in accordance with DOE Order 460.2A, Departmental Materials Transportation and Packaging Management. DOE concluded that, overall, transportation operations at the Laboratory are performed as required and that BNL has been implementing improvements. However, DOE also concluded that the Laboratory needs to continue to focus on the implementation of additional corrective actions that were developed during previous self-assessments. BNL agreed to include any additional corrective actions resulting from this assessment into an existing corrective action plan that resulted from a previous assessment of on-site movements of hazardous and radioactive materials. Corrective actions will be tracked to completion through the Laboratory's ATS.

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 2012, Laboratory facilities released a total of 4,901 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: 20.48 minutes) emitted from the BLIP constituted more than 99.9 percent of radiological air emissions on site in 2012. The annual facility emissions of particulate matter and oxides of nitrogen were at their lowest in the last decade.

Monitoring was also conducted at one other active facility, BNL's Target Processing Laboratory (TPL), and one inactive facility, the HFBR. Releases from the TPL in 2012 continued to be very small (0.0944 μCi). Low levels of tritium from the HFBR (0.81 Ci) were primarily due to the presence of residual tritium in ambient air exhausted from the facility prior to and during monthly structural integrity inspections.

The Laboratory conducts ambient radiological air monitoring to verify local air quality and 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 2012 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 monitoring. Two of the four boilers at the CSF, specifically 6 and 7, are equipped with continuous emission monitors to measure nitrogen oxide (NOx) emissions and opacity. NOx 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 2012, there were no exceedances of the NOx emission standards for either boiler, and there were nine excess opacity measurements recorded for Boiler 6, also discussed in Compliance Monitoring Program above. The only recorded opacity excursions were observed during performance testing of the opacity monitors.

Because natural gas prices were lower than residual fuel oil prices throughout 2012, BNL's CSF used natural gas to supply more than 99 percent of the heating and cooling needs of the Laboratory's major facilities during the year. As a result, annual facility emissions of particulate matter and nitrogen oxides were at their lowest in the last decade.

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

Water Quality Surveillance Program

The Laboratory discharges treated wastewater into the headwaters of the Peconic River via BNL's 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.

In 2012, 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 detected once in the STP effluent at a concentration just above the minimum detectable activity (630 pCi/L ± 350 pCi/L), which is 3 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 2012, monitoring of the STP effluent showed that, except for isolated incidents of noncompliance for metals, organic and inorganic parameters were within SPDES effluent limitations or other applicable standards.

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 2012, there were no reported gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins, and tritium was detected in a single sample, just above method detection limits. Inorganics (i.e., metals) were detected; however, their presence is due primarily to sediment run-off in stormwater discharges.

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 west of BNL, is monitored as a geographical control location for comparative purposes, as it is not affected by Laboratory operations. Radiological data from Peconic River surface water sampling in 2012 show 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 or tritium attributable to Laboratory operations were detected either upstream or downstream of the STP. 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 or within 1 mile 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 2012 in on-site deer meat was 0.27 pCi/g, wet weight (wet weight is before a sample is dried for analysis and the form most likely to be consumed). 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 in 2012 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. With 13 years of Sr-90 data providing a sound baseline indicating on- and off-site values having overlapping distributions, BNL will discontinue testing for Sr-90 content in 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. Sampling is now alternated each year either as part of BNL's routine surveillance monitoring program or sampling performed as part of the post cleanup monitoring for the Peconic River cleanup project. In 2012, fish monitoring results showed low levels of Cs-137 from the Peconic River System, and all samples from the Carmans River were non-detectable. Levels of Cs-137 in all fish species appear to be declining, compared to historic values.

Nonradiological analysis of fish in 2012 detected chromium in a single sample from the Peconic River system. Nickel values in three samples were above the minimum detection level. These reported values are not considered to 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, and all values were less than the method detection limit.

Annual sampling of sediment and vegetation in the Peconic River and a control location on the Carmans River was also conducted in 2012. 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. In addition, low levels of Cs-137 were detected in sediments at off-site locations. Metals analysis conducted indicated metals at background levels, many of which 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 three locations in 2011. Post cleanup monitoring of the three locations indicated low levels of Cs-137 and one location had a mercury concentration above the 2.0 mg/kg goal set by the Peconic River cleanup project, but it was below SCDHS action levels. Water column sampling for mercury and methyl mercury was performed at 6 of 15 Peconic River sampling locations and BNL's STP outfall. The general trend of total mercury in Peconic River water samples decreased with increasing distance downstream from the STP. Methyl mercury concentrations fluctuated between sampling periods and between both on- and off-site locations.

On-site garden sampling in 2012 did not detect any Cs-137 in vegetables, but was detected in soils at a very low level, which is considered consistent with background levels. Ten years of monitoring at the BNL garden area has provided a sufficient baseline showing no impact from any historic or recent operations; therefore, surveillance monitoring will be discontinued in 2013. Grassy vegetation samples also contained very low levels of Cs-137 and are also considered consistent with historical background levels. One soil sample associated with grassy vegetation had a Cs-137 concentration of 43.9 pCi/g. This sample was outside of the former Hazardous Waste Management Facility (HWMF) and just outside of an area that had previously been remediated.

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 2012, research included flying squirrel radiotelemetry surveys and genetics, box turtle home range determination and resource use, acoustic and mist net bat surveys, and impact assessments related to the construction and operation of the Long Island Solar Farm on site.

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 interpretation. Cultural resource management activities performed in 2012 included the loan of BNL artifacts, presentations, and a dedication ceremony at BNL's Chemistry Building as a Historical Chemical Landmark. In addition, the Laboratory completed revisions to BNL's Cultural Resource Management Plan and prepared the plan for submission to the New York State Historic Preservation Office for review.

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 15 years and continues to make progress in achieving its goal of preventing new groundwater impacts and remediating previously contaminated groundwater. 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. In 2012, BNL collected groundwater samples from 796 permanent monitoring wells and 44 temporary wells during 1,791 individual sampling events.

During 2012, BNL continued to make significant progress in restoring groundwater quality with the removal of approximately 239 pounds of volatile organic compounds (VOCs) and approximately 1.9 mCi of Sr-90 from the groundwater. With the treatment of approximately 1.5 billion gallons of groundwater to date, 6,948 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, and Building 96 areas. Also to date, two of the treatment systems have removed approximately 27 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 2012.

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 is calculated to the maximally exposed off-site individual (MEOSI), which is defined as the possible largest dose to a person at a residence, office, or school beyond 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 2012 was comparable to natural background radiation levels.

To measure direct radiation from Laboratory operations, 49 environmental thermoluminescent dosimeters (TLDs) were placed on site and 12 TLDs were placed in surrounding communities in 2012. 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.

In 2012, the annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was estimated as 68 ± 12 mrem (680 ± 120 µSv) and the annual off-site external dose was estimated as 62 ± 10 mrem (610 ± 100 µSv). The effective dose to the ME-OSI from air emissions was estimated as 2.35E-01 mrem (2.4 µSv). The ingestion pathway dose was estimated as 2.21 mrem (22 µSv) from the consumption of deer meat and 1.0E-01 mrem (1.0 µSv) from consumption of fish caught in the vicinity of the Laboratory. The total dose to the maximally exposed individual (MEI) from all pathways was estimated as 2.55 mrem (26 µSv). The dose from the air inhalation pathway attributable to BNL operations was less than 3 percent of EPA's annual regulatory dose limit of 10 mrem (100 µSv) and the DOE's annual dose limit of 100 mrem (1,000 µSv) from all pathways. Doses to aquatic and terrestrial biota and also from short-term projects, such as remediation work and waste management disposal activities, were also evaluated and found to be well below the regulatory limits.

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 2012, the Laboratory used six off-site contract analytical laboratories to analyze environmental samples: General Engineering Lab, H2M Lab, Test America, Chemtex Lab, Caltest Analytical, and American Radiation Services. 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 2012 SER are of acceptable quality.

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

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The SER Team realizes that many other employees contributed to this report and thanks everyone for their assistance.

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A Note from the Editor

Throughout the Site Environmental Report, there are many references to Brookhaven National Laboratory (BNL), the U.S. Department of Energy (DOE), and the U.S. Environmental Protection Agency (EPA). These acronyms, and others that are explained in each chapter, are used interchangeably with their spelled-out forms as an aid to readers. The most up-to-date, accurate version of this report is online at *http://www.bnl.gov/ewms/ser/*.

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Introduction 1

Established in 1947, Brookhaven National Laboratory is a multi-program national laboratory managed for the U.S. Department of Energy by Brookhaven Science Associates (BSA), a partnership formed by Stony Brook University and Battelle Memorial Institute. BSA has been managing and operating the Laboratory under a performance-based contract with DOE since 1998. From 1947 to 1998, BNL was operated by Associated Universities, Incorporated. Prior to 1947, the site operated as Camp Upton, a U.S. Army training camp, which was active from 1917 to 1920 during World War I and from 1940 to 1946 during World War II.

BNL is one of 10 national Laboratories under DOE's Office of Science, which provides most of the Laboratory's research dollars and direction. BNL has a history of outstanding scientific achievements, including seven Nobel Prizes. For over 60 years, Laboratory researchers have successfully worked to envision, construct, and operate large and innovative scientific facilities in pursuit of research advances in many fields. Programs in place at BNL emphasize continual improvement in environmental, safety, security, and health performance.

1.1 LABORATORY MISSION

BNL's broad mission is to produce excellent science and advanced technology in a safe and environmentally sound manner with the cooperation, support, and involvement of its scientific and local communities. The fundamental elements of the Laboratory's role in support of DOE's strategic missions are the following:

- To conceive, design, construct, and operate complex, leading-edge, user-oriented research facilities in response to the needs of DOE and the international community of users.
- To carry out basic and applied research in long-term, high-risk programs at the frontier of science.
- To develop advanced technologies that address national needs and to transfer them to other organizations and to the commercial sector.
- To disseminate technical knowledge, to educate future generations of scientists and engineers, to maintain technical capabilities in the nation's workforce, and to encourage scientific awareness in the general public.

BNL's Environmental, Safety, Security, and Health (ESSH) Policy is the Laboratory's commitment to continual improvement in ESSH performance. Under this policy, the Laboratory's goals are to protect the environment, conserve resources, and prevent pollution; maintain a safe workplace by planning work and performing it safely; provide security for people, property, information, computing systems, and facilities; protect human health within our boundaries and in the surrounding community; achieve and maintain compliance with applicable ESSH requirements; maintain an open, proactive, and constructive relationship with employees, neighbors, regulators, DOE, and other stakeholders; and continually improve ESSH performance.

BNL was the first DOE Office of Science National Laboratory to be registered under the prestigious International ISO 14001 environmental management standard in 2001. In addition, in December 2006, BNL was the first DOE Laboratory to achieve full registration under the Occupational Health and Safety Assessment Series (OHSAS) 18001 Standard. These programs are described in detail in Chapter 2 of this report. Registration to these standards was maintained throughout 2012.

1.2 RESEARCH AND DISCOVERIES

BNL conducts research in nuclear and high-energy physics, the physics and chemistry of materials, nanoscience, energy and environmental research, national security and nonproliferation, neurosciences and medical imaging, structural biology, and computational sciences. BNL's world-class research facilities are also available to university, industrial, and government personnel.

To date, seven Nobel Prizes have been awarded for discoveries made wholly or partly at BNL. Some significant discoveries and developments made at the Laboratory include L-dopa, used to treat Parkinson's disease; the first synthesis of human insulin; the use of x-rays and neutrons to study biological specimens; the radionuclide thallium-201, used in millions of cardiac stress tests each year; the radionuclide technetium-99, also used to diagnose heart disease; x-ray angiography for noninvasive cardiac imaging; research on solar neutrinos and how they change form as they move through space; magnetically levitated (maglev) trains; energy technologies studies; and researching pollution-eating bacteria.

The Laboratory's mission for the coming decade will focus on advancing fundamental research in nuclear and particle physics to gain a deeper understanding of matter, energy, space, and time; applying photon sciences and nanomaterials research to energy problems of critical importance to the nation; and performing cross-disciplinary research to understand the relationship between climate change, sustainable energy, and the Earth's ecosystems.

1.3 HISTORY

BNL was founded in 1947 by the Atomic Energy Commission (AEC), a predecessor to the present DOE. AEC provided the initial funding for BNL's research into peaceful uses of the atom. The objective was to promote basic research in the physical, chemical, biological, and engineering aspects of the atomic sciences. The result was the creation of a regional laboratory to design, construct, and operate large scientific machines that individual institutions could not afford to develop on their own.

Although BNL no longer operates any research reactors, the Laboratory's first major scientific facility was the Brookhaven Graphite Research Reactor (BGRR), which was the first reactor to be constructed in the United States following World War II. The reactor's primary mission was to produce neutrons for scientific experimentation in the fields of medicine, biology, chemistry, physics, and nuclear technology. The BGRR operated from 1950 to 1968 and decommissioning was completed in June 2012. The BGRR will undergo long-term routine inspection and surveillance.

The High Flux Beam Reactor (HFBR) was in operation from 1965 through 1996. The facility was used solely for scientific research and provided neutrons for experiments in materials science, chemistry, biology, and physics. For more than 30 years, the HFBR was one of the premier neutron beam reactors in the world. In late 1996, workers discovered that a leak in the HFBR spent fuel storage pool had been releasing tritium to the groundwater (see SER, Volume II, Groundwater Status Report, for further details). The reactor was shut down for routine maintenance at the time of the discovery and was never restarted. In November 1999, DOE decided that the HFBR would be permanently shut down. With input from the community, a final Record of Decision (ROD) was approved outlining the remedy for the HFBR's permanent decontamination and decommissioning (D&D). To date, completed actions include the removal and disposal of HFBR fuel and primary coolant; shipment of equipment for reuse at other facilities; cleanup and transfer of the Cold Neutron Facility for reuse; dismantling of ancillary buildings, including fanhouses; removal and disposal of the reactor control rod blades and beam plugs; draining and isolation of all utility piping penetrating the reactor building; removal of the stack silencer baffles; and rendering all former hazardous material storage tanks permanently out of service. Demolition of the stack will be completed by 2020 in accordance with the ROD. Starting in 2010, the HFBR entered a period of long-term surveillance and maintenance. During this period, the building will remain unheated and electrical services will only be energized during periodic inspections. The HFBR will remain in this state for 65 years to permit decay of remaining radioactivity within the reactor. At the end of the low-energy period, D&D of the reactor will continue.

Medical research at BNL began in 1950 with the opening of one of the first hospitals devoted to nuclear medicine. It was followed by the Medical Research Center in 1958 and the Brookhaven Medical Research Reactor (BMRR) in 1959. The BMRR was the first nuclear reactor in the nation to be constructed specifically for medical research. Due to a reduction of research funding, the BMRR was shut down in December 2000. All spent fuel from the BMRR has been removed and transported off site, and the facility is currently in a "cold" shutdown mode as a radiological facility.

The Brookhaven Linac Isotope Producer (BLIP) was built in 1973. It creates radioactive forms of ordinary chemical elements that can be used alone or incorporated into radiotracers for use in nuclear medicine research or for clinical diagnosis and treatment. BNL's Center for Translational Neuroimaging (CTN) uses brain-imaging tools, including positron emission tomography (PET) and magnetic resonance imaging (MRI) equipment, to research causes of, and treatments for, brain diseases such as drug addiction, appetite disorders, attention deficit disorder, and neurodegenerative disease. The development of PET and MRI also has helped facilitate the development of new drugs for physicians worldwide to treat patients for cancer and heart disease.

High-energy particle physics research at BNL began in 1952 with the Cosmotron, the first particle accelerator to achieve billion-electron-volt energies. Work at the Cosmotron resulted in a Nobel Prize in 1957. After 14 years of service, the Cosmotron ceased operation and was dismantled due to design limitations. The Alternating Gradient Synchrotron (AGS), a much larger particle accelerator, became operational in 1960. The AGS has allowed scientists to accelerate protons to energies that have yielded many discoveries of new particles and phenomena, for which BNL researchers were awarded three Nobel Prizes in physics. The AGS receives protons from BNL's linear accelerator (Linac), designed and built in the late 1960s as a major upgrade to the AGS complex. The Linac's purpose is to provide accelerated protons for use at AGS facilities and BLIP. The AGS booster, constructed in 1991, further enhanced the capabilities of the AGS, enabling it to accelerate protons and heavy ions to even higher energies. The Tandem Van de Graaff accelerator began operating in 1970 and is the starting point of the chain of accelerators that provide ions of gold, other heavy metals, and protons for experiments at the Relativistic Heavy Ion Collider (RHIC). In 2010, the Collider Accelerator Department received approval from DOE to begin operation of a new heavy ion beam source for use by RHIC and the NASA Space Radiation Laboratory (NSRL), the Electron Beam Ion Source (EBIS). This new source produces and accelerates intense and bright heavy ion beams, allowing studies with new types of ions previously unavailable from the Tandem Van DeGraaff accelerator.

RHIC began operation in 2000. Inside this two-ringed particle accelerator, two beams of gold ions, heavy metals, or protons circulate at nearly the speed of light and collide head-on, releasing large amounts of energy. RHIC is used to study what the universe may have looked like in the first few moments after its creation, offering insights into the fundamental forces and properties of matter. Planned upgrades to RHIC will expand the facility's research capabilities. The first upgrade, RHIC II, will increase the collider's collision rates and improve the sensitivity of the large detectors it uses. Another planned upgrade, the eRHIC, will add a high-energy electron ring to create the world's first electron and heavy ion collider.

The NASA Space Radiation Laboratory (NSRL) became operational in 2003. It is jointly managed by DOE's Office of Science and NASA's Johnson Space Center. The NSRL uses heavy ions extracted from the AGS booster to produce beams of radiation similar to radiation that would be encountered by astronauts on long missions. Studies are conducted to assess risks and test protective measures. The NSRL is one of the few facilities in the world that can simulate the harsh cosmic and solar radiation environment found in space.

The National Synchrotron Light Source (NSLS) uses a linear accelerator and booster synchrotron to guide charged particles in orbit inside two electron storage rings for use in a wide range of physical and biological experiments. The NSLS produces beams of very intense light in the x-ray, ultraviolet, and infrared spectra, allowing scientists to study the structure of proteins, investigate the properties of new materials, and understand the fate of chemicals in the environment. Although the current NSLS has been continually updated since its commissioning in 1982, today the practical limits of its performance have been reached. To continue advances in these fields, construction of the NSLS-II, conceived as the next generation synchrotron light source, began in 2008. To help meet the critical scientific challenges of our energy future, this new state-of-the-art, medium-energy electron storage ring synchrotron will provide x-rays more than 10,000 times brighter than the current NSLS and will focus on research at the nanoscale. The NSLS-II will enable scientists to focus on some of the nation's most important scientific challenges at the nanoscale level, including clean, affordable energy, molecular electronics, and high-temperature superconductors. The NSLS-II is expected to be operational in 2015.

The Laboratory's Research Support Building (RSB) was completed in 2006, and provides administrative and support functions in a single location for employees and visiting scientists. The RSB has been awarded the Leadership in Energy and Environmental Design (LEED) Silver certification from the U.S. Green Building Council. The award is based on five categories: sustainability, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality.

Construction of BNL's Center for Functional Nanomaterials (CFN) was completed in May 2007. The CFN provides state-of-the-art capabilities for the fabrication and study of nanoscale materials, with an emphasis on atomic-level tailoring to achieve desired properties and functions. Nanoscience has the potential to bring about and accelerate new technologies in energy distribution, drug delivery, sensors, and industrial processes. The CFN is a science-based user facility, used for developing strong scientific programs while offering broad access to its capabilities and collaboration through an active user program. It is one of five Nanoscale Science Research Centers funded by DOE's Office of Science and supports the Laboratory's goal of leadership in the development of advanced materials and processes for energy applications. Like the RSB, the CFN building has also been awarded LEED Silver certification.

Site preparation began in 2009 for the new Interdisciplinary Science Building (ISB), an energy-efficient and environmentally sustainable building that will provide labs, offices, and support functions to bring together a broad spectrum of researchers, including industry, universities, and other National Laboratories, in a single location to foster energy research, focusing on the effective uses of renewable energy through improved conversion, transmission, and storage. The ISB is expected to be fully operational in 2013.

In addition, construction of a 32 megawatt Long Island Solar Farm (LISF) at BNL was completed in the fall of 2011. The LISF is the largest solar photovoltaic (PV) electric generating plant in the Northeast region. Its goal is to help Long Island be less reliant on fossil fuel-driven power generation and to meet peak load demands from summertime air conditioning use. It is generating enough renewable energy to power approximately 4,500 homes and is helping New York State meets its clean energy and carbon reduction goals. The LISF will also become one of the most studied solar installations, as it will be a focal point of a Northeast Solar Energy Research Center (NSERC) being planned for the Laboratory. The NSERC will offer research capabilities and field testing of solar technologies under actual northeast climatic and weather conditions. Research will include work done at the LISF, as well as a dedicated research array for testing solar panel modules, inverters, and other equipment being developed for the solar energy industry. Additional information on the LISF can be found in Chapters 2 and 6 of this report.

1.4 FACILITIES AND OPERATIONS

Most of the Laboratory's principal facilities are located near the center of the site. The developed area is approximately 1,820 acres:

- 500 acres originally developed by the Army (as part of Camp Upton) and still used for offices and other operational buildings
- 200 acres occupied by large, specialized research facilities
- 520 acres used for outlying facilities, such as the Sewage Treatment Plant, ecology field, housing facilities, and fire breaks
- 400 acres of roads, parking lots, and connecting areas
- 200 acres occupied by the Long Island Solar Farm

The balance of the site, approximately 3,400 acres, is mostly wooded and represents the native pine barrens ecosystem.

The location of the major scientific facilities at BNL are shown in Figure 1-1. Additional facilities, shown in Figure 1-2 and briefly described below, support BNL's science and technology mission by providing basic utility and environmental services.

- *Central Chilled Water Plant.* This plant provides chilled water sitewide for air conditioning and process refrigeration via underground piping. The plant has a large refrigeration capacity and reduces the need for local refrigeration plants and air conditioning.
- *Central Steam Facility (CSF).* This facility provides high-pressure steam for facility and process heating sitewide. Either natural gas or fuel oil can be used to produce the steam, which is conveyed to other facilities through underground piping. Condensate is collected and returned to the CSF for reuse, to conserve water and energy.
- *Fire Station.* The Fire Station houses six response vehicles. The BNL Fire Rescue Group provides on-site fire suppression, emergency medical services, hazardous material response, salvage, and property protection.
- *Major Petroleum Facility (MPF).* This facility provides reserve fuel for the CSF during times of peak operation. With a total capacity of 2.3 million gallons, the MPF primarily stores No. 6 fuel oil. The 1997 conversion of CSF boilers to burn natural gas as well as oil has significantly reduced the Laboratory's reliance on oil as a sole fuel source when other fuels are more economical.
- *Sewage Treatment Plant (STP).* This plant treats sanitary and certain process wastewater from BNL facilities prior to discharge into the Peconic River, similar to the operations of a municipal sewage treatment plant. The plant has a design capacity of 3 million gallons per day. Effluent is monitored and controlled under a permit issued by the New York State Department of Environmental Conservation (NYSDEC).
- *Waste Management Facility (WMF).* This facility is a state-of-the-art complex for managing the wastes generated from BNL's research and operations activities. The facility was built with advanced environmental protection systems and features, and began operation in December 1997.
- *Water Treatment Plant (WTP).* The potable water treatment plant has a capacity of 5 million gallons per day. Potable water is obtained from five on-site wells. Three wells located along the western boundary of the site are treated at the WTP with a lime-softening process to remove naturally occurring iron and with the addition of sodium hypochlorite for bacterial control. The plant is also equipped with dual air-stripping towers to ensure that volatile organic compounds (VOCs) are at or below New York State drinking water standards. Two wells located along the eastern section of the developed site are treated by the addition of sodium hydroxide to increase the pH of the water to make it less corrosive, and by the addition of sodium hypochlorite to control bacteria. BNL's potable water met all drinking water standards in 2012.

Past operations and research at the BNL site

Figure 1-1. Major Scientific Facilities at BNL.

1. Relativistic Heavy Ion Collider (RHIC)
2. NASA Space Radiation Laboratory (NSRL)
3. Alternating Gradient Synchrotron (AGS)
4. AGS Booster
5. Brookhaven Linac Isotope Producer (BLIP) and Linear Accelerator (Linac)
6. Heavy Ion Transfer Line (HITL)
7. Radiation Therapy Facility (RTF)
8. Scanning Transmission Electron Micro-scope (STEM)
9. Interdisciplinary Science Building (ISB)
10. Center for Functional Nanomaterials (CFN)
11. National Synchrotron Light Source II (NSLS-II)
12. National Synchrotron Light Source (NSLS)
13. Tandem Van de Graff and Cyclotron

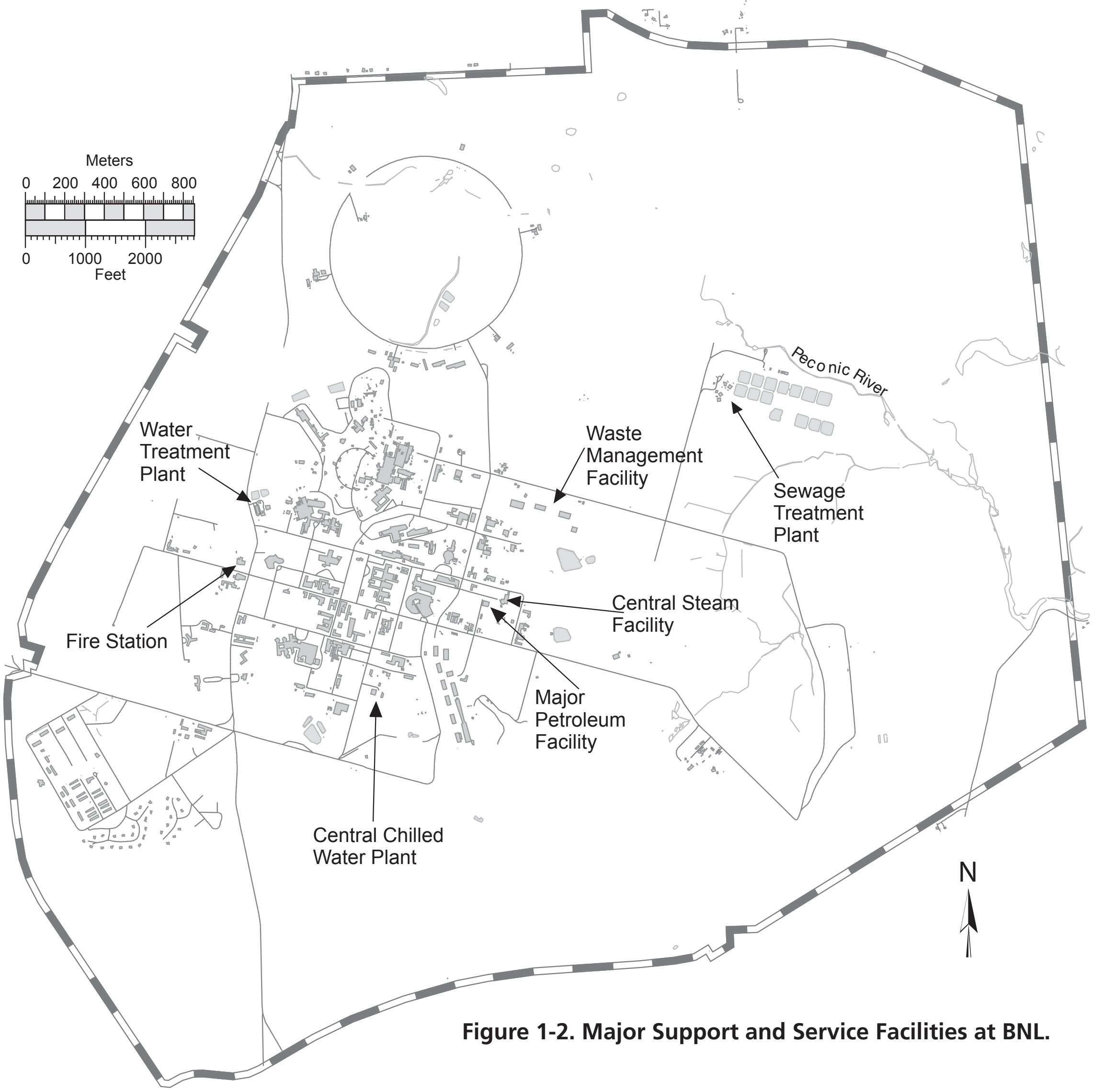


Figure 1-2. Major Support and Service Facilities at BNL.

dating back to the early 1940s when it was Camp Upton have resulted in localized environmental contamination. As a result, the Laboratory was added to the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List of contaminated sites in 1989. One of 40 sites on Long Island identified for priority cleanup, BNL has made significant progress toward improving environmental operations and remediating past contamination. DOE will continue to fund cleanup projects until the Laboratory is restored and removed from the National Priorities List. Major accomplishments in cleanup activities at BNL are discussed further throughout this report.

1.5 LOCATION, LOCAL POPULATION, AND LOCAL ECONOMY

BNL is located near the geographical center of Suffolk County, Long Island, New York. The Laboratory's 5,265-acre site is located in Brookhaven Township, approximately 60 miles east of New York City. Nearly one-third of the 1.49 million people who reside in Suffolk County live in Brookhaven Township, the largest township (both in area and population) in Suffolk County.

BNL is one of the five largest high-technology employers on Long Island, with approximately

3,400 employees that include scientists, engineers, technicians, and administrative personnel. More than 75 percent of BNL employees live and shop in Suffolk County. In addition, the Laboratory annually hosts an estimated 4,000 visiting scientists, more than 30 percent of whom are from New York State universities and businesses. The visiting scientists and sometimes their families, as well as visiting students, reside in apartments and dormitories on site or in nearby communities.

BNL strengthens Long Island's position as a center of innovation in energy, the life sciences, and other fields crucial to the growth of New York State's economy. With an annual budget of over $696 million, the Laboratory has a significant economic impact on New York State. In fiscal year 2012, employee salaries, wages and fringe benefits accounted for over $401 million of its total annual budget. Supporting local and state businesses whenever possible, BNL spent $346 million on goods and services in fiscal year 2012. It is estimated that between 2012 and 2014, the Laboratory will generate, on an average annual basis, $947 million in economic output and 7,092 jobs throughout New York State.

1.6 GEOLOGY AND HYDROLOGY

BNL is situated on the western rim of the shallow Peconic River watershed. The marshy areas in the northern and eastern sections of the site are part of the headwaters of the Peconic River. Depending on the height of the water table relative to the base of the riverbed, the Peconic River both recharges to, and receives water from, the underlying upper glacial aquifer. In times of sustained drought, the river water recharges to the groundwater; with normal to above-normal precipitation, the river receives water from the aquifer.

In general, the terrain of the BNL site is gently rolling, with elevations varying between 44 and 120 feet above mean sea level. Depth to groundwater from the land surface ranges from 5 feet near the Peconic River to about 80 feet in the higher elevations of the central and western portions of the site. Studies of Long Island hydrology and geology in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, composed of highly permeable glacial sands and gravel, are between 120 and 250 feet thick (Warren et al. 1968, Scorca et al. 1999). Water penetrates these deposits readily, and there is little direct runoff into surface streams unless precipitation is intense. The sandy deposits store large quantities of water in the Upper Glacial aquifer. On average, about half of the annual precipitation is lost to the atmosphere through evapotranspiration, and the other half percolates through the soil to recharge the groundwater (Koppelman 1978).

The Long Island Regional Planning Board and Suffolk County have identified the Laboratory site as overlying a deep-flow recharge zone for Long Island groundwater (Koppelman 1978). Precipitation and surface water that recharge within this zone have the potential to replenish the Magothy and Lloyd aquifer systems lying below the Upper Glacial aquifer. It has been estimated that up to two-fifths of the recharge from rainfall moves into the deeper aquifers. The extent to which groundwater on site contributes to deep-flow recharge has been confirmed through the use of an extensive network of shallow and deep wells installed at BNL and surrounding areas (Geraghty & Miller 1996). This groundwater system is the primary source of drinking water for both on- and off-site private and public supply wells and has been designated a sole source aquifer system by the Environmental Protection Agency.

During 2012, the Laboratory used approximately 1.34 million gallons of groundwater per day to meet potable water needs and heating and cooling requirements. Approximately 75 percent of the water pumped from BNL supply wells is returned to the aquifer through on-site recharge basins and permitted discharges to the Peconic River. Under normal hydrologic conditions, most of the water discharged to the river recharges to the Upper Glacial aquifer before leaving the site. Human consumption, evaporation (cooling tower and wind losses), and sewer line losses account for the remaining 25 percent. An additional 4.2 million gallons of groundwater were pumped each day from remediation wells. This water is treated to remove contaminants and is then returned to the aquifer by way of recharge basins or injection wells.

Groundwater flow directions across the BNL site are influenced by natural drainage systems: eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River (Figure 1-3). Pumping from on-site supply wells affects the direction and speed of groundwater flow, especially in the central, developed areas of the site. The main groundwater divide on Long Island is aligned generally east–west and lies approximately one-half mile north of the Laboratory. Groundwater north of the divide flows northward and ultimately discharges to the Long Island Sound. Groundwater south of the divide flows east and south, discharging to the Peconic River, Peconic Bay, south shore streams, Great South Bay, and Atlantic Ocean. The regional groundwater flow system is discussed in greater detail in Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity (Scorca et al. 1999). In most areas at BNL, the horizontal velocity of groundwater is approximately 0.75 to 1.2 feet per day (Geraghty & Miller 1996). In general, this means that groundwater travels for approximately 20 to 22 years as it moves from the central, developed area of the site to the Laboratory's southern boundary.

1.7 CLIMATE

The Meteorological Group at BNL has been recording weather data on site since 1949. The

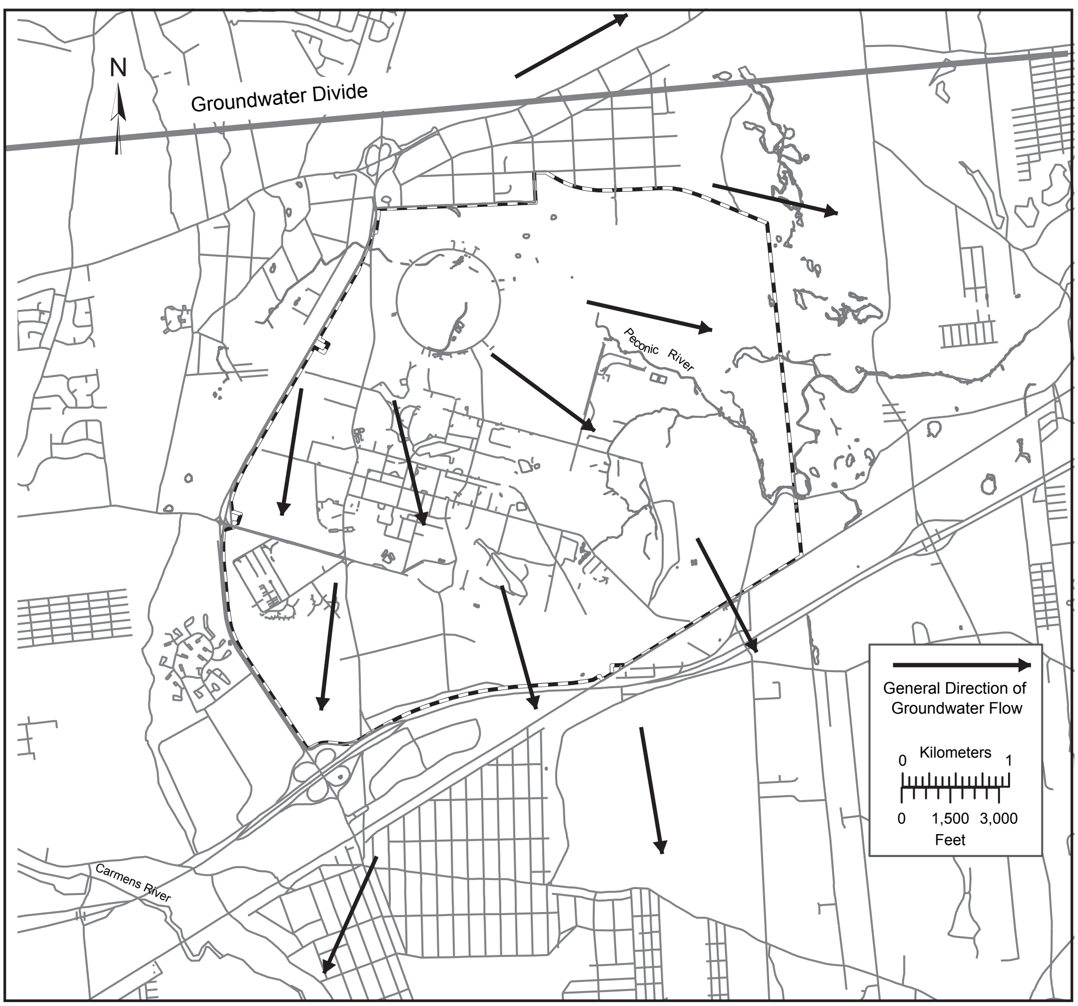


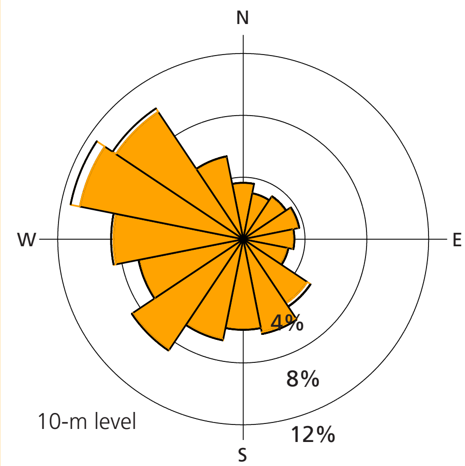
Figure 1-3. BNL Groundwater Flow Map.

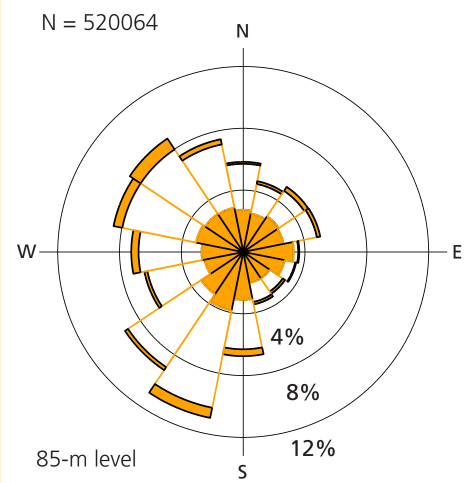
Laboratory is broadly influenced by continental and maritime weather systems. Locally, the Long Island Sound, Atlantic Ocean, and associated bays influence wind directions and humidity and provide a moderating influence on extreme summer and winter temperatures. The prevailing ground-level winds at BNL are from the southwest during the summer, from the northwest during the winter, and about equally from those two directions during the spring and fall (Nagle 1975, 1978). Figure 1-4 shows the 2012 annual wind rose for BNL, which depicts the annual frequency distribution of wind speed and direction, measured at an on-site meteorological tower at heights of 33 feet (10 meters) and 300 feet (85 meters) above land surface.

The average monthly temperature in the area for 2012 was 54 degrees Fahrenheit (°F). The average yearly temperature for the area was 50°F. Figures 1-5 and 1-6 show the 2012 monthly mean temperatures and the historical annual mean temperatures, respectively. The total annual precipitation in 2012 was 50 inches. Figures 1-7 and 1-8 show the 2012 monthly and the 63-year annual precipitation data. The average snowfall for the 2011–2012 winter season was 51.8 inches, well above the 5.5 inches recorded for 2011 and the 31 inches average yearly snowfall for Long Island.

1.8 NATURAL RESOURCES

The Laboratory is located in the oak/chestnut forest region of the Coastal Plain and constitutes about 5 percent of the 100,000-acre New York State–designated region on Long Island known as the Central Pine Barrens. The section of the Peconic River running through BNL is designated as "scenic" under the New York State Wild, Scenic, and Recreational River System Act of 1972. Due to the general topography and porous soil, the land is very well drained and there is little surface runoff or open standing water. However, depressions form numerous small, pocket wetlands with standing water on a seasonal basis (vernal pools), and there are six regulated wetlands on site. Thus, a mosaic of wet and dry areas correlates with variations in topography and depth to the water table.





Explanation: Wind direction was measured at heights of 10 and 85 meters above the ground, for a total of 520,064 measurements at each height. The readings were plotted on the charts to indicate how often wind came from each direction. The concentric circles represent multi-percentage increases in the frequency. So, for example, at 10 meters above the ground, wind was from due south 5 percent of the time. The predominant wind direction in 2011 was from the northwest at both the 10-m level and the 85-m level.

Figure 1-4. BNL Wind Rose (2012).

Vegetation on site is in various stages of succession, which reflects a history of disturbances to the area. For example, when Camp Upton was constructed in 1917, the site was entirely cleared of its native pines and oaks. Although portions of the site were replanted in the 1930s, portions were cleared again in 1940 when Camp Upton was reactivated by the U.S. Army. Other past disturbances include fire, local flooding, and draining. Current operations minimize disturbances to the more natural areas of the site.

More than 200 plant species have been identified at the Laboratory, including two species that are threatened in New York State and two that are classified as rare. Fifteen animal species identified on site include a number that are protected in New York State, as well as species common to mixed hardwood forests and open grassland habitats. Approximately 85 species of birds have been observed nesting on site, and more than 200 transitory bird species have been documented visiting the site. (BNL is located within the Atlantic Flyway, with scrub/shrub habitats that offer food and rest to migratory song-birds.) Permanently flooded retention basins and other watercourses support amphibians and aquatic reptiles. Thirteen amphibian and 12 reptile species have been identified at BNL. Recent ecological studies have confirmed 26 breeding sites for the New York State endangered eastern tiger salamander in ponds and recharge basins. Ten species of fish have been identified as endemic to the site, including the banded sunfish and the swamp darter, both of which are threatened in New York State. Two types of butterflies that are protected in New York State are believed to breed on site due to the presence of their preferred habitat and host plants, and a New York State threatened damselfly was found on site in 2005. To eliminate or minimize any negative effects that Laboratory operations might cause to these species, precautions are in place to protect the on-site habitats and natural resources.

In November 2000, DOE established the Upton Ecological and Research Reserve at BNL. The 530-acre Upton Reserve (10 percent of the Laboratory's property) is on the eastern portion of the site, in the Core Preservation Area of the

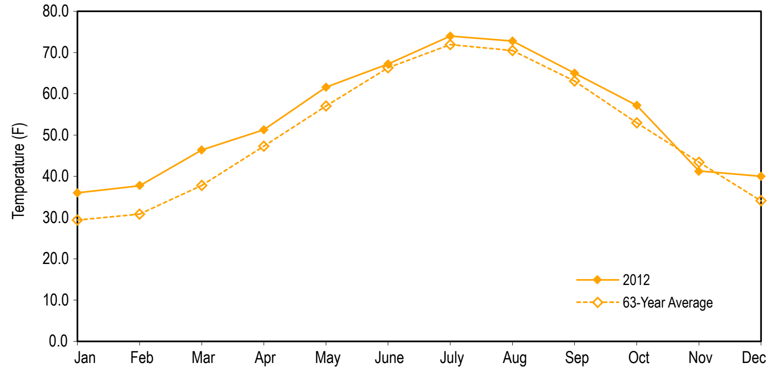


Figure 1-5. BNL 2012 Monthly Mean Temperature versus 63-Year Monthly Average.

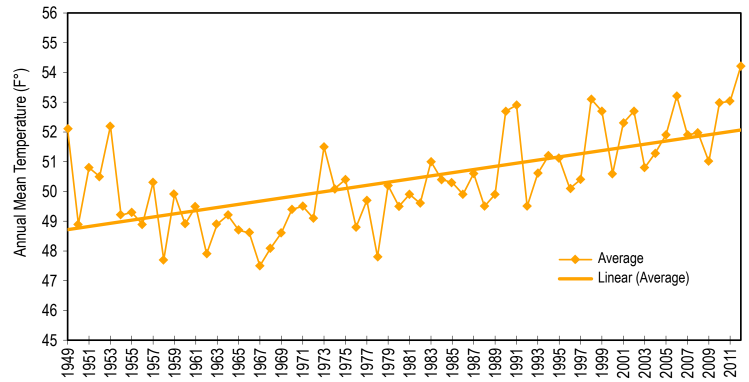


Figure 1-6. BNL 2012 Annual Mean Temperature Trend (63 Years).

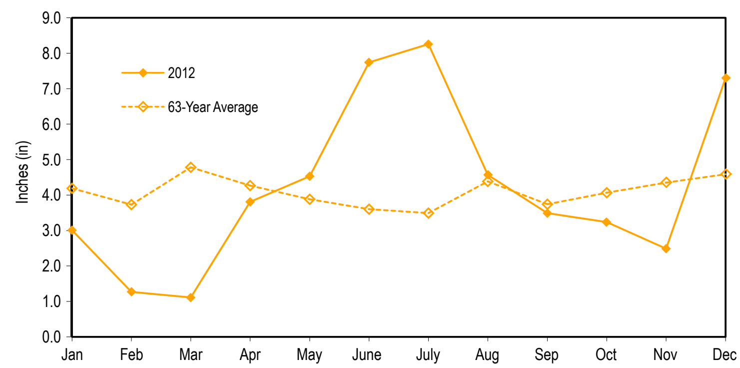


Figure 1-7. BNL 2012 Monthly Precipitation versus 63-Year Monthly Average.

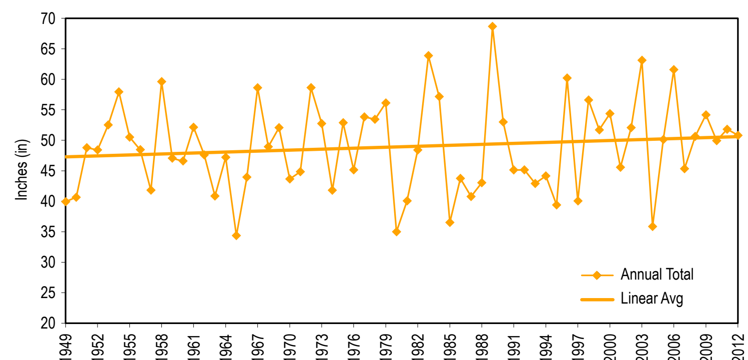


Figure 1-8. BNL 2012 Annual Precipitation Trend (63 Years).

Central Pine Barrens. The Upton Reserve creates a unique ecosystem of forests and wetlands that provides habitats for plants, mammals, birds, reptiles, and amphibians. From 2000 to 2004, funding provided by DOE under an Inter-Agency Agreement between DOE and the U.S. Fish & Wildlife Services was used to conduct resource management programs for the conservation, enhancement, and restoration of wildlife and habitat in the reserve. In 2005, management was transitioned to the Foundation for Ecological Research in the Northeast (FERN). Management of the Upton Reserve falls within the scope of BNL's Natural Resource Management Plan, and the area will continue to be managed for its key ecological values and as an area for ecological research. Additional information regarding the Upton Reserve and the Laboratory's natural resources can be found in Chapter 6 of this report.

1.9 CULTURAL RESOURCES

The Laboratory is responsible for ensuring compliance with historic preservation requirements. BNL's Cultural Resource Management Plan was developed to identify, assess, and document the Laboratory's historic and cultural resources. These resources include World War I trenches; Civilian Conservation Corps features; World War II buildings; and historic structures, programs, and discoveries associated with high-energy physics, research reactors, and other science conducted at BNL. The Laboratory currently has three facilities classified as eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor complex, the High Flux Beam Reactor complex, and the World War I training trenches associated with Camp Upton. Further information can be found in Chapter 6.

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Environmental Management System 2

One of Brookhaven National Laboratory's highest priorities is ensuring that its environmental commitment is as strong as its passion for discovery. Brookhaven Science Associates (BSA), the contractor operating the Laboratory on behalf of DOE, takes environmental stewardship very seriously. As part of its commitment to environmentally responsible operations, BSA has established the BNL Environmental Management System (EMS).

An EMS ensures that environmental issues are systematically identified, controlled, and monitored. Moreover, an EMS provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement. The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard, with additional emphasis on compliance, pollution prevention, and community involvement. Annual audits are required to maintain an EMS registration, and recertification audits of the entire EMS occur every 3 years. In 2012, an EMS surveillance audit determined that BNL remains in conformance with the ISO 14001: 2004 Standard.

BNL continued its strong support of its Pollution Prevention Program, which seeks ways to eliminate waste and toxic materials. In 2012, pollution prevention projects resulted in more than $3.0 million in cost avoidance or savings and resulted in the reduction or reuse of approximately 13.1 million pounds of waste. Also in 2012, the BNL Pollution Prevention Council funded three new proposals or special projects, investing approximately $13,500. Anticipated annual savings from these projects are estimated at approximately $179,000, for an average payback period of approximately 1 month. The ISO 14001-registered EMS and the nationally recognized Pollution Prevention Program continue to contribute to the Laboratory's success in promoting pollution prevention.

BNL continues to address legacy issues under the Groundwater Protection group and openly communicates with neighbors, regulators, employees, and other interested parties on environmental issues and cleanup progress on site.

2.1 INTEGRATED SAFETY MANAGEMENT, ISO 14001, AND OHSAS 18001

The Laboratory's Integrated Safety Management System (ISMS) integrates environment, safety, and health management into all work planning and execution. The purpose of BNL's ISMS is to ensure that the way we do work integrates DOE's five Core Functions and seven Guiding Principles into all work processes. The five Core Functions, as defined by DOE P 450.4, Safety Management System Policy, are:

- DEFINE THE SCOPE OF WORK: Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

- IDENTIFY AND ANALYZE HAZARDS ASSOCIATED WITH THE WORK: Hazards associated with the work are identified, analyzed, and categorized.
- DEVELOP AND IMPLEMENT HAZARD CONTROLS: Applicable standards and requirements are identified and agreed upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.
- PERFORM WORK WITHIN CONTROLS: Readiness is confirmed and work is performed safely.
- PROVIDE FEEDBACK ON ADEQUACY OF CONTROLS AND CONTINUE TO IMPROVE SAFETY MANAGEMENT: Feedback information on the adequacy of controls is gathered; opportunities for improving the definition and planning of work are identified and implemented; line and independent oversight is conducted; and, if necessary, regulatory enforcement actions occur.

The seven Guiding Principles, as defined by DOE Manual 450.4-1, Integrated Safety Management System Manual, are:

- LINE MANAGER CLEARLY RESPONSIBLE FOR ENVIRONMENT, SAFETY & HEALTH (ES&H): Line management is directly responsible for the protection of the public, the workers, and the environment.
- CLEAR ES&H ROLES AND RESPONSIBILITIES: Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels within the Department and its contractors.
- COMPETENCE COMMENSURATE WITH RESPONSIBILITIES: Personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.
- BALANCED PRIORITIES: Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment shall be a priority whenever activities are planned and performed.
- IDENTIFY ES&H STANDARDS AND REQUIREMENTS: Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established which, if properly implemented, will provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences.
- HAZARD CONTROLS TAILORED TO WORK: Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.
- OPERATIONS AUTHORIZATION: The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed upon.

The integrated safety processes within ISMS contributed to BNL achieving ISO 14001 and Occupational Health and Safety Assessment Series (OHSAS) 18001 registrations.

The ISO 14001 Standard is globally recognized and defines the structure of an organization's EMS for purposes of improving environmental performance. OHSAS 18001 mirrors the ISO 14001 structure for purposes of improving safety and providing a safe and healthy workplace free from recognized hazards for all operations. The process-based structure of the ISO 14001 and OHSAS 18001 Standards are based on the "Plan-Do-Check-Act" improvement cycle. Both standards require an organization to develop a policy, create plans to implement the policy, implement the plans, check progress and take corrective actions, and review the system periodically to ensure its continuing suitability, adequacy, and effectiveness.

The Laboratory's EMS was officially registered to the ISO 14001 Standard in July 2001 and was the first DOE Office of Science Laboratory to obtain third-party registration to this environmental standard. BNL was officially registered to the OHSAS 18001 Standard in 2006, and was again the first DOE Office of Science Laboratory to achieve this registration. Each certification requires the Laboratory to undergo annual audits by an accredited registrar to assure that the systems are maintained.

An ISO 14001 and OHSAS 18001 surveillance audit was conducted by three NSF auditors in June 2012 (OHSAS 18001 results are not included in this report). The Laboratory was recommended for continued certification to the ISO-14001 standard with one Minor Nonconformance regarding the need for better document control to prevent unintended use of obsolete documents. This Minor Nonconformance is being addressed and will be tracked to closure.

2.2 ENVIRONMENTAL, SAFETY, SECURITY, AND HEALTH POLICY

The cornerstone of an EMS is a commitment to environmental protection at the highest levels of an organization. BNL's environmental commitments are incorporated into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy. The policy, issued and signed by the Laboratory Director, makes clear the Laboratory's commitment to environmental stewardship, the safety of the public and BNL employees, and the security of the site. The policy continues as a statement of the Laboratory's intentions and principles regarding overall environmental performance. It provides a framework for planning and action and is included in employee, guest, and contractor training programs. The ESSH Policy is posted throughout the Laboratory and on the BNL website at *http://www.bnl.gov.* The goals and commitments focusing on compliance, pollution prevention, community outreach, and continual improvement include:

- ENVIRONMENT: We protect the environment, conserve resources, and prevent pollution.
- SAFETY: We maintain a safe workplace, and we plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers, and guests.
- SECURITY: We protect people, property, information, computing systems, and facilities.
- HEALTH: We protect human health within our boundaries and in the surrounding community.
- COMPLIANCE: We achieve and maintain compliance with applicable ESSH requirements.
- COMMUNITY: We maintain open, proactive, and constructive relationships with our employees, neighbors, regulators, DOE, and our other stakeholders.
- CONTINUAL IMPROVEMENT: We continually improve ESSH performance.

2.3 PLANNING

The planning requirements of the ISO 14001 Standard require BNL to identify the environmental aspects and impacts of its activities, products, and services; to evaluate applicable legal and other requirements; to establish objectives and targets; and to create action plans to achieve the objectives and targets.

2.3.1 Environmental Aspects

An "environmental aspect" is any element of an organization's activities, products, and services that can impact the environment. As required by the ISO 14001 Standard, BNL evaluates its operations, identifies the aspects that can impact the environment, and determines which of those impacts are significant. The Laboratory's criteria for significance are based on actual and perceived impacts of its operations and on regulatory requirements.

BNL utilizes several processes to identify and review environmental aspects. Key among these is the Process Assessment Procedure. This is an evaluation that is documented on a Process Assessment Form, which consists of a written process description, a detailed process flow diagram, a regulatory determination of all process inputs and outputs, identification of pollution prevention opportunities, and identification of any assessment, prevention, and control measures that should be considered.

Environmental professionals work closely with Laboratory personnel to ensure that environmental requirements are integrated into each process. Aspects and impacts are evaluated annually to ensure that they continue to reflect stakeholder concerns and changes in regulatory requirements.

2.3.2 Legal and Other Requirements

To implement the compliance commitments of the ESSH Policy and to meet its legal requirements, BNL has systems in place to review changes in federal, state, or local environmental regulations and to communicate those changes to affected staff. Laboratory-wide procedures for documenting these reviews and recording the actions required to ensure compliance are available to all staff through BNL's web-based Standards-Based Management System (SBMS) subject areas.

Signed in 2009, Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance, establishes sustainability goals for federal agencies and focuses on improving their environmental, energy, and economic performance. In addition to guidance, recommendations, and plans, which are due by specific sustainability due dates, EO 13514 has set numerical targets for agencies.

Each governmental facility is required to have a Site Sustainability Plan (SSP) in place detailing the strategy for achieving these long-term goals, and to provide an annual status. The requirements will influence the future of BNL's EMS program and most have already been incorporated into BNL's SSP. Table 2-1 identifies the EO goal, the actions contained in the SSP, and BNL's performance in 2012.

2.3.3 Objectives and Targets

The establishment of environmental objectives and targets is accomplished through a Performance-Based Management System. This system is designed to develop, align, balance, and implement the Laboratory's strategic objectives, including environmental objectives. The system drives BNL's improvement agenda by establishing a prioritized set of key objectives, called the Performance Evaluation Management Plan. BSA works closely with DOE to clearly define expectations and performance measures. Factors for selecting environmental priorities include:

- Meeting the intent and goals of EO 13514
- Significant environmental aspects
- Risk and vulnerability (primarily, threat to the environment)
- Legal requirements (laws, regulations, permits, enforcement actions, and memorandums of agreement)
- Commitments (in the ESSH Policy) to regulatory agencies, and to the public
- Importance to DOE, the public, employees, and other stakeholders

Laboratory-level objectives and targets are developed on a fiscal year (FY) schedule. In FY 2012 (October 1, 2011 through September 30, 2012), BNL's environmental objectives included:

- Commitment to satisfy all Comprehensive Environmental Compensation and Liability Act (CERCLA) Record of Decision (ROD) requirements for groundwater, soil, and sediment remediation, and the decontamination and decommissioning (D&D) and long term surveillance and maintenance of the BNL reactor facilities.
- Continued improvement of environmental operational performance by supporting

Table 2-1. EO 13514 Goals: Status Summary for Fiscal Year (FY) 2012.

DOE Goal	BNL Performance Status	BNL Planned Actions and Contributions
Goal 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory		
Reduce building energy intensity (British Thermal Units per Gross Square Foot [BTU/GSF]) by 30% by FY 2015 from a FY 2003 baseline	▪ FY 2003: 323,780 ▪ FY 2012: 297,605 Percent Change: -8.1%	▪ Energy Conservation Measures include use of HVAC setback, efficient chillers, steam charge-back to users, and lighting upgrades.
Achieve 5% annual electricity consumption from renewable sources in FY 2010-2012 and 7.5% by FY 2013 onward	▪ Long Island Solar Farm (LISF) began operation on 11/01/11; 50,646,000 kWh/yr power generated on site in FY 2012.	▪ BNL Research & Development Solar Array at 800+ kW. ▪ Initiate investment-grade feasibility study for a combined heat and power facility. ▪ Completion of an ongoing wind energy and biomass feasibility study. ▪ Continue bio-based fuel for satellite boilers.

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Table 2-1. EO 13514 Goals: Status Summary for Fiscal Year (FY) 2012 *(continued).*

DOE Goal	BNL Performance Status	BNL Planned Actions and Contributions
Goal 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory *(continued)*		
Sulfur hexafluoride (SF_6) reduction	▪ FY 2008: 965 ▪ FY 2012: 1,049 Percent Change: +8.7%	▪ First draft High Energy Equipment Management Plan prepared; the plan is a proactive approach for detecting, preventing, and repairing leaks of SF6 dielectric. ▪ Final plan targeted for completion second quarter of FY 2013.
Achieve individual building or process metering for 90% of electricity consumed by 10/01/12 and for 90% of steam, natural gas, and chilled water consumed by 10/01/15	▪ BNL is exceeding targets for metering.	▪ Advanced steam and water metering to be installed, where appropriate.
Install cool roofs when economical for roof replacement (unless project has a previous CD-2 approval; new roofs must have thermal resistance of at least R-30	▪ Continue to factor DOE cool roof requirements into all roofing projects. ▪ While conformance with ASRAE reflectivity standards is attainable, meeting R-30 insulation value is often not economically viable. ▪ In FY 2012, only partial re-roofing of 3,100 square feet of Building 725 economically viable. ▪ FIMS updated to reflect effort. ▪ New construction of Interdisciplinary Science Building (ISB) will meet cool roof criteria.	▪ Roofing project managers reminded of requirement to evaluate economic viability for all roofing projects. ▪ BNL expects to add the cool roof areas of ISB to Facility Information Management System (FIMS) in FY 2013. ▪ A 9,000 square foot long-beam line addition to Building 740 is being constructed with cool roof.
Training	▪ Costs for training on Energy Policy Act 1992 in FY 2012 were $27,800.	▪ International certifications obtained by many professionals within the Facilities & Operations organization ▪ Awaiting further guidelines from DOE on training requirements.
Achieve net zero energy in new or major renovation facilities	▪ No FY 2012 projects met criteria.	▪ Review of FY 2013 planned projects did not find any projects meeting criteria to require consideration.
Evaluate 25% of 75% of facility energy use over 4-year cycle	▪ 100% of applicable buildings evaluated within the last 4 years.	▪ Facility Condition Assessments and Energy Audits are combined, reducing costs and ensuring 4-year cycle is met.
Reduce Scope 3 Greenhouse Gas (GHG) reduction by 13% by FY 2020 from a FY 2008 baseline; reduce employee travel GHG by 12% by FY 2020 from a FY 2008 baseline	▪ FY 2008: 20,003 ▪ FY 2012: 21,996 ▪ Percent Change: +10 ▪ As electric loads increase from 2013-2016, GHG from transmission and distribution will rise proportionately. ▪ Increases in employee population have contributed to rise in commuting GHG.	▪ Policy Council supported the establishment of flex work week for non-bargaining non-exempt employees and compressed work week schedules for non-bargaining employees. ▪ Procedures to implement policy will be developed in second quarter, FY 2013. ▪ New pilot carpool coop established in Wading River community in November 2012; pilot will be expanded to several additional areas.
Reduce Scopes 1 and 2 GHG by 28% by FY 2010 from a FY 2008 baseline	▪ FY 2008: 205,3542 ▪ FY 2012: 138,020 Percent Change: -32.8 ▪ FY 2012 adjusted for Long Island Solar Farm: 92,100 Percent Change: 44.8	▪ Hydro power, Long Island Solar Farm Research and Development PV Array, combined heat and power, and Renewable Energy Credits to meet renewable energy requirement.
Goal 2: High Performance and Sustainable Buildings (HPSB), Energy Saving Performance Contracts (ESPC) Initiative, Regional and Local Planning		
Ensure 15% of existing buildings more than 5,000 gross square feet (GSF) are compliant with the Guiding Principals (GPs) of HPSB by FY 2015	▪ Energy conservation measure project design completed. ▪ Funding enabled early construction starts on several projects.	▪ Completion of several projects, including RTU for Bldg. 438, night setback controls in Bldg. 438, occupancy sensors in all HPSB buildings, and HPSB improvements in Bldg. 817.
Ensure all new construction, major renovations, and alterations of buildings greater than 5,000 GSF comply with GPs	▪ No FY 2012 projects met criteria.	▪ A review of FY 2013 planned projects found no projects meeting criteria. ▪ BNL will seek CD-0 for the ISB II project in FY 2013. ▪ ISB II will be designated to obtain a Leadership in Energy and Environmental Design (LEED) Gold rating.

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Table 2-1. EO 13514 Goals: Status Summary for Fiscal Year (FY) 2012 *(continued).*

DOE Goal	BNL Performance Status	BNL Planned Actions and Contributions
Goal 2: High Performance and Sustainable Buildings (HPSB), Energy Saving Performance Contracts (ESPC) Initiative, Regional and Local Planning *(continued)*		
ESPC initiative, IE, and third party financing	▪ Utility Energy Services Contracts (UESC) Phase I Scope and contract documents completed. ▪ Ready for requests for proposals.	▪ UESC Phase I to be awarded in FY 2013. ▪ UESC Phase II expected in FY 2014.
Regional and local planning	▪ BNL continues to investigate public transportation and increased car-pool ridership. ▪ Local renewable energy is supported through the LISF and the National Energy Research Scientific Computing Center (NERSC). ▪ Natural Resource activities include measuring impact of large-scale solar installations. ▪ Stakeholder involvement includes hosting numerous conferences and routine communications with regulatory and community groups.	▪ Continue to measure ecological impacts of solar installations. ▪ Continue routine meetings with regulatory and local environmental groups.
Goal 3: Fleet Management		
Achieve a 10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline beginning in FY 2015	▪ Alternative fueling infrastructure exists for compressed natural gas, 85% ethanol fuel (E85), diesel, and biodiesel.	▪ Continue to purchase alternative fuel vehicles (AFVs) and remove petroleum vehicles as much as possible.
Achieve a 2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline	▪ BNL is reducing petroleum consumption by replacing gasoline and diesel vehicles with AFVs, as budgets permit.	▪ Continue to purchase AFVs and remove petroleum vehicles as much as possible.
Ensure that 75% of light duty vehicle purchases consist of AFVs by FY 2000 and thereafter	▪ In FY 2012, 100% of light duty vehicles purchased were AFVs.	▪ Continue to purchase 100% light duty vehicles as AFVs.
Submit the Right-Sizing the Fleet Management Plan for approval and identify mission critical/non-mission critical vehicles by 12/31/2012	▪ Right-Sizing the Fleet Management Plan was developed.	▪ Right-Sizing the Fleet Management Plan will be submitted on schedule.
Goal 4: Water Use Efficiency and Management		
Reduce water intensity by 26% by FY 2020 from a FY 2007 baseline	▪ Water use down 10% since 2007 due to decreased process cooling usage at the Alternative Gradient Synchrotron and elsewhere on site. ▪ BNL has focused heavily on water conservation prior to FY 2007; water use down 57% since 1999. ▪ Final design and site preparation for water recharge project in FY 2013.	▪ Continue to practice cost-effective water conservation. ▪ Implement the groundwater recharge project, which will replenish over 70% of BNL's water usage directly back to the aquifer.
Reduce water consumption of industrial, landscaping, and agricultural (ILA) water by 20% by FY 2020 from a FY 2010 baseline	▪ No permanent landscaping or agricultural water use.	▪ No actions are planned.
Goal 5: Pollution Prevention and Waste Reduction		
Divert at least 50 percent of non-hazardous solid waste, excluding construction and demolition debris by FY 2015	▪ BNL's non-hazardous solid waste recycling rate was 57% in FY 2012.	▪ During FY 2012, the focus will be on recycling awareness for new employees and contractors. ▪ Re-emphasize recycling in computer-based training.
Divert at least 50 % of construction and demolition debris by FY 2015	▪ BNL's construction and demolition materials and debris recycling rate was 95%+ in FY 2012.	▪ Continue sending construction and demolition materials to the on-site Borrow Pit for consolidation and recycling.

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Table 2-1. EO 13514 Goals: Status Summary for Fiscal Year (FY) 2012 *(concluded).*

DOE Goal	BNL Performance Status	BNL Planned Actions and Contributions
Goal 6: Sustainable Acquisition		
Ensure 95% of procurements meet sustainability requirements annually and include sustainable acquisition clause	▪ All contract actions for construction and custodial products met sustainable acquisition requirements in FY 2012.	▪ Performance in sustainable acquisition will be documented in the FY 2012 PPTRS reporting system. ▪ Requirements for bio-based products will be incorporated into BNL's Terms and Conditions in FY 2013.
Goal 7: Electronic Stewardship and Data Centers		
Ensure all data centers are metered to measure a monthly Power Usage Effectiveness (PUE) (100% by FY 2015)	▪ Additional meters added in FY 2012. ▪ Identification of remaining required metering complete.	▪ Installation of remaining metering will be completed in FY 2013 and FY 2014.
Achieve maximum annual weighted average PUE of 1.4 by FY 2015	▪ Large Data Center currently at 1.52. ▪ Completion of data center study to develop plan for obtaining PUE <1.4 in FY 2012.	▪ Develop funding strategy as required based upon report issued from data center study.
Ensure 100% of eligible PCs, laptops, and monitors have power management actively implemented and in use by FY 2012	▪ LANDesk power management implemented on all suitable systems.	▪ Continue to assess if any additional systems can use the power management systems.
Goal 8: Agency Innovation & Government-Wide Support		
Agency Innovation and Government-Wide support	▪ On-site generation.	▪ Completion of the construction of the Solar Test Array.

implementation of the modifications to BNL's Sewage Treatment Plant (STP) and submitting preliminary designs to the New York State Department of Environmental Conservation (NYSDEC); implementation of the Freon remediation project; and improvement of radiological waste characterization.

- Improvement of radiological operational performance through establishment of an improved moratorium metals program to allow metals recycling, management of the electronic capture/digitization of radiological exposure records in support of the Energy Employees Occupational Illness Compensation Program Act (EEIOCPA) and incorporation of the electronic data into the Health Physics Reporting System (HPRS) database; and conducted an independent review of the Radiological Controls Division assessment process.
- Third-party verification of ESS&H program effectiveness. This included recertification of the ISO 14001 and OHSAS 18001 registrations.
- Manage and reduce the impact of legacy activities at the Laboratory. This included minimizing the inventory of radioactive sealed sources and supporting the coordination and transfer of Facilities and Materials between DOE Office of Science and DOE Environmental Management.

These objectives and targets have been implemented and efforts are continuing, where necessary.

2.3.4 Environmental Management Programs

Each organization within BNL develops an action plan detailing how they will achieve their environmental objectives and targets, as well as commit the resources necessary to successfully implement both Laboratory-wide and facility-specific programs. BNL has a budgeting system designed to ensure that priorities are balanced and to provide resources essential to the implementation and control of the EMS.

The Laboratory continues to review, develop, and fund important environmental programs to further integrate environmental stewardship into all facets of its missions.

2.3.4.1 Compliance

BNL has an extensive program to ensure that the Laboratory remains in full compliance with all applicable environmental regulatory requirements and permits. Legislated compliance is outlined by the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs), Clean Water Act (e.g., State Pollutant Discharge Elimination System [SPDES]), Safe Drinking Water Act (SDWA), Resource Conservation and Recovery Act (RCRA), and other programs. Other compliance initiatives at the Laboratory involve special projects, such as upgrading petroleum and chemical storage tank facilities, upgrading the sanitary sewer system, closing underground injection control devices, retrofitting or replacing air conditioning equipment refrigerants, and managing legacy facilities. (See Chapter 3 for a list of regulatory programs to which BNL subscribes, and a thorough discussion of these programs and their status.)

2.3.4.2 Groundwater Protection

BNL's Groundwater Protection Management Program is designed to prevent negative impacts to groundwater and to restore groundwater quality by integrating pollution prevention efforts, monitoring groundwater restoration projects, and communicating performance. The Laboratory has also developed a Groundwater Protection Contingency Plan that defines an orderly process for quickly taking corrective actions in response to unexpected monitoring results. Key elements of the groundwater program are full, timely disclosure of any off-normal occurrences, and regular communication on the performance of the program. Chapter 7 and SER Volume II, Groundwater Status Report, provide additional details about this program, its performance, and monitoring results for 2012.

2.3.4.3 Waste Management

As a byproduct of the world-class research it conducts, BNL generates a wide range of wastes. These wastes include materials common to many businesses and industries, such as office wastes (e.g., paper, plastic, etc.), aerosol cans, batteries, paints, and oils. However, the Laboratory's unique scientific activities also generate waste streams that are subject to additional regulation and special handling, including radioactive, hazardous, and mixed waste.

Facilities for collecting, storing, transporting, and managing the disposal of waste generated at the Laboratory include BNL's Waste Management Facility (WMF), managed and operated by the Environmental Protection Division (EPD). This modern facility was designed for handling hazardous, industrial, radioactive, and mixed waste and is comprised of two staging areas: a facility for hazardous waste and mixed waste (both hazardous and radioactive) in Building 855, which is regulated by RCRA, and a reclamation building for radioactive material in Building 865. The RCRA building is managed under a permit issued by NYSDEC. These buildings are used for short-term storage of waste before it is packaged or consolidated for off-site shipment to permitted treatment and disposal facilities. Due to the relatively small quantities and infrequent generation of mixed waste, BNL has reduced its waste storage footprint by consolidating hazardous and mixed wastes into its RCRA waste building.

In 2012, BNL received approval from NYSDEC to close Building 870, a former mixed waste storage facility. Subsequent to this approval, the Laboratory submitted a modification to it's RCRA permit to NYSDEC to remove all references to this building; the modification was approved in 2012.

In 2012, BNL generated the following types and quantities of waste from routine operations:

- Hazardous waste: 4.1 tons
- Mixed waste: 40 ft^3
- Radioactive waste: 4,340 ft^3

Hazardous waste from routine operations in 2012 was basically unchanged from 2011 generation rates, as shown in Figure 2-1a. Mixed waste generation increased from 2011 rates, as shown in Figure 2-1b, and can be attributed primarily to increased activities at the Collider Accelerator Department (CAD). As shown in Figure 2-1c, the radioactive waste quantity for routine operations also increased from the previous year and is also primarily attributed to increased operations at CAD. Routine operations are defined as ongoing industrial and experimental operations.

Wastes generated by remediation projects, decommissioning activities performed by the Environmental Restoration Projects (ERP) Group, or one-time events (e.g., lab clean-out) are considered non-routine. In 2012, BNL's EPD continued to reduce the inventory of legacy waste materials through laboratory cleanouts. Wastes from restoration and decommissioning activities included primary debris remaining from the BGRR decommissioning. Other non-routine wastes included disposal of lead-contaminated debris, lead shielding, and polychlorinated biphenyl (PCB) wastes.

Figures 2-1d through 2-1f show wastes generated under the ERP Group, as well as other non-routine operations. Waste generation from these activities has varied significantly from year to year. This is expected, as various remedial actions are conducted.

2.3.4.4 Pollution Prevention and Waste Minimization

The BNL Pollution Prevention (P2) Program is an essential element for the successful accomplishment of the Laboratory's broad mission. 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 BNL's operating philosophy.

Pollution prevention and waste reduction goals have been incorporated into the DOE contract with BSA, into BNL's ESSH Policy, the Performance Evaluation Management Plan associated with the Laboratory's operating contract with DOE, and BNL's SSP. Key elements of the P2 Program include:

- Eliminate or reduce emissions, effluents, and waste at the source, where possible, and ensure that they are "as low as reasonably achievable"
- Procure environmentally preferable products (known as "affirmative procurement")
- Conserve natural resources and energy
- Reuse and recycle materials
- Achieve or exceed BNL/DOE waste minimization, P2, recycling, and affirmative procurement goals
- Comply with applicable requirements (e.g., New York State Hazardous Waste Reduction Goal, Executive Orders, etc.)
- Reduce waste management costs
- Implement P2 projects
- Improve employee and community awareness of P2 goals, plans, and progress

Three Pollution Prevention proposals were funded in 2012, for a combined investment of approximately $13,500. The anticipated annual savings from these projects is estimated at $179,000, for an average payback period of approximately 1 month. The BNL P2 and recycling programs have achieved significant reductions in waste generated by routine operations, as shown in Figures 2-1a through 2-1c. This continues a positive trend and is further evidence that pollution prevention planning is well integrated into the Laboratory's work planning process. These positive trends are also driven by the EMS emphasis on preventing pollution and establishing objectives and targets to reduce environmental impacts. Table 2-2 describes the P2 projects implemented through 2012 and provides the number of pounds of materials reduced, reused, or recycled, as well as the estimated cost benefit of each project.

The implementation of pollution prevention opportunities, recycling programs, and conservation initiatives has significantly reduced both waste volumes and management costs. In 2012, these efforts resulted in more than $3.0 million in cost avoidance or savings and approximately 13.1 million pounds of materials being reduced, recycled, or reused annually.

The Laboratory also has an active and successful solid waste recycling program, which involves all employees. In 2012, BNL collected approximately 142 tons of office paper for recycling. Cardboard, bottles and cans, construction debris, motor oil, scrap metals, lead, automotive batteries, electronic scrap, fluorescent light bulbs, and drill press/machining coolant were also recycled. Table 2-3 shows the total number of tons (or units) of the materials recycled in 2012.

2.3.4.5 Water Conservation

BNL's water conservation program has achieved dramatic reductions in water use since the mid 1990s. The Laboratory continually evaluates water conservation as part of facility upgrades or new construction initiatives. These efforts include more efficient and expanded use of chilled water for cooling and heating/ventilation and air conditioning (HVAC) systems, and reuse of once-through cooling water for other systems, such as cooling towers. Through an annual program at the Laboratory, approximately $50K per year is allocated to replace existing conventional plumbing fixtures with low-flow devices.

BNL's goal is to reduce the consumption of potable water and reduce the possible impact of clean water discharges on Sewage Treatment Plant (STP) operations. Figure 2-2 shows the 14-year trend of water consumption. Total water consumption for 2012 was approximately 111 million gallons less than in 2011. This decrease can be attributed to water conservation efforts and less water used for cooling. In each of the past 5 years, the water consumption total was approximately half the 1999 total — a reduction of nearly a half-billion gallons per year.

2.3.4.6 Energy Management and Conservation

Since 1979, the Laboratory's Energy Management Group has been working to reduce energy use and costs by

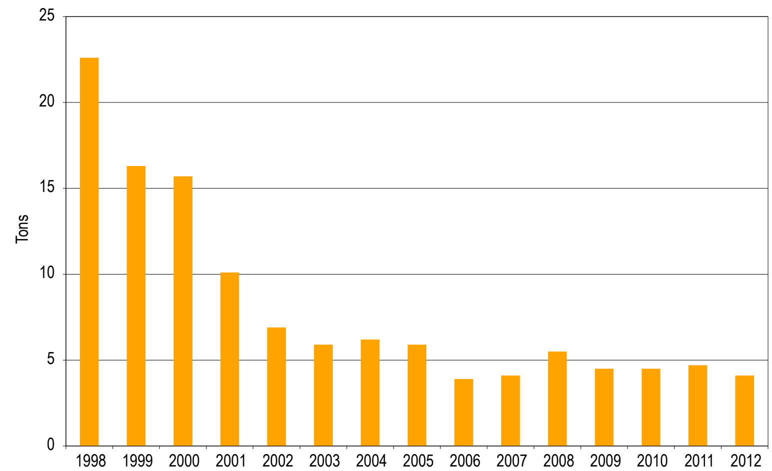

Figure 2-1a. Hazardous Waste Generation from Routine Operations, 1998 – 2012.

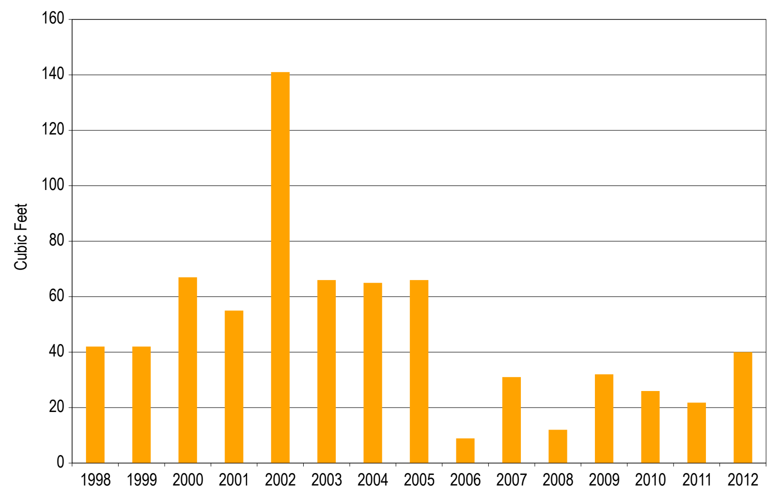

Figure 2-1b. Mixed Waste Generation from Routine Operations, 1998 – 2012.

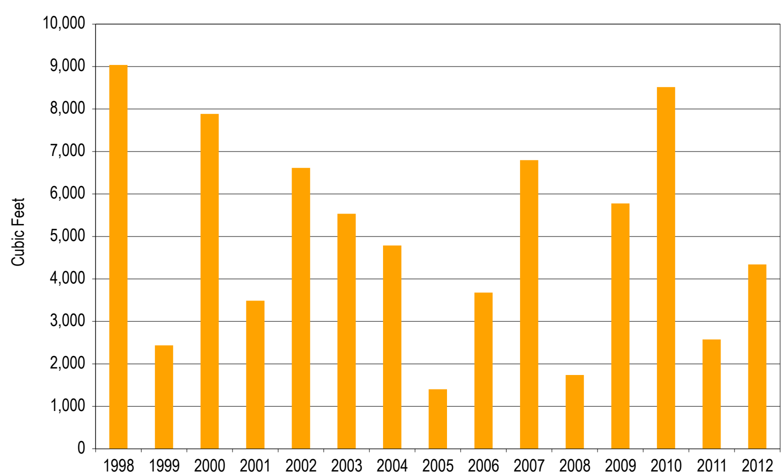

Figure 2-1c. Radioactive Waste Generation from Routine Operations, 1998 – 2012.

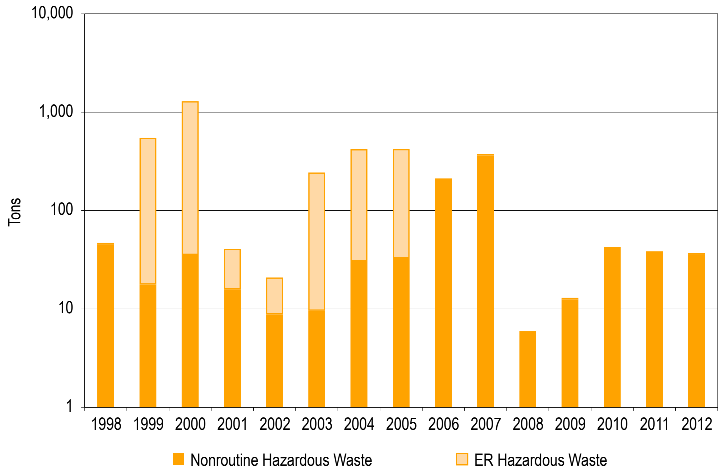

Figure 2-1d. Hazardous Waste Generation from ER and Nonroutine Operations, 1998 – 2012.

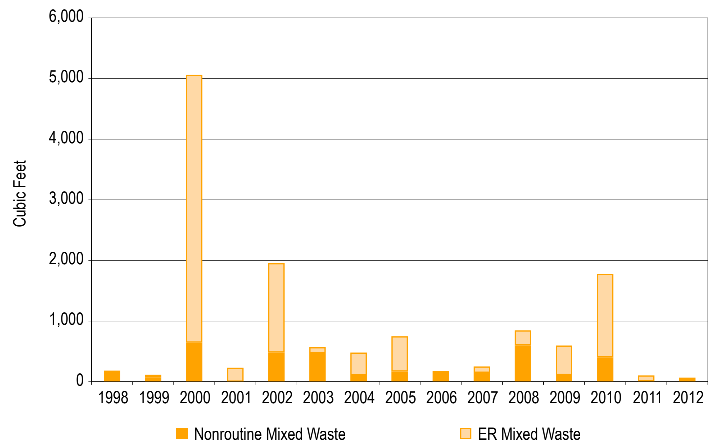

Figure 2-1e. Mixed Waste Generation from ER and Nonroutine Operations, 1998 – 2012.

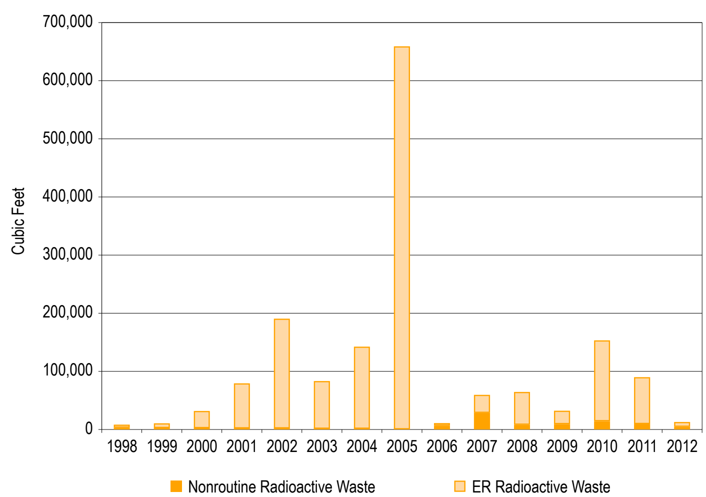

Figure 2-1f. Radioactive Waste Generation from ER and Nonroutine Operations, 1998 – 2012.

identifying and implementing cost-effective, energy-efficient projects; monitoring energy use and utility bills; and assisting in obtaining the least expensive energy sources possible. The group is responsible for developing, implementing, and coordinating BNL's Energy Management Plan and assisting DOE in meeting the energy and sustainability goals in EO 13514; DOE Order 436.1, Environmental Protection Program; and the Secretary's initiatives. The Laboratory's SSP addresses all aspects of the DOE energy, water, and sustainability goals.

The Laboratory has more than 4 million square feet of building space. Many BNL scientific experiments use particle beams generated and accelerated by electricity, with the particles controlled and aligned by large electromagnets. In 2012, the Laboratory used approximately 278 million kilowatt hours (kWh) of electricity, 108,000 gallons of fuel oil, 17,000 gallons of propane, and 581 million ft^3 of natural gas. Fuel oil and natural gas produce steam at BNL's Central Steam Facility (CSF). Responding to market conditions, fuel oil and natural gas were used whenever each respective fuel was least expensive. However, whenever possible, BNL will purchase natural gas over oil in order to help reduce greenhouse gas emissions (GHG). Additional information on natural gas and fuel oil use can be found in Chapter 4. In addition, over

Table 2-2. BNL Pollution Prevention, Waste Reduction, and Recycling Programs.

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2012	Waste Type	Potential Costs for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details
Replacement of small PCB capacitors	Substitution	N/A	PCB	$4,000	$4,000	$0	Collider Accelerator removed and replaced 50 small PCB-containing capacitors and removed an additional 25 PCB-containing capacitors from obsolete equipment.
Once thru cooling	Water Conservation	7,188,480	Water	$0	$4,000	$0	Replaced a once thru cooling system with a closed loop system supplied by BNL's Chilled Water Plant.
Replacement of X-Ray film processing with chemiluminicent Imaging	Substitution	835	Hazardous and Industrial Liquid Wastes	$27,000	$5,500	$179,000	Cost savings reflect labor savings, waste disposal savings, and items (such as film) which no longer need to be purchased.
Motion sensors in Building 725	Energy Conservation	N/A	Greenhouse Gas/Energy Conservation	N/A	$0	$6,000	Installation of motion-sensored lighting in hallways, restrooms, and conference rooms in Building 725 during 2011.
LED lighting in 490 Conference Room	Energy Conservation	N/A	Greenhouse Gas/Energy Conservation/ Manpower	$2,940	$0	$3,710	(40) 65-Watt incandecent bulbs were replaced with LED bulbs during 2011; savings of $1190/ year in energy costs and $2520/year in manpower costs.
Plastic granulator for Medical Department	Recycling	N/A	Regulated Medical Waste	$5,500	$0	$5,500	Plastic granulator shreds Laboratory plasticware (petri dishes, flacks, etc.) rendering it unrecognizable.
Motion sensors for Building 820	Energy Conservation	N/A	Greenhouse Gas/Energy Conservation	N/A	$0	$1,650	Installation of motion-sensored lighting in Physics research area of Building 820.
Sewage sludge	Publicly-Owened Treatment Works (POTW)	3,000	Low-Level Radiological Waste	$500,000	$12,000	$488,000	Rad constituents were eliminated from within the Sewage Treatment Facility and the sludge is now sent to a POTW.
Alkaline batteries	Recycling	174	Industrial Waste	$10	$0	$10	150 pounds of alkaline batteries were collected and sent for recycling.
BioDiesel tank, E-85, CNG	Alternative Fuels	0	Greenhouse Gas/Energy Conservation	$0	$0	$0	BNL is utilizing different alternative fuels to operate maintainance vehicles.
Motion sensors for on-site labs*	Energy Conservation	N/A	Greenhouse Gas/Energy Conservation	N/A	$0	$5,817	Installation of motion detector lighting in common areas of Buildings 490 and 463.
"Bio Circle Cleaner" parts washer	Substitution	640	Hazardous Waste	$10,000	$0	$10,000	Eliminates the need for toxic solvents, chemical storage, and disposal associated with the cleaning of vacuum parts.

(continued on next page)

Table 2-2. BNL Pollution Prevention, Waste Reduction, and Recycling Programs *(continued)*.

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2012	Waste Type	Potential Costs for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details
Aerosol can disposal system	Recycling	528	Hazardous Waste	$43,872	$0	$43,872	Empty aerosol cans are recycled as scrap, rather then sent to the Waste Management Division as hazardous waste. Eight units (F&O=5; CA=1; NSLS=1; BES =1) each handle 66 lbs of hazardous waste.
Electronic Reuse	Reuse	23,287	E-Waste	$58,218	$0	$58,218	BNL tracks electronic equipment and takes a reuse credit for transfer of equipment to another user.
Building demolition recycling	Recycling	11,000,000	Industrial Waste	$484,935	$25,000	$459,935	On-site demolition products (steel and concrete) are segregated, recycled, and reused.
System One parts cleaner	Substitution	1,280	Hazardous Waste	$12,000	$0	$12,000	Central Fabrications and Motor Pool each purchased a System One parts washer to re-distill dirty solvent, eliminating the need for a vendor, such as Safety Kleen. Removed grit and sludge are mixed with the waste oil.
Animal bedding conveying system	Composting	74,000	Low-level Radiological Waste	$898,128	$0	$898,128	Animal bedding material is no longer sent to sanitary sewer. It is now conveyed to a dumpster that is emptied and composted at the stump dump. The sanitary sludge was previously sent out as low-level radioactive waste.
Lead acid batteries	Recycled	4,000	Universal Waste	$29,248	$0	$29,248	Avoids hazardous waste disposal costs for approximately 40 lbs of lead per battery.
Short half-life waste - CA	Decay in Storage	142	Radioactive Waste	$56,232	$0	$56,232	During 2012, 21 boxes of filters from Buildings 914 and 918 (147 ft^3) were managed in accordance with BNL decay-in-storage requirements, rendering the wastes eligible for volumetric release.
Cooling Tower chemicals	Source Reduction	6,000	Industrial Waste	$12,000	$0	$12,000	Ozone water treatment units were installed on cooling towers at the National Space Radiation Laboratory (957), the Special Ejection Magnet (912A), and the Relativistic Heavy Ion Collider Reseach Facility (1004) for biological control of cooling water. These systems eliminate the need for water treatment chemicals (typically toxic biocides), save labor, and reduce analytical costs for monitoring cooling tower blowdown.

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Table 2-2. BNL Pollution Prevention, Waste Reduction, and Recycling Programs *(concluded).*

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2012	Waste Type	Potential Costs for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details
Blasocut machining coolant	Recycled/ Reused	44,880	Industrial waste	$110,530	$0	$120,130	Central Shops Division operates a recycling system that reclaims Blasocut machining coolant and supplies it Laboratory-wide. In 2012, 5,610 gallons (44,580 lb) of Blasocut lubricant were recycled. Recycling involves aeration, centrifuge, and filtration. This avoids cost of disposal as industrial waste and an avoided cost of buying 12 drums of concentrate ($800/drum) and 113 empty drums for shipping ($50/drum).
Fluorescent bulbs	Recycled	15,727	Universal Waste	$802,077	$20,000	$782,077	Fluorescent bulbs are collected and sent to a recycling facility under the Universal Waste exemption rule.
Tyvek	Recycled	105	Industrial Waste	$6	$0	$11	BNL is recycling tyvek through Garment Recovery Systems.
Used motor oil	Energy Recovery	12,680	Industrial Waste	$31,651	$0	$31,651	Used motor oil from the Motor Pool and the on-site gas station is given to Strebel's Laundry Service to fire their boilers. In 2012, they collected 1,585 gallons of oil at no charge to BNL, which avoided the costs for disposal and 31 shipping drums ($50/drum).
Office paper	Recycled	284,120	Industrial Waste	$14,916	$0	$20,599	Cost avoidance based on $105/ton for disposal as trash, plus $40/ton revenue.
Cardboard	Recycled	200,600	Industrial Waste	$10,532	$0	$13,039	Cost avoidance based on $1055/ton for disposal as trash, plus $25/ton revenue.
Electronic waste	Recycled	61,840	Industrial/ Universal Waste	$154,600	$0	$181,795	Cost avoidance based on $105/ton for disposal as trash, plus $900/ton revenue.
Metals	Recycled	555,900	Industrial waste	$29,185	$0	$273,650	Cost avoidance based on $105/ton for disposal as trash, plus $900/ton revenue.
Bottles/cans	Recycled	36,040	Industrial Waste	$1,892	$0	$1,892	Cost avoidance based on $105/ton for disposal as trash.
Construction debris	Recycled	760,580	Industrial Waste	$39,930	$0	$19,775	Cost avoidance based on $52/ton difference for disposal as trash.
	TOTALS	13,082,523		$2,799,961	$45,000	$3,030,079	

* Cost savings of projects funded by the BNL Pollution Prevention Council will be tracked for 3 years.

3,000 gallons of biofuels were used in several applications.

BNL continues to participate in the New York Independent System Operator (NYISO) Special Case Resource (SCR) Program, which is an electric load reduction curtailment program. Through this program, the Laboratory has agreed to reduce electrical demand during critical days throughout the summer when NYISO expects customer demand to meet or exceed the available supply. In return, BNL receives a rebate for each megawatt reduced on each curtailment day. Three curtailment days were required in 2012. BNL continues to keep electric loads at a minimum during the summer by scheduling operations at the Relativistic Heavy Ion Collidar (RHIC) to avoid peak demand periods. This scheduling reduced the electric demand by 25 MW, which allowed the Laboratory to save approximately $2 million in electric costs in 2012, and greatly helps maintain the reliability of the Long Island Power Authority (LIPA) electric system to meet all of its users' needs.

BNL also maintains a contract with the New York Power Authority (NYPA) that resulted in an overall cost avoidance of $30.2 million in 2012. The Laboratory will continue to seek alternative energy sources to meet its future energy needs, support federally required "green" initiatives, and reduce energy costs. Further, BNL's energy supply now includes approximately 110 million kWh of clean, renewable hydropower.

In 2011, BP Solar completed construction of the Long Island Solar Farm (LISF) on DOE/BNL property. The array is currently the largest solar photovoltaic (PV) array (32 MW) in the Northeast and spans 195 acres with 164,000 panels. BNL worked extensively with LIPA, BP Solar, the State of New York, and other organizations to evaluate the site and develop the project, with LIPA purchasing the output through a 20-year Power Purchase Contract. The estimated annual output of 44 million kWh will result in an avoidance of approximately 31,000 tons of carbon per year over its 30- to 40-year life span. In fact, the actual output for the first operational year was 54 million kWh, substantially above the estimated annual average value. As an outcome of constructing this large array on site, the Laboratory are developing a solar research program that will look at impacts of climate change on large utility-scale PV systems, as well as research and development for solar power storage and inverter efficiencies. In addition, the Laboratory is in the process of installing approximately 1 MW of solar PV on site for additional research. The Federal Energy Management Program (FEMP) recognizes the importance of the efforts of BNL and the DOE Brookhaven Site Office to host the LISF on site and are providing credit toward BNL's SSP renewable energy goal.

To reduce energy use at non-research facilities, several additional activities also were undertaken by the Energy Management Group in 2012:

- *NYPA Power Contract:* First full year of a 10-year contract that includes 15 MW of renewable, nearly zero GHG of hydropower. This contract is estimated to save in excess of $26 million per year compared to prevailing energy rates, with an option to renew for an additional 5 years. Actual savings for FY 2012 were $30 million.
- *DOE Sustainability Initiative:* Continued to provide substantial support to the Federal/DOE-wide Sustainability Initiative; fostered the creation of a BNL Sustainability Leadership Team, which is developing a formal site-wide sustainability program beyond DOE requirements; participated in one of three subcommittees for DOE on sustainability initiatives; and provided numerous evaluations and estimates on energy use, GHG, renewable energy, and energy-efficiency options.
- *Substantial Progress on Several Initiatives included in BNL's 2012 SSP, including:* new electric and steam meter installations; funding for energy conservation initiatives; new energy-efficient lighting installed in parking lots and offices; the purchase of Renewable Energy Credits (RECs) in meeting the SSP goal; and training various parties on energy conservation initiatives and the set-back.
- *Utility Energy Services Contract:* Major support to DOE/BHSO in developing a UESC, which included a preliminary audit,

Table 2-3. BNL Recycled Program Summary.

Recycled Material	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mixed paper	209	182	185	193	184	177	151	127	174	186	142
Cardboard	157	176	179	143	135	121	147	152	141	126	100
Bottles/Cans	19	23	22	22.1	27.7	24.4	19.6	23.7	24	22.5	18
Tires	3.5	12.3	11	12.8	32.5	19.9	34.5	15.5	10.1	9.2	10
Construction debris	304	334	367	350	297	287	302	312	416	256	380
Used motor oil (gallons)	1,920	3,920	3,860	4,590	2,780	2,020	1,500	1,568	1,700	1,145	1,585
Metals	48	193	128	559	158	382	460	91	131	84	278
Automotive batteries	6.3	4.6	5	4.6	5.5	2.5	2.7	4	1.6	2.1	2
Printer/Toner cartridges (units)	449	187	105	0	0	0	3,078	1,251	4,132	4,186	4,100
Fluorescent bulbs (units)	25,067	13,611	12,592	7,930	11,740	25,448	36,741	10,223	8,839	20,220	15,727
Blasocut coolant (gallons)	8,180	5,030	6,450	3,890	3,970	2,432	3,340	3,810	4,830	5,660	5,610
Antifreeze (gallons)	0	165	325	0	0	0	0	0	0	0	700
Tritium exit signs (each)	28	181	142	0	0	0	0	0	0	18	0
Smoke detectors (each)	40	0	0	0	0	0	0	0	0	0	0
Road base	2,016	0	2,666	0	0	0	0	0	0	0	0
Electronic reuse	0	0	0	0	0	0	16.3	11.4	12	11.6	3.2
Scrap electronics	0	0	0	6.1	70.3	40.5	48.9	17	16.7	19.9	30.9
Animal Bedding (composted)	0	0	0	0	6.3	19.6	42	41	52	54	43
Tyvek (lbs)	0	0	0	0	0	0	0	84	60	92	105
Metals (building demolition)	8	23	11	6	35	0	0	0	0	0	41
Concrete (building demolition)	891	590	3,000	328	5,505	6175	0	0	4,050	0	3,200
Other construction and debris (building demolition)	790	388	1,200	157	818	0	0	0	0	0	0

Notes:
Units = tons, except where noted

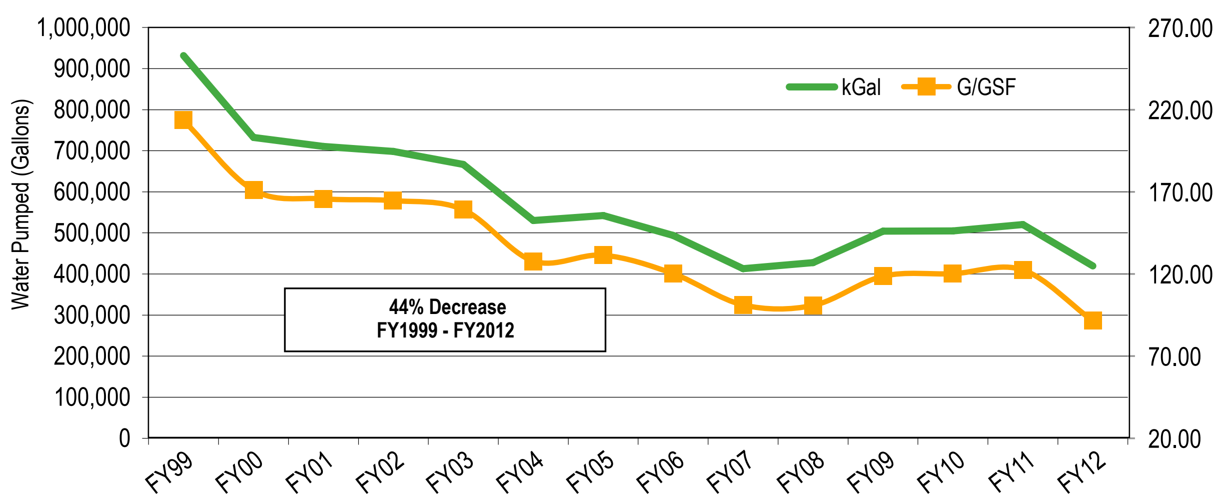

Figure 2-2. Annual Potable Water Use, 1999-2012.

completion of a follow-on Investment Grade Audit (IGA), and major progress towards development of the UESC contract terms and requirements. The first phase of the UESC, which includes energy-efficient lighting, new building controls and commissioning, and an energy-efficient chiller project, are expected to be initiated in late 2013.

- *Energy Conservation:* Evaluated several projects for energy conservation opportunities that were submitted by Laboratory employees, and continued development of an Energy Dashboard.
- *High Performance Sustainability Buildings (HPSB):* Completed evaluations of 24 buildings and developed plans and budgets to implement various energy and water conservation projects to achieve compliance in the EPA Portfolio Manager program. Construction contracts were awarded to complete various HPSB initiatives in various buildings.
- *Renewable Energy:* Provided project support to BHSO for the LISF Project, including presentations, hosting tours, and assisting operating personnel.
- *Central Chilled Water Facility (CCWF)-Phase II:* The CCWF Phase-II project was completed in 2011 and is now providing chilled water to BNL buildings and processes such as the National Synchrotron Light Source (NSLS) and the data center, using modern energy-efficient chillers.
- *Natural Gas Purchase Contract:* This contract is estimated to save $6 million compared to oil and $600k compared to purchasing directly from National Grid.
- *Energy Savings:* 25 MW of demand was rescheduled to avoid coinciding with the utility summer peak, saving over 2 million dollars in electricity charges. In addition, work continued in the replacement of aging, inefficient T-40 fluorescent lighting fixtures with new, efficient T-8 and T-5 units (two to three hundred fixtures are typically replaced annually), saving tens of thousands of kWhs and reducing costs by several thousand dollars.

Due to continued conservation efforts, overall facilities energy usage for FY 2012 was approximately 7.3 percent less than in FY 2003, saving $720,000. In addition, approximately 24,000 gasoline gallon equivalents (gge) of natural gas were used in place of gasoline for the Laboratory's vehicle fleet.

The National Energy Conservation Policy Act, as amended by the Federal Energy Management Improvement Act of 1988 and the Energy Policy Acts of 1992 and 2005, as well as the Energy Independence and Security Act (EISA) of 2007, requires federal agencies to apply energy conservation measures and to improve federal building design to reduce energy consumption per square foot. Current goals are to reduce energy consumption per square foot, relative to 2003, by 2 percent per year from FY 2006 – FY 2015. Further, EO 13514 and associated orders have set even more stringent requirements, including increased use of renewable energy and reductions in transportation fuels that go significantly beyond the previous goal of a 30 percent reduction by FY 2005, compared to FY 1985. As shown in Figure 2-3, BNL's energy use per square foot in 2012 was 30 percent less than in FY 1985 and 4 percent less than in FY 2003. It is important to note that energy use for buildings and facilities at the Laboratory is largely weather dependent.

2.3.4.7 Natural and Cultural Resource Management Programs

BNL continues to enhance its Natural Resource Management Program in cooperation with the Foundation for Ecological Research in the Northeast (FERN) and the Upton Ecological and Research Reserve. The Laboratory also continues to enhance its Cultural Resource Management Program. A BNL Cultural Resource Management Plan has been developed to identify and manage properties that are determined to be eligible or potentially eligible for inclusion on the National Register of Historic Places. See Chapter 6 for further information about these programs.

2.3.4.8 Environmental Restoration

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund, was enacted

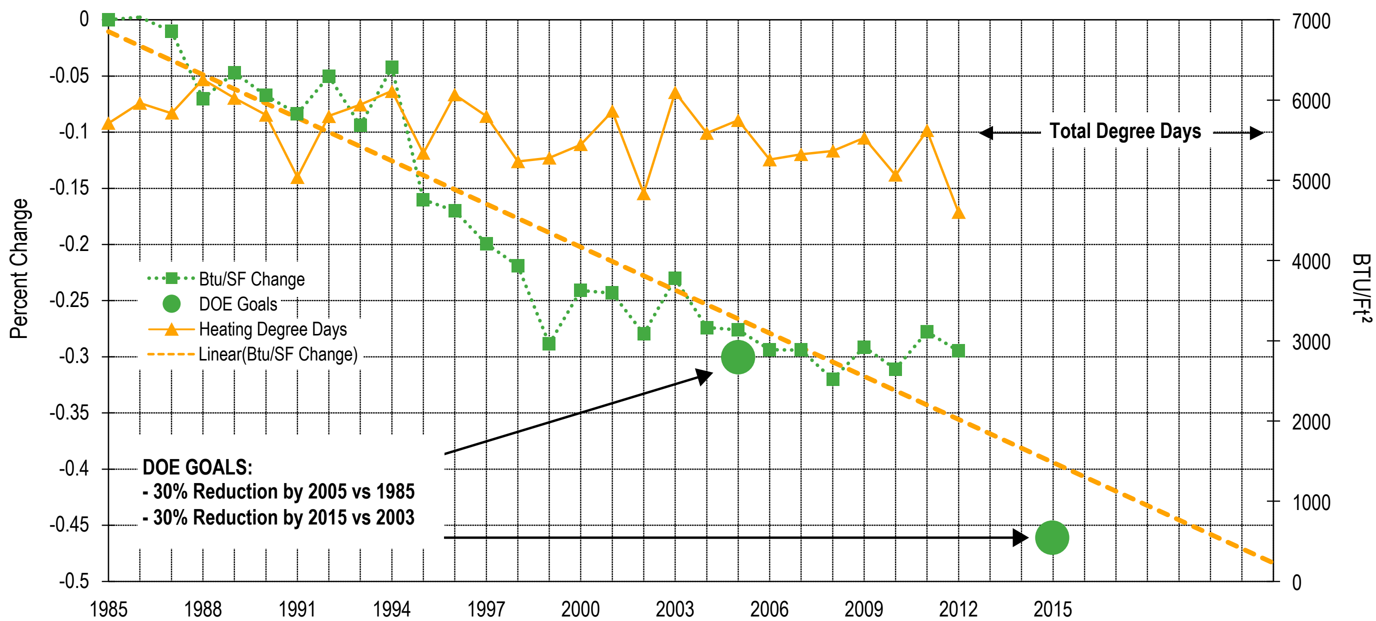

Figure 2-3. BNL Building Energy Performance (BTU/FT² Change % vs. Baseline Years).

by Congress in 1980. As part of CERCLA, EPA established the National Priorities List, which identifies sites where cleanup of past contamination is required. BNL was placed on the list with 27 other Long Island sites, 12 of which are in Suffolk County.

Each step of the CERCLA cleanup process is reviewed and approved by DOE, EPA, and NYSDEC, under an Interagency Agreement (IAG). This agreement was formalized in 1992. Although not a formal signatory of the IAG, the Suffolk County Department of Health Services (SCDHS) also plays a key role in the review process. Most of the contamination at the Laboratory is associated with past accidental spills and outmoded practices for handling, storing, and disposing of chemical and radiological material.

BNL follows the CERCLA process, which includes the following steps:

- Conduct a Remedial Investigation to characterize the nature and extent of contamination and assess the associated risks
- Prepare a Feasibility Study and Proposed Plan to identify and evaluate remedial action alternatives and present the proposed alternative
- Issue a Record of Decision (ROD), which is the remedy/corrective action agreed to by DOE, EPA, and NYSDEC
- Perform the Remedial Design/Remedial Action, which includes final design, construction specifications, and carrying out the remedy selected

In 2012, significant work was performed for the BGRR and BNL's groundwater treatment systems. The BGRR ROD required the removal of the graphite pile and the biological shield, as well as the installation of a water infiltration control and monitoring system. Following removal of the 700-ton graphite pile in 2010, removal of the BGRR biological shield commenced and was completed in May 2012. This work was funded, in part, through the American Recovery and Reinvestment Act of 2009 (ARRA). The biological shield roof was removed and special torch-cutting tools, as well as a large excavator, were deployed to remove the biological shield steel and reinforced concrete walls. An Explanation of Significant Differences (ESD) to the BGRR ROD describes and justifies one instance where the completed end state is different than described in the ROD. The BGRR ROD anticipated removal of the biological shield walls from the top of the bioshield to its base, which is 3 feet below the floor level. Per the ESD, the portion of the biological shield below the floor level was not removed and was left in place (this portion of the biological shield contains activation products). In July 2012, transition of the long-term surveillance and maintenance (S&M) program for the BGRR to the Environmental Protection Division (EPD) was completed.

All near-term activities identified in the HFBR ROD have been completed, except for the demolition of the HFBR stack. In accordance with the ROD, demolition of the stack will be completed prior to 2020. In May 2012, transition of the long-term S&M program for the HFBR Stack and Grounds and the Waste Loading Area to EPD was completed.

The productive operation and maintenance (O&M) of the Laboratory's 14 groundwater treatment systems removed approximately 239 pounds of solvents and 1.9 mCi of Sr-90 from the sole source aquifer in 2012. Since the operation of the first treatment system in 1996, a cumulative total of approximately 6,948 pounds of solvents and 27.5 mCi of Sr-90 have been removed from the groundwater.

Other work performed in 2012 included the start-up of a new treatment system to address trichlorofluoromethane (Freon-11) contamination in groundwater downgradient of Building 452, a site maintenance facility. An ESD to the OU III ROD was issued in July 2012 to document this change to the OU III remedy. In addition, a new extraction well was installed to address deeper VOC contamination at the OU III south boundary.

Post-cleanup monitoring of Peconic River surface water, sediment, and wetland vegetation continued, and the results were reported in the Annual Peconic River Monitoring Report (see Chapter 6). Monitoring and re-vegetation was performed at three Peconic wetland areas that were remediated in 2011. As a result, the conditions identified in the 2010 State Equivalency Permit were met. Invasive species monitoring will continue for these areas through 2014 to satisfy federal requirements.

The groundwater systems operate in accordance with the O&M manuals, while the Peconic and surface soil cleanup areas are monitored via the Soil and Peconic River S&M Plan. Institutional controls are also monitored and maintained for the cleanup areas in accordance with the RODs to help ensure the remedies remain protective of human health and the environment. An annual evaluation of these controls is submitted to the regulators.

Table 2-4 provides a description of each OU and a summary of environmental restoration actions taken. See Chapter 7 and SER Volume II, Groundwater Status Report, for further details.

2.4 Implementing the Environmental Management System

2.4.1 Structure and Responsibility

All employees at BNL have clearly defined roles and responsibilities in key areas, including environmental protection. Employees are required to develop and sign their own Roles, Responsibilities, Accountabilities, and Authorities (R2A2) document, which must also be signed by two levels of supervision. BSA has clearly defined expectations for management and staff which must be included in this document. Under the BSA performance-based management model, senior managers must communicate their expectation that all line managers and staff take full responsibility for their actions and be held accountable for ESSH performance. Environmental and waste management technical support personnel assist the line organizations with identifying and carrying out their environmental responsibilities. The Environmental Compliance Representative Program, initiated in 1998, is an effective means of integrating environmental planning and pollution prevention into the work planning processes of the line organizations. A comprehensive training program for staff, visiting scientists, and contractor personnel is also in place, thus ensuring that all personnel are aware of their ESSH responsibilities.

2.4.2 Communication and Community Involvement

In support of BNL's EMS commitment to communication and community involvement, the Community, Education, Government and Public Affairs (CEGPA) Directorate develops best-in-class communications, science education, government relations, and community involvement programs that advance the science and science education missions of the Laboratory. CEGPA contributes to public understanding of science and enhances the value of the Laboratory as a community asset and ensures that internal and external stakeholders are properly informed and have a voice in decisions of interest and importance to them. CEGPA also works to maintain relationships with BNL employees, key stakeholders, neighbors, elected officials, regulators, and other community members to provide an understanding of the Laboratory's science and operations, including environmental stewardship and restoration activities, and to incorporate community input into BNL's decision-making process.

To facilitate stakeholder input, CEGPA's Community Relations Office participates in or conducts on- and off-site meetings which include discussions, presentations, roundtables, and workshops. Community Relations staff attend local civic association meetings, canvass surrounding neighborhoods, conduct Laboratory tours, and coordinate informal information sessions and formal public meetings, which are held during public comment periods for environmental projects. BNL's Internal Communications Office manages programs to increase internal stakeholder awareness, understanding, and support of Laboratory initiatives, fosters two-way communications, and updates internal stakeholders on BNL priorities, news, programs, and events.

2.4.2.1 Communication Forums

To create opportunities for effective dialogue between the Laboratory and key stakeholders, several forums for communication and involvement have been established:

- The Brookhaven Executive Roundtable (BER), established in 1997 by DOE's Brookhaven Site Office, meets routinely to update local, state, and federal elected officials and their staff, regulators, and other government agencies on environmental and operational issues, as well as scientific discoveries and initiatives.
- The Community Advisory Council (CAC), established by BNL in 1998, advises Laboratory management primarily on environmental, health, and safety issues related to BNL that are of importance to the community. The CAC is composed of 27 member organizations and individuals representing civic, education, employee, community, environmental, and health interests. The CAC sets its own agenda in cooperation with the Laboratory and meets monthly. The CAC is one of the primary ways the Laboratory keeps the community informed. Meetings are open to the public and are announced in the monthly community e-newsletter, *LabLink*, on the BNL homepage calendar, and on the Community Relations website. An opportunity for public comment is provided at each meeting and organizations interested in participating on the CAC are encouraged to attend meetings and make their interest known.
- Monthly teleconference calls are held with parties to the Laboratory's Interagency Agreement and other federal, state, and local regulators to keep them up-to-date on project status and to provide feedback and input, as well as opportunities to discuss emerging environmental findings.
- The Community Relations Office website is used to host links to the CAC webpage, which contains meeting agendas and past meeting presentations and minutes, and also hosts links to important documents and announcements for public meeting dates. Community Relations also manages several outreach programs that provide opportunities for stakeholders to become familiar with the Laboratory's facilities and research projects, as well as new initiatives. Outreach programs include:
  – *Tour Program:* Opportunities to learn

about BNL are offered to college, university, professional, and community groups. Tour groups visit the Laboratory's scientific machines and research facilities and meet with scientists who conduct research. Agendas are developed to meet the interests of the groups and may include sustainability and environmental stewardship issues. Tours were provided for more than 2,350 visitors in 2012.

– *The Speakers' Bureau:* Speakers are provided for educational institutions and community organizations, such as Rotary Clubs, civic organizations, and professional societies, to update them on Laboratory research and operations accomplishments, including environmental stewardship.
– *Summer Sundays:* Held on four Sundays each summer, these open houses enable the public to visit BNL science facilities, experience hands-on activities, and learn about research projects and environmental stewardship programs. In 2012, more than 5,400 visitors participated in the program.

The Laboratory participates in various outreach events throughout the year that include BNL's Earth Day celebration, off-site fairs and festivals, and workshops and conferences such as the Long Island Earth Summit, the Long Island Green Infrastructure Conference, Long Island Regional Economic Development Council, and the Suffolk County Planning Federation Conference. Brown bag lunch meetings, held periodically, cover topics of interest to employees, including project status updates, newly proposed initiatives, wildlife management concerns, and employee benefits information.

BNL's Media & Communications Office issues press releases to news and media outlets and the Internal Communications Office publishes both electronic and print weekly employee newsletters – Brookhaven This Week and The Brookhaven Digest – that are geared toward employees with email access and those who do not have direct access to a computer. Also, a Director's Office web-based publication, Monday Memo, is issued bi-weekly to employees and focuses on administrative topics important to the Laboratory population.

The Laboratory maintains an informative website at *www.bnl.gov*, where these publications, as well as extensive information about BNL's science and operations, past and present, are posted. In addition, employees and the community can subscribe to the Laboratory's e-mail news service at *http://lists.bnl.gov/mailman/listinfo/bnl-announce-1*.

Community members who have questions or comments can submit them via the "Contact Us" form found on the Community Relations Office website at *www.bnl.gov/community/contact.asp.* Community members can also subscribe to the monthly e-newsletter, *LabLink*, found on the Community Relations webpage at *www.bnl.gov/lablink. LabLink* keeps the community informed about happenings at BNL, explains the science behind Laboratory research, and invites subscribers to educational and cultural events.

2.4.2.2 Community Involvement in Cleanup Projects

In 2012, BNL shared information with stakeholders on several environmental projects:

- *Brookhaven Graphite Research Reactor (BGRR):* Work on the dismantlement of the BGRR continued into 2012. Because of challenges removing the concrete bioshield, changes were made to the Work Plan and an ESD ROD was prepared. In January, presentations on the work plan change, which called for leaving a portion of the concrete floor in place, were provided to the CAC and BER. Additionally, the CAC was given updates on the equipment removal and waste shipments, and on water found in the deep pit from dust suppression activities associated with demolition of the bioshield. The CAC was also given a close-out report from the DOE project manager and were notified when the ESD was finalized. A Notice of Availability announcing the ESD was published in July 2012.
- *Operable Unit III Explanation of Significant Differences (ESD):* Following the 2011 discovery of Freon-11 in a monitoring well in the vicinity of Building 452 during

Table 2-4. Summary of BNL 2012 Environmental Restoration Activities.

Project	Description	Environmental Restoration Actions
Soil Projects	Operable Unit (OU) I/II/III/VII	▪ Performed monitoring and maintenance of institutional controls for cleanup areas.
Groundwater Projects	OU III	▪ Continued operation of 10 groundwater treatment systems that remove volatile organic compounds (VOCs) and two systems that remove strontium-90 (Sr-90). ▪ Began operation of a new treatment system to address trichlorofluoromethane (Freon-11) contamination in groundwater downgradient of Building 452, a site maintenance facility. An Explanation of Significant Differences (ESD) to the OU III Record of Decision (ROD) was issued in July 2012 to document this change to the OU III remedy. Began operation of a new extraction well to address deeper VOC contamination at the OU III south boundary. ▪ 239 pounds of VOCs and 1.9 mCi of Sr-90 were removed during the treatment of 1.5 billion gallons of groundwater. Since the first groundwater treatment system started operating in December 1996, approximately 6,948 pounds of VOCs and 27.5 mCi of Sr-90 have been removed, while treating over 19 billion gallons of groundwater. ▪ Collected and analyzed approximately 1,561 sets of groundwater samples from 662 monitoring wells. ▪ Installed several temporary wells and collected multiple samples from each location. ▪ Continued monitoring and operation of the High Flux Beam Reactor (HFBR) tritium pump and recharge system. ▪ Continued post-closure groundwater monitoring at the former Carbon Tetrachloride groundwater treatment system and OU IV. ▪ Continued monitoring the g-2 tritium plume using temporary and permanent monitoring wells.
Peconic River	OU V	▪ Performed seventh year of long-term post-cleanup monitoring of Peconic River surface water and sediment. ▪ Fish collection is now performed every other year. ▪ Performed monitoring and maintenance of the three excavated sediment locations within the Peconic River; this satisfied the State equivalency permit conditions.
Reactors	Brookhaven Graphite Research Reactor (BGRR)	▪ Completed removal and off-site disposal of the bioshield. An ESD for the BGRR ROD was issued to document a change to the completed end state. ▪ Completed transition of the BGRR long-term surveillance and maintenance program to the Environmental Protection Division (EPD).
	High Flux Beam Reactor (HFBR)	▪ Completed transition of the HFBR Stack and Grounds and Waste Loading Area long-term surveillance and maintenance program to EPD.
	Stack (Building 705)	▪ Removed stack silencers and shipped to disposal.
	Brookhaven Medical Research Reactor (BMRR) (Project managed by EPD)	▪ Continued surveillance and maintenance activities.
Buildings 810/811	Radiological Liquid Processing Facility (Project managed by EPD)	▪ Performed routine surveillance and maintenance of the facility. ▪ EPD removed and shipped the last of the 20,000-gal tanks from the facility to disposal. ▪ EPD emptied and decontaminated Building 810 for use as a propylene glycol recycling facility.
Building 801	Inactive Radiological Liquid Holdup Facility (Project managed by EPD)	▪ Performed routine surveillance and maintenance of the facility.
Building 650	Inactive Radiological Decon Facility (Project managed by EPD)	▪ Performed routine surveillance and maintenance of the facility.

routine sampling, further characterization was conducted and a change to the groundwater remedy for the Operable Unit (OU) III ROD was proposed. An ESD was prepared that outlined the addition of Freon-11 to the list of volatile organic compounds (VOCs) to be remediated under CERCLA and the Building 452 area was designated as Area of Concern (AOC) 32. The CAC and BER received presentations and updates on the construction of the groundwater treatment system and the ESD. The ESD was published in Long Island's *Newsday* on April 7, 2012.

In addition to the projects outlined above, stakeholders were updated on the progress of other environmental cleanup projects, additional initiatives, and health and safety issues via mailings and briefings and presentations given at CAC and BER meetings. These topics included:

- *Wastewater Treatment Modification Project:* As part on an ongoing State Pollutant Discharge Elimination System (SPDES) project that began in 2009 where BNL proposed to eliminate the discharge of its Sewage Treatment Plant effluent to the Peconic River and instead process wastewater through groundwater recharge basins, the CAC and BER received several updates on the design and construction status of this project.
- *The 2010 Site Environmental Report:* In January 2012, an overview of BNL's EMS ISO 14001 and OHSAS 18001 recertification, the Laboratory's Pollution Prevention program, waste generation, and energy management and conservation was provided. Information on compliance status, inspections, assessments, water monitoring, radiological and non-radiological air quality, and dose assessments was also presented.
- Following the detection of VOCs at deeper levels than anticipated and the 2010 CERCLA Five-Year Review recommendation that an additional extraction well be added to the OU III Southern Boundary groundwater treatment system, an update was given on the installation of the well and its impact on the ROD cleanup objectives for the Upper Glacial Aquifer.
- *The 2011 Site Environmental Report:* In October 2012, the CAC received a presentation on the Laboratory's environmental impact for the previous year. Updates on the Lab's EMS and opportunities for its improvement (outcomes of the annual assessment) and pollution prevention projects implemented during the year were provided. Statistics on waste generation, energy management and conservation, water quality, and air quality were also discussed.

Working closely with the community, employees, elected officials, and regulatory agency representatives, DOE and BNL continue to openly share information on issues, projects, and programs and welcome all input and feedback offered.

2.4.3 Monitoring and Measurement

The Laboratory monitors effluents and emissions to ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. BNL's Environmental Monitoring
Program is a comprehensive, sitewide program that identifies potential pathways for exposure of the public and employees, evaluates the impact activities have on the environment, and ensures compliance with environmental permit requirements. The monitoring program is reviewed and revised, as necessary or on an annual basis, to
reflect changes in permit requirements, changes in facility-specific monitoring activities, or the need to increase or decrease monitoring based on a review of previous analytical results.

As required under DOE Order 436.1, Departmental Sustainability, BNL prepares an Environmental Monitoring Plan, which outlines annual sampling goals by media and frequency. The plan uses the EPA Data Quality Objective approach for documenting the decisions associated with the monitoring program. In addition to the required triennial update, an annual electronic update is also prepared.

As shown in Table 2-5, in 2012 there were 7,800 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges under the Environmental Monitoring Program. Specific sampling programs for the various media are described further in Chapters 3 through 8.

The Environmental Monitoring Program addresses three components: compliance, restoration, and surveillance monitoring.

2.4.3.1 Compliance Monitoring

Compliance monitoring is conducted to ensure that wastewater effluents, air emissions, and groundwater monitoring data comply with regulatory and permit limits issued under the federal Clean Air Act, Clean Water Act, Oil Pollution Act, SDWA, and the New York State equivalents. Included in compliance monitoring are the following:

- *Air emissions monitoring* is conducted at reactors, accelerators, and other radiological emission sources, as well as the Central Steam Facility (CSF). Real-time, continuous emission monitoring equipment is installed and maintained at some of these facilities, as required by permits and other regulations. At other facilities, samples are collected and analyzed periodically to ensure compliance with regulatory requirements. Analytical data are routinely reported to the permitting authority. See Chapters 3 and 4 for details.
- *Wastewater monitoring* is performed at the point of discharge to ensure that the effluent

Table 2-5. Summary of BNL 2012 Sampling Program Sorted by Media.

Environmental Media	No. of Sampling Events(a)	Purpose
Groundwater	1,816 (b) 277 ES/C (c)	Groundwater is monitored to evaluate impacts from past and present operations on groundwater quality, under the Environmental Restoration, Environmental Surveillance, and Compliance sampling programs. See Chapter 7 and SER Volume II, Groundwater Status Report for further detail.
On-Site Recharge Basins	128	Recharge basins used for wastewater and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes. See Chapter 5 for further detail.
Potable Water	47 ES 184 C	Potable water wells and the BNL distribution system are monitored routinely for chemical and radiological parameters to ensure compliance with Safe Drinking Water Act requirements. In addition, samples are collected under the Environmental Surveillance Program to ensure the source of the Laboratory's potable water is not impacted by contamination. See Chapters 3 and 7 for further detail.
Sewage Treatment Plant (STP)	388	The STP influent and effluent and several upstream and downstream Peconic River stations are monitored routinely for organic, inorganic, and radiological parameters to assess BNL impacts. The number of samples taken depends on flow. For example, samples are scheduled for collection at Station HQ monthly, but if there is no flow, no sample can be collected. See Chapters 3 and 5 for further detail.
Precipitation	16	Precipitation samples are collected from two locations to determine if radioactive emissions have impacted rainfall, and to monitor worldwide fallout from nuclear testing. The data are also used, along with wind speed, wind direction, temperature, and atmospheric stability to help model atmospheric transport and diffusion of radionuclides. See Chapter 4 for further detail.
Air – Tritium	363	Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess environmental tritium levels. See Chapter 4 for further detail.
Air – Particulate	498 ES/C 53 NYSDOH	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. Samples are also collected for the New York State Department of Health Services (NYSDOH) as part of their program to assess radiological air concentrations statewide. See Chapter 4 for further detail.
Air – Charcoal	52	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. See Chapter 4 for further detail.

(continued on next page)

Table 2-5. Summary of BNL 2012 Sampling Program Sorted by Media *(concluded).*

Environmental Media	No. of Sampling Events(a)	Purpose
Fauna	63	Fish and deer are monitored to assess impacts on wildlife associated with past or current BNL operations. See Chapter 6 for further detail.
Flora	27	Vegetation is sampled to assess possible uptake of contaminants by plants and fauna, since the primary pathway from soil contamination to fauna is via ingestion. See Chapter 6 for further detail.
Soils	50	Soil samples are collected as part of the Natural Resource Management Program to assess faunal uptake, during Environmental Restoration investigative work, during the closure of drywells and underground tanks, and as part of preconstruction background sampling.
Miscellaneous	482	Samples are collected periodically from potable water fixtures and dispensers, manholes, spills, to assess process waters, and to assess sanitary discharges.
Groundwater Treatment Systems and Remediation Monitoring	1,019	Samples are collected from groundwater treatment systems and as long-term monitoring after remediation completion under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program. The Laboratory has 14 operating groundwater treatment systems. See discussion in Chapter 7.
Vehicle Monitor Checks	216	Materials leaving the Laboratory pass through the on-site vehicle monitor that detects if radioactive materials are present. Any radioactive material discovered is properly disposed of through the Waste Management Program. The vehicle monitor is checked on a daily basis.
State Pollutant Discharge Elimination System (SPDES)	423	Samples are collected to ensure that the Laboratory complies with the requirements of the New York State Department of Environmental Conservation (NYSDEC)- issued SPDES permit. Samples are collected at the STP, recharge basins, and four process discharge sub-outfalls to the STP.
Flow Charts	609	Flowcharts are exchanged weekly as part of BNL's SPDES permit requirements to report discharge flow at the recharge basin outfalls.
Floating Petroleum Checks	110	Tests are performed on select petroleum storage facility monitoring wells to determine if floating petroleum products are present. The number of wells and frequency of testing is determined by NYSDEC licensing requirements (e.g., Major Petroleum Facility), NYSDEC spill response requirements (e.g., Motor Pool area), or other facility-specific sampling and analysis plans.
Radiological Monitor Checks	744	Daily instrumentation checks are conducted on the radiation monitors located in Buildings 569 and 592. These monitors are located 30 minutes upstream and at the STP. Monitoring at these locations allows for diversion of wastes containing radionuclides before they are discharged to the Peconic River.
Quality Assurance/ Quality Control Samples (QA/QC)	235	To ensure that the concentrations of contaminants reported in the Site Environmental Report are accurate, additional samples are collected. These samples detect if contaminants are introduced during sampling, transportation, or analysis of the samples. QA/QC samples are also sent to the contract analytical
Total number of sampling events	**7,800**	The total number of sampling events includes all samples identified in the Environmental Monitoring Plan (BNL 2009), as well as samples collected to monitor Environmental Restoration (CERCLA) projects, air and water treatment system processes, and by the Environmental Protection Division Field Sampling Team as special requests. The number does not include samples taken by Waste Management personnel, waste generators, or Environmental Compliance Representatives for waste characterization purposes.

Notes:

(a) A sampling event is the collection of samples from a single georeferenced location. Multiple samples for different analyses (i.e., tritium, gross alpha, gross beta, and volatile organic compounds) can be collected during a single sample event.

(b) Includes 28 temporary wells; many of which are used to collect multiple samples at different depth intervals.

(c) Includes 50 temporary wells, many of which are used to collect multiple samples at different depth intervals.

C = Compliance

ER = Environmental Restoration (CERCLA)

ES = Environmental Surveillance

complies with release limits in the Laboratory's SPDES permits. Twenty-four point-source discharges are monitored under the BNL program: 12 under the Environmental Restoration Program and 12 under the SPDES permit. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly and monitored for organic, inorganic, and radiological parameters. Monthly reports that provide analytical results and an assessment of compliance for that reporting period are filed with the permitting agency. See Chapter 3, Section 3.6 for details.

- *Groundwater monitoring* is performed to comply with regulatory operating permits. Specifically, monitoring of groundwater is required under the Major Petroleum Facility License for the CSF and the RCRA permit for the Waste Management Facility. Extensive groundwater monitoring is also conducted under the CERCLA program (described in Section 2.4.3.2 below). Additionally, to ensure that the Laboratory maintains a safe drinking water supply, BNL's potable water supply is monitored as required by SDWA, which is administered by SCDHS.

2.4.3.2 Restoration Monitoring

Restoration monitoring is performed to determine the overall impact of past operations, to delineate the real extent of contamination, and to ensure that Removal Actions are effective and remedial systems are performing as designed under CERCLA.

This program typically involves collecting soil and groundwater samples to determine the lateral and vertical extent of the contaminated area. Samples are analyzed for organic, inorganic, and radiological contaminants, and the analytical results are compared with guidance, standards, cleanup goals, or background concentrations. Areas where impacts have been confirmed are fully characterized and, if necessary, remediated to mitigate continuing impacts. Follow-up monitoring of groundwater is conducted in accordance with a ROD with the regulatory agencies (see Chapter 7 and SER Volume II, Groundwater Status Report, for details).

2.4.3.3 Surveillance Monitoring

Pursuant to DOE Order 436.1, surveillance monitoring is performed in addition to compliance monitoring, to assess potential environmental impacts that could result from routine facility operations. The BNL Surveillance Monitoring Program involves collecting samples of ambient air, surface water, groundwater, flora, fauna, and precipitation. Samples are analyzed for organic, inorganic, and radiological contaminants. Additionally, data collected using thermoluminescent dosimeters (devices to measure radiation exposure) strategically positioned on and off site are routinely reviewed under this program. Control samples (also called background or reference samples) are collected on and off the site to compare Laboratory results to areas that could not have been affected by BNL operations.

The monitoring programs can be broken down further by the relevant law or requirement (e.g., Clean Air Act) and even further by specific environmental media and type of analysis. The results of monitoring and the analysis of the monitoring data are the subject of the remaining chapters of this report. Chapter 3 summarizes environmental requirements and compliance data, Chapters 4 through 8 give details on media-specific monitoring data and analysis, and Chapter 9 provides supporting information for understanding and validating the data shown in this report.

2.4.4 EMS Assessments

To periodically verify that the Laboratory's EMS is operating as intended, audits are conducted as part of BNL's Self-Assessment Program. The audits are designed to ensure that any nonconformance to the ISO 14001 Standard is identified and addressed. In addition, compliance with regulatory requirements is verified through routine inspections, operational evaluations, and focused compliance audits. BNL's Self-Assessment Program consists of several processes:

- *Self-assessment* is the systematic evaluation of internal processes and performance. The approach for the environmental self-assessment program includes evaluating programs and processes within organizations that have environmental aspects. Conformance to the Laboratory's EMS requirements is verified, progress toward achieving environmental objectives is monitored, operations are inspected to verify compliance with regulatory requirements, and the overall effectiveness of the EMS is evaluated. BNL environmental staff routinely participate in these assessments. Laboratory management conducts assessments to evaluate BNL environmental performance from a programmatic perspective, to determine if there are Laboratory-wide issues that require attention, and to facilitate the identification and communication of "best management" practices used in one part of the Laboratory that could improve performance in other parts. BNL management also routinely evaluates progress on key environmental improvement projects. The Laboratory and DOE periodically perform assessments to facilitate the efficiency of assessment activities and ensure that the approach to performing the assessments meets DOE expectations.

- *Independent assessments* are performed by BNL staff members who do not have line responsibility for the work processes involved, to ensure that operations are in compliance with Laboratory requirements. These assessments verify the effectiveness and adequacy of management processes (including self-assessment programs) at the division, department, directorate, and Laboratory levels. Special investigations are also conducted to identify the root causes of problems, as well as identify corrective actions and lessons learned.

The Laboratory's Self-Assessment Program is augmented by programmatic, external audits conducted by DOE. BSA staff and subcontractors also perform periodic independent reviews. An independent third party conducts ISO 14001 registration audits of BNL's EMS. The Laboratory is also subject to extensive oversight by external regulatory agencies (see Chapter 3 for details). Results of all assessment activities related to environmental performance are included, as appropriate, throughout this report.

2.5 ENVIRONMENTAL STEWARDSHIP AT BNL

BNL has extensive knowledge of its potential environmental vulnerabilities and current operations due to ongoing process evaluations, the work planning and control system, and the management systems for groundwater protection, environmental restoration, and information management. Compliance assurance programs have improved the Laboratory's compliance status and pollution prevention projects have reduced costs, minimized waste generation, and reused and recycled significant quantities of materials.

BNL is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and progress. To maintain stakeholder trust, the Laboratory will continue to deliver on commitments and demonstrate improvements in environmental performance. The Site Environmental Report is an important communication mechanism, as it summarizes BNL's environmental programs and performance each year. Additional infor-mation about the Laboratory's environmental programs is available on BNL's website at *http://www.bnl.gov*.

Due to external recognition of the Laboratory's knowledge and unique experience implementing the EMS program, BNL is often asked to share its experiences, lessons learned, and successes. The Laboratory's environmental programs and projects have been recognized with international, national, and regional awards. Audits have consistently observed a high level of management involvement, commitment, and support for environmental protection and the EMS.

For more than 50 years, the unique, leading-edge research facilities and scientific staff at BNL have made many innovative scientific contributions possible. Today, BNL continues its research mission while focusing on cleaning up and protecting the environment. The Laboratory's environmental motto, which was generated in an employee suggestion contest, is "Exploring Earth's Mysteries … Protecting Its Future," and reflects the Laboratory's desire to balance world-class research with environmentally responsible operations.

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Compliance Status 3

Brookhaven National Laboratory is subject to more than 100 sets of federal, state, and local environmental regulations; numerous site-specific permits; 13 equivalency permits for operation of groundwater remediation systems; and several other binding agreements. In 2012, the Laboratory operated in compliance with most of the requirements defined in these governing documents. Instances of noncompliance were reported to regulatory agencies and corrected expeditiously. Routine inspections conducted during the year found no significant instances of noncompliance.

The Laboratory received two Notices of Violation (NOV) from EnergySolutions of Utah and one Notice of Non-Compliance from the Environmental Protection Agency. The two NOVs from EnergySolutions were received in June and August and resulted in 600 points against BNL's Utah Generator Site Access Permit, but with no monetary fines. In July, EPA issued a Notice of Non-Compliance of Subpart H, 40 CFR 61, National Emissions Standards for Hazardous Pollutants–radionuclides (rad-NESHAP) as a result of some findings from an inspection visit on July 12, 2012 and review of BNL's 2011 rad-NESHAPs Report. A revised annual report was submitted to address the non-compliance findings.

Emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the Central Steam Facility were all within permit limits. There were nine unexpected opacity excursions on January 4, 2012 for Boiler 6 due to the sudden buildup of soot across the transmissometer light path, for which there was no apparent cause. Subsequent shutdown of the boiler and cleaning of the light path brought recorded opacity readings back to normal; other opacity excursions reported for Boiler 6 and 7 were only noted during testing periods. Halon portable fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as they are encountered. The existing supply of Halon in storage was transferred to the Department of Defense Ozone Depleting Substances Reserve during December 2012.

Monitoring of BNL's potable water system indicated that all drinking water requirements were met. During 2012, most of the liquid effluents discharged to surface water and groundwater met applicable New York State Pollutant Discharge Elimination System permit requirements. Nine minor excursions above permit limits were reported for the year; three occurred at the Sewage Treatment Plant (iron, total nitrogen, and total nitrogen load), five pH excursions were recorded for discharges to recharge basins (one at Outfall 007 and four at Outfall 008), and one oil and grease excursion at recharge basin 006B. The permit excursions were reported to the New York State Department of Environmental Conservation (NYSDEC) and the Suffolk County Department of Health Services. Groundwater monitoring at the Laboratory's Major Petroleum Facility 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 2012. There were 15 reportable spills of petroleum products, antifreeze, or chemicals, which was slightly less than what was reported in 2011. The severity of releases were minor, and all releases were cleaned up to the satisfaction of NYSDEC.

BNL participated in 9 environmental inspections or reviews by external regulatory agencies in 2012. These inspections included Sewage Treatment Plant operations, waste water discharges to other regulated outfalls and recharge basins, regulated petroleum and chemical bulk storage facilities, and the potable water system. Immediate corrective actions were taken to address all issues raised during these inspections.

3.1 COMPLIANCE WITH REQUIREMENTS

The federal, state, and local environmental statutes and regulations that BNL operates under are summarized in Table 3-1, along with a discussion of the Laboratory's compliance status with each. A list of all applicable environmental regulations is contained in Appendix D.

3.2 ENVIRONMENTAL PERMITS

3.2.1 Existing Permits

Many processes and facilities at BNL operate under permits issued by environmental regulatory agencies. Table 3-2 provides a complete list of the existing permits, some of which are briefly described below.

- State Pollutant Discharge Elimination System (SPDES) permit, issued by NYSDEC
- Major Petroleum Facility (MPF) license, issued by NYSDEC
- Resource Conservation and Recovery Act (RCRA) permit, issued by NYSDEC for BNL's Waste Management Facility
- Registration certificate from NYSDEC for tanks storing bulk quantities of hazardous substances
- Seven radiological emission authorizations

Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL.

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
EPA: 40 CFR 300 40 CFR 302 40 CFR 355 40 CFR 370	The Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) provides the regulatory framework for remediation of releases of hazardous substances and remediation (including decontamination and decommis-sioning [D&D]) of inactive hazardous waste dis-posal sites. Regulators include EPA, DOE, and the New York State Department of Environmental Conservation (NYSDEC).	In 1992, BNL entered into a tri-party agreement with EPA, NYSDEC, and DOE. BNL site remediation is conducted by the Environmental Restoration Program in accordance with milestones established under this agreement. In 2005, BNL completed the restoration portion of the cleanup project and entered the surveillance and maintenance mode. In 2012 the D&D of the BGRR, including completion of the graphite pile removal and demolition of the bioshield, was completed. The BGRR was then transitioned to the long term surveillance and maintenance program managed by the Environmental Protection Division after completion of this work.	2.3.4.8
Council for Env. Quality: 40 CFR 1500–1508 DOE: 10 CFR 1021	The National Environmental Policy Act (NEPA) requires federal agencies to follow a prescribed process to anticipate the impacts on the environment of proposed major federal actions and alternatives. DOE codified its implementation of NEPA in 10 CFR 1021.	BNL is in full compliance with NEPA requirements. The Laboratory has established sitewide procedures for implementing the NEPA requirements.	3.3
Advisory Council on Historic Preservation: 36 CFR 60 36 CFR 63 36 CFR 79 36 CFR 800 16 USC 470	The National Historic Preservation Act (NHPA) identifies, evaluates, and protects historic proper-ties eligible for listing in the National Register of Historic Places, commonly known as the National Register. Such properties can be archeological sites or historic structures, documents, records, or objects. NHPA is ad-ministered by state historic preservation offices (SHPOs; in New York State, NYSHPO). At BNL, structures that may be subject to NHPA include the High Flux Beam Reactor (HFBR), the Brookhaven Graphite Research Reactor (BGRR) complex, World War I training trenches near the Relativistic Heavy Ion Collider project, and the former Cosmotron building.	The HFBR, BGRR complex, and World War I trenches are eligible for inclusion in the National Register. The former Cosmotron building was identified as potentially eligible in an April 1991 letter from NYSHPO. Any proposed activities involving these facilities must be identified through the NEPA/NHPA processes and evaluated to deter-mine if the action would affect the features that make the facility eligible. Some actions required for D&D of the BGRR were determined to affect its eligibility, and mitigative actions are proceeding according to a Memorandum of Agreement between DOE and NYSHPO. BNL has a Cultural Resource Management Plan to ensure compliance with cultural resource regulations.	3.4
EPA: 40 CFR 50-0 40 CFR 82 NYSDEC: 6 NYCRR 200–257 6 NYCRR 307	The Clean Air Act (CAA) and the NY State Environmental Conservation Laws regulate the release of air pollutants through permits and air quality limits. Emissions of radionuclides are regulated by EPA, via the National Emission Standards for Hazardous Air Pollutants (NESHAPs) authorizations.	All air emission sources are incorporated into the BNL Title V permit or have been exempted under the New York State air program, which is codified under the New York Codes, Rules, and Regulations (NYCRR). Radiological air emission sources are registered with the EPA.	3.5

(continued on next page)

Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL *(continued).*

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
EPA: 40 CFR 109–140 40 CFR 230, 231 40 CFR 401, 403 NYSDEC: 6 NYCRR 700–703 6 NYCRR 750	The Clean Water Act (CWA) and NY State Environmental Conservation Laws seek to improve surface water quality by establishing standards and a system of permits. Wastewater discharges are regulated by NYSDEC permits through the State Pollutant Discharge Elimination System (SPDES).	At BNL, permitted discharges include treated sanitary waste, and cooling tower and stormwater discharges. With the exception of eight excursions, these discharges met the SPDES permit limits in 2012.	3.6
EPA: 40 CFR 141–149 NYSDOH: 10 NYCRR 5	The Safe Drinking Water Act (SDWA) and New York State Department of Health (NYSDOH) stan-dards for public water supplies establish mini-mum drinking water standards and monitoring requirements. SDWA requirements are enforced by the Suffolk County Department of Health Ser-vices (SCDHS).	BNL maintains a sitewide public water supply. This water supply met all primary drinking water standards, as well as operational and maintenance requirements.	3.7
EPA: 40 CFR 112 40 CFR 300 40 CFR 302 40 CFR 355 40 CFR 370 40 CFR 372	The Oil Pollution Act, the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Superfund Amendment Reauthorization Act (SARA) require facilities with large quantities of petroleum products or chemicals to prepare emergency plans and report their inventories to EPA, the state, and local emergency planning groups.	Since some facilities at BNL store or use chemicals or petroleum in quantities exceeding threshold planning quan-tities, the Laboratory is subject to these requirements. BNL fully complied with all reporting and emergency planning requirements in 2012.	3.8.1 3.8.2 3.8.3
EPA: 40 CFR 280 NYSDEC: 6 NYCRR 595–597 6 NYCRR 611–613 SCDHS: SCSC Article 12	Federal, state, and local regulations govern the storage of chemicals and petroleum products to prevent releases of these materials to the environment. Suffolk County Sanitary Codes (SCSC) are more stringent than federal and state regulations.	The regulations require that these materials be managed in facilities equipped with secondary containment, overfill pro-tection, and leak detection. BNL complies with all federal and state requirements and has achieved conformance to county codes.	3.8.4 3.8.5 3.8.6
EPA: 40 CFR 260–280 NYSDEC: 6 NYCRR 360–372	The Resource Conservation Recovery Act (RCRA) and New York State Solid Waste Disposal Act govern the generation, storage, handling, and disposal of hazardous wastes.	BNL is defined as a large-quantity generator of hazardous waste and has a permitted waste management facility.	3.9
EPA: 40 CFR 700–763	The Toxic Substances Control Act (TSCA) regulates the manufacture, use, and distribution of all chemicals.	BNL manages all TSCA-regulated materials, including PCBs, in compliance with all requirements.	3.10
EPA: 40 CFR 162–171[f] NYSDEC: 6 NYCRR 320 6 NYCRR 325–329	The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and corresponding NY State regulations govern the manufacture, use, storage, and disposal of pesticides and herbicides, as well as the pesticide containers and residuals.	BNL employs NY State-certified pesticide applicators to apply pesticides and herbicides. Each applicator attends training, as needed, to maintain current certification and files an annual report to the state detailing the types and quantity of pesticides applied.	3.11
DOE: 10 CFR 1022 NYSDEC: 6 NYCRR 663 6 NYCRR 666	DOE regulations require its facilities to comply with flood-plain/wetland review requirements. The New York State Fresh Water Wetlands and Wild, Scenic, and Recreational Rivers rules govern development in the state's natural waterways. Development or projects within a half-mile of regulated waters must have NYSDEC permits.	BNL is in the Peconic River watershed and has several jurisdictional wetlands; consequently, development of loca-tions in the north and east of the site requires NYSDEC permits and review for compliance under DOE wetland/floodplain regulations. In 2012, there were three projects permitted under the NYS Fresh Water Program.	3.12
U.S. Fish & Wildlife Service: 50 CFR 17 NYSDEC: 6 NYCRR 182	The Endangered Species Act and corresponding New York State regulations prohibit activities that would jeopardize the continued existence of an endangered or threatened spe-cies, or cause adverse modification to a critical habitat.	BNL is host to numerous species of flaura and fauna. Many species have been categorized by NYS as endangered, threatened, or of special concern. The Laboratory's Natural Resource Management Plan outlines activities to protect these vulnerable species and protect their habitats (see Chapter 6).	3.13

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Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL *(continued).*

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
U.S. Fish & Wildlife Service: Migratory Bird Treaty Act 16 USC 703-712 The Bald and Golden Eagle Protection Act 16 USC 668 a-d	The Migratory Bird Treaty Act (MBTA) imple-ments various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful. Birds protected under the act include all common songbirds, waterfowl, shorebirds, hawks, owls, eagles, ravens, crows, native doves and pigeons, swifts, martins, swal-lows, and others, and includes their body parts (feathers, plumes etc), nests, and eggs. The Bald and Golden Eagle Protection Act (BGEPA) prohibits any form of possession or taking of both bald and golden eagles.	Compliance with the MBTA and the BGEPA are documented through the BNL Natural Resource Management Plan. The plan includes provisions for enhancing local habitat through the control of invasive species, planting of native grasses as food sources, and construction of nesting sites. All con-struction activities, including demolition, are reviewed to ensure no impacts to nesting individuals.	3.13
DOE: Order 231.1B Manual 231.1-1A	The Environment, Safety, and Health Reporting program objective is to ensure timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed to ensure that DOE is kept fully informed on a timely basis about events that could ad-versely affect the health and safety of the public, workers, the environment, the intended purpose of DOE facilities, or the credibility of the Depart-ment. Included in the order are the requirements for the Occurrence Reporting and Processing of Operations Program (ORPS).	BNL prepares an annual Site Environmental Report and provides data for DOE to prepare annual NEPA summaries and other Safety, Fire Protection, and Occupational Health and Safety Administration (OSHA) reports. The Laboratory developed the ORPS Subject Area for staff and management who perform specific duties related to discovery, response, notification, investigation, and reporting of occurrences to BNL and DOE management. The ORPS Subject Area is supported by: Occurrence Reporting Program Description, Critiques Subject Area, Occurrence Categorizer's Procedure, and the ORPS Office Procedure.	All chapters
DOE: Order 414.1 10 CFR 830, Subpart A Policy 450.5	The Quality Assurance (QA) program objective is to establish an effective management system using the performance requirements of this Order, coupled with technical standards, where appropriate, to ensure: senior management provides planning, organization, direction, control, and support to achieve DOE objectives; line organizations achieve and maintain quality while minimizing safety and health risks and environ-mental impacts, and maximizing reliability and performance; line organizations have a basic management system in place supporting this Order; and each DOE element reviews, evaluates, and improves its overall performance and that of its contractors using a rigorous assessment process based on an approved QA Program.	BNL has a Quality Management (QM) system to implement quality management methodology throughout its management systems and associated processes to: 1) plan and perform Laboratory operations reliably and effectively to minimize the impact on the safety and health of humans and on the environment; 2) standardize processes and support continuous improvement in all aspects of Laboratory operations; and 3) enable the delivery of products and services that meet customers' requirements and expectations. Having a comprehensive program ensures that all environmental monitoring data meet QA and quality control requirements. Samples are collected and analyzed using standard operating procedures, to ensure representative samples and reliable, defensible data. Quality control in the analytical labs is maintained through daily instrument calibration, efficiency and background checks, and testing for precision and accuracy. Data are verified and validated according to project-specific quality objectives before they are used to support decision making.	Chapter 9
DOE: Order 435.1	The Radioactive Waste Management Program (RWMB) objective is to ensure that all DOE radioactive waste is managed in a manner that protects workers, public health and safety, and the environment. Order 435.1 requires all DOE organizations that generate radioactive waste to implement a waste certification program. DOE Laboratories must develop a Radioactive Waste Management Basis (RWMB) Program Description, which includes exemption and time-frame requirements for staging and storing both routine and non-routine radioactive wastes.	The BNL Waste Certification Program Plan (WCPP) in the RWMB Program Description defines the radioactive waste management program's structure, logic, and methodology for waste certification. New or modified operations or activities that do not fall within the scope of the RWMB Program Description must be documented and approved before implementation. The Laboratory's RWMB Program Description describes the BNL policies, procedures, plans, and controls demonstrating that BNL has the management systems, administrative controls, and physical controls to comply with DOE Order 435.1.	2.3.4.3

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Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL *(concluded).*

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
DOE: Order 436.1	The DOE Departmental Sustainability Order replaces former DOE Orders 450.1A Environmental Protection Programs and 430.2B Departmental Energy, Renewable Energy and Transportation Management. The intent of the new order is to incorporate and implement the requirements of E.O 13514 and to continue compliance with E.O. 13423. The new order is supported by DOE requirements for sound sustainability programs implemented under the DOE 2010 Strategic Sustainability Performance Plan. Contractor requirements under the order require preparation of a site sustainability plan and implementation of a sound Environmental Management System (EMS).	In accordance with the requirements of the DOE Strategic Sustainability Performance Plan BNL has developed and implemented a Site Sustainability Plan. The Goals and Strategic Objectives of the DOE SSPP are tracked and reported on annually. BNL's EMS was officially registered to the ISO 14001:1996 standard in 2001 and recertified to the revised standard in 2004, 2007 and 2010. In June 2012, an external surveillance audit was conducted that found the BNL EMS to be functioning well.	Chapter 2
DOE: Order 458.1, Change 2	In February 2011, DOE released DOE Order 458.1 Radiation Protection of the Public and Environment which replaced former Order 5400.5. The order establishes requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE pursuant to the Atomic Energy Act of 1954, as amended. The Order requires the preparation of an Environmental Radiation Protection Plan which outlines the means by which facilities monitor their impacts on the public and environment. Full compliance with the Order is required by August 2012.	In accordance with the requirements of DOE Order 458.1, Brookhaven National Laboratory (BNL) main-tains and implements several plans and programs for ensuring that the management of facilities, wastes, effluents, and emissions does not present risk to the public, workers, or environment. These plans and programs have existed for decades and were previously implemented under prior DOE Order 5400.5 and in accordance with the current DOE O 435.1, Radioactive Waste Management, and 10 CFR 835. Environmental monitoring plans are well documented and the results are published annually in the Site Environmental Report prepared in accordance with DOE O 231.1B. The Environmental Radiation Protection Program (ERPP), which was published in September 2012, provides a record of the requirements of DOE O 458.1 and documents how BNL meets these requirements.	Chapters 4, 5, 6 & 8

Notes:
CFR = Code of Federal Regulations
NYCRR = New York Codes, Rules, and Regulations
SCSC = Suffolk County Sanitary Code

issued by the United States Environmental Protection Agency (EPA) under the National Emission Standards for Hazardous Air Pollutants (NESHAPs)

- Air emissions permit, issued by NYSDEC under Title V of the Clean Air Act (CAA) Amendments authorizing the operation of 37 emission sources
- Three permits issued by NYSDEC for construction activities within the Peconic River corridor
- EPA Underground Injection Control (UIC) Area permit for the operation of 133 UIC wells
- Permit for the operation of six domestic water supply wells, issued by NYSDEC
- Thirteen equivalency permits for the operation of groundwater remediation systems installed via the Interagency Agreement (Federal Facility Agreement under the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA])

3.2.2 New or Modified Permits

3.2.2.1 SPDES Permits

In June 2009, NYSDEC finalized a major modification to BNL's SPDES permit. This modification was initiated in 2007 as a comprehensive review of the Laboratory's Sewage Treatment Plant (STP) and evaluation of point source discharges from BNL operations. The modified permit proposed significant reductions in the concentration of six metals (copper, iron, lead, mercury, nickel, and zinc) discharged from BNL's STP to the Peconic River. Studies were completed to assess the sources of these metals and to evaluate the feasibility of achieving new discharge limits. In order to achieve compliance

Table 3-2. BNL Environmental Permits.

Issuing Agency	Bldg. or Facility	Process/Permit Description	Permit ID No.	Expiration or Completion	Emission Unit ID	Source ID
EPA - NESHAPs	510	Calorimeter Enclosure	BNL-689-01	None	NA	NA
EPA - NESHAPs	705	Building Ventilation	BNL-288-01	None	NA	NA
EPA - NESHAPs	820	Accelerator Test Facility	BNL-589-01	None	NA	NA
EPA - NESHAPs	AGS	AGS Booster - Accelerator	BNL-188-01	None	NA	NA
EPA - NESHAPs	RHIC	Accelerator	BNL-389-01	None	NA	NA
EPA - NESHAPs	931	Brookhaven Linear Isotope Producer	BNL-2009-1	None	NA	NA
NYSDEC - NESHAPs	REF	Radiation Effects/Neutral Beam	BNL-789-01	None	NA	NA
NYSDEC - NESHAPs	RTF	Radiation Therapy Facility	BNL-489-01	None	NA	NA
EPA - SDWA	BNL	Underground Injection Control	NYU500001	(a)	NA	NA
NYSDEC - Air Equivalency	517/518	South Bdry/Middle Road System	1-51-009	NA	NA	NA
NYSDEC - Air Equivalency	598	OU I Remediation System	1-52-009	NA	NA	NA
NYSDEC - Air Equivalency	539	Western South Boundary System	1-52-009	NA	NA	NA
NYSDEC - Air Equivalency	TR 867	T-96 Remediation System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	517/518	South Bdry/Middle Road System	1-51-009	NA	NA	NA
NYSDEC - SPDES Equivalency	539	West South Boundary System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	598	OU I Remediation System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	598	Tritium Remediation System	1-52-009	04-May-16	NA	NA
NYSDEC - SPDES Equivalency	670	Sr-90 Treatment System	None	25-Feb-18	NA	NA
NYSDEC - SPDES Equivalency	TR 829	Carbon Tetrachloride System	None	Closed out 2010	NA	NA
NYSDEC - SPDES Equivalency	OS-4	Airport/LIPA Treatment System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-2	Industrial Park East Treatment System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-5	North St./North St. East Treatment System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-6	Ethylene Di-Bromide Treatment System	None	16-Dec-14	NA	NA
NYSDEC - SPDES Equivalency	855	Sr-90 Treatment System - BGRR/WCF	None	16-Dec-14	NA	NA
NYSDEC - SPDES Equivalency	TR 867	T-96 Remediation System	1-52-009	20-Mar-17	NA	NA
NYSDEC - SPDES Equivalency	644	Freon-11 Treatment System	None	NA	NA	NA
NYSDEC - Hazardous Substance	BNL	Bulk Storage Registration Certificate	1-000263	27-Jul-13	NA	NA
NYSDEC - LI Well Permit	BNL	Domestic Potable/Process Wells	1-4722-00032/00113	13-Sep-18	NA	NA
NYSDEC - Air Quality	197	Lithographic Printing Presses	1-4722-00032/00115	29-Jun-13	U-LITHO	19709-10
NYSDEC - Air Quality	423	Metal Parts Cleaning Tanks	1-4722-00032/00115	29-Jun-13	U-METAL	42308
NYSDEC - Air Quality	423	Gasoline Storage and Fuel Pumps	1-4722-00032/00115	29-Jun-13	U-FUELS	42309-10
NYSDEC - Air Quality	423	Motor Vehicle A/C Servicing	1-4722-00032/00115	29-Jun-13	U-MVACS	MVAC1- 4
NYSDEC - Air Quality	244	Paint Spray Booth	1-4722-00032/00115	29-Jun-13	U-PAINT	244-02
NYSDEC - Air Quality	244	Flammable Liquid Storage Cabinet	1-4722-00032/00115	29-Jun-13	U-PAINT	244 AE
NYSDEC - Air Quality	479	Metal Parts Cleaning Tank	1-4722-00032/00115	29-Jun-13	U-METAL	47908
NYSDEC - Air Quality	510	Spin Coating Operation	1-4722-00032/00115	29-Jun-13	U-INSIG	510 AR
NYSDEC - Air Quality	801	Target Processing Laboratory	1-4722-00032/00115	29-Jun-13	U-INSIG	80101
NYSDEC - Air Quality	Site	Aerosol Can Processing Units	1-4722-00032/00115	29-Jun-13	U-INSIG	AEROS
NYSDEC - Air Quality	498	Aqueous Cleaning Facility	1-4722-00032/00115	29-Jun-13	U-METAL	49801
NYSDEC - Air Quality	535B	Plating Tanks	1-4722-00032/00115	29-Jun-13	U-INSIG	53501
NYSDEC - Air Quality	535B	Etching Machine	1-4722-00032/00115	29-Jun-13	U-INSIG	53502
NYSDEC - Air Quality	535B	Printed Circuit Board Process	1-4722-00032/00115	29-Jun-13	U-INSIG	53503
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	29-Jun-13	U-61005	61005

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Table 3-2. BNL Environmental Permits *(concluded).*

Issuing Agency	Bldg. or Facility	Process/Permit Description	Permit ID No.	Expiration or Completion	Emission Unit ID	Source ID
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	29-Jun-13	U-61006	61006
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	29-Jun-13	U-61007	61007
NYSDEC - Air Quality	610	Metal Parts Cleaning Tray	1-4722-00032/00115	29-Jun-13	U-METAL	61008
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	29-Jun-13	U-61005	6101A
NYSDEC - Air Quality	630	Gasoline Storage and Fuel Pumps	1-4722-00032/00115	29-Jun-13	U-FUELS	63001-03
NYSDEC - Air Quality	630	Parts Cleaning Tray	1-4722-00032/00115	29-Jun-13	U-METAL	630 AB
NYSDEC - Air Quality	902	Epoxy Coating/Curing Exhaust	1-4722-00032/00115	29-Jun-13	U-COILS	90206
NYSDEC - Air Quality	903	Metal Parts Cleaning Tank	1-4722-00032/00115	29-Jun-13	U-METAL	90304
NYSDEC - Air Quality	919B	Electroplating Operation	1-4722-00032/00115	29-Jun-13	U-INSIG	91904
NYSDEC - Air Quality	630	Parts Cleaning Tray	1-4722-00032/00115	29-Jun-13	U-METAL	630 AD
NYSDEC - Air Quality	922	Electroplating Operation	1-4722-00032/00115	29-Jun-13	U-INSIG	92204
NYSDEC - Air Quality	923	Electronic Equipment Cleaning	1-4722-00032/00115	29-Jun-13	U-METAL	9231A
NYSDEC - Air Quality	923	Parts Drying Oven	1-4722-00032/00115	29-Jun-13	U-METAL	9231B
NYSDEC - Air Quality	924	Magnet Coil Production Press	1-4722-00032/00115	29-Jun-13	U-INSIG	92402
NYSDEC - Air Quality	924	Vapor/Ultrasonic Degreasing Unit	1-4722-00032/00115	29-Jun-13	U-METAL	92404
NYSDEC - Air Quality	Site	Halon 1211 Portable Extinguishers	1-4722-00032/00115	29-Jun-13	U-HALON	H1211
NYSDEC - Air Quality	Site	Halon 1301 Fire Suppression Systems	1-4722-00032/00115	29-Jun-13	U-HALON	H1301
NYSDEC - Air Quality	Site	Packaged A/C Units	1-4722-00032/00115	29-Jun-13	U-RFRIG	PKG01-02
NYSDEC - Air Quality	Site	Reciprocating Chillers	1-4722-00032/00115	29-Jun-13	U-RFRIG	REC01-53
NYSDEC - Air Quality	Site	Rotary Screw Chillers	1-4722-00032/00115	29-Jun-13	U-RFRIG	ROTO1-11
NYSDEC - Air Quality	Site	Split A/C Units	1-4722-00032/00115	29-Jun-13	U-RFRIG	SPL01-02
NYSDEC - Air Quality	Site	Centrifugal Chillers	1-4722-00032/00115	29-Jun-13	U-RFRIG	CEN01-24
NYSDEC - Hazardous Waste	WMF	Waste Management	1-4722-00032/00102	19-Nov-16	NA	NA
NYSDEC - Water Quality	CSF	Major Petroleum Facility	1-1700	31-Mar-17	NA	NA
NYSDEC - Water Quality	STP	STP and Recharge Basins	NY-0005835	28-Feb-15	NA	NA
NYSDEC - Water Quality	Site	Solar farm construction	1-4722-05846/00001	06-May-15	NA	NA
NYSDEC - Water Quality	Site	Construction of Fences and Platforms at RHIC	1-4722-00032/00144	11-Jul-16	NA	NA

(a) Permit renewal under review by EPA
A/C = Air Conditioning
AGS = Alternating Gradient Synchrotron
BGRR = Brookhaven Graphite Research Reactor
CSF = Central Steam Facility
EPA = Environmental Protection Agency
LIPA = Long Island Power Authority
NA = Not Applicable
NESHAPs = National Emission Standards for Hazardous Air Pollutants
NYSDEC = New York State Department of Environmental Conservation
OU = Operable Unit
RTF = Radiation Therapy Facility
RHIC = Relativistic Heavy Ion Collider
SDWA = Safe Drinking Water Act
SPDES = State Pollutant Discharge Elimination System
Sr-90 = Strontium-90
STP = Sewage Treatment Plant
WCF = Waste Concentration Facility
WMF = Waste Management Facility

with the required discharge limits at the STP, a decision was made to modify the STP from a surface water discharge to a groundwater discharge system. Final design and specifications were approved by NYSDEC and the Suffolk Country Department of Health Services (SCDHS) in November 2012. The modified treatment process is scheduled to be completed by September 2014, and a modified SPDES permit application to reflect this change was prepared and submitted to NYSDEC for review in May 2012.

Included in the May 2012 permit modification was a request to change an existing September 2012 SPDES permit mercury limit from 50 ng/L to 100 ng/L until construction of a new filtration system and recharge basins are complete. In September 2012, BNL received a letter from NYSDEC extending the current 200 ng/L mercury limit for 6 months or upon issuance of the above-mentioned SPDES permit modification, whichever comes first. This decision was based on BNL's efforts to implement a successful mercury minimization program and ultimate plans to relocate the on-site wastewater treatment plant discharge to groundwater via recharge basins.

3.2.2.2 New York State Wetlands and Wild Scenic, Recreational Rivers Act

Two actions continued and one new action commenced in 2012 that required permits under the New York State Wetland and/or Wild, Scenic and Recreational Rivers Act legislation. Continuation projects included post-construction activities associated with the on-site Long Island Solar Farm (LISF) and the installation of fencing and air conditioning platforms at the Relativistic Heavy Ion Collider (RHIC). A new project for the construction of recharge basins associated with upgrades to the Laboratory's STP was initiated in 2012, which will allow for the eventual discharge of tertiary-treated wastewater directly to groundwater.

3.2.2.3 CERCLA Groundwater Equivalency Permits

During 2012, BNL maintained SPDES equivalency permits for 12 groundwater remediation systems where treated groundwater is discharged to either recharge basins or injection wells. In March 2012, NYSDEC issued an equivalency permit for the recently installed Building 452 Freon-11 Plume groundwater treatment system. The system started full-time operation in April 2012.

3.3 NEPA ASSESSMENTS

The National Environmental Policy Act (NEPA) regulations require federal agencies to evaluate the environmental effects of proposed major federal activities. The prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made. During 2012, environmental evaluations were completed for 104 proposed projects at BNL. Of those, 96 were considered minor actions requiring no additional documentation. Eight projects were addressed by submitting notification forms to DOE, which determined that seven of the projects were covered by existing "Categorical Exclusions" per 10 CFR 1021 or fell within the scope of a previous environmental assessment. One project, Management of the White-tailed Deer (Odocoileus virginianus) Population at Brookhaven National Laboratory, was determined to require an Environmental Assessment (EA) that will be completed in 2013. The Laboratory's three general categorical exclusions, which most of the research is conducted under, were updated and approved by DOE. These included bench scale work, general maintenance, and Work for Others/CRADA.

3.4 PRESERVATION LEGISLATION

The Laboratory is subject to several cultural resource laws, most notably the National Historic Preservation Act and the Archeological Resource Protection Act. These laws require agencies to consider the effects of proposed federal actions on historic structures, objects, and documents, as well as cultural or natural places important to Native Americans or other ethnic or cultural groups.

BNL has three structures or sites that are eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor (BGRR) complex, the High Flux Beam Reactor (HFBR) complex, and the World War I Army training trenches associated with Camp Upton. Several other structures are also of historic significance as identified in BNL's Cultural Resources Management Plan, including the Brookhaven Center, and Building 120. Two other buildings, Berkner Hall and the Chemistry Building, are considered Architecturally Significant. A Department of Interior questionnaire regarding historic and cultural resources is prepared annually. Additional activities associated with historic preservation compliance are described in Chapter 6.

3.5 CLEAN AIR ACT

The objectives of the CAA, which is administered by EPA and NYSDEC, are to improve or maintain regional ambient air quality through operational and engineering controls on stationary or mobile sources of air pollution. Both conventional and hazardous air pollutants are regulated under the CAA.

3.5.1 Conventional Air Pollutants

The Laboratory has a variety of conventional, nonradioactive air emission sources that are subject to federal or state regulations. The following subsections describe the more significant sources and the methods used by BNL to comply with the applicable regulatory requirements.

3.5.1.1 Boiler Emissions

BNL has four boilers (Nos. 1A, 5, 6, and 7) at the Central Steam Facility (CSF) that are subject to NYSDEC "Reasonably Available Control Technology" (RACT) requirements. Three of the boilers can burn either residual fuel oil or natural gas; Boiler 1A burns fuel oil only. In 2012, natural gas was the predominant fuel burned at the CSF. For boilers with maximum operating heat inputs greater than or equal to 25 MMBtu/hr (7.3 MW), the RACT requirements establish emission standards for oxides of nitrogen (NOx). Boilers with a maximum operating heat input between 25 and 250 MMBtu/hr (7.3 and 73.2 MW) can demonstrate compliance with the NOx standard using periodic emission tests or by using continuous emission monitoring equipment. Emission tests conducted in 1995 and 2006 confirmed that boilers 1A and 5, both in this size category, met the NOx emission standards when burning residual fuel oil with low nitrogen content. To ensure continued compliance, an outside contract analytical laboratory analyzes composite samples (collected quarterly) of fuel deliveries. The analyses conducted in 2012 confirmed that the fuel-bound nitrogen content met these requirements. Compliance with the 0.30 lbs/MMBtu NOx emission standards for boilers 6 and 7 was demonstrated by continuous emission monitoring of the flue gas. In 2012, NOx emissions from Boilers 6 and 7 averaged 0.088 lbs/MMBtu and 0.081 lbs/MMBtu, respectively. There were no known exceedances of the NOx emission standard for either boiler.

The Laboratory also maintains continuous opacity monitors for boilers 6 and 7. These monitors measure the transmittance of light through the exhaust gas and report the measurement in percent attenuated. Opacity limitations state that no facility may emit particulates such that the opacity exceeds 20 percent, calculated in 6-minute averages, except for one period not to exceed 27 percent in any one hour. In January 2012, there were nine 6-minute periods where measured opacity readings for Boiler 6 exceeded 20 percent. These were due to a sudden buildup of soot (with no apparent cause) across the transmissometer light path. Subsequent shut down of the boiler and cleaning of the light path brought recorded opacity readings back to normal. The only other reported periods when opacity measurements for Boilers 6 or 7 exceeded the 6-minute, 20 percent average, occurred during quarterly calibration error tests of the opacity monitors. These opacity measurements were artificially induced when opacity attenuator filters were inserted across the opacity transmissometer light path during the calibration error tests and are not considered excess opacity readings.

3.5.1.2 Ozone-Depleting Substances

Refrigerant: The Laboratory's preventative maintenance program requires regular inspection and maintenance of refrigeration and air conditioning equipment that contains ozone-depleting substances such as R-11, R-12, and R-22. All refrigerant recovery and recycling equipment is certified to meet refrigerant evacuation levels specified by 40 CFR 82.158. As a matter of BNL's standard practice, if a refrigerant leak is found, technicians will either immediately repair the leak or isolate it and prepare a work order for the needed repairs. This practice is more stringent than the leak repair provisions of 40 CFR 82.156. In 2012, 1,319 pounds of R-11, 20 pounds of R-12, 436 pounds of R-22, and 2 pounds of R-401a were recovered and recycled from refrigeration equipment that was serviced.

Halon: Halon 1211 and 1301 are extremely efficient fire suppressants, but are being phased out due to their effect on the earth's ozone layer. In 1998, the Laboratory purchased equipment to comply with the halon recovery and recycling requirements of the CAA, 40 CFR 82 Subpart H. When portable fire extinguishers or fixed systems are removed from service and when halon cylinders are periodically tested, BNL technicians use halon recovery and recycling devices to comply with CAA provisions. Halon recovered from excessed systems is stored for reuse by BNL or shipped to the Department of Defense Ozone Depleting Substances Reserve.

In 2012, 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. In December 2012, the Laboratory transferred excess ozone depleting substances to the Department of Defense Ozone Depleting Substances Reserve in Richmond, Virginia. The transfer included 3,158 pounds of Halon 1211 from excessed potable extinguishers, 1,318 pounds of Halon 1301 from fixed fire suppression systems removed from service, and 460 pounds of R-500 from refrigeration equipment no longer in service. The transfer was made in accordance with the Class I Ozone Depleting Substances Disposition Guidelines prepared by the DOE Office of Environmental Policy and Guidance.

3.5.2 Hazardous Air Pollutants

In 1970, the CAA established standards to protect the general public from hazardous air pollutants that may lead to death or an increase in irreversible or incapacitating illnesses. The NESHAPs program was established in 1977 and the governing regulations were updated significantly in 1990. EPA developed NESHAPs to limit the emission of 189 toxic air pollutants. The program includes a list of regulated contaminants, a schedule for implementing control requirements, aggressive technology-based emission standards, industry-specific requirements, special permitting provisions, and a program to address accidental releases. The following subsections describe BNL's compliance with NESHAPs regulations.

3.5.2.1 Maximum Available Control Technology

Based on the Laboratory's periodic review of Maximum Available Control Technology (MACT) standards in 2012, it has been determined that none of the proposed or newly promulgated MACT standards apply to the emissions from existing permitted operations or the anticipated emissions from proposed activities and operations at BNL.

3.5.2.2 Asbestos

In 2012, the Laboratory notified the EPA Region II office regarding removal of materials containing asbestos. During the year, 9,500 linear feet of pipe insulation, 145,930 square feet of non-friable (e.g. floor tiles, siding material), and 120 cubic yards of asbestos-containing debris were removed and disposed of according to EPA requirements.

3.5.2.3 Radioactive Airborne Emissions

Minor and major sources of radiological emissions are evaluated from BNL's facilities and activities to ensure that they do not impact the environment, on-site workers, or people residing at or near the Laboratory. A full description of radiological emissions monitoring conducted in 2012 is provided in Chapter 4. BNL transmitted all data pertaining to radioactive air emissions and dose calculations to EPA in fulfillment of the June 30 annual reporting requirement. As in past years, the maximum off-site dose due to airborne radioactive emissions from the Laboratory continued to be far below the 10 mrem (100 µSv) annual dose limit specified in 40 CFR 61 Subpart H (see Chapters 4 and 8 for more information on the estimated air dose). Using EPA modeling software, the dose to the hypothetical maximally exposed individual resulting from BNL's airborne emissions in 2012 was 2.30E-01 mrem (≈2.0 µSv).

In July 2012, a representative from EPA visited the site and met with BNL and DOE personnel for the purpose of reviewing the Laboratory's implementation and compliance with Subpart H, 40 CFR 61. During this review, EPA identified two findings that resulted in a noncompliance with Subpart H. In reviewing the

Annual NESHAPs Report with BNL staff, the EPA inspector identified that BNL was reporting calculated dose to a hypothetical Maximally Exposed Individual (MEI) at the fence line and not a Maximally Exposed Off-Site Individual (MEOSI) at an actual point where there is a residence, school, business, or office, as required in Subpart H. In addition, the inspector noted that the wind rose data (see Chapter 1 for full description of wind rose) illustrated in BNL's Site Environmental Report and the wind file used in the CAP-88 calculations were inconsistent, which lead to incorrect identification of the MEOSI. BNL submitted a revised annual report on August 30, 2012, which addressed the two non-compliance findings; on December 3, 2012, EPA concluded that BNL was in compliance with Subpart H.

3.6 CLEAN WATER ACT

The disposal of wastewater generated by Laboratory operations is regulated under the Clean Water Act (CWA) as implemented by NYSDEC and under DOE Order 458.1, Radiation Protection of the Public and the Environment. The goals of the CWA are to achieve a level of water quality that promotes the propagation of fish, shellfish, and wildlife; to provide waters suitable for recreational purposes; and to eliminate the discharge of pollutants into surface waters. New York State was delegated CWA authority in 1975. NYSDEC has issued a SPDES permit to BNL to regulate wastewater effluents from the Laboratory. The permit was significantly modified in June 2009 and renewed, effective March 1, 2010. The permit specifies monitoring requirements and effluent limits for 9 of 12 outfalls, as described below. See Figure 5-5 in Chapter 5 for the locations of BNL outfalls.

- Outfall 001 is used to discharge treated effluent from the STP to the Peconic River.
- Outfalls 002, 002B, 003, 005, 006A, 006B, 008, 010, 011, and 012 are recharge basins used to discharge cooling tower blow-down, once-through cooling water, and/or stormwater. Since only stormwater or once-through cooling water is discharged to Outfalls 003, 011, and 012, NYSDEC imposes no monitoring requirements for these discharges.
- Outfall 007 receives backwash water from the Potable Water Treatment Plant filter building.
- Outfall 009 consists of numerous subsurface and surface wastewater disposal systems (e.g., drywells) that receive predominantly sanitary waste and steam- and air-compressor condensate discharges. NYSDEC does not require monitoring of this outfall.

Each month, the Laboratory prepares Discharge Monitoring Reports that describe monitoring results, evaluate compliance with permit limitations, and identify corrective measures taken to address permit excursions. These reports are submitted to NYSDEC central and regional offices and SCDHS. Details of the monitoring program conducted for the groundwater treatment systems and of SPDES equivalency permit performance are provided in SER Volume II, Groundwater Status Report. Evaluation of the current effluent quality shows it to consistently meet all groundwater effluent standards, and in most cases, ambient water quality standards for groundwater.

As stated in Section 3.2.2.1, BNL is in the process of modifying its SPDES permit to reflect an approved modified treatment process that will replace the existing sand filters with free standing self-enclosed filtration units and divert the discharge to on-site recharge basins. A NEPA EA for this upgrade project was prepared in 2011 and a Finding of No Significant Impact was issued by DOE. Final design and specifications for the modified treatment process were approved by NYSDEC and SCDHS in November 2012. Field preparation activities were initiated in August 2012 and construction will be completed by September 2014.

3.6.1 Sewage Treatment Plant

Sanitary and process wastewater generated by BNL operations is conveyed to the STP for processing before discharge to the Peconic River. The STP provides tertiary treatment of the wastewater and includes the following processes: settling/sedimentation, biological reduction of organic matter and nitrogen, sand filtration, and UV disinfection. Chapter 5 provides a detailed description of the treatment process.

A summary of SPDES monitoring results for the STP discharge at Outfall 001 is provided in Table 3-3. The relevant SPDES permit limits are also shown. The Laboratory monitors the STP discharge for more than 100 parameters monthly and more than 200 parameters quarterly. BNL's overall compliance with effluent limits was greater than 99 percent in 2012.

There were three excursions of the SPDES permit limits at Outfall 001 in 2012: iron, total nitrogen, and total nitrogen loading. In January, the total iron concentration in the wastewater effluent sample for Outfall 001 was reported at 0.55mg/L, which exceeded the SPDES limit of 0.37 mg/L. In October, the total nitrogen concentration was 10.8 mg/L and the maximum total nitrogen load was calculated at 22.5 pounds per day, which exceeds the permit limits of 10 mg/L and 20 pounds per day, respectively. All other parameters at Outfall 001 were within permit limits.

Upstream sources of soluble iron were investigated in January and none were identified. Attention was then turned toward the STP process to determine what process parameter could be adjusted to reduce the levels of soluble iron in the effluent. Increased aeration of the treatment tanks was initiated in February, which proved effective in decreasing soluble iron levels in the effluent.

Maintenance (i.e. re-coating of concrete surfaces) being performed on the primary and backup modular aeration tanks in late September/early October, which disrupted biological activities, and lower than normal flow conditions were identified as the most likely causes to the increased levels of nitrogen in the discharge. Figures 3-1 through 3-7 plot the 5-year trends for the monthly concentrations of copper, iron, lead, mercury, nickel, silver, and zinc in the STP discharge.

3.6.1.1 Chronic Toxicity Testing

The Laboratory's SPDES permit requires that "whole effluent toxicity" (WET) tests be conducted to ensure that chemicals present in the STP effluent are not toxic to aquatic organisms. In 2012, BNL continued to perform quarterly chronic toxicity testing using water fleas (Ceriodaphnia dubia). In each test, sets of 10 organisms are exposed to varying concentrations of the STP effluent (100, 75, 50, 25, and 12.5 percent) for 7 days. During testing, the rate of reproduction for the water flea is measured and compared to

Table 3-3. Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001.

Analyte	Low Report	High Report	Min. Monitoring. Freq.	SPDES Limit	Exceedances	% Compliance*
Max. temperature (°F)	50	81	Daily	90	0	100
pH (SU)	6.5	7.5	Continuous Recorder	Min 5.8, Max. 9.0	0	100
Max. 5-Day BOD (mg/L)	<2	<2	Twice Monthly	5	0	100
% BOD Removal	> 85	> 98	Monthly	85	0	100
Max. TSS (mg/L)	<0.5	<0.6	Twice Monthly	20	0	100
% TSS Removal	> 99	>99	Monthly	85	0	100
Settleable solids (ml/L)	0	0	Daily	0.1	0	100
Ammonia nitrogen (mg/L)	< 0.1	0.39	Twice Monthly	1.5	0	100
Total nitrogen (mg/L)	1.24	10.8	Twice Monthly	10	1	96
Total nitrogen (lbs./day)	11	22.5 (b)	(May – October)	20	1	83
Total phosphorus (mg/L)	0.6	1.7	Twice Monthly	NA	0	100
Cyanide (mcg/L)	< 1.5	< 3.3	Twice Monthly	100	0	100
Copper (mg/L)	0.015	0.106	Twice Monthly	0.15	0	100
Iron (mg/L)	0.072	0.552 (a)	Twice Monthly	0.37	1	96
Lead (mg/L)	<0.001	0.009	Twice Monthly	0.019	0	100
Mercury (ng/L)	32	74	Twice Monthly	200	0	100

(continued on next page)

Table 3-3. Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001 *(concluded).*

Analyte	Low Report	High Report	Min. Monitoring. Freq.	SPDES Limit	Exceedances	% Compliance*
Methylene chloride (ug/L)	< 2	< 5.9	Twice Monthly	5	0	100
Nickel (mg/L)	0.002	0.006	Twice Monthly	0.11	0	100
Silver (mg/L)	< 0.001	0.004	Twice Monthly	0.015	0	100
Toluene (ug/L)	< 1	< 1	Twice Monthly	5	0	100
Zinc (mg/L)	0.016	0.092	Twice Monthly	0.1	0	100
1,1,1-trichloroethane (ug/L)	< 1	< 1	Twice Monthly	5	0	100
2-butanone (ug/L)	< 5	< 5	Twice Monthly	50	0	100
PCBs (ug/L)	< 0.05	< 0.2	Quarterly	NA	0	100
Max. Flow (MGD)	0.33	1.10	Continuous Recorder	2.3	0	100
Avg. Flow (MGD)	0.26	0.50	Continuous Recorder	NA	0	100
Avg. Fecal Coliform (MPN/100 ml)	<1	4.5	Twice Monthly	200	0	100
Max. Fecal Coliform (MPN/100 ml)	<2	8	Twice Monthly	400	0	100
HEDP (mg/L)	<0.05	<0.25	Monthly	NA	0	100
Tolytriazole (mg/L)	< 0.005	< 0.005	Monthly	NA	0	100

Notes:
See Chapter 5, Figure 5-5, for location of Outfall 001.
* % Compliance = total no. samples – total no. exceedances/total no. of samples x 100
BOD = Biological Oxygen Demand
HEDP = 1-Hydroxyethylidene Diphosphonic acid
MGD = Million Gallons per Day
MPN = Most Probable Number
NA = Not Applicable
SPDES = State Pollutant Discharge Elimination System
SU = Standard Unit
TSS = Total Suspended Solids
(a) A single permit exceedance for iron was reported in January. See Section 3.6.1 for an explanation of this permit exceedance.
(b) A single permit exceedance for total nitrogen load was reported in October.

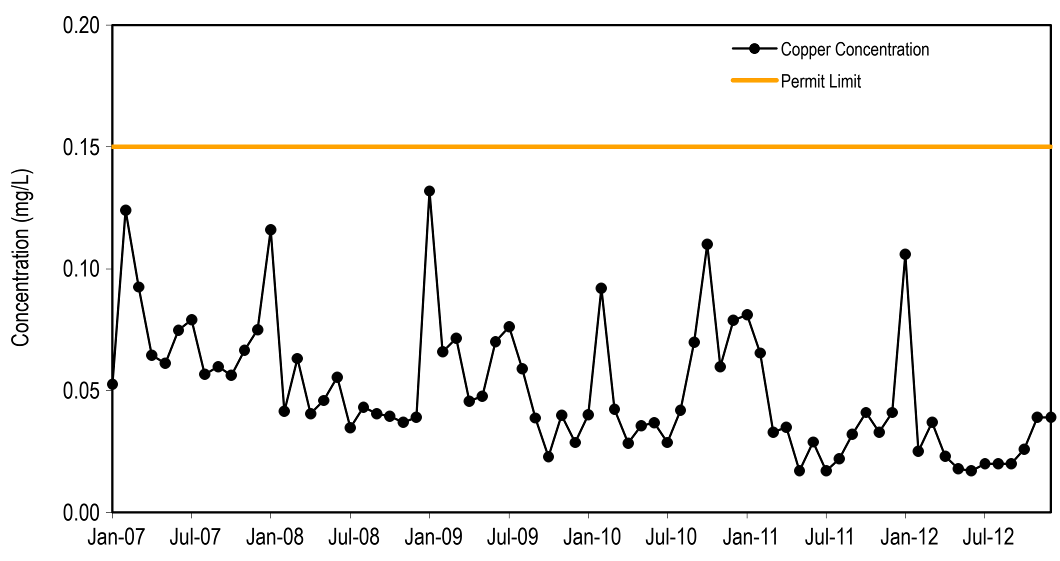


Figure 3-1. Maximum Concentrations of Copper Discharged from the BNL Sewage Treatment Plant, 2007–2012.

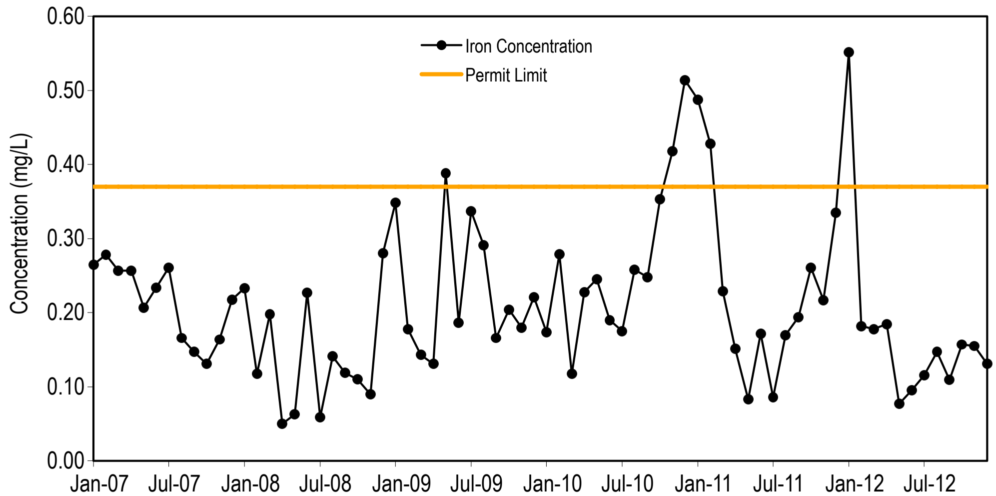


Figure 3-2. Maximum Concentrations of Iron Discharged from the BNL Sewage Treatment Plant, 2007–2012.

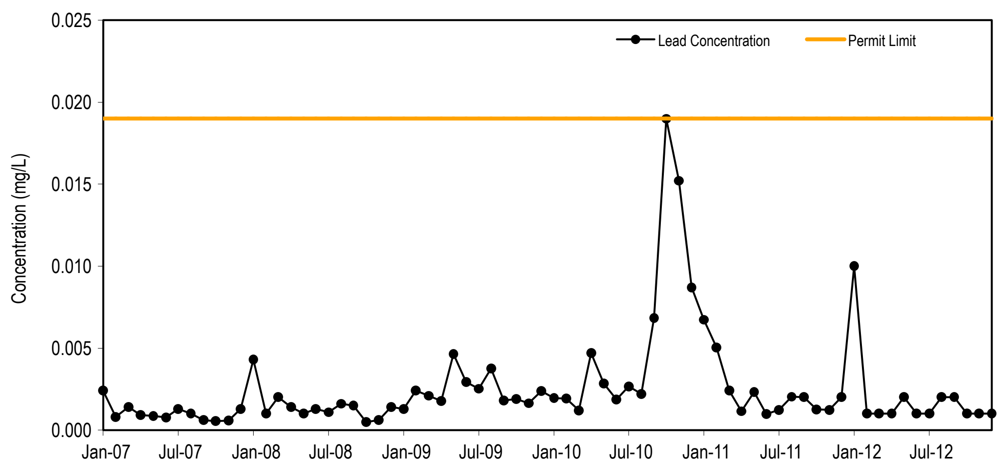


Figure 3-3. Maximum Concentrations of Lead Discharged from the BNL Sewage Treatment Plant, 2007–2012.

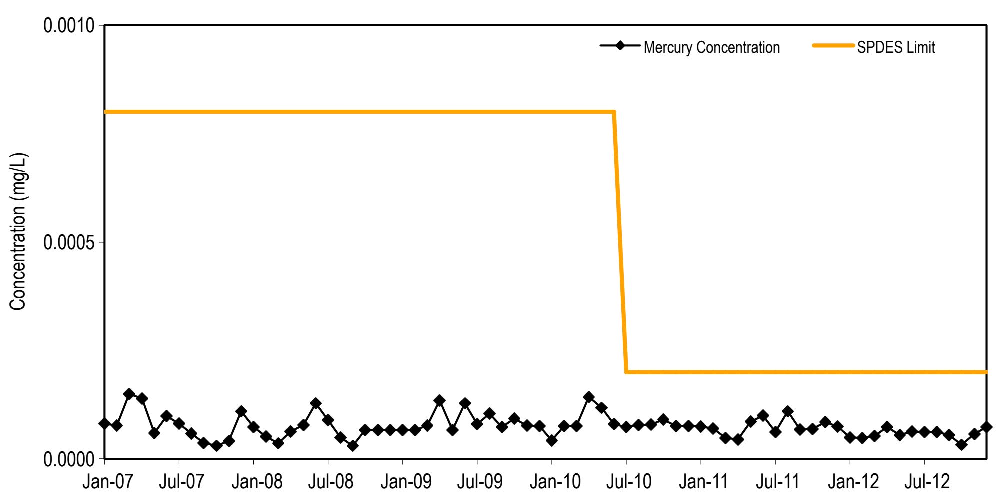


Figure 3-4. Maximum Concentrations of Mercury Discharged from the BNL Sewage Treatment Plant, 2007–2012.

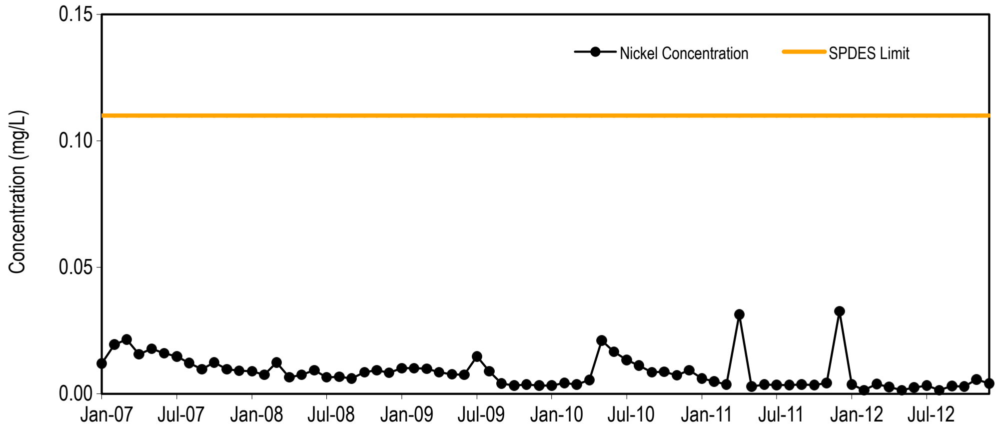


Figure 3-5. Maximum Concentrations of Nickel Discharged from the BNL Sewage Treatment Plant, 2007–2012.

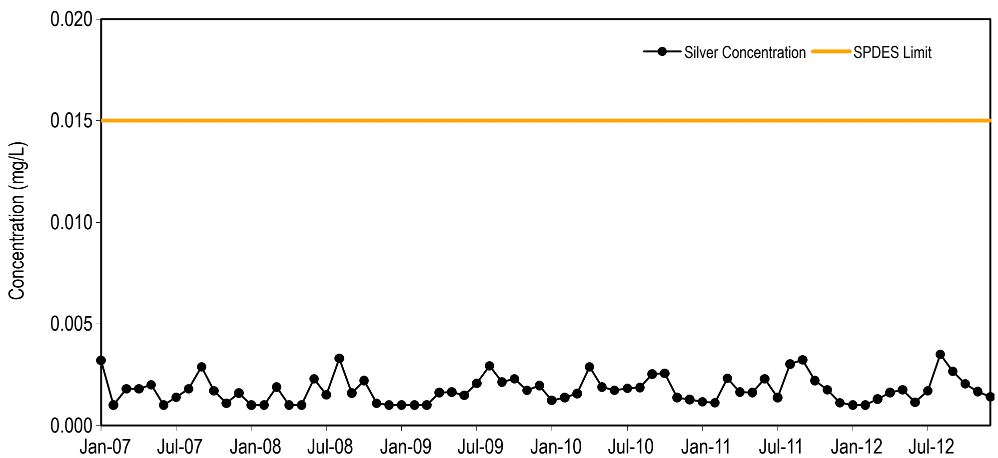
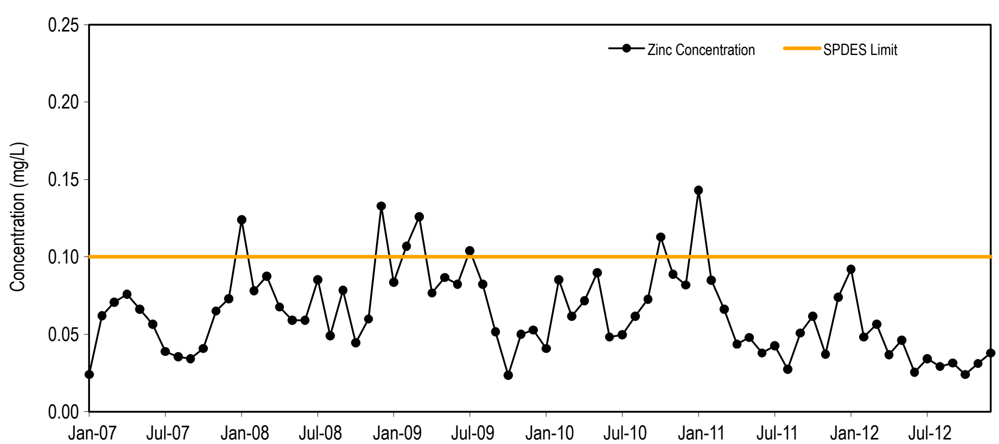


Figure 3-6. Maximum Concentrations of Silver Discharged from the BNL Sewage Treatment Plant, 2007–2012.



Note: Per New York State Department of Environmental Conservation guidance, the concentrations of zinc exhibited in the effluent during January and December 2008, February, March, July 2009, October 2010, and January 2011 were not considered in violation of the State Pollutant Discharge Elimination System effluent limit of 0.1 mg/L, due to rounding off of significant figures.

Figure 3-7. Maximum Concentrations of Zinc Discharged from the BNL Sewage Treatment Plant, 2007–2012.

untreated organisms (i.e., controls). The test results are submitted to NYSDEC for review.

Testing in 2012 showed that there was no toxicity demonstrated in the four tests performed. Reproduction and survival rates were comparable to the control population, indicating that the STP effluent is not toxic to invertebrate organisms. Under the terms of BNL's SPDES permit, testing is required throughout the term of the permit; consequently, testing will continue in 2013.

3.6.2 Recharge Basins and Stormwater

Water discharged to Outfalls 002 through 008 and Outfalls 010 through 012 recharges to groundwater, replenishing the underlying aquifer. Monitoring requirements for each of these discharges vary, depending on the type of wastewater received and the type of cooling water treatment reagents used. Table 3-4 summarizes the monitoring requirements and performance results.

There were five pH excursions and one oil and grease excursion reported for these outfalls during 2012. Samples collected from Outfall 008 (HW) in January, June, August, and December exhibited pH values of 9.1, 9.1, 9.2, and 9.6, respectively, which exceeded the SPDES permit limit of 8.5 SU. For each event, it was determined that the cause of the pH excursions was from construction activities associated with the National Synchrotron Light Source II (NSLS-II), including concrete forming/washout activities and the existence of construction road/parking lot base using recycled concrete aggregate (RCA). During heavy rain events, this outfall receives a significant amount of stormwater from the NSLS-II construction site. The prime contractor was directed to improve housekeeping in this area, which included moving and/or placing tarps over the concrete blocks and other building materials and repairing silt fencing and filter fabric associated with catch basins connected to Outfall 008. These corrective actions, along with completing final grading and seeding and installation of the final layer of asphalt over exposed RCA parking lots and roads, should address the elevated pH associated with these materials/activities.

In September, the pH at Outfall 007 was 9.2 SU, which exceeded the permit limit of 9.0 SU. Investigation into the pH excursion identified that Water Treatment Plant (WTP) operators were performing maintenance of the system and were also in the

Table 3-4. Analytical Results for Wastewater Discharges to Outfalls 002, 005 – 008, and 010.

Analyte		Outfall 002	Outfall 002B	Outfall 005	Outfall 006A	Outfall 006B	Outfall 007	Outfall 008	Outfall 010	SPDES Limit	No. of Exceedances	% Compliance*
Flow (MGD)	N	CR	CR	CR	CR	CR	CR	9	9			
	Min.	0.03	0.00006	0.15	0.06	0.02	0.08	0.01	0.008	NA		
	Max.	0.83	0.06	0.66	0.17	0.15	0.16	1.4	0.72	NA	NA	NA
pH (SU)	Min.	7.1	7.5	6.8	7.0	7.0	6.4	7.6	7.2	NA		
	Max.	8.3	8.3	8.4	8.9	8.8	9.2	9.6	8.5	8.5, 9.0 (a)	5	99
Oil and grease (mg/L)	N	12	11	12	12	12	NR	10	10			
	Min.	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	NR	< 1.1	< 1.1	NA		
	Max.	1.5	2.0	1.8	1.6	59.8	NR	2.2	2.6	15	1	99
Copper (mg/L)	N	NR	NR	4	NR	NR	NR	NR	2			
	Min.	NR	NR	< 0.003 (T)	NR	NR	NR	NR	< 0.001 (D)	NA		
	Max.	NR	NR	0.09	NR	NR	NR	NR	0.005 (D)	1.0	0	100
Aluminum (mg/L)	N	4	NR	NR	NR	NR	NR	2	2			
	Min.	< 0.07 (T)	NR	NR	NR	NR	NR	0.1 (D)	< 0.07 (D)	NA		
	Max	< 0.07	NR	NR	NR	NR	NR	0.4 (D)	0.1 (D)	2.0	0	100

(continued on next page)

Table 3-4. Analytical Results for Wastewater Discharges to Outfalls 002, 005 – 008, and 010 *(concluded).*

Analyte		Outfall 002	Outfall 002B	Outfall 005	Outfall 006A	Outfall 006B	Outfall 007	Outfall 008	Outfall 010	SPDES Limit	No. of Exceedances	% Compliance*
Lead, Dissolved (mg/L)	N	NR	NR	NR	NR	NR	NR	NR	2			
	Min.	NR	NR	NR	NR	NR	NR	NR	< 0.0005	NA		
	Max	NR	NR	NR	NR	NR	NR	NR	< 0.0005	0.05	0	100
Vanadium, Dissolved (mg/L)	N	NR	NR	NR	NR	NR	NR	NR	2			
	Min.	NR	NR	NR	NR	NR	NR	NR	0.003	NA		
	Max	NR	NR	NR	NR	NR	NR	NR	0.003	NPL	NA	NA
Chloroform (µg/L)	N	4	NR	NR	NR	NR	NR	NR	NR			
	Min.	< 1	NR	NR	NR	NR	NR	NR	NR	NA		
	Max.	1.8	NR	NR	NR	NR	NR	NR	NR	7	0	100
Bromodichloromethane (µg/L)	N	4	NR	NR	NR	NR	NR	NR	NR			
	Min.	< 1	NR	NR	NR	NR	NR	NR	NR	NA		
	Max.	1.9	NR	NR	NR	NR	NR	NR	NR	50	0	100
1,1,1-trichloroethane (µg/L)	N	4	NR	NR	NR	NR	NR	9	NR			
	Min.	< 1	NR	NR	NR	NR	NR	< 1	NR	NA		
	Max.	< 1	NR	NR	NR	NR	NR	< 1	NR	5	0	100
1,1-dicloroethylene (µg/L)	N	NR	NR	NR	NR	NR	NR	9	NR			
	Min.	NR	NR	NR	NR	NR	NR	< 1	NR	NA		
	Max.	NR	NR	NR	NR	NR	NR	< 1	NR	5	0	100
Hydroxyethylidene-diphosphonic acid (mg/L)	N	4	4	4	4	4	NR	NR	NR			
	Min.	<0.02	<0.05	<0.05	<0.05	<0.05	NR	NR	NR	NA		
	Max.	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	NR	NR	NR	0.5	0	100
Tolyltriazole (mg/L)	N	4	4	4	4	4	NR	NR	NR			
	Min.	<0.005	<0.005	<0.005	<0.005	<0.005	NR	NR	NR	NA		
	Max.	<0.005	<0.005	<0.005	<0.005	<0.005	NR	NR	NR	0.2	0	100

Notes:
See Chapter 5, Figure 5-5, for location of outfalls.
There are no monitoring requirements for Outfalls 009, 011, and 012.
* % Compliance = total no. samples – total no. exceedances/total no. of samples x 100
CR = Continuous Recorder
D = Dissolved
MGD = Million Gallons per Day
Max. = Maximum value
Min. = Minimum value
N = Number of samples
NA = Not Applicable
NPL = No permit limit, monitoring only
NR = Analysis Not Required
SU = Standard Unit
T = Total Recoverable
(a) pH limit is 8.5 for Outfalls 005, 008, and 010 and pH limit is 9.0 for Outfalls 002, 002B, 006A, 006B, and 007.

process of recalibrating and adjusting the lime system prior to sample collection activities. The maintenance procedure caused a temporary lime overfeed into the iron removal filter beds leading to a pH of 9.2 SU during backwashing. As soon as the high pH was discovered, the lime feed system was shut down allowing water of a lower pH to enter the system. This water was used to flush the WTP and distribution system until water quality was returned to background levels. The lime feed system was readjusted and returned to service following the flushing. A sample was collected the next day and the pH was 7.7 SU, indicating that the corrective actions were successful.

Also in September, the oil and grease result at Outfall 006B (HT-E) was 59.8 mg/L, which exceeded the permit limit of 15 mg/L. No visible observations of any sheen were identified at the time of sample collection and follow-up inspection of the outfall did not reveal any obvious oil staining in the area. The discharge to Outfall 006B is currently comprised of mainly stormwater runoff. There are no once-through cooling water systems and only one active cooling tower that discharge to this outfall. The cause of this elevated oil and grease value was determined to be an isolated event and most likely runoff from parking lot discharges. The Laboratory has an active spill prevention program that educates employees on what they can do to help reduce both the number of spills that occur and the associated impacts to the environment.

A sample collected from this outfall in October exhibited an oil and grease concentration of 1.5 mg/L, which is 10 times lower than the permit limit of 15 mg/L and typical of what is normally observed at this location.

3.7 SAFE DRINKING WATER ACT

The extraction and distribution of drinking water is regulated under the federal Safe Drinking Water Act (SDWA). In New York State, implementation of the SDWA is delegated to the New York State Department of Health (NYSDOH) and administered locally by SCDHS. Because BNL provides potable water to more than 25 full-time residents, it is subject to the same requirements as a municipal water supplier. Monitoring requirements are prescribed annually by SCDHS, and a Potable Water Sampling and Analysis Plan (Chaloupka 2012) is prepared by BNL to comply with these requirements.

3.7.1 Potable Water

The Laboratory maintains five water supply wells for on-site distribution of potable water. As required by NYSDOH regulations, BNL monitors the potable wells regularly for bacteria, inorganics, organics, and pesticides. The Laboratory also voluntarily monitors drinking water supplies for radiological contaminants yearly. Tables 3-5 and 3-6 provide potable water supply monitoring data. In 2012, only iron exceeded New York State Drinking Water Standards (NYS DWS) in samples collected from three of the wells (wells 4, 6, and 7) before distribution. Groundwater from these three wells is treated to reduce naturally occurring iron and the color index of the water. Treatment at BNL's WTP effectively reduces these levels to below NYS DWS limits. To ensure that the Laboratory's water supply continually meets NYS DWS, groundwater is also treated with air stripping to remove volatile organic compounds (VOCs). At the point of consumption, drinking water complied with all NYS DWS during 2012. In addition to the compliance sampling program, all wells are also sampled and analyzed quarterly under the BNL environmental surveillance program. Data collected under this program are consistent with the data reported in Tables 3-5 and 3-6. This additional testing goes beyond the minimum SDWA testing requirements.

To ensure that consumers of on-site drinking water are informed about the quality of Laboratory-produced potable water, BNL annually publishes a Consumer Confidence Report (CCR) by the end of May, a deadline stipulated by the SDWA. This report provides information regarding BNL's source water, supply system, the analytical tests conducted, and the detected contaminants as compared to federal drinking water standards. The CCR also describes the measures the Laboratory takes to protect its water source and limit consumer exposure to contaminants. The CCR is distributed to all BNL employees and on-site residents, either in paper

Table 3-5. Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value).

Compound	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	Potable Distribution Sample	NYS DWS
Water Quality Indicators							
Ammonia ((mg/L)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	SNS
Chlorides (mg/L)	52	50	48	48	52	52	250
Color (units)	< 5	< 5	< 5	< 5	< 5	15	15
Conductivity (mmhos/cm)	231	210	230	317	349	284	SNS
Cyanide (mg/L)	< 20	< 20	< 20	< 20	< 20	< 20	SNS
MBAS (mg/L)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	SNS
Nitrates (mg/L)	0.17	0.18	0.35	0.69	0.75	0.31	10
Nitrites (mg/L)	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	<0.002	1
Odor (units)	0	0	0	0	0	0	3
pH (Standard Units)	5.9	5.9	6	6	6	7.1	SNS
Sulfates (mg/L)	12	12	13	12	13	9.17	250
Total coliform	ND	ND	ND	ND	ND	ND	Negative
Metals							
Antimony (mg/L)	< 5	< 5	< 5	< 5	< 5	< 5	6
Arsenic (mg/L)	< 5	< 5	< 5	< 5	< 5	< 5	50
Barium (mg/L)	0.042	0.039	0.027	0.042	0.04	0.034	2
Beryllium (mg/L)	< 1	< 1	< 1	< 1	< 1	< 1	4
Cadmium (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5
Chromium (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.1
Fluoride (mg/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2.2
Iron (mg/L)	2.2*	4.4*	0.69*	0.02	0.01	0.13	0.3
Lead (mg/L)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	15
Manganese (mg/L)	0.25	0.1	0.03	< 0.01	< 0.01	0.17	0.3
Mercury (mg/L)	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	2
Nickel (mg/L)	< 0.005	0.012	< 0.005	< 0.005	< 0.005	< 0.005	SNS
Selenium (mg/L)	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	50
Sodium (mg/L)	30	26	28	26	32	32	SNS

(continued on next page)

Table 3-5. Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value) *(concluded).*

Compound	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	Potable Distribution Sample	NYS DWS
Silver (mg/L)	< 1	< 1	< 1	< 1	< 1	< 1	100
Thallium (mg/L)	< 2	< 2	< 2	< 2	< 2	< 2	2
Zinc (mg/L)	0.02	0.02	0.02	0.02	< 0.01	0.01	5
Radioactivity							
Gross alpha activity (pCi/L)	< 1.67	< 1.82	< 1.97	1.66	<1.58	NR	15
Gross beta activity (pCi/L)	< 1.98	< 2.22	< 2.29	< 2.28	< 2.44	NR	(a)
Radium-228 (pCi/L)	< 0.54	< 0.74	0.76	< 0.74	< 0.92	NR	5
Strontium-90 (pCi/L)	< 0.76	< 0.76	< 0.46	< 0.77	< 0.73	NR	8
Tritium (pCi/L)	< 230	< 234	< 234	< 228	< 232	NR	20,000
Other							
Alkalinity (mg/L)	20	16	22	38	26	56	SNS
Asbestos (M. fibers/L)	NR	NR	NR	NR	NR	< 0.20	7
Calcium (mg/L)	6.91	6.49	7.05	11	8.42	14	SNS
HAA5 (mg/L)	NR	NR	NR	NR	NR	0.017	0.06**
Residual chlorine - MRDL (mg/L)	NR	NR	NR	NR	NR	1.2	4
TTHM (mg/L)	NR	NR	NR	NR	NR	0.03	0.08**

Notes:
See Figure 7-3 for well locations.
Well 12 was not operational for 2010. No testing was completed during this time.
HAA5 = Five Haloacetic Acids
MBAS = Methylene Blue Active Substances
MRDL = Maximum Residual Disinfectant Level
ND = Not Detected
NR = Analysis Not Required
NS = Not Sampled
NYS DWS = New York State Drinking Water Standard
SNS = Drinking Water Standard Not Specified
TTHM = Total Trihalomethanes
* Water from these wells is treated at the Water Treatment Plant for color and iron reduction prior to site distribution.
** Limit imposed on distribution samples only.
*** A single sample tested positive for coliform. Upon retesting, all samples were negative.
(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in late 2003. Gross beta activity does not identify specific radionuclides; therefore, a dose equivalent can not be calculated. No specific nuclides were detected; therefore, compliance with the requirement is demonstrated.

form or electronically at *http://www.bnl.gov/bnlweb/pubaf/water/reports.htm.*

3.7.2 Cross-Connection Control

The SDWA requires that public water suppliers implement practices to protect the water supply from sanitary hazards. One of the safety requirements is to rigorously prevent cross-connections between the potable water supply and facility piping systems that may contain hazardous substances. Cross-connection control is the installation of control devices (e.g., double-check valves, reduced pressure zone valves, etc.) at the interface between a facility and the domestic water main. Cross-connection control devices are required at all facilities where hazardous materials are used in a manner that could result in their introduction into the domestic water system, especially under low-pressure conditions. In addition, secondary cross-connection

Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, and Micro-Extractables.

Compound	WTP Effluent	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	NYS DWS
	µg/L						
tert-butylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,2,4-trimethylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
sec-butylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
4-Isopropyltoluene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
n-butylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Chloroform	2.4	1.3	2.3	9.2	0.8	1.7	50
Bromodichloromethane	2.7	< 0.5	< 0.5	6.2	< 0.5	< 0.5	50
Dibromochloromethane	3	< 0.5	< 0.5	3.3	< 0.5	< 0.5	50
Bromoform	0.7	< 0.5	< 0.5	0.8	< 0.5	< 0.5	50
Methyl tert-butyl ether	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	50
Toxaphene	NR	< 1	< 1	< 1	< 1	< 1	3
Total PCB's	NR	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	0.5
2,4,5,-TP (Silvex)	NR	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	10
Dinoseb	NR	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	50
Dalapon	NR	< 1	< 1	< 1	< 1	< 1	50
Pichloram	NR	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	50
Dicamba	NR	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	50
Pentachlorophenol	NR	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	1
Hexachlorocyclopentadiene	NR	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5
Bis(2-ethylhexyl)Phthalate	NR	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	50
Bis(2-ethylhexyl)Adipate	NR	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	50
Hexachlorobenzene	NR	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5
Benzo(A)Pyrene	NR	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	50
Lindane	NR	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.2
Heptachlor	NR	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.4
Aldrin	NR	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	5
Heptachlor Epoxide	NR	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.2
Dieldrin	NR	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	5
Endrin	NR	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.2
Methoxychlor	NR	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	40
Chlordane	NR	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2
2,4,-D	NR	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	50
Alachlor	NR	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2
Simazine	NR	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	50
Atrazine	NR	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	3
Metolachlor	NR	<0.75	<0.75	<0.75	<0.75	<0.75	50
Metribuzin	NR	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	50
Butachlor	NR	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	50
Propachlor	NR	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	50

Notes:
See Chapter 7, Figure 7-3, for well locations.
For compliance determination with New York State Department of Health standards, potable water samples were analyzed quarterly for Principal Organic Compounds and annually for other organics by EcoTest Labs Inc., a New York State-certified contractor laboratory.
The minimum detection limits for principal organic compound analytes are 0.5 µg/L. Minimum detection limits for synthetic organic chemicals and micro-extractables are compound-specific, and, in all cases, are less than the New York State Department of Health drinking water standard.

Well 12 was offline and remained unused during 2012.
NA = Not available
NR = Analysis Not Required
SNS = Drinking Water Standard Not Specified
NYS DWS = New York State Drinking Water Standard
WTP = Water Treatment Plant

controls at the point of use are recommended to protect users within a specific facility from hazards that may be posed by intra-facility operations.

The Laboratory maintains approximately 200 cross-connection control devices, including primary devices installed at interfaces to the potable water main, and secondary control devices at the point of use. In 2012, 129 cross-connection control units were tested, including primary and secondary devices. If a problem with a cross-connection device is encountered during testing, the device is repaired and re-tested to ensure proper function. Copies of the cross-connection device test reports are filed with SCDHS throughout the year.

3.7.3 Underground Injection Control (UIC)

UIC wells are regulated under the SDWA. At the Laboratory, UICs include drywells, cesspools, septic tanks, and leaching pools, all of which are classified by EPA as Class V injection wells. Proper management of UIC devices is vital for protecting underground sources of drinking water. In New York State, the UIC program is implemented through EPA because NYSDEC has not adopted UIC regulatory requirements. (Note: New York State regulates the discharges of pollutants to cesspools under the SPDES program.) Under EPA's UIC program, all Class V injection wells must be included in an inventory maintained with the agency.

In 2012, there were 23 Class V injection wells added and 30 former cesspools removed. Fourteen new UIC devices were installed at the NSLS-II site; three near Buildings 326 and 423, and six proposed at the Northeast Solar Energy Research Center site, which is currently under construction. All of the 23 UIC devices will be used solely for the disposal of storm water runoff. The 30 cesspools formerly served cottages used for housing students and visiting researchers; the cottages were demolished and cesspools sampled in late 2011. BNL review of the data in comparison with applicable regulatory action levels revealed that 13 of the 30 cesspools would require some level of remediation due to slightly elevated semi-volatile organic compound concentrations. This data was shared with Suffolk County Department of Health Services (SCDHS) Pollution Control for final determination of necessary remedial action. In early 2012, the cesspools were remediated by removing and properly disposing of the bottom two feet of soil. After remediation was completed, endpoint samples were collected to prove the remediation satisfactory and SCDHS provided approval to backfill all remaining cesspools.

In June 2010, an application was filed with EPA to renew the Class V UIC permit for the site. In August 2012, BNL received a letter from EPA indicating that addition or removal of UICs from the existing inventory would be "authorized by rule," pursuant to 40 CFR §144.24, however, it is still unclear if EPA intends on renewing BNL's Class V UIC permit. In addition to the UICs maintained for routine Laboratory discharges of sanitary waste and storm water, UICs also are maintained at several on- and off-site treatment facilities used for groundwater remediation. Contaminated groundwater is treated and then returned to the aquifer via drywells, injection wells, or recharge basins. Discharges to these UICs are authorized by rule rather than by permit. Under the authorized by rule requirements, a separate inventory is maintained for these treatment facilities and is periodically updated whenever a new device is added or closed.

3.8 PREVENTING AND REPORTING SPILLS

Federal, state, and local regulations are in place to address the management of storage facilities containing chemicals, petroleum, and other hazardous materials. The regulations include specifications for the design of storage facilities, requirements for written plans relating to unplanned releases, and requirements for reporting releases that do occur. BNL's compliance with these regulations is further described in the following sections.

3.8.1 Preventing Oil Pollution and Spills

As required by the Oil Pollution Act, BNL maintains a Spill Prevention Control and Countermeasures (SPCC) Plan as a condition of its license to store petroleum fuel. The purpose of this plan is to provide information regarding release prevention measures, the design of storage facilities, and maps detailing storage facility locations. The plan also outlines mitigating and remedial actions that would be taken in the event of a major spill. BNL's SPCC Plan (Chaloupka 2011) is filed with NYSDEC, EPA, and DOE. BNL remained in full compliance with SPCC requirements in 2012.

3.8.2 Emergency Reporting Requirements

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of the Superfund Amendments and Reauthorization Act (SARA) require that facilities report inventories (i.e., Tier II Report) and releases (i.e., Tier III Report) of certain chemicals that exceed specific release thresholds. These reports are submitted to the local emergency planning committee and the state emergency response commission. Community Right-to-Know requirements are codified under 40 CFR Parts 355, 370, and 372. The table on the following page summarizes the applicability of the regulations to BNL. The Laboratory complied with these requirements in 2012 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312 for calendar year 2011. In 2012, through a Tier III report, BNL reported releases of lead (~46,470 pounds), mercury (~256 pounds), polychlorinated biphenyls (PCBs) (~6 pounds), benzo(g,h,i)perylene (<1 pound), and polycyclic aromatic compounds (<1 pound) for calendar year 2011. Releases of lead, PCBs, and mercury were predominantly in the form of shipments of waste for off-site recycling or disposal. Releases of benzo(g,h,i)perylene and polycyclic aromatic compounds were as by-products of the combustion of fuel oils. In 2012, there were no releases of "extremely hazardous substances" reportable under Part 304.

3.8.3 Spills and Releases

When a spill of hazardous material occurs, Laboratory and contractor personnel are required to immediately notify the on-site Fire Rescue Group, whose members are trained to respond to such releases. Fire Rescue's initial response is to contain and control any release and to notify additional response personnel (i.e., BNL environmental professionals, industrial hygienists, etc.). Environmental professionals reporting to the scene assess the spill for environmental impact and determine if it is reportable to regulatory agencies. Any release of petroleum products to soil must be reported to both NYSDEC and SCDHS, and any release affecting surface water is also reported to the EPA National Response Center. In addition, a release of more than 5 gallons of petroleum product to impermeable surfaces or containment areas must be reported to NYSDEC and SCDHS. Spills of chemicals in quantities greater than the CERCLA-reportable limits must be reported to the EPA National Response Center, NYSDEC, and SCDHS. Remediation of the spill is conducted, as necessary, to prevent impacts to the environment, minimize human health exposures, and restore the site.

During 2012, there were 42 spills, 15 of which met regulatory agency reporting criteria. The remaining 27 spills were small-volume releases either to containment areas or to other impermeable surfaces that did not exceed a reportable quantity. Table 3-7 summarizes each of the 15 reportable events, including a description of the cause and corrective actions taken. There were no long-term effects from these releases and no significant impact on the environment. All but two of the reported events were 5 gallons or less in volume. Eight of the releases occurred during Laboratory construction/operational activities, either by leaks from construction equipment (e.g. fork lifts, dump trucks, and street sweepers), vehicles, or from operational equipment. The two larger-volume petroleum-based releases included a 10 gallon spill of hydraulic oil from a failed hydraulic line on a fork lift and a discovery of approximately 55 gallons of hydraulic oil from a failed elevator jack during a code compliance inspection of a freight elevator pit in Building 725. In all cases, the releases were cleaned up to the satisfaction of NYSDEC.

Three of the releases required reporting to DOE through BNL's Occurrence Report Processing System (ORPS), a system for identifying, categorizing, notifying, investigating, analyzing, and reporting to DOE events or conditions discovered on site. All three releases were associated with loss of refrigerant (Freon-11 and Freon-22) from air conditioning systems. New York State has very stringent release reporting requirements for certain chemicals. The reporting threshold for Freon-11 is one pound to the soil and for Freon-22, one pound to the air. Any release reported to an outside regulatory agency is reportable to DOE through ORPS unless specifically exempted (e.g., small volume releases of oil and ethylene glycol are exempt from ORPS reporting). In August 2012, BNL submitted a letter to NYSDEC requesting that refrigerant leaks of Freon 22 and Freon 113 to atmosphere from air conditioning and refrigeration units would not have to be reported in accordance with 6NYCRR Part 595 as long as the release was due to routine refrigeration equipment leaks discovered during preventative maintenance inspections or service calls. A summary of these types of releases would be included in the annual update to BNL's Spill Prevention Report submitted pursuant to 6 NYCRR 598.1(k) and annual Emission Statements submitted pursuant to BNL's Title V Facility Permit. NYSDEC approval of this request would exempt reporting of these types of release to DOE through BNL's ORPS. NYSDEC approval was still pending at the end of 2012.

In all instances described above, any recoverable material was removed, spill absorbents were used to remove the residual product, and all materials were collected and containerized for off-site disposal. For releases to soil, contaminated soil was removed to the satisfaction of the State or local inspector and containerized for off-site disposal.

3.8.4 Major Petroleum Facility (MPF) License

The storage and transfer of 2.3 million gallons of fuel oil (principally No. 6 oil) subjects the Laboratory to MPF licensing by NYSDEC. The bulk of the fuel is used at the CSF to produce high-pressure steam to heat and cool BNL facilities, and is stored in six tanks with capacities ranging from 300,000 to 600,000 gallons. In April 2010, due to a directive from NYSDEC asserting their sole jurisdiction over petroleum storage at Major Oil Storage Facilities (MOSF), BNL had to update its MPF license to include an additional 54 petroleum storage facilities ranging from 100 to 10,000 gallons that were previously regulated by SCDHS under Suffolk County Sanitary Code Article 12. These storage facilities are located throughout the site where there is a need for building heat, emergency power, or other miscellaneous petroleum needs (motor oil, waste oil, lube oil).

In March 2012, BNL received its renewed MPF license, which expires on March 3, 2017 and included a total of 63 petroleum storage facilities. During 2012, BNL remained in full compliance with MPF license requirements, which include monitoring groundwater in the vicinity of the six above-ground storage tanks. The license also requires the Laboratory to inspect the storage facilities monthly and test the tank leak detection systems, high-level monitoring, and secondary containment. Tank integrity is also checked periodically. Groundwater monitoring consists of monthly checks for the presence of floating products and twice-yearly analyses for VOCs and semi-volatile organic compounds (SVOCs). In 2012, no VOCs, SVOCs, or floating products attributable to MPF activities were detected. See SER Volume II, Groundwater Status Report, for additional information on groundwater monitoring results.

On February 14 and 15, 2012, NYSDEC conducted its annual inspection of all storage facilities included on the MPF license. Three conditions that required corrective action were

Applicability of EPCRA to BNL				
EPCRA 302–303	Planning Notification	YES [X]	NO [ ]	NOT REQUIRED [ ]
EPCRA 304	EHS Release Notification	YES [ ]	NO [ ]	NOT REQUIRED [X]
EPCRA 311–312	MSDS/Chemical Inventory	YES [X]	NO [ ]	NOT REQUIRED [ ]
EPCRA 313	TRI Reporting	YES [X]	NO [ ]	NOT REQUIRED [ ]

Table 3-7. Summary of Chemical and Oil Spill Reports.

Spill No. and Date	Material and Quantity	ORPS Report	Source/Cause and Corrective Actions
12-02 1/10/12	HCFC-22 3 pounds	Yes	While replacing a refrigerant line on a split air conditioner unit servicing Building 1005, workers accidentally dislodged an active refrigerant line soldered to the line being replaced, causing the entire charge of HCFC-22 to be released into the building's alcove.
12-04 1/24/12	Lubricating oil & HCFC-22 60 pounds	Yes	While servicing a package A/C unit, the pressurized line failed causing the entire refrigerant charge of 60 pounds of HCFC-22 to be released to the air and lubricating oil to be discharged to adjacent soil. Contaminated soil and sorbent pads were containerized in a bucket for off-site disposal.
12-07 3/8/12	Hydraulic Fluid 0.5 gallons	No	While moving shielding block outside Building 933, a forklift leaked gear oil to soil. Impacted soil and recycled concrete aggregate was recovered and placed into two 55 gallon drums for off-site disposal.
12-08 3/21/12	CFC-11 100-200 pounds	Yes	During an inspection of the mechanical equipment room in Building 725, a pool of CFC-11 was discovered on the floor. The refrigerant had leaked from the corroded underside of a refrigerant vessel of a centrifugal chiller. Pooled refrigerant was captured using adsorbent pads and booms. The manway to the equipment room was opened to permit vapors to exit. Since the outside ambient temperature was less than the 74.7 ºF boiling point of CFC-11, there was some concern that vapors may have condensed below the manway and migrated to nearby soil. A soil sample was collected and results revealed that CFC-11 was less than method detection limits. Sorbent pads were containerized in a bucket for off-site disposal.
12-10 4/11/12	Gear Oil 12 quarts	No	Approximately 12 quarts of gear oil leaked from the rear differentials of a brush truck destroyed in an April 9 fire when BNL's Fire Department pulled the vehicle along a dirt path approximately 1.25 miles east from the point where the brush truck had been consumed by the fire. Contaminated soil recovered from the trail of oil left behind was shoveled into two 55-gallon drums for off-site disposal.
12-11 4/26/12	Mineral oil 1 quart HCFC-22 24 pounds	No	A compressor failure caused by an electrical short caused mineral oil from a package A/C unit to leak onto the pavement in front of Building 922. Absorbent material was used to pick up the mineral oil, which was swept up and containerized for off-site disposal. Approximately 24 pounds of HCFC-22 was released to the atmosphere.
12-12 4/19/12	Lubricating oil 3-4 ounces HCFC-22 20 pounds	No	A hairline fracture on a pressurized condenser line of a package air condition unit east of Building 1012 caused 3-4 ounces of lubricating oil to spray on the interior of the housing unit and left spots on the exterior of the fan housing. The leak was from a 1/4 inch hairline stress fracture in a high-pressure copper condenser line fitting thought to have been due to repeated vibrational loading. Twenty pounds of HCFC-22 was released to atmosphere. Adsorbent pads from cleanup of mineral oil from the interior and exterior of the equipment housing were placed in 5-gallon bucket for off-site disposal.
12-15 6/21/12	Hydraulic Fluid 10 gallons	No	While traveling northeast on Yale Road, a hydraulic line on a fork lift failed causing hydraulic fluid to leak to the road bed. Pans were placed under the vehicle to collect dripping fluid and Green Stuff® adsorbent was used to clean the roadway. Impacted soil adjacent to the road and adsorbent was recovered to two 55-gallon drums for off-site disposal. Ten gallons of hydraulic fluid recovered from the fork lift was placed into a separate drum.
12-16 6/21/12	Transmission Fluid <1 gallon	No	After a Laboratory vehicle accidentally hit the railing of a wheelchair ramp in front of Building 317, transmission fluid leaked onto the underlying pavement with a small amount impacting adjacent soil. Absorbent material used to clean the fluid and contaminated soil was placed in a 55-gallon drum for off-site disposal.
12-20 7/25/12	Hydraulic Fluid 4 gallons	No	Approximately four gallons of hydraulic fluid leaked to the ground from a failed hydraulic line as a dump truck was unloading concrete at the Borrow Pit. Contaminated soil and recycled concrete aggregate was excavated and staged within a dump trailer that was later transferred to four 55-gallon drums for off-site disposal.
12-21 8/1/12	Hydraulic Fluid 1 gallon	No	While transferring soil to the Laboratory's transfer station, hydraulic fluid leaked from the housing of a vacuum pump onto the platform of a Vacmaster 4000 road sweeper and to soil beneath the vehicle. A plastic tarp placed beneath the vehicle contained the leaking fluid. Contaminated soil was transferred to two 5-gallon pails and taken to a waste accumulation area for off-site disposal.
12-26 8/24/12	Hydraulic Fluid 0.5 gallon	No	Hydraulic fluid leaked onto the road and to adjacent soil from dump trailer hydraulic hose as it traveled on First Street north of Brookhaven Avenue. Adsorbent pads used to clean fluid from the pavement and contaminated soil was placed into two 55-gallon drums and taken to a waste accumulation area in Building 452 where is was subsequently bulked for off-site disposal.

(continued on next page)

Table 3-7. Summary of Chemical and Oil Spill Reports *(concluded).*

Spill No. and Date	Material and Quantity	ORPS Report	Source/Cause and Corrective Actions
12-38 11/30/12	Hydraulic Fluid 55 gallons	No	During a code compliance inspection of the Building 725 freight elevator pit ladder, a water/oil mixture was observed in the annular space around the elevator jack. A mixture of oil and murky water was pumped from the annular space into three 55-gallon drums. An oil absorbent pad was pushed down into the casing and wrapped around the exterior surface of the jack to capture residual oil that drained down the outer surface of the jack. A drift test of the elevator was conducted to determine whether oil was still actively leaking from the jack. After replacing packing around the jack and a jack wiper, a sight glass lowered into the elevator pit was used to confirm that residual oil present in the water column below the elevator casing was minimal.
12-40 12/14/12	Hydraulic Fluid 0.5 gallons	No	During a post-hurricane cleanup of debris and vegetation behind Berkner Hall, a hydraulic hose to the lifting bucket began leaking. A containment tray was placed beneath the leaking hose and the backhoe was transported to the Heavy Equipment Shop for repairs. Recovered soil was transferred to a 55-gallon drum for off-site disposal.
12-41 12/18/12	Compressor Oil 2 gallons	No	When power was restored after a power dip tripped off a compressor on the cryogenic helium tank located north of Building 912, a pressure relief valve to the tank opened releasing helium and a fine mist of compressor oil. Compressor oil settled on the side of the cryogenic pumping facility building, the side of the helium tank, and to the soil between the helium tank and the building. Contaminated soil was recovered and placed into two 55-gallon drums. Absorbent rags used to wipe clean oil from the exterior of the tank and building were deposited into another 55-gallon drum. To prevent the 250 psig relief valve from lifting, a new 240 psig pressure switch was tested and installed on the compressor skid that will cause the compressor to automatically shutdown as discharge pressure rises above 240 psig.

identified: the audible segment of the high-level alarm for one of the satellite fuel oil storage tanks failed to operate; the need to take level readings from the Automatic Tank Gauge for BNL's underground storage tanks before and after each delivery and compare the delivery tickets to ensure accuracy; and the identification of a minor piping leak under the regular gasoline pump at the on-site service station. All conditions were corrected in 2012 in accordance with NYSDEC directives.

3.8.5 Chemical Bulk Storage

Title 6 of the Official Compilation of the Codes, Rules, and Regulations of the State of New York (NYCRR) Part 597 requires that all aboveground tanks larger than 185 gallons and all underground tanks that store specific chemicals be registered with NYSDEC. The Laboratory holds a Hazardous Substance Bulk Storage Registration Certificate for six tanks that store treatment chemicals for potable water (sodium hydroxide and sodium hypochlorite). The tanks range in capacity from 200 to 1,000 gallons. In August 2012, BNL received a renewed Hazardous Substance Bulk Storage Registration Certificate that recognized a like-in-kind sodium hydroxide tank replacement/installation that was completed in Well House #11, which expires in July 2013.

NYSDEC conducted an inspection of the Chemical Bulk Storage facilities in February 2012 that identified two conditions that required corrective actions: stress cracks were noted in the transfer station containment floors for Tanks 634-02 and 635-04 that require repairs to ensure their ability to contain a release, and the common atmospheric vent for the tanks inside Building 624 was not terminated in secondary containment. Both of these conditions were evaluated and corrected in 2012 in accordance with NYSDEC directives.

3.8.6 County Storage Requirements

Article 12 of the Suffolk County Sanitary Code regulates the storage and handling of toxic and hazardous materials in aboveground or underground storage tanks, drum storage facilities, piping systems, and transfer areas. Article 12 specifies design criteria to prevent environmental impacts resulting from spills or leaks, and specifies administrative requirements such as identification, registration, and spill reporting procedures. In 1987, the Laboratory entered into a voluntary Memorandum of Agreement with SCDHS, in which DOE and BNL agreed to conform to the environmental requirements of Article 12. In April 2010, due to a directive from NYSDEC asserting their sole jurisdiction over petroleum storage at MOSF, SCDHS notified BNL that they will cease permitting activities (review/approval for new construction and modifications, issuance of operating permits, and registration requirement) for all petroleum bulk storage facilities. In 2011, the Laboratory received further information that indicated SCDHS had ceased applying Article 12 requirements to both petroleum and chemical storage at BNL regardless of whether the storage is regulated by NYSDEC. Currently, there are approximately 118 active storage facilities that are not regulated by NYSDEC and would normally fall under SCSC Article 12 jurisdiction. This includes storage of wastewater and chemicals, as well as storage facilities used to support BNL research.

To ensure that storage of chemicals and petroleum continue to meet Article 12 requirements, BNL will continue to abide by the original 1987 agreement with Suffolk County and will maintain conformance with applicable requirements of Article 12. These requirements include design, operational, and closure requirements for current and future storage facilities. The Laboratory will no longer submit new design plans for SCDHS review/approval or continue to perform other administrative activities such as registration of exempt facilities and updates of shared databases. The Laboratory will continue to inspect all storage facilities to ensure operational requirements of SCSC Article 12 are maintained.

3.9 RCRA REQUIREMENTS

The Resource Conservation and Recovery Act regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In New York State, EPA delegates the RCRA program to NYSDEC, with EPA retaining an oversight role. Because the Laboratory may generate greater than 1,000 Kg (2,200 pounds) of hazardous waste in a month, it is considered a large-quantity generator and has a RCRA permit to store hazardous wastes for up to 1 year before shipping the wastes off site to licensed treatment and disposal facilities. As noted in Chapter 2, BNL also has a number of satellite accumulation and 90-day waste storage areas. Included with the hazardous wastes regulated under RCRA are mixed wastes which are generated in small quantities at BNL. Mixed wastes are materials that are both hazardous (under RCRA guidelines) and radioactive. In 2010, BNL began proceedings to “close” the mixed hazardous/radioactive waste permitted storage facility, Building 870. The closure process included collecting subsurface soil samples from several locations within and outside the building to look for evidence of hazardous waste releases, and the preparation of a closure report. The building is no longer needed for waste storage and has been changed to a general storage building.

In July 2012, NYSDEC approved the closure of Building 870 enabling BNL to begin preparing a minor modification to its RCRA Permit to have all references to the building removed. The proposed minor modification package was submitted to NYSDEC in October 2012 for review, and the modification was approved by NYSDEC in December 2012.

3.10 POLYCHLORINATED BIPHENYLS

The storage, handling, and use of PCBs are regulated under the Toxic Substance and Control Act. Capacitors manufactured before 1970 that are believed to be oil filled are handled as if they contain PCBs, even when that cannot be verified from the manufacturer’s records. All equipment containing PCBs must be inventoried, except for capacitors containing less than 3 pounds of dielectric fluid and items with a concentration of PCB source material of less than 50 parts per million. Certain PCB-containing articles or PCB containers must be labeled. The inventory is updated by July 1 of each year. The Laboratory responds to any PCB spill in accordance with standard emergency response procedures. BNL was in compliance with all applicable PCB regulatory requirements during 2012.

The Laboratory has aggressively approached reductions in its PCB inventory, reducing it by more than 99 percent since 1993. The only known regulated PCB-contaminated piece of electrical equipment remaining on site is a one-of-a-kind klystron located in BNL's Chemistry Department.

3.11 PESTICIDES

The storage and application of pesticides (insecticides, rodenticides, herbicides, and algicides) are regulated under the Federal Insecticide, Fungicide and Rodenticide Act. BNL uses an Integrated Pest Management (IPM) plan that was developed over a decade ago, and subsequently audited by a third party during 2012. Pesticides are used at the Laboratory to control undesirable insects, mice, and rats; microbial growth in cooling towers; and to maintain certain areas free of vegetation (e.g., around fire hydrants and inside secondary containment berms). Insecticides are also applied in research greenhouses on site. Herbicide use is minimized wherever possible (e.g., through spot treatment of weeds). All pesticides are applied by BNL-employed, New York State–certified applicators. By February 1, each applicator files an annual report with NYSDEC detailing insecticide, rodenticide, algaecide, and herbicide use for the previous year. The Laboratory was in full compliance with the legislated requirements in 2012.

3.12 WETLANDS AND RIVER PERMITS

As noted in Chapter 1, portions of the site are situated in the Peconic River floodplain. Portions of the Peconic River are listed by NYSDEC as "scenic" under the Wild, Scenic, and Recreational River Systems Act. The Laboratory also has six areas regulated as wetlands and a number of vernal (seasonal) pools. Construction or modification activities performed within these areas require permits from NYSDEC.

Activities that could require review under the BNL Natural and Cultural Resource Management Programs are identified during the NEPA process (see Section 3.3). In the preliminary design stages of a construction project, design details required for the permit application process are specified. These design details ensure that the construction activity will not negatively affect the area, or if it does, that the area will be restored to its original condition. When design is near completion, permit applications are filed. During and after construction, the Laboratory must comply with the permit conditions.

In 2012, BNL submitted a permit package to NYSDEC for the construction of recharge basins associated with upgrades to the STP as required by wetlands regulations and the Wild, Scenic, and Recreational River Systems Act. The upgrades for the STP will allow for the eventual discharge of the tertiary treated wastewater directly to groundwater.

A 2011 permit for the installation of fencing and air conditioning platforms at the RHIC facility continues to remain open, pending completion of work.

A permit prepared by BNL for the LISF continues to be open and will be closed once vegetation is established throughout the solar farm, and invasive plants in a modified tiger salamander habitat are under control.

3.13 PROTECTION OF WILDLIFE

3.13.1 Endangered Species Act

In 2012, the Laboratory updated its list of endangered, threatened, and species of special concern (see Table 6-1 in Chapter 6). There are no federally recognized endangered species on the BNL site. State recognized endangered (E) or threatened (T) species include: eastern tiger salamander (E), persius duskywing (E), crested fringed orchid (E), Engelman spikerush (E), dwarf huckleberry (E), whorled loosestrife (E), Swamp darter (T), Banded Sunfish (T), frosted elfin (T), little bluet (T), scarlet bluet (T), pine barrens bluet (T), northern harrier (T), stargrass (T), and stiff-leaved goldenrod (T). Although the tiger salamander is no longer the only state endangered species found at the Laboratory, it is the most notable and best-studied species on site. Tiger salamanders are listed as endangered in New York State because populations have declined due to habitat loss through development, road mortality during breeding migration, introduction of predatory fish into breeding sites, historical collection for the bait and pet trade, water level fluctuations, pollution, and general disturbance of breeding sites. The Laboratory updated its BNL Natural Resource Management Plan (NRMP) in October 2011. One component of the plan formalizes the strategy and actions needed to protect 26 confirmed tiger salamander breeding locations on site. The strategy includes identifying and mapping habitats, monitoring breeding conditions, improving breeding sites, and controlling activities that could negatively affect breeding. As part of environmental benefits associated with the LISF, a small tiger salamander habitat was modified to ensure improved water retention for longer periods of time.

The banded sunfish and swamp darter are found in the Peconic River drainage areas on site. Both species are listed as threatened within New York State, with eastern Long Island having the only known remaining populations of these fish in New York. Measures taken, or being taken, by the Laboratory to protect the banded sunfish and swamp darter and their habitats include: eliminating, reducing, or controlling pollutant discharges; reducing nitrogen loading in the Peconic River; monitoring populations and water quality to ensure that habitat remains viable; and minimizing disturbances to the river and adjacent banks.

Three butterfly species that are endangered, threatened, or of special concern have been historically documented at the Laboratory. These include the frosted elfin, persius duskywing, and the mottled duskywing. None have been documented in recent surveys. Habitat for the frosted elfin and persius duskywing exists on Laboratory property and the mottled duskywing is likely to exist on site; therefore, management of habitat and surveys for the three butterflies has been added to the NRMP. BNL is currently working with NYSDEC in developing a recovery plan for the frosted elfin.

Surveys for damselflies and dragonflies conducted periodically during the summer months confirmed the presence of one of the three threatened species of damselflies expected to be found on site. In June 2005, the pine-barrens bluet, a threatened species, was documented at one of the many coastal plain ponds at BNL.

The Laboratory is also home to 14 species that are listed as species of special concern. Such species have no protection under the state endangered species laws, but may be protected under other state and federal laws (e.g., Migratory Bird Treaty Act). New York State monitors species of special concern and manages their populations and habitats, where practical, to ensure that they do not become threatened or endangered. Species of special concern found at BNL include the mottled duskywing butterfly, marbled salamander, eastern spadefoot toad, spotted turtle, eastern box turtle, eastern hognose snake, worm snake, horned lark, whip-poor-will, vesper sparrow, grasshopper sparrow, and Cooper's hawk. The management efforts for the tiger salamander also benefit the marbled salamander. At present, no protective measures are planned for the eastern box turtle or spotted turtle, as little activity occurs within their known habitat at the Laboratory. However, BNL is working with Hofstra University to study reproductive strategies and habitat use of the eastern box turtle and it is a focal species for study within the LISF. Results of these studies may show the need for conservation and management needs. BNL continues to evaluate bird populations as part of the management strategy outlined in the NRMP. In addition to the bird species mentioned above, 18 other bird species listed as species of special concern and two federally threatened species have been observed during spring and fall migrations.

The Laboratory has 28 plant species that are protected under state law: three are endangered plants, the Engelman spikerush, dwarf huckleberry, whorled loosestrife, and crested fringed orchid; two are threatened plants, the stiff-leaved goldenrod and stargrass; and four are rare plants, the small-flowered false foxglove, narrow-leafed bush clover, wild lupine, and long-beaked bald-rush. The other 18 species are considered to be "exploitably vulnerable," meaning that they may become threatened or endangered if factors that result in population declines continue. These plants are currently sheltered due to the large areas of undeveloped pine-barren habitat on site. As outlined in the NRMP, locations of these rare plants must be determined, populations estimated, and management requirements established. In an effort to locate and document rare plants, BNL is working with a botanist to assess the flora found on site. See Chapter 6 for further details.

3.13.2 Migratory Bird Treaty Act

As mentioned in Chapter 1, the Laboratory has identified more than 185 species of migratory birds since 1948; of those, approximately 85 species nest on site. Under the Migratory Bird Treaty Act, migratory birds are protected from capture, harassment, and destruction or disturbance of nests without permits issued by the U.S. Fish and Wildlife Service. In the past, migratory birds have caused health and safety issues, especially through the deposition of fecal matter and the bird's assertive protection of nesting sites. When this occurs, proper procedures are followed to allow the birds to nest and preventive measures are taken to ensure that they do not cause problems in the future. Canada geese (Branta canadensis) are managed under an annual permit from the U.S. Fish and Wildlife Services goose nest management program. Occasionally, nesting migratory birds come in conflict with construction and the conflict must be resolved. When this occurs, the USDA-APHIS-Wildlife Services Division is called for consultation and resolution, if possible. Each incident is handled on a case-by-case basis to ensure the protection of migratory birds, while maintaining fiscal responsibility. See Chapter 6 for more information on migratory birds.

3.13.3 Bald and Golden Eagle Protection Act

While BNL does not have bald or golden eagles nesting on site, they do occasionally visit the area during migration. At times, immature golden eagles have spent several weeks in the area of the Laboratory. Bald eagles are known to spend long periods of time on the north and south shores of Long Island. In general, the Laboratory has no concerns with eagles and has no specific management needs concerning them.

3.14 PUBLIC NOTIFICATION OF CLEARANCE OF PROPERTY

In accordance with DOE Order 458.1, authorized releases of property suspected of containing residual radioactive material must meet DOE and other federal, state, and local radiation protection policies and requirements. Released property must be appropriately surveyed and must adequately demonstrate that authorized limits are met. In addition, documentation supporting the release of property should be publicly available. The release of property off the BNL site from radiological areas is controlled. No vehicles, equipment, structures, or other materials can be released from the Laboratory unless the amount of residual radioactivity on such items is less than the authorized limits. The default authorized limits are specified in the Brookhaven National Laboratory Site Radiological Control Manual (RCM) (July 16, 2012) and are consistent with the pre-approved authorized release limits set by DOE Order 458.1.

In 2012, excess materials such as scrap metal (228 tons) and electronics equipment (40 tons) were released to interested parties or to an off-site location. All materials were surveyed, as required, using appropriate calibrated instruments and released based on DOE pre-approved authorized limits. There were no releases of real property in 2012.

3.15 EXTERNAL AUDITS AND OVERSIGHT

3.15.1 Regulatory Agency Oversight

A number of federal, state, and local agencies oversee BNL activities. In addition to external audits and oversight, the Laboratory has a comprehensive self-assessment program, as described in Chapter 2. In 2012, BNL was inspected by federal, state, or local regulators on 10 occasions. These inspections included:

- *Air Compliance*. NYSDEC did not perform a formal inspection of the Laboratory's air compliance program in 2012; however, NYSDEC was present during a portion of the annual relative accuracy test audit of the continuous emissions monitoring system at the CSF; there were no issues identified during this inspection.
- *Potable Water*. In July, SCDHS collected samples and conducted its annual inspection of the BNL potable water system. Identified deficiencies are being addressed by the Laboratory's Energy and Utilities Division.

- *Sewage Treatment Plant*. SCDHS conducts quarterly inspections of the Laboratory's STP to evaluate operations and sample the effluent. In 2012, no performance or operational issues were identified. NYSDEC performed an annual surveillance inspection in February; there were no issues identified.
- *Recharge Basins*. SCDHS inspected several on-site SPDES-regulated outfalls in 2012; there were no issues identified.
- *Major Petroleum Facility*. The annual NYSDEC inspection of the MPF was performed in February 2012. See Section 3.8.4 for a discussion of the issues identified.
- *Chemical Bulk Storage (CBS) Facilities*. The CBS facilities are inspected periodically by NYSDEC. An inspection was conducted in February 2012. See Section 3.8.5 for a discussion of the issues identified.
- *RCRA*. NYSDEC and EPA did not conduct any RCRA inspections in 2012.

3.15.2 DOE Assessments/Inspections

The DOE Brookhaven Site Office (BHSO) conducts environmentally-related assessments each year, some of which are supported by the DOE Chicago Office. In May 2012, BHSO conducted a Readiness Assessment for Transition of the BGRR and HFBR Long-Term Surveillance and Maintenance (S&M) Program. The purpose of the assessment was to review Brookhaven Science Associates (BSA) progress in implementing the BGRR and HFBR Long-Term S&M Transition Plan and to identify any issues or impediments to successfully transferring long-term stewardship responsibilities for the BGRR, HFBR, and completed Environmental Management Legacy Scope from the Laboratory's Environmental Restoration Projects to other organizations within BNL. The assessment consisted of verification of the completion of the required actions and development of an open action list, which will be monitored and tracked to completion through the Laboratory's assessment tracking system (ATS).

In July 2012, BHSO performed a surveillance audit of BNL's Response to the Building 705 Stack Drain Tank High-Level Alarm during a severe rainstorm on July 28, 2012. Rainwater that touches the interior surfaces of the stack becomes radioactively contaminated. This water is collected via a stack drain collection system and flows into a double-walled, underground storage tank. During the storm, the tank was overfilled and set off an alarm indicating that water entered the overfill containment sump and ultimately the interstitial space between the primary and secondary containment of the tank. Although there was no release of contaminated water to the environment as a result of this overfilling event, BHSO concluded that the alarm response was inadequate and recommended that BNL evaluate the event and consider potential vulnerabilities across the site where alarm response and notification procedures may be less than adequate. Following the assessment, the Laboratory identified several corrective actions to address the findings and tracked them to completion using BNL's ATS.

In June 2012, BHSO performed a surveillance audit of the Laboratory's SPDES Discharge Monitoring Report Preparation. The intent of the audit was to review BNL's process to track permit requirements, to ensure the correct wastewater samples are collected for analysis, the laboratory's contract for laboratory analyses, conduct quality assurance reviews of sample results, and to transpose results for reporting to NYSDEC. No findings were identified.

In November 2012, BHSO, with assistance from the Chicago Integrated Support Center, conducted an assessment of BNL's Packaging and Transportation Program, in accordance with DOE Order 460.2A, Departmental Materials Transportation and Packaging Management. DOE concluded that, overall, transportation operations at the Laboratory are performed as required and that BNL has been implementing improvements. However, DOE also concluded that the Laboratory needs to continue to focus on the implementation of additional corrective actions that were developed during previous self-assessments. BNL agreed to include any additional corrective actions resulting from this assessment into an existing corrective action plan that resulted from a previous assessment of on-site movements of hazardous and radioactive materials. Corrective actions will be tracked to completion through the Laboratory's ATS.

3.15.2.1 Environmental Multi-Topic Assessment

In 2012, BNL conducted a programmatic self-assessment on several aspects of the Laboratory's environmental management program. Topics for this assessment were determined based on institutional risk, DOE and regulatory agency expectations, and to ensure that key environmental requirements are being implemented as designed. The self-assessment focused on requirements related to liquid effluents, radiological and non-radiological air emissions, and storage and transfer of hazardous and nonhazardous materials. During the course of the assessment, a representative sampling of managers, supervisors, and workers were interviewed. In addition, numerous documents and activities were reviewed to enable a comprehensive, independent, and objective assessment of the conformance to requirements and the effectiveness of implementation.

The assessment of these subject areas identified two Noteworthy Practices, four Minor Non-Conformities, 10 Observations, and 15 Opportunities for Improvement. To prevent future occurrences of the findings from the assessment, a causal analysis was performed, followed by the development of a corrective action plan for the minor non-conformances. All corrective actions are being tracked to completion in BNL's ATS.

3.15.2.2 Nevada National Security Site

The Laboratory continues to be a certified Nevada National Security Site (NNSS) waste generator. As part of the NNSS waste certification process, the NNSS Maintenance and Operations Contractor conducts random unannounced inspections. NNSS did not perform any inspection at BNL in 2012.

3.16 ENFORCEMENT ACTIONS AND AGREEMENTS

In addition to the rules and regulations discussed throughout this chapter, there were two existing agreements between BNL, DOE, and regulatory agencies that remained in effect and three Notices of Violation/Non-Compliance that were accessed in 2012. Table 3-8 lists the existing agreements with regulatory agencies that oversee Laboratory operations and provides more detail on the formal NOVs or enforcement actions that occurred throughout the year.

The NOVs associated with waste shipments to EnergySolutions were also reported to DOE through the BNL ORPS. Four other incidents occurred in 2012 that required reporting through ORPS. The incidents are summarized in Table 3-9. Causal analyses were performed for all incidents and corrective actions were taken to prevent recurrence of the issues.

Table 3-8. Existing Agreements and Enforcement Actions Issued to BNL, with Status.

Number	Title	Parties	Effective Date	Status
Agreements				
No Number	Suffolk County Agreement	SCDHS, DOE, and BNL	Originally signed on 09/23/87	This Agreement was developed to ensure that the storage and handling of toxic and hazardous materials at BNL conform to the environmental and technical requirements of Suffolk County codes.
II-CERCLA-FFA-00201	Federal Facility Agreement under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 120 (also known as the Interagency Agreement or "IAG" of the Environmental Restoration Program)	EPA, DOE, and NYSDEC	05/26/92	Provides the framework, including schedules, for assessing the extent of contamination and conducting the BNL cleanup. Work is performed either as an Operable Unit or a Removal Action.The IAG integrates the requirements of CERCLA, Resource Conservation and Recovery Act (RCRA), and the National Environmental Policy Act (NEPA). While all clean-up actions were completed in 2005, BNL continues to perform surveillance and maintenance of operating remediation systems and remediation of the BGRR and HFBR. All systems operated as required in 2012.
Notices of Violation/Enforcement Actions				
None	Notice of Violation	State of Utah and BNL	06/7/2012	On May 17, 2012, BNL received a Condition Report notification from EnergySolutions stating that two intermodals shipped from BNL were found to have free liquids in them, which were noncompliant with the EnergySolutions Waste Acceptance Criteria (WAC). Both waste shipments were from the Brookhaven Graphite Research Reactor (BGRR) Restoration Project and the cause was most probably rain infiltration into the containers during storage/transport. During the investigation of this occurrence, BNL received a Notice of Violation (NOV) issued by the Director of the Utah Division of Radiation Control, dated June 7, 2012, which assessed 475 points against BNL's Utah Generator Site Access Permit, but had no monetary fines associated with it. BNL assembled a team to perform fact finding, causal analysis, and determine corrective/preventative actions, which were all completed by June 14, 2012.
None	Notice of Non-Compliance	EPA and BNL	07/23/2012	On July 23, 2012, BNL received a notice of non-compliance of Subpart H, 40 CFR 61, National Emissions Standards for Hazardous Air Pollutants – radionuclides (rad-NESHAP) as a result of some findings from an inspection visit on July 12, 2012. In reviewing the Annual NESHAPs Report with Laboratory staff, the EPA inspector identified that BNL was reporting calculated dose to a hypothetical Maximally Exposed Individual (MEI) at the fence line and not a Maximally Exposed Off-Site Individual (MEOSI) at an actual point where there is a residence, school, business, or office, as required in Subpart H. In addition, the inspector noted that the wind rose data illustrated in BNL's Site Environmental Report and the wind file used in the CAP-88 calculations were inconsistent, which lead to incorrect identification of the MEOSI. BNL submitted a revised Annual Report on August 30, 2012, which addressed the two non-compliance findings, and on December 3, 2012, EPA concluded that BNL was in compliance with Subpart H.
None	Notice of Violation	State of Utah and BNL	08/17/2012	On August 17, 2012, BNL received a letter from the State of Utah's Division of Radiation Control citing a NOV for a non-compliant shipment that arrived at Energy Solutions of Utah. On July 23, 2012 a radioactive waste shipment consisting of magnets from CAD was sent via truck to Energy Solutions in Utah for disposal. The magnets were packaged in six IP-1 certified woven polyfiber packages called supersacks, and secured to the transport vehicle with chains. When the shipment arrived at Energy Solutions on July 30, 2012, a State of Utah inspector observed that some of the packages had tears in them. The packages were inspected prior to leaving BNL and did not have tears at that time. It is believed that the tears occurred during transportation from chafing between the padding placed between the super sacks and the chains. The packages did not lose any of their contents. As stated in the NOV, the damaged packages are a violation of 49 CFR 173.410(f). As such, the State of Utah assessed a penalty of 125 points against BNL's Utah Generator Site Access Permit, but had no fines associated with it. A causal analysis was performed and corrective actions were identified and completed to prevent recurrence of this violation.

Notes:
EPA = Environmental Protection Agency
NYSDEC = New York State Department of Environmental Conservation
ORPS = Occurrence Reporting and Processing System
SCDHS = Suffolk County Department of Health Services

Table 3-9. Summary of Other Environmental Occurrence Reports.

ORPS* ID: EM-BHSO-BNL-BNL-2012-0017	Date: 05/22/12
On May 17, 2012, BNL received a Condition Report notification from EnergySolutions stating that two intermodals shipped from BNL were found to have free liquids in them, which were noncompliant with the EnergySolutions Waste Acceptance Criteria (WAC). See Table 3-8 for more detailed information.	**Status:** Closed. Corrective actions identified and completed.
ORPS* ID: SC-BHSO-BNL-BNL-2012-0001	**Date: 01/12/12**
On January 10, 2012, while replacing a refrigerant line to an air conditioning (A/C) unit 1, located in the Building 1005B Alcove, the A/C Mechanics removed line set 1 when line set 2 (active line) unexpectedly ruptured causing an unplanned release of approximately 3 pounds of gaseous Freon 22® (R-22) into the atmosphere. The R-22 leak set off a nearby smoke detector which alarmed to the fire detection system. The Environmental Protection Division (EPD) was notified of the event by an Environmental, Safety, and Health Representative. An EPD Designee reported the incident to New York State Department of Environmental Conservation immediately as a non-routine release of regulated compounds, as is required by the State. The damaged line set was repaired by A/C Mechanics.	**Status:** Closed. Repairs completed and spill report submitted.
ORPS* ID: SC-BHSO-BNL-AGS-2012-0001	**Date: 01/24/12**
On January 24, 2012, Air Conditioning (A/C) technicians from BNL's Facility and Operations Directorate noticed an apparent leak from the compressor of the Building 1004A A/C unit, which is located outside the building on a concrete mat. The A/C technicians opened the unit covers and found that about 60 pounds of Freon 22 (R-22) refrigerant had leaked to the atmosphere from one of the two compressor units and about a quart of mineral oil, mixed in with the R-22 as a lubricant, had leaked to the surrounding soil at the concrete mat. The Environmental Protection Division reported the incident to Suffolk County, New York State Department of Environmental Conservation, and DOE as a non-routine release of regulated compounds, as is required. Spill to soil and concrete mat was cleaned up and repairs to the compressor were made.	**Status:** Closed. Repairs completed and spill report closed out.
ORPS* ID: SC-BHSO-BNL-BNL-2012-0008	**Date: 03/23/12**
On March 21, 2012, a Freon® (R-11) leak was discovered in Mechanical Equipment Room #2 within the National Synchrotron Light Source, Building 725. The Freon product was leaking from HVAC Trane Chiller unit number 2. The leak was discovered during a routine walk-through inspection of the area. It is believed that approximately 100 to 200 pounds of material was spilled. Upon discovery of the leak, the area was well ventilated through opening of two large louvers that open to the building exterior and adsorbent was placed around the spill to contain the liquid. It is believed that wear and rusting of connections resulted in containment failure and leakage of the R-11. The Environmental Protection Division reported the incident to Suffolk County, New York State Department of Environmental Conservation, and DOE as a non-routine release of regulated compounds, as is required. Soil samples outside the building and adjacent to the R-11 vapor exit point were taken and analyzed for R-11 content. No R-11 contamination was detected.	**Status:** Closed. Repairs completed and spill report closed out.
ORPS* ID: SC-BHSO-BNL-BNL-2012-0012	**Date: 04/10/12**
On April 9, 2012, BNL declared an Operational Emergency (OE) due to a brush fire near Building 1002 on the northern portion of the site at the Relativistic Heavy Ion Collider (RHIC) complex. The BNL Emergency Operations Center was activated, the Sewage Treatment Plant was evacuated as a precaution, and neighboring fire departments provided mutual aid assistance. The fire affected 300 acres and was brought under control. There was no damage to buildings on site. On April 10, 2012, it was discovered that a Manorville brush truck was destroyed the previous day by the fire while the truck was on BNL property (Northeast corner of BNL), which resulted in a release of petroleum to the soil. Environmental Protection Division personnel reported the incident to regulatory agencies and were involved in the preparation and implementation of the Recovery Management Plan.	**Status:** Closed. No corrective actions directly initiated by this one event, however, the Recovery Management Plan continues to be implemented.
ORPS* ID: SC-BHSO-BNL-BNL-2012-0025	**Date: 08/20/12**
On August 17, 2012, BNL received a letter from the State of Utah's Division of Radiation Control citing a Notice of Violation (NOV) resulting from the arrival of a Low Level Radioactive waste shipment in torn containers at EnergySolutions of Utah. See Table 3-8 for more detailed information.	Closed. Corrective actions identified and completed.

Notes:
* Reportable under the Occurrence Reporting and Processing System (ORPS), established by the requirements of DOE Order 231.1A.
ATS = Assessment Tracking System

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Air Quality 4

Brookhaven National Laboratory monitors both radioactive and nonradioactive emissions at several facilities on site to ensure compliance with the requirements of the Clean Air Act. In addition, BNL conducts ambient air monitoring to verify local air quality and assess possible environmental impacts from Laboratory operations.

During 2012, BNL facilities released a total of 4,901 curies of short-lived radioactive gases. Oxygen-15 and carbon-11 emitted from the Brookhaven Linac Isotope Producer constituted more than 99.9 percent of the site's radiological air emissions.

Since natural gas prices were comparatively lower than residual fuel prices throughout the year, BNL's Central Steam Facility used natural gas to meet 99 percent of the heating and cooling needs of the Laboratory's major facilities in 2012. As a result, annual facility emissions of particulate matter and oxides of nitrogen were at their lowest in the last decade.

4.1 RADIOLOGICAL EMISSIONS

Federal air quality laws and DOE regulations that govern the release of airborne radioactive material include 40 CFR 61 Subpart H: National Emission Standards for Hazardous Air Pollutants (NESHAPs)—part of the Clean Air Act (CAA), and DOE Order 458.1 Chg 2, Radiation Protection of the Public and the Environment. Under NESHAPs Subpart H, facilities that have the potential to deliver an annual radiation dose of greater than 0.1 mrem (1 µSv) to a member of the public must be continuously monitored for emissions. Facilities capable of delivering radiation doses below that limit require periodic, confirmatory monitoring. BNL has one facility that is continuously monitored with an in-line detection system, the Brookhaven Linac Isotope Producer (BLIP). Periodic monitoring was conducted at one active facility, the Target Processing Laboratory (TPL), and two inactive facilities, the High Flux Beam Reactor (HFBR) and the Brookhaven Graphite Research Reactor (BGRR) in 2012. Figure 4-1 indicates the locations of these monitored facilities, and Table 4-1 presents the airborne release data from each of these facilities during 2012. Annual emissions from monitored facilities are discussed in the following sections of this chapter. The associated radiation dose estimates are presented in Chapter 8, Table 8-4.

4.1.1 High Flux Beam Reactor

In 1997, a plume of tritiated groundwater was traced back to a leak in the HFBR spent fuel storage pool. Consequently, the HFBR was put in standby mode, the pool was pumped out, and the heavy tritiated water (HTO) from the pool was properly disposed of as radioactive waste. The pool was repaired and double lined in accordance with Suffolk County Article 12 regulations (SCDHS 1993) and remained empty while the facility was in a standby mode. The HFBR continued in standby mode until November 1999, when DOE declared that it was to be permanently shut down. Residual tritium in water in the reactor vessel and piping systems continued to diffuse into the building's air through valve seals and other system penetrations, though emission rates were much lower than during the years of operation.

As shown in Figure 4-2, the increase in emissions in 2003 was attributed to evaporative losses when HTO remaining in the reactor core was pumped out for approved disposal. In 2005,

Figure 4-1. Air Emission Release Points Subject to Monitoring.

tritium emissions climbed to 17.9 Ci, apparently due to evaporation of residual heavy water through an open drain-tank vent line. In 2006, tritium emissions dropped to 4.03 Ci, a level consistent with 2004 emissions. In 2007, the downward trend continued, as tritium emissions fell to 1.33 Ci. The rise in tritium emissions in 2008 to 20.06 Ci was due to periodic venting of the reactor vessel when domestic water was added to the reactor vessel in preparation for the removal of the HFBR control rod blades. Observed tritium emission increases in 2009 were due to HFBR decontamination and decommissioning (D&D) activities that included the removal of control rod blades from January through March; draining and properly disposing of tritiated heavy water from the reactor vessel, piping systems, and the fuel canal from late spring into the summer; and the opening of contaminated piping systems to allow for the removal of residual volumes of tritiated heavy water. Tritium emissions in 2010 were primarily due to the draining of residual heavy tritiated water from tanks and piping components from January through June in preparation for long-term facility surveillance and maintenance. The low levels of tritium in 2012, 0.81 Ci, were due to the presence of residual tritium and only periodic sampling of the facility for entry during the monthly structural integrity inspections.

From 2002 through 2008, emissions from the HFBR facility were monitored via air sampling of the building at a frequency of one week per month. In 2009, the frequency of monitoring was increased to bi-weekly to better account for changes in tritium emissions during planned D&D activities. In 2010, the HFBR was disconnected from the 100-meter stack, and a new HFBR exhaust system was installed in 2011. Consistent with the HFBR Long-Term Surveillance and Maintenance Manual, prior to scheduled surveillance and maintenance activities, air samples are now collected from outside the HFBR confinement using a permanently installed sample port. The samples are collected by bubbling air through a container of water using a fritted sampling device to ensure better collection efficiency. Samples are analyzed in-house for tritium, to ensure that air quality within the building is acceptable to permit staff entry. Additionally, samples are collected one week per month from the HFBR exhaust system using a standard desiccant sampling system for tritium analysis. Desiccant samples are analyzed by an off-site contract laboratory.

4.1.2 Brookhaven Linac Isotope Producer

Protons from the Linear Accelerator (Linac) are sent via an underground beam tunnel to the BLIP, where they strike various metal targets to produce new radionuclides for medical diagnostics. The activated metal targets are transferred to the TPL in Building 801 for separation and shipment to various radiopharmaceutical research laboratories. During irradiation, the targets become hot and are cooled by a continuously recirculating water system. The cooling

Table 4-1. Airborne Radionuclide Releases from Monitored Facilities.

Facility	Nuclide	Half-Life	Ci Released
BGRR	Tritium	12.3 years	1.40E-03
HFBR	Tritium	12.3 years	8.06E-01
BLIP	Carbon-11	20.4 minutes	1.60E+03
	Oxygen-15	122 seconds	3.31E+03
	Tritium	12.3 years	2.42E-04
TPL - Bldg. 801	Arsenic-74	17.8 days	2.45E-09
	Bromine-77	57.0 hours	2.59E-08
	Germanium-68	270.8 days	5.93E-08
	Selenium-75	119.8 days	6.75E-09
Total			**4.90E+03**

Notes:
Ci = 3.7E+10 Bq
BGRR = Brookhaven Graphite Research Reactor
BLIP = Brookhaven Linac Isotope Producer
HFBR = High Flux Beam Reactor (operations were terminated in November 1999)
TPL = Target Processing Laboratory

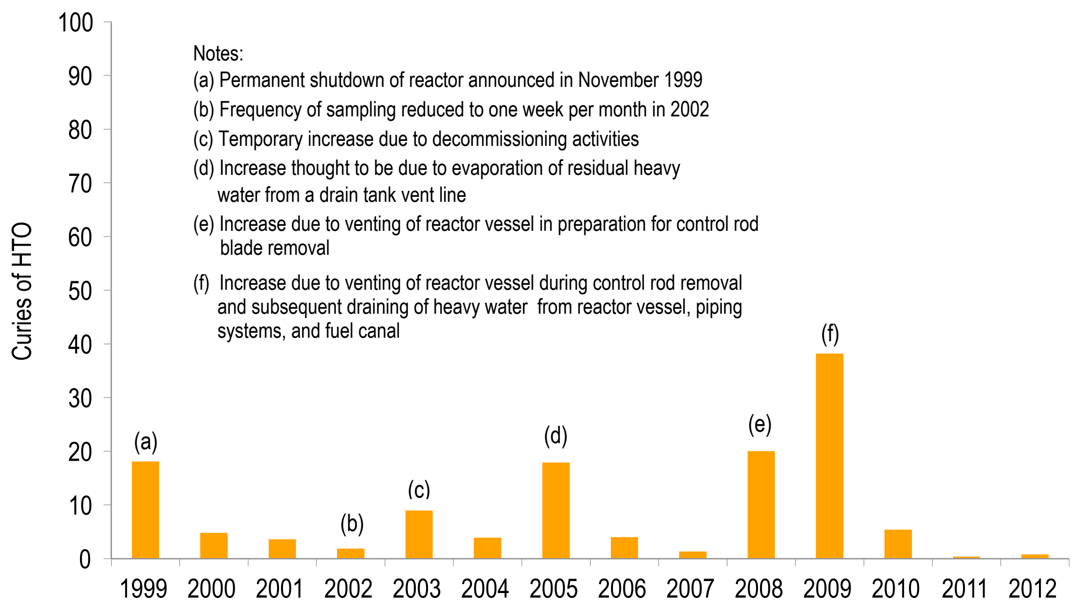


Figure 4-2. High Flux Beam Reactor Tritium Emissions, Multi-Year Trend (1999–2012).

water also becomes activated during the process, producing secondary radionuclides. The most significant of these radionuclides are oxygen-15 (O-15, half-life: 122 seconds) and carbon-11 (C-11, half-life: 20.4 minutes). Both of these isotopes are released as gaseous, airborne emissions through the facility's 33-foot stack. Emissions of these radionuclides are dependent on the current and energy of the proton beam used to manufacture the radioisotopes.

In 2012, BLIP operated over a period of 30 weeks, during which 1,595Ci of C-11 and 3,305 Ci of O-15 were released. Tritium produced from activation of the target cooling water was also released, but in a much smaller quantity, 2.42 E-4 Ci. Combined emissions of C-11 and O-15 were 15 percent less than the combined emission of these isotopes in 2011.

4.1.3 Target Processing Laboratory

As mentioned in Section 4.1.3, metal targets irradiated at the BLIP are transported to the TPL in Building 801, where isotopes are chemically extracted for radiopharmaceutical production. Airborne radionuclides released during the extraction process are drawn through multistage HEPA and charcoal filters and then vented to the atmosphere. The types of radionuclides that are released depend on the isotopes chemically extracted from the irradiated metal targets, which may change from year to year. Annual radionuclide quantities released from this facility are very small, typically in the μCi to mCi range. In 2012, the total release from the TPL was 0.0944 μCi (see Table 4-1 for details).

4.1.4 Brookhaven Graphite Research Reactor

The BGRR was constructed in 1950 for the sole purpose of providing neutrons for research projects. When the air-cooled graphite-moderated reactor operated, filtered outside air was drawn though a reactor pile, cooled in the ductwork, and then exhausted to a 100-meter stack. The reactor was shut down in 1969 and fuel was removed and transported from the site in June of 1972. Commencing in 2010 and continuing into 2012, the graphite pile and the biological shield housing it, which acted as a neutron moderator for the reactor, were removed. During this project, approximately 1.4 million pounds of activated graphite blocks and 5,000 tons of activated concrete from the bioshield were removed from Building 701 and then packaged, transported, and disposed of at an off-site location. Much of the removal, packaging, and waste transfer work was conducted under a 46-foot long, 32-feet wide, and 26-foot high contamination control envelope (CCE) supported with steel trusses and draped with a flame-retardant polyvinyl chloride covering that was constructed over the biological shield. A temporary HEPA ventilation system consisting of four 6,000 cfm HEPA-filtered fans was used to maintain the CCE under a negative pressure with respect to Building 701. Throughout the project, emissions discharged through a 36-inch diameter galvanized steel stack erected on the east exterior wall and extending 5 feet above the roof line were monitored for the presence of airborne radiological constituents such as tritium, particulates, and iodine. Continuous monitoring from January through April 2012 showed that 1.4 E-3 Ci of tritium were released (see Table 4-1 for details).

4.1.5 Additional Minor Sources

Several research departments at BNL use designated fume hoods for work that involves small quantities of radioactive materials (in the μCi to mCi range). The work typically involves labeling chemical compounds and transferring material between containers using pipettes. Due to the use of HEPA filters and activated charcoal filters, the nature of the work conducted, and the small quantities involved, these operations have a very low potential for atmospheric releases of any significant quantities of radioactive materials. Compliance with NESHAPs Subpart H is demonstrated through the use of an inventory system that allows an upper estimate of potential releases to be calculated. Facilities that demonstrate compliance in this way include Buildings 463, 490A, 510A, 535, 555, 725, 801, and 830, where research is conducted in the fields of biology, high energy physics, chemistry, photon science, advanced technology, and environmental sciences. See Table 8-4 in Chapter 8 for the calculated dose from these facility emissions.

4.1.6 Nonpoint Radiological Emission Sources

Nonpoint radiological emissions from a variety of diffuse sources were evaluated in 2012 for compliance with NESHAPs Subpart H. Diffuse sources evaluated included planned research and planned D&D activities. The EPA-approved CAP88-PC dose modeling computer program was used to calculate the possible dose to members of the public from each of the planned activities. The evaluations determined whether NESHAPs permitting and continuous monitoring requirements were applicable, or whether periodic confirmatory sampling was needed to ensure compliance with Subpart H standards for radionuclide emissions. Chapter 8 discusses the NESHAPs evaluations of environmental restoration activities that occurred in 2012.

4.2 FACILITY MONITORING

Radioactive emissions are monitored at the TPL, and BLIP. The samplers in the TPL exhaust duct and the exhaust stack for BLIP are equipped with glass-fiber filters that capture samples of airborne particulate matter generated at these facilities (see Figure 4-3 for locations). The filters are collected and analyzed weekly for gross alpha and beta activity. Particulate filter analytical results for gross alpha and beta activity in 2012 are reported in Table 4-2. The average gross alpha and beta airborne activity levels for samples collected from the BLIP exhaust stack were 0.0011 and 0.0182 pCi/m^3, respectively. Annual average gross alpha and beta airborne activity levels for samples collected from the TPL were 0.0013 and 0.0145 pCi/m^3, respectively.

4.3 AMBIENT AIR MONITORING

As part of the Environmental Monitoring Program, air monitoring stations are in place around the perimeter of the BNL site (see Figure 4-3 for locations). Samples are collected using equipment at six blockhouse stations and three pole-mounted, battery-powered silica-gel samplers. The blockhouses are fenced to control access and protect costly sampling equipment.

At each blockhouse, vacuum pumps draw air through columns where particulate matter is captured on a glass-fiber filter. Particulate filters are collected weekly and are analyzed for gross alpha and beta activity using a gas-flow proportional counter. Also, water vapor for tritium analysis is collected on silica-gel absorbent material for processing by liquid scintillation analysis. In 2012, silica-gel samples were collected every 2 weeks.

4.3.1 Gross Alpha and Beta Airborne Activity

Particulate filter analytical results for gross alpha and beta airborne activity are reported in Table 4-3. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., sample air volumes were not acceptable). The annual average gross alpha and beta airborne activity levels for the six monitoring stations were 0.0018 and 0.0144 pCi/m^3, respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 4-4. The results for this location are typical for the site. The trend shows seasonal variation in activity within a range that is representative of natural background levels. The New York State Department of Health (NYSDOH) received duplicate filter samples that were collected at Station P7, using a sampler they provided. These samples were collected weekly and analyzed by the NYSDOH laboratory for gross beta activity only. The analytical results found were comparable to the Station P7 samples analyzed by General Engineering Lab, an analytical laboratory contracted by BNL. New York State's analytical results for gross beta activity at the Laboratory were between 0.0038 and 0.0152 pCi/m^3, with an average concentration of 0.0088 pCi/m^3. BNL results ranged from 0.0035 to 0.00154 pCi/m^3, with an average concentration of 0.0094 pCi/m^3. As part of a statewide monitoring program, NYSDOH also collects air samples in Albany, New York, a control location with no potential to be influenced by nuclear facility emissions. In 2012, NYSDOH reported that airborne gross beta activity at that location varied between 0.0065 and 0.0210 pCi/m^3, and the average concentration was 0.0110 pCi/m^3. All of the sample results measured at the Laboratory fell within this range, demonstrating that on-site radiological air quality was consistent

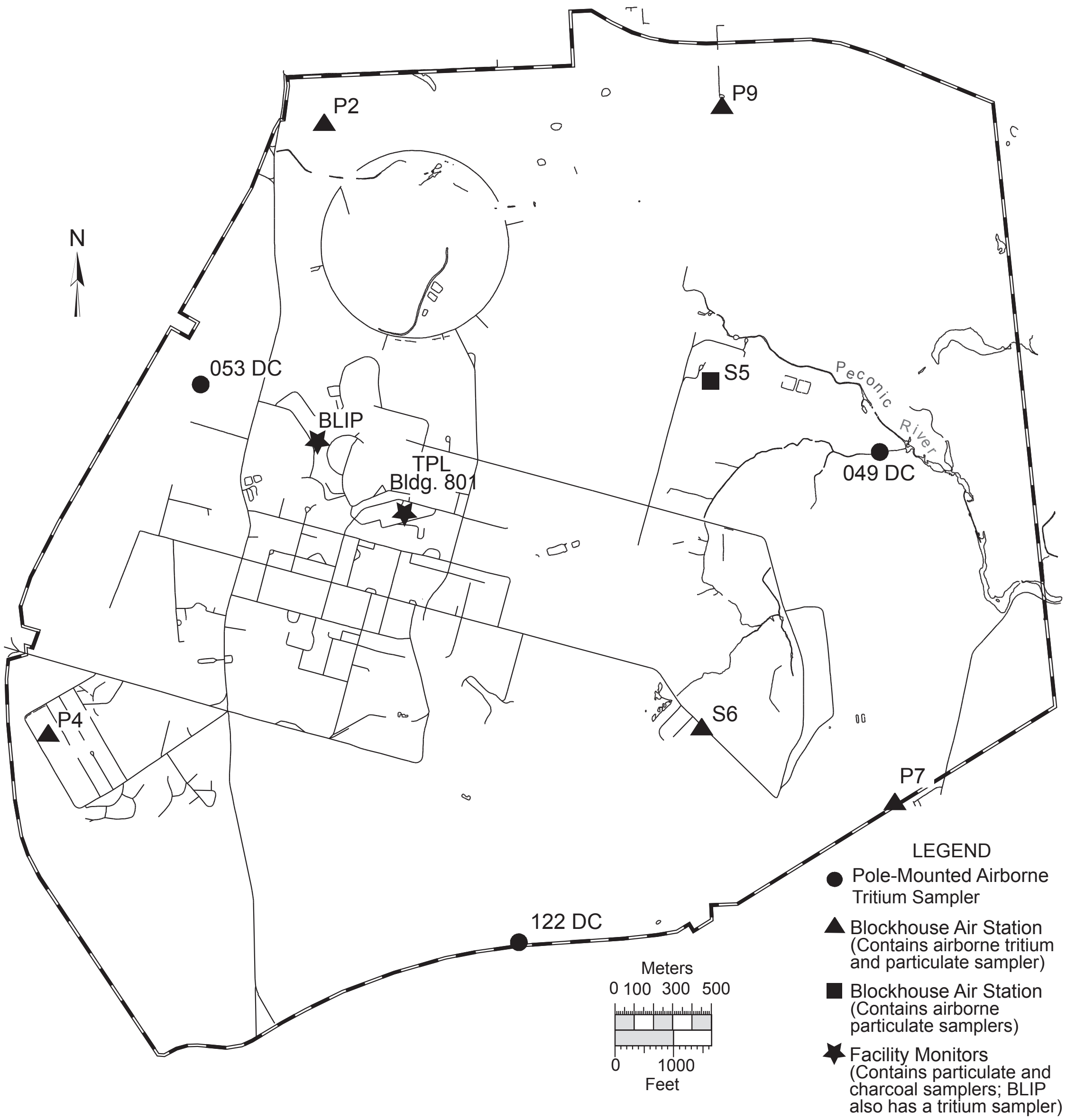


Figure 4-3. BNL On-Site Ambient Air Monitoring Stations.

with that observed at locations in New York State not located near radiological facilities.

4.3.2 Airborne Tritium

Airborne tritium in the form of HTO is monitored throughout the BNL site. In addition to the five blockhouses containing tritium samplers, three pole-mounted monitors used for tritium sampling are located at or near the Laboratory's property boundary (see Figure 4-3 for sample locations). Observed concentrations of tritium at the sampling stations in 2012 were lower than concentrations observed in 2011. Table 4-4 lists the number of validated samples collected at each location, the maximum value observed, and the annual average concentration. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., a battery failure in the sampler, frozen or supersaturated silica gel, insufficient sample volumes, or the loss of sample during preparation at the contract analytical laboratory). Airborne tritium samples were collected every 2 weeks from each sampling station during 2012; however, the contract laboratory rejected numerous samples because moisture captured on silica gel was insufficient for analysis. The average tritium concentrations at all of the sampling locations were less than

Table 4-2. Gross Activity in Facility Air Particulate Filters.

Facility Monitor		Gross Alpha (pCi/m^3)	Gross Beta
BLIP	N	47	47
	Max.	0.0278 ± 0.0024	0.194 ± 0.0050
	Avg.	0.0011 ± 0.0005	0.0182± 0.0014
	MDL	0.0006*	0.0009*
TPL-Bldg. 801	N	53	53
	Max.	0.0159 ± 0.0014	0.0459 ± 0.0017
	Avg.	0.0013± 0.0004	0.0145 ± 0.0010
	MDL	0.0003*	0.0005*

Notes:
See Figure 4-3 for sample station locations.
All values shown with a 95% confidence interval.
BLIP = Brookhaven Linac Isotope Producer
MDL = Minimum Detection Limit
N = Number of validated samples collected
TPL = Target Processing Laboratory
*Average MDL for all validated samples taken at this location

Table 4-3. Gross Activity Detected in Ambient Air Monitoring Particulate Filters.

Sample Station		Gross Alpha (pCi/m^3)	Gross Beta
P2	N	50	50
	Max	0.0035 ± 0.0009	0.0247 ± 0.0019
	Avg.	0.0018 ± 0.0006	0.0140 ± 0.0013
	MDL	0.0005*	0.0008*
P4	N	51	51
	Max	0.0529 ± 0.0153	0.4580 ± 0.0313
	Avg.	0.0028 ± 0.0009	0.0243 ± 0.0019
	MDL	0.0007*	0.0010*
P7	N	46	46
	Max	0.0020 ± 0.0006	0.0154 ± 0.0012
	Avg.	0.0011 ± 0.0004	0.0094 ± 0.0008
	MDL	0.0006*	0.0005*
P9	N	48	48
	Max	0.0065 ± 0.0017	0.0284 ± 0.0024
	Avg.	0.0020 ± 0.0007	0.0158 ± 0.0015
	MDL	0.0006*	0.0009*
S5	N	51	51
	Max	0.0034 ± 0.0013	0.0128 ± 0.0012
	Avg.	0.0010 ± 0.0005	0.0059 ± 0.0008
	MDL	0.0004*	0.0006*
S6	N	48	48
	Max	0.0036 ± 0.0011	0.0284 ± 0.0023
	Avg.	0.0020 ± 0.0008	0.0170 ± 0.0016
	MDL	0.0006*	0.0009*
Grand Average		**0.0018 ± 0.0007**	**0.0144 ± 0.0012**

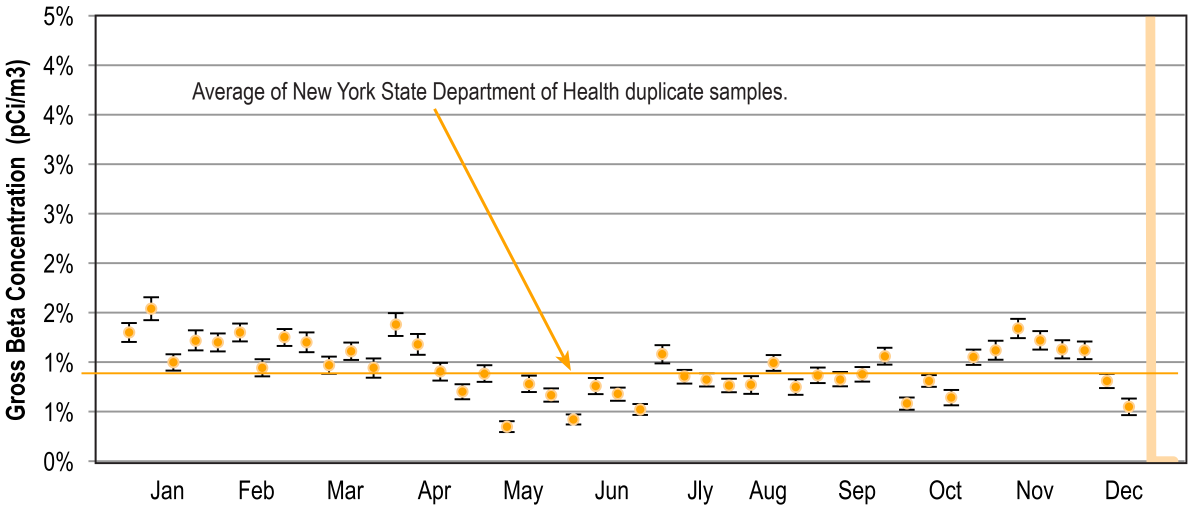
Notes:
See Figure 4-3 for sample station locations.
All values shown with a 95% confidence interval.
MDL = Minimum Detection Limit
N = Number of validated samples collected
*Average MDL for all validated samples taken at this location

the typical minimum detection limit (MDL), which ranged from 2.0 to 12.0 pCi/m^3.

4.4 NONRADIOLOGICAL AIRBORNE EMISSIONS

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 for nonradiological emissions. The Laboratory has several other emission sources subject to state and federal regulatory requirements that do not require emission monitoring (see Chapter 3 for more details). The CSF supplies steam for heating and cooling to major BNL facilities through an underground steam distribution and condensate grid. The location of the CSF is shown in Figure 4-1. The combustion units at the CSF are designated as Boilers 1A, 5, 6, and 7. Boiler 1A, which was installed in 1962, has a heat input of 16.4 MW (56.7 million British thermal units [MMBtu] per hour). Boiler 5, installed in 1965, has a heat input of 65.3 MW (225 MMBtu/hr). The newest units, Boilers 6 and 7, were installed in 1984 and 1996, and each has a heat input of 42.6 MW (147 MMBtu/hr). For perspective, National Grid's Northport, New York, power station has four utility-sized turbine/generator boilers, each with a maximum rated heat input of 1,082 MW (3,695 MMBtu/hr).

Because of their design, heat inputs, and dates of installation, Boilers 6 and 7 are subject to Title 6 of the New York Code, Rules, and Regulations (NYCRR) Part 227-2, and the Federal New Source Performance Standard (40 CFR 60 Subpart Db: Standards of Performance for Industrial-Commercial-Institutional Steam Boilers). These boilers are equipped with continuous



Note: All values are presented with a 95 percent confidence interval.

Figure 4-4. Airborne Gross Beta Concentration Trend Recorded at Station P7.

emission monitors to measure nitrogen oxides (NO_x) and with continuous opacity monitors to demonstrate compliance with Subpart Db opacity monitoring requirements. To measure combustion efficiency, the boilers are also monitored for carbon dioxide (CO_2). Continuous emission monitoring results from the two boilers are reported quarterly to EPA and the New York State Department of Environmental Conservation (NYSDEC).

From May 1 to September 15, the peak ozone period, compliance with the 0.30 lbs/MMBtu (129 ng/J) NO_x emission standard for No. 6 oil and the 0.20 lbs/MMBtu (86 ng/J) NO_x emission standard for No. 2 oil and natural gas is demonstrated by calculating the 24-hour average emission rate from continuous emission monitoring system readings and comparing the value to the emission standard. During the remainder of the year, the calculated 30-day rolling average emission rate is used to establish compliance. Boiler 6 and 7 opacity levels are recorded as 6-minute averages. Measured opacity levels cannot exceed 20 percent opacity, except for one 6-minute period per hour of not more than 27 percent opacity. In 2012, there were no measured exceedances of the NO_x emission standards for either boiler.

In 2012, nine excess opacity measurements recorded by Boiler 6 during routine operations on January 4 were due to an unexplained buildup of soot across the transmissometer light path. After CSF operators shut down the boiler and cleared soot from the light path, no further exceedances occurred. During the third quarter quality assurance tests of the opacity monitors for Boilers 6 and 7 and the fourth quarter quality assurance test of the Boiler 6 opacity monitor, multiple 6-minute periods greater than 20 percent opacity were recorded. These excursions were documented in quarterly Site-Wide Air Emissions and Monitoring Systems Performance Reports submitted to NYSDEC.

While there are no regulatory requirements to continuously monitor opacity for Boilers 1A and 5, surveillance monitoring of visible stack emissions is a condition of BNL's Title V operating permit. Daily observations of stack gases recorded by CSF personnel throughout the year showed no visible emissions, with opacity levels lower than the regulatory limits established for these boilers.

To satisfy quality assurance requirements for the continuous emissions monitoring system of the Laboratory's Title V operating permit, a relative accuracy test audit (RATA) of the Boilers 6 and 7 continuous emissions monitoring systems for NO_x and CO_2 was conducted in December 2012. The results of the RATA demonstrated that the Boiler 6 and 7 NO_x and CO2

Table 4-4. Ambient Airborne Tritium Measurements in 2012.

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m^3)	Average (pCi/m^3)
049	E	19	13.6 ± 5.7	3.4 ± 5.1
053	NW	17	85.9 ± 5.7	9.4 ± 3.9
122	SSE	16	8.0 ± 2.8	3.1 ± 4.3
P2	NNW	24	11.8 ± 7.3	1.9 ± 4.0
P4	WSW	27	5.1 ± 5.5	0.7 ± 2.3
P7	ESE	8	3.4 ± 2.6	1.4 ± 1.9
P9	NE	22	7.4 ± 5.9	2.1 ± 3.8
S6	SE	23	11.5 ± 5.4	2.1 ± 3.4
Grand Average				**2.8 ± 3.6**

Notes:
See Figure 4-3 for station locations.
Wind sector is the downwind direction of the sample station from the HFBR stack.
All values reported with a 95% confidence interval.
Typical minimum detection limit for tritium is between 2.0 and 12.0 pCi/m^3.
DOE Order 5400.5 Air Derived Concentration Guide is 100,000 pCi/m^3.

continuous emissions monitoring systems met RATA acceptance criteria, which are defined in 40 CFR 60, Appendix B, Specifications 2 and 3.

In 2012, residual fuel prices exceeded those of natural gas throughout the year. As a result, natural gas was used to supply more than 99 percent of the heating and cooling needs of BNL's major facilities during the year. By comparison, in 2005, residual fuel satisfied 99.9 percent of the major facility heating and cooling needs. Consequently, 2012 emissions of particulates, NOx, and sulfur dioxide (SO_2) were 12.7, 51.3, and 91.9 tons less than the respective totals for 2005, when No. 6 oil was the predominant fuel. All emissions were well below the respective permit limits of 113.3, 159, and 445 tons. Table 4-5 shows fuel use and emissions since 2003.

4.5 GREENHOUSE GAS EMISSIONS

One of the overarching goals of Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance, is for federal agencies to establish agency-wide greenhouse gas (GHG) reduction targets for their combined Scope 1 and 2 greenhouse gas emissions and for their Scope 3 greenhouse gas emissions (see Appendix A for definitions). DOE has set the following GHG emission reduction goals for fiscal year 2020: reduce Scope 1 and 2 GHG emissions by 28 percent relative to their fiscal year (FY) 2008 baseline and reduce Scope 3 GHG emissions by 13 percent relative to their FY 2008 baseline.

BNL includes these same goals in its annual Site Sustainability Plan (SSP), which is submitted to DOE in December of each year. Due to planned programmatic growth with the addition of the Laboratory's National Synchrotron Light Source II (NSLS-II) and other programs, Scope 1 and 2 emissions are projected to increase to 289,000 metric tons carbon dioxide equivalent ($MtCO_2e$) by 2020, a 95 percent increase from the FY 2008 baseline of 205,542 $MtCO_2e$. Due to the projected increase, meeting the Scope 1 and 2 reduction goal will be especially difficult and BNL's SSP identifies a number of actions that have or will be taken to help the Laboratory move towards this goal.

In November 2011, the Long Island Solar Farm (LISF), a large array of more than 164,000 solar photovoltaic panels constructed on site property began producing solar power. Annually, the LISF is expected to deliver 44 million kilowatt-hours of solar energy. This equates to 28,000 $MtCO_2e$ that BNL can count on as GHG offsets or reductions. In March 2011, BNL began receiving 15 megawatts per hour of hydropower from the New York Power Authority. In 2012, BNL consumed 118,231 megawatts of hydropower, providing a net GHG reduction of 72,606 $MtCO_2e$.

In 2012, BNL completed a preliminary study for a combined heat and power plant. Based on analysis of current and projected thermal loads from projects under construction, a 4-5 megawatt combined heat and power plant would meet a significant portion of the site's thermal needs and produce 31,000-39,000 megawatt-hours of power annually. A plant of this size would provide GHG emission offsets of 14,000-18,000 $MtCO_2e$ per year. A more detailed study will be performed in FY 2013 that will include an evaluation of permitting requirements, potential conflicts with existing power-purchase agreements, and to confirm the feasibility of incorporating gasification of local wood waste streams into the design.

To meet the 2020 Scope 3 GHG emissions reduction goal, Scope 3 emissions must be lowered by nearly 2,600 $MtCO_2e$ from the FY 2008 baseline of 20,000 MtCO2e. A secondary Scope 3 goal set by DOE is to reduce GHG emissions from employee business travel by 12 percent from the FY 2008 baseline or 1,065 $MtCO_2e$. Overall, Scope 3 GHG emissions have dropped by 1,645 $MtCO_2e$ or 8.2 percent from FY 2008 to FY 2012, despite a 1,785 $MtCO_2e$ or 20.6 percent increase in employee business travel GHG emissions over the same period. This reduction was a direct result of the purchase and use of 118,231 megawatt-hours of hydropower from the New York Power Authority in 2012. Hydro power purchased in 2012 accounted for 42.5 percent of all BNL power purchases. As a result, GHG emissions from transmission and distribution losses dropped 3,400 $MtCO_2e$, or 30.5 percent.

To achieve the employee travel reduction goal, BNL must reduce its employee travel GHGs by 1,040 $MtCO_2e$. Reaching this goal is complicated by a growing employee population that rose 11.2 percent from 2,669 full-time employees at the end of FY 2008 to 2,967 at the end of FY 2012. Further increases are projected due to programmatic growth. In November 2011, BNL presented three proposals to the Laboratory's Policy Council to establish an annual airline mileage reduction goal applicable to all organizations. After a follow-up meeting in October 2012 to discuss how each of the proposals would impact individual organizations, the Policy Council did not approve any of the proposals because they would significantly impact travel considered essential to meeting mission critical research objectives. Instead they recommended the formation of a workgroup to identify paths to reducing GHG emissions in each of the four business travel categories. Options that will be explored include:

- The adoption of a site-wide 9/80 work schedule
- Establishing employee incentives to encourage electric, plug-in hybrid, and hybrid and high mileage vehicle purchases
- Setting restrictions on employee use of full size and luxury vehicle rentals and encouraging the rental of hybrids
- Identifying job classifications where Telework arrangements would be practical to employees and their supervisors

Table 4-5. Central Steam Facility Fuel Use and Emissions (2003 – 2012).

Annual Fuel Use and Fuel Heating Values							Emissions			
Year	No. 6 Oil (10^3 gals)	Heating Value (MMBtu)	No. 2 Oil (10^3 gals)	Heating Value (MMBtu)	Natural Gas (10^6 ft^3)	Heating Value (MMBtu)	TSP (tons)	NO_x (tons)	SO_2 (tons)	VOCs (tons)
2003	4,290.95	628,765	402.06	56,288	0.98	1,000	22.8	75.3	107.1	0.6
2004	4,288.76	628,063	2.45	343	0.11	109	16.4	81.9	104.7	2.4
2005	4,206.12	618,590	0.87	122	0.00	0	15.2	80.4	93.1	2.4
2006	2,933.00	432,430	0.22	30	191.35	195,177	11.8	66.9	66.3	2.2
2007	2,542.85	374,432	0.00	0	263.04	268,301	9.7	77.3	59.3	2.2
2008	1,007.49	148,939	0.10	14	496.48	506,406	5.7	46.7	23.0	1.9
2009	1,904.32	283,734	0.00	0	375.03	382,529	9.0	53.4	44.9	2.1
2010	447.47	66,591	0.00	0	561.42	568,939	3.4	41.5	10.0	1.8
2011	31.49	4,726	0.01	2	657.06	668,564	2.6	30.4	0.9	1.8
2012	43.44	6,519	0.00	0	613.44	630,616	2.5	29.1	1.2	1.7
Permit Limit (in tons)							113.3	159.0	445.0	39.7

Notes:
NO_x = Oxides of Nitrogen
SO_2 = Sulfur Dioxide
TSP = Total Suspended Particulates
VOCs = Volatile Organic Compounds

- Identifying non-mission critical conferences and workshops requiring airline travel where attendance is optional or the number of attendees could be reduced

Actions taken in 2012 that will help BNL to move forward in meeting the employee business travel GHG reduction goals included:

- BNL staff worked with administrators of MetroPool, the New York State Department of Transportation regional commuting services contractor, to develop a rideshare portal customized to meet the needs of employees interested in ridesharing. The proposed portal would include ridematch maps, displaying the location of other employee homes within a defined radius of the person seeking partners or home locations of other employees near the route traveled by the employee. The portal will include other features, such as the location of park & ride lots, a commute cost calculator, Guaranteed Ride Service Information, and a live link to traffic conditions on major arteries.
- The Policy Council approved Human Resources Division plans to expand flexible and compressed work week scheduling arrangements to non-bargaining nonexempt employees. Employees approved to work a 9-80 compressed work week schedule would reduce their frequency commuting 1 day every 2 weeks and their commuting GHG footprint by 10 percent.

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Water Quality 5

Wastewater generated from operations at Brookhaven National Laboratory is discharged to surface waters via the Sewage Treatment Plant (STP) and to groundwater via 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 requirements and that the public, employees, and the environment are protected.

Analytical data for 2012 show that the average gross alpha and beta activity levels in the STP discharge were within the typical range of historical levels and were well below New York State Drinking Water Standards (NYS DWS). During 2012, tritium was detected in the STP effluent only once at a concentration just above the minimum detectable activity (630 ± 350 pCi/L), which is 3 percent of the drinking water standard. Analysis of the STP effluent continued to show no detection of cesium-137, strontium-90, or other gamma-emitting nuclides attributable to Laboratory operations. Similarly, there were no radionuclides detected along the Peconic River in 2012 that were attributable to BNL operations.

Nonradiological monitoring of the STP effluent showed that, except for isolated incidents of noncompliance, organic and inorganic parameters were within State Pollutant Discharge Elimination System (SPDES) effluent limitations or other applicable standards.

Examination of radiological analytical data for discharges to recharge basins showed that the average concentrations of gross alpha and beta activity were within typical ranges and no gamma-emitting radionuclides were detected in 2012. Tritium was detected in a single sample collected at Basin HT-W at a very low level, (550 ± 290 pCi/L). This basin receives discharges from the Collider-Accelerator complex. Review of organic data shows that disinfection byproducts are detected at very low concentrations, just above the contract analytical laboratory's method detection limit, in discharges to recharge basins 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 run-off in stormwater discharges.

Radiological data from Peconic River surface water sampling in 2012 show 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. Tritium was not detected above contract laboratory method detection limits at any of the Peconic River sampling stations in 2012. 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. Concentrations of copper, lead, and zinc detected were consistent with concentrations found in the STP discharge and were within BNL SPDES permit limits.

5.1 SURFACE WATER MONITORING PROGRAM

Treated wastewater from the Laboratory's STP is discharged into the headwaters of the Peconic River. This discharge is permitted under the New York State Department of Environmental Conservation (NYSDEC) SPDES Program. Effluent limits are based on water quality standards established by NYSDEC, as well as historic operational data. To assess the impact of wastewater discharge on the quality of the river, surface water is monitored at several locations upstream and downstream of the discharge point. Monitoring Station HY (see Figure 5-7), on site but upstream of all Laboratory operations, provides information on the background water quality of the Peconic River. The Carmans River is monitored as a geographic control location for comparative purposes, as it is not affected by operations at BNL or within the Peconic River watershed.

On the Laboratory site, the Peconic River is an intermittent stream. Off-site flow occurs only during periods of sustained precipitation, typically in the spring. Similar to 2011, there was very little off-site flow in 2012. The only measurable flow was due to heavy precipitation that occurred in August 2012. When flow ceased, standing water was continuous throughout the year in several of the deeper sections of the river. The following sections describe BNL's surface water monitoring and surveillance program.

5.2 SANITARY SYSTEM EFFLUENTS

The STP effluent (Outfall 001) is a discharge point authorized under BNL's SPDES permit. Figure 5-1 shows a schematic of the STP and its sampling locations. The Laboratory's STP treatment process includes four principal steps: 1) aerobic oxidation for secondary removal of biological matter and nitrification of ammonia, 2) secondary clarification, 3) sand filtration for final solids removal, and 4) ultraviolet disinfection for bacterial control prior to discharge to the Peconic River. Tertiary treatment for nitrogen removal is also provided by controlling the

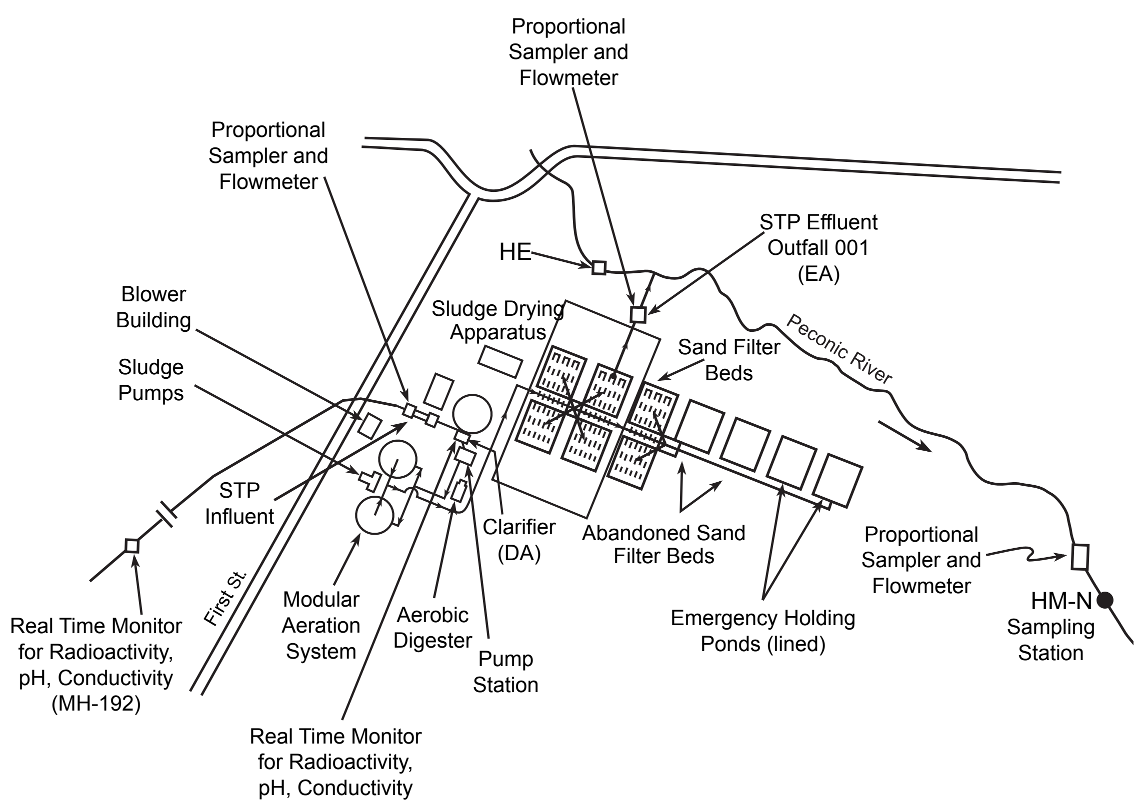

Figure 5-1. Schematic of BNL's Sewage Treatment Plant (STP).

oxygen levels in the aeration tanks. During the aeration process, the oxygen levels are allowed to drop to the point where microorganisms use nitrate-bound oxygen for respiration; this liberates nitrogen gas and consequently reduces the concentration of nitrogen in the STP discharge.

Nitrogen is an essential nutrient in biological systems that, in high concentrations, can cause excessive aquatic vegetation growth. During the night (when photosynthesis does not occur), aquatic plants use oxygen in the water. Too much oxygen uptake by aquatic vegetation deprives a water system of oxygen needed by fish and other aquatic organisms for survival. Limiting the concentration of nitrogen in the STP discharge helps keep plant growth in the Peconic River in balance with the nutrients provided by natural sources.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity occurs at two locations. The first site, MH-192 (see Figure 5-1), is approximately 1.1 miles upstream of the STP, providing a minimum of 30 minutes' warning to the STP operators if wastewater is en route that may exceed SPDES limits or BNL effluent release criteria. The second site is at the point where the STP influent enters the treatment process.

Based on the data collected by the real-time monitoring systems, any influent to the STP that may not meet SPDES limits and BNL effluent release criteria is diverted to two double-lined holding ponds. The total combined capacity of the two holding ponds exceeds 6 million gallons, or approximately 18 days of flow. Diversion continues until the effluent's water quality meets the permit limits and release criteria. If wastewater is diverted to the holding ponds, it is tested and evaluated against the requirements for release. If necessary, the wastewater is treated and then reintroduced into the STP at a rate that ensures compliance with SPDES permit limits for nonradiological parameters or BNL effluent release criteria for radiological parameters.

In 2012, there was one instance that resulted in diversion of wastewater to the hold-up ponds. Between October 18 and October 24, BNL wastewater was diverted to one of the holdup ponds due to elevated concentrations of the radionuclide iodine-131 (I-131: half-life, 8.02 days). An environmental sampling technician performing daily checks of the sewage line monitoring system observed an elevated radiation baseline (~100 counts/min) at a manhole upstream of the STP. A sample was collected and In Situ Object Counting System (ISOCs) was utilized to identify I-131 as the cause of the increased radiation levels. Levels continued to increase to >1000 counts/min, as measured at the STP. A second sample was collected and I-131 was confirmed, but at levels 4-6 times higher than the previous sample. As designed, the STP went into automatic diversion, and the wastewater was directed to a holding pond. Environmental Protection personnel conferred with Radiological Control management and confirmed that no I-131 was in use at the Laboratory. The suspected source was identified as patient excreta from someone undergoing thyroid treatment. On October 19, the source was confirmed as an on-site resident that had undergone ablation therapy. The STP remained in diversion operating mode until October 24, at which time the concentration of I-131 dropped to near drinking water limits, and the plant was placed back into normal operations on October 24.

Although there are no regulatory statutes which would require the Laboratory to divert this wastewater for holdup, BNL decided to maintain diversion and hold the wastewater for decay prior to release as an environmental best-management practice.

Solids separated in the clarifier are pumped to aerobic digesters for continued biological solids reduction and sludge thickening. Once the sludge in the aerobic digester reaches a solids content of 6 percent, the sludge is sampled to ensure it meets the waste acceptance criteria for disposal at the Suffolk County Department of Public Works Sewage Treatment Facility at Bergen Point, in West Babylon, New York.

5.2.1 Sanitary System Effluent–Radiological Analyses

Wastewater at the STP is sampled at the inlet to the treatment process, Station DA (see Figure

5-1) and at the Peconic River Outfall (Station EA). At each location, samples are collected on a flow-proportional basis; that is, for every 1,000 gallons of water treated, approximately 4 fluid ounces of sample are collected and composited into a 5-gallon collection container. These samples are analyzed for gross alpha and gross beta activity and for tritium concentrations. In 2012, samples were collected three times weekly. Samples collected from these locations are also composited and analyzed monthly for gamma-emitting radionuclides and strontium-90 (Sr-90: half-life, 29 years).

Although the Peconic River is not used as a direct source of potable water, the Laboratory applies the stringent Safe Drinking Water Act (SDWA) standards for comparison purposes when monitoring the effluent, in lieu of DOE wastewater criteria. Under the SDWA, water standards are based on a 4 mrem (40 µSv) dose limit. The SDWA specifies that no individual may receive an annual dose greater than 4 mrem from radionuclides that are beta or photon emitters, which includes up to 168 individual radioisotopes. BNL performs radionuclide-specific gamma analysis to ensure compliance with this standard. The SDWA annual average gross alpha activity limit is 15 pCi/L, including radium-226 (Ra-226: half-life, 1,600 years), but excluding radon and uranium. Other SDWA-specified drinking water limits are 20,000 pCi/L for tritium (H-3: half-life, 12.3 years), 8 pCi/L for Sr-90, 5 pCi/L for Ra-226 and radium-228 (Ra-228: half-life, 5.75 years), and 30 µg/L for uranium. Gross activity (alpha and beta) measurements are used as a screening tool for detecting the presence of radioactivity. Table 5-1 shows the monthly gross alpha and beta activity data and tritium concentrations for the STP influent and effluent during 2012. Annual average gross alpha and beta activity levels in the STP effluent were 0.5 ± 0.1 pCi/L and 4.6 ± 0.2 pCi/L, respectively. These concentrations remain essentially unchanged from year to year. The one elevated gross beta concentration (346 ± 35 pCi/L) detected at the STP influent in October is directly related to the employee off-site medical isotope treatment discussed in Section 5.2. Control location data from the Carmans River Station HH (see Figure 5-7) show average gross alpha and beta levels of 0.78 ± 0.27 pCi/L and 1.05 ± 0.37 pCi/L, respectively (see Table 5-6). The average concentrations of gross alpha and beta activity in Peconic River water samples collected upstream of the STP outfall were 0.67 ± 0.48 pCi/L and 1.55 ± 0.33 pCi/L, respectively.

A plot of the 2012 tritium concentrations recorded in STP effluent is presented in Figure 5-2. A 15-year trend plot of annual average tritium concentrations measured in the STP discharge is shown in Figure 5-3. The annual average concentration trend has been consistently less than 1 percent of the NYS DWS since 2000.

In 2012, with the exception of a single low-level reported value, tritium was not detected in the discharge of the STP (EA, Outfall 001) for the entire year. A concentration measured in the single sample of the STP discharge in December (see Figure 5-2) was 630 ± 350 pCi/L. Due to the low level of detection and the high uncertainty (~50 percent), this concentration is indistinguishable from the typical minimum detection limit. The annual average tritium concentration, as measured in the STP effluent, was 43 ± 16 pCi/L, which is only 17 percent of the average minimum detection level (MDL), 246 pCi/L, and well below the NYS DWS of 20,000 pCi/L. Using the annual average concentration and the flow recorded for the year, a total of 0.0149 Ci (14.9 mCi) of tritium was released during the year, which is consistent with total releases of tritium over the past 5 years (see Figure 5-4). In 2012, there were no gamma-emitting nuclides detected in the STP effluent, which is consistent with data reported since 2003. Sr-90 was detected in two effluent samples collected in July and August (0.32 pCi/L and 0.64 pCi/L, respectively); however, these values are consistent with historical levels both upstream and downstream of the STP and most likely attributable to worldwide fallout and not BNL-derived.

5.2.2 Sanitary System Effluent – Nonradiological Analyses

In addition to the compliance monitoring

Table 5-1. Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant (STP).

		Flow (a) (Liters)	Tritium (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)	
			max.	avg.	max.	avg.	max.	avg.
January	*influent*	3.03E+07	< 240	<MDL	2.3 ± 1.6	0.8 ± 0.5	7.1 ± 1.4	4.9 ± 0.8
	effluent	2.25E+07	< 270	<MDL	< 2.3	0.4 ± 0.3	6.0 ± 1.2	4.1 ± 0.6
February	*influent*	2.41E+07	< 150	<MDL	< 2.2	0.3 ± 0.3	8.0 ± 1.4	5.5 ± 0.9
	effluent	1.89E+07	< 160	<MDL	< 2.0	0.7 ± 0.3	6.4 ± 1.2	4.9 ± 0.5
March	*influent*	2.86E+07	< 140	<MDL	< 2.2	0.6 ± 0.3	8.1 ± 1.4	5.7 ± 0.8
	effluent	2.18E+07	< 110	<MDL	< 1.8	0.4 ± 0.4	6.5 ± 1.2	5.3 ± 0.4
April	*influent*	3.72E+07	< 180	<MDL	< 2.3	0.4 ± 0.2	7.7 ± 1.3	6.2 ± 0.6
	effluent	2.53E+07	< 140	<MDL	2.2 ± 1.4	0.7 ± 0.4	6.3 ± 1.2	5.2 ± 0.4
May	*influent*	4.28E+07	< 130	<MDL	< 2.2	0.6 ± 0.3	6.8 ± 1.3	4.7 ± 0.8
	effluent	2.81E+07	< 170	<MDL	< 1.6	0.3 ± 0.3	5.4 ± 1.1	4.6 ± 0.4
June	*influent*	4.07E+07	< 130	<MDL	2.4 ± 1.4	0.6 ± 0.4	8.1 ± 1.6	5.9 ± 0.7
	effluent	4.21E+07	< 130	<MDL	< 2.3	0.7 ± 0.3	6.4 ± 1.3	4.7 ± 0.5
July	*influent*	5.44E+07	< 170	<MDL	3.4 ± 1.7	0.5 ± 0.6	7.9 ± 1.5	4.5 ± 1.4
	effluent	4.65E+07	< 220	<MDL	< 1.9	0.3 ± 0.3	5.6 ± 1.2	4.7 ± 0.4
August	*influent*	6.24E+07	< 150	<MDL	< 2.6	0.2 ± 0.3	7.4 ± 1.5	4.8 ± 0.8
	effluent	5.08E+07	< 150	<MDL	< 1.9	0.5 ± 0.3	7.3 ± 1.3	4.3 ± 0.6
September	*influent*	3.83E+07	< 460	<MDL	< 2.8	0.8 ± 0.3	7.3 ± 1.5	5.2 ± 0.8
	effluent	3.07E+07	< 390	<MDL	1.8 ± 1.3	0.7 ± 0.4	6.6 ± 1.3	5.1 ± 0.4
October	*influent*	3.95E+07	< 420	<MDL	4.0 ± 1.7	0.7 ± 0.6	346.0 ± 35.0	36.4 ± 51.0
	effluent	2.86E+07	< 320	<MDL	1.5 ± 1.3	0.6 ± 0.3	6.8 ± 1.0	5.0 ± 0.6
November	*influent*	2.78E+07	< 370	<MDL	2.2 ± 1.3	0.3 ± 0.5	7.2 ± 1.1	5.1 ± 0.8
	effluent	2.38E+07	< 450	<MDL	2.7 ± 1.4	0.5 ± 0.4	5.3 ± 1.1	3.9 ± 0.4
December	*influent*	3.60E+07	< 340	<MDL	< 1.4	0.2 ± 0.3	6.5 ± 1.1	4.1 ± 0.9
	effluent	3.63E+07	630 ± 350	<MDL	< 1.6	0.1 ± 0.3	5.1 ± 1.1	3.3 ± 0.4
Annual Avg.	*influent*			<MDL		0.5 ± 0.1		7.8 ± 4.4
	effluent			<MDL		0.5 ± 0.1		4.6 ± 0.2
Total Release		**3.76E+08**		**14.9 mCi**		**0.2 mCi**		**1.6 mCi**
Average MDL (pCi/L)				**246.3**		**1.7**		**1**
SDWA Limit (pCi/L)				**20000**		**15**		**(b)**

Notes:
All values are reported with a 95% confidence interval.
Negative numbers occur when the measured value is lower than background (see Appendix B for description).
To convert values from pCi to Bq, divide by 27.03.
MDL = Minimum Detection Limit
SDWA = Safe Drinking Water Act
(a) Effluent values greater than influent values occur when water that had been diverted to the holding ponds is tested, treated (if necessary), and released.
(b) The drinking water standards were changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. As gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.

discussed in Chapter 3, effluent from the STP is also monitored for nonradiological contaminants under the BNL Environmental Surveillance Program. Data are collected for field-measured parameters such as temperature, specific conductivity, pH, and dissolved oxygen. Composite samples of the STP effluent are collected using a flow-proportional refrigerated

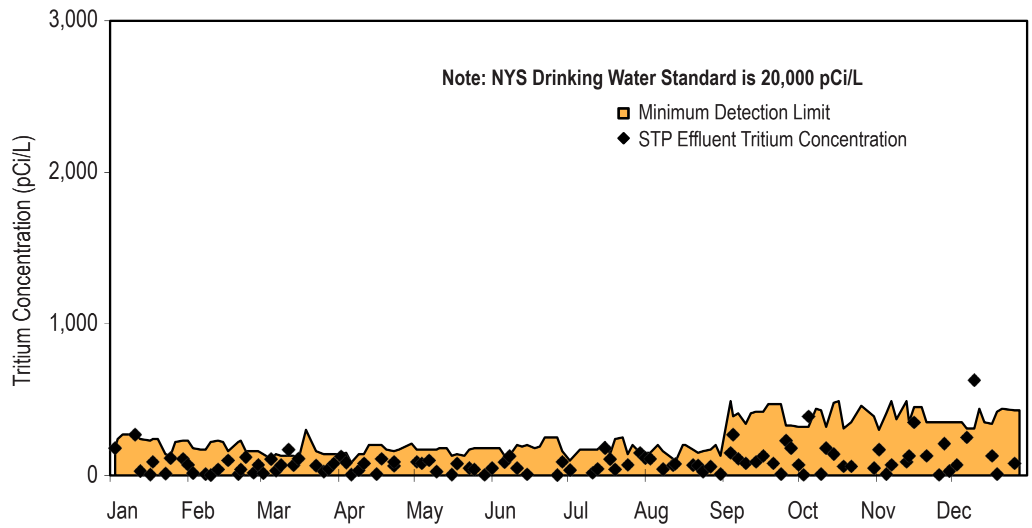

Figure 5-2. Tritium Concentrations in Effluent from the BNL Sewage Treatment Plant (2012).

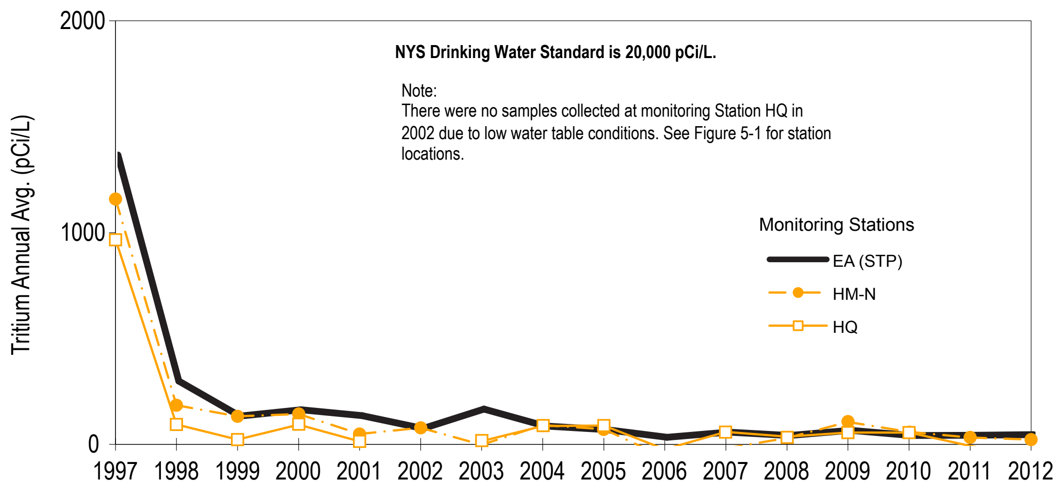

Figure 5-3. Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations (1997–2012).

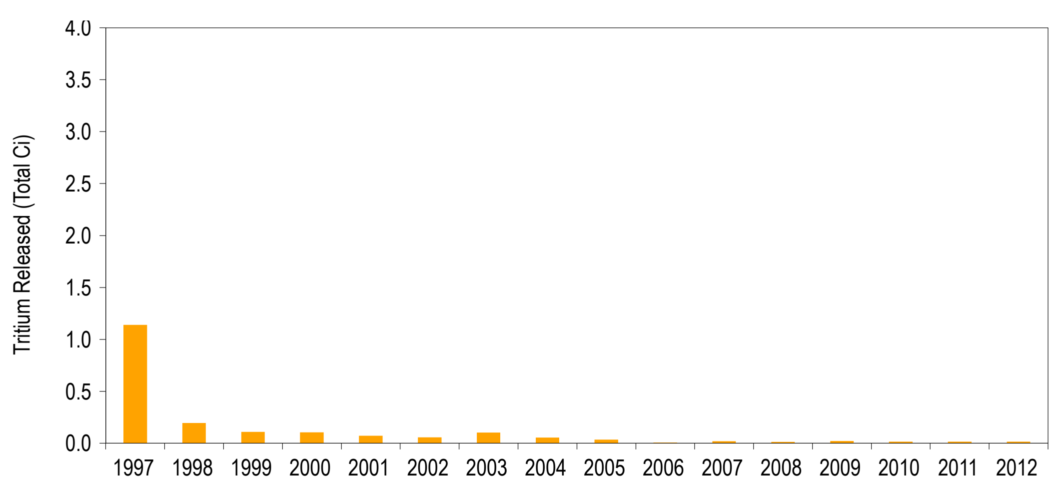

Figure 5-4. Tritum Released to the Peconic River, 15-Year Trend (1997–2012).

sampling device (ISCO Model 3700RF) and are analyzed by contract analytical laboratories. Samples are analyzed for 23 inorganic elements, anions, semivolatile organic compounds (SVOCs), pesticides, and herbicides. In addition, grab samples are collected monthly from the STP effluent and analyzed for 38 different volatile organic compounds (VOCs). Daily influent and effluent logs are maintained by the STP operators for flow, pH, temperature, and settleable solids, as part of routine monitoring of STP operations.

Table 5-2 summarizes the water quality and inorganic analytical results for the STP samples in 2012. Comparing the effluent data to the SPDES effluent limits (or New York State Ambient Water Quality Standards [NYS AWQS]), as appropriate, shows that most of the analytical parameters were within effluent permit limits (see also the compliance data in Chapter 3). Aluminum and iron were detected in the effluent at concentrations exceeding the SPDES permit limits or ambient water quality standards. All data reported in Table 5-2 are for "total recoverable" concentrations of the analyte, which includes suspended and dissolved fractions. Consequently, the data are conservative (err on the side of caution) for many of the analytes. Aluminum was detected in samples collected in June and December at a concentration of 173 µg/L and 117 µg/L, respectively, which is just above the NYS AWQS standard of 100 µg/L. Aluminum is regulated in the ionic (i.e., dissolved) form. Iron was detected in a sample collected in February at concentrations of 0.40mg/L, which is consistent with the data reported in Chapter 3. In 2012, acetone was the only VOC detected in the STP effluent above method detection limits. Acetone was detected at concentrations ranging from 1.2 µg/L to a maximum of 11 µg/L. Acetone is a common solvent used in the contract analytical laboratory and is routinely detected due to cross-contamination within the laboratory.

5.3 PROCESS-SPECIFIC WASTEWATER

Wastewater that may contain constituents above SPDES permit limits or ambient water quality discharge standards must be held by the generating facility and characterized to determine the appropriate means of disposal. The analytical results are compared with the appropriate discharge limit, and the wastewater is released to the sanitary system if the volume and concentration of contaminants in the discharge would not jeopardize the quality of the STP effluent and, subsequently, the Peconic River.

The Laboratory's SPDES permit includes requirements for quarterly sampling and analysis of process-specific wastewater discharged from printed-circuit-board fabrication operations conducted in Building 535B, metal cleaning operations in Building 498, and cooling tower discharges from Building 902. These operations are monitored for contaminants such as metals, cyanide, VOCs, and SVOCs. In 2012, analyses of these waste streams showed that, although several operations contributed contaminants (principally metals) to the STP influent in concentrations exceeding SPDES-permitted levels, these discharges did not affect the quality of the STP effluent.

Process wastewaters that were not expected to be of consistent quality because they were not routinely generated were held for characterization before release to the site sewer system. The process wastewaters typically included purge water from groundwater sampling, wastewater from cleaning of heat exchangers, wastewater generated as a result of restoration activities, and other industrial wastewaters. To determine the appropriate disposal method, samples were analyzed for contaminants specific to the process. The analyses were then reviewed and the concentrations were compared to the SPDES effluent limits and BNL's effluent release criteria. If the concentrations were within limits, authorization for sewer system discharge was granted; if not, alternate means of disposal were used. Any waste that contained elevated levels of hazardous or radiological contaminants in concentrations that exceeded Laboratory effluent release criteria was sent to the BNL Waste Management Facility for proper management and off-site disposal.

5.4 RECHARGE BASINS

Recharge basins are used for the discharge

Table 5-2. BNL Sewage Treatment Plant (STP) Water Quality and Metals Analytical Results.

ANALYTE	Units	STP Influent N	Min.	Max.	Avg.	STP Effluent N	Min.	Max.	Avg.	SPDES Limit or AWQS (1)	Comment or Qualifier
pH	SU	CM	7.2	7.5	NA	CM	6.6	7.8	NA	5.8 - 9.0	
Conductivity	μS/cm	CM	NR	NR	NR	164 (a)	240	526	407	SNS	
Temperature	°C	CM	NR	NR	NR	164 (a)	5.8	29.7	16.8	SNS	
Dissolved Oxygen	mg/L	NM	NM	NM	NM	164 (a)	6.5	13.8	9.4	SNS	
Chlorides	mg/L	12	52.2	102.0	78.5	12.0	53.2	99.9	75.7	SNS	
Nitrate (as N)	mg/L	12	1.2	8.5	4.3	12.0	1.0	9.0	5.1	10	Total N
Sulfates	mg/L	12	13.5	18.9	16.8	12.0	11.8	20.3	16.5	250	GA
Aluminum	μg/L	12	120.0	1080.0	327.2	12.0	16.0	173.0	52.7	100	Ionic
Antimony	μg/L	12	2.0	6.6	< 5	12.0	2.2	< 5	< 5	3	GA
Arsenic	μg/L	12	1.1	13.0	< 5	12.0	1.0	< 5	< 5	150	Dissolved
Barium	μg/L	12	45.8	103.0	70.6	12.0	16.4	27.9	21.5	1000	GA
Beryllium	μg/L	12	0.4	< 2	< 2	12.0	< 0.5	< 2	< 2	11	Acid Soluble
Cadmium	μg/L	12	0.1	< 2	< 2	12.0	0.1	< 2	< 2	1.1	Dissolved
Calcium	mg/L	12	13.5	21.2	17.2	12.0	11.1	18.4	15.0	SNS	
Chromium	μg/L	12	4.0	< 10	< 10	12.0	3.5	< 10	< 10	34.4	Dissolved
Cobalt	μg/L	12	0.5	1.8	0.8	12.0	0.2	< 5	< 5	5	Acid Soluble
Copper	μg/L	12	79.3	402.0	141.5	12.0	12.0	66.3	27.9	150	SPDES
Iron	mg/L	12	0.7	2.9	1.3	12.0	0.1	0.4	0.2	0.37	SPDES
Lead	μg/L	12	4.6	27.2	10.9	12.0	0.5	5.2	1.9	19	SPDES
Magnesium	mg/L	12	3.0	5.2	4.2	12.0	2.8	4.9	3.7	SNS	
Manganese	μg/L	11	30.9	92.6	49.8	11.0	0.9	10.2	3.2	300	GA
Mercury	μg/L	12	0.2	2.2	0.5	12.0	0.1	< 0.2	< 0.2	0.2	SPDES
Nickle	μg/L	12	2.3	14.3	6.0	12.0	2.1	4.1	3.2	110	SPDES
Potassium	mg/L	12	4.8	9.0	7.1	12.0	3.3	7.5	5.3	SNS	
Selenium	μg/L	12	1.9	< 5	< 5	12.0	< 5	< 5	< 5	4.6	Dissolved
Silver	μg/L	12	0.3	2.7	1.3	12.0	0.7	6.9	2.1	15	SPDES
Sodium	mg/L	12	37.1	70.3	51.6	12.0	36.5	68.3	49.4	SNS	
Thallium	μg/L	12	1.1	< 5	< 5	12.0	0.6	< 5	< 5	8	Acid Soluble
Vanadium	μg/L	12	3.4	< 10	< 10	12.0	3.4	< 10	< 10	14	Acid Soluble
Zinc	μg/L	12	60.0	326.0	127.5	12.0	22.5	78.2	38.8	100	SPDES

Notes:
See Figure 5-1 for locations of the STP influent and effluent monitoring locations.
All analytical results were generated using total recoverable analytical techniques.
For Class C Ambient Water Quality Standards (AWQS), the solubility state for the metal is provided.
(1) Unless otherwise provided, the reference standard is NYSDEC Class C Surface Water Ambient Water Quality Standards (AWQS).
(a) The conductivity, temperature, and dissolved oxygen values reported are based on analyses of daily grab samples collected every three days.
AWQS = Ambient Water Quality Standards
CM = Continuously monitored
GA = Class GA (groundwater) AWQS
N = Number of samples
NA = Not Applicable
NM = Not Monitored
NR = Not Recorded
NYSDEC = New York State Department of Environmental Conservation
SNS = Standard Not Specified
SPDES = State Pollutant Discharge Elimination System
SU = Standard Units

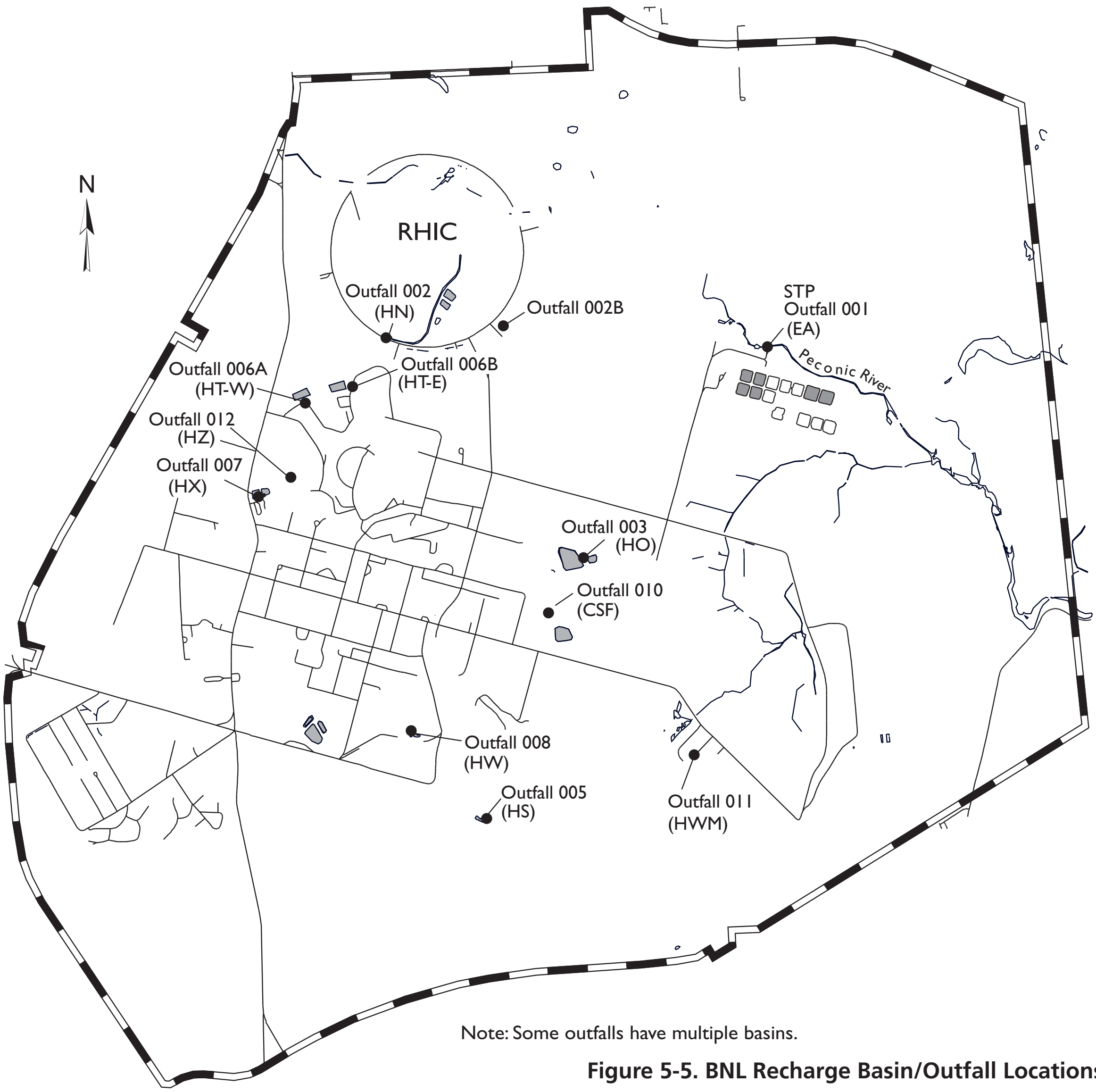

Figure 5-5. BNL Recharge Basin/Outfall Locations.

of "clean" wastewater streams, including once-through cooling water, stormwater runoff, and cooling tower blowdown. With the exception of elevated temperature and increased natural sediment content, these wastewaters are suitable for direct replenishment of the groundwater aquifer. Figure 5-5 shows the locations of the Laboratory's discharges to recharge basins (also called "outfalls" under BNL's SPDES permit). Figure 5-6 presents an overall schematic of potable water use at the Laboratory. Eleven recharge basins are used for managing once-through cooling water, cooling tower blowdown, and stormwater runoff:

- Basins HN, HT-W, and HT-E receive once-through cooling water discharges generated at the Alternating Gradient Synchrotron (AGS) and Relativistic Heavy Ion Collider (RHIC), as well as cooling tower blowdown and stormwater runoff.
- Basin HS receives predominantly stormwater runoff, once-through cooling water from Building 555 (Chemistry Department) and minimal cooling tower blowdown from the National Synchrotron Light Source (NSLS).
- Basin HX receives Water Treatment Plant filter backwash water.

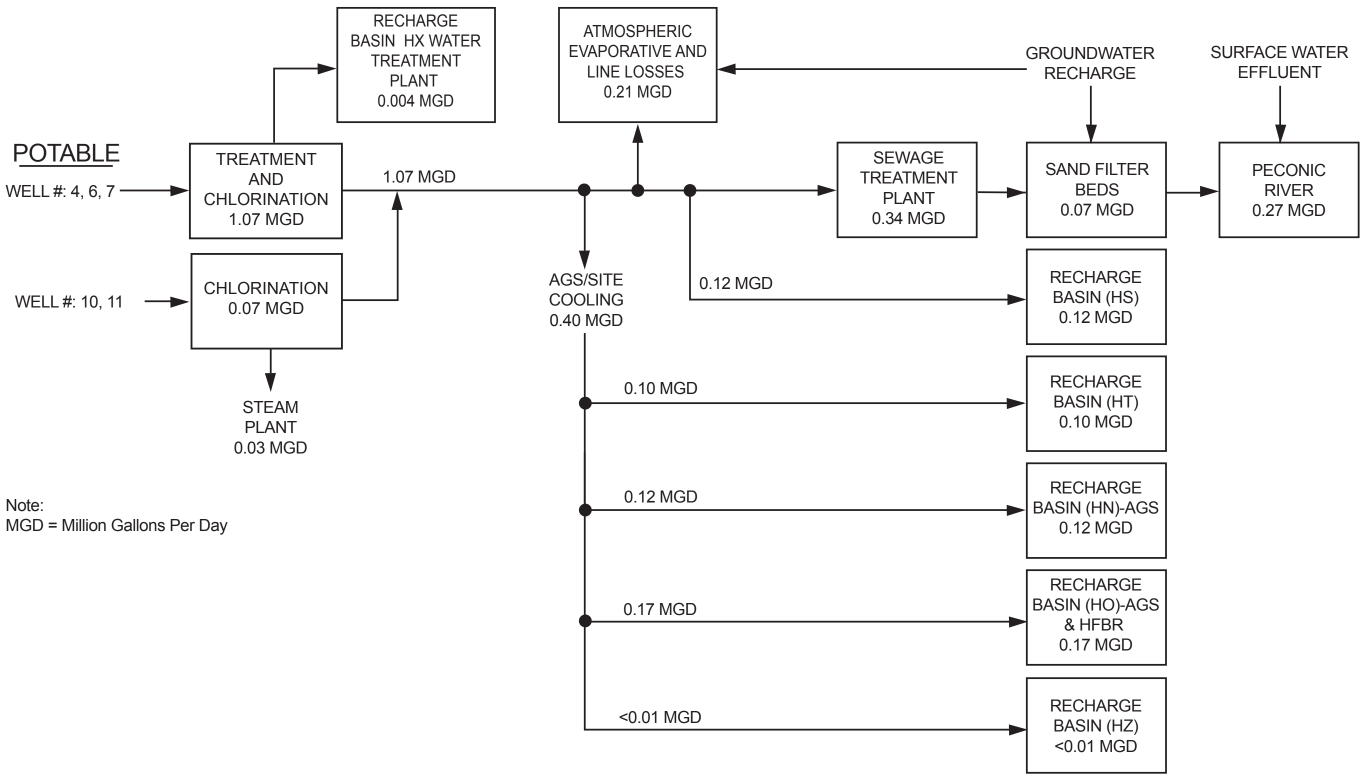

Figure 5-6. Schematic of Potable Water Use and Flow at BNL.

- Basin HO receives cooling water discharges from the AGS and stormwater runoff from the area surrounding the High Flux Beam Reactor (HFBR).
- Several other recharge areas are used exclusively for discharging stormwater runoff. These areas include Basin HW near the National Synchrotron Light Source II (NSLS-II) construction site, Basin CSF at the Central Steam Facility (CSF), Basin HW-M at the former Hazardous Waste Management Facility (HWMF), and Basin HZ near Building 902.

Each of the recharge basins is a permitted point-source discharge under the Laboratory's SPDES permit. Where required by the permit, the discharge to the basin is equipped with a flow monitoring station; weekly recordings of flow are collected, along with measurements of pH. The specifics of the SPDES compliance monitoring program are provided in Chapter 3. To supplement the monitoring program, samples are also routinely collected and analyzed under BNL's Environmental Surveillance Program for radioactivity, VOCs, metals, and anions. During 2012, water samples were collected from all basins listed above except recharge basin HX at the Water Treatment Plant (exempted by NYSDEC from sampling due to documented non-impact to groundwater) and the recharge basin at the former HWMF, as there are no longer any operations that could lead to the contamination of runoff.

5.4.1 Recharge Basins – Radiological Analyses

Discharges to the recharge basins were sampled throughout the year for subsequent analyses for gross alpha and beta activity, gamma-emitting radionuclides, and tritium. The results are presented in Table 5-3 and show that low levels of alpha and beta activity were detected in most of the basins. Activities ranged from non-detectable to 3.5 ± 1.2 pCi/L for gross alpha activity, and from non-detectable to 6.9 ± 1.5 pCi/L for gross beta activity. Typically, low-level detections of gross alpha and beta activity are attributable to very low levels of naturally occurring radionuclides, such as potassium-40

(K-40: half-life, 1.3E+09 years).

The contract analytical laboratory reported no gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins in 2012. Tritium was detected in a single sample collected at Basin HT-W at a very low level (550 ± 290 pCi/L). This basin receives discharges from the Collider-Accelerator complex.

5.4.2 Recharge Basins – Nonradiological Analyses

To determine the overall impact on the environment of discharges to the recharge basins, the nonradiological analytical results were compared to groundwater discharge standards promulgated under Title 6 of the New York Codes, Rules, and Regulations (NYCRR), Part 703.6. Samples were collected quarterly for water quality parameters, metals, and VOCs, and were analyzed by a contract analytical laboratory. Field-measured parameters (pH, conductivity, and temperature) were routinely monitored and recorded. The water quality and metals analytical results are summarized in Tables 5-4 and 5-5.

Low concentrations of disinfection byproducts were periodically detected above method detection limits in discharges to several of the basins throughout the year. Sodium hypochlorite and bromine, used to control bacteria in the drinking water and algae in cooling towers, lead to the formation of VOCs, including bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. All concentrations were less than 5 µg/L. No other VOCs were detected above method detection limits in any of the recharge basins in 2012.

The analytical data in Table 5-4 show that for 2012, the concentrations of all analytes were within effluent standards, except for a high detection of chlorides in Basin HT-E and an elevated pH in Basin HW. Chlorides are found to be higher in samples collected during the winter and are attributed to road salt used to control snow and ice buildup. A sample from Basin HT-E, collected in November 2012, showed high concentrations of sodium; it was confirmed that road salt was the source of the chlorides, as the Long Island area had recently experienced an early winter snow storm. It was also determined that the elevated pH observed in Basin HW was most likely due to construction activities associated with the NSLS-II (concrete forming/washout activities and construction of road/parking lot base using recycled concrete aggregate). This outfall only receives flow during heavy rain events, and the only source of stormwater to this outfall is from the NSLS-II construction site.

The data in Table 5-5 show that all parameters, except for aluminum and iron complied

Table 5-3. Radiological Analysis of Samples from On-Site Recharge Basins at BNL.

Basin		Gross Alpha	Gross Beta	Tritium
		(pCi/L)		
No. of samples		4	4	4
HN	*max.*	2.1 ± 1.1	2.5 ± 0.84	<140
	avg.	0.87 ± 0.84	1.66 ± 0.61	<MDL
HO	*max.*	1.61 ± 0.86	2.42 ± 0.89	< 350
	avg.	0.38 ± 0.87	1.02 ± 1.06	<MDL
HS	*max.*	3 ± 1.3	4.4 ± 1	<470
	avg.	0.9 ± 1.38	2.53 ± 1.29	<MDL
HT-E	*max.*	2.8 ± 1.9	6.9 ± 1.5	<78
	avg.	1.19 ± 1.52	3.58 ± 3.33	<MDL
HT-W	*max.*	< 1.3	1.42 ± 0.72	< 78
	avg.	0.24 ± 0.4	1.02 ± 0.37	<MDL
HW	*max.*	3.5 ± 1.2	4.9 ± 1.1	< 360
	avg.	2.12 ± 1.4	4.23 ± 0.76	<MDL
HZ	*max.*	< 0.93	1.58 ± 0.69	550 ± 290
	avg.	0.61 ± 0.23	1.15 ± 0.58	<MDL
SDWA Limit		15	(a)	20,000

Notes:
See Figure 5-5 for the locations of recharge basins/outfalls.
All values reported with a 95% confidence interval.
Negative numbers occur when the measured value is lower than background (see Appendix B for description).
To convert values from pCi to Bq, divide by 27.03.
(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. As gross beta activity does not identify specific radionuclides, a dose equivalent of this value cannot be calculated.
MDL = Minimum Detection Limit
SDWA = Safe Drinking Water Act

Table 5-4. Water Quality Data for BNL On-Site Recharge Basin Samples.

ANALYTE		Recharge Basin HN (RHIC)	HO (AGS)	HS (s)	HT-W (Linac)	HT-E (AGS)	HW (s)	CSF (s)	HZ (s)	NYSDEC Effluent Standard	Typical MDL
	No. of samples	4	4	4	4	4	4	4	4		
pH (SU)	*min.*	7.0	7.6	7.0	7.4	7.2	7.9	7.6	7.7	6.5 - 9.0	NA
	max.	7.6	8.4	8.2	8.8	8.8	9.2	8.4	8.2		
Conductivity (µS/cm)	*min.*	214	104	79	123	90	64	74	107	SNS	NA
	max.	336	212	604	268	510	246	252	226		
	avg.	258	162	269	209	328	155	155	146		
Temperature (ºC)	*min.*	9.0	14.0	6.8	4.8	4.2	5.8	6.3	7.7	SNS	NA
	max.	23.5	19.2	19.3	23.1	25.4	23.8	24.3	18.8		
	avg.	13.5	17.0	11.2	10.7	11.5	12.5	13.6	13.7		
Dissolved oxygen (mg/L)	*min.*	6.7	8.4	7.3	6.7	6.9	9.0	9.3	9.0	SNS	NA
	max.	10.8	10.6	12.4	11.7	11.7	10.6	11.0	10.9		
	avg.	9.3	9.3	10.2	9.8	10.2	9.8	10.4	10.1		
Chlorides (mg/L)	*min.*	33.6	16.1	19.4	46.9	4.9	1.1	4.0	18.7	500	4
	max.	85.7	54.0	157.0	56.3	788.0	16.5	64.6	52.5		
	avg.	51.6	42.5	95.8	50.9	243.8	6.4	20.4	42.4		
Sulfates (mg/L)	*min.*	6.1	3.5	5.9	8.7	2.5	5.3	3.1	4.2	500	4
	max.	15.7	9.7	19.9	9.9	27.5	12.2	11.9	9.8		
	avg.	9.6	7.8	14.4	9.2	16.6	7.3	5.9	8.0		
Nitrate as nitrogen (mg/L)	*min.*	0.3	0.2	0.7	0.3	0.3	0.2	0.4	0.2	10	1
	max.	0.7	0.3	1.8	0.3	1.0	0.6	0.6	0.3		
	avg.	0.5	0.3	1.3	0.3	0.6	0.3	0.5	0.3		

Notes:
See Figure 5-5 for the locations of recharge basins/outfalls.
(s) = stormwater
AGS = Alternating Gradient Synchrotron Beam Reactor
CSF = Central Steam Facility
Linac = Linear Accelerator
MDL = Minimum Detection Limit
NA = Not Applicable
NYSDEC = New York State Department of Environmental Conservation
RHIC = Relativistic Heavy Ion Collider
SNS = Effluent Standard Not Specified

with the respective water quality or groundwater discharge standards. Due to the natural prevalence of these metals in soils, the presence of these elements is likely due to suspended soil in the samples at the time of collection. Acidification of the samples results in the dissolution of the element and its detection during analysis. This is supported by the observation that the concentrations in all filtered samples were significantly less and well below the discharge standard or AWQS. As these metals are in particulate form, they pose no threat to groundwater quality, because the recharge basin acts as a natural filter, trapping the particles before they reach groundwater.

5.4.3 Stormwater Assessment

All recharge basins receive stormwater runoff. Stormwater at BNL is managed by collecting runoff from paved surfaces, roofs, and other impermeable surfaces and directing it to recharge basins via underground piping and above-grade vegetated swales. Recharge basin HS receives most of the stormwater runoff from the central, developed portion of the Laboratory site. Basins HN, HZ, HT-W, and HT-E receive runoff from

Table 5-5. Metals Analysis of Water Samples from BNL On-Site Recharge Basins.

METAL		Recharge Basin: HN (RHIC)		HO (AGS)		HS (stormwater)		HT-E (AGS)		HT-W (Linac)		HW (stormwater)		CSF (stormwater)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
	No. of samples	4	2	4	2	4	3	4	2	4	2	4	4	4	4	4	2		
Ag Silver (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	50	2.0
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Al Aluminum (µg/L)	*min.*	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	1290.0	< 50.0	876.0	< 50.0	< 50.0	< 50.0	2,000	50
	max.	67.2	< 50.0	126.0	< 50.0	4300.0	151.0	123.0	< 50.0	< 50.0	< 50.0	2860.0	159.0	2970.0	92.3	276.0	< 50.0		
	avg.	< 50.0	< 50.0	54.5	< 50.0	1142.8	82.0	73.5	< 50.0	< 50.0	< 50.0	2185.0	116.3	1509.0	55.5	69.0	< 50.0		
As Arsenic (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	50	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Ba Barium (µg/L)	*min.*	<20.0	<20.0	<20.0	<20.0	29.1	<20.0	<20.0	35.8	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	2,000	20
	max.	40.6	36.0	44.8	41.1	64.7	48.4	45.4	36.0	41.6	40.0	<20.0	<20.0	22.6	<20.0	36.7	36.4		
	avg.	27.7	24.1	25.2	24.8	47.2	28.4	33.1	35.9	22.7	27.0	<20.0	<20.0	<20.0	<20.0	21.2	20.8		
Be Beryllium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	SNS	2.0
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Cd Cadmium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	10	2.0
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Co Cobalt (µg/L)	*min.*	< 5.0	0.4	< 5.0	0.9	1.4	0.5	< 5.0	0.9	< 5.0	0.5	0.5	0.4	0.7	0.3	< 5.0	3.1	5	0.1
	max.	< 5.0	2.0	< 5.0	1.8	< 5.0	3.8	< 5.0	2.4	< 5.0	2.5	1.0	< 5.0	1.7	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	1.2	< 5.0	1.4	< 5.0	2.2	< 5.0	1.6	< 5.0	1.5	0.8	< 5.0	1.0	< 5.0	< 5.0	< 5.0		
Cr Chromium (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	100	10.0
	max.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Cu Copper (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	11.2	14.6	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	1,000	10.0
	max.	48.3	23.3	< 10.0	< 10.0	10.8	< 10.0	41.1	15.7	< 10.0	< 10.0	< 10.0	< 10.0	14.2	< 10.0	23.8	< 10.0		
	avg.	18.7	15.0	< 10.0	< 10.0	< 10.0	< 10.0	24.2	15.2	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	11.4	< 10.0		

(continued on next page)

Table 5-5. Metals Analysis of Water Samples from BNL On-Site Recharge Basins *(continued)*.

METAL		HN (RHIC)		HO (AGS)		HS (stormwater)		HT-E (AGS)		HT-W (Linac)		HW (stormwater)		CSF (stormwater)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
No. of samples		4	2	4	2	4	3	4	2	4	2	4	4	4	4	4	2		
Fe Iron (mg/L)	*min.*	0.09	< 0.05	0.05	< 0.05	< 0.05	< 0.05	0.10	0.18	0.05	< 0.05	0.99	< 0.05	1.01	< 0.05	0.07	< 0.05	0.6	0.05
	max.	0.32	< 0.05	0.28	< 0.05	3.78	0.11	0.92	0.26	0.10	< 0.05	2.34	0.12	3.41	0.05	0.37	0.07		
	avg.	0.17	< 0.05	0.18	< 0.05	1.01	0.05	0.55	0.22	0.07	< 0.05	1.79	0.07	1.72	0.04	0.18	0.05		
Hg Mercury (µg/L)	*min.*	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1.4	0.2
	max.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
	avg.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	*min.*	< 5.0	5.4	5.2	< 5.0	5.1	27.3	6.2	23.3	< 5.0	< 5.0	23.6	< 5.0	22.6	< 5.0	< 5.0	7.2	600	5.0
	max.	17.0	10.6	44.5	6.7	142.0	29.6	44.7	25.2	57.8	23.5	40.0	12.0	58.6	15.9	11.3	8.9		
	avg.	9.3	8.0	16.3	5.2	63.8	28.5	25.3	24.3	17.9	12.6	31.1	8.2	38.3	8.0	7.8	8.1		
Na Sodium (mg/L)	*min.*	18.6	18.7	10.2	10.4	11.1	10.8	4.7	62.0	26.6	26.3	1.2	1.1	3.2	3.2	13.5	13.3	SNS	0.25
	max.	47.4	30.3	31.0	29.5	72.3	70.8	575.0	569.0	31.8	28.6	9.4	9.3	30.9	29.2	29.7	29.4		
	avg.	29.8	24.5	25.5	20.0	49.5	40.8	181.4	315.5	29.3	27.5	4.6	4.5	12.3	11.6	25.5	21.4		
Ni Nickel (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	200	10
	max.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Pb Lead (µg/L)	*min.*	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	7.1	< 3.0	< 3.0	< 3.0	50	3.0
	max.	< 3.0	< 3.0	< 3.0	< 3.0	10.1	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	5.4	< 3.0	31.3	< 3.0	17.9	< 3.0		
	avg.	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	4.4	< 3.0	17.5	< 3.0	6.3	< 3.0		
Sb Antimony (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Se Selenium (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	20	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Tl Thallium (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	SNS	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	0.9	< 5.0	< 5.0		

Recharge Basin columns: HN through HZ.

(continued on next page)

Table 5-5. Metals Analysis of Water Samples from BNL On-Site Recharge Basins *(concluded).*

METAL		HN (RHIC)		HO (AGS)		HS (stormwater)		HT-E (AGS)		HT-W (Linac)		HW (stormwater)		CSF (stormwater)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
	No. of samples	4	2	4	2	4	3	4	2	4	2	4	4	4	4	4	2		
V Vanadium (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.3	< 5.0	< 5.0	< 5.0	SNS	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	10.3	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	7.4	< 5.0	14.6	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.1	< 5.0	8.8	< 5.0	< 5.0	< 5.0		
Zn Zinc (µg/L)	*min.*	27.5	29.5	< 10.0	< 10.0	< 10.0	< 10.0	18.6	21.3	< 10.0	< 10.0	32.7	< 10.0	32.6	< 10.0	< 10.0	< 10.0	5000	10
	max.	144.0	115.0	33.5	23.6	40.5	< 10.0	40.0	30.8	16.8	12.7	47.5	13.3	55.4	21.9	47.6	34.7		
	avg.	70.5	72.3	10.5	11.8	16.7	< 10.0	33.9	26.1	< 10.0	< 10.0	38.5	10.1	44.5	11.2	21.1	17.4		

Notes:
See Figure 5-5 for the locations of recharge basins/outfalls.
AGS = Alternating Gradient Synchrotron
AWQS = Ambient Water Quality Standards
CSF = Central Steam Facility
Linac = Linear Accelerator
MDL = Minimum Detection Limit
NYSDEC = New York State Department of Environmental Conservation
RHIC = Relativistic Heavy Ion Collider
SNS = Effluent Standard Not Specified

the Collider–Accelerator complex. Basin HO receives runoff from the Brookhaven Graphite Research Reactor (BGRR) and HFBR areas. Basin CSF receives runoff from the CSF area and along Cornell Avenue east of Renaissance Road. Basin HW receives runoff from the NSLS-II construction site, and HW-M receives runoff from the fenced area at the former HWMF.

Stormwater runoff at the Laboratory typically has elevated levels of inorganics and has low pH. The inorganics are attributable to high sediment content in stormwater (inorganics occur naturally in native soil). In an effort to further improve the quality of stormwater runoff, BNL has finalized formal procedures for managing and maintaining outdoor work and storage areas. The requirements include covering areas to prevent contact with stormwater, conducting an aggressive maintenance and inspection program, implementing erosion control measures during soil disturbance activities, and restoring these areas when operations cease. Basin sediment sampling is conducted on a 5-year testing cycle to ensure these discharges are not compromising the quality of the basins. Samples were collected in 2012 and results are presented in Chapter 6. The next sampling event will occur in 2017.

5.5 PECONIC RIVER SURVEILLANCE

Several locations are monitored along the Peconic River to assess the overall water quality of the river and to assess any impact from BNL discharges. Sampling points along the Peconic River are identified in Figure 5-7. In total, 10 stations (three upstream and seven downstream of the STP) were regularly sampled in 2012. A sampling station along the Carmans River (HH) was also monitored as a geographic control location, not affected by Laboratory operations or within the Peconic River watershed. All locations were routinely monitored for radiological and nonradiological parameters. The sampling stations are located as follows:

Upstream sampling stations

- HY, on site, immediately east of the William Floyd Parkway
- HV, on site, just east of the 10:00 o'clock Experimental Hall in the RHIC Ring

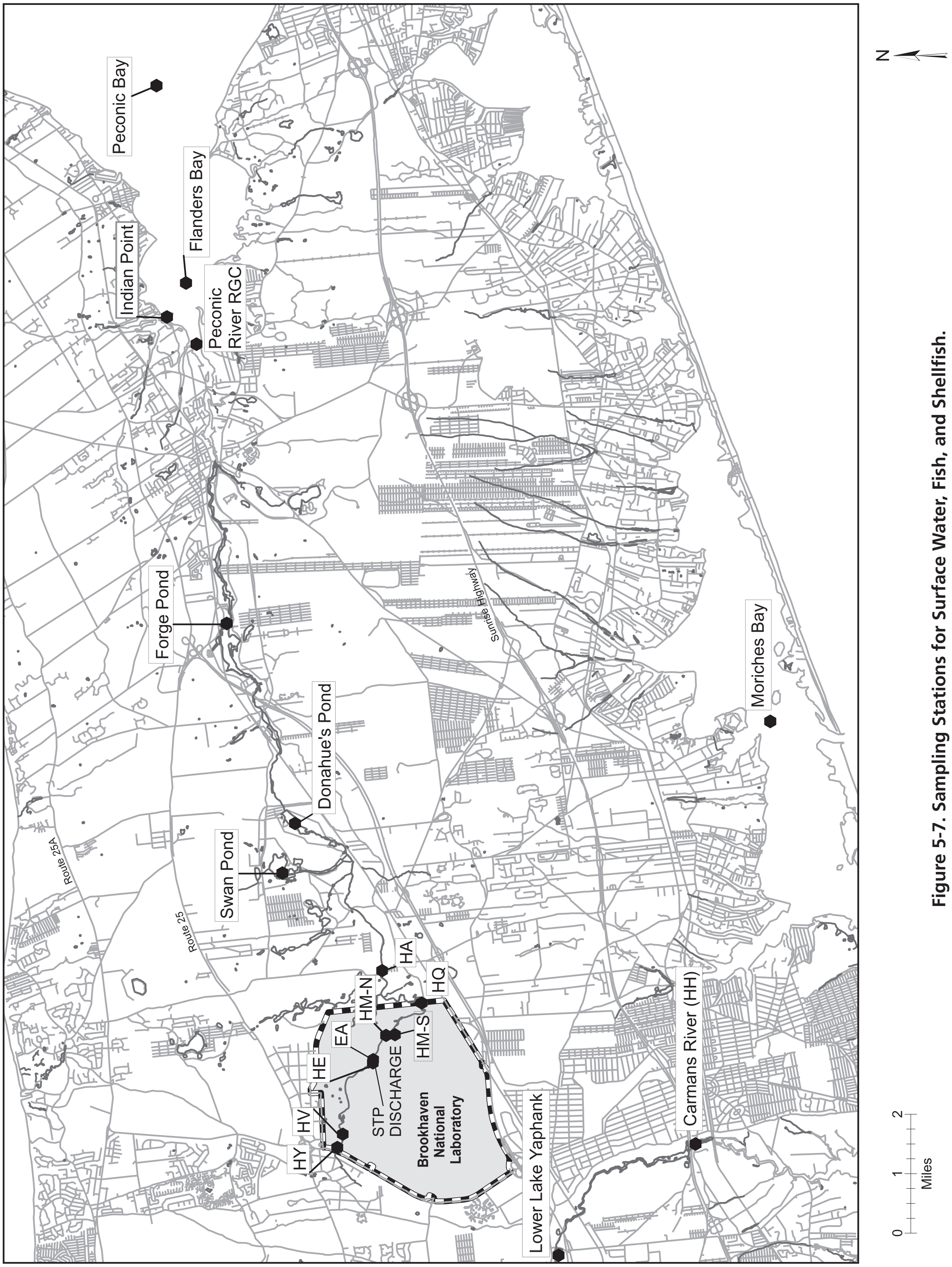

Figure 5-7. Sampling Stations for Surface Water, Fish, and Shellfish.

- HE, on site, approximately 20 feet upstream of the STP outfall (EA)

Downstream sampling stations

- HM-N, on site, 0.5 mile downstream of the STP outfall
- HM-S, on site, on a typically dry tributary of the Peconic River
- HQ, on site, 1.2 miles downstream of the STP outfall at the site boundary
- HA, first station downstream of the BNL boundary, 3.1 miles from the STP outfall
- Donahue's Pond, off site, 4.3 miles downstream of the STP outfall
- Forge Pond, off site
- Swan Pond, off site, not within the influence of BNL discharges

Control location

- HH, Carmans River

5.5.1 Peconic River – Radiological Analyses

Radionuclide measurements were performed on surface water samples collected from the Peconic River at all 10 sampling locations, plus the control location. Routine samples at stations HM-N and HQ were collected once per month, as flow allowed. All other stations were sampled quarterly unless conditions (such as no water flow) prevented collection. Stations HE, HM-N, and HQ have been equipped with Parshall flumes that allow automated flow-proportional sampling and volume measurements. All other sites were sampled by collecting instantaneous grab samples, as flow allowed.

The radiological data from Peconic River surface water sampling in 2012 are summarized in Table 5-6. Radiological analysis of water samples collected both upstream and downstream of the STP discharge and from background locations had very low concentrations of gross alpha and gross beta activity. The maximum concentration of gross alpha and beta activity was found at station HM-N, located

Table 5-6. Radiological Results for Surface Water Samples from the Peconic and Carmans Rivers.

Sampling Station		Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Tritium (pCi/L)	Sr-90 (pCi/L)
Peconic River					
HY (headwaters) on site, west of the RHIC ring	N	3	3	3	3
	max	1.97 ± 0.87	4.28 ± 0.98	< 360	< 0.27
	avg	1.33 ± 0.67	2.87 ± 1.62	<MDL	0.09 ± 0.18
HV (headwaters) on site, inside the RHIC ring	N	3	3	3	NS
	max	2.7 ± 1.1	3.6 ± 1	< 360	
	avg	2.02 ± 0.67	2.62 ± 0.99	<MDL	
HE upstream of STP outfall	N	4	4	4	4
	max	< 1.3	1.99 ± 0.7	<140	0.54 ± 0.2
	avg	0.67 ± 0.48	1.55 ± 0.33	<MDL	0.38 ± 0.19
HM-N downstream of STP, on site	N	12	12	12	3
	max	4.6 ± 2	10.7 ± 1.7	< 250	< 0.71
	avg	0.94 ± 0.72	5.24 ± 1.2	<MDL	0.26 ± 0.28
HM-S tributary, on site	N	(b)	(b)	(b)	NS
	max				
	avg				
HQ downstream of STP, at BNL site boundary	N	1	1	1	NS
	max	< 1.3	< 1.1	< 250	
	avg	NA	NA	NA	
HA off site	N	4	4	4	4
	max	1.18 ± 0.68	1.61 ± 0.75	< 140	0.41 ± 0.16
	avg	0.65 ± 0.48	1.03 ± 0.57	<MDL	0.17 ± 0.18
Donahue's Pond off site	N	4	4	4	4
	max	< 1.1	1.73 ± 0.75	<140	< 0.25
	avg	0.39 ± 0.15	1.38 ± 0.43	<MDL	0.09 ± 0.11
Forge Pond off site	N	4	4	4	4
	max	< 1.1	1.75 ± 0.72	<140	< 0.33
	avg	0.72 ± 0.13	0.96 ± 0.57	<MDL	0.15 ± 0.07
Carmans River HH control location, off site	N	4	4	4	4
	max	< 1.3	1.61 ± 0.68	< 78	< 0.29
	avg	0.78 ± 0.27	1.05 ± 0.37	<MDL	0.12 ± 0.01
Swan Pond control location, off site	N	4	4	4	4
	max	1.39 ± 0.9	5.4 ± 1.1	<140	0.37 ± 0.24
	avg	0.72 ± 0.49	2.78 ± 1.85	<MDL	0.21 ± 0.14
SDWA Limit (pCi/L)		**15**	**(a)**	**20,000**	**8**

Notes:
See Figure 5-7 for the locations of sampling stations.
All values reported with a 95% confidence interval.
Negative numbers occur when the measured values are lower than background (see Appendix B).
To convert values from pCi to Bq, divide by 27.03.
(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.
(b) No samples were collected from Station HM-S in 2012 due to no water flow conditions.
MDL = Method Detection Limit
N = Number of samples analyzed
NA = Not Applicable
NS = Not Sampled for this analyte
RHIC = Relativistic Heavy Ion Collider
SDWA = Safe Drinking Water Act
STP = Sewage Treatment Plant

downstream of the STP Outfall on site. The average concentrations from off-site and control locations were indistinguishable from BNL on-site levels. The beta activity for all locations is therefore attributed to natural sources. 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. Tritium was not detected above contract laboratory method detection limits at any of the Peconic River sampling stations in 2012.

Monitoring for Sr-90 was performed at most Peconic River and both control location stations in 2012. Samples from Stations HV, HM-S, and HQ were not collected due to no water flow conditions. Low-level detections were found at Stations HE, HA, and Swan Pond at very consistent levels of 0.54 ± 0.2, 0.41 ± 0.16, and 0.37 ± 0.24 pCi/L, respectively. All concentrations detected were much less than the NYS DWS of 8 pCi/L, are consistent with historical levels, and can be attributed to worldwide fallout.

5.5.2 Peconic River – Nonradiological Analyses

River water samples collected in 2012 were analyzed for water quality parameters (pH, temperature, conductivity, and dissolved oxygen), anions (chlorides, sulfates, and nitrates), metals, and VOCs. The analytical data for the Peconic River and Carmans River samples are summarized in Tables 5-7 (water quality) and 5-8 (metals). There were no VOCs detected above the contract analytical laboratory's method detection limits from any of the Peconic River sampling stations in 2012.

Peconic River water quality data collected upstream and downstream showed that water quality was consistent throughout the river system. The data were also consistent with water samples collected from the Carmans River control location (HH). Sulfates and nitrates tend to be slightly higher in samples collected immediately downstream of the STP discharge (Stations HM-N and HQ) and were consistent with the concentrations in the STP discharge. Chlorides and sulfates were highest at Station HM-N, which is immediately downstream of the STP outfall and likely a result of road salting operations at the Laboratory. There are no NYS AWQS imposed for chloride or sulfates in discharges to surface water; however, since the Peconic River recharges to groundwater, the AWQS for groundwater (250 mg/L) for these substances is used for comparison purposes.

Ambient water quality standards for metallic elements are based on their solubility state. Certain metals are only biologically available to aquatic organisms if they are in a dissolved or ionic state, whereas other metals are toxic in any form (i.e., dissolved and particulate combined). In 2012, the BNL monitoring program continued to assess water samples for both the

Table 5-7. Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.

Analyte		Peconic River Station Locations: HY	HE	HM-N	HM-S	HQ	HA	Donahue's Pond	Forge Pond	Swan Pond	(Control) HH	NYSDEC Effluent Standard	Typical MDL
	No. of samples	3	4	12	(b)	1	4	4	4	4	4		
pH (SU)	*min.*	6.6	6.5	7.1	—	NA	6.3	6.4	6.6	6.2	6.5	6.5-8.5	NA
	max.	6.9	7.3	8.1	—	7.6	7.7	7.2	7.0	6.9	7.6		
Conductivity (µS/cm)	*min.*	52	110	154	—	NA	25	37	64	46	88	SNS	NA
	max.	135	168	495	—	59	220	67	121	91	230		
	avg.	82	130	332	—	NA	85	58	103	70	173		

(continued on next page)

Table 5-7. Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers *(concluded).*

Temperature (ºC)	*min.*	11.4	5.8	4.9	—	NA	6.7	5.9	6.4	5.4	5.3	SNS	NA
	max.	13.7	20.0	26.1	—	5.4	21.0	23.3	24.6	21.4	19.4		
	avg.	12.5	13.6	14.7	—	NA	13.1	13.6	14.2	12.8	11.7		
Dissolved oxygen (mg/L)	*min.*	7.9	4.6	6.2	—	NA	5.8	7.1	8.1	7.2	9.7	>4.0	NA
	max.	9.2	10.1	12.7	—	12.5	10.4	11.1	11.1	10.3	11.0		
	avg.	8.7	8.4	10.3	—	NA	8.4	9.1	9.1	8.7	10.2		
Chlorides (mg/L)	*min.*	5.8	15.3	33.3	—	NA	4.3	7.6	15.8	8.5	25.4	250(a)	4.0
	max.	26.5	26.5	89.6	—	43.4	10.5	16.1	26.0	16.9	37.1		
	avg.	12.9	19.8	69.5	—	NA	6.7	10.4	19.1	11.5	31.6		
Sulfates (mg/L)	*min.*	2.3	3.4	8.9	—	NA	1.2	1.6	7.2	2.8	11.1	250(a)	4.0
	max.	4.9	6.2	17.8	—	12.7	5.3	7.6	16.7	7.9	12.8		
	avg.	3.2	5.3	15.0	—	NA	3.3	4.8	10.9	5.8	12.0		
Nitrate as nitrogen (mg/L)	*min.*	< 1.0	< 1.0	< 1.0	—	NA	< 1.0	< 1.0	< 1.0	< 1.0	1.5	10(a)	1.0
	max.	< 1.0	< 1.0	9.6	—	2.3	< 1.0	< 1.0	< 1.0	< 0.02	2.5		
	avg.	< 1.0	< 1.0	4.8	—	NA	< 1.0	< 1.0	< 1.0	< 0.02	1.9		

Notes:
See Figure 5-7 for the locations of recharge basins/outfalls.
(a) Since there are no NYSDEC Class C surface Ambient Water Quality Standards (AWQS) for these compounds, the AWQS for groundwater is provided, if specified.
(b) There was no flow at Outfall HM-S during 2012.
Donahue's Pond = Peconic River, off site
Forge Pond = Peconic River, off site
HA = Peconic River, off site
HE = Peconic River, upstream of STP Outfall
HH = Carmans River control location, off site
HM-N = Peconic River on site, downstream of STP
HM-S = Peconic River tributary, on site
HQ = Peconic River, downstream of STP at BNL site boundary
HY = Peconic River headwaters, on site, east of Wm Floyd Pkwy.
MDL = Minimum Detection Limit
NA = Not Applicable
NYSDEC = New York State Department of Environmental Conservation
SNS = Effluent Standard Not Specified

dissolved and particulate form. Dissolved concentrations were determined by filtering the samples prior to acid preservation and analysis. Examination of the total (i.e., particulate form) metals data showed that aluminum, cobalt, copper, iron, lead, and zinc were present in concentrations at some locations that exceeded NYS AWQS. The highest concentrations of aluminum and iron were found at upstream and off-site locations, indicating a natural source of these elements. Aluminum and iron are detected throughout the Peconic and Carmans Rivers at concentrations that exceed the NYS AWQS in both the filtered and unfiltered fractions. Iron and aluminum are found in high concentrations in native Long Island soil and, for iron, at high levels in groundwater. The highest levels for copper, lead, and zinc were found in samples collected immediately downstream of the STP discharge (Station HM-N) at concentrations greater than the NYS AWQS. The concentrations detected were consistent with the concentrations found in the STP discharge and were within the BNL SPDES permit limits. The NYS AWQS limits for copper, lead, and zinc are very restrictive; consequently, the NYS-granted SPDES permit allows higher limits, provided toxicity testing shows no impact to aquatic organisms. Cobalt was detected in a single filtered sample collected from Donahue's Pond and is likely due to contamination by the filter media itself. Filtration of the samples reduced concentrations of most metals to below the NYS AWQS, indicating that most detections were due to sediment carryover.

Table 5-8. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers.

METAL		Peconic River Locations HY		HE		HM-N		HM-S		HQ		HA		DP		Swan Pond		Forge Pond		Control HH		NYSDEC AWQS	Typical MDL
Total or Dissolved		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
No. of samples		3	2	4	3	14	4	1	1	4	2	4	2	4	2	4	2	4	2	4	2		
Ag (I) Silver (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	0.1	2
	max.	< 2.0	< 2.0	< 2.0	< 2.0	25.2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	3.7	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Al (I) Aluminum (µg/L)	*min.*	157.0	< 50.0	103.0	61.9	< 50.0	< 50.0	218.0	70.0	57.9	50.8	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	100	50
	max.	661.0	57.3	286.0	125.0	4060.0	34.5	218.0	70.0	148.0	79.6	69.9	< 50.0	75.5	< 50.0	< 50.0	< 50.0	53.6	< 50.0	149.0	< 50.0		
	avg.	369.3	< 50.0	177.0	95.4	493.4	< 50.0	218.0	70.0	95.4	65.2	54.3	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	62.8	< 50.0		
As (D) Arsenic (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	150	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Ba Barium (µg/L)	*min.*	10.9	6.1	15.3	14.7	12.9	12.6	10.6	8.6	7.2	6.1	6.2	8.0	5.5	4.6	11.2	10.2	30.7	31.3	31.8	33.0	SNS	1.8
	max.	23.7	11.9	18.6	17.1	86.2	23.8	10.6	8.6	13.3	11.5	17.4	14.2	9.0	5.8	28.0	24.7	47.8	44.6	50.4	43.6		
	avg.	15.8	9.0	17.2	16.0	26.7	17.6	10.6	8.6	9.5	8.8	11.4	11.1	7.1	5.2	19.2	17.5	37.5	38.0	39.2	38.3		
Be (AS) Beryllium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 0.5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	11	2
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Cd (D) Cadmium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	1.1	2
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Co (AS) Cobalt (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.8	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Cr (I) Chromium (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	34	10
	max.	< 10.0	< 10.0	< 10.0	< 10.0	12.8	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Cu (D) Copper (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10.6	22.8	20.3	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	4	10
	max.	< 10.0	< 10.0	< 10.0	< 10.0	238.0	52.3	22.8	20.3	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 10.0	40.0	25.4	22.8	20.3	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		

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Table 5-8. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers *(continued)*.

METAL		Peconic River Locations: HY		HE		HM-N		HM-S		HQ		HA		DP		Swan Pond		Forge Pond		Control HH		NYSDEC AWQS	Typical MDL
Total or Dissolved		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
No. of samples		3	2	4	3	14	4	1	1	4	2	4	2	4	2	4	2	4	2	4	2		
Fe (AS) Iron (mg/L)	*min.*	0.3	0.1	0.5	0.2	0.1	0.0	0.2	0.1	0.5	0.3	0.5	0.3	0.0	0.1	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.075
	max.	0.3	0.1	2.0	0.8	3.9	0.2	0.2	0.1	2.1	1.2	2.6	1.6	0.2	0.1	1.5	1.1	0.4	0.2	1.4	0.2		
	avg.	0.3	0.1	1.2	0.5	0.5	0.1	0.2	0.1	1.2	0.8	1.2	0.9	0.1	0.1	0.8	0.7	0.3	0.2	0.7	0.2		
Hg (D) Mercury (µg/L)	*min.*	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	0.2
	max.	< 0.2	< 0.2	< 0.2	< 0.2	1.7	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
	avg.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	*min.*	16.2	11.6	53.1	27.3	5.2	5.7	9.0	9.4	11.5	16.8	27.9	29.5	6.3	31.6	29.5	56.7	27.2	24.4	33.6	32.0	SNS	2
	max.	83.4	31.2	152.0	78.7	64.2	7.6	9.0	9.4	47.2	47.0	177.0	164.0	82.7	32.1	197.0	121.0	69.5	58.8	158.0	108.0		
	avg.	43.9	21.4	92.8	49.8	11.9	6.7	9.0	9.4	35.9	31.9	77.8	96.8	51.7	31.9	117.4	88.9	53.5	41.6	90.4	70.0		
Na Sodium (mg/L)	*min.*	4.4	6.9	10.7	11.0	22.5	31.6	31.2	30.7	3.7	3.8	5.7	5.5	5.6	4.9	10.7	10.8	16.9	19.5	18.0	18.2	SNS	1
	max.	13.1	13.6	13.4	11.6	61.9	55.6	31.2	30.7	5.9	5.0	8.7	6.4	10.4	6.6	14.5	11.4	20.9	21.3	20.0	19.6		
	avg.	8.1	10.2	11.7	11.2	44.8	43.8	31.2	30.7	4.6	4.4	6.7	6.0	7.3	5.8	11.9	11.1	19.4	20.4	19.1	18.9		
Ni (D) Nickel (µg/L)	*min.*	< 1.1	< 1.1	< 1.1	< 1.1	1.9	2.4	2.9	3.2	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	<1.1	<1.1	23	1.1
	max.	1.6	< 1.1	1.2	1.4	12.3	3.7	2.9	3.2	< 10.0	1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	<1.1		
	avg.	1.1	< 1.1	< 1.1	1.1	3.6	3.0	2.9	3.2	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	<1.1		
Pb (D) Lead (µg/L)	*min.*	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	3.1	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	<3.0	<3.0	1.4	3
	max.	3.3	< 3.0	< 3.0	< 3.0	22.3	3.1	3.1	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	<3.0	<3.0		
	avg.	< 3.0	< 3.0	< 3.0	< 3.0	3.3	< 3.0	3.1	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	<3.0	<3.0		
Sb Antimony (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	SNS	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Se (D) Selenium (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	4.6	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Tl (AS) Thallium (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		

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Table 5-8. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers *(concluded)*.

METAL		Peconic River Locations																		Control		NYSDEC AWQS	Typical MDL
		HY		HE		HM-N		HM-S		HQ		HA		DP		Swan Pond		Forge Pond		HH			
	Total or Dissolved	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
	No. of samples	3	2	4	3	14	4	1	1	4	2	4	2	4	2	4	2	4	2	4	2		
V (AS) Vanadium (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	14	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Zn (D) Zinc (µg/L)	*min.*	22.6	18.0	< 10.0	10.0	14.2	22.3	50.5	50.4	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	34	10
	max.	53.9	37.7	< 10.0	10.0	180.0	56.1	50.5	50.4	< 10.0	< 10.0	11.3	< 10.0	< 10.0	10.1	12.3	< 10.0	< 10.0	< 10.0	< 10.0	38.4		
	avg.	34.1	27.9	< 10.0	< 10.0	41.1	33.5	50.5	50.4	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	19.2		

Notes:
See Figure 5-7 for the locations of sampling stations.
AWQS = Ambient Water Quality Standards
AS = Acid Soluble
D = Dissolved
DP = Donahue's Pond
NA = Not Applicable
SNS = Effluent Standard Not Specified for these elements in Class C Surface Waters
T = Total

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Natural and Cultural Resources 6

The Brookhaven National Laboratory Natural Resource Management Program is designed to protect and manage flora and fauna and the ecosystems in which they exist. The Laboratory's natural resource management strategy is based on understanding the site's resources and on maintaining compliance with applicable regulations. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with staff and the public on ecological issues. BNL focuses on protecting New York State threatened and endangered species on site, as well as continuing the Laboratory's leadership role within the greater Long Island Central Pine Barrens ecosystem.

Monitoring to determine whether current or historical activities are affecting natural resources is also part of this program. In 2012, deer and fish sampling results were consistent with previous years. Vegetables grown in the BNL garden plot continue to support historical analyses that there are no Laboratory-generated radionuclides in produce.

The overriding goal of the Cultural Resource Management Program is to ensure that proper stewardship of BNL and DOE historic resources is established and maintained. Additional goals of the program include maintaining compliance with various historic preservation and archeological laws and regulations, and ensuring the availability of identified resources to on-site personnel and the public for research and interpretation.

6.1 NATURAL RESOURCE MANAGEMENT PROGRAM

The purpose of the Natural Resource Management Program at BNL is to promote stewardship of the natural resources found at the Laboratory, as well as to integrate natural resource management and protection with BNL's scientific mission. To meet this purpose, the Laboratory uses a Natural Resource Management Plan (NRMP) to describe the program strategy, elements, and planned activities for managing the various resources found on site. The NRMP was first developed through wide participation with local agencies providing professional input as participants of a Technical Advisory Group. The first iteration of the NRMP was approved in 2003, with recommendations for review and update every 5 years. The current NRMP (BNL 2011) is the result of changes made based on experience and knowledge gained through the implementation of the earlier version and incorporates the principles of adaptive management.

6.1.1 Identification and Mapping

An understanding of an environmental baseline is the foundation of natural resource management planning. BNL uses digital global positioning systems (GPS) and geographic information systems (GIS) to clearly relate various "layers" of geographic information (e.g., vegetation types, soil condition, habitat, forest health, etc.). This is done to gain insight into interrelationships between the biotic systems and physical conditions at the Laboratory.

In 2012, a catastrophic forest fire was started on the northern part of BNL property, burning approximately 300 acres on site and an additional 700 acres off site. Within 2 days of the fire, Laboratory personnel began recording the extent of the fire using GPS, established photo points, and began tracking both damage and post-fire recovery. Maps of the fire and photo locations were entered into the GIS for future reference. No radiological areas were involved in the fire. Air monitoring Station P-9 was involved in the fire, and monitoring data from that station, both on the day of the fire and one week later, indicated no impacts.

Work associated with tracking impacts from the construction of the Long Island Solar Farm (LISF) located on site (also referred to as the solar farm) continue to be entered into the GIS as a tool to assist analysis of changes to wildlife populations and vegetation.

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the site. Through implementation of the NRMP, endangered, threatened, and species of special concern have been identified as having been resident at BNL during the past 30 years or are expected to be present on site. The only New York State endangered species confirmed as currently inhabiting Laboratory property is the eastern tiger salamander (*Ambystoma t. tigrinum*). Additionally, the New York State endangered Persius duskywing butterfly (*Erynnis p. persius*) and the crested fringed orchid (*Plantathera cristata*) have been identified on site in the past.

Three additional endangered plants were added to the BNL list in 2012, including the Engelman spikerush (*Eleocharis engelmannii*), dwarf huckleberry (*Gaylussacia bigeloviana*), and whorled loosestrife (*Lysimachia quadrifolia*). Six New York State threatened species have been positively identified on site and three other species are considered likely to be present. Fish species, including the banded sunfish (*Enneacanthus obesus*) and swamp darter (*Etheostoma fusiforme*), and plants, including the stiff goldenrod (*Solidago rigida*) and stargrass (*Aletris farinose*), have been previously reported in 2000. The northern harrier (*Circus cyaneus*) was seen hunting over open fields in November 2003 and along the Peconic River in October 2010. In 2005, the Pine Barrens bluet (*Enallagma recurvatum*), a damselfly, was confirmed at one of the many coastal plain ponds located on site. Two other threatened damselflies, the little bluet (*Enallagma minisculum*) and the scarlet bluet (*Enallagma pictum*), are likely to be present at one or more of the ponds on site. The frosted elfin (*Callophrys irus*), a butterfly, has been identified as possibly being at BNL, based on historic documentation and the presence of its preferred habitat and host plant, wild lupine (*Lupinus perennis*).

A number of other species that are listed as rare, of special concern, or exploitably vulnerable by New York State either currently inhabit the site, visit during migration, or have been identified historically (see Table 6-1).

6.1.2 Habitat Protection and Enhancement

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

6.1.2.1 Salamander Protection Efforts

To safeguard eastern tiger salamander breeding areas, a map of the locations is reviewed when new projects are proposed. Distribution of the map is limited to protect the salamander from exploitation by collectors and the pet trade. The map is routinely updated as new information concerning the salamanders is generated through research and monitoring. The most recent update extends the buffer area around tiger salamander habitat from 800 feet to 1,000 feet based on guidance from the New York State Department of Environmental Conservation (NYSDEC).

Other efforts to protect this state-endangered species include determining when adult salamanders are migrating toward breeding locations, when metamorphosis has been completed, and when juveniles are migrating after metamorphosis. During these times, construction and maintenance activities near their habitats are postponed or closely monitored. BNL environmental protection staff must review any project planned near eastern tiger salamander habitats, and every effort is made to minimize impacts.

Water quality testing is conducted as part of the routine monitoring of recharge basins, as discussed in Chapter 5. In cooperation with NYSDEC, habitat surveys have been routinely conducted since 1999. Biologists conducting egg mass and larval surveys have confirmed 26 on-site ponds that are used by eastern tiger salamanders. Egg mass surveys confirmed the presence of salamanders in 3 of 26 ponds in 2012. Dry conditions on Long Island resulted in most ponds remaining dry throughout the year. Whenever possible, ponds with documented egg masses from the spring surveys are revisited in June and July to check for the presence of larval salamanders. When new information is obtained, it is entered into the GIS and used to visualize distributions, track reproductive success, and identify areas for focused management or study.

Protection of the eastern tiger salamander was a key component of the Environmental Assessment (EA) conducted for the LISF project. The unique shape of the project, in part, came about due to the need to provide sufficient, viable habitat for the tiger salamander within the area to be developed. In 2010, the LISF completed habitat enhancement to improve one of BNL's tiger salamander ponds; the enhancements to the pond are intended to allow it to retain water for longer periods of time to support larval development. The enhanced pond is currently being managed to remove invasive plants that moved into the pond from surrounding areas. Several areas of the solar farm have maintained standing water since construction, and these areas have been monitored for use by amphibians.

6.1.2.2 Other Species

A number of other species are found at the Laboratory, including 25 species of reptiles and amphibians that have been observed and recorded over the past several years. These species include: the northern red-back salamander

Table 6-1. New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL.

Common Name	Scientific Name	State Status	BNL Status
Insects			
Comet darner	*Anax longipes*	SGCN	Confirmed
Frosted elfin	*Callophrys iris*	T	Likely
New England bluet	*Enallagma laterale*	SGCN	Likely
Little bluet	*Enallagma minusculum*	T	Confirmed
Scarlet bluet	*Enallagma pictum*	T	Likely
Pine Barrens bluet	*Enallagma recurvatum*	T	Confirmed
Mottled duskywing	*Erynnis martialis*	SC	Likely
Persius duskywing	*Erynnis persius persius*	E	Likely
Fish			
Banded sunfish	*Enniacanthus obesus*	T	Confirmed
Swamp darter	*Etheostoma fusiforme*	T	Confirmed
Amphibians			
Marbled salamander	*Ambystoma opacum*	SC	Confirmed
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	E	Confirmed
Fowler's toad	*Bufo fowleri*	SGCN	Confirmed
Four-toed salamander	*Hemidactylium scutatum*	SGCN	Confirmed
Eastern spadefoot toad	*Scaphiopus holbrookii*	SC	Confirmed
Reptiles			
Worm snake	*Carphophis amoenus*	SC	Confirmed
Snapping turtle	*Chelydra serpentina*	SGCN	Confirmed
Spotted turtle	*Clemmys guttata*	SC	Confirmed
Northern black racer	*Coluber constrictor*	SGCN	Confirmed
Eastern hognose snake	*Heterodon platyrhinos*	SC	Confirmed
Stinkpot turtle	*Sternotherus odoratus*	SGCN	Confirmed
Eastern box turtle	*Terrapene carolina*	SC	Confirmed
Eastern ribbon snake	*Thamnophis sauritus*	SGCN	Confirmed
Birds (nesting, transient, or potentially present)			
Cooper's hawk	*Accipiter cooperii*	SC	Confirmed
Sharp-shinned hawk	*Accipiter striatus*	SC	Confirmed
Grasshopper sparrow	*Ammodramus savannarum*	SC	Confirmed
Great egret	*Ardea alba*	SGCN	Confirmed
Whip-poor-will	*Caprimulgus vociferus*	SC	Confirmed
Northern harrier	*Circus cyaneus*	T	Confirmed
Black-billed cuckoo	*Coccyzus erythropthalmus*	SGCN	Confirmed
Northern bobwhite	*Colinus virginianus*	SGCN	Confirmed
Prairie warbler	*Dendroica discolor*	SGCN	Confirmed
Horned lark	*Eremophila alpestris*	SC	Confirmed
Wood thrush	*Hylocichla mustelina*	SGCN	Confirmed
Red-headed woodpecker	*Melanerpes erythrocephalus*	SC	Confirmed
Osprey	*Pandion haliaetus*	SC	Confirmed
Scarlet tanager	*Piranga olivacea*	SGCN	Confirmed
Glossy ibis	*Plegadis falcinellus*	SGCN	Confirmed
Brown thrasher	*Toxostoma rufum*	SGCN	Confirmed
Blue-winged warbler	*Vermivora pinus*	SGCN	Confirmed
Plants			
Small-flowered false foxglove*	*Agalinis paupercula*	R	Confirmed
Stargrass	*Aletris farinosa*	T	Confirmed
Butterfly weed	*Asclepias tuberosa ssp. interior*	V	Confirmed
Spotted wintergreen	*Chimaphila maculata*	V	Confirmed
Flowering dogwood	*Cornus florida*	V	Confirmed

(continued on next page)

Table 6-1. New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL *(concluded).*

Common Name	Scientific Name	State Status	BNL Status
Plants (cont'd.)			
Pink lady's slipper	*Cypripedium acaule*	V	Confirmed
Ground pine	*Dendrolycopodium obscurum*	V	Confirmed
Round-leaved sundew*	*Drosera rotundifolia var. rotundifolia*	V	Confirmed
Marginal wood fern*	*Dryopteris marginalis*	V	Confirmed
Engelman spikerush*	*Eleocharis engelmannii*	E	Confirmed
Dwarf huckleberry*	*Gaylussacia bigeloviana*	E	Confirmed
Winterberry	*Ilex verticillata*	V	Confirmed
Sheep laurel	*Kalmia angustifolia*	V	Confirmed
Narrow-leafed bush clover	*Lespedeza augustifolia*	R	Confirmed
Wild lupine*	*Lupinus perennis*	R	Confirmed
Whorled loosestrife*	*Lysimachia quadrifolia*	E	Confirmed
Bayberry	*Myrica pensylvanica*	V	Confirmed
Stiff-leaved goldenrod	*Oligoneuron rigida*	T	Confirmed
Cinnamon fern	*Osmunda cinnamomea*	V	Confirmed
Clayton's fern	*Osmunda claytoniana*	V	Confirmed
Royal fern	*Osmunda regalis*	V	Confirmed
Crested fringed orchid	*Plantathera cristata*	E	Likely
Green fringed orchis*	*Platanthera lacera*	V	Confirmed
Swamp azalea	*Rhododendron viscosum*	V	Confirmed
Long-beaked bald-rush	*Rhynchospora scirpoides*	R	Confirmed
New York fern	*Thelypteris novaboracensis*	V	Confirmed
Marsh fern	*Thelypteris palustris var. pubescens*	V	Confirmed
Virginia chain-fern	*Woodwardia virginica*	V	Confirmed

Notes:
* Table information based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data. No federally listed threatened or endangered species are known to occur at BNL.

E = endangered
T = threatened
SC = species of special concern
R = rare
V = exploitably vulnerable
SGCN = species of greatest conservation need

(*Plethodon c. cinereus*), marbled salamander (*Ambystoma opacum*), four-toed salamander (*Hemidactylium scutatum*), red-spotted newt (*Notophthalmus viridescens*), spring peeper (*Pseudacris crucifer*), wood frog (*Lithobates sylvatica*), gray tree frog (*Hyla versicolor*), bullfrog (*Lithobates catesbiana*), green frog (*Lithobates clamitans*), pickerel frog (*Lithobates palustris*), Fowler's toad (*Bufo woodhousei fowleri*), eastern spadefoot toad (*Scaphiopus holbrooki*), snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys p. picta*), musk turtle (*Sternotherus odoratus*), spotted turtle (*Clemmys guttata*), eastern box turtle (*Terrapene c. carolina*), northern black racer (*Coluber constrictor*), eastern ribbon snake (*Thamnophis s. sauritus*), eastern garter snake (*Thamnophis s. sirtalis*), northern water snake (*Nerodia s. sipedon*), northern ring-necked snake (*Diadophis puctatus edwardsi*), brown snake (*Storeria d. dekayi*), northern red-bellied snake (*Storeria occiptiomaculata*), and the eastern wormsnake (*Carphophis amoenus*). This list indicates that BNL has one of the most diverse herpetofaunal assemblages on Long Island.

Banded sunfish protection efforts include observing whether adequate flow in the Peconic River is maintained within areas currently identified as sunfish habitat, ensuring that existing vegetation in their habitat is not disturbed, and evaluating all activities taking place on the river for potential impacts on these habitats. Population estimates are periodically conducted within various waters on site to determine the current health of the banded sunfish. The last estimate was conducted in 2011, with a population of approximately 6,400 fish.

6.1.2.3 Migratory Birds

A total of 216 species of birds have been identified at BNL since 1948; at least 85 species are known to nest on site. Some of these nesting birds have shown declines in their populations nationwide over the past 30 years. The Laboratory conducts routine monitoring of songbirds along seven permanent bird survey routes in various habitats on site (a new route was established in 2010 in the vicinity of the LISF).

In 2012, monthly surveys were conducted starting at the end of May and extending through the end of August. Two routes associated with the solar farm were monitored biweekly from mid-May through mid-September. These surveys identified 69 songbird species, comparable to the 62 species surveyed in 2011 and 71 species during 2010. A total of 129 bird species have been identified in surveys in the past 13 years; 45 of these species were present each year. Variations in the number and species identified reflect the time of sampling, variations in weather patterns between years, and actual changes in the environment. The two most diverse transects pass near on-site wetlands by the former Biology Fields (now the LISF) and the Peconic River. The four transects passing through the various forest types on site (white pine, moist pine barrens, and dry pine barrens) showed a less diverse bird community.

Data are stored in an electronic database. In 2012, BNL began working with a statistician to analyze 12 years of collected data to determine trends and link data to habitat. This effort will likely result in one or more papers being developed for publication in peer-reviewed journals.

No known data on the effects of a utility-scale solar array are known within scientific literature. To assess the effects of the on-site solar farm on local bird populations, the collection of migratory bird data in both the Biology Field transect and the solar farm transect is important. The LISF is predicted to improve habitat for some migratory birds over time, as understory vegetation begins to grow below the arrays and deer are kept out of the area. One species, indigo bunting (*Passerina cyanea*), was absent along the Biology Field transect in 2011, but was heard along the solar farm transect in 2012. This temporary absence is thought to be due to disturbance from construction activities at the solar farm.

The eastern bluebird (*Sialia sialis*) has been identified as one of the declining species of migratory birds in North America. This decline is due to loss of habitat and to nest site competition from European starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*). BNL's NRMP includes habitat enhancement for the eastern bluebird. Since 2000, the Laboratory has installed more than 56 nest boxes around open grassland areas on site to enhance their population. Many of these boxes were removed from service in 2010 in preparation for the construction of the LISF. After completion, the LISF created nearly 200 acres of suitable habitat for the eastern blue bird; therefore, 40 additional boxes were installed around the northern most portions of the solar farm in 2012, with an additional 40 planned for installation or replacement of older boxes in 2013.

Migratory birds occasionally cause safety and health concerns. Birds that typically are of concern include Canada geese (*Branta canadensis*) and several species of migratory birds that occasionally nest on buildings or in construction areas. Over the past several years, the resident Canada goose population began increasing with the potential to reach large numbers that could result in health and safety issues at BNL. In 2007, under a permit from the U.S. Fish & Wildlife Service (FWS), the Laboratory began managing the resident goose population. In 2012, 20 nests were treated, but a number of nests were missed and approximately 12 goslings were produced. The overall population has declined to around 100 individuals, mostly through off-site hunting in the fall.

In April 2012, a Cooper's hawk (*Accipiter cooperii*) flew through an open roll-up door at the construction site of the National Synchrotron Light Source II (NSLS-II) and was trapped. Environmental Protection (EP) staff, working with a falconer and other resources, attempted to either encourage the bird to fly out of the building or to trap the bird for release. Because Cooper's hawks are forest canopy fliers, the rafters of the NSLS-II were similar to native habitat, allowing the bird to fly throughout the facility, but never coming low enough to identify an escape route. After several weeks, the hawk became tired and dehydrated, eventually landing on the floor where it was captured. It was transported to a local veterinary hospital, but did not survive. In August, researchers working around the on-site meteorological tower noticed a bird of prey on the ground and called EP staff for assistance. The bird, an immature Osprey (*Pandion haliaetus*), had an injured wing. It was captured and transported to a local veterinary hospital; its injuries were too great and it could not be saved.

To further educate BNL facility managers and other environmental and safety personnel about migratory birds, a module on the Migratory Bird Treaty Act and other bird regulations was prepared. This additional training is anticipated to result in continued timely notification of bird issues for early resolution.

6.1.3 Population Management

The Laboratory also monitors and manages other populations, including species of interest, to ensure that they are sustained and to control invasive species.

6.1.3.1 Wild Turkey

The forested areas of BNL provide good nesting and foraging habitat for wild turkey (*Meleagris gallapavo*). The on-site population was estimated at 60 to 80 birds in 1999 and had grown to approximately 500 birds in 2004. Since 2004, the population appears to have stabilized at approximately 300 birds. The population across Suffolk County, Long Island, was determined to be of sufficient size to support hunting in 2009. The annual hunt (5 days) results in over 100 birds taken annually in Suffolk County, with little or no evidence of effects on the BNL turkey population. Turkey hunting on Long Island has been so successful that NYSDEC began holding a spring youth hunt in 2012.

6.1.3.2 White-Tailed Deer

BNL consistently updates information on the resident population of white-tailed deer (*Odocoileus virginianus*). As there are no natural predators on site and hunting is currently not permitted at the Laboratory, there are no significant pressures on the population to migrate beyond their typical home range of approximately 1 square mile. Normally, a population density of 10 to 30 deer per square mile is considered an optimum sustainable level for a given area. This would equate to approximately 80 to 250 deer inhabiting the property, under normal circumstances. This was the approximate density in 1966, when BNL reported an estimate of 267 deer on site (Dwyer 1966). The Laboratory has been conducting population surveys of the white-tailed deer since 2000. In 2004, based on results of aerial infrared surveys, BNL adjusted the methods for estimating its deer population. The method utilizes GIS data layers for vegetation to adjust deer counts based on habitat. The deer population increased to an estimated 800 deer by December 2008. In 2009, the deer population increased to an estimated 893 animals in the spring and began declining in the fall. By December 2009, the population estimate was 731. This decrease is, in part, supported by the increased number of car–deer accidents reported on site during October and November of that year.

To gain additional information on deer populations, an aerial deer survey was conducted in March 2010 with a count of 226 deer, which when corrected for expected errors, resulted in a population estimate of 310 animals. This survey is very similar to the aerial surveys conducted in February and March 2004. The much lower numbers estimated are due largely to continued poor health and winter mortality. Deer surveys were not conducted in the fall of 2010 due to the start of construction of the LISF, which impeded access to the three survey routes used on site. Based on births of fawns during summer 2011, the deer population was roughly estimated to be between 450 and 500 animals (55–61 deer per square mile). This increase in population was evidenced by more car/deer accidents and one bicyclist/deer accident. Routine surveys resumed in 2012 with a winter/spring estimate of over 500 animals and a fall 2012 estimate of greater than 600 animals.

Deer overpopulation can affect animal and human health (e.g., animal starvation, Lyme disease from deer ticks, collision injuries to both human and animal), species diversity (songbird species reduction due to selective grazing and destruction of habitat by deer), and property values (collision damage to autos and browsing damage to ornamental plantings). In 2012, there were fewer deer-related collisions on site as compared to 2011, but more than the one accident in 2010.

High deer populations are a regional problem, and the Laboratory is just one area on Long Island with such an issue. By 2012, several governmental entities on eastern Long Island began working to manage deer populations.

In 2008, the BNL Policy Council approved moving forward with deer management planning with the first step being the engagement of Laboratory employees and guests in discussions concerning the need and methods for deer management. This planning process has been ongoing since 2008, with several delays due to higher-priority projects needing National Environmental Policy Act (NEPA) coverage.

In 2012, an EA under NEPA was completed and sent to NY State for comment. The Final EA is expected to be completed in early 2013.

6.1.4 Compliance Assurance and Potential Impact Assessment

The NEPA review process at BNL is a key to ensuring that environmental impacts of a proposed action or activity are adequately evaluated and addressed. The Laboratory will continue to use NEPA (or NEPA-like) processes under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Environmental Restoration Program when identifying potential environmental impacts associated with site activities, especially with physical alterations. As appropriate, stakeholders such as EPA, NYSDEC, Suffolk County Department of Health Services (SCDHS), BNL's Community Advisory Council, and the BNL Brookhaven Executive Roundtable are involved in reviewing major projects that have the potential for significant environmental impacts. Formal NEPA reviews are coordinated with the State of New York. As discussed previously, in 2012, BNL started an EA for the proposed management of white-tailed deer on the BNL site. A summary of NEPA reviews is provided in Chapter 3.

6.2 UPTON ECOLOGICAL AND RESEARCH RESERVE

On November 9, 2000, then-Secretary of Energy Bill Richardson and Susan MacMahon, the Acting Regional Director of Region 5 FWS, dedicated 530 acres of Laboratory property as an ecological research reserve. The property was designated by DOE as the Upton Ecological and Research Reserve (Upton Reserve) and was managed by FWS until 2005 under an Interagency Agreement (DOE–FWS 2000). The Upton Reserve, on the eastern boundary of BNL, is home to a wide variety of flora and fauna. It contains wetlands and is largely within the core preservation area of the Long Island Central Pine Barrens. Based on information from a 1994–1995 biological survey of the Laboratory, experts believe the reserve is home to more than 200 plant species and at least 162 species of mammals, birds, fish, reptiles, and amphibians (LMS 1995).

A transition from FWS management of the Upton Reserve to management by BNL and the Foundation for Ecological Research in the Northeast (FERN) occurred in 2005. During that year, FERN initiated its first pine barrens–wide monitoring program to assess the health of the various forest types within the Pine Barrens, followed by a continuation of the effort in 2006. FERN established 91 permanent plots over the 2-year period of the monitoring program. One significant finding from that study is the lack of forest regeneration. In virtually every forest type, there is a lack of survival of trees from seedlings through to saplings. This is likely a result of either deer over-abundance or lack of sunlight penetrating to the understory. The Laboratory was able to utilize three of the forest health plots as controls for the establishment of deer exclosures (areas fenced off to prevent entry by deer) to further study the effects of deer on forest ecosystems. A fourth exclosure was established in 2012 in the area burned by the April 2012 wild fire. Much of FERN's activities have transitioned to providing seed money to initiate research within the pine barrens and other Long Island ecosystems.

Research supported by FERN in 2012 included continued investigation into the microbial world of soils located within the pine barrens and experimental areas on site. Microbial research carried out by a scientist from Dowling College, New York, has identified several new species of fungus and bacteria, resulting in publications. Funding was also provided by FERN for bat and horseshoe crab larvae research. Information on these projects and others is provided in Section 6.5.

6.3 MONITORING FLORA AND FAUNA

The Laboratory routinely conducts surveillance monitoring of flora and fauna to determine the effects of past and present activities on site. In addition to surveillance monitoring, CERCLA required monitoring results associated with post-cleanup monitoring of the Peconic River are now addressed in the Site Environmental Report. Because soil contaminated with a radioactive isotope of cesium (Cs-137) was used in some BNL landscaping projects in the past, traces have now been found in deer and in other animals and plants. At the cellular level, Cs-137 takes the place of potassium (K), an essential nutrient.

Most radionuclide tables in this chapter list data for both Cs-137 and potassium-40 (K-40), a naturally occurring radioisotope of potassium. Because K-40 is naturally in the environment, it is commonly found in flora and fauna. In general, K-40 values do not receive significant discussion in the scientific literature because it occurs naturally. Studies indicate that Cs-137 out-competes K and K-40 when potassium salts are limited in the environment, which is typical on Long Island. The results of the annual sampling conducted under the flora and fauna monitoring program follow.

6.3.1 Deer Sampling

White-tailed deer in New York State typically are large, with males weighing, on average, about 150 pounds; females typically weigh 1/3 less, approximately 100 pounds. However, white-tailed deer on Long Island tend to be much smaller, weighing an average of 80 pounds. The available meat on local deer ranges from 20 to 40 pounds per deer. This fact has implications for calculating the potential radiation dose to consumers of deer meat containing Cs-137, because smaller deer do not provide sufficient amounts of venison to support the necessary calculations.

In 2012, as in recent years, an on- and off-site deer-sampling program was conducted. While most off-site samples are the result of car/deer accidents near the Laboratory, in most years, samples from deer taken by hunters beyond BNL boundaries or samples from car/deer accidents greater than 1 mile from BNL are used. Based on more than a decade of sampling, deer taken from more than 1 mile from BNL represent background. In all, four deer were obtained on site and five deer were from off-site locations within 1 mile of the Laboratory. No deer samples were obtained from areas greater than 1 mile in 2012. The results of deer sampling are presented in Table 6-2.

BNL sampling technicians collect the samples and process them for analysis. Samples of meat (flesh), liver, and bone are taken from each deer, when possible. The meat and liver are analyzed for Cs-137 and the bone is analyzed for strontium-90 (Sr-90). Meat and liver data are reported on a wet-weight basis, and bone data are reported as dry weight.

6.3.1.1 Cesium-137 in White-Tailed Deer

Based on historic and current data, white-tailed deer sampled at or near the Laboratory contain higher concentrations of Cs-137 than deer from greater than 1 mile off site (BNL 2000), most likely because they graze on vegetation growing in soil where elevated Cs-137 levels are known to exist. Cs-137 in soil can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing animals.

Removal of contaminated soil areas on site has occurred under the Laboratory's cleanup program. All major areas of contaminated soil were remediated by September 2005. In addition, all buildings at the former Hazardous Waste Management Facility (HWMF) were removed in 2003, and the cleanup of the remainder of the facility was completed by fall 2005. Subsequent to the completion of cleanup at the former HWMF, additional minor contamination outside that facility was found and characterized, and the majority of that contamination was removed in 2009. Further characterization of the area surrounding the former HWMF was performed in late 2009, with a portion of the work completed in 2010 to allow use of the area for the LISF. Further characterization of perimeter soils is expected in 2013.

The number of deer obtained for sampling steadily increased between 1996 and 2004. However, the numbers of deer obtained from 2005 to 2012 were significantly lower. In 1998, a statistical analysis based on existing data suggested that 40 deer from off site and 25 deer from on site are needed to achieve a statistically sound data set. Since that analysis was completed, BNL has attempted to obtain the required number of deer. The number obtained each year has varied due to the sampling method, which depends on vehicle and deer accidents and people reporting dead deer. The number of deer hit

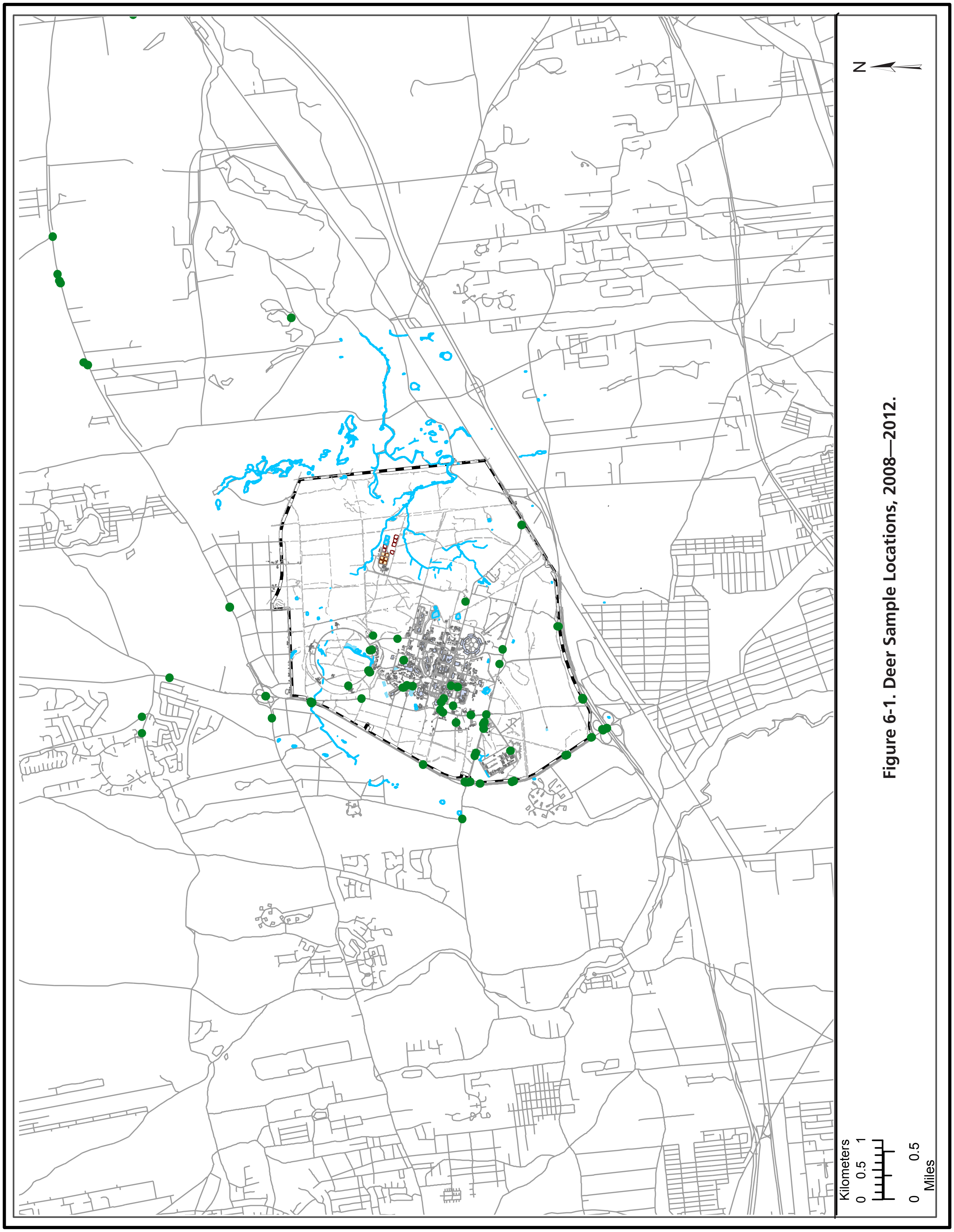


Figure 6-1. Deer Sample Locations, 2008—2012.

Table 6-2. Radiological Analyses of Deer Tissue (2012).

Sample Location	Collection Date	Tissue	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)	Sr-90 pCi/g (Dry Weight)
BNL, On Site					
Bldg. 931	03/15/12	flesh	3.10±0.32	0.14±0.02	
		liver	1.97±0.26	0.03±0.01	
		bone			ND
Bldg. 50	03/16/12	flesh	3.68±0.36	0.02±0.01	
		bone			3.99±0.63
Bldg. 931	04/12/12	flesh	2.90±0.31	0.03±0.01	
		liver	2.89±0.30	0.03±0.01	
		bone*			1.42±0.38
East Princeton	09/27/12	flesh	3.54±0.33	0.27±0.02	
		liver	2.29±0.27	0.09±0.01	
		bone			ND
Offsite < 1 mile					
William Floyd Parkway at North Gate	01/26/12	flesh	3.23±0.33	0.76±0.07	
		bone*			1.75±0.44
William Floyd Parkway at Long Island Expressway	02/03/12	flesh	3.14±0.34	0.35±0.03	
		bone*			1.36±0.46
William Floyd Parkway	02/13/12	flesh	3.05±0.29	0.07±0.01	
		liver	2.34±0.33	0.03±0.01	
		bone			ND
William Floyd Parkway, 1/2 mile south of BNL Main Gate	04/21/12	flesh	3.07±0.31	0.02±0.01	
		bone			ND
William Floyd Parkway, 1/2 mile south of BNL Main Gate	11/06/12	flesh	3.27±0.29	1.52±0.12	
		liver	2.60±0.24	0.41±0.03	
		bone			2.57±0.70
Averages by Tissue					
Flesh Averages					
All Samples (9)			3.22±0.96	0.35±0.15	
BNL Average (4)			3.31±0.66	0.12±0.03	
< 1 Mile Average (5)			3.15±0.70	0.54±0.15	
BNL + < 1 Mile Average (9)			3.22±0.96	0.35±0.15	
Liver Averages					
All Samples (5)			2.42±0.63	0.12±0.04	
BNL Average (3)			2.38±0.48	0.05±0.02	
< 1 Mile Average (2)			2.47±0.41	0.22±0.04	
BNL + < 1 Mile Average (5)			2.42±0.63	0.12±0.04	
Bone Averages					
All Samples (9)					1.60±2.13
BNL Average (4)					1.63±1.39
< 1 Mile Average (5)					1.57±1.61
BNL + < 1 Mile Average (9)					1.60±2.13

(continued on next page)

Table 6-2. Radiological Analyses of Deer Tissue (2012) *(concluded).*

Sample Location	Collection Date	Tissue	K-40 pCi/g (Wet Weight)	Cs-137 pCi/g (Wet Weight)	Sr-90 pCi/g (Dry Weight)

Notes:
All values are shown with a 95% confidence interval.
K-40 Occurs naturally in the environment and is presented as a comparison to Cs-137.
All averages are the arithmetic average. Confidence limits are 2 sigma (95%) propogated error.
* = estimated value for Sr-90

Cs-137 = cesium-137
K-40 = potassium-40
ND = Non-detected
Sr-90 = strontium-90

by vehicles varies widely from year to year, depending on the population of deer present near major roadways and the traffic density. Figure 6-1 shows the location of all deer samples taken within a 5-mile radius of the Laboratory since 2008. Most of the off-site samples are concentrated along the William Floyd Parkway on the west boundary of BNL, whereas the concentration on site is near the front gate area and the constructed portions of the Laboratory. This distribution is most likely due to the fact that people on their way to work see and report dead deer. Vehicle collisions with deer on site occur primarily early or late in the day, when deer are more active and traffic to and from the front gate is greatest.

In 2012, Cs-137 concentrations in deer meat (flesh) samples were obtained from four deer on site with a range of values from 0.02 pCi/g, wet weight, to 0.27 pCi/g, wet weight, and an arithmetic average of 0.12 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 2012 (0.27pCi/g, wet weight) was 10 times lower than the highest on-site sample reported in 2011 (3.08 pCi/g wet weight) and 43 times lower than the highest level ever reported (11.74 pCi/g, wet weight, in 1996).

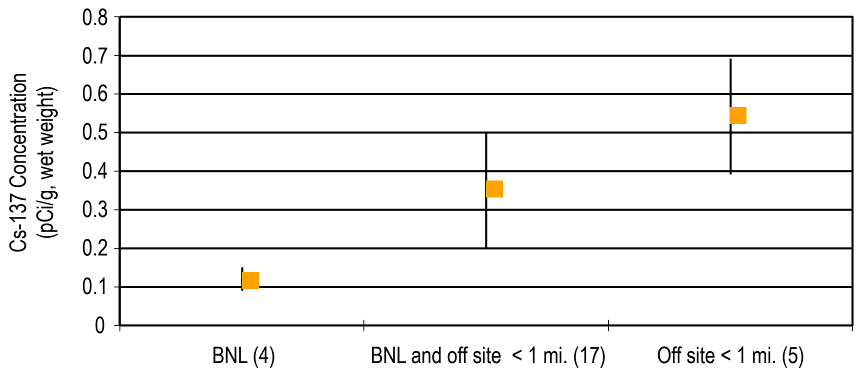
Cs-137 concentrations in off-site deer meat samples are typically separated into two groups: samples taken within 1 mile of BNL (five samples) and samples taken farther away (no samples in 2012), as shown in Table 6-2. Concentrations in meat samples taken within 1 mile ranged from 0.02 to 1.52 pCi/g, wet weight, with an arithmetic average of 0.54 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 2012, this was 0.35 pCi/g, wet weight.

Figure 6-2 compares the average values of Cs-137 concentrations in meat samples collected in 2012 from three different location groupings. Although not shown on the figure, 89 percent of all meat samples taken both on and off site are below 1 pCi/g, wet weight.

Figure 6-3 presents the 10-year trend of on-site and near off-site Cs-137 averages in deer meat. While similar in number to the samples taken in 2007, samples from 2012 indicate a similar range of error. The average is approximately 40 percent lower than the 2007 average, and is the lowest average seen since trending began in 2000. Although these sample results continue to indicate the effectiveness of cleanup actions across the Laboratory, the trend is slightly upward from 2003 to 2012, and likely reflects the seasonality of sample acquisition. In 2003, a seasonal pattern in Cs-137 concentrations in deer meat was noticed. This seasonality was present in data from earlier years and occurred again in 2012. Deer sampled from October to December typically have higher Cs-137 values than samples obtained in the spring and summer.

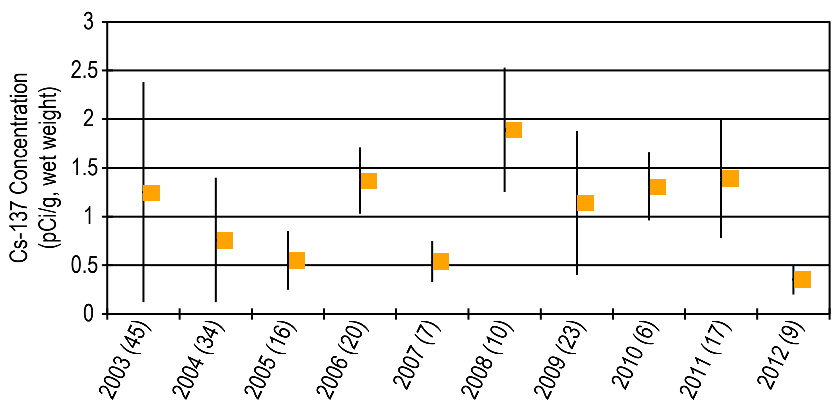
During the summer of 2004, a student in the Community College Intern Program reviewed all data from 2000–2003, analyzed the data statistically, and determined that there was a statistical seasonal variation in values for deer both on site as well as far off site (Florendo 2004). This seasonality is likely due to diet and the biological processing of Cs-137.

From January through May, deer have a



Notes: Averages are shown for samples collected at BNL, on site and off site within 1 mile, and off site but within 1 mile of BNL.
Numbers in parentheses indicate the number of samples in that data set.
All values are presented with a 95% confidence interval.
Cs-137 = Cesium-137

Figure 6-2. Comparison of Cs-137 Average Concentrations in Deer Meat, 2012.



Notes: Averages are shown for samples collected at BNL, and within 1 mile.
Numbers in parentheses indicate the number of samples in that data set.
All values are presented with a 95% confidence interval.
Cs-137 = cesium-137

Figure 6-3. Ten-Year Trend of Cs-137 Concentrations in Deer Meat.

limited food supply—mostly dry vegetation from the previous year's growth (with a fixed concentration of Cs-137 because plants are dormant). In the summer and fall (July through mid-December), deer eat more and the vegetation is constantly growing and taking up nutrients and contaminants from the soil. In summer and fall, deer feeding on vegetation growing in soil containing Cs-137 are more likely to obtain a continuous supply, which is incorporated into their tissues. This increased concentration of Cs-137 in tissues is evidenced by the highest value seen in deer in 2012 (1.52 pCi/g, wet weight) from a sample taken in November 2012. By late-January to February, the Cs-137 in tissues is eliminated through biological processes. The levels of Cs-137 in deer tissue during June through early August are not well known, as there are few vehicle/deer accidents at this time of year.

When possible, liver samples are taken concurrently with meat samples. Liver generally accumulates Cs-137 at a lower rate than muscle tissue. The typically lower values in liver allow the results to be used as a validity check for meat values (i.e., if liver values are higher than meat values, results can be considered questionable and should be confirmed). In liver samples collected on site in 2012, Cs-137 concentration ranged from 0.03 to 0.09 pCi/g, wet weight, with an average of 0.05 pCi/g, wet weight. The off-site Cs-137 concentration in liver ranged from 0.03 to 0.41 pCi/g, wet weight, with an arithmetic average for all off-site liver samples of 0.22 pCi/g, wet weight.

The potential radiological dose resulting from deer meat consumption is discussed in Chapter 8. The New York State Department of Health (NYSDOH) has formally considered the potential public health risk associated with elevated Cs-137 levels in on-site deer and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999).

With respect to the health of on-site deer based on their exposure to radionuclides, the International Atomic Energy Agency (IAEA) has concluded that chronic dose rates of 100 millirad per day to even the most radiosensitive species in terrestrial ecosystems are unlikely to cause detrimental effects in animal populations (IAEA 1992). A deer containing a uniform distribution of Cs-137 within muscle tissue at the highest levels observed to date (11.74 pCi/g, wet weight, reported in 1996) would carry a total amount of approximately 0.2 µCi. That animal would receive an absorbed dose of approximately 3 millirad per day, which is only 3 percent of the threshold evaluated by IAEA. The deer observed and sampled on site appear to have no health effects from the level of Cs-137 found in their tissues.

6.3.1.2 Strontium-90 in Deer Bone

BNL began testing deer bones for Sr-90 content in 2000. In 2012, Sr-90 content ranged from non-detectable to 3.99pCi/g, dry weight, in samples taken on site. Sr-90 in off-site samples taken within 1 mile of BNL ranged from non-detectable to 2.57 pCi/g, dry weight. There is significant overlap across all values, which suggests that Sr-90 is present in the environment at background levels, probably as a result of worldwide fallout from nuclear weapons testing. Sr-90 is present at very low levels in the environment, is readily incorporated into bone tissue, and may concentrate over time. With 13 years of Sr-90 data providing a sound baseline indicating on- and off-site values having overlapping distributions, the Laboratory has made a decision to discontinue to test for Sr-90 in white-tailed deer bone, starting in 2013.

6.3.2 Other Animals Sampled

When other animals, such as wild turkey or Canada geese, are found dead along the roads of BNL and the immediate vicinity due to road mortality, they are tested for Cs-137 and Sr-90 content in bone, when possible. In 2012, two turkeys were found dead from various traumas. A sample of the breast meat was sent for radiological analysis, and Cs-137 content was detected at 0.03 pCi/g, wet weight in one, and 0.20 pCi/g, wet weight in the other. A single goose was found hit by a car, and breast meat was sent for analysis resulting in a non-detection for Cs-137. All three animals also had a piece of bone sent for Sr-90 analysis, with all results being non-detected.

6.3.3 Fish Sampling

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. Large areas of open water on site resulting from the cleanup of the Peconic River have resulted in sufficient habitat to support larger fish. During sampling activities, numerous schools of fry of bass and sunfish have been noticed. While low-dissolved oxygen levels continue to be a problem for fish, the deeper pools provide areas of cooler, more highly oxygenated water for long-term survival. Fish were sampled early in 2012 to take advantage of periods when dissolved oxygen levels are higher, supporting the presence of fish.

All samples were analyzed for edible (fillet) content of each of the analytes reported. Samples collected on site were from Area D of the Peconic River near the site boundary. Various species of fish were also collected off site from Swan Pond, Donahue's Pond, Forge Pond, and Lower Lake on the Carmans River (see Figure 5-7 for sampling stations). Swan Pond is a semi-control location on the Peconic River system (a tributary of the Peconic not connected to the BNL branch), and Lower Lake on the Carmans River is the non-Peconic control site. Sampling is carried out under a permit from NYSDEC by BNL's sampling team. Sampling is also separated into samples taken as part of BNL's routine surveillance monitoring program and those taken as part of the post cleanup monitoring for the Peconic River cleanup project (primarily for mercury analysis). As a result of a 5-year review process completed in 2011, monitoring between the two programs, with the exception of Lower Lake on the Carmans River, is alternated with surveillance monitoring occurring in even-numbered years and post-cleanup monitoring occurring in odd-numbered years. Therefore, data presented for 2012 is based on routine surveillance monitoring of the Peconic River. Data for 2013 will consist of post-cleanup monitoring of fish from four Peconic River locations, as well as surveillance monitoring of fish from Lower Lake on the Carmans River. Post-cleanup monitoring will likely consist of fewer samples than in the past.

6.3.3.1 Radiological Analysis of Fish

The species collected for radiological analysis in 2012 included brown bullhead (*Ictalurus nebulosus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and yellow perch (*Perca flavescens*). Gamma spectroscopy analysis was performed on all samples. When fish were not of sufficient mass to conduct all non-radiological and radiological analyses, samples of the same species were composited to gain sufficient volume for radiological analysis. Table 6-3 presents specific information on the sampling location, species collected, and analytical results. All sample results are presented as wet weight concentrations, and information on the naturally occurring radioisotope K-40 is included as a comparison.

Cs-137 was measured at levels ranging from non-detected to 0.30 pCi/g, wet weight, from the Peconic River system, and all samples from the Carmans River were non-detectable levels. Detectable levels in fish ranged from 0.06 pCi/g, wet weight, in two brown bullhead taken from Donahue's Pond to 0.30 pCi/g, wet weight, in a brown bullhead taken from Area D. This is compared to the highest recent value of 0.78 pCi/g, wet weight, in a composite sample of bluegill (*Lepomis macrochirus*) taken from Forge Pond in 2011.

To account for the different feeding habits and weights of various species, it is important to compare species with similar feeding habits (i.e., bottom feeders such as brown bullhead should be compared to other bottom feeders). This comparison within different feeding guilds extends to other potential contaminants and is not limited to comparisons for radionuclides. Cs-137 concentrations in brown bullhead collected at all locations along the Peconic River had values less than 0.30 pCi/g, wet weight. Largemouth bass, the top predator from the Peconic River, showed Cs-137 levels of 0.28 pCi/g, wet weight, or less. Levels of Cs-137 in all fish species appear to be declining, compared to historic values.

Though it is clear from discharge records and sediment sampling that past BNL operations have contributed to anthropogenic (human-caused) radionuclide levels in the Peconic River system, most of these radionuclides were released between the late 1950s and early 1970s. Concentrations continue to decline over time through natural decay. Cs-137 has a half-life of 30 years. No Cs-137 was released from the BNL Sewage Treatment Plant (STP) to the Peconic River between 2003 and 2012. Additionally, the cleanup of both on- and off-site portions of the Peconic River in 2004 and 2005 removed approximately 88 percent of Cs-137 in the sediment that was co-located with mercury. Removal of this contamination is expected to result in continued decreases in Cs-137 levels in fish.

6.3.3.2 Fish Population Assessment

BNL suspended fish sampling on site in 2001 because prior fish sampling had depleted the population and limited the remaining fish to smaller sizes. Sampling resumed in 2007 when multiple schools of small fish were observed throughout the on-site portions of the river. The relative sizes of fish caught during annual

Table 6-3. Radiological Analysis of Fish from the Peconic River System and Carmans River, Lower Lake.

Location/Species	K-40	Cs-137
	pCi/g	
BNL, On Site		
Area D		
Largemouth Bass	2.65±1.14	0.28±0.10
Largemouth Bass	3.14±0.73	0.23±0.05
Brown Bullhead	3.56±0.67	0.19±0.05
Brown Bullhead	3.37±0.85	0.30±0.07
Brown Bullhead	3.50±0.80	0.18±0.06
Brown Bullhead	3.81±0.67	0.18±0.07
Black Crappie (composite)	2.90±1.18	0.22±0.07
Donahue's Pond		
Largemouth Bass	3.33±0.84	0.12±0.05
Largemouth Bass	3.57±0.84	0.12±0.04
Brown Bullhead	3.15±0.62	0.09±0.04
Brown Bullhead	3.15±0.78	0.09±0.04
Brown Bullhead	2.72±0.66	0.06±0.04
Brown Bullhead	3.53±0.69	0.06±0.04
Brown Bullhead	2.21±1.33	ND
Black Crappie	2.29±1.51	0.21±0.10
Black Crappie	2.96±1.00	ND
Black Crappie	3.38±1.18	ND
Forge Pond		
Largemouth Bass	3.81±1.00	ND
Largemouth Bass	2.75±1.45	ND
Largemouth Bass	2.34±1.29	ND
Largemouth Bass	4.31±0.96	ND
Largemouth Bass	2.13±1.34	ND
Largemouth Bass	2.96±1.12	ND
Brown Bullhead	3.32±0.96	ND
Yellow Perch	2.79±0.84	0.13±0.06
Yellow Perch	3.15±0.94	ND
Yellow Perch	4.20±1.26	ND
Yellow Perch	3.49±1.01	0.12±0.08
Black Crappie	2.55±1.12	ND
Black Crappie	2.52±1.09	ND
Black Crappie	4.32±1.02	ND

(continued)

Table 6-3. Radiological Analysis of Fish from the Peconic River System and Carmans River, Lower Lake *(concluded)*.

Location/Species	K-40	Cs-137
	pCi/g	
Swan Pond		
Largemouth Bass	4.80±1.08	ND
Largemouth Bass	1.61±1.27	ND
Largemouth Bass	3.21±1.34	ND
Largemouth Bass	3.95±1.38	ND
Largemouth Bass	ND	ND
Chain Pickerel	3.54±1.65	ND
Chain Pickerel	3.18±1.34	ND
Yellow Perch	4.66±1.08	ND
Lower Lake, Carmans River		
Largemouth Bass	2.82±0.59	ND
Largemouth Bass	3.23±0.77	ND
Largemouth Bass	3.30±0.54	ND
Largemouth Bass	2.90±0.58	ND
Largemouth Bass	2.46±0.58	ND
Largemouth Bass	4.14±0.86	ND
Brown Bullhead	3.56±0.56	ND
Brown Bullhead	4.32±0.85	ND

Notes:
All samples analyzed as edible portions (fillets).
Cs-137 = cesium-137
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137
K-40 = potassium-40
ND = not detected, based on analytical laboratory qualifiers

sampling events are tracked and modifications to future sampling events are made, as necessary, to ensure long-term health of the on-site fish populations. Successful sampling of sufficiently large fish for analysis from 2008 through 2012 indicated that populations are maintaining themselves and can continue to support annual sampling in 2013.

6.3.3.3 Non-Radiological Analysis of Fish

Beginning in 2005, all fish of sufficient size have been analyzed as edible portions (fillets). Smaller fish, such as golden shiners are no longer taken for analysis. In 2007, fish sampling was moved to the spring months, when possible,

Table 6-4. Surveillance Monitoring Metals Analysis of Fish from the Peconic River System and Carmans River, Lower Lake.

Location/Species	Barium	Copper	Iron	Manganese	Mercury	Silver	Zinc
	mg/kg						
BNL - Area D							
Largemouth Bass	<MDL	0.293	<MDL	0.261	1.08	<MDL	5.15
Largemouth Bass	<MDL	<MDL	<MDL	0.311	1.05	<MDL	5.3
Black Crappie (composite)	0.13	<MDL	<MDL	0.326	0.106	<MDL	4.63
Brown Bullhead	0.21	0.402	8.77	0.363	0.227	<MDL	6.33
Brown Bullhead	0.188	0.356	9.04	0.444	0.265	<MDL	5.69
Brown Bullhead	0.132	0.33	<MDL	0.318	0.126	<MDL	4.49
Brown Bullhead	0.172	0.318	8.92	0.441	0.338	<MDL	4.66
Donahue's Pond							
Largemouth Bass	0.181	<MDL	<MDL	0.53	0.329	<MDL	6.11
Largemouth Bass	<MDL	<MDL	<MDL	0.259	0.934	<MDL	7.11
Black Crappie	2.49	<MDL	<MDL	4.72	0.877	<MDL	9.24
Black Crappie	0.1	<MDL	<MDL	0.295	0.49	<MDL	5.74
Black Crappie	<MDL	<MDL	<MDL	0.221	0.171	<MDL	5.43
Brown Bullhead	0.282	<MDL	13.6	0.228	0.382	<MDL	4.58
Brown Bullhead	0.604	<MDL	<MDL	0.366	0.286	<MDL	5.09
Brown Bullhead	0.351	<MDL	<MDL	0.268	0.534	<MDL	6.9
Brown Bullhead	0.446	<MDL	8.92	0.25	0.379	<MDL	5.56
Brown Bullhead	0.633	<MDL	<MDL	0.271	0.129	<MDL	5.2
Forge Pond							
Largemouth Bass	0.11	<MDL	<MDL	0.281	0.169	<MDL	4.55
Largemouth Bass	<MDL	<MDL	<MDL	<MDL	0.45	0.116	5.84
Largemouth Bass	0.185	0.351	<MDL	0.697	0.152	<MDL	5.79
Largemouth Bass	<MDL	<MDL	<MDL	0.273	0.0866	0.0965	5.4
Largemouth Bass	<MDL	<MDL	<MDL	0.227	0.15	<MDL	5.2
Largemouth Bass	<MDL	0.325	<MDL	0.218	0.132	0.119	6.4
Black Crappie	0.0967	0.363	<MDL	0.186	0.117	<MDL	6.1
Black Crappie	0.102	<MDL	31.5	0.285	0.0917	0.122	6.82
Black Crappie	<MDL	0.284	<MDL	0.184	0.0806	0.107	6.67
Yellow Perch	0.105	0.325	<MDL	0.378	0.137	0.116	6.67
Yellow Perch	0.105	0.321	<MDL	0.266	0.0498	<MDL	6.82
Yellow Perch	0.106	<MDL	<MDL	0.242	0.175	<MDL	5.83
Yellow Perch	<MDL	<MDL	<MDL	0.3	0.137	0.109	7.25
Brown Bullhead	0.261	0.388	7.91	0.239	0.0739	<MDL	6.62
Swan Pond (Peconic River control location)							
Largemouth Bass	<MDL	0.328	<MDL	0.419	0.348	<MDL	4.7
Largemouth Bass	<MDL	<MDL	<MDL	0.661	0.211	<MDL	5.01
Largemouth Bass	<MDL	<MDL	<MDL	0.36	0.26	<MDL	4.19
Largemouth Bass	<MDL	<MDL	<MDL	0.358	0.261	<MDL	4.34

(continued on next page)

Table 6-4. Surveillance Monitoring Metals Analysis of Fish from the Peconic River System and Carmans River, Lower Lake *(concluded)*.

Location/Species	Barium	Copper	Iron	Manganese	Mercury	Silver	Zinc
	mg/kg						
Largemouth Bass	0.128	<MDL	<MDL	0.377	0.396	<MDL	4.9
Chain Pickerel	0.121	<MDL	<MDL	0.978	0.173	<MDL	7.46
Chain Pickerel	0.128	<MDL	<MDL	4.62	0.223	<MDL	8.1
Yellow Perch	0.0957	<MDL	<MDL	0.642	0.13	<MDL	6.14
Lower Lake, Carmans River (control location)							
Largemouth Bass	0.107	0.344	<MDL	0.223	0.661	<MDL	4.85
Largemouth Bass	<MDL	0.282	<MDL	0.234	0.287	<MDL	3.84
Largemouth Bass	<MDL	<MDL	<MDL	0.182	0.136	<MDL	4.75
Largemouth Bass	0.098	<MDL	<MDL	0.277	0.0428	<MDL	5.72
Largemouth Bass	<MDL	0.339	<MDL	0.267	0.111	<MDL	7.45
Largemouth Bass	0.114	7.78	<MDL	1.97	0.0898	<MDL	11.3
Brown Bullhead	0.342	0.305	<MDL	0.324	0.0708	<MDL	4.16
Brown Bullhead	0.318	<MDL	<MDL	0.364	0.0338	<MDL	4.67

Notes:
See Figure 5-7 for sampling locations.
All fish were analyzed as edible portions (fillets).
MDL = Minimum Detection Limit

to lessen the effect of low oxygen levels on fish distributions. All samples for surveillance monitoring of the Peconic River were obtained between April and mid-June.

Table 6-4 shows the 2012 concentrations of metals in fish taken for surveillance monitoring within the Peconic River and Lower Lake on the Carmans River. Due to the fact that values for aluminum, antimony, arsenic, beryllium, cadmium, cobalt, silver, selenium, thallium, and vanadium were near or less than the minimum detection level (MDL) for the analytical procedure, they were not included in Table 6-4. Additionally, metals common to biological process including calcium, magnesium, potassium, and sodium are also not presented in Table 6-4. Chromium and nickel are the only other metals tested but not included in the table, as most values reported for these metals were less than the MDL.

Chromium was detected in a single sample of a black crappie from Donahue's Pond at a concentration of 0.205 mg/kg. Nickel values that were above the MDL and without laboratory qualifiers were as follows: two largemouth bass taken from Lower Lake measured 0.139 and 0.232 mg/kg, respectively, and a brown bullhead from the same location measured 0.165 mg/kg. These reported values and those presented in Table 6-4, excluding mercury, are not considered to pose any health risks to humans or other animals that may consume fish. Fish taken both on and off site are important to the post-cleanup monitoring program; they are analyzed for mercury and the data are presented comparatively in Table 6-5.

Due to its known health effects, mercury is the metal of highest concern. Surveillance monitoring data are provided in Table 6-4 for Area D, Donahue's Pond, Forge Pond, Swan Pond, and Lower Lake on the Carmans River. During 2012, mercury ranged from 0.106 mg/kg in a composite sample of black crappie to 1.08 mg/kg in a largemouth bass at Area D; 0.129mg/kg in a brown bullhead to 0.934 mg/kg in a largemouth bass at Donahue's Pond; from 0.0498 mg/kg in a yellow perch to 0.45 mg/kg in a largemouth bass at Forge Pond; from 0.13 mg/kg in a yellow perch to 0.396 mg/kg in a largemouth bass at Swan Pond; and from 0.0338 mg/

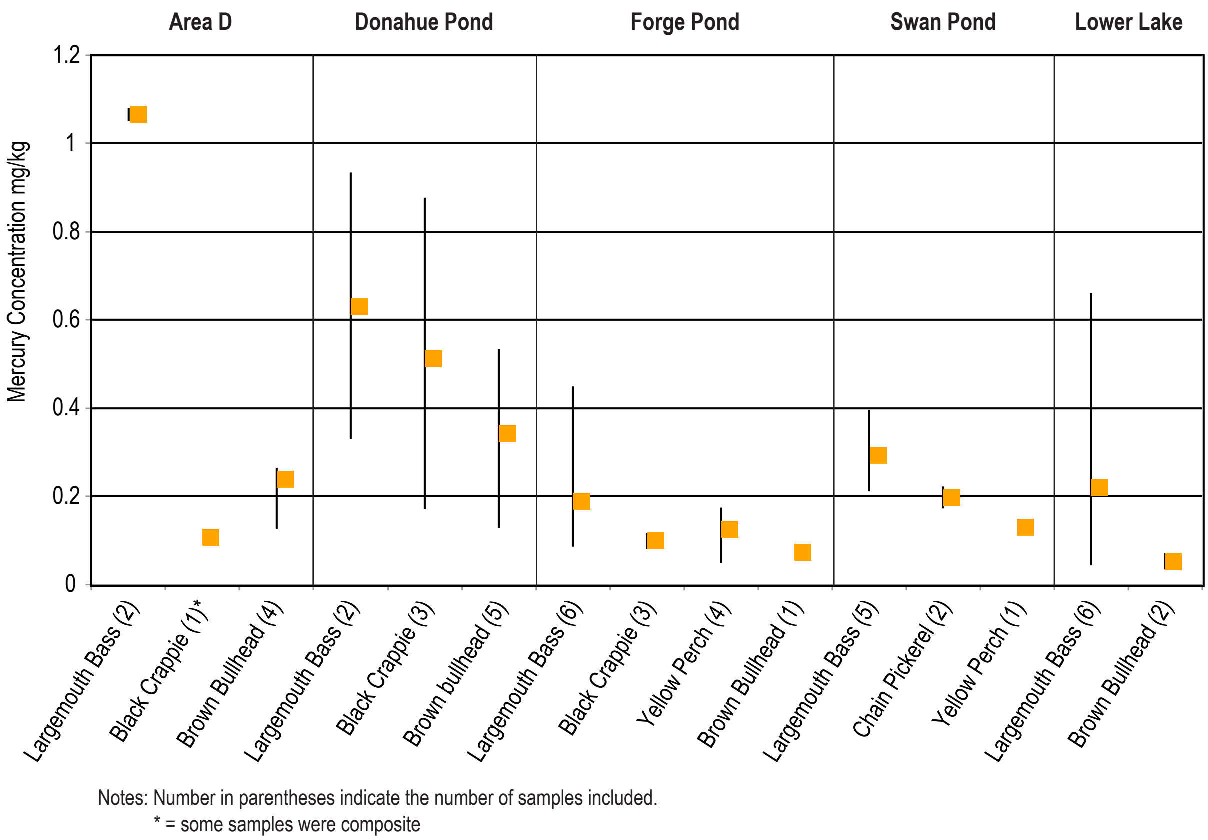


Figure 6-4. Peconic River and Lower Lake, Carmans River Mercury Distribution in Fish Species (Minimum, Maximum, and Average Values).

kg in a brown bullhead to 0.661 mg/kg in a largemouth bass from Lower Lake on the Carmans River.

Monitoring data for mercury analysis in fish is presented in Table 6-5 and is shown as a range of results by species and area sampled to reduce the size of the table. The data are presented graphically in Figure 6-4. Data are typically compared to the EPA mercury water criterion of 0.3 mg/kg. Samples taken for mercury analysis in the main channel of the Peconic River historically sampled as part of the post clean-up monitoring came from Area D on site and Donahue's Pond off site. A total of 17 samples were taken from the two locations with an average of 0.45 mg/kg. When the entire main stem samples from the Peconic River are combined (inclusion of Forge Pond samples), the average is 0.31 mg/kg. As a comparison to the main portion of the river, mercury values for Swan Pond (eight samples) average 0.25 mg/kg and Lower Lake on the Carmans River (eight samples) average 0.18 mg/kg.

In comparing data from location to location along the Peconic River from year to year, a wide range of values are seen between locations and both within and between species. The presented data are from larger fish, which allow for the analysis of all metals of interest, as well as radiological analysis for Cs-137 and K-40. Data are also presented graphically in Figure 6-4 and in a similar manner as in the past to facilitate comparison from year to year.

Pesticide analyses in fish was discontinued in 2008, since several years of sampling detected pesticides in only a few fish far off site. PCB analyses in fish was also discontinued from surveillance monitoring, but continued to be completed for fish collected on site. All fish taken from Area D on site in 2012 were analyzed for polychlorinated biphenyls (PCBs) and all values received were less than the method detection limit. The cleanup of the Peconic River that was completed in 2005 and

Table 6-5. Mercury Analysis of Fish from the Peconic River System and Lower Lake, Carmans River.

Location/Species (number)	Mercury mg/kg Min	Max	Avg
BNL, On Site			
Area D			
Largemouth Bass (2)	1.05	1.08	1.07
Black Crappie (1)*	0.11	0.11	0.11
Brown Bullhead (4)	0.13	0.34	0.24
Donahue's Pond			
Largemouth Bass (2)	0.33	0.93	0.63
Black Crappie (3)	0.17	0.88	0.51
Brown Bullhead (5)	0.13	0.53	0.34
Forge Pond			
Largemouth Bass (6)	0.09	0.45	0.19
Black Crappie (3)	0.08	0.12	0.10
Yellow Perch (4)	0.05	0.18	0.12
Brown Bullhead (1)	0.07	0.07	0.07
Swan Pond			
Largemouth Bass (5)	0.21	0.40	0.30
Chain Pickerel (2)	0.17	0.22	0.20
Yellow Perch (1)	0.13	0.13	0.13
Lower Lake			
Largemouth Bass (6)	0.04	0.66	0.22
Brown Bullhead (2)	0.03	0.07	0.05
River Averages (all fish)			
Peconic River			
Main River (31)	0.05	1.08	0.31
Swan Pond (8)	0.13	0.40	0.25
Carmans River			
Lower Lake, Carmans River (8)	0.03	0.66	0.18

Notes:
All samples were analyzed as edible portions (fillets), including composite samples.
Area letter designation refers to Peconic River cleanup areas on site.
* = one or more samples in the average were composite samples

Table 6-6. Radiological Analyses of Aquatic Vegetation and Sediment from the Peconic River and Carmans River system, Lower Lake.

Location/Sample Type	K-40 (pCi/g)	Cs-137 (pCi/g)
BNL, On Site		
Aquatic vegetation	3.2 ± 0.36	ND
Aquatic vegetation	3.57 ± 0.41	ND
Aquatic vegetation	2.67 ± 0.33	ND
Aquatic vegetation	3.94 ± 0.58	ND
Sediment - ST1-80-U20	NP	0.42 ± 0.12
Sediment - PR-WC-06-D1-L50	3.4 ± 1.3	5.48 ± 0.69
Area D, Off Site		
Sediment - PR-SS-15-U1-L65-O	5.7 ± 1.2	0.72 ± 0.13
Donahue's Pond		
Aquatic vegetation	2.02 ± 0.25	0.04 ± 0.01
Sediment	2.94 ± 0.63	0.11 ± 0.04
Forge Pond		
Aquatic vegetation	2.99 ± 0.4	ND
Sediment	2.31 ± 0.31	0.06 ± 0.02
Swan Pond (Peconic River control location)		
Aquatic vegetation	2.32 ± 0.26	0.02 ± 0.01
Sediment	1.84 ± 0.85	0.83 ± 0.12
Lower Lake, Carmans River (control location)		
Aquatic vegetation	2.82 ± 0.64	ND
Sediment	3.71 ± 0.89	0.42 ± 0.09

Notes:
Aquatic vegetation values are reported as wet weight.
Sediment values are reported as dry weight.
Cs-137 = cesium-137
K-40 = potassium-40
ND = not detected based on analytical laboratory qualifiers
NP = not provided by analytical laboratory

the supplemental cleanup completed in 2011 removed most PCBs within the sediments. Although BNL has discontinued most pesticide and PCB monitoring, the Laboratory may periodically test for PCBs and pesticides in fish to verify the presence/absence in fish tissue.

6.3.4 Aquatic Sampling

6.3.4.1 Radiological Analysis

Annual sampling of sediment and vegetation in the Peconic River and a control location on the Carmans River was conducted in 2012. (See Chapter 5 for a discussion on water quality and monitoring, and Figure 5-7 for the locations of sampling stations. Additionally, refer to Section 6.3.5 for a discussion of sediment and water analysis related to monitoring post-cleanup of the Peconic River.) Because annual analysis of sediment and water samples are being taken under the post-cleanup monitoring, fewer samples are being taken under the surveillance monitoring program to reduce duplication of effort.

Table 6-6 summarizes the radiological data. Cs-137 was not detected in any on-site aquatic vegetation samples in 2012 and was detected at levels near the detection limit at off-site locations. As in the past, low levels of Cs-137 were detected in sediments at Donahue's Pond, Swan Pond, Forge Pond, and Lower Lake on the Carmans River.

6.3.4.2 Metals in Aquatic Samples

Metals analyses, as shown in Table 6-7, were conducted on aquatic vegetation and sediments from the Peconic River and Lower Lake on the Carmans River. The data indicate metals at background levels. The standard used for comparison of sediments is the SCDHS soil cleanup objectives for heavy metals. Vegetation results are compared to soil cleanup standards, because metals in vegetation may accumulate via uptake from sediment. In general, metals are seen in vegetation at levels lower than in associated sediment.

Other metals analyzed for, but not listed in Table 6-7, include antimony, arsenic, beryllium, cadmium, magnesium, potassium, selenium, sodium, and thallium. In general, levels of these metals are either below detection limits, below action levels, or like sodium, are common in the environment. Cadmium was found in sediments at Lower Lake with a concentration of 0.98mg/kg and was consistent with past values. Chromium was found in sediment at Lower Lake with a concentration of 50 mg/kg, which is below action levels.

6.3.5 Peconic River Post-Cleanup Monitoring

Approximately 20 acres of sediment from the Peconic River were remediated in 2004 and 2005 to remove mercury and associated contaminants from the river. To ensure that the cleanup provided adequate protection of human health and the environment, monitoring of the sediment, surface water, and fish was performed for 5 years (2006–2010). The mercury concentrations from the monitoring identified approximately 0.39 acres in three small areas (PR-WC-06, PR-SS-15, and sediment trap areas) with mercury concentrations greater than the cleanup goal of 2.0 mg/kg. The three areas were cleaned between November 2010 and February 2011 (see Section 6.3.5.4). The 2012 sediment and surface water results follow.

During the 5-year review process in 2011, all data and accomplishments related to the Peconic River cleanup and subsequent monitoring were summarized and reviewed. BNL recommended to the various regulatory agencies that reduced monitoring should take place beginning in 2012, and all future reporting of post-cleanup monitoring results would be documented in the annual BNL Site Environmental Report; this is the first year that data for the post-cleanup monitoring is provided in the SER as the primary method of reporting.

6.3.5.1 Sediment Sampling

Sediment was sampled in May 2012 at three Peconic River locations associated with the supplemental cleanup areas (See Tables 6-6 and 6-7). During the 5-year review, a recommendation was made and approved by the regulators to reduce sampling from 33 sampling locations to only the locations associated with the three supplemental cleanup areas.

Radiological analysis of sediments at the three locations (Table 6-6) indicate that low levels of Cs-137 are present, ranging from 0.42 pCi/g to 5.48 pCi/g. Analysis of sediment for mercury (Table 6-7) resulted in values ranging from 0.25 mg/kg to 3.6 mg/kg. As noted in past reports, the cleanup of mercury in the Peconic River has been considered successful, and roughly 88 percent of all Cs-137 was co-located with mercury. The single sample from location PR-WC-06-D1-L50 is a good example of this co-locality, as values for both mercury and Cs-137 are higher than other values. While the value for mercury is above the 2.0 mg/kg goal for the

Table 6-7. Metals Analysis of Aquatic Vegetation and Sediment from the Peconic River System and Lower Lake, Carmans River.

Location/ Sample Type	Aluminum	Barium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Vanadium	Zinc
	mg/kg													
BNL, On Site														
Aquatic vegetation	15.3	2.4	825	< MDL	< MDL	1.48	21	< MDL	26.7	0.0564	0.341	< MDL	< MDL	4.36
Aquatic vegetation	7.26	8.07	1210	< MDL	< MDL	1.98	73	< MDL	12.9	< MDL	0.149	< MDL	< MDL	5.19
Aquatic vegetation	< MDL	4.31	1620	< MDL	< MDL	1.92	22.6	< MDL	99.4	< MDL	0.287	< MDL	< MDL	6.97
Aquatic vegetation	10.2	5.32	2990	< MDL	< MDL	1.91	52.6	< MDL	64.1	< MDL	0.158	< MDL	< MDL	6.75
Sediment - ST1-80-U20	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.38	NT	NT	NT	NT
Sediment - PR-WC-06-D1-L50	NT	NT	NT	NT	NT	NT	NT	NT	NT	3.6	NT	NT	NT	NT
Area D, Off Site														
Sediment - PR-SS-15-U1-L65-O	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.25	NT	NT	NT	NT
Donahue's Pond														
Aquatic vegetation	< MDL	4.26	422	< MDL	< MDL	< MDL	33.1	< MDL	15	< MDL	< MDL	< MDL	< MDL	1.54
Sediment	1830	23.5	1220	7.39	3.44	5.59	2900	14.6	30.3	0.114	2.95	0.604	28.6	34.1
Forge Pond														
Aquatic vegetation	< MDL	16.8	880	< MDL	< MDL	1.05	45	< MDL	96.6	< MDL	< MDL	< MDL	< MDL	5.07
Sediment	442	5.23	55.7	0.73	< MDL	0.474	320	3.25	9.1	< MDL	0.283	< MDL	0.861	2.12
Swan Pond (Peconic River control location)														
Aquatic vegetation	< MDL	14.2	1960	< MDL	< MDL	< MDL	22.5	107	100	< MDL	< MDL	< MDL	< MDL	4.57
Sediment	6660	99.1	8540	16.7	2.88	21.7	7070	< MDL	2190	0.187	10.8	< MDL	29.5	92.5
Lower Lake, Carmans River (control location)														
Aquatic vegetation	6.66	47.7	2930	< MDL	0.168	< MDL	70	0.151	214	< MDL	< MDL	< MDL	< MDL	6.41
Sediment	5200	123	3760	50	5.73	11.9	12100	67.8	749	< MDL	7.42	0.823	27.8	102
SCDHS														
Action Levels	SNS	4000	N/A	100	N/A	8500	N/A	2000	N/A	3.7	650	50	N/A	N/A
Cleanup Objectives	SNS	820	N/A	20	N/A	1700	N/A	450	N/A	0.7	130	10	N/A	N/A

Notes:
MDL = Method Detection Limit
N/A = not applicable
SCDHS = Suffolk County Department of Health Services
SNS = Standard Not Specified

cleanup, it is below SCDHS action levels and does not significantly alter the overall average of mercury in sediments from numerous post cleanup samples.

6.3.5.2 Water Column Sampling

Surface water was analyzed in June and July 2012 for total mercury and methyl mercury at 6 of the 15 Peconic River sampling stations (Table 6-8). Water column sampling locations are shown in Figure 6.5. A sample of the treated STP was also collected during each round of sampling. Nine stations could not be sampled in June and July due to either being dry or having low water levels. The maximum total mercury concentrations in the June (55.9 ng/L) and July (49.1 ng/L) STP effluent samples were typical of what has been seen since efforts at mercury minimization have been implemented. The total mercury concentrations generally trended downwards, with minor fluctuations at increasing distance downstream from the STP until reaching concentrations of 6.5 ng/L (June 2012) and 3.3 ng/L (July 2012) at sampling stations west of the cranberry bogs, about 4.77 miles downstream of the STP outfall.

Methyl mercury is the form of mercury that is bio-available to aquatic organisms. Methyl mercury was detected in STP effluent samples in June at a concentration of 0.03 ng/L and was not detected in a July sample. Between the station downstream of the STP and the BNL boundary, the June methyl mercury concentrations fluctuated between 1.4 ng/L and 0.81 ng/L, and the July concentrations fluctuated between 0.36 ng/L and 3.9 ng/L. The 3.9 ng/L measured at PR-WC-06 was higher than it had measured at the same location in August 2011 (0.88 ng/L); this is a result of higher methylation due to wet/dry cycles in the sediments. The methyl mercury values from downstream of the BNL boundary to the station west of the cranberry bogs (PR-WCS-04) fluctuated between 0.7 ng/L and 0.32 ng/L in June (which is consistent with or lower than 2011 measurements) and between 1.6 ng/L and 0.42 ng/L in July. The 1.6 ng/L measured at PR-WC-03 in July is higher than the 0.67 ng/L measured in August 2011, again likely attributed to methylation resulting from the wet/dry cycling in the sediments. As evidenced by the number of stations too shallow or dry for sampling (9 of 15 stations), 2012 was a fairly dry year. Alternating wet/dry periods often facilitate the methylation of mercury.

6.3.5.3 Fish Sampling

In 2012, fish were not collected under the post cleanup monitoring for the Peconic River. Results of fish taken under the surveillance monitoring program are discussed in Sections 6.3.3. Following the 5-year review, it was recommended that fish sampling be conducted every other year, with the next round of post cleanup fish monitoring to be conducted in 2013 and results reported in the annual BNL Site Environmental Report.

6.3.5.4 Remedial Actions

Three areas (PR-WC-06, Sediment Trap, and PR-SS-15) that were cleaned up between November 2010 and February 2011 were replanted with native Peconic River plants transplanted from previously remediated sections of the river. The restoration has been successful in meeting the requirements of the NYSDEC wetlands equivalency permit, but must be monitored and managed to remove invasive species for up to 3 more years in order to meet federal requirements.

6.3.6 Vegetation Sampling

6.3.6.1 Farm and Garden Vegetables

On-site sampling of garden vegetables was conducted in 2012. The data on garden vegetables are presented in Table 6-9. Samples of corn, string beans, cucumber, green pepper, and eggplant were analyzed for Cs-137 content. Cs-137 was not detected in any vegetables sampled from the on-site garden, but was detected in soils from the garden at a very low level (0.17 pCi/g). This value for Cs-137 in soil is consistent with historic values and background levels resulting from worldwide fallout from historic above-ground nuclear testing. Ten years of monitoring at the BNL garden area has provided a sufficient baseline showing no impact from any historic or recent operations. There are no other sources of radiological contamination

Table 6-8. Post Cleanup Peconic River Water Column Monitoring.

Location	Station Description	Dist from STP (miles)	June 2012 Mercury (ng/L)	June 2012 Methyl Mercury (ng/L)	June 2012 TSS (mg/L)	July 2012 Mercury (ng/L)	July 2012 Methyl Mercury (ng/L)	July 2012 TSS (mg/L)
PR-WC-15	Upstream of Forest Path	-0.17	SW	SW	SW	SW	SW	SW
PR-WC-14	Upstream of Sewage Treatment Plant	-0.13	SW	SW	SW	SW	SW	SW
PR-WC-13	Upstream of Sewage Treatment Plant	-0.07	SW	SW	SW	D	D	D
PR-WC-12-D7	Downstream of Sump	-0.04	11.4	1.2	6	3.4	1.2	2
STP-EFF-UVG	Grab Sample	0	55.9	0.03	1	49.1	ND	ND
PR-WC-11DS	50" downstream of outfall	0.01	SW	SW	SW	SW	SW	SW
PR-WC-10	West of Station HMN	0.3	69.3	1.4	10	37.1	0.36	ND
PR-WC-09	Downstream of Station HMN	0.56	SW	SW	SW	SW	SW	SW
PR-WC-08	South of Area B	0.78	39	0.5	10	33.1	0.88	24
PR-WC-07	South of Area C	0.96	SW	SW	SW	SW	SW	SW
PR-WC-06	South of Area D	1.1	27.4	0.81	18	39.1	3.9	66
PR-WC-05	Downstream of Station HQ	1.46	D	D	D	D	D	D
PR-WC-04	2nd downstream of Station HQ	1.7	SW	SW	SW	SW	SW	SW
PR-WC-03	3rd west of Schultz Rd.	2.1	44.4	0.7	12	45.7	1.6	38
PR-WC-02	2nd west of Schultz Rd.	2.52	SW	SW	SW	SW	SW	SW
PR-WCS-04	West of Cranberry Bogs	4.77	6.5	0.32	4	3.3	0.42	2

Notes:
See Figure 6-5 for Peconic River water sampling locations.
D = dry river
SW = water too shallow to sample
ND = not detected based on lab qualifiers
NT = not tested
NS = not sampled during period

available from operations. The surveillance monitoring of garden vegetables will be discontinued beginning in 2013. Farm vegetables from area farms will be sampled on their routine 5-year cycle in 2013.

6.3.6.2 Grassy Plants

Grassy vegetation sampling around the Laboratory was conducted in 2012. Vegetation was sampled from 10 locations around the Laboratory (see Figure 6-6) in areas where contaminated soils had been removed during the environmental cleanup process. All samples were analyzed for Cs-137 content. Data are presented in Table 6-9. The grassy vegetation samples had levels of Cs-137 ranging from non-detectable to 0.39 pCi/g, wet weight, which is consistent with past sampling efforts. Grassy vegetation sampling is utilized for the annual dose to biota analysis reported in Chapter 8.

6.4 OTHER MONITORING

6.4.1 Soil Sampling

Soil sampling was conducted at the same 10 locations where grassy vegetation was sampled in 2012. Soil samples were analyzed for Cs-137 and the data are presented in Table 6-9.

Cs-137 content in soils ranged from 0.14 pCi/g to 43.9 pCi/g. Most values were consistent with past the soil analysis and indicative of the success of the cleanup operations in the areas. The one high value is from a wetland area

Table 6-9. Radiological Analysis of Garden Vegetables, Grassy Vegetation, and Associated Soils.

Location/Sample	K-40	Cs-137
	pCi/g	
BNL Garden		
Corn	1.89 ± 0.20	ND
String Beans	2.6 ± 0.26	ND
Cucumber	1.76 ± 0.18	ND
Green Pepper	1.67 ± 0.17	ND
Eggplant	2.12 ± 0.24	ND
Soil	6.15 ± 0.67	0.17 ± 0.03
BNL Grassy Vegetation and Soils		
Bldg. 30 Lawn		
Vegetation	4.91 ± 0.67	ND
Soil	4.6 ± 0.78	0.39 ± 0.06
Bldg. 490, South side		
Vegetation	5.19 ± 0.74	ND
Soil	5.71 ± 0.90	0.10 ± 0.05
Bldg. 515, Front Lawn		
Vegetation	6.05 ± 0.71	0.13 ± 0.03
Soil	6.55 ± 1.01	1.51 ± 0.16
Bldg. 725, East Lawn		
Vegetation	7.09 ± 0.83	ND
Soil	5.73 ± 0.99	0.14 ± 0.05
STP, Sand Filter Bed 8		
Vegetation	3.22 ± 0.55	0.35 ± 0.05
Soil	4.69 ± 0.76	0.38 ± 0.08
STP Sand Filter Bed 7		
Vegetation	3.78 ± 0.63	0.05 ± 0.03
Soil	3.81 ± 0.69	0.23 ± 0.05
FHWMF, Wetland		
Vegetation	3.28 ± 0.45	0.06 ± 0.02
Soil	5.93 ± 1.01	0.47 ± 0.08
Vegetation	5.46 ± 0.87	0.39 ± 0.06
Soil	5.18 ± 0.93	43.9 ± 3.63
FHWMF		
Vegetation	3.3 ± 0.61	0.04 ± 0.03
Soil	6.76 ± 1.09	0.80 ± 0.11
Vegetation	4.16 ± 0.52	0.24 ± 0.03
Soil	4.63 ± 0.82	0.51 ± 0.07

Notes:
Soil results are reported as dry weight values.
Vegetation results are reported as wet weight values.
See Figure 6-6 for sample locations.
Cs-137 = cesium-137
FHWMF = Former Hazardous Waste Management Facility
K-40 = Potassium-40

outside the former HWMF fence. However, the value of 43.9 pCi/g is below the cleanup goal of 67 pCi/g established for the FHWMF. This area was not part of the CERCLA cleanup that was completed in 2005.

Since 2005, several investigations of areas of radiologically-contaminated soil surrounding the former HWMF, referred to as the former HWMF Perimeter Area, have been conducted to determine the extent and nature of contamination. These investigations identified radiological contamination along Brookhaven Avenue, within a contiguous area northeast of the former HWMF (approximately 18,750 square feet), as well as several other discrete locations within wooded areas along the perimeter of the former HWMF boundaries. The contamination is believed to be a result of historical operations associated with the transfer and management of wastes to and within the former HWMF and stormwater runoff from contaminated soils within the facility.

To date, the cleanup of identified radiological contamination surrounding the former HWMF has occurred, and was documented in two phases since being discovered in 2005 (Phase I and II). Additional discrete areas of soil contamination within the former HWMF perimeter area that were not addressed in Phase I and II investigations will be included in Phase III efforts. The area containing the 43.9 pCi/g Cs-137 is scheduled for further characterization as part of Phase III.

6.4.2 Basin Sediments

A 5-year testing cycle for basin sediment samples was established in 2003. There are 11 basins associated with outfalls that receive discharges permitted under the State Pollutant Discharge Elimination System (SPDES) permit (see Figure 5-5 for outfall locations). Basin sediments were sampled in 2012 and results are presented in Tables 6-10 through 6-12.

Although there have not been any radiological concerns with discharges to these basins, sediments were analyzed for radiological components. Samples taken from Basins CSF, HT-W, and HN-M had detectable levels of Cs-137 ranging from 0.06 pCi/g, dry weight, at Basin

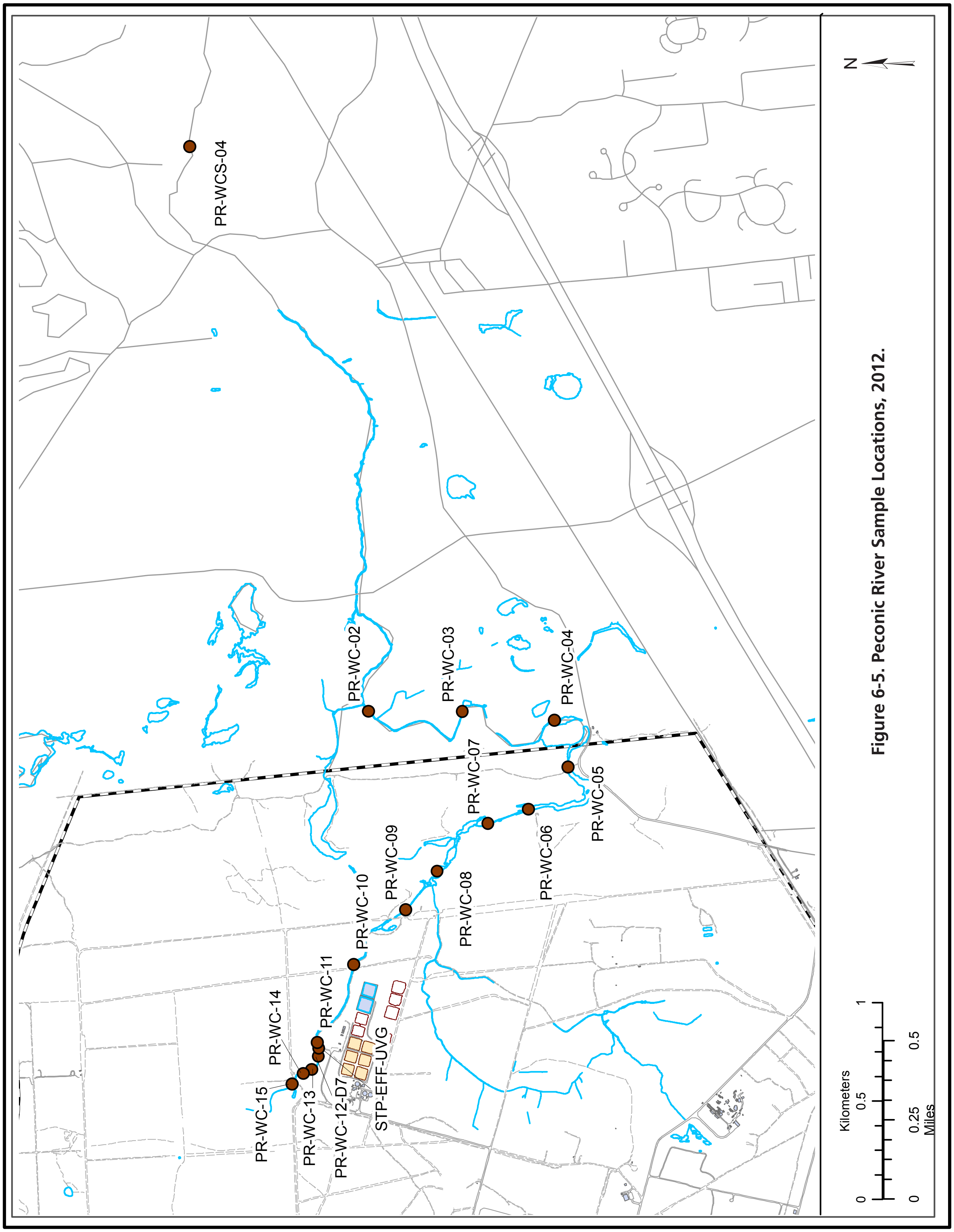


Figure 6-5. Peconic River Sample Locations, 2012.

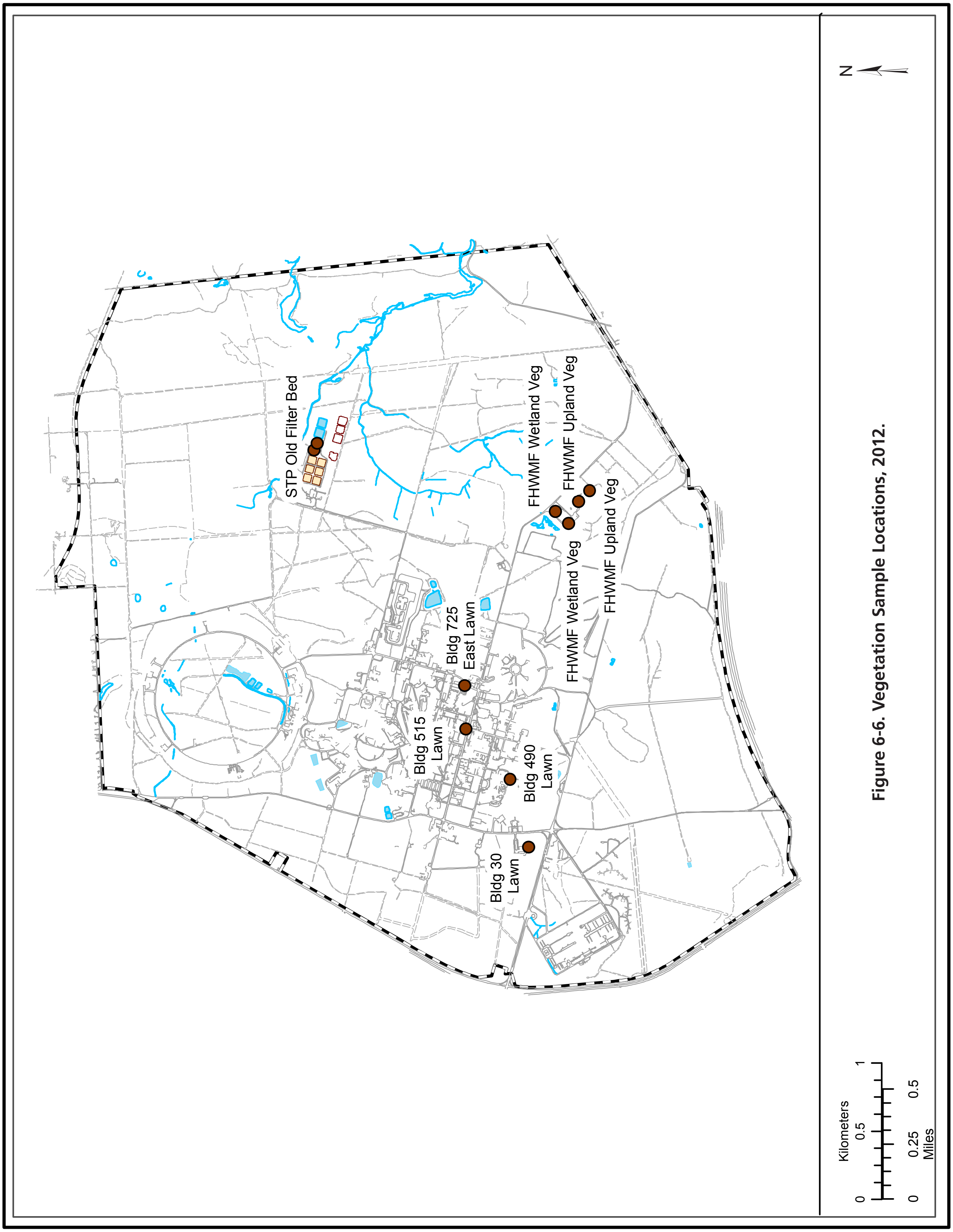


Figure 6-6. Vegetation Sample Locations, 2012.

CSF to 0.17 pCi/g, dry weight, at Basin HT-W. The other eight basins had no detectable levels. The values seen in basin sediments are consistent with historic monitoring and soil/vegetation monitoring discussed above.

Metals analysis of basin sediments is presented in Table 6-10 and data are compared to SCDHS action levels or NYSDEC recommended soil cleanup objectives (6 NYCRR Part 375-Industrial), where appropriate. Review of the data show that all metals results were less than SCDHS action levels or NYSDEC Part 375-Industrial levels, and many of the results are well within the typical background concentrations for natural soils.

Semi-volatile organic compound (SVOC) results are presented in Table 6-11. Most of the SVOC results were less than the method detection limit for several of the contaminants. Results below MDLs are not shown. With the exception of Basin HT-W, the results showed most basins to have low-level detections of SVOCs consisting mostly of polycyclic aromatic hydrocarbons (PAHs), which are petroleum breakdown products and most likely attributable to road runoff and the combustion of fossil fuels. Basin HT-W had several PAHs at higher concentrations, but below SCDHS action levels. Four PAHs were detected at concentrations ranging from two to nine times higher than SCDHS action levels. Work planning to resample and further characterize Basin HT-W was initiated at the end of 2012, with expectations for sampling in early 2013. Results of this sampling and any necessary corrective actions will be presented in the annual BNL Site Environmental Report for 2013.

PCBs analysis are presented in Table 6-12. Low levels of the pesticide DDT and its breakdown products were detected in several basins, as were breakdown products of Endrin. Detections of long-lived organochlorine pesticides, which are chlorinated hydrocarbons used extensively from the 1940s through the 1960s in agriculture and mosquito control, continue to be detected long after their use has stopped. Analysis of basin sediments for PCBs indicated the continued presence of low levels of Aroclor-1254 and 1260 from historic use at BNL, which are within the range of values previously detected in the basins. The next round of routine basin sampling will be completed in 2017.

6.4.3 Chronic Toxicity Tests

Under BNL's SPDES discharge permit, the Laboratory conducted chronic toxicity testing of STP effluents. The results of the chronic toxicity tests are discussed in Chapter 3, Section 3.6.1.1. Testing will continue in 2013.

6.4.4 Radiological and Mercury Monitoring of Precipitation

As part of the BNL Environmental Monitoring program, precipitation samples were collected quarterly at air monitoring Stations P4 and S5 (see Figure 4-3 for station locations). Samples were analyzed for radiological content and total mercury (see Table 6-13). A total of four samples were taken from each of these two stations in 2012 and tested for radiological parameters. Gross alpha activity measurements were above the MDL at P4 in the first two and last quarter of 2012, and the first quarter at S5 in 2012.

Gross beta activity was measured in samples the first two and last quarter at P4 and all four quarters at S5 in 2012. In general, radioactivity in precipitation comes from naturally occurring radionuclides in dust and from activation products that result from solar radiation. Location P4 had a maximum gross beta activity level of 6.71 pCi/L. Location S5 had a maximum gross beta activity level of 7.3 pCi/L. Gross beta activity values were within the range of historically observed values at these two locations. Beryllium-7 (Be-7) was not detected at either P4 or S5 in 2012.

Analysis of mercury in precipitation is completed to document the range of mercury deposition that occurs on site. This information is compared to Peconic River monitoring data and aids in understanding the sources of mercury within the Peconic River. Mercury was detected

Table 6-10. Metals analysis of Basin Sediments.

Basin	HW	CSF	HZ	HO	HT-E	HT-W	HS	HN-NS-1	HN-S	HN- M	HN - N	SCDHS Action Level	BNL Site Background
Metals	mg/kg												
Aluminum	2,170	4,050	2,440	1,640	5,640	1,350	5,940	947	1,940	2,640	4,170	NS	1,940-16,491
Antimony	0.29*	0.68	0.26*	0.22*	0.9	0.58*	0.36*	0.16*	0.23*	0.29*	0.15*	NS	ND-13.1
Arsenic	1.0*	2.3	1.3	1.1*	4.6	0.88*	1.5	0.27*	0.74*	0.65*	0.86*	30	0.64-1.9
Barium	11.7	30.5	10.7	25.5	57.8	15.7	19.2	3.8	6.9	10.8	18.1	4,000	4.3-37
Beryllium	0.11*	0.15	*	0.071*	0.31	0.054*	0.15	0.024*	0.049*	0.068*	0.11	240	ND-0.5
Cadmium	0.031*	1.3	0.13	0.1	1.3	0.099	0.086	0.057	0.11	0.19	0.14	40	ND-1.5
Calcium	906	4,320	465	518	5,220	1,530	601	163*	262	286	325	NS	63-580
Chromium	3.1	13.7	4.8	4.1	28.2	5.4	6.8	1.9	4.3	5	5.7	100	3.6-14.2
Cobalt	0.95	4.5	1.3	2.3	10	0.95	1.5	0.37	0.88	1.4	1.3	NS	1.1-4.1
Copper	4.2	47.5	19.3	19	251	101	8.6	7.6	20.1	40	59.6	8,500	1.8-32
Iron	2,930	8,990	4,020	4,600	13,500	3,450	5,640	1,220	3,150	3,880	4,650	NS	2,690-14,429
Lead	3.6	556	18.5	9	89.8	13.2	14.7	3	8.9	13.5	19.2	2000	1.4-32
Magnesium	582	2170	480	496	3210	791	677	209	419	626	575	NS	470-2,122
Manganese	61.3	117	37.8	299	128	29.9	42.2	11.8	24	24.6	26.9	10,000**	24-122
Mercury	0.024*	0.046	0.047	< MDL	0.081	0.022*	0.25*	< MDL	0.017*	0.031*	< MDL	3.7	0.02-0.19
Nickel	2	44.8	3.1	5.4	31.1	3.6	4.2	1.4	2.7	4.4	3.9	650	4.65-11.4
Potassium	152	290	139	132	356	122	238	77.3	112	148	169	NS	146-628
Selenium	0.51*	0.51*	0.38*	< MDL	0.93	< MDL	0.43*	< MDL	0.30*	0.19*	0.31*	6,800**	ND-0.65
Silver	< MDL	0.14*	0.043*	< MDL	0.71	0.13*	0.056*	0.018*	0.044*	0.058*	0.12*	50	ND-2
Sodium	58.6*	107*	44.2*	46.3*	407	61.3*	56.7*	17.0*	19.4*	31.6*	25.9*	NS	ND-196
Thallium	0.19*	0.12*	< MDL	< MDL	0.24B	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS	ND-0.35
Vanadium	5.2	97.2	7.1	7.4	42.7	5.5	11.4	2.4	5.8	8	9.2	NS	ND-26
Zinc	13.1	210	50.9	44.9	612	83.1	42.9	24.3	44.4	67.4	48.4	10,000**	4.9-43

Notes:
* = estimated value based on analytical laboratory qualifiers
** = No SCDHS action level listed for this metal. Value used is NYSDEC recommended soil cleanup objective (6 NYCRR Part 375 - Industrial)
MDL = Method Detection Limit
NS = value not specified
NYCRR = New York Codes, Rules, and Regulations
NYSDEC = New York State Department of Environmental Conservation
SCDHS = Suffok County Department of Health Services

Table 6-11. Analytical Results of Basin Sediment sampling for Semivolatile Organic Compounds.

Basin	HW	CSF	HZ	HO	HT-E	HT-W	HS	HN-NS-1	HN-S	HN-M	HN-N	SCDHS Action Level
Contaminants	ug/kg											
Naphthalene	< MDL	< MDL	< MDL	< MDL	< MDL	2,600	< MDL	< MDL	< MDL	< MDL	< MDL	NS
2-Methylnaphthalene	< MDL	< MDL	< MDL	< MDL	< MDL	1,400	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Acenaphthene	< MDL	< MDL	140*	< MDL	< MDL	5,800	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Dibenzofuran	< MDL	< MDL	73*	< MDL	< MDL	3,400	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Dibenzo(a,h)anthracene	< MDL	76*	180*	< MDL	94*	2,700	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Fluorene	< MDL	< MDL	140*	< MDL	< MDL	4,600	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Pyrene	230*	330*	970	160*	390*	31,000**	120*	< MDL	81*	98*	< MDL	200,000
Phenanthrene	140*	170*	1,100	110*	260*	38,000**	< MDL	< MDL	< MDL	46*	< MDL	200,000
Anthracene	< MDL	48*	240*	< MDL	68*	6,400	< MDL	< MDL	< MDL	< MDL	< MDL	200,000
Carbazole	< MDL	< MDL	170*	< MDL	55*	6,800	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Fluoranthene	320*	560	1,800	290*	700	47,000**	140*	< MDL	130*	150*	< MDL	200,000
Butyl benzyl phthalate	160*	< MDL	< MDL	< MDL	83*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Benzo(a)anthracene	170*	340*	920	130*	280*	18,000**	88*	< MDL	60*	68*	< MDL	2,000
Chrysene	150*	370	960	140*	340*	18,000**	98*	< MDL	70*	76*	< MDL	2,000
bis(2-Ethylhexyl)phthalate	71*	150*	83*	77*	430*	140*	< MDL	< MDL	< MDL	64*	< MDL	NS
Benzo(b)fluoranthene	210*	540	1,200	210*	440*	19,000**	170*	34*	100*	130*	< MDL	3,400
Benzo (k)Fluoranthene	85*	200*	440	71*	150*	5,500	60*	< MDL	42*	41*	< MDL	3,400
Benzo (a) pyrene	150*	340*	740	130*	250*	14,000**	100*	< MDL	61*	73*	< MDL	44,000
Indeno (1,2,3-cd) pyrene	150*	300*	510	110*	240*	11,000**	94*	40*	53*	58*	< MDL	16,000
Benzo (ghi) perylene	130*	310*	460	110*	300*	7,000	69*	70*	48*	55*	< MDL	200,000

Notes:
* = estimated value based on analytical laboratory parameters
** = value is based on a dilution of the original sample
MDL = method detection limit
NS = action level not specified
NYCRR = New York Codes, Rules, and Regulations
SCDHS = Suffolk County Department of Health Services

in all eight precipitation samples and at both sampling stations. Mercury ranged from 2.92 ng/L at station S5 in October to 11.6 ng/L at station P4 in July.

6.5 Wildlife Programs

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

In 2012, EPD and FERN hosted 13 interns and 2 faculty members. Two of the interns worked with a faculty member from Dowling College as part of the BNL Visiting Faculty Program (VFP) and a third student worked with a statistician, also from Dowling College.

The VFP Intern team continued ongoing work on soil microbial studies of Pine Barrens soils. The intern working with the statistician worked on a statistical analysis of 12 years' worth of migratory bird data collected as part of the Natural Resource Management program. Undergraduate interns worked on box turtle home range determination and resource use, flying squirrel radio-telemetry surveys and genetics, acoustic surveys of bats, and impact assessments of the LISF. A limited discussion concerning each project is presented below and, where possible, associated papers and posters are available at *www.bnl.gov/esd/wildlife/research.asp.*

Work associated with the LISF involved tracking 26 eastern box turtles outfitted with transmitters to determine home range sizes and use of the solar farm by turtles. Many of the turtles were captured in or near the LISF in order to determine if they utilize habitats found in the facility. None of the turtles outfitted with transmitters stayed within the confines of the solar farm. Several turtles remained in the vicinity, while others moved significant distances. By the end of the summer, many of the transmitters glued to the turtles had fallen off; the

Table 6-12. Results of Analysis of Basin Sediments for Pesticides and PCBs.

Basin	HW	CSF	HZ	HO	HT-E	HT-W	HS	HN-NS-1	HN-S	HN-M	HN-N	6 NYCRR Part 375
Pesticide/PCB	ug/kg											
Chlordane	< MDL	12*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS
4,4'-DDD	0.31*	0.37*	1.1*	< MDL	2.6*	0.39*	0.35*	< MDL	< MDL	< MDL	< MDL	NS
4,4'-DDE	1.6*	1.4*	3	0.75*	< MDL	1.8*	1.5*	< MDL	< MDL	< MDL	< MDL	NS
4,4'-DDT	1.4 *	2.0**	1.6*	< MDL	< MDL	< MDL	1.3*	< MDL	< MDL	< MDL	< MDL	NS
Endrin aldehyde	< MDL	2.2**	< MDL	0.65*	< MDL	2.2*	0.65*	< MDL	0.47*	0.60*	< MDL	NS
Endrin ketone	< MDL	< MDL	< MDL	0.51*	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	NS
Aroclor 1254	< MDL	< MDL	< MDL	< MDL	210	< MDL	23*	12*	6.6*	25*	< MDL	3,200
Aroclor 1260	< MDL	< MDL	13*	16*	62	180	12*	< MDL	6.4*	17*	< MDL	3,200

Notes:
* = estimated value based on laboratory qualifiers
** = value has greater than 40 percent difference between original and confirmation analysis results
GW = Groundwater
MDL = method detection limit
NYCRR = New York Codes, Rules, and Regulations

Table 6-13. Precipitation Monitoring (Radiological and Mercury).

Location/ Period	Be-7	Gross Alpha	Gross Beta	Mercury
	pCi/L			ng/L
P4				
01/12/12	–	–	–	4.04
01/31/12	ND	1.40± 0.69	5.4 ± 1.1	–
04/03/12	–	–	–	8.89
04/30/12	ND	1.03 ± 0.64	2.25 ± 0.82	–
07/11/12	–	–	–	11.6
07/31/12	ND	ND	ND	–
10/10/12	–	–	–	8.14
10/31/12	ND	3.6 ± 1.2	6.7 ± 1.3	–
S5				
01/12/12	–	–	–	7.4
01/31/12	ND	3.3 ± 1.0	7.3 ± 1.3	–
04/03/12	–	–	–	8.65
04/30/12	ND	ND	1.47 ± 0.75	–
07/11/12	–	–	–	9.73
07/31/12	ND	ND	2.04 ±0.77	–
10/10/12	–	–	–	2.92
10/31/12	ND	ND	2.33 ± 0.82	–

Notes:
Method detection limit for mercury is 0.2 ng/L.
– = parameter not tested on date
Bd-7 = Beryllium-7
ND = not dected
P4 = precipitation sampler near BNL Apartment area
S5 = precipitation sampler near BNL Sewage Treatment Plant

transmitters were cleaned and were either re-deployed or put into storage for re-deployment in 2013.

A second function of following turtles outfitted with transmitters was to begin to determine what foods they eat and if it affects home range, and also to determine reproductive success. Turtles will be tracked for up to 6 years to gain long-term data on home range and reproduction.

Interns also conducted surveys in and around the LISF to begin to understand the relationship and impacts of this facility on the local ecosystems. Data was gathered on paired transects for vegetation during the summer and fall growing seasons; paired small mammal trapping grids and moveable cameras were used to look at use of fence penetrations. Paired transects for vegetation allow comparison of vegetation growth and establishment inside and outside of the LISF. Interior transects were established based on vegetative assemblage that existed prior to construction. Paired trapping grids were established to compare small mammal population in the core of the facility to core habitats outside of the facility, and to compare recruitment of small mammals from the forest to the immediate interior of the solar farm (one grid on either side of the LISF fence). Wildlife cameras were placed for 2-week periods on individual openings along the fence line to document wildlife use of the fence. Initial review of photos suggests that all species expected to use the opening are doing so.

To facilitate analysis of data, placement of transects, placement of trapping grids, and placement of cameras, a summer intern conducted a GIS mapping project in which all openings were mapped and a detailed GIS map of the LISF was created.

Work on soil microbes continued in cooperation with a microbiologist from Dowling College and several students interns. Interns worked on isolating novel microbes from pine barrens soils, as well as looking at radio-resistant bacteria isolated from soils in the Gamma Forest on site to determine ecological effects of radiation on the ecosystem. The Gamma Forest was an area that was exposed to a gamma radiation source between 1961 and 1978.

A radio-telemetry study on southern flying squirrels was completed in 2012. This last year of a 3-year study looked at home range and habitat use in diverse habitats across the BNL site. Eleven squirrels were fitted with radio collars and tracked for approximately 12 weeks. In total, 26 were tracked over the 3-year study. Data continues to be reviewed in order to prepare a manuscript for publication. When possible, cheek swabs were taken to continue a genetic study of this cryptic species. Initial results of mitochondrial DNA suggest significant variance in the squirrel's genetics. To get a better understanding of this variation, BNL and others will seek genetic material from museum specimens, as well as new materials from limited trapping events in 2013 and beyond.

In early March 2011, an individual bat was found on the ground outside a building at BNL.

The bat appeared to have discoloration on the fur around its muzzle, which triggered a call to NYSDEC to report a possible incidence of white-nose syndrome. White-nose syndrome is a recently identified fungal infection impacting bats throughout the northeast and Midwest. The bat was identified as northern bat (*Myotis septentrionalis*) and was the first recorded incidence of white-nose syndrome on Long Island. This event resulted in BNL working with NYSDEC to establish permanent acoustical survey routes on Long Island. These survey routes were again monitored in 2012, and the Laboratory worked with a bat specialist to capture and document bats on site and at the Wertheim National Wildlife Refuge using mist-netting. BNL work also allowed comparison of bat use between burned and unburned areas associated with the April 2012 wildfire on site and between the LISF and forested areas to the north of the facility. Results from mist netting suggest that bat populations on Long Island have not been as severely impacted as those in other areas of the northeast. This raises several questions as to why the impacts are less.

Members of EPD and other Laboratory departments volunteered as speakers for schools and civic groups and provided on-site ecology tours. EPD also hosted several environmental events in association with Earth Day. In October, BNL hosted the Seventeenth Annual Pine Barrens Research Forum for ecosystems researchers to share and discuss their results. BNL and FERN participated in the Third Annual Pine Barrens Discovery Day held in association with the Tri-Hamlet Celebration at the Wertheim National Wildlife Refuge. In addition, BNL and several environmental groups began working together to develop the Long Island Nature Organization (*www.longislandnature.org*) and hosted the first annual Long Island Natural History conference in November.

The Laboratory also hosted 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. Post-fire monitoring of the April wildfire indicated that prescribed fires have been somewhat effective at reducing fuel loads and reducing fire severity of wildfire. BNL intends to continue the use of prescribed fire for fuel and forest management in the future, and is working with NYSDEC to prepare additional prescriptions for a larger portion of the northern and eastern sections of the Laboratory property.

6.6 CULTURAL RESOURCE ACTIVITIES

The BNL Cultural Resource Management (CRM) Program ensures that the Laboratory fully complies with numerous cultural resource regulations. The Cultural Resource Management Plan for Brookhaven National Laboratory (BNL 2005) guides the management of all of the Laboratory's historical resources. Along with achieving compliance with applicable regulations, one of the major goals of the CRM program is to fully assess both known and potential cultural resources. The range of the BNL's cultural resources includes buildings and structures, World War I (WWI) earthwork features, the Camp Upton Historical Collection, scientific equipment, photo/audio/video archives, and institutional records. As various cultural resources are identified, plans for their long-term stewardship are developed and implemented. Achieving these goals will ensure that the contributions BNL and the site have made to our history and culture are documented and available for interpretation.

The Laboratory has three structures or sites that have been determined to be eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor (BGRR) complex, the High Flux Beam Reactor (HFBR) complex, and the WWI training trenches associated with Camp Upton. The trenches are examples of the few surviving WWI earthworks in the United States.

In 2012, BNL completed revisions to the CRMP and prepared the plan for submission to the New York State Historic Preservation Office for review. Other cultural resource activities conducted in 2012 included the loan of the

"Atoms for Peace" art work, a BGRR model, and period material from the 1950s to the Long Island Museum located in Stony Brook, New York for a display titled "Long Island America's 1950s Frontier; a presentation of the history of the BNL site to the Bellport Historical Society; and a talk on the natural history of the BNL site with a focus on the historical aspects of human use of the site given at the First Annual Natural History Conference.

In October 2012, the American Chemical Society's NY Section named the BNL Chemistry Building (Building 555) a Historical Chemical Landmark. This designation was presented during a ceremony at the facility along with several talks presented in the Hamilton Seminar room located in the building. The designation was given in recognition to the significant contribution by BNL scientists for the development of 18FDG, the first successful radiotracer for positron emission tomography that continues to be used worldwide for brain research and cancer diagnosis.

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Groundwater Protection

7

Brookhaven National Laboratory has implemented aggressive pollution prevention measures to protect groundwater resources. An extensive groundwater monitoring well network is used to verify that prevention and restoration activities are effective. During 2012, BNL collected groundwater samples from 796 permanent monitoring wells and 44 temporary wells during 1,791 individual sampling events. Twelve groundwater remediation systems removed 239 pounds of volatile organic compounds (VOCs) and returned approximately 1.5 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 6,948 pounds of VOCs by treating nearly 21 billion gallons of groundwater. During 2012, two groundwater treatment systems removed approximately 1.9 millicuries of strontium-90 (Sr-90) while remediating approximately 15 million gallons of groundwater. Since 2003, BNL has removed approximately 27 millicuries of Sr-90 from the groundwater while remediating 104 million gallons of groundwater.

7.1 THE BNL GROUNDWATER PROTECTION MANAGEMENT PROGRAM

The primary goal of BNL's Groundwater Protection Program is to ensure that plans for groundwater protection, management, monitoring, and restoration are fully defined, integrated, and managed in a manner that is consistent with federal, state, and local regulations. The program helps to fulfill the environmental monitoring requirements outlined in various New York State operating permits, DOE Order 458.1, Radiation Protection of the Public and Environment, and DOE Order 436.1, Departmental Sustainability. This program also satisfies the requirements of several Comprehensive Environmental Response, Compensation and Liability (CERCLA) Records of Decision (RODs). The program consists of four interconnecting elements: 1) preventing pollution of the groundwater, 2) monitoring the effectiveness of engineered and administrative controls at operating facilities, 3) restoring the environment by cleaning up contaminated soil and groundwater, and 4) communicating with stakeholders on groundwater protection issues. The Laboratory is committed to protecting groundwater resources from further chemical and radionuclide releases, and to remediate existing contaminated groundwater.

7.1.1 Prevention

As part of BNL's Environmental Management System, the Laboratory has implemented a number of pollution prevention activities that are designed to protect groundwater resources (see Chapter 2). BNL has established a work control program that requires the assessment of all experiments and industrial operations to determine their potential impact on the environment. The program enables the Laboratory to integrate pollution prevention and waste minimization, resource conservation, and compliance into planning and decision making. Efforts have been implemented to achieve or maintain compliance with regulatory requirements and to implement best management practices designed to protect groundwater (see Chapter 3). Examples include upgrading underground storage tanks, closing cesspools, adding engineered controls (e.g., barriers to prevent rainwater infiltration that could move contaminants out of the soil and into groundwater), and administrative controls (e.g., reducing the toxicity and volume of chemicals in use or storage). BNL's comprehensive groundwater monitoring program is used to confirm that these controls are working.

7.1.2 Monitoring

The Laboratory's groundwater monitoring network is designed to evaluate the impacts of groundwater contamination from former and current operations and to track cleanup progress. Each year, BNL collects groundwater samples from an extensive network of on- and off-site monitoring wells. Results from groundwater monitoring are used to verify that protection and restoration efforts are working. Groundwater monitoring is focused on two general areas: 1) Facility Monitoring, designed to satisfy DOE and New York State monitoring requirements for active research and support facilities, and 2) CERCLA monitoring related to the Laboratory's obligations under the Federal Facilities Agreement (FFA). These monitoring programs are coordinated to ensure completeness and to prevent duplication of effort in the installation, monitoring, and decommissioning of wells. The monitoring program elements include data quality objectives; plans and procedures; sampling and analysis; quality assurance; data management; and the installation, maintenance, and decommissioning of wells. These elements are integrated to create a cost-effective monitoring system and to ensure that water quality data are available for review and interpretation in a timely manner.

7.1.3 Restoration

BNL was added to the National Priorities List in 1989. To help manage the restoration effort, 32 separate Areas of Concern (AOC) were grouped into six Operable Units (OUs). Remedial actions have been implemented for each OU, and the focus is currently on operating and maintaining cleanup systems. Contaminant sources (e.g., contaminated soil and underground storage tanks) have been removed or remediated to prevent further contamination of groundwater. All remediation work is carried out under the FFA involving EPA, the New York State Department of Environmental Conservation (NYSDEC), and DOE.

7.1.4 Communication

BNL's Community Education, Government and Public Affairs Office ensures that the Laboratory communicates with its stakeholders in a consistent, timely, and accurate manner. A number of communication mechanisms are in place, such as press releases, web pages, mailings, public meetings, briefings, and roundtable discussions. Specific examples include routine meetings with the Community Advisory Council and the Brookhaven Executive Roundtable (see Chapter 2, Section 2.4.2). Quarterly and annual technical reports that summarize data, evaluations, and program indices are prepared. In addition, The Laboratory has developed a Groundwater Protection Contingency Plan (BNL 2008) that provides formal processes to promptly communicate off-normal or unusual monitoring results to BNL management, DOE, regulatory agencies, and other stakeholders, including the public and employees.

7.2 GROUNDWATER PROTECTION PERFORMANCE

BNL has made significant investments in environmental protection programs over the past 15 years and continues to make progress in achieving its goal of preventing new groundwater impacts and to remediate previously contaminated groundwater. No new impacts to groundwater quality were discovered during 2012. The Laboratory will continue efforts to prevent new groundwater impacts and is vigilant in measuring and communicating its performance.

7.3 GROUNDWATER MONITORING PROGRAMS

Elements of the groundwater monitoring program include installing monitoring wells; planning and scheduling; developing and following quality assurance procedures; collecting and analyzing samples; verifying, validating, and interpreting data; and reporting. Monitoring wells are used to evaluate BNL's 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. The groundwater beneath the site is classified by New York State as Class GA groundwater, which is defined as a source of potable water. Federal drinking water standards (DWS), New York State DWS, and New York State Ambient Water Quality Standards (NYS AWQS) for Class GA groundwater are used as goals for groundwater protection and remediation. BNL evaluates the potential impact of radiological and nonradiological contamination by comparing analytical results to the standards. Contaminant concentrations that are below the standards are also compared to background values to evaluate the potential effects of facility operations. The detection of low concentrations of facility-specific volatile organic compounds (VOCs) or radionuclides may provide important early indications of a contaminant release and allow for timely identification and remediation of the source.

Groundwater quality at BNL is routinely monitored through a network of approximately 800 on- and off-site wells (see SER Volume II, Groundwater Status Report, for details). In addition to water quality assessments, water levels are routinely measured in more than 775 on- and off-site wells to assess variations in the direction and velocity of groundwater flow. Groundwater flow directions in the vicinity of the Laboratory are shown in Figure 7-1.

The following active BNL facilities have groundwater monitoring programs: the Sewage Treatment Plant (STP), Waste Management Facility (WMF), Major Petroleum Facility (MPF), Alternating Gradient Synchrotron (AGS), Relativistic Heavy Ion Collider (RHIC), National Synchrotron Light Source II (NSLS-II), and several vehicle maintenance and petroleum storage facilities. Inactive facilities include the former Hazardous Waste Management Facility (HWMF), two former landfill areas, Waste Concentration Facility (WCF), Brookhaven Graphite Research Reactor (BGRR), High Flux Beam Reactor (HFBR), and the Brookhaven Medical Research Reactor (BMRR). Maps showing the main VOC and radionuclide plumes are provided as Figures 7-2 and 7-3, respectively.

7.4 GROUNDWATER MONITORING RESULTS

During 2012, the Facility Monitoring program monitored 134 wells during 230 individual sampling events. Forty-four temporary wells were also installed as part of this program. No new impacts to groundwater quality were discovered during the year. The CERCLA groundwater monitoring program monitored 662 monitoring wells during 1,561 individual groundwater sampling events. Thirty-three temporary wells were also installed as part of this program. Detailed descriptions and maps related to the groundwater monitoring programs can be found in SER Volume II, Groundwater Status Report.

Highlights of the groundwater monitoring programs for 2012 include:

- Groundwater monitoring results for 2012 indicate that there has been significant progress in remediating groundwater contamination in a number of on- and off-site areas. As noted in Section 7.5, BNL will submit Petitions for Shutdown to the regulatory agencies for four groundwater treatment systems and a Petition for Closure (decommissioning) for one system.
- Proposed remedial actions were documented in an Explanation of Significant Differences under the OU III ROD (BNL 2012) for the Building 452 Freon-11 plume discovered in 2011. During 2012, approximately 71 pounds of Freon-11 were removed from the aquifer, and significant reductions in Freon-11 concentrations were observed in the source area and downgradient portions of the plume. Compared to 2011, when Freon-11 concentrations up to 38,000 µg/L were detected in source area wells, concentrations decreased to less than 1,150 µg/L by November 2012. The detection of low levels of Freon-11 in Building 96 treatment well RTW-2 indicates that

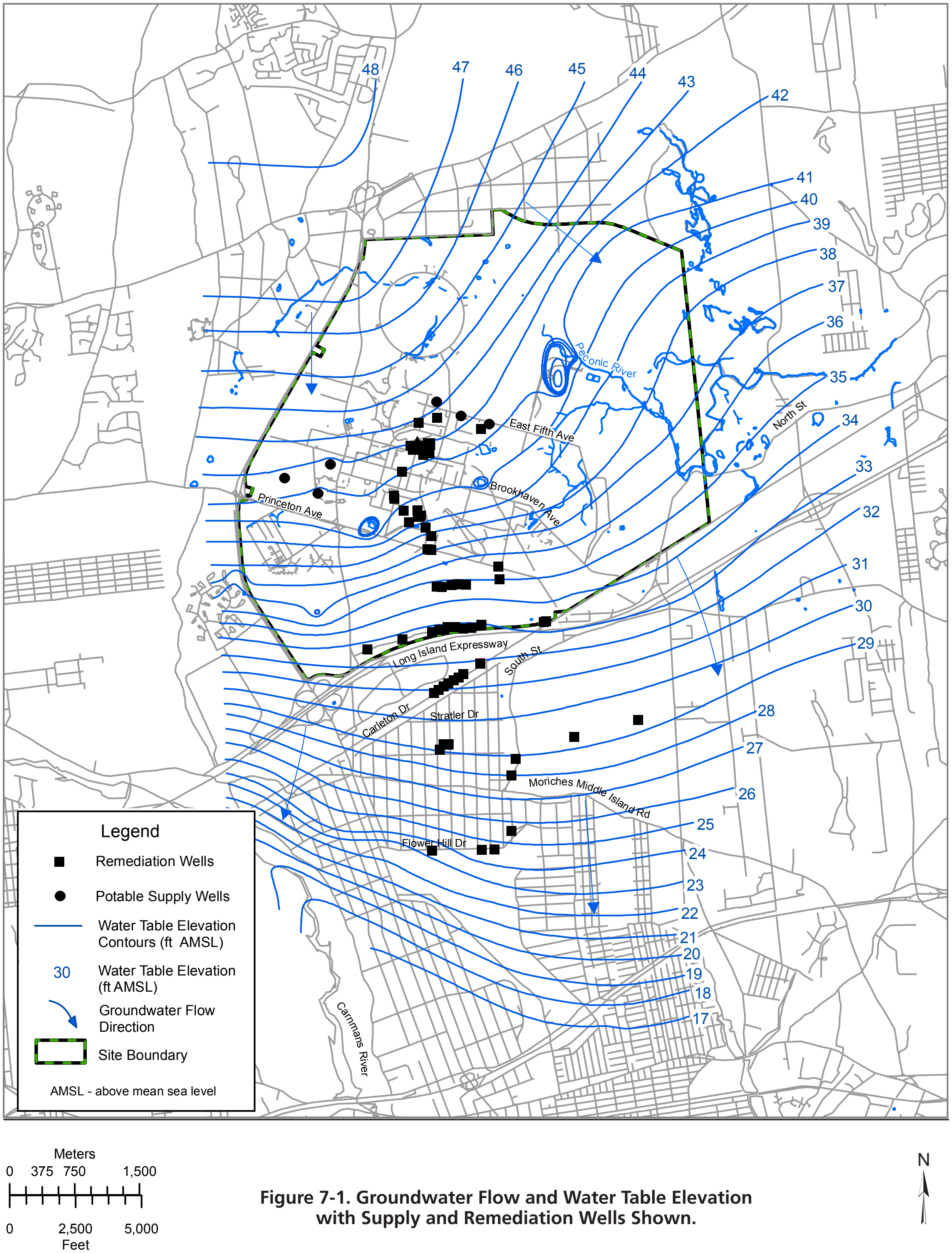

Figure 7-1. Groundwater Flow and Water Table Elevation with Supply and Remediation Wells Shown.

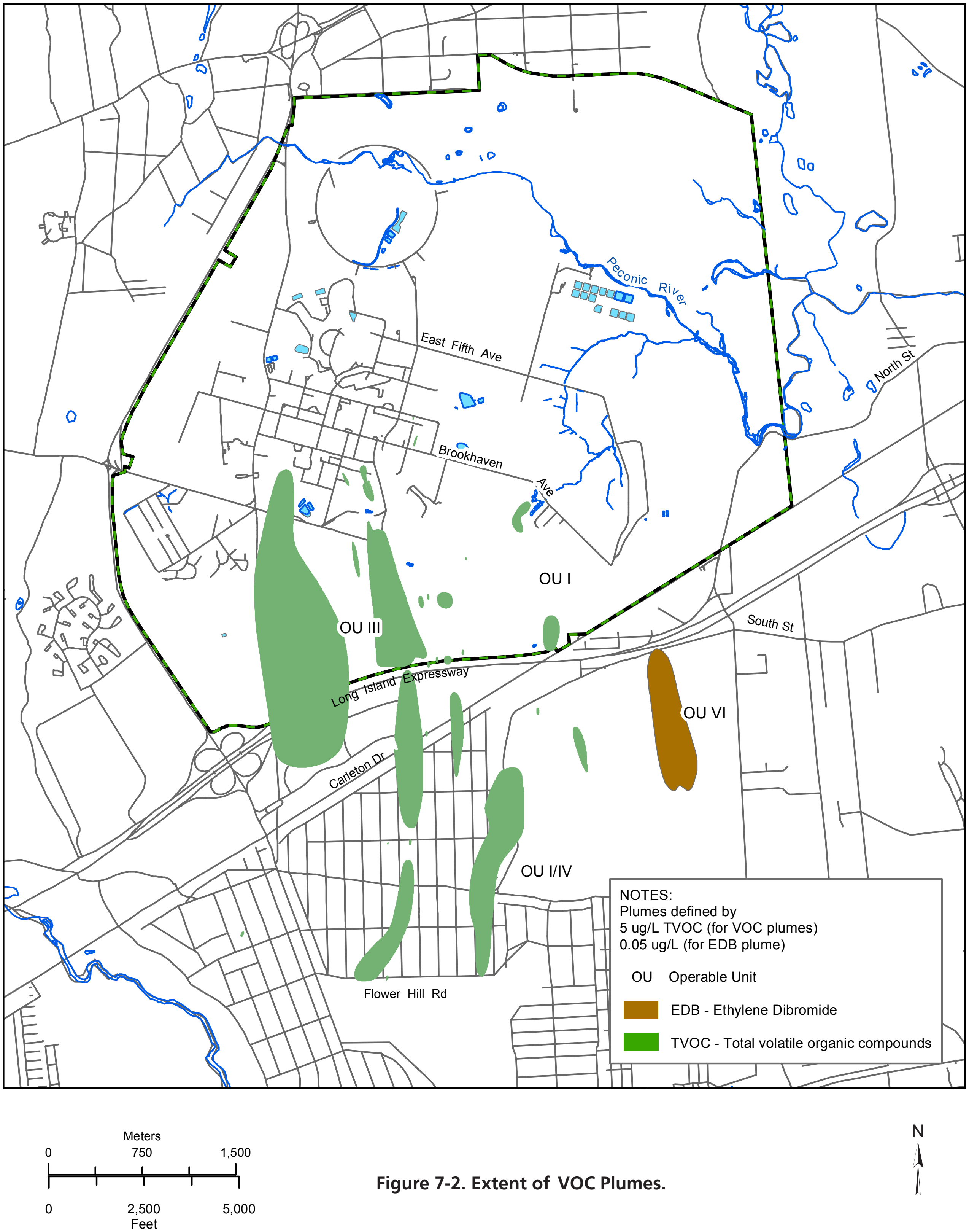

Figure 7-2. Extent of VOC Plumes.

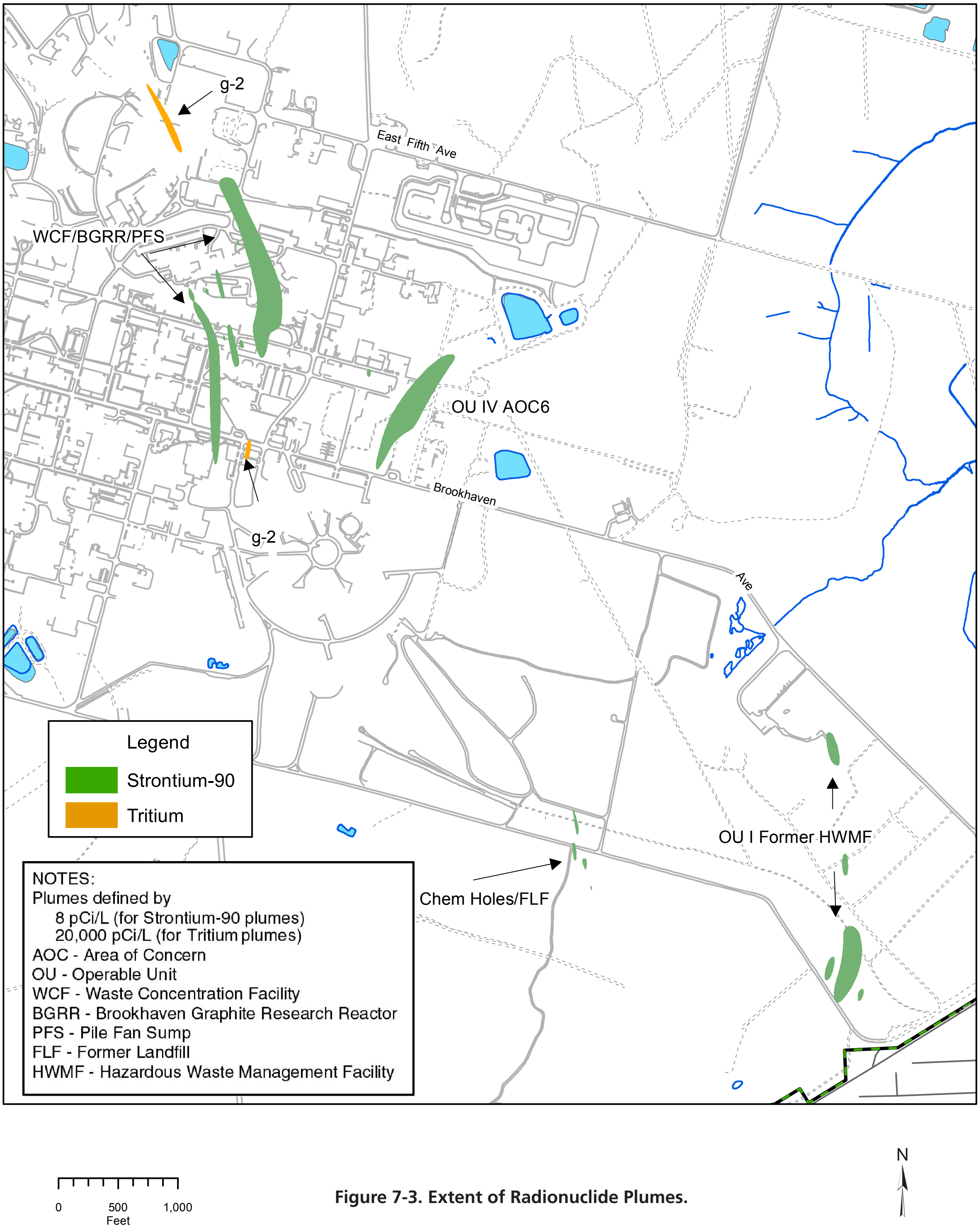

Figure 7-3. Extent of Radionuclide Plumes.

the southward migration of Freon-11 was greater than identified during the 2011 characterization of the plume.

- The OU III South Boundary Treatment System was modified in 2012 to include the addition of a new extraction well. The new extraction well has been effective in capturing and treating VOC contamination in the deep Upper Glacial aquifer at the site boundary. The extent to which these deeper VOCs have migrated off-site will be evaluated during 2013.
- Significant reductions in VOC concentrations have been observed in the Building 96 source area monitoring wells following the 2010 excavation of contaminated source area soils. In a monitoring well located immediately downgradient of the excavation, total VOC concentrations decreased from a maximum of 2,435 µg/L in early 2011, to 161 µg/L in late 2012.
- Although all VOC concentrations in the OU V monitoring wells were below the DWS from 2008 through 2010, trichloroethylene (TCE) was detected at slightly above the 5 µg/L standard in a single off-site monitoring well (000-122) during 2011 and 2012. A petition to conclude the OU V monitoring program was approved by the regulatory agencies in 2012, and it was proposed to continue monitoring this single well on an annual basis (BNL 2012b).
- Following the 2010 detection of Sr-90 concentrations up to 491 pCi/L in the groundwater immediately downgradient of the BGRR, Sr-90 levels were significantly lower during 2011 and 2012, with concentrations dropping to less than 10 pCi/L by December 2012. Continued monitoring is required to determine the long-term effectiveness of the engineered cap installed in 2011. The cap is designed to prevent rainwater infiltration into the contaminated soils below the BGRR.
- Tritium concentrations in the groundwater immediately downgradient of the HFBR remained below the 20,000 pCi/L DWS during 2012.
- The HFBR Pump and Recharge system was operational during all of 2012. Monitoring data for 2010 through 2012 indicate that tritium concentrations in the downgradient segment of the plume have remained below the 20,000 pCi/L DWS. A petition for shutdown of the pump and recharge system will be prepared in early 2013.
- Tritium continues to be detected in the g-2 source area monitoring wells at concentrations above the 20,000 pCi/L DWS, with a maximum concentration of 88,200 pCi/L in January 2012. By October 2012, the maximum tritium concentration was 37,700 pCi/L. The overall reduction in tritium concentrations observed over the past 10 years indicates that the engineered stormwater controls are effectively protecting the activated soil shielding at the source area.
- As a result of natural radioactive decay and dispersion in the aquifer, the downgradient portion of the g-2 tritium plume has been reduced to several hundred feet in length, and is presently located entirely south of the NSLS facility. During 2012, the highest observed tritium concentration was 50,000 pCi/L in a temporary well installed immediately south of Brookhaven Avenue. Because the plume segment has migrated south of Brookhaven Avenue, a ROD contingency action was triggered in late 2011. In response, a plan was developed to monitor this plume segment on a more frequent basis (DOE 2012). Tritium concentrations in the small plume segment are expected to naturally attenuate to less than the 20,000 pCi/L DWS within several years.
- Since April 2006, all tritium concentrations in the Brookhaven Linear Isotope Producer (BLIP) facility surveillance wells have been less than the 20,000 pCi/L DWS. The maximum tritium concentration during 2012 was 4,360 pCi/L. These results indicate that the engineered stormwater controls are effectively protecting the activated soil shielding.
- At the on-site Upton Service Station, VOCs associated with petroleum products and the solvent tetrachloroethylene (PCE) continue to be detected in the groundwater directly downgradient of the facility. Total

VOC concentrations in one well reached 269 µg/L; with the contamination consisting mostly of xylenes, ethylbenzene, and trimethylbenzenes. Groundwater monitoring results indicate that the petroleum-related compounds break down within a short distance from the facility. Monitoring of the leak detection systems at the Upton Service Station indicates that the gasoline storage tanks and associated distribution lines are not leaking, and all waste oils and used solvents are being properly stored and recycled. Therefore, it is believed that the contaminants detected in groundwater originate from historical vehicle maintenance activities and are not related to current operations.

7.5 GROUNDWATER TREATMENT SYSTEMS

The primary mission of the CERCLA program is to operate and maintain groundwater treatment systems and prevent additional groundwater contamination from migrating off site. The cleanup objectives will be met by a combination of active treatment and natural attenuation. The specific cleanup goals are as follows:

- Achieve maximum contaminant levels (MCLs) for VOCs in the Upper Glacial aquifer by 2030
- Achieve MCLs for VOCs in the Magothy aquifer by 2065
- Achieve MCLs for Sr-90 at the BGRR in the Upper Glacial aquifer by 2070
- Achieve MCLs for Sr-90 at the Chemical Holes in the Upper Glacial aquifer by 2040

During 2012, BNL continued to make significant progress in restoring groundwater quality. Figure 7-4 shows the locations of 14 groundwater treatment systems currently in operation. Table 7-1 provides a summary of the amount of VOCs and Sr-90 removed from the aquifer since the start of active remediation in December 1996. During 2012, approximately 239 pounds of VOCs and approximately 1.9 mCi of Sr-90 were removed from the groundwater, and approximately 1.5 billion gallons of treated groundwater were returned to the aquifer.

To date, 6,948 pounds of VOCs have been removed from the aquifer and noticeable improvements in groundwater quality are evident in a number of on- and off-site areas. Furthermore, two of the treatment systems have removed approximately 27 mCi of Sr-90. Based on progress that has been made to remediate groundwater contamination, in early 2013, Petitions for Shutdown will be submitted to the regulatory agencies for the OU I South Boundary System, Industrial Park System, North Street System, and the HFBR Pump and Recharge System. In addition, a Petition for Closure will be submitted for the Industrial Park East System. Detailed information on the groundwater treatment systems can be found in SER Volume II, Groundwater Status Report.

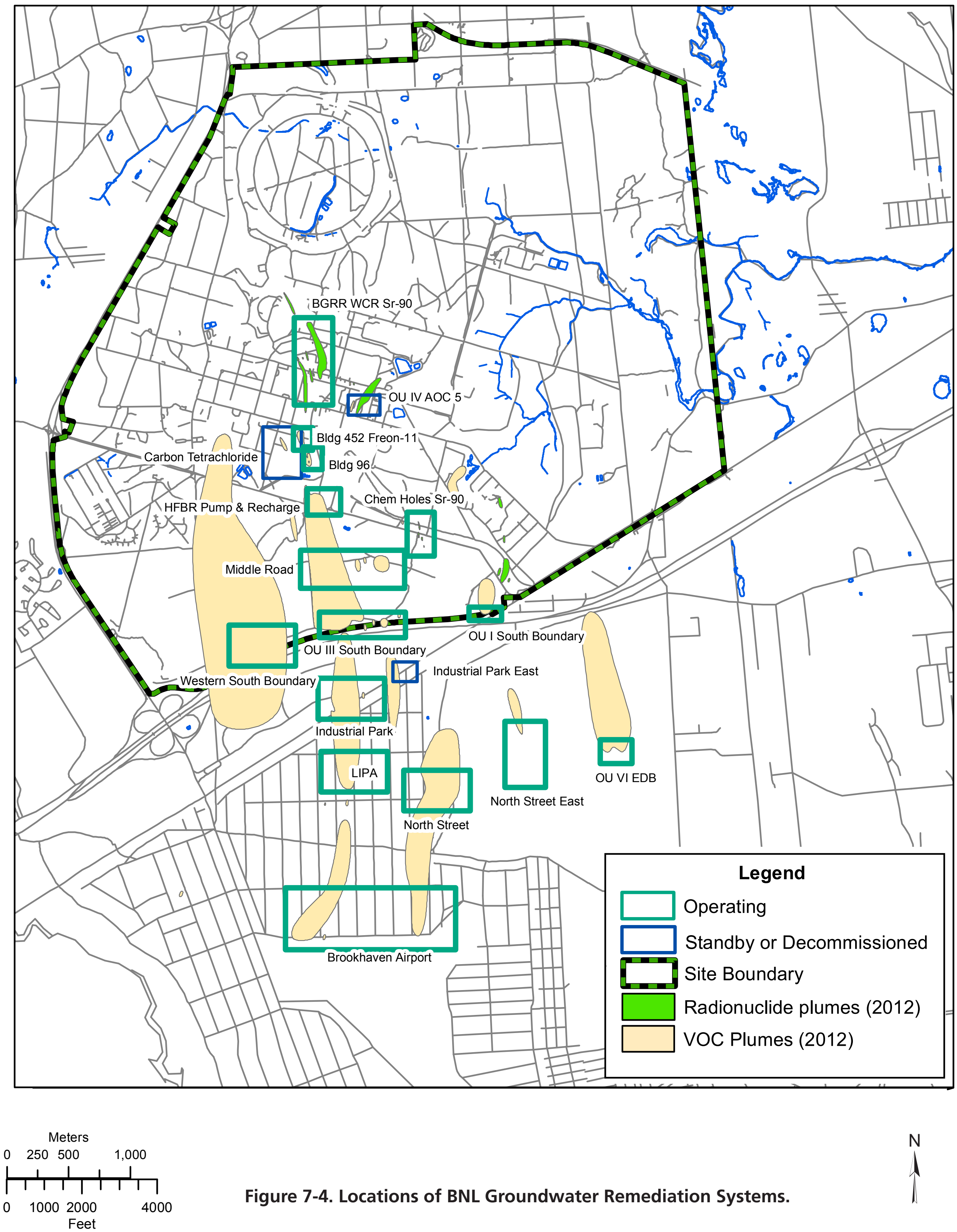

Figure 7-4. Locations of BNL Groundwater Remediation Systems.

Table 7-1. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2012.

Remediation System	Start Date	1997-2011		2012	
		Water Treated (Gallons)	VOCs Removed (Pounds) (e)	Water Treated (Gallons)	VOCs Removed (Pounds) (e)
OU I South Boundary	12/1996	3,853,732,000	363	112,201,000	5
OU III HFBR Tritium Plume (a)	05/1997	537,129,000	180	74,311,000	0
OU III Carbon Tetrachloride (d)	10/1999	153,538,075	349	Decommissioned	0
OU III Building 96	01/2001	248,822,416	108	44,292,000	9
OU III Middle Road	10/2001	1,859,388,550	971	243,376,000	55
OU III South Boundary	06/1997	3,690,854,850	2,834	223,969,000	66
OU III Western South Boundary	09/2002	911,116,000	92	125,245,000	12
OU III Industrial Park	09/1999	1,740,962,330	1,057	112,011,000	2
OU III Industrial Park East	06/2004	357,192,000	38	0	0
OU III North Street	06/2004	1,179,193,000	321	122,441,000	5
OU III North Street East	06/2004	683,772,000	38	100,663,000	3
OU III LIPA/Airport	08/2004	1,621,542,000	323	211,336,000	11
OU III Building 452 Freon-11	03/2012	0	0	26,812,000	71
OU IV AS/SVE (b)	11/1997	(c)	35	Decommissioned	0
OU VI EDB	10/2004	960,709,000	(f)	129,133,000	(f)
Total		**19,295,173,221**	**6,709**	**1,525,790,000**	**239**

Remediation System	Start Date	2003–2011		2012	
		Water Treated (Gallons)	Sr-90 Removed (mCi)	Water Treated (Gallons)	Sr-90 Removed (mCi)
OU III Chemical Holes Sr-90	02/2003	38,162,826	4.4	6,673,000	0.18
OU III BGRR/WCF Sr-90	06/2005	51,563,000	21.2	8,019,000	1.7
Total		**89,725,826**	**25.6**	**14,692,000**	**1.88**

Notes:
(a) System was reactivated in late 2007 as a contingency action.
(b) System was shut down on January 10, 2001 and decommissioned in 2003.
(c) Air Sparging/Soil Vapor Extraction (AS/SVE) system performance was measured by pounds of VOCs removed per cubic feet of air treated.
(d) System was shut down and placed in standby mode in August 2004 and decommissioned in 2009.
(e) Values are rounded to the nearest whole number.
(f) Because EDB has only been detected at trace levels in the treatment system influent, no removal of VOCs is reported.

BGRR = Brookhaven Graphite Research Reactor
EDB = ethylene dibromide
HFBR = High Flux Beam Reactor
LIPA = Long Island Power Authority
OU = Operable Unit
VOCs = volitile organic compounds
WCF = Waste Concentration Facility

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8 Radiological Dose Assessment

BNL's annual radiological dose assessment assures stakeholders that on-site facilities and BNL operations are in compliance with federal, state, and local regulations, and that the public is protected. The potential radiological dose to members of the public is calculated at an off-site location closest to emission source as the maximum dose that could be received by an off-site individual defined as the "maximally exposed off-site individual" (MEOSI). Based on MEOSI dose calculation criteria, members of the public will receive a dose less than the MEOSI, under all circumstances. 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. The 2012 Total Effective Dose (TED) 2.55 mrem (26 µSv) 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 was estimated as 2.35E-01 mrem (2.4 µSv) to the MEOSI. The dose from the ingestion pathway was estimated as 2.21 mrem (22 µSv) from the consumption of deer meat and 1.0E-01 mrem (1.0 µSv) from the consumption of fish caught in the vicinity of the Laboratory. The total annual dose to the MEOSI from all pathways was estimated as 2.55 mrem (26 µSv). The BNL dose from the inhalation pathway was approximately 3 percent of EPA's annual regulatory dose limit of 10 mrem (100 µSv). The total dose from all environmental pathways was less than 3 percent of DOE's annual dose limit of 100 mrem (1,000 µSv). The population dose was 6.22 person-rem for approximately 6 million persons residing within a 50-mile radius of the Laboratory.

Dose to the maximally exposed on-site individual outside of the controlled areas would be from skyshine radiation from Building 356; the dose was calculated to be 18 mrem above the natural background radiation. The average annual on-site external dose from ambient sources was 68 ± 12 mrem (680 ± 120 µSv) and 62 ± 10 mrem (620 ± 100 µSv) at off-site locations. Both on- and off-site external dose measurements include the contribution from natural terrestrial and cosmic background radiation. A statistical comparison of the average doses measured using 49 on-site thermoluminescent dosimeters (TLDs) and 12 off-site TLDs showed that there was no external dose contribution from BNL operations distinguishable from the natural background radiation level. An additional nine TLDs were used to measure on-site areas known to have radiation dose slightly above the natural background radiation. The results of these measurements are discussed in Section 8.1.2.

Doses to aquatic and terrestrial biota were also evaluated and found to be minuscule and well below DOE regulatory limits. Other short-term projects, such as remediation work and waste management disposal activities, were assessed for radiological emissions; the potential dose from each of these activities was below regulatory limits; thus, there was minimal radiological risk to the public, workers, or the environment. In summary, the overall dose impact from all Laboratory activities in 2012 was comparable to natural background radiation levels.

8.0 INTRODUCTION

This chapter discusses the dose risk consequences from research activities, radiation-generating devices, facilities, and minor bench-top radiation sources at BNL. It is important to understand the health impacts of radiation to the public and workers, as well as radiation effects to the environment, fauna, and flora. The Laboratory's routine operations, scientific experiments, and new research projects are evaluated for their radiological dose risk. The dose risks from decommissioned facilities and decontamination work were also evaluated for dose impact. All environmental pathway scenarios that can give a dose to humans, aquatic life, plants, and animals are evaluated to calculate the dose risks on site. Because all research reactors at BNL have been shut down, defueled, or fully decommissioned, there is no dose risk from these facilities. The Laboratory's current radiological risks are from very small quantities of radionuclides used in the small sciences, radiopharmaceuticals produced at the Brookhaven Linear Isotope Facility (BLIP), and the BNL accelerators: Alternating Gradient Synchrotron (AGS), Relativistic Heavy Ion Collider (RHIC), National Synchrotron Light Source (NSLS), and the future National Synchrotron Light Source II (NSLS-II), which may begin start-up operations in 2014. The radiological dose assessments are performed to ensure that dose risks from all Laboratory operations meet regulatory requirements and remain "As Low As Reasonably Achievable" (ALARA) to members of the public, workers, and the environment.

8.1 DIRECT RADIATION MONITORING

A direct radiation-monitoring program is used to measure the external dose contribution to the public and workers from radiation sources at BNL. This is achieved by measuring direct penetrating radiation exposures at both on- and off-site locations. The direct measurements taken at the off-site locations are with the premise that off-site exposures represent true natural background radiation (with contribution from both cosmic and terrestrial sources) and represent no contribution from Laboratory operations. On- and off-site external dose measurements were averaged and then compared using the statistical t-test to assess the contribution, if any, from Laboratory operations.

8.1.1 Ambient Radiation Monitoring

To assess the dose impact of direct radiation from BNL operations, TLDs are deployed on site and in the surrounding communities. On-site TLD locations are determined based on the potential for exposure to gaseous plumes, atmospheric particulates, scattered radiation, and the location of radiation-generating devices. The Laboratory perimeter is also posted with TLDs to assess the dose impact, if any, beyond the site's boundaries. On- and off-site locations are divided into grids, and each TLD is assigned an identification code based on the grids.

In 2012, a total of 58 environmental TLDs were deployed on site, of which 9 were placed in known radiation areas. Another 12 TLDs were deployed at off-site locations (see Figures 8-1 and 8-2 for locations). An additional 30 TLDs were stored in a lead-shielded container for use as reference and control TLDs for comparison purposes. The average of the control TLD values, reported as "075-TLD4" in Tables 8-1 and 8-2, was 40 ± 7 mrem. This dose accounts for any small "residual" dose not removed during the annealing process and the natural background and cosmic radiation sources that are not completely shielded. The on- and off-site TLDs were collected and read quarterly to determine the external radiation dose measured.

Table 8-1 shows the quarterly and yearly on-site radiation dose measurements for 2012. The on-site average external doses for the first through fourth quarters were 17.9 ± 4.9, 15.2 ± 3.1, 15.2 ± 3.3, and 19.6 ± 3.3 mrem, respectively. The on-site average annual external dose from all potential environmental sources, including cosmic and terrestrial radiation sources, was 68 ± 12 mrem (680 ± 120 µSv).

Table 8-2 shows the quarterly and yearly off-site radiation dose measurements for 2012. The off-site average external doses for the first through fourth quarters were 16.5 ± 3.4, 14.0 ± 2.1, 14.4 ± 2.5, and 16.6 ± 4.9 mrem, respectively. The off-site average annual ambient dose

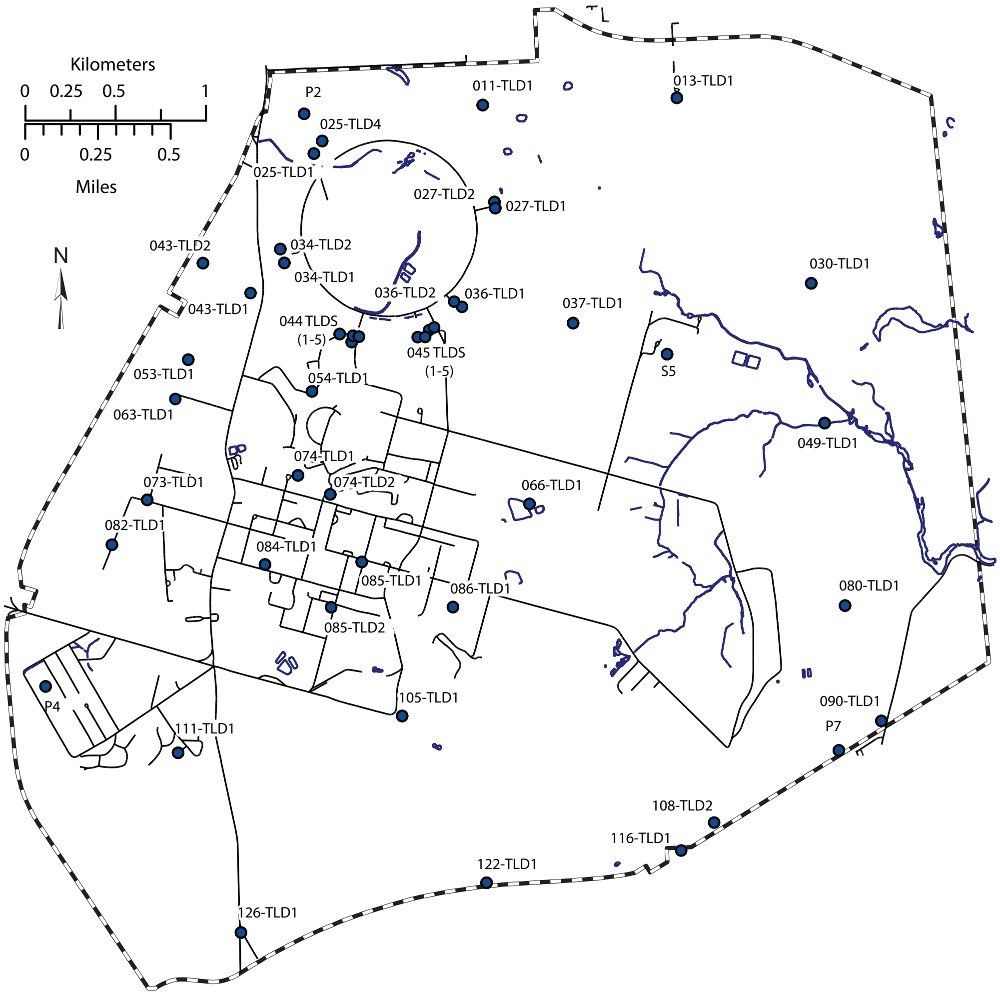


Figure 8-1. On-Site TLD Locations.

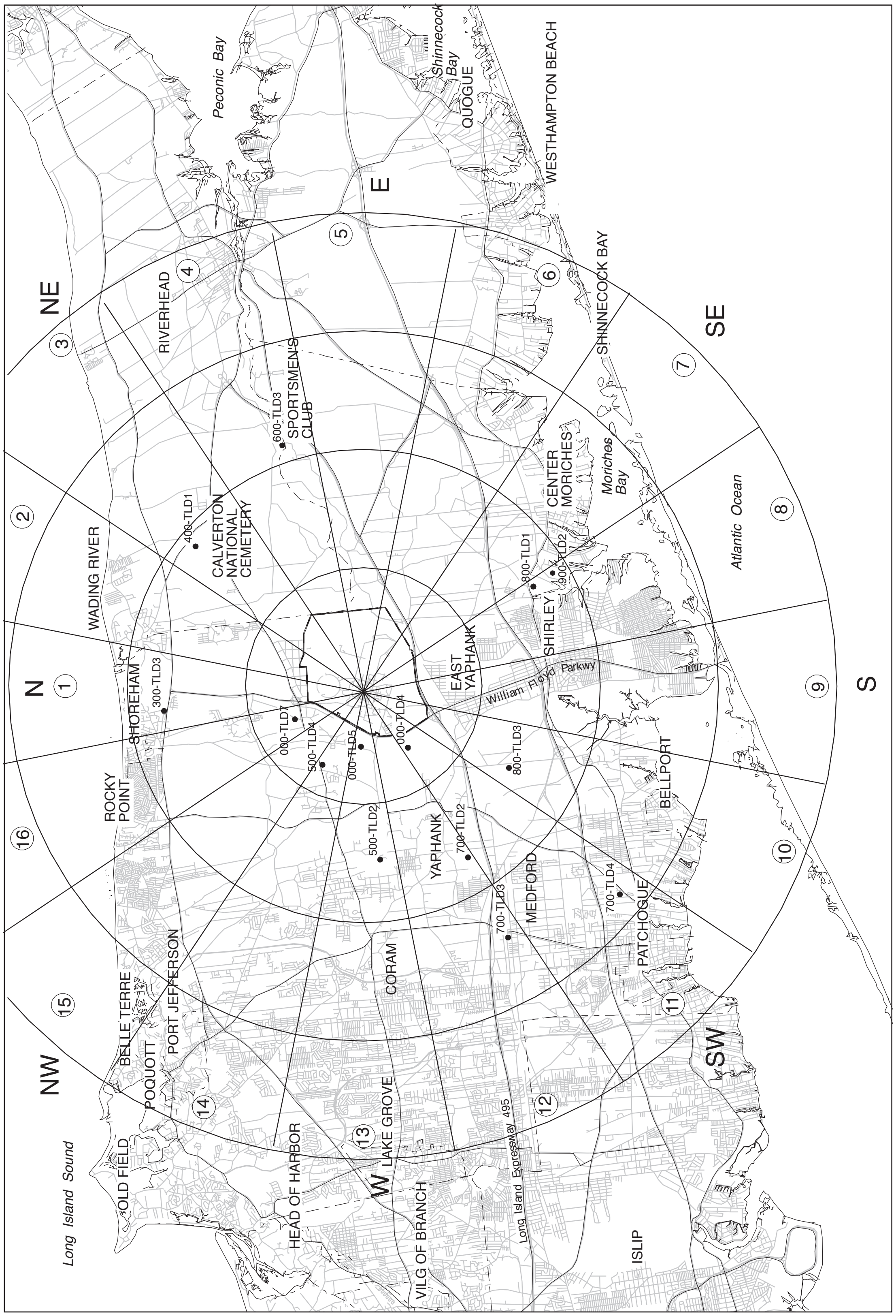
from all potential environmental sources, including cosmic and terrestrial radiation sources, was 62 ± 10 mrem (610 ± 100 µSv).

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 (68 ± 12 mrem) and on-site dose (62 ± 10 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 2012.

In 2012, the MEOSI dose on site and outside of controlled areas was measured at 3 mrem (first quarter), 3 mrem (second quarter), 7 mrem (third quarter), and 5 mrem (fourth quarter). The total dose to the on-site MEOSI was 18 mrem.

8.1.2 Facility Area Monitoring

Nine on-site TLDs were designated as facility-area monitors (FAMs) because they were posted in known radiation areas (near "facilities"). Table 8-3 shows the external doses measured with the FAM-TLDs. Environmental TLDs 088-TLD1 through 088-TLD4 are posted at the S-6 blockhouse location and on the fence



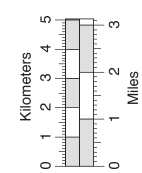


Figure 8-2. Off-Site TLD Locations.

Table 8-1. On-Site Direct Ambient Radiation Measurements.

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Avg./Qtr. ±2σ (95%)	Annual Dose ±2σ (95%)
		(mrem)					
011-TLD1	North firebreak	13.7	13.6	14.0	16.7	15 ± 3	58 ± 12
013-TLD1	North firebreak	16.1	15.1	14.8	19.3	16 ± 4	65 ± 16
025-TLD1	Bldg. 1010, beam stop 1	15.6	14.1	13.5	18.4	15 ± 4	62 ± 17
025-TLD4	Bldg. 1010, beam stop 4	16.0	15.5	14.0	18.6	16 ± 4	64 ± 15
027-TLD1	Bldg. 1002A South	16.7	14.3	12.3	17.1	15 ± 4	60 ± 18
027-TLD2	Bldg. 1002D East	14.5	12.6	14.4	17.8	15 ± 4	59 ± 17
030-TLD1	NE Firebreak	19.0	15.0	14.3	18.6	17 ± 5	67 ± 19
034-TLD1	Bldg. 1008, collimator 2	17.0	14.7	14.3	19.9	16 ± 5	66 ± 20
034-TLD2	Bldg. 1008, collimator 4	18.6	14.4	14.4	20.6	17 ± 6	68 ± 24
036-TLD1	Bldg. 1004B, East	14.7	15.0	12.6	18.8	15 ± 5	61 ± 20
036-TLD2	Bldg. 1004, East	18.1	15.9	14.3	18.3	17 ± 4	67 ± 15
037-TLD1	S-13	18.1	13.6	15.4	18.7	16 ± 5	66 ± 19
043-TLD1	North access road	17.8	17.2	18.7	21.7	19 ± 4	75 ± 16
043-TLD2	North of Meteorology Tower	17.5	14.9	17.4	18.2	17 ± 3	68 ± 11
044-TLD1	Bldg. 1006	19.6	16.0	13.8	19.0	17 ± 5	68 ± 21
044-TLD2	South of Bldg. 1000E	17.3	14.4	16.7	18.4	17 ± 3	67 ± 13
044-TLD3	South of Bldg. 1000P	19.6	15.1	15.4	20.2	18 ± 5	70 ± 21
044-TLD4	NE of Bldg. 1000P	20.2	16.7	14.7	18.1	17 ± 5	70 ± 18
044-TLD5	N of Bldg. 1000P	16.8	15.1	15.7	21.3	17 ± 6	69 ± 22
045-TLD1	Bldg. 1005S	16.0	14.2	15.2	18.3	16 ± 3	64 ± 14
045-TLD2	E of Bldg. 1005S	20.1	16.1	14.6	21.0	18 ± 6	72 ± 24
045-TLD3	SE of Bldg. 1005S	16.5	15.2	14.1	20.1	16 ± 5	66 ± 20
045-TLD4	SW of Bldg. 1005S	15.4	14.4	14.8	21.6	17 ± 7	66 ± 27
045-TLD5	WSW of Bldg. 1005S	16.7	14.0	12.9	17.3	15 ± 4	61 ± 17
049-TLD1	East firebreak	17.0	14.8	15.6	19.9	17 ± 4	67 ± 18
053-TLD1	West firebreak	20.7	16.6	16.4	21.7	19 ± 5	75 ± 22
054- TLD1	Bldg. 914	19.1	19.1	16.7	19.6	19 ± 3	75 ± 10
063-TLD1	West firebreak	20.3	17.8	18.1	23.2	20 ± 5	79 ± 20
066-TLD1	Waste Management Facility	17.4	12.5	13.3	18.4	15 ± 6	62 ± 23
073-TLD1	Meteorology Tower/Bldg. 51	16.5	15.2	15.3	20.2	17 ± 5	67 ± 18
074-TLD1	Bldg. 560	18.8	16.2	16.9	21.3	18 ± 4	73 ± 18
074-TLD2	Bldg. 907	18.0	16.2	15.3	21.5	18 ± 5	71 ± 21
080-TDL1	East firebreak	19.2	17.2	17.9	NP	18 ± 2	72 ± 8
082-TLD1	West firebreak	22.4	18.8	18.3	21.9	20 ± 4	81 ± 16
084-TLD1	Tennis courts	17.5	17.4	15.3	20.0	18 ± 4	70 ± 15
085-TDL2	Upton gas station	L	14.6	15.8	19.8	17 ± 5	67 ± 21
085-TLD1	Diversity Office	17.4	L	16.1	18.5	17 ± 2	69 ± 9
086-TLD1	Baseball fields	17.2	13.7	14.2	19.6	16 ± 5	65 ± 22
090-TLD1	North St. Gate	17.1	13.7	14.7	18.7	16 ± 4	64 ± 18
105-TLD1	South firebreak	29.7	16.4	16.2	22.1	21 ± 12	84 ± 50

(continued on next page)

Table 8-1. On-Site Direct Ambient Radiation Measurements *(concluded).*

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Avg./Qtr. ±2σ (95%)	Annual Dose ±2σ (95%)
		(mrem)					
108-TLD1	Water tower	17.5	13.4	15.5	19.5	16 ± 5	66 ± 21
108-TLD2	Tritium pole	20.6	18.9	19.0	24.2	21 ± 5	83 ± 19
111-TLD1	Trailer park	18.2	15.5	15.9	20.4	18 ± 4	70 ± 18
122-TLD1	South firebreak	16.7	14.6	13.6	19.2	16 ± 5	64 ± 19
126-TLD1	South gate	19.9	16	19.0	21.6	19 ± 5	77 ± 18
P2		16.4	12.3	12.5	16.2	14 ± 4	57 ± 18
P4		18.3	14.7	13.9	18.4	16 ± 5	65 ± 19
P7		16.9	14.8	15.8	20.2	17 ± 5	68 ± 18
S5		15.7	13.9	13.5	18.6	15 ± 5	62 ± 18
On-site average		**17.9**	**15.2**	**15.2**	**19.6**	**17 ± 3**	**68 ± 12**
Std. dev. (2 σ)		**4.9**	**3.1**	**3.3**	**3.3**		
075-TLD4	**Control TLD average**	**10.8**	**10.5**	**8.8**	**9.5**	**9.9 ± 2**	**40 ± 7**

Notes:
See Figure 8-1 for TLD locations.
L = TLD lost
NP = TLD not posted

of the former Hazardous Waste Management Facility (HWMF). These TLDs measured external doses that were slightly elevated compared to the normal natural background radiation doses measured from other areas on site. This can be attributed to the presence of small amounts of contamination in soil. However, a comparison of the current ambient dose rates to doses from previous years shows that the dose rates have significantly declined since the removal of the contaminated soil within the former HWMF. As recorded in Table 8-3, the 2012 dose was just slightly above natural background levels. The former HWMF is fenced, access is controlled, and only radiologically-trained employees are allowed inside the fenced area.

Two TLDs (075-TLD3 and 075-TLD5) near Building 356 showed slightly higher quarterly averages of 23 ± 6 mrem (230 ± 60 µSv) for both locations above the normal ambient background radiation. The yearly doses were measured at 92 ± 23 mrem (920 ± 230 µSv) for 075-TLD3 and 90 ± 26 mrem (900 ± 260 µSv) for 075-TLD5. The standard deviation associated with the measured dose near Building 356 was higher due to a large variation in the dose between each quarter while the facility was operational. The direct doses were also higher than the on-site annual average because Building 356 houses a cobalt-60 (Co-60) source, which is used to irradiate materials, parts, and electronic circuit boards. The slightly elevated dose from Building 356 is attributed to the "sky-shine" phenomenon. Although it is conceivable that individuals who use the parking lot adjacent to Building 356 could receive a dose from this source, the dose would be small due to the low occupancy factor.

Two FAM-TLDs placed on fence sections northeast and northwest of Building 913B (the AGS tunnel access) showed slightly elevated above-average ambient external dose. The first-quarter dose at that site was measured at 25.6 mrem for 054-TLD2 and 22.1 mrem for 054-TLD3 (compared to the site-wide first-quarter dose of 17.9 ± 4.9 and off-site dose of 16.5 ± 3.4 mrem). For the remaining quarters, both TLDs showed dose comparable to natural background radiation.

The AGS accelerates protons to energies up to 30 GeV and heavy ion beams to 15 GeV/amu. RHIC has two beams circulating in opposite

Table 8-2. Off-Site Direct Radiation Measurements.

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Avg./Qtr. ± 2 σ (95%)	Annual Dose ± 2 σ (95%)
		(mrem)					
000-TLD4	Private property	13.6	13.8	L	11.0	13 ± 3	51 ± 12
000-TLD5	Longwood Estate	L	13.7	13.4	18.0	16 ± 6	63 ± 26
000-TLD7	Mid-Island Game Farm	L	13.8	14.4	17.4	16 ± 4	64 ± 17
300-TLD3	Private property	NP	NP	NP	NP	0 ± 0	0 ± 0
400-TLD1	Calverton Nat. Cemetary	17.5	14.0	16.2	20.0	17 ± 5	68 ± 20
500-TLD2	Private property	15.6	14.1	13.6	15.4	15 ± 2	59 ± 8
500-TLD4	Private property	NP	NP	NP	NP	0 ± 0	0 ± 0
600-TLD3	Sportsmen's Club	15.9	13.5	15.3	17.3	16 ± 0	62 ± 0
700-TLD2	Private property	L	L	L	15.1	15 ± 0	60 ± 0
700-TLD3	Private property	17.6	12.6	13.3	15.9	15 ± 5	59 ± 18
700-TLD4	Private property	17.2	16.4	14.0	17.2	16 ± 3	65 ± 12
800-TLD1	Private property	15.3	L	L	NP	15 ± 0	61 ± 0
800-TLD3	Suffolk County CD	19.8	15.1	16.3	19.1	18 ± 4	70 ± 18
900-TLD2	Private property	16.2	13.0	12.9	NP	14 ± 0	56 ± 0
Off-site average		**16.5**	**14.0**	**14.4**	**16.6**	**13 ± 11**	**53 ± 45**
Std. dev. (2 σ)		**3.4**	**2.1**	**2.5**	**4.9**		
075-TLD4	**Control TLD average**	**10.8**	**10.5**	**8.8**	**9.5**	**9.9 ± 2**	**40 ± 7**

Notes:
See Figure 8-2 for TLD locations.
CD = Correctional Department
NP = TLD not posted for the quarter
L = TLD Lost

Table 8-3. Facility Area Monitoring.

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Average ± 2σ (95%)	Annual Dose ± 2σ (95%)
		(mrem)					
054-TLD2	NE of Bldg. 913B	25.6	17.2	16.5	20.2	20 ± 8	80 ± 32
054-TLD3	N/W of Bldg. 913B	22.1	19.2	15.5	19.7	19 ± 5	77 ± 21
S6		18.8	17.1	17.4	22.8	19 ± 5	76 ± 21
088-TLD1	FWMF, 50' East of S-6	18.1	16.1	15.8	21.4	18 ± 5	71 ± 20
088-TLD2	FWMF, 50' West of S-6	19.6	19.1	18.5	21.4	20 ± 2	79 ± 10
088-TLD3	FWMF, 100' West of S-6	21.3	18.0	20.1	22.5	20 ± 4	82 ± 15
088-TLD4	FWMF, 150' West of S-6	17.7	15.4	16.9	20.1	18 ± 4	70 ± 15
075-TLD3	Bldg. 356	24.9	19.8	21.5	26.1	23 ± 6	92 ± 23
075-TLD5	North Corner of Bldg. 356	20.6	19.1	23.9	26.4	23 ± 6	90 ± 26

Notes:
See Figure 8-1 for TLD locations.
FWMF = Former Waste Management Facility

directions and is capable of accepting either protons or heavy ions up to gold. At the RHIC, protons and heavy ions received from the AGS are further accelerated up to final energies of 250 GeV for protons and 100 GeV per nucleon for gold ions. Under these high-energy conditions, facilities such as AGS and RHIC have the potential to generate high-energy neutrons when the charged particles leave the confines of the accelerator and produce nuclear fragments along their path or when they collide with matter. A passive monitoring TLD provides dose information from the neutron interactions when placed at strategic locations. In 2012, 12 neutron-monitoring TLDs (Harshaw Badge 8814) were posted at these strategic locations to measure the dose contribution from the high-energy neutrons (see Figure 8-3 for locations). The technical criteria used for the placement of the neutron TLDs is based on design aspects such as the thickness of the berm shielding, location of soil activation areas, beam stop areas and beam collimators, and proximity to the site boundary. A passive monitor for the neutron dose, 054-TLD-N1, in the vicinity of BLIP facility, showed 1 mrem neutron dose in the third quarter of 2012. A neutron TLD (034-TLD-N1) at the collimator of Building 1008 showed neutron dose of 1 mrem in the third quarter. Another neutron TLD (043-TLD N1) in the vicinity of Building 1008 showed 2 mrem dose.

8.2 DOSE MODELING

EPA regulates radiological emissions from DOE facilities under the requirements set forth in 40 CFR 61, Subpart H, National Emission Standards for Hazardous Air Pollutants (NESHAPs). This regulation specifies the compliance and monitoring requirements for reporting radiation doses received by members of the public from airborne radionuclides. The regulation mandates that no member of the public shall

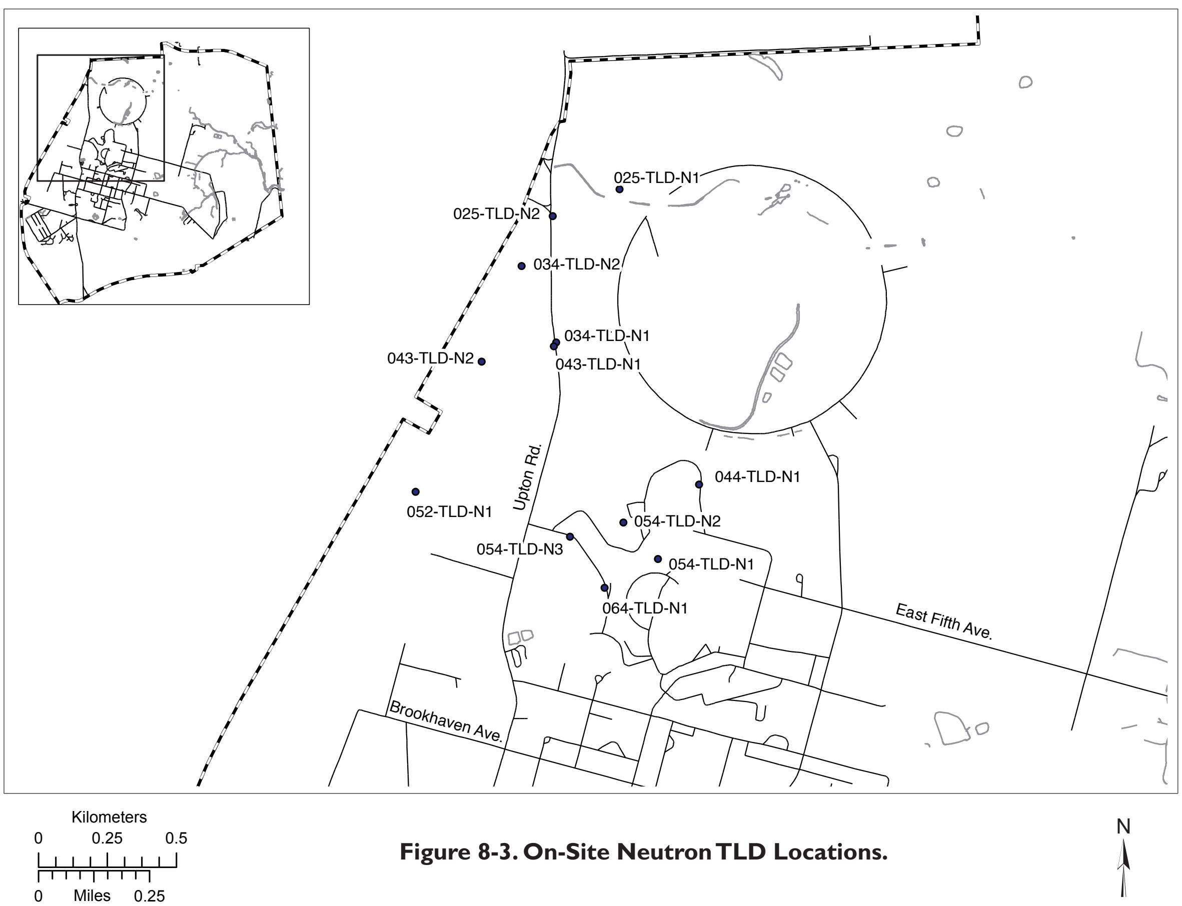


Figure 8-3. On-Site Neutron TLD Locations.

receive a dose that is greater than 10 mrem (100 µSv) in a year from airborne emissions. The emission monitoring requirements are set forth in Subpart H, Section 61.93(b), and include the use of a reference method for continuous monitoring at major release points (defined as those with a potential to exceed 1 percent of the 10 mrem standard) and a periodic confirmatory measurement for all other release points. The regulations also require DOE facilities to submit an annual NESHAPs report to EPA that describes the major and minor emission sources and dose to the MEOSI. The dose estimates from various facilities are given in Table 8-4, and the actual air emissions for 2012 are discussed in detail in Chapter 4.

As a part of the NESHAPs review process at BNL, any source that has the potential to emit radioactive materials is evaluated for regulatory compliance. Although the activities conducted

Table 8-4. Maximally Exposed Offsite Individual Effective Dose Equivalent From Facilities or Routine Processes.

Building No.	Facility or Process	Construction Permit No.	MEOSI Dose (mrem) (a)	Notes
348	Radiation Protection	None	ND	(g)
463	Biology Facility	None	5.38E-05	(b)
490	Medical Research	BNL-489-01	ND	(d)
490A	Energy and Environment National Security	None	ND	(b)
491	Brookhaven Medical Research Reactor	None	1.31E-08	(h)
510	Calorimeter Enclosure	BNL-689-01	ND	(d)
510A	Physics	None	ND	(g)
535	Instrumentation	None	ND	(g)
555	Chemistry Facility	None	ND	(g)
701	Brookhaven Graphite Research Reactor	None	1.56E-08	(i)
705	Stack	None	7.03E-05	(i)
725	National Synchrotron Light Source	None	2.90E-11	(b)
750	High Flux Beam Reactor	None	1.35E-04	(c)
801	Target Processing Lab	None	3.98E-05	(b)(c)
802B	Evaporator Facility	BNL-288-01	NO	(d)(e)
820	Accelerator Test Facility	BNL-589-01	ND	(h)
830	Environmental Science Department	None	ND	(h)
865	Reclamation Building	None	ND	(h)
906	Medical-Chemistry	None	ND	(h)
925	Accelerator Department	None	ND	(h)
931	Brookhaven Linac Isotope Producer	BNL-2009-01	2.35E-01	(c)
938	REF/NBTF	BNL-789-01	ND	(d)
942	Alternate Gradient Syncrotron Booster	BNL-188-01	ND	(f)
—	Relativistic Heavy Ion Collider	BNL-389-01	ND	(h)
Total Potential Dose from BNL Operations			**2.35E-01**	
EPA Limit			**10.0 mrem**	

Notes:
NBTF = Neutron Beam Test Facility
REF = Radiation Effects Facility
ND = No Dose from the emission sources in 2012.
(a) "Dose" in this table means effective dose equivalent to MEOSI.
(b) Dose is based on emissions calculated using 40 CFR 61, Appendix D methodology.
(c) Emissions are continuously monitored at the facility.
(d) This facility was decommssioned and is zero emission facility
(e) This facility is decontaminated and demolished
(f) Booster ventilation system prevents air release through continuous air recirculation.
(g) No radiological dispersible material inventory in 2012.
(h) No detectable emissions from the facility in 2012.
(i) diffusive losses

by the Laboratory's Environmental Restoration Group are exempt under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), these activities are also monitored and assessed for any potential to release radioactive materials and to determine their dose contribution, if any, to the environment. Any new radiological processes or activities are also evaluated for compliance with NESHAPs regulations using EPA's approved dose modeling software (see Section 8.2.1 for details). Because this model was designed to treat radioactive emission sources as continuous over the course of a year, it is not well suited for estimating short-term or acute releases. Consequently, it overestimates potential dose contributions from short-term projects and area sources. For that reason, the results are considered to be "conservative"— that is, erring on the side of caution.

8.2.1 Dose Modeling Program

Compliance with NESHAPs regulations is demonstrated through the use of EPA dose modeling software and the Clean Air Act Assessment Package 1988 (CAP88-PC), Version 3.0. This computer program uses a Gaussian plume model to estimate the average dispersion of radionuclides released from elevated stacks or diffuse sources. It calculates a final value of the projected dose at the specified distance from the release point by computing dispersed radionuclide concentrations in air, rate of deposition on ground surfaces, and intake via the food pathway (where applicable). CAP88-PC calculates both the EDE to the MEOSI and the collective population dose within a 50-mile radius of the emission source. In most cases, the CAP88-PC model provides conservative doses. For the purpose of modeling the dose to the MEOSI, all emission points are co-located at the BLIP Facility within the developed portion of the site. The dose calculations are based on very low concentrations of environmental releases and on chronic, continuous intakes in a year. The input parameters used in the model include radionuclide type, emission rate in curies (Ci) per year, stack parameters such as height and diameter, and emission exhaust velocity.

Site-specific weather and population data are factored into the dose assessment. Weather data are supplied by measurements from the Laboratory's meteorological tower. These measurements include wind speed, direction, frequency, and air temperature (see Chapter 1 for details). A population of 6 million (6,031,539) people, based on the geographical information system design population survey performed by Oak Ridge National Laboratory for BNL, was used in the model.

8.2.2 Dose Calculation Methods and Pathways

8.2.2.1 Maximally Exposed Off-site and On-site Individual

The MEOSI is defined as a person who resides at a residence, office, or school beyond the BNL site boundary such that no other member of the public could receive a higher dose than the MEOSI. This person is assumed to reside 24 hours a day, 365 days a year off site and close to the nearest emission point of the BNL site boundary and consumes significant amounts of fish and deer containing radioactivity supposedly attributable to Laboratory operations based on projections from the New York State Department of Health (NYSDOH). In reality, it is highly unlikely that such a combination of "maximized dose" to any single individual would occur, but the concept is useful for evaluating maximum potential risk and dose to members of the public. The on-site maximally exposed individual (MEI) who could receive any dose outside of BNL's controlled areas was monitored with TLDs in the vicinity of Building 356. The potential source of external radiation to the on-site individual would be from skyshine radiation from Building 356.

8.2.2.2 Effective Dose Equivalent

The EDE to the MEOSI for low levels of radioactive materials dispersed into the environment was calculated using the CAP88-PC dose modeling program, Version 3.0. Site meteorology data were used to calculate annual dispersions for the midpoint of a given wind sector and distance. Facility-specific radionuclide release rates (Ci/yr) were used for continuously monitored facilities. For small sources, the emissions were calculated using the method set forth in 40 CFR 61, Appendix D. The Gaussian dispersion model calculated the EDE at the site boundary and the collective population dose values from immersion, inhalation, and ingestion pathways. These dose and risk calculations to the MEOSI are based on low emissions and chronic intakes.

8.2.2.3 Dose Calculation: Fish Ingestion

To calculate the EDE from the fish consumption pathway, the intake is estimated. Intake is the average amount of fish consumed by a person engaged in recreational fishing in the Peconic River. Based on a NYSDOH study, the consumption rate is estimated at 15 pounds (7 kg) per year (NYSDOH 1996). For each radionuclide of concern for fish samples, the dry weight activity concentration was converted to picocuries per gram (pCi/g) 'wet weight," since wet weight is the form in which fish are caught and consumed. A dose conversion factor was used for each radionuclide to convert the activity concentration into the EDE. For example, the committed dose equivalent conversion factor for cesium-137 (Cs-137) is 5.0E-02 rem/µCi, as set forth in DOE/EH-0071. The dose was calculated as: dose (rem/yr) = intake (kg/yr) × activity in flesh (µCi/kg) × dose factor (rem/µCi).

8.2.2.4 Dose Calculation: Deer Meat Ingestion

The dose calculation for the deer meat ingestion pathway is similar to that for fish consumption. The Cs-137 radionuclide dose conversion factor was used to estimate dose, based on the U.S. Environmental Protection Agency Exposure Factors Handbook (EPA 1996). No other radionuclides associated with Laboratory operations have been detected in deer meat. The total quantity of deer meat ingested during the course of a year was estimated at 64 pounds (29 kg) (NYSDOH 1999).

8.3 SOURCES: DIFFUSE, FUGITIVE, "OTHER"

Diffuse sources, also known as nonpoint or area sources, are described as releases of radioactive contaminants to the atmosphere that do not have well-defined emission points. Fugitive sources include leaks through window and door frames, and unintended releases to the air through vents or stacks when they are supposedly inactive (i.e., leaks from vents are fugitive sources). As a part of the NESHAPs review process, in addition to stack emissions, any fugitive or diffuse emission source that could potentially emit radioactive materials to the environment is evaluated. Although CERCLA-prompted actions such as remediation projects are exempt from the procedural requirements to obtain federal, state, or local permits, any BNL activity or process with the potential to emit radioactive material must be evaluated and assessed for dose impact to members of the public. The following radiological sources were evaluated in 2012 for potential contribution to the overall site dose.

8.3.1 Remediation Work

Remediation work continued in 2012 for Area of Concern (AOC) 31, which included the demolition of ancillary Buildings 704 and 802. These two buildings were demolished and the demolition debris was properly disposed to an off-site facility. Remediation work for the two buildings included dismantling and removing structures, systems, components, ducts, filter house inlets (above and below), resin beds, plenums, pipes, asphalt, and the soil below the overall footprint of the buildings. Building 802 was an EPA NESHAP-approved facility under permit BNL-288-01.

8.4 DOSE FROM POINT SOURCES

8.4.1 Brookhaven Linac Isotope Producer

Source term descriptions for point sources are given in Chapter 4. The BLIP facility is the only emission source with the potential to contribute dose to members of the public greater than 1 percent of the EPA limit (i.e., 0.1 mrem or 1.0 µSv). The BLIP facility is considered a major emission source in accordance with the ANSI N13.1-1999 standard's graded approach; that is, a potential impact category (PIC) of II. The emissions are directly and continuously measured in real-time with an in-line, low-resolution NaI gamma spectrometer connected to the exhaust ventilation system for recording emissions. The particulate emissions are monitored on a weekly frequency using a conventional fiberglass filter and analyzed at an off-site laboratory. The tritium samples are also collected continuously using a silica gel absorbent and are then analyzed at an off-site laboratory on a biweekly basis.

In 2012, the BLIP facility operated over a period of 30 weeks. During the year, 1,595 Ci of carbon-11 (C-11) and 3,305 Ci of oxygen-15 (O-15) were released from the BLIP facility. A small quantity (5.0E-04 Ci) of tritiated water vapor from activation of the targets' cooling water was also released. The EDE to the MEOSI was calculated to be 2.35E-01 mrem (2.4 µSv) in a year from BLIP operations.

8.4.2 High Flux Beam Reactor

In 2012, the residual tritium emissions from the High Flux Beam Reactor (HFBR) Facility were measured at 0.806 Ci, but conservatively estimated at 6.0 curies. The dose, based on estimated value, was 1.35E-04 mrem (1.4 nSv) in a year.

8.4.3 Brookhaven Medical Research Reactor

In 2012, the Brookhaven Medical Research Reactor (BMRR) facility remained in a cold-shutdown mode as a radiological facility with institutional controls in place. There was no dose contribution from the BMRR.

8.4.4 Brookhaven Graphite Research Reactor

In 2012, the demolition of the biological shield wall inside the Brookhaven Graphite Research Reactor (BGRR) was completed. The remaining waste from the biological shield was packaged and shipped off site to a licensed disposal facility, consisting mostly of activated metals and concrete. All the remediation work performed at BGRR was monitored for emissions; there were no emissions, with exception of residual tritium (1.40E-03 Ci). The dose consequence was 1.56E-08 mrem (0.2 pSv).

8.4.5 Waste Management Facility

In 2012, there was no dose contribution from the Waste Management Facility.

8.4.6 Unplanned Releases

There were no unplanned releases in 2012.

8.5 DOSE FROM INGESTION

Radionuclides in the environment bioaccumulate in deer and fish tissues, bones, and organs; consequently, samples from deer and fish were analyzed to evaluate the dose contribution to humans from the ingestion pathway. As discussed in Chapter 6, deer meat samples collected off site and less than 1 mile from the BNL boundary were used to assess the potential dose impact to the MEOSI. The maximum tissue concentration in the deer meat (flesh) collected "off site and less than 1 mile" was used to calculate the potential dose. Potassium-40 (K-40) and Cs-137 were detected in the tissue samples. K-40 is a naturally occurring radionuclide and is not related to BNL operations.

In 2012, the average K-40 concentrations in tissue samples (off site < 1 mile) were 3.15 ± 0.70 pCi/g (wet weight) in the flesh and 2.47 ± 0.41 pCi/g (wet weight) in the liver. The maximum Cs-137 concentrations were 1.52 ± 0.12 pCi/g (wet weight) in the flesh and 0.22 ± 0.04 pCi/g (wet weight) in the liver (see Table 6-2). The average Cs-137 concentration was calculated at 0.54 ± 0.15 pCi/g; however, the maximum concentration of 1.52 pCi/g was used for the purpose of MEOSI dose calculations. The maximum estimated dose to humans from consuming deer meat containing the maximum Cs-137 concentration was estimated to be 2.21 mrem (22 µSv) in a year. This dose is well below the health advisory limit of 10 mrem (100 µSv) established by NYSDOH.

In collaboration with the New York State Department of Environmental Conservation (NYSDEC) Fisheries Division, the Laboratory maintains an ongoing program of collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. In 2012, a Brown Bullhead species had the highest concentration of Cs-137 at 0.30 ± 0.07 pCi/g; this was used to estimate the EDE to the MEOSI. The potential dose from consuming 15 pounds of such fish annually was calculated to be 1.0E-01 mrem (1.0 µSv)—well below the NYSDOH health advisory limit of 10 mrem.

8.6 DOSE TO AQUATIC AND TERRESTRIAL BIOTA

DOE-STD-1153-2002, A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota, provides the guidelines for screening methods to estimate radiological doses to aquatic animals and terrestrial plants and animals, using site-specific environmental surveillance data. The RESRAD-BIOTA 1.21 biota dose level 2 computer program was used to evaluate compliance with the requirements for protection of biota specified in DOE Order 458.1, Radiation Protection of the Public and the Environment, and DOE Order 436.1, Departmental Sustainability.

In 2012, the terrestrial animal and plant doses were evaluated based on 1.51 pCi/g of Cs-137 found in surface soils in the Building 515 front lawn area and a strontium-90 (Sr-90) concentration of 0.54 pCi/L in the surface waters collected at the HE location. The dose to terrestrial animals was calculated to be 72.7 µGy/day, and to plants, 6.84 µGy/day. The d oses to terrestrial animals were well below the biota dose limit of 1 mGy/day, and below the limit for terrestrial plants.

To calculate the dose to aquatic and riparian animals, Sr-90 radionuclide concentration values for surface water from the HE location and the Cs-137 in sediments found at PR-WC-06-D1-L50 were used (see Table 6-6). The Cs-137 sediment concentration was 5.48 pCi/g and the Sr-90 concentration in surface water was 0.54 pCi/L. The calculated dose to aquatic animals was 1.21 µGy/day, and to riparian animals, 3.69 µGy/day. Therefore, the dose to aquatic and riparian animals were also well below the 10 mGy/day limit specified by the regulations.

8.7 CUMULATIVE DOSE

Table 8-5 summarizes the potential cumulative dose from the BNL site in 2012. The total dose to the MEOSI from air and ingestion pathways was estimated to be 2.55 mrem (26 µSv). In comparison, the EPA regulatory limit for the air pathway is 10 mrem (0.10 mSv), and the DOE limit from all pathways is 100 mrem (1 mSv). The cumulative population dose would be 6.22 person-rem (0.06 person-Sv) in a year. The effective dose is well below the DOE and EPA regulatory limits, and the ambient TLD dose is within normal background levels seen at the Laboratory site. The potential dose from drinking water was not estimated, because most residents adjacent to the BNL site get their drinking water from the Suffolk County Water Authority, rather than private wells.

To put the potential dose impact into perspective, a comparison was made with other sources of radiation. The annual dose from all natural background sources and radon is approximately 311 mrem (3.11 mSv). A mammogram gives a dose of 250 mrem (2.5 mSv) and a dental x-ray gives a dose of approximately 160 mrem (1.6 mSv) to an individual. Therefore, a dose of 2.55 mrem from all environmental pathways is a minute fraction of one routine dental x-ray.

Table 8-5. BNL Site Dose Summary.

Pathway	Dose to Maximally Exposed Individual	Percent of DOE 100 mrem/year Limit	Estimated Population Dose per year
Inhalation			
Air	2.35E-01	<3%	6.22 Person-rem
Ingestion			
Drinking water	None	None	None
Fish	1.00E-01	<1%	Not tracked
Deer Meat	2.21	<2%	Not tracked
All Pathways	2.55 mrem (25µSv)	<3%	6.22 Person-rem

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Quality Assurance 9

Quality assurance is an integral part of every activity at Brookhaven National Laboratory. A comprehensive Quality Assurance/Quality Control (QA/QC) Program is in place to ensure that all environmental monitoring samples are representative and that data are reliable and defensible. The QC in the contract analytical laboratories is maintained through daily instrument calibration, 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. The multilayered components of QA monitored at BNL ensure that all analytical data reported for the 2012 Site Environmental Report are reliable and of high quality.

9.1 QUALITY PROGRAM ELEMENTS

As required by DOE Order 450.1, Environmental Protection Program, BNL has established a QA/QC Program to ensure that the accuracy, precision, and reliability of environmental monitoring data are consistent with the requirements of Title 10 of the Code of Federal Regulations, Part 830 (10 CFR 830), Subpart A, Quality Assurance Requirements (2000) and DOE Order 414.1A, Quality Assurance. The responsibility for quality at BNL starts with the Laboratory director, who approves the policies and standards of performance governing work, and extends throughout the entire organization. The purpose of the BNL Quality Management (QM) System is to implement QM methodology throughout the various Laboratory management systems and associated processes, in order to:

- Plan and perform operations in a reliable and effective manner to minimize any impact on the health and safety of the public, employees, and the environment
- Standardize processes and support continual improvement in all aspects of Laboratory operations
- Enable the delivery of products and services that meet customers' requirements and expectations

For environmental monitoring, QA is deployed as an integrated system of management activities. These activities involve planning, implementation, control, reporting, assessment, and continual improvement. QC activities measure each process or service against the QA standards. QA/QC practices and procedures are documented in manuals, plans, and a comprehensive set of standard operating procedures (SOPs) for environmental monitoring (EM-SOPs). Staff members who must follow these procedures are required to document that they have reviewed and understand them.

The ultimate goal of the environmental monitoring and analysis QA/QC program is to ensure that results are representative and defensible, and that data are of the type and quality needed to verify protection of the public, employees, and the environment. Figure 9-1 depicts the flow of the QA/QC elements of BNL's Environmental Monitoring Program and indicates the sections of this chapter that discuss each element in more detail.

Laboratory environmental personnel determine sampling requirements using the EPA Data Quality Objective (DQO) process (EPA 2000) or its equivalent. During this process, the project manager for each environmental program determines the type, amount, and quality of data needed to support decision making, the legal requirements, and stakeholder concerns. An environmental monitoring plan or project-specific sampling plan is then prepared, specifying the location, frequency, type of sample, analytical

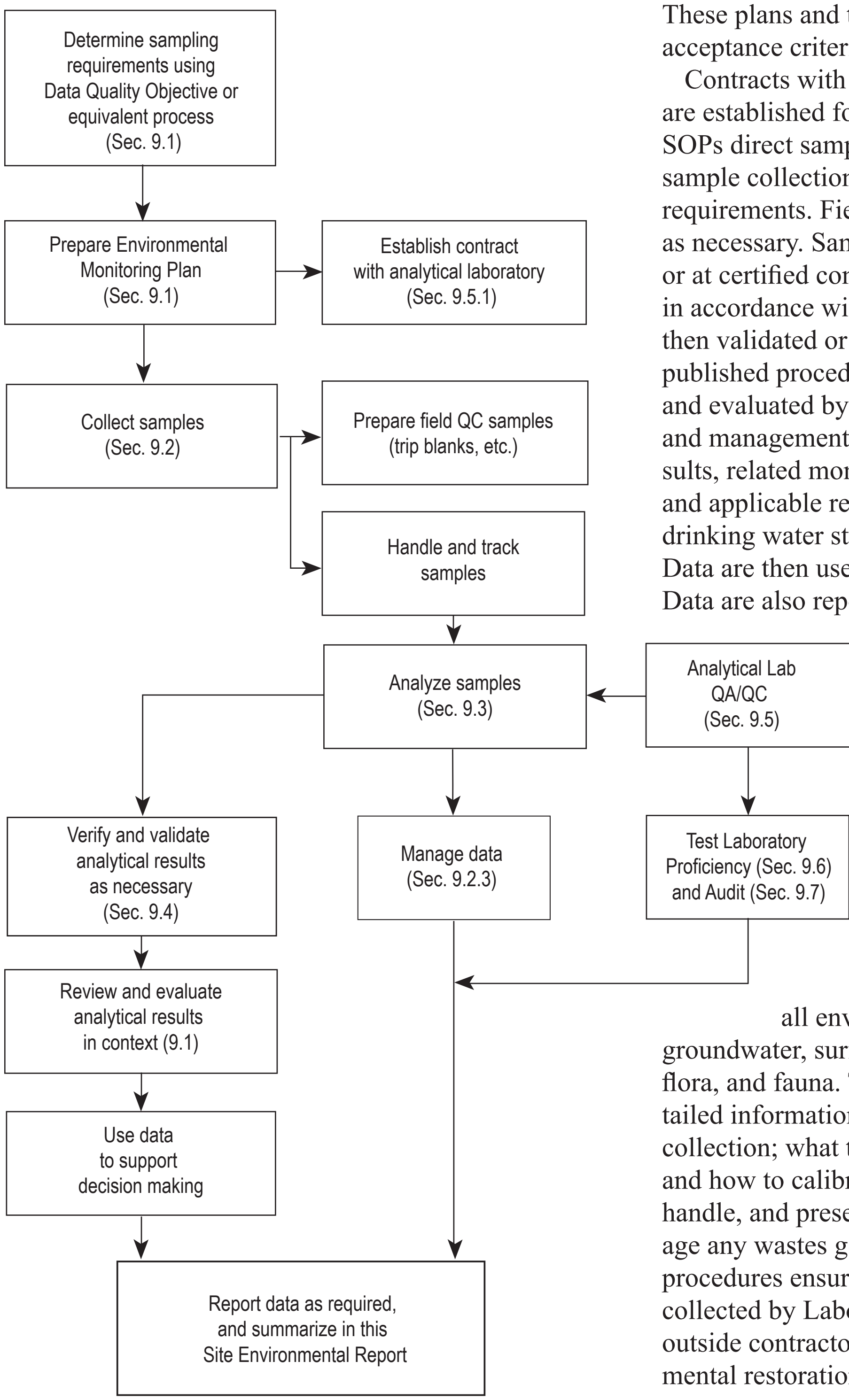


Figure 9-1. Flow of Environmental Monitoring QA/QC Program Elements.

methods to be used, and a sampling schedule. These plans and the EM-SOPs also specify data acceptance criteria.

Contracts with off-site analytical laboratories are established for sampling analysis. The EM-SOPs direct sampling technicians on proper sample collection, preservation, and handling requirements. Field QC samples are prepared as necessary. Samples are analyzed in the field or at certified contract analytical laboratories in accordance with EM-SOPs. The results are then validated or verified in accordance with published procedures. Finally, data are reviewed and evaluated by environmental professionals and management in the context of expected results, related monitoring results, historical data, and applicable regulatory requirements (e.g., drinking water standards, permit limits, etc.). Data are then used to support decision making. Data are also reported as required and summarized in this annual report.

9.2 SAMPLE COLLECTION AND HANDLING

In 2012, environmental monitoring samples were collected, as specified, by EM-SOPs, the BNL Environmental Monitoring Plan Update (BNL 2012), and project-specific work plans. BNL has sampling SOPs for all environmental media, including groundwater, surface water, soil, sediment, air, flora, and fauna. These procedures contain detailed information on how to prepare for sample collection; what type of field equipment to use and how to calibrate it; how to properly collect, handle, and preserve samples; and how to manage any wastes generated during sampling. The procedures ensure consistency between samples collected by Laboratory sampling personnel and outside contractors in support of the environmental restoration, compliance, and surveillance programs.

QC checks of sampling processes include the collection of field duplicates, matrix spike samples, field blanks, trip blanks, and equipment blanks. For example, field readings of water quality parameters are taken until all parameters are within acceptable limits. Also, specific sampling methodologies include QC checks. An example of this is the low-flow groundwater sampling technique, which includes checks to ensure that monitoring wells are properly purged before readings are taken.

All wastes generated during sampling (contaminated equipment, purge water from wells, etc.) are managed in accordance with applicable requirements. A factor considered during sample collection is minimizing the amount of waste generated, consistent with the Pollution Prevention Program described in Chapter 2.

9.2.1 Field Sample Handling

To ensure the integrity of samples, chain-of-custody (COC) was maintained and documented for all samples collected in 2012. A sample is considered to be in the custody of a person if any of the following rules of custody are met: 1) the person has physical possession of the sample, 2) the sample remains in view of the person after being in possession, 3) the sample is placed in a secure location by the custody holder, or 4) the sample is in a designated secure area. These procedures are outlined in EM-SOP 109, "Chain-of-Custody, Storage, Packaging, and Shipment of Samples" (BNL 2010a). All environmental monitoring samples in 2012 maintained a valid COC from the time of sample collection through sample disposal by the contract analytical laboratories.

9.2.1.1 Custody and Documentation

Field sampling technicians are responsible for the care and custody of samples until they are transferred to a receiving group or contract analytical laboratory. Samples requiring refrigeration are placed immediately into a refrigerator or a cooler with cooling media, and kept under custody rules. The technician signs the COC form when relinquishing custody, and contract analytical laboratory personnel sign the COC form when accepting custody.

As required by EM-SOP-201, "Documentation of Field Activities" (BNL 2010b), the field sampling technician is also required to maintain a bound, weatherproof field logbook, which is used to record sample ID number, collection time, description, collection method, and COC number. Daily weather conditions, field measurements, and other appropriate site-specific observations also are recorded in the logbook.

9.2.1.2 Preservation and Shipment

Before sample collection, the field sampling technicians prepare all bottle labels and affix them to the appropriate containers, as defined in the QA program plan or applicable EM-SOPs. Appropriate preservatives are added to the containers before or immediately after collection; in appropriate cases, samples are refrigerated. For example, samples collected for methyl mercury are cooled immediately and shipped to the contract analytical laboratory on the day of collection. After samples arrive at the laboratory, they are preserved with hydrochloric acid.

Sample preservation is maintained as required throughout shipping. If samples are sent via commercial carrier, a bill-of-lading is used. COC seals are placed on the shipping containers; their intact status upon receipt indicates that custody was maintained during shipment. These procedures are outlined in EM-SOP 109, "Chain-of-Custody, Storage, Packaging, and Shipment of Samples."

9.2.2 Field Quality Control Samples

Field QC samples collected for the environmental monitoring program include equipment blanks, trip blanks, field blanks, field duplicate samples, and matrix spike/matrix spike duplicate samples. The rationale for selecting specific field QC samples, and minimum requirements for their use in the environmental monitoring program, are provided in the BNL EM-SOP 200 series, Quality Assurance. Equipment blanks and trip blanks were collected for all appropriate media in 2012.

An *equipment blank* is a volume of solution (in this case, laboratory-grade water) that is used to rinse a sampling tool after decontamination. The rinse water is collected and tested to verify that the sampling tool is not contaminated. Equipment blank samples are collected, as needed, to verify the effectiveness of the decontamination procedures on non-dedicated or reusable sampling equipment.

A *trip blank* is provided with each shipping container of samples to be analyzed for volatile organic compounds (VOCs). The use of trip blanks provides a way to determine whether contamination of a sample occurred during shipment from the manufacturer, while in bottle storage, in shipment to a contract analytical laboratory, or during analysis at a lab. Trip blanks consist of an aliquot of laboratory-grade water sealed in a sample bottle, usually prepared by the contract analytical laboratory prior to shipping the sample bottles to BNL. If trip blanks were not provided by the lab, then field sampling technicians prepare trip blanks before they collect the samples. Trip blanks were included with all shipments of aqueous samples for VOC analysis in 2012.

Field blanks are collected to check for cross-contamination that may occur during sample collection. For the Groundwater Monitoring Program, one field blank is collected for every 20 samples, or one per sampling round, whichever is more frequent. Field blanks are analyzed for the same parameters as groundwater samples. For other programs, the frequency of field blank collection is based on their specific DQOs.

In 2012 (as in other years), the most common contaminants detected in the trip, field, and equipment blanks included chloroform, methyl chloride, and methylene chloride. These compounds are commonly detected in blanks and do not pose significant problems with the reliability of the analytical results. Several other compounds were also detected, such as methyl bromide and toluene, at low levels. When these contaminants are detected, validation or verification procedures are used, where applicable, to qualify the associated data as "nondetects," (see Section 9.4). The results from blank samples collected during 2012 did not indicate any significant impact on the quality of the results.

Field duplicate samples are analyzed to check the reproducibility of sampling and analytical results, based on EPA Region II guidelines (EPA 2006a,b). For example, in the Groundwater Monitoring Program, duplicates are collected for 5 percent of the total number of samples collected for a project per sampling round. During 2012, 56 duplicate samples were collected for nonradiological analyses, and 50 duplicate samples were collected for radiological analyses. All duplicate samples were acceptable for input into BNL's Environmental Information Management System (EIMS) database, which is used to manage the Laboratory's environmental data. Duplicates were analyzed only for the parameters relevant to the program they monitored. Of the 4,261 nonradiological parameters analyzed in 2012, 99 percent of the analyses met QA criteria. Of the 118 radiological parameters monitored, 97 percent met QA criteria.

Matrix spike and *matrix spike duplicates* are performed to determine whether the sample matrix (e.g., water, soil, air, vegetation, bone, or oil) adversely affected the sample analysis. A spike is a known amount of analyte added to a sample. Matrix spikes are performed at a rate specified by each environmental program's DQOs. The rate is typically one per 20 samples collected per project. No significant matrix effects were observed in 2012 for routine matrices such as water and soil. Non-routine matrices, such as oil, exhibited the expected matrix issues.

9.2.3 Tracking and Data Management

Most environmental monitoring samples and analytical results were tracked in BNL's EIMS. A small number of environmental samples that were not tracked in the EIMS were from Chemtex Lab, which cannot produce the electronic data deliverables needed to enter the data into the EIMS. Tracking was initiated when a sample was recorded on a COC form. Copies of the COC form and supplemental forms were provided to the project manager or the sample coordinator and forwarded to the data coordinator to be entered into the EIMS. Each contract analytical laboratory also maintained its own internal sample tracking system.

Following sample analysis, the contract analytical laboratory provides the results to the project manager or designee and, when applicable, to the validation subcontractor, in accordance with their contract. Once results of the analyses are entered into the EIMS, reports can be generated by project personnel and DOE

Brookhaven Site Office staff using a web-based data query tool.

9.3 SAMPLE ANALYSIS

In 2012, environmental samples were analyzed by one of six contract analytical laboratories, whose selection is discussed in Section 9.3.1. All samples were analyzed according to EPA-approved methods, where such methods exist, and by standard industry methods where there are no EPA methods. In addition, field sampling technicians performed field monitoring for parameters such as conductivity, dissolved oxygen, pH, temperature, and turbidity.

9.3.1 Qualifications

BNL used the following contract analytical laboratories for analysis of environmental samples in 2012:

- General Engineering Lab (GEL) in Charleston, South Carolina, for radiological and nonradiological analytes
- H2M Lab in Babylon and Melville, New York, for nonradiological analytes
- Test America (TA), based in St. Louis, Missouri, for radiological and nonradiological analytes
- Chemtex Lab in Port Arthur, Texas, for select nonradiological analytes
- Caltest Analytical in Napa, California, for mercury and methyl mercury analyses
- American Radiation Services (ARS) in Port Allen, Louisiana, for radiological analyses

The process of selecting off-site contract analytical laboratories involves a number of factors: 1) their record on performance evaluation (PE) tests, 2) their contract with the DOE Integrated Contract Procurement Team, 3) pre-selection bidding, and 4) their adherence to their own QA/QC programs, which must be documented and provided to BNL. Routine QC procedures that laboratories must follow, as discussed in Section 9.5, include daily instrument calibrations, efficiency and background checks, and standard tests for precision and accuracy. All the laboratories contracted by BNL in 2012 were certified by the New York State Department of Health (NYSDOH) for the relevant analytes, where such certification existed. The laboratories also were subject to PE testing and DOE-sponsored audits (see Section 9.7).

9.4 VERIFICATION AND VALIDATION OF ANALYTICAL RESULTS

Environmental monitoring data are subject to data verification and, in certain cases, data validation, when the data quality objectives of the project require this step. For example, groundwater samples collected for the Groundwater Protection Group (GPG) undergo data verification, whereas specific data collected for specific waste streams undergo full validation.

The data verification process involves checking for common errors associated with analytical data. The following criteria can cause data to be rejected during the data verification process:

- *Holding time missed* – The analysis is not initiated or the sample is not extracted within the time frame required by EPA or by the contract.
- *Incorrect test method* – The analysis is not performed according to a method required by the contract.
- *Poor recovery* – The compounds or radioisotopes added to the sample before laboratory processing are not recovered at the recovery ratio required by the contract.
- *Insufficient QA/QC data* – Supporting data received from the contract analytical laboratory are insufficient to allow validation of results.
- *Incorrect minimum detection limit (MDL)* – The contract analytical laboratory reports extremely low levels of analytes as “less than minimum detectable,” but the contractually required limit is not used.
- *Invalid chain-of-custody* – There is a failure to maintain proper custody of samples, as documented on COC forms.
- *Instrument failure* – The instrument does not perform correctly.
- *Preservation requirements not met* – The requirements identified by the specific analytical method are not met or properly documented.
- *Contamination of samples from outside sources* – These possible sources include sampling equipment, personnel, and the

contract analytical laboratory.

- *Matrix interference* – Analysis is affected by dissolved inorganic/organic materials in the matrix.

Data validation involves a more extensive process than data verification. Validation includes all the verification checks as well as checks for less common errors, including instrument calibration that was not conducted as required, internal analyte standard errors, transcription errors, and calculation errors. The amount of data checked varies, depending on the environmental media and on the DQOs for each project. Data for some projects, such as long-term groundwater monitoring, may require only verification. Data from some waste streams receive the more rigorous validation testing, performed on 20 to 100 percent of the analytical results. The results of the verification or validation process are entered into the EIMS.

9.4.1 Checking Results

Nonradiological data analyzed in 2012 were verified and/or validated, when project DQOs required, using BNL EM-SOPs in the 200 Series and EPA contract laboratory program guidelines (EPA 2006a, b). Radiological packages were verified and validated using BNL and DOE guidance documents (BNL 2012a). During 2012, the verifications were conducted using a combination of manually checking the hard copy data packages and the use of a computer program developed at the Laboratory to verify that the information reported electronically is stored in the EIMS.

9.5 CONTRACT ANALYTICAL LABORATORY QA/QC

In 2012, procedures for calibrating instruments, analyzing samples, and assessing QC were consistent with EPA methodology. QC checks performed included: analyzing blanks and instrument background; using Amersham Radiopharmaceutical Company or National Institute for Standards and Technology (NIST) traceable standards; and analyzing reference standards, spiked samples, and duplicate samples. Analytical laboratory contracts specify analytes, methods, required detection limits, and deliverables, which include standard batch QA/QC performance checks. As part of the laboratory selection process, candidate laboratories are required to provide BNL with copies of their QA/QC manuals and QA program plans.

When discrepancies were found in field sampling designs, documented procedures, COC forms, data analyses, data processing systems, and QA software, or when failures in PE testing occur, nonconformance reports are generated. Following investigation into the root causes, corrective actions are taken and tracked to closure.

9.6 PERFORMANCE OR PROFICIENCY EVALUATIONS

Five of the contract analytical laboratories (GEL, TA, H2M, ARS, and Caltest) participated in several national and state PE testing programs in 2012. The fifth contractor, Chemtex Lab, did not participate in PE testing because there is no testing program for the specific analytes Chemtex analyzed: tolytriazole, polypropylene glycol monobutyl ether, and 1,1-hydroxyethylidene diphosphonic acid. Each of the participating laboratories took part in at least one testing program, and several laboratories participated in multiple programs. Results of the tests provide information on the quality of a laboratory's analytical capabilities. The testing was conducted by Environmental Resource Associates (ERA), the voluntary Mixed Analyte Performance Evaluation Program (MAPEP), Resource Technology Corporation (RTC), and NYSDOH Environmental Laboratory Accreditation Program (ELAP). The results from these tests are summarized in Section 9.6.1. Because Caltest only analyzed samples for mercury and methyl mercury, their PE results are not summarized.

9.6.1 Summary of Test Results

In Figures 9-2 and 9-3, results are plotted as percentage scores that were "Acceptable," "Warning (But Acceptable)," or "Not Acceptable." A Warning (But Acceptable) is considered by the testing organization to be "satisfactory." An "average overall satisfactory" score is the sum of results rated as Acceptable and those rated as Warning (But Acceptable), divided by the total number of results reported. A Not Acceptable rating reflects a result that is greater than three standard deviations from the known value — a criterion set by the independent testing organizations.

Figure 9-2 summarizes radiological performance scores in the ERA, MAPEP, and ELAP programs. GEL, TA, and ARS had average overall satisfactory scores of 98, 93, and 93 percent, respectively. Additional details about the radiological assessments are discussed in Section 9.6.1.1.

Figure 9-3 summarizes the nonradiological performance results of three of the four participating laboratories (GEL, H2M, and TA) in the ERA, RTC, MAPEP, and ELAP tests. For nonradiological tests, the average overall satisfactory results were 99 percent for all three laboratories. Since the fourth laboratory, Caltest, only analyzed mercury samples, its passing proficiency results were not graphed. Additional details on nonradiological evaluations are discussed in Section 9.6.1.2.

9.6.1.1 Radiological Assessments

Since ARS only analyzed tritium and strontium-90 (Sr-90) in water samples during 2012, only PE results for these analytes were reviewed. GEL and TA participated in the ERA radiological PE studies. Of GEL's tests on radiological samples, 98.5 percent were in the Acceptable range and 91.8 percent of TA's tests were Acceptable. TA and ARS participated in the ELAP evaluations; 95.7 percent of TA's ELAP tests on radiological samples were in the Acceptable range and 93.3 percent of ARS's ELAP test results were in the Acceptable range. GEL also participated in the MAPEP evaluations; 94.4 percent of GEL's tests on radiological samples were in the Acceptable range.

9.6.1.2 Nonradiological Assessments

During 2012, H2M and TA participated in the NYSDOH ELAP evaluations of performance on tests of nonpotable water, potable water, and solid wastes. NYSDOH found 99.3 percent of H2M's nonradiological tests to be in the Acceptable range and 100 percent of TA's nonradiological tests to be in the Acceptable range.

TA and GEL participated in the ERA water supply and water pollution studies, although this evaluation is not required for New York State certification. ERA found that 99.5 percent of TA's tests were in the Acceptable range, as were 99.4 percent of GEL's tests.

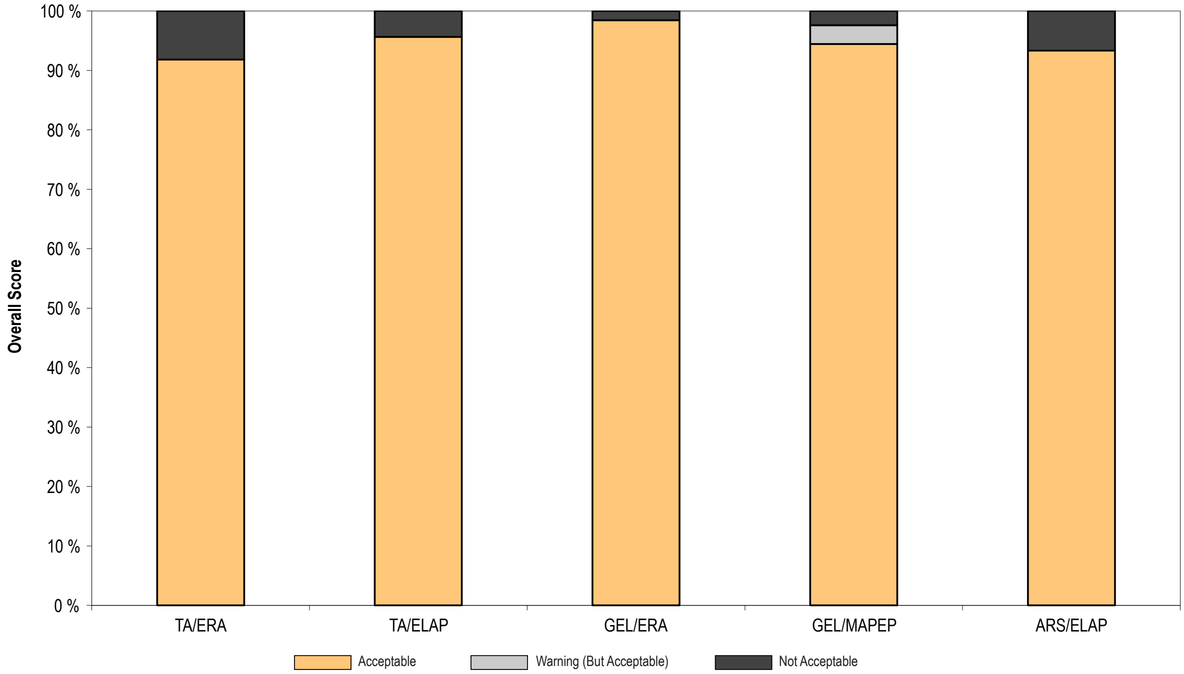
GEL participated in the MAPEP water supply and water pollution studies. MAPEP found that 99.7 percent of GEL's results were in the Acceptable range. GEL also participated in RTC nonradiological evaluations, which showed that 96.5 percent of GEL's results were in the Acceptable range.

9.7 AUDITS

As part of DOE's Integrated Contract Procurement Team Program, TA, GEL, and ARS were audited during 2012 (DOE 2012a,b,c). During the audits, errors are categorized into Priority I and Priority II findings. Priority I status indicates a problem that can result in unusable data or a finding that the contract analytical laboratory cannot adequately perform services for DOE. 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 (DOE 2002). There were no Priority I findings during 2012 that affected samples analyzed for BNL.

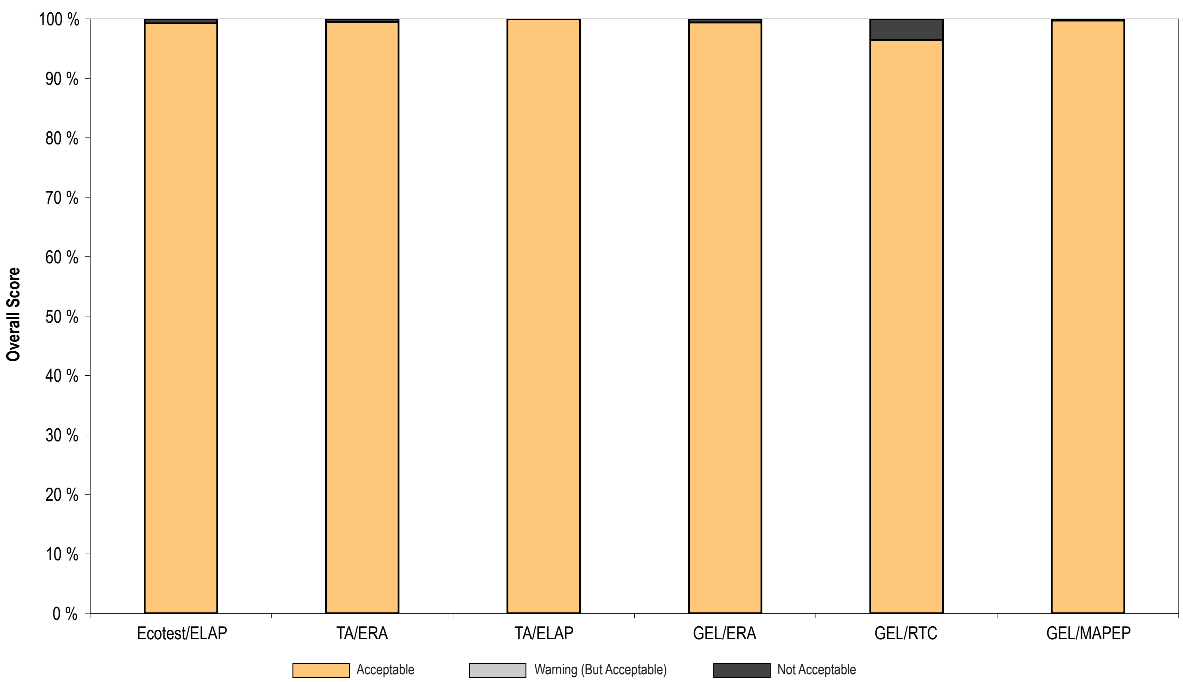
The results of the TA audit included 11 Priority II findings. A previous Priority I finding for select radionuclide analyses in a vegetation matrix remained open at the time of the audit. This Priority I finding did not affect any BNL samples. The Priority II findings were in the following departments: two in Quality Assurance Management Systems, three in the Data Quality for Organic Analyses, one in the Inorganic and Wet Chemistry Department, one in the Radiological Department, one in Laboratory Information Management Systems/Electronic Data Management, and three in Hazardous and Radioactive Materials Management.

The results of the GEL audit included ten Priority II findings. The Priority II findings were in the following departments: one in the Quality Assurance Department, six in the Data Quality for Organic Analyses, one in the Inorganic and



Note that the Acceptable scores and the Warning (But Acceptable) scores combined constitute the "overall satisfactory" category referred to in the text of this chapter.

Figure 9-2. Summary of Scores in the Radiological Proficiency Evaluation Programs.



Note that the Acceptable scores and the Warning (But Acceptable) scores combined constitute the "overall satisfactory" category referred to in the text of this chapter.

Figure 9-3. Summary of Scores in the Nonradiological Proficiency Evaluation Programs.

Wet Chemistry Department, and two in Hazardous and Radioactive Materials Management. In December 2012, GEL also received a Priority I finding for Uranium 234/233 in a filter matrix and a Priority II finding for cobalt-57 in a soil matrix. Since BNL has not sent GEL samples for these analyte/matrix pairings during 2012, these findings did not affect BNL.

The results of the ARS audit included six Priority II findings. The Priority II findings were in the following departments: four Priority II findings in the Quality Assurance Department and two in Hazardous and Radioactive Materials Management. Based on the audits, the analytical data met DOE's criteria for Acceptable status.

9.8 CONCLUSION

Based on the data validations, data verifications, and results of the independent Performance Evaluation assessments, the chemical and radiological results reported in this 2012 Site Environmental Report are of acceptable quality.

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Acronyms and Abbreviations

These acronyms and abbreviations reflect the typical manner in which terms are used for this specific document and may not apply to all situations. Items with an asterisk (*) are described in the glossary of technical terms, which follows this list.

ACTS	DOE Academies Creating Teacher Scientists
AFYs	Alterntaive Fuel Vehicles
AEC	Atomic Energy Commission
AGS	Alternating Gradient Synchrotron
ALARA*	"As Low As Reasonably Achievable"
AMSL	above mean sea level
AOC*	area of concern
APG	Analytical Products Group
ARARs	Applicable, Relevant, and Appropriate Requirements
ARPA*	Archeological Resource Protection Act
ARRA	American Recovery and Reinvestment Act
AS/SVE*	air sparging/soil vapor extraction
AST	aboveground storage tank
AWQS	Ambient Water Quality Standards
BAF	Booster Applications Facility
BGD	belowground duct
BGRR	Brookhaven Graphite Research Reactor
BHSO	DOE Brookhaven Site Office
BLIP	Brookhaven Linac Isotope Producer
BMRR	Brookhaven Medical Research Reactor
BNL	Brookhaven National Laboratory
BOD*	biochemical oxygen demand
Bq*	becquerel
Bq/g	becquerel per gram
Bq/L	becquerel per liter
BRAHMS	Broad Range Hadron Magnetic Spectrometer
BSA	Brookhaven Science Associates
Btu	British thermal units
CAA*	Clean Air Act
CAAA*	CAA Amendments (1990)
CAC	Community Advisory Council
CAP	Clean Air Act Assessment Package
CBS	chemical bulk storage
CCR	Consumer Confidence Report
CEGPA	Community, Education, Government and Public Affairs
CERCLA*	Comprehensive Environmental Response, Compensation and Liability Act
CFC-11	an ozone-depleting refrigerant
cfm, cfs	cubic feet per minute, per second
CFN	Center for Functional Nanomaterials
CFR	U.S. Code of Federal Regulations
Ci*	curie
CO	certificate to operate
COC*	chain-of-custody
CRM	Cultural Resource Management
CRMP	Cultural Resource Management Plan
Cs	cesium
CSF	Central Steam Facility
CTN	Center for Transitional Neuroimaging
CWA*	Clean Water Act
CY	calendar year
D_2O*	heavy water
DAC	Derived Air Concentration
DCA	1,1-dichloroethane
DCE	1,1-dichloroethylene
DCG*	derived concentration guide
D&D	decontamination and decommissioning
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DMR	Discharge Monitoring Report
DOE*	U.S. Department of Energy
DOE CH	DOE Chicago Operations Office
DQO	Data Quality Objective
DSA	Documented Safety Analysis
DSB	Duct Service Building
DUV – FEL	Deep UltraViolet – Free Electron Laser
DWS	Drinking Water Standards
EA*	Environmental Assessment
ECM	Energy Conservation Measures
EDB*	ethylene dibromide
EDE*	Effective Dose Equivalent
EDTA	ethylenediaminetetraacetic acid
EE/CA	Engineering Evaluation/Cost Analysis
EE-IOCPA	Energy Employees Occupational Illness Compensation Program Act
EIMS*	Environmental Information Management System
EISA	Energy Independence and Security Act
ELAP	Environmental Laboratory Approval Program
EML	Environmental Measurements Laboratory
EMP	Environmental Monitoring Plan
EMS*	Environmental Management System
EO	Executive Order
EPA*	U.S. Environmental Protection Agency

EPCRA* Emergency Planning and Community Right-to-Know Act
EPEAT Electronic Product Environmental Assessment Tool
EPD Environmental Protection Division
EPP Environmentally Preferable Products
ERP Environmental Restoration Projects
ERA Environmental Resource Associates
ERD Environmental Restoration Division
ES* environmental surveillance
ESPC Energy Savings Performance Contract
ESR Experimental Safety Review
ES&H Environment, Safety, and Health
ESA* Endangered Species Act
ESH&Q Environment, Safety, Health, and Quality Directorate
ESPC Energy Savings Performance Contract
ESSH Environmental Safety, Security and Health
FaST Facility and Student Teams Program
FAMS Facility area monitors
FEMP Federal Emergency Management Program
FERN Foundation for Ecological Research in the Northeast
FFCA* Federal Facilities Compliance Act
FFA Federal Facilities Agreement
FIFRA* Federal Insecticide, Fungicide, and Rodenticide Act
FM Facility Monitoring
FRP Facility Response Plan
FWS* U.S. Fish & Wildlife Service
FY fiscal year
GBq giga (billion or E+09) becquerel
GAB gross alpha and beta
GC/ECD gas chromatography/electron capture detector
GC/MS gas chromatography/mass spectrometry
GDS Groundwater Discharge Standard
GEL General Engineering Laboratory, LLC
GeV giga (billion) electron volts
gge gas gallon equivalent
GHG Greenhouse Gas
GIS Geographical Information System
GPG Groundwater Protection Group
GWh gigawatt hour
GWP Global warming potential
H2M H2M Labs, Inc.
HEPA high efficiency particulate air
HFBR High Flux Beam Reactor
HFCs Hydrofluorocarbons
HITL Heavy Ion Transfer Line
HPRS Health Physics Reporting System
HPSB High Performance and Sustainable Buildings
HSS Health, Safety and Security
HTO tritiated water (liquid or vapor)
HVAC heating/ventilation/air conditioning
HWMF Hazardous Waste Management Facility
I Iodine
IAEA International Atomic Energy Agency
IAG Interagency Agreement
IC ion chromatography
ICP/MS inductively coupled plasma/mass spectrometry
ISMS Integrated Safety Management System
ISO* International Organization for Standardization
K potassium
kBq kilobecquerels (1,000 Bq)
KeV kilo (thousand) electron volts
Kr kryptonite
kwH kilowatt hours
LDR Land Disposal Restriction
LED light emitting diode
LEED Leadership in Energy and Environmental Design
LIE Long Island Expressway
LIMS Laboratory Information Management System
Linac Linear Accelerator
LIPA Long Island Power Authority
LISF Long Island Solar Farm
LSTPD Laboratory Science Teacher Professional Development
LTRA Long Term Remedial Action
mA milli-amperes
MACT Maximum Available Control Technology
MAPEP Mixed Analyte Performance Evaluation Program
MAR Materials-at-risk
MCL maximum contaminant level
MDL* minimum detection limit
MEI* maximally exposed individual
MEOSI maximally exposed off-site individual
MeV million electron volts
MGD million gallons per day
mg/L milligrams per liter
MMBtu million British thermal units
MOA Memorandum of Agreement
MPF Major Petroleum Facility
MPN most probable number
mrem milli (thousandth of a) rem
MRI Magnetic Resonance Imaging
MRC Medical Research Center
MSL* mean sea level
mSv millisievert
MTBE methyl tertiary butyl ether
MW megawatt
µg/L micrograms per liter
NA not analyzed

NCRP National Council on Radiation Protection and Measurements
ND not detected
NEAR Neighbors Expecting Accountability and Remediation
NELAC National Environmental Laboratory Accreditation Conference
NELAP National Environmental Laboratory Accreditation Program
NEPA* National Environmental Policy Act
NESHAPs* National Emission Standards for Hazardous Air Pollutants
ng/J nano (one-billionth) gram per Joule
NHPA* National Historic Preservation Act
NIST National Institute for Standards and Technology
nm nanometer
NNSS Nevada National Security Site
NO_2 nitrogen dioxide
NOV Notice of Violation
NO_x* nitrogen oxides
NOEC no observable effect concentration
NPDES National Pollutant Discharge Elimination System
NR not required
NRMP Natural Resource Management Plan
NS not sampled
NSF-ISR NSF-International Strategic Registrations, Ltd.
NSLS National Synchrotron Light Source
NSLS-II National Synchrotron Light Source II
NSRC Nanoscale Science Research Centers
NSRL NASA Space Radiation Laboratory
NT not tested
NTS Nevada Test Site
NYCRR* New York Codes, Rules, and Regulations
NYISO New York Independent System Operator
NYPA New York Power Authority
NYS New York State
NYSDEC NYS Department of Environmental Conservation
NYSDOH NYS Department of Health
NYSHPO NYS Historic Preservation Office
O_3* ozone
O&M Operation and Maintenance
ODS ozone-depleting substances
OHSAS Occupational Health and Safety Assessment Series
OMC Occupational Medical Clinic
ORC oxygen-releasing compound
ORPS* Occurrence Reporting and Processing System
OSHA Occupational Health and Safety Administration
OSSP Open Space Stewardship Program
OU* operable unit
P2* pollution prevention
PAAA* Price-Anderson Act Amendment
PAF Process Assessment Form
Pb lead
PBT persistent, bioaccumulative, and toxic
PCBs* polychlorinated biphenyls
PCE tetrachloroethylene (or perchloroethylene)
pCi/g picocuries per gram
PE performance evaluation
PET positron emission tomography
PFCs Perfluorocarbons
PIC potential impact category
ppb parts per billion
ppm parts per million
PRAP Proposed Remedial Action Plan
QA* quality assurance
QAPP Quality Assurance Program Plan
QC* quality control
QM Quality Management
R-11 (etc.) ozone-depleting refrigerant
RA* removal action
RACT Reasonably Available Control Technology
RATA Relatiivistic accuracy test
RCRA* Resource Conservation and Recovery Act
RD/RA Remedial Design/Remedial Action
REC Renewable Energy Credit
RF resuspension factor
RHIC Relativistic Heavy Ion Collider
ROD* Record of Decision
RPD relative percent difference
RSB Research Support Building
RFT Radiation Therapy Facility
RWMB Radioactive Waste Management Basis
RWP Radiological Work Permit
SARA* Superfund Amendments and Reauthorization Act
SBMS* Standards Based Management System
SCDHS Suffolk County Department of Health Services
SCR Special Case Resource
SCSC Suffolk County Sanitary Code
SDL Source Development Laboratory
SDWA* Safe Drinking Water Act
SER Site Environmental Report
SI International System (measurement units)
SNS standard not specified
SO_2 sulfur dioxide
SOP standard operating procedure
SPCC Spill Prevention Control and Countermeasures
SPDES* State Pollutant Discharge Elimination System
Sr strontium
SSP Site Sustainability Plan
SSPP Strategic Sustainablility Performance Plan

STAR	Solenoid Tracker at RHIC
STEM	Scanning Transmission Electron Microscope
STL	Severn Trent Laboratories, Inc.
STP	Sewage Treatment Plant
SU	standard unit
SUNY	State University of New York
Sv*	sievert; unit for assessing radiation dose risk
SVE*	soil vapor extraction
SVOC*	semivolatile organic compound
$t_{1/2}$*	half-life
TAG	Technical Advisory Group
TBq	tera (trillion, or E+12) becquerel
TCA	1,1,1-trichloroethane
TCAP	Transportation Safety and Operations Compliance Assurance Process
TCE*	trichloroethylene
TCLP	toxicity characteristic leaching procedure
TEAM	Transformational Energy Action Management
TEDE	Total Effective Dose Equivalent
TKN	Total Kjeldahl nitrogen
TLD*	thermoluminescent dosimeter
TPL	Target Processing Laboratory
TRE	Toxic Reduction Evaluation
TRI	Toxic Release Inventory
TSCA*	Toxic Substances Control Act
TVDG	Tandem Van de Graaff
TVOC*	total volatile organic compounds
UESC	Utility Energy Services Contract
UIC*	underground injection control
UST*	underground storage tank
VOC*	volatile organic compound
VUV*	very ultraviolet
WAC	waste acceptance criteria
WBS	Work Breakdown Structure
WCPP	Waste Certification Program Plan
WCF	Waste Concentration Facility
WET	Whole Effluent Toxicity
WLA	Waste Loading Area
WM	Waste Management
WMF	Waste Management Facility
WTP	Water Treatment Plant

Technical Terms

These definitions reflect the typical manner in which the terms are used for this specific document and may not apply to all situations. Bold-face words in the descriptions are defined in separate entries.

A

AA (atomic absorption) – A spectroscopy method used to determine the elemental composition of a sample. In this method, the sample is vaporized and the amount of light it absorbs is measured.

accuracy – The degree of agreement of a measurement with an accepted reference or true value. It can be expressed as the difference between two values, as a percentage of the reference or true value, or as a ratio of the measured value and the reference or true value.

activation – The process of making a material radioactive by bombardment with neutrons, protons, or other high energy particles.

activation product – A material that has become radioactive by bombardment with neutrons, protons, or other high energy particles.

activity – Synonym for radioactivity.

Administrative Record – A collection of documents established in compliance with **CERCLA**. Consists of information the CERCLA lead agency uses in its decision on the selection of response actions. The Administrative Record file should be established at or near the facility and made available to the public. An Administrative Record can also be the record for any enforcement case.

aerobic – An aerobic organism is one that lives, acts, or occurs only in the presence of oxygen.

aerosol – A gaseous suspension of very small particles of liquid or solid.

ALARA (As Low As Reasonably Achievable) – A phrase that describes an approach to minimize exposures to individuals and minimize releases of radioactive or other harmful material to the **environment** to levels as low as social, technical, economic, practical, and public policy considerations will permit. ALARA is not a dose limit, but a process with a goal to keep dose levels as far below applicable limits as is practicable.

alpha radiation – The emission of alpha particles during radioactive decay. Alpha particles are identical in makeup to the nucleus of a helium atom and have a positive charge. Alpha radiation is easily stopped by materials as thin as a sheet of paper and has a range in air of only an inch or so. Despite its low penetration ability, alpha radiation is densely ionizing and therefore very damaging when ingested or inhaled. Naturally occurring radioactive sources such as radon emit alpha radiation.

air stripping – A process for removing **VOCs** from contaminated water by forcing a stream of air through the water in a vessel. The contaminants evaporate into the air stream. The air may be further treated before it is released into the atmosphere.

ambient air – The surrounding atmosphere, usually the outside air, as it exists around people, animals, plants, and structures. It does not include the air immediately adjacent to emission sources.

analyte – A constituent that is being analyzed.

anneal – To heat a material and then cool it. In the case of thermoluminescent dosimeters (TLDs), this is done to reveal the amount of radiation the material had absorbed.

anion – A negatively charged ion, often written as a superscript negative sign after an element symbol, such as Cl^-.

anthropogenic – Resulting from human activity; anthropogenic radiation is human-made, not naturally occurring.

AOC (area of concern) – Under **CERCLA**, this term refers to an area where releases of hazardous substances may have occurred or a location where there has been a release or threat of a release of a hazardous substance, pollutant, or contaminant (including **radionuclide**s). AOCs may include, but need not be limited to, former spill areas, landfills, surface impoundments, waste piles, land treatment units, transfer stations, wastewater treatment units, incinerators, container storage areas, scrap yards, cesspools, tanks, and associated piping that are known to have caused a release into the environment or whose integrity has not been verified.

aquifer – A water-saturated layer of rock or soil below the ground surface that can supply usable quantities of **groundwater** to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.

ARPA (Archaeological Resources Protection Act) This law, passed in 1979, has been amended four times. It protects any material remains of past human life or activities that are of archaeological interest. Known *and potential* sites of interest are protected from uncontrolled excavations and pillage, and artifacts found on public and Indian lands are banned from commercial exchange.

AS/SVE (air sparging/soil vapor extraction) – A method of extracting **volatile organic compounds** from the **groundwater**, in place, using compressed air. (In contrast, air stripping occurs in a vessel.) The vapors are typically collected using a soil vapor extraction system.

B

background – A sample or location used as reference or control to compare BNL analytical results to those in areas that could not have been impacted by BNL operations.

background radiation – **Radiation** present in the environment as a result of naturally occurring radioactive materials in the Earth, cosmic radiation, or human-made radiation sources, including fallout.

beta radiation – Beta radiation is composed of charged particles emitted from a nucleus during radioactive decay. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation is more penetrating than alpha radiation, but it may be stopped by materials such as aluminum or Lucite™ panels. Naturally occurring radioactive elements such as potassium-40 emit beta radiation.

blank – A sample (usually reagent-grade water) used for quality control of field sampling methods, to demonstrate that cross contamination has not occurred.

blowdown – Water discharged from either a boiler or cooling tower in order to prevent the build-up of inorganic matter within the boiler or tower and to prevent scale formation (i.e., corrosion).

BOD (biochemical oxygen demand) – A measure of the amount of oxygen in biological processes that breaks down organic matter in water; a measure of the organic pollutant load. It is used as an indicator of water quality.

Bq (becquerel) – A quantitative measure of **radioactivity**. This alternate measure of activity is used internationally and with increasing frequency in the United States. One Bq of activity is equal to one nuclear decay per second.

bremsstrahlung – Translates as "fast braking" and refers to electromagnetic radiation produced by the sudden retardation of a charged particle in an intense electric field.

C

CAA (Clean Air Act), CAA Amendments (CAAA) – The original Clean Air Act was passed in 1963, but the U.S. air pollution control program is based on the 1970 version of the law. The 1990 Clean Air Act Amendments (CAAA) are the most far-reaching revisions of the 1970 law. In common usage, references to the CAA typically mean to the 1990 amendments. (*source*: EPA's "Plain English Guide to the Clean Air Act" glossary, accessed 3-7-05)

caisson – A watertight container used in construction work under water or as a foundation.

cap – A layer of natural or synthetic material, such as clay or gunite, used to prevent rainwater from penetrating and spreading contamination. The surface of the cap is generally mounded or sloped so water will drain off.

carbon adsorption/carbon treatment – A treatment system in which contaminants are removed from **groundwater**, surface water, and air by forcing water or air through tanks containing activated carbon (a specially treated material that attracts and holds or retains contaminants).

carbon tetrachloride – A poisonous, nonflammable, colorless liquid, CCl_4.

CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) – Pronounced "sir-klah" and commonly known as Superfund, this law was enacted by Congress on December 11, 1980. It created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified

The law authorizes two kinds of response actions: short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response, and long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on **EPA**'s National Priorities List (NPL). CERCLA was amended by the Superfund Amendments and Reauthorization Act (**SARA**) on October 17, 1986, accessed 03-7-05)

CFR (Code of Federal Regulations) – A codification of all regulations developed and finalized by federal agencies in the Federal Register. The CFR is arranged by "title," with Title 10 covering energy- and radiation-related issues, and Title 40 covering protection of the environment. Subparts within the titles are included in citations, as in "40 CFR Subpart H."

characterization – Facility or site sampling, monitoring, and analysis activities to determine the extent and nature of contamination. Characterization provides the basis of necessary technical information to select an appropriate cleanup alternative.

Ci (**curie**) – A quantitative measure of radioactivity. One Ci of activity is equal to 3.7E+10 decays per second. One curie has the approximate activity of 1 gram of radium. It is named after Marie and Pierre Curie, who discovered radium in 1898.

Class GA groundwater – New York State Department of Environmental Conservation classification for high quality groundwater, where the best intended use is as a source of drinking water supply.

closure – Under **RCRA** regulations, this term refers to a hazardous or solid waste management unit that is no longer operating and where potential hazards that it posed have been addressed (through clean up, immobilization, capping, etc.) to the satisfaction of the regulatory agency.

CO_2 equivalent (CO_2e) – The universal unit of measurement to indicate the GWP of each of the six GHGs expressed in terms of the GWP of one unit of CO_2. It is used to evaluate the release (or the avoided release) of different GHG emissions against a common basis, and is commonly expressed as metirc tons carbon dioxide equivalent ($MtCO_2e$), which is calculated by multiplying the metric tons of GHG by its GWP.

COC (chain-of-custody) – A method for documenting the history and possession of a sample from the time of collection, through analysis and data reporting, to its final disposition.

cocktail – a mixture of chemicals used for **scintillation** counting.

collective Effective Dose Equivalent – A measure of health risk to a population exposed to radiation. It is the sum of the **EDEs** of all individuals within an exposed population, frequently considered to be within 50 miles (80 kilometers) of an environmental release point. It is expressed in person-**rem** or person-**sievert**.

Committed Effective Dose Equivalent – The total **EDE** received over a 50-year period following the internal deposition of a **radionuclide**. It is expressed in **rems** or **sieverts**.

composite sample – A sample of an environmental medium containing a certain number of sample portions collected over a period of time, possibly from different locations. The constituent samples may or may not be collected at equal time intervals over a predefined period of time, such as 24 hours.

confidence interval – A numerical range within which the true value of a measurement or calculated value lies. In the SER, radiological values are shown with a 95 percent confidence interval: there is a 95 percent probability that the true value of a measurement or calculated value lies within the specified range. *See also* "Uncertainty" discussion in Appendix B.

conservative – Estimates that err on the side of caution because all possibly deleterious components are included at generous or high values.

contamination – Unwanted radioactive and/or hazardous material that is dispersed on or in equipment, structures, objects, air, soil, or water.

control – *See* **background**.

cooling water – Water used to cool machinery and equipment. *Contact* cooling water is any wastewater that contacts machinery or equipment to remove heat from the metal; *noncontact* cooling water has no direct contact with any process material or final product. *Process wastewater* cooling water is water used for cooling that may have become contaminated through contact with process raw materials or final products.

cover boards – Sheets of plywood placed on the ground near ponds to serve as attractive habitat for salamanders, as part of a population study.

curie – *See* **Ci**.

CWA (Clean Water Act) – Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. It established the basic structure for regulating discharges of pollutants into the waters of the United States, giving **EPA** the authority to implement pollution control programs such as setting wastewater standards for industry. The CWA also continued requirements to set water quality standards for all contaminants in surface waters and made it unlawful for any person to discharge any pollutant from a **point source** into navigable waters unless a permit was obtained. The CWA also funded the construction of sewage treatment plants and recognized the need for planning to address the critical problems posed by **nonpoint source pollution**.

Revisions in 1981 streamlined the municipal construction grants process. Changes in 1987 phased out the construction grants program. Title I of the Great Lakes Critical Programs Act of 1990 put into place parts of the Great Lakes Water Quality Agreement of 1978, signed by the U.S. and Canada; the two nations agreed to reduce certain toxic pollutants in the Great Lakes. Over the years many other laws have changed parts of the CWA, accessed 03-7-05).

D

D_2O – *See* **heavy water**.

daughter, progeny – A given **nuclide** produced by radioactive decay from another nuclide (the "parent"). *See also* **radioactive series**.

DCG (derived concentration guide) – The concentration of a **radionuclide** in air or water that, under conditions of continuous exposure for one year by a single pathway (e.g., air inhalation, absorption, or ingestion), would result in an effective dose equivalent of 100 mrem (1 mSv). The values were established in **DOE Order 5400.5**.

decay product – A **nuclide** resulting from the radioactive disintegration of a **radionuclide**, being formed either directly or as a result of successive transformations in a radioactive series. A decay product may be either radioactive or stable.

decontamination – The removal or reduction of **radioactive** or hazardous contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques to achieve a stated objective or end condition.

disposal – Final placement or destruction of waste.

DOE (Department of Energy) – The federal agency that promotes scientific and technical innovation to support the national, economic, and energy security of the United States. DOE has responsibility for 10 national laboratories and for the science and research conducted at these laboratories, including Brookhaven National Laboratory.

DOE Order 231.1A – This order, Environment, Safety, and Health Reporting, is dated 8/19/03. It replaces the 1995 version, Order 231.1, as well as the "ORPS" order, DOE Order 232.1A, Occurrence Reporting and Processing of Operations Information, dated 7/21/97, and Order 210.1, Performance Indicator…, dated 9/27/95.

DOE Order 450.1 – This order, Environmental Protection Program, is dated 1/15/03. It replaces DOE Order 5400.1, General Environmental Protection Program, dated 11/9/88.

DOE Order 5400.5 – This order, Radiation Protection of the Public and the Environment, was first published by **DOE** in 1990 and was modified in 1993. It established the standards and requirements for operations of DOE and DOE contractors with respect to protecting the public and the **environment** against undue risk from radiation.

dose – *See* **EDE**.

dosimeter – A portable detection device for measuring exposure to ionizing radiation. See Chapter 8 for details.

downgradient – In the direction of **groundwater** flow from a designated area; analogous to "downstream."

DQO (Data Quality Objective) –The Data Quality Objective (DQO) process was developed by **EPA** for facilities to use when describing their environmental monitoring matrices, sampling methods, locations, frequencies, and measured parameters, as well as methods and procedures for data collection, analysis, maintenance, reporting, and archiving. The DQO process also addresses data that monitor quality assurance and quality control.

drift fence – A stretch of temporary fencing to prevent an animal population from leaving the area, used at BNL as part of a population study.

dry weight – The dry weight concentration of a substance is after a sample is dried for analysis. Dry weight concentrations are typically higher than wet weight values.

D-waste – Liquid waste containing radioactivity.

E

EA (Environmental Assessment) – A report that identifies potentially significant effects from any federally approved or funded project that might change the physical **environment**. If an EA identifies a "significant" potential impact (as defined by **NEPA**), an Environmental Impact Statement (EIS) must be researched and prepared.

EDB (ethylene dibromide) – A colorless, nonflammable, heavy liquid with a sweet odor; slightly soluble in water. Although the U.S. Department of Health and Human Services has determined that ethylene dibromide may reasonably be anticipated to be a carcinogen, it is still used to treat felled logs for bark beetles; to control wax moths in beehives; as a chemical intermediary for dyes, resins, waxes, and gums; to spot-treat milling machinery; and to control Japanese beetles in ornamental plants.

EDE (Effective Dose Equivalent) – A value used to express the health risk from radiation exposure to tissue in terms of an equivalent whole body exposure. It is a "normalized" value that allows the risk from radiation exposure received by a specific organ or part of the body to be compared with the risk due to whole-body exposure. The EDE equals the sum of the doses to different organs of the body multiplied by their respective **weighting factors**. It includes the sum of the EDE due to radiation from sources external to the body and the committed effective dose equivalent due to the internal deposition of **radionuclide**s. EDE is expressed in **rems** or **sieverts**.

effluent – Any liquid discharged to the environment, including stormwater **runoff** at a site or facility.

EIMS (Environmental Information Management System) – A database system used to store, manage, verify, protect, retrieve, and archive BNL's environmental data.

EM (environmental monitoring) – Sampling for contaminants in air, water, sediment, soil, food stuffs, plants, and animals, either by directly measuring or by collecting and analyzing samples.

emissions – Any gaseous or particulate matter discharged to the atmosphere.

EMS (Environmental Management System) – The BNL EMS meets the requirements of the **ISO 14001 EMS standard**, with emphasis on compliance assurance, pollution prevention, and community outreach. An extensive environmental monitoring program is one component of BNL's EMS.

environment – Surroundings (including air, water, land, natural resources, flora, fauna, and humans) in which an organization operates, and the interrelation of the organization and its surroundings.

environmental aspect – Elements of an organization's activities, products, or services that can interact with the surrounding air, water, land, natural resources, flora, fauna, and humans.

environmental impact – Any change to the surrounding air, water, land, natural resources, flora, and fauna, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products, or services.

environmental media – Includes air, **groundwater**, surface water, soil, flora, and fauna.

environmental monitoring or **surveillance** – *See* **EM**.

EPA (U. S. Environmental Protection Agency) – The federal agency responsible for developing and enforcing environmental laws. Although state or local regulatory agencies may be authorized to administer environmental regulatory programs, EPA generally retains oversight authority.

EPCRA (Emergency Planning and Community Right-to-Know Act) – Also known as Title III of SARA, EPCRA was enacted by Congress as the national legislation on community safety, to help local groups protect public health, safety, and the environment from chemical hazards. To implement EPCRA, Congress required each state to appoint a State Emergency Response Commission (SERC). The SERCs were required to divide their states into Emergency Planning Districts and to name a Local Emergency Planning Committee for each district

Broad representation by fire fighters, health officials, government and media representatives, community groups, industrial facilities, and emergency managers ensures that all necessary elements of the planning process are represented.

ES (environmental surveillance) – Sampling for contaminants in air, water, sediment, soil, food stuffs, plants, and animals, either by directly measuring or by collecting and analyzing samples.

ESA (Endangered Species Act) – This provides a program for conserving threatened and endangered plants and animals and their habitats. The **FWS** maintains the list of 632 *endangered* species (326 are plants) and 190 *threatened* species (78 are plants). Species include birds, insects, fish, reptiles, mammals, crustaceans, flowers, grasses, and trees. Anyone can petition FWS to include a species on this list. The law prohibits any action, administrative or real, that results in a "taking" of a listed species *or* adversely affects habitat. Likewise, import, export, interstate, and foreign commerce of listed species are all prohibited. **EPA**'s decision to register pesticides is based in part on the risk of adverse effects on endangered species as well as environmental fate (how a pesticide will affect habitat). Under **FIFRA**, EPA can issue emergency suspensions of certain pesticides to cancel or restrict their use if an endangered species will be adversely affected.

evapotranspiration – A process by which water is transferred from the soil to the air by plants that take the water up through their roots and release it through their leaves and other aboveground tissue.

exposure – A measure of the amount of ionization produced by x-rays or gamma rays as they travel through air. The unit of radiation exposure is the roentgen (R).

F

fallout – Radioactive material, made airborne as a result of aboveground nuclear weapons testing, that has been deposited on the Earth's surface.

FFCA (Federal Facility Compliance Act) – Formerly, the federal government maintained that it was not subject to fines and penalties under solid and hazardous waste law because of the doctrine of "sovereign immunity." The State of Ohio challenged this in *Ohio v. the Department of Energy (1990)*. The U.S. Circuit Court of Appeals found in favor of the State (June 11, 1990), writing that the federal government's sovereign immunity is waived under both the **CWA** sovereign immunity provision and **RCRA**'s citizen suit provision. The Circuit Court decision was overturned by the Supreme Court on April 21, 1992, in *DOE v. Ohio,* which held that the waiver of sovereign immunity in RCRA and CWA is not clear enough to allow states to impose civil penalties directly. After the high court's ruling, the consensus among lawmakers was that a double standard existed: the same government that developed laws to protect human health and the environment and required compliance in the private sector, was itself not assuming the burden of compliance. As a result, Congress enacted the FFCA (October 6, 1992, Pub. Law 102-386), which effectively overturned the Supreme Court's ruling. In the legislation Congress specifically waived sovereign immunity with respect to RCRA for federal facilities.

Under section 102, FFCA amends section 6001 of RCRA to specify that federal facilities are subject to "all civil and administrative penalties and fines, regardless of whether such penalties or fines are punitive or coercive in nature." These penalties and fines can be levied by **EPA** or by authorized states. In addition, FFCA states that "the United States hereby expressly waives any immunity otherwise applicable to the United States." Although federal agents, employees, and officers are not liable for civil penalties, they are subject to criminal sanctions. No departments, agencies, or instrumentalities are subject to criminal sanctions. Section 104 (1) and (2) require EPA to conduct annual RCRA inspections of all federal facilities.

FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) – The primary focus of this law was to provide federal control of pesticide distribution, sale, and use. **EPA** was given authority under FIFRA not only to study the consequences of pesticide usage but also to require users (farmers, utility companies, and others) to register when purchasing pesticides. Through later amendments to the law, users also must take exams for certification as applicators of pesticides. All pesticides used in the U.S. must be registered (licensed) by EPA. Registration assures that pesticides will be properly labeled and that if used in accordance with specifications, will not cause unreasonable harm to the environment.

FS (feasibility study) – A process for developing and evaluating remedial actions using data gathered during the remedial investigation. The FS defines the objectives of the remedial program for the site and broadly develops remedial action alternatives, performs an initial screening of these alternatives, and performs a detailed analysis of a limited number of alternatives that remain after the initial screening stage.

FWS (U.S. Fish & Wildlife Service) – The U.S. Fish and Wildlife Service is the principal federal agency responsible for conserving, protecting, and enhancing fish, wildlife, plants, and their habitats for the continuing benefit of the people of the United States. FWS manages the 95-million-acre National Wildlife Refuge System, which encompasses 544 national wildlife refuges, thousands of small wetlands, and other special management areas. It also operates 69 national fish hatcheries, 64 fishery resources offices, and 81 ecological services field stations. The agency enforces federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign and Native American tribal governments with their conservation efforts. It also oversees the Federal Assistance Program, which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

fugitive source – Unanticipated sources of volatile hazardous air pollutants due to leaks from valves, pumps, compressors, relief valves, connectors, flanges, and various other pieces of equipment.

G

gamma radiation – Gamma radiation is a form of electromagnetic radiation, like radio waves or visible light, but with a much shorter wavelength. It is more penetrating than **alpha** or **beta** radiation, capable of passing through dense materials such as concrete.

gamma spectroscopy – This analysis technique identifies specific **radionuclide**s. It measures the particular energy of a radionuclide's gamma radiation emissions. The energy of these emissions is unique for each nuclide, acting as a "fingerprint."

geotextile – A product used as a soil reinforcement agent and as a filter medium. It is made of synthetic fibers manufactured in a woven or loose manner to form a blanket-like product.

grab sample – A single sample collected at one time and place.

Green Building – Construction that adheres to guidelines established by the Green Building Council, a coalition of leaders from across the building industry working to promote structures that are environmentally responsible, profitable, and healthy places to live and work.

greenhouse gas (GHG) – Carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

global warming potential (GWP) – A factor describing the ratiative forcing impact of one unti of a given GHG relative to one unti of CO_2.

groundwater – Water found beneath the surface of the ground (subsurface water). Groundwater usually refers to a zone of complete water saturation containing no air.

gunite – A mixture of cement, sand, and water sprayed over a mold to form a solid, impermeable surface. Formerly a trademarked name, now in general usage.

H

half-life ($t_{1/2}$) – The time required for one-half of the atoms of any given amount of a radioactive substance to disintegrate; the time required for the activity of a radioactive sample to be reduced by one half.

halon – An ozone-depleting fire suppressant; suffixes (-1301, etc.) indicate variants.

hazardous waste – Toxic, corrosive, reactive, or ignitable materials that can injure human health or damage the environment. It can be liquid, solid, or sludge, and include heavy metals, organic solvents, reactive compounds, and corrosive materials. It is defined and regulated by **RCRA**, Subtitle C.

heat input – The heat derived from combustion of fuel in a steam generating unit. It does not include the heat from preheated combustion air, recirculated flue gases, or the exhaust from other sources.

heavy water (D_2O) – A form of water containing deuterium, a nonradioactive isotope of hydrogen.

herpetofaunal – Relating to the study of reptiles.

hot cell – Shielded and air-controlled facility for the remote handling of radioactive material.

hydrofluorocarbons (HFCs) – One of six primary GHGs primarily used as refrigerants; a class of gases containing hydrogen, fluorine, and carbon, and possessing a range of GWP values from 12 to 11,700.

hydrology – The science dealing with the properties, distribution, and circulation of natural water systems.

I

inert – Lacking chemical or biological action.

influent – Liquid (such as stormwater runoff or wastewater) flowing into a reservoir, basin, or treatment plant.

intermittent river – A stream that dries up on occasion, usually as a result of seasonal factors or decreased contribution from a source such as a wastewater treatment plant.

ionizing radiation – Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. High doses of ionizing radiation may produce severe skin or tissue damage. *See also* **alpha, beta, gamma radiation; x-rays**.

ISO 14001 EMS standard – The International Organization for Standardization (ISO) sets standards for a wide range of products and management operations. Following the success of the ISO 9000 Standards for quality management, ISO introduced the 14000 series for environmental management. BNL was the first DOE Office of Science laboratory to obtain third-party registration to this globally recognized environmental standard.

isotope – Two or more forms of a chemical element having the same number of protons in the nucleus (the same atomic number), but having different numbers of neutrons in the nucleus (different atomic weights). Isotopes of a single element possess almost identical chemical properties.

L

leaching – The process by which soluble chemical components are dissolved and carried through soil by water or some other percolating liquid.

light water – As used in this document, tap water, possibly filtered.

liquid scintillation counter – An analytical instrument used to quantify tritium, carbon-14, and other beta-emitting **radionuclide**s. *See also* **scintillation**.

M

matrix, matrices – The natural context (e.g., air, vegetation, soil, water) from which an environmental sample is collected.

MDL (minimum detection limit) – The lowest level to which an analytical parameter can be measured with certainty by the analytical laboratory performing the measurement. While results below the MDL are sometimes measurable, they represent values that have a reduced statistical confidence associated with them (less than 95 percent confidence).

MEI (maximally exposed individual) – The hypothetical individual whose location and habits tend to maximize his/her radiation dose, resulting in a dose higher than that received by other individuals in the general population.

metamorphic – In the state of changing from larval to mature forms.

mixed waste – Waste that contains both a hazardous waste component (regulated under Subtitle C of **RCRA)** and a radioactive component.

monitoring – The collection and analysis of samples or measurements of effluents and emissions for the purpose of characterizing and quantifying contaminants, and demonstrating compliance with applicable standards.

monitoring well – A well that collects **groundwater** for the purposes of evaluating water quality, establishing groundwater flow and elevation, determining the effectiveness of treatment systems, and determining whether administrative or engineered controls designed to protect groundwater are working as intended.

MSL (mean sea level) – The average height of the sea for all stages of the tide. Used as a benchmark for establishing groundwater and other elevations.

N

NEPA (National Environmental Policy Act) – Assures that all branches of government give proper consideration to the environment before any land purchase or any construction projects, including airports, buildings, military complexes, and highways. Project planners must assess the likely impacts of the project by completing an Environmental Assessment (EA) and, if necessary, an Environmental Impact Statement (EIS).

NESHAPs (National Emissions Standards for Hazardous Air Pollutants) – Standards that limit emissions from specific sources of air pollutants linked to serious health hazards. NESHAPs are developed by **EPA** under the CAA. Hazardous air pollutants can be chemical or radioactive. Their sources may be human-made, such as vehicles, power plants, and industrial or research processes, or natural, such as radioactive gas in soils.

neutrino – A small, neutral particle created as a result of particle decay. Neutrinos were believed to be massless, but recent studies have indicated that they have small, but finite, mass. Neutrinos interact very weakly.

NHPA (National Historic Preservation Act) – With passage of the National Historic Preservation Act in 1966, Congress made the federal government a full partner and a leader in historic preservation. The role of the federal government is fulfilled through the National Park Service. State participation is through State Historic Preservation Offices. "Before 1966, historic preservation was mainly understood in one-dimensional terms: the proverbial historic shrine or Indian burial mound secured by lock and key—usually in a national park—set aside from modern life as an icon for study and appreciation. NHPA largely changed that approach, signaling a much broader sweep that has led to the breadth and scope of the vastly more complex historic preservation mosaic we know today."

nonpoint source pollution – Nonpoint source pollution occurs when rainfall, snowmelt, or irrigation water runs over land or through the ground, picks up pollutants, and deposits them into rivers, lakes, and coastal waters or introduces them into **groundwater**. Nonpoint source pollution also includes adverse changes to the hydrology of water bodies and their associated aquatic habitats. After Congress passed the Clean Water Act in 1972, the nation's water quality community emphasized **point source** pollution (coming from a discrete conveyance or location, such as industrial and municipal waste discharge pipes). Point sources were the primary contributors to the degradation of water quality then, and the significance of nonpoint source pollution was poorly understood. Today, nonpoint source pollution remains the largest source of water quality problems. It is the main reason that approximately 40 percent of surveyed rivers, lakes, and estuaries are not clean enough to meet basic uses such as fishing or swimming.

NO_x – Nitrogen oxides are gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced, for example, by the combustion of fossil fuels in vehicles and electric power plants. In the atmosphere, NO_x can contribute to the formation of smog, impair visibility, and have health consequences. NO_x are considered "criteria air pollutants" under the CAA.

nuclide – A species of atom characterized by the number of protons and neutrons in the nucleus.

NYCRR (New York Codes, Rules, and Regulations) The NYCRR primarily contains state agency rules and regulations adopted under the State Administrative Procedure Act. There are 22 Titles: one for each state department, one for miscellaneous agencies and one for the Judiciary. Title 6 addresses environmental conservation, so many references in the SER are to "6 NYCRR."

O

O_3 – *See* ozone.

on site – The area within the boundaries of a site that is controlled with respect to access by the general public.

opacity – Under the Clean Air Act (**CAA**), a measurement of the degree to which smoke (emissions other than water vapor) reduces the transmission of light and obscures the view of an object in the background.

ORPS (Occurrence Reporting and Processing System) A system for identifying, categorizing, notifying, investigating, analyzing, and reporting to DOE events or conditions discovered at the BNL site. It was originally established by DOE Order 232.1, which has been replaced by **DOE Order 231.1A.**

OU (operable unit) – Division of a contaminated site into separate areas based on the complexity of the problems associated with it. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action. They may also consist of any set of actions performed over time, or actions that are concurrent, but located in different parts of a site. An OU can receive specific investigation and a particular remedy may be proposed. A Record of Decision (**ROD**) is prepared for each OU.

outfall – The place where wastewater is discharged.

oxides of nitrogen (NO_X) – *See* **NO_X**.

ozone (O_3) – A very reactive type of oxygen formed naturally in the upper atmosphere which provides a shield for the earth from the sun's ultraviolet rays. At ground level or in the lower atmosphere, it is pollution that forms when oxides of nitrogen and hydrocarbons react with oxygen in the presence of strong sunlight. Ozone at ground level can lead to health effects and cause damage to trees and crops.

P

P2 (pollution prevention) – Preventing or reducing the generation of pollutants, contaminants, hazardous substances, or wastes at the source, or reducing the amount for treatment, storage, and disposal through recycling. Pollution prevention can be achieved through reduction of waste at the source, segregation, recycle/reuse, and the efficient use of resources and material substitution. The potential benefits of pollution prevention include the reduction of adverse environmental impacts, improved efficiency, and reduced costs.

PAAA (Price-Anderson Act Amendments) – The Price-Anderson Act (PAA) was passed in 1957 to provide for prompt compensation in the case of a nuclear accident. The PAA provided broad financial coverage for damage, injury, and costs, and required DOE to indemnify contractors. The amended act of 1988 (PAAA) extended indemnification for 15 years and required DOE to establish and enforce nuclear safety rules. The PAAA Reauthorization, passed in December of 2002, extended current indemnification levels through 2004. 10 CFR 820 and its Appendix A provide DOE enforcement procedure and policy.

Parshall flume – An engineered channel used to measure the flow rate of water. It was named after the inventor, who worked for the U.S. government as an irrigation research engineer.

PCBs (polychlorinated biphenyls) – A family of organic compounds used from 1926 to 1979 (when they were banned by **EPA**) in electrical transformers, lubricants, carbonless copy paper, adhesives, and caulking compounds. PCBs are extremely persistent in the environment because they do not break down into different and less harmful chemicals. PCBs are stored in the fatty tissues of humans and animals through the bioaccumulation process.

percent recovery – For analytical results, the ratio of the measured amount, divided by the known (spiked) amount, multiplied by 100.

perfluorocarbons (PFCs) – One of the six primary GHGs consisting of a class of gases containing carbon and fluorine typically emitted as by-products of industrial and manufacturing processes, and possessing GWPs ranging from 5,700 to 11,900.

permit – An authorization issued by a federal, state, or local regulatory agency. Permits are issued under a number of environmental regulatory programs, including **CAA**, **CWA**, **RCRA**, and **TSCA**. Permits grant permission to operate, to discharge, to construct, and so on. Permit provisions may include emission/effluent limits and other requirements such as the use of pollution control devices, monitoring, record keeping and reporting. Also called a "license" or "certificate" under some regulatory programs.

pH – A measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, neutral solutions have a pH of 7, and basic solutions have a pH greater than 7 and up to 14.

plume – A body of contaminated **groundwater** or polluted air flowing from a specific source. The movement of a groundwater plume is influenced by such factors as local groundwater flow patterns, the character of the aquifer in which groundwater is contained, and the density of contaminants. The movement of an air contaminant plume is influenced by the ambient air motion, the temperatures of the ambient air and of the plume, and the density of the contaminants.

point source – Any confined and discrete conveyance (e.g., pipe, ditch, well, or stack) of a discharge.

pollutant – Any hazardous or radioactive material naturally occurring or added to an environmental medium, such as air, soil, water, or vegetation.

potable water – Water of sufficient quality for use as drinking water without endangering the health of people, plants, or animals.

precision – A statistical term describing the dispersion of data around a central value, usually represented as a variance, standard deviation, standard error, or confidence interval.

putrescible waste – Garbage that contains food and other organic biodegradable materials. There are special management requirements for this waste in 6 **NYCRR** Part 360.

Q

QA (quality assurance) – In environmental monitoring, any action to ensure the reliability of monitoring and measurement data. Aspects of QA include procedures, interlaboratory comparison studies, evaluations, and documentation.

QC (quality control) – In environmental monitoring, the routine application of procedures to obtain the required standards of performance in monitoring and measurement processes. QC procedures include calibration of instruments, control charts, and analysis of replicate and duplicate samples.

qualifier – A letter or series of letter codes in a graph or chart indicating that the associated value did not meet analytical requirements or was estimated.

quenching – Anything that interferes with the conversion of decay energy to electronic signal in the photomultiplier tubes of detection equipment, usually resulting in a reduction in counting efficiency.

R

R (roentgen) – A unit of exposure to ionizing radiation. It is the amount of gamma or x-rays required to produce ions carrying one electrostatic unit of electrical charge in one cubic centimeter of dry air under standard conditions. It is named after the German scientist Wilhelm Roentgen, who discovered x-rays.

RA (removal actions, "removals") – Interim actions that are undertaken to prevent, minimize, or mitigate damage to the public health or environment that may otherwise result from a release or threatened release of hazardous substances, pollutants, or contaminants pursuant to **CERCLA**, and that are not inconsistent with the final remedial action. Under CERCLA, **EPA** may respond to releases or threats of releases of hazardous substances by starting an RA to stabilize or clean up an incident or site that immediately threatens public health or welfare. Removal actions are less comprehensive than *remedial* actions. However, removal actions must contribute to the efficiency of future remedial actions.

radiation – Some atoms possess excess energy, causing them to be physically unstable. Such atoms become stable when the excess energy is released in the form of charged particles or electromagnetic waves, known as radiation.

radiation event – A single detection of a charged particle or electromagnetic wave.

radioactive series – A succession of **nuclide**s, each of which transforms by radioactive disintegration into the next until a stable nuclide results. The first member of the series is called the parent and the intermediate members are called daughters or progeny.

radioactivity – The spontaneous transition of an atomic nucleus from a higher energy to a lower energy state. This transition is accompanied by the release of a charged particle or electromagnetic waves from the atom. Also known as "activity."

radionuclide – A radioactive element characterized by the number of protons and neutrons in the nucleus. There are several hundred known radionuclides, both artificially produced and naturally occurring.

RCRA (Resource Conservation and Recovery Act) Pronounced "rick-rah," this act of Congress gave **EPA** the authority to control the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of nonhazardous wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites (*see* CERCLA). In 1984, amendments to RCRA called the Hazardous and Solid Waste Amendments (HSWA, pronounced "hiss-wa") required phasing out the land disposal of hazardous waste. Some other mandates of this strict law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank (UST) program.

recharge – The process by which water is added to a zone of saturation (aquifer) from surface infiltration, typically when rainwater soaks through the earth to reach an aquifer.

recharge basin – A basin (natural or artificial) that collects water. The water will infiltrate to the aquifer.

release – Spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a hazardous substance, pollutant, or contaminant into the environment. The National Contingency Plan also defines the term to include a threat of release.

rem – Stands for "**roentgen** equivalent man," a unit by which human radiation dose is assessed (*see also* **Sv**). The rem is a risk-based value used to estimate the potential health effects to an exposed individual or population. 100 rem = 1 sievert.

remedial (or **remediation) alternatives** – Options considered under **CERCLA** for decontaminating a site such as an operable unit (**OU**) or area of concern (**AOC**). Remedial actions are long-term activities that prevent the possible release, or stop or substantially reduce the actual release, of substances that are hazardous but not immediately life-threatening. *See also* feasibility study (**FS**) and Record of Decision (**ROD**).

residual fuel – Crude oil, Nos. 1 and 2 fuel oil that have a nitrogen content greater than 0.05 weight percent, and all fuel oil Nos. 4, 5, and 6, as defined by the American Society of Testing and Materials in ASTM D396-78, *Standard Specifications for Fuel Oils,* (c. 2001).

riparian – An organism living on the bank of a river, lake, or tidewater.

ROD (Record of Decision) – A document that records a regulatory agency's decision for the selected remedial action. The ROD also includes a responsiveness summary and a bibliography of documents that were used to reach the remedial decision. When the ROD is finalized, remedial design and implementation can begin.

roentgen – *See* R.

RPD (relative percent difference) – A measure of precision, expressed by the formula: RPD = [(A-B)/(A+B)] x 200, where A equals the concentration of the first analysis and B equals the concentration of the second analysis.

runoff – The movement of water over land. Runoff can carry pollutants from the land into surface waters or uncontaminated land.

S

sampling – The extraction of a prescribed portion of an effluent stream or environmental media for purposes of inspection or analysis.

SARA (Superfund Amendments and Reauthorization Act) – This Act of Congress in 1986 reauthorized CERCLA to continue cleanup activities around the country. Several site-specific amendments, definitions clarifications, and technical requirements were added to the legislation, including additional enforcement authorities. Title III of SARA also authorized EPCRA.

SBMS (Standards-Based Management System) – A document management tool used to develop and integrate systems, and to demonstrate BNL's conformance to requirements to perform work safely and efficiently.

scintillation – Flashes of light produced in a phosphor by a radioactive material.

Scope 1 emissions – Direct greenhouse gas emissions from sources that are owned or controlled by a Federal agency.

Scope 2 emissions – Indirect greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency.

Scope 3 emissions – Greenhouse gas emissions from sources not owned or directly controlled by a Federal agency, but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting.

SDWA (Safe Drinking Water Act) – The Safe Drinking Water Act was established to protect the quality of drinking water in the United States. It focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. The SDWA authorized **EPA** to establish safe standards of purity and required all owners or operators of public water systems to comply with health-related standards. State governments assume regulatory power from EPA.

sediment – The layer of soil and minerals at the bottom of surface waters, such as streams, lakes, and rivers.

sensitivity – The minimum amount of an analyte that can be repeatedly detected by an instrument.

sievert – *See* **Sv**.

skyshine – Radiation emitted upward from an open-topped, shielded enclosure and reflected downward, resulting in the possibility that flora and fauna (including humans) outside the shielded enclosure can be exposed to radiation.

sludge – Semisolid residue from industrial or water treatment processes.

sole source aquifer – An area defined by **EPA** as being the primary source of drinking water for a particular region. Includes the surface area above the sole source aquifer and its recharge area.

SPDES (State Pollutant Discharge Elimination System) This permit program is delegated to the states, but the effluent limitations and other requirements are set by the federal government. 6 NYCRR Section 750-1.11(a) concerns the provisions of SPDES permits and lists the citations for the various effluent limitations from the Federal Register and the **CFR**.

stable – Nonradioactive.

stakeholder – People or organizations with vested interests in BNL and its environment and operations. Stakeholders include federal, state, and local regulators; the public; DOE; and BNL staff.

stripping – A process used to remove volatile contaminants from a substance (*see also* **air stripping**).

sulfur hexafluoride (SF_6) – One of six primary GHGs, consisting of a single sulfur atom and six fluoride atoms, a GWP of 23,900, and primarily used in electrical transmission and distribution systems.

sump – A pit or tank that catches liquid **runoff** for drainage or disposal.

Sv (sievert) – A unit for assessing the risk of human radiation dose, used internationally and with increasing frequency in the United States. One sievert is equal to 100 rem.

SVE (soil vapor extraction) – An *in situ* (in-place) method of extracting **VOCs** from soil by applying a vacuum to the soil and collecting the air, which can be further treated to remove the VOCs, or discharged to the atmosphere.

SVOC – A general term for volatile organic compounds that vaporize relatively slowly at standard temperature and pressure. See also VOC.

synoptic – Relating to or displaying conditions as they occur over a broad area.

T

$t_{1/2}$ (half-life) – The time required for one-half of the atoms of any given amount of a radioactive substance to disintegrate; the time required for the activity of a radioactive sample to be reduced by one half.

TCE (trichloroethylene, also known as **trichloroethene)** A stable, colorless liquid with a low boiling point. TCE has many industrial applications, including use as a solvent and as a metal degreasing agent. TCE may be toxic when inhaled or ingested, or through skin contact, and can damage vital organs, especially the liver. S*ee also* **VOC**.

Tier III reports – Reports, required by **SARA**, that are prepared to document annual emissions of toxic materials to the environment. These are also known as TRI Section 313 reports.

TLD (thermoluminescent dosimeter) – A device used to measure radiation dose to occupational workers or radiation levels in the environment.

tritium – The heaviest and only radioactive nuclide of hydrogen, with a **half-life** of 12.3 years and a very-low-energy radioactive decay (tritium is a **beta** emitter).

TSCA (Toxic Substances Control Act) – Enacted by Congress in1976, TSCA empowers **EPA** to track the 75,000 industrial chemicals produced or imported into the United States. EPA repeatedly screens these chemicals and can require reporting or testing of any that may pose an environmental or human health hazard. EPA can ban the manufacture or import of chemicals that pose an unreasonable risk.

TVOC (total volatile organic compounds) – A sum of all individual **VOC** concentrations detected in a given sample.

U

UIC (underground injection control) – A hole with vertical dimensions greater than its largest horizontal dimensions; used for disposal of wastewater.

UST (underground storage tank) – A stationary device, constructed primarily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10 percent or more of the volume of the tank system is below the surface of the ground.

upgradient/upslope – A location of higher **groundwater** elevation; analogous to "upstream."

V

vadose – Relating to water in the ground that is above the permanent groundwater level.

vernal pool – A small, isolated, and contained basin that holds water on a temporary basis, most commonly during winter and spring. It has no aboveground outlet for water and is extremely important to the life cycle of many amphibians (such as the tiger salamander), as it is too shallow to support fish, a major predator of amphibian larvae.

VOC (volatile organic compound) –A general term for organic compounds capable of a high degree of vaporization at standard temperature and pressure. Because VOCs readily evaporate into the air, the potential for human exposure is greatly increased. Due to widespread industrial use, VOCs are commonly found in soil and groundwater.

VUV – Stands for "very ultraviolet" and refers to a beamline at the NSLS with wavelengths at the far ultraviolet end of the spectrum.

W

waste minimization – Action that avoids or reduces the generation of waste, consistent with the general goal of minimizing current and future threats to human health, safety, and the environment. Waste minimization activities include recycling, improving energy usage, reducing waste at the source, and reducing the toxicity of hazardous waste. This action is associated with pollution prevention, but is more likely to occur after waste has been generated.

water table – The water-level surface below the ground where the unsaturated zone ends and the saturated zone begins. It is the level to which a well that is screened in the unconfined aquifer will fill with water.

watershed – The region draining into a river, a river system, or a body of water.

weighting factor – A factor which, when multiplied by the dose equivalent delivered to a body organ or tissue, yields the equivalent risk due to a uniform radiation exposure of the whole body. *See also* **EDE**.

wet weight – The wet weight concentration of a substance is before a sample is dried for analysis (in other words, in its "natural" state), and is the form most likely to be consumed. Wet weight concentrations are typically lower than dry weight values.

wind rose – A diagram that shows the frequency of wind from different directions at a specific location.

X

x-rays – A form of electromagnetic **radiation** with short wavelength, generated when high-energy electrons strike matter or when lower-energy **beta** radiation is absorbed in matter. **Gamma** radiation and x-rays are identical, except for the source.

Z

zeolite – A naturally occurring group of more than 100 minerals, formed of silicates and aluminum, with unique and diverse crystal properties. Zeolites can perform ion exchange, filtering, odor removal, and chemical sieve and gas absorption tasks. Synthetic zeolites are now used for most applications.

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Understanding Radiation

This section introduces the general reader to some basic concepts of radioactivity and an understanding of the radiation emitted as radioactive materials decay to a stable state. To better comprehend the radiological information in the Site Environmental Report (SER), it is important to remember that not all radiations are the same and that different kinds of radiation affect living beings differently.

This appendix includes discussions on the common sources of radioactivity in the environment, types of radiation, the analyses used to quantify radioactive material, and how radiation sources contribute to radiation dose. Some general statistical concepts are also presented, along with a discussion of radionuclides that are of environmental interest at BNL. The discussion begins with some definitions and background information on scientific notation and numerical prefixes used when measuring dose and radioactivity. The definitions of commonly used radiological terms are found in the Technical Topics section of the glossary, Appendix A, and are indicated in boldface type here only when the definition in the glossary provides additional details.

RADIOACTIVITY AND RADIATION

All substances are composed of atoms that are made of subatomic particles: protons, neutrons, and electrons. The protons and neutrons are tightly bound together in the positively charged nucleus (plural: nuclei) at the center of the atom. The nucleus is surrounded by a cloud of negatively charged electrons. Most nuclei are stable because the forces holding the protons and neutrons together are strong enough to overcome the electrical energy that tries to push them apart. When the number of neutrons in the nucleus exceeds a threshold, then the nucleus becomes unstable and will spontaneously "decay," or emit excess energy ("nuclear" energy) in the form of charged particles or electromagnetic waves. Radiation is the excess energy released by unstable atoms. Radioactivity and radioactive refer to the unstable nuclear property of a substance (e.g., radioactive uranium). When a charged particle or electromagnetic wave is detected by radiation-sensing equipment, this is referred to as a radiation event.

Radiation that has enough energy to remove electrons from atoms within material (a process called ionization) is classified as ionizing radiation. Radiation that does not have enough energy to remove electrons is called nonionizing radiation. Examples of nonionizing radiation include most visible light, infrared light, microwaves, and radio waves. All radiation, whether ionizing or not, may pose health risks. In the SER, radiation refers to ionizing radiation.

Radioactive elements (or radionuclides) are referred to by name followed by a number, such as cesium-137. The number indicates the mass of that element and the total number of neutrons and protons contained in the nucleus of the atom. Another way to specify cesium-137 is Cs-137, where Cs is the chemical symbol for cesium in the Periodic Table of the Elements. This type of abbreviation is used throughout the SER.

SCIENTIFIC NOTATION

Most numbers used for measurement and quantification in the SER are either very large or very small, and many zeroes would be required to express their value. To avoid this, scientific notation is used, with numbers represented in multiples of 10. For example, the number two million five hundred thousand (two and a half million, or 2,500,000) is written in scientific notation as 2.5×10^6, which represents "2.5 multiplied by 10 raised to the power of 6." Since even "2.5×10^6" can be cumbersome, the capital letter E is substituted for the phrase "10 raised to the power of …" Using this format, 2,500,000 is represented as 2.5E+06. The "+06" refers to the number of places the decimal point was moved to the left to create the shorter version. Scientific notation is also used to represent numbers smaller than zero, in which case a

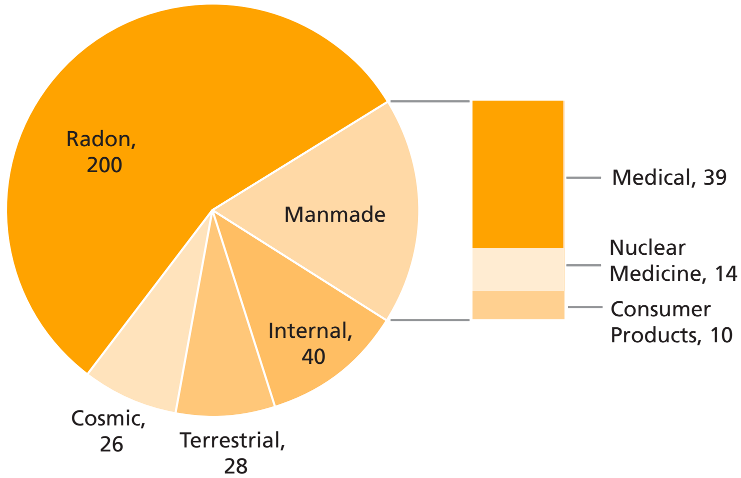

Figure B-1. Typical Annual Radiation Doses from Natural and Man-Made Sources (mrem). *Source: NCRP Report No. 93 (NCRP 1987)*

minus sign follows the E rather than a plus. For example, 0.00025 can be written as 2.5 x 10^{-4} or 2.5E-04. Here, "-04" indicates the number of places the decimal point was moved to the right.

NUMERICAL PREFIXES

Another method of representing very large or small numbers without using many zeroes is to use prefixes to represent multiples of ten. For example, the prefix *milli* (abbreviated m) means that the value being represented is one-thousandth of a whole unit; 3 mg (milligrams) is 3 thousandths of a gram or E-03. See Appendix C for additional common prefixes, including *pico* (p), which means trillionth or E-12, *giga* (G), which means billion or E+09, and *tera* (T), which means trillion, E+12.

SOURCES OF IONIZING RADIATION

Radiation is energy that has both natural and manmade sources. Some radiation is essential to life, such as heat and light from the sun. Exposure to high-energy (ionizing) radiation has to be managed, as it can pose serious health risks at large doses. Living things are exposed to radiation from natural background sources: the atmosphere, soil, water, food, and even our own bodies. Humans are exposed to ionizing radiation from a variety of common sources, the most significant of which follow.

Background Radiation **–** Radiation that occurs naturally in the environment is also called background activity. Background radiation consists of cosmic radiation from outer space, radiation from radioactive elements in soil and rocks, and radiation from radon and its decay products in air. Some people use the term background when referring to all non-occupational sources commonly present. Other people use natural to refer only to cosmic and terrestrial sources, and background to refer to common man-made sources such as medical procedures, consumer products, and radioactivity present in the atmosphere from former nuclear testing. In the SER, the term natural background is used to refer to radiation from cosmic and terrestrial radiation.

Cosmic **–** Cosmic radiation primarily consists of charged particles that originate in space, beyond the earth's atmosphere. This includes ionizing radiation from the sun, and secondary radiation generated by the entry of charged particles into the earth's atmosphere at high speeds and energies. Radioactive elements such as hydrogen-3 (tritium), beryllium-7, carbon-14, and sodium-22 are produced in the atmosphere by cosmic radiation. Exposure to cosmic radiation increases with altitude, because at higher elevations the atmosphere and the earth's magnetic field provide less shielding. Therefore, people who live in the mountains are exposed to more cosmic radiation than people who live at sea level. The average dose from cosmic radiation to a person living in the United States is approximately 26 mrem per year. (For an explanation of dose, see *effective dose equivalent* in Appendix A. The units *rem* and *sieverts* also are explained in Appendix A.)

Terrestrial **–** Terrestrial radiation is released by radioactive elements that have been present in the soil since the formation of the earth. Common radioactive elements that contribute to terrestrial exposure include isotopes of potassium, thorium, actinium, and uranium. The average dose from terrestrial radiation to a person living in the United States is approximately 28 mrem per year, but may vary considerably depending on the local geology.

Internal **–** Internal exposure occurs when radionuclides are ingested, inhaled, or absorbed through the skin. Radioactive material may be incorporated into food through the uptake of terrestrial radionuclides by plant roots. People can ingest radionuclides when they eat contaminated plant matter or meat from animals that have consumed contaminated plants. The average dose from food for a person living in the United States is about 40 mrem per year. A larger exposure, for most people, comes from breathing the decay products of naturally occurring radon gas. The average dose from breathing air with radon byproducts is about 200 mrem per year, but that amount varies depending on geographical location. An Environmental Protection Agency (EPA) map shows that BNL is located in one of the regions with the lowest potential radon risk.

Medical **–** Every year in the United States, millions of people undergo medical procedures that use ionizing radiation. Such procedures include chest and dental x-rays, mammography, thallium heart stress tests, and tumor irradiation therapies. The average doses from nuclear medicine and x-ray examination procedures are about 14 and 39 mrem per year, respectively.

Anthropogenic **–** Sources of anthropogenic (man-made) radiation include consumer products such as static eliminators (containing polonium-210), smoke detectors (containing americium-241), cardiac pacemakers (containing plutonium-238), fertilizers (containing isotopes from uranium and thorium decay series), and tobacco products (containing polonium-210 and lead-210). The average dose from consumer products to a person living in the United States is 10 mrem per year (excluding tobacco contributions).

COMMON TYPES OF IONIZING RADIATION

The three most common types of ionizing radiation are described below.

Alpha Radiation **–** An alpha particle is identical in makeup to the nucleus of a helium atom, consisting of two neutrons and two protons. Alpha particles have a positive charge and have little or no penetrating power in matter. They are easily stopped by materials such as paper and have a range in air of only an inch or so. However, if alpha-emitting material is ingested, alpha particles can pose a health risk inside the body. Naturally occurring radioactive elements such as uranium emit alpha radiation.

Beta Radiation **–** Beta radiation is composed of particles that are identical to electrons. Therefore, beta particles have a negative charge. Beta radiation is slightly more penetrating than alpha radiation, but most beta radiation can be stopped by materials such as aluminum foil and plexiglass panels. Beta radiation has a range in air of several feet. Naturally occurring radioactive elements such as potassium-40 emit beta radiation. Some beta particles present a hazard to the skin and eyes.

Gamma Radiation **–** Gamma radiation is a form of electromagnetic radiation, like radio waves or visible light, but with a much shorter wavelength. Gamma rays are emitted from a radioactive nucleus along with alpha or beta particles. Gamma radiation is more penetrating than alpha or beta radiation, capable of passing through dense materials such as concrete. Gamma radiation is identical to x-rays except that x-rays are more energetic. Only a fraction of the total gamma rays a person is exposed to will interact with the human body.

TYPES OF RADIOLOGICAL ANALYSES

The amount of radioactive material in a sample of air, water, soil, or other material can be assessed using several analyses, the most common of which are described below.

Gross alpha **–** Alpha particles are emitted from radioactive material in a range of different energies. An analysis that measures all alpha particles simultaneously, without regard to their particular energy, is known as a gross alpha activity measurement. This type of measurement is valuable as a screening tool to indicate the total amount but not the type of alpha-emitting radionuclides that may be present in a sample.

Gross beta **–** This is the same concept as that for gross alpha analysis, except that it applies to the measurement of gross beta particle activity.

Tritium **–** Tritium radiation consists of low-energy beta particles. It is detected and quantified by liquid scintillation counting. More information on tritium is presented in the section Radionuclides of Environmental Interest, later in this appendix.

Strontium-90 **–** Due to the properties of the radiation emitted by strontium-90 (Sr-90), a special analysis is required. Samples are chemically processed to separate and collect any strontium atoms that may be present. The collected atoms are then analyzed separately. More information on Sr-90 is presented in the section Radionuclides of Environmental Interest.

***Gamma* –** This analysis technique identifies specific radionuclides. It measures the particular energy of a radionuclide's gamma radiation emission. The energy of these emissions is unique for each radionuclide, acting as a "fingerprint" to identify it.

STATISTICS

Two important statistical aspects of measuring radioactivity are uncertainty in results, and negative values.

***Uncertainty* –** Because the emission of radiation from an atom is a random process, a sample counted several times usually yields a slightly different result each time; therefore, a single measurement is not definitive. To account for this variability, the concept of uncertainty is applied to radiological data. In the SER, analysis results are presented in an x ± y format, where "x" is the analysis result and "± y" is the 95 percent "confidence interval" of that result. That means there is a 95 percent probability that the true value of x lies between (x + y) and (x – y).

***Negative values* –** There is always a small amount of natural background radiation. The laboratory instruments used to measure radioactivity in samples are sensitive enough to measure the background radiation along with any contaminant radiation in the sample. To obtain a true measure of the contaminant level in a sample, the background radiation level must be subtracted from the total amount of radioactivity measured. Due to the randomness of radioactive emissions and the very low concentrations of some contaminants, it is possible to obtain a background measurement that is larger than the actual contaminant measurement. When the larger background measurement is subtracted from the smaller contaminant measurement, a negative result is generated. The negative results are reported, even though doing so may seem illogical, but they are essential when conducting statistical evaluations of data.

Radiation events occur randomly; if a radioactive sample is counted multiple times, a spread, or distribution, of results will be obtained. This spread, known as a Poisson distribution, is centered about a mean (average) value. Similarly, if background activity (the number of radiation events observed when no sample is present) is counted multiple times, it also will have a Poisson distribution. The goal of a radiological analysis is to determine whether a sample contains activity greater than the background reading detected by the instrument. Because the sample activity and the background activity readings are both Poisson distributed, subtraction of background activity from the measured sample activity may result in values that vary slightly from one analysis to the next. Therefore, the concept of a minimum detection limit (MDL) was established to determine the statistical likelihood that a sample's activity is greater than the background reading recorded by the instrument.

Identifying a sample as containing activity greater than background, when it actually does not have activity present, is known as a Type I error. Most laboratories set their acceptance of a Type I error at 5 percent when calculating the MDL for a given analysis. That is, for any value that is greater than or equal to the MDL, there is 95 percent confidence that it represents the detection of true activity. Values that are less than the MDL may be valid, but they have a reduced confidence associated with them. Therefore, all radiological data are reported, regardless of whether they are positive or negative

At very low sample activity levels that are close to the instrument's background reading, it is possible to obtain a sample result that is less than zero. This occurs when the background activity is subtracted from the sample activity to obtain a net value, and a negative value results. Due to this situation, a single radiation event observed during a counting period could have a significant effect on the mean (average) value result. Subsequent analysis may produce a sample result that is positive. When the annual data for the SER are compiled, results may be averaged; therefore, all negative values are retained for reporting as well. This data handling practice is consistent with the guidance provided in the Handbook of

Radioactivity Measurements Procedures (NCRP 1985) and the Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (DOE 1991). Average values are calculated using actual analytical results, regardless of whether they are above or below the MDL, or even equal to zero. The uncertainty of the mean, or the 95 percent confidence interval, is determined by multiplying the population standard deviation of the mean by the $t_{(0.05)}$ statistic.

RADIONUCLIDES OF ENVIRONMENTAL INTEREST

Several types of radionuclides are found in the environment at BNL due to historical operations.

Cesium-137 – Cs-137 is a fission-produced radionuclide with a half-life of 30 years (after 30 years, only one half of the original activity level remains). It is found in the worldwide environment as a result of past aboveground nuclear weapons testing and can be observed in near-surface soils at very low concentrations, usually less than 1 pCi/g (0.004 Bq/g). Cs-137 is a beta-emitting radionuclide, but it can be detected by gamma spectroscopy because its decay product, barium-137m, emits gamma radiation.

Cs-137 is found in the environment at BNL mainly as a soil contaminant, from two main sources. The first source is the worldwide deposition from nuclear accidents and fallout from weapons testing programs. The second source is deposition from spills or releases from BNL operations. Nuclear reactor operations produce Cs-137 as a byproduct. In the past, wastewater containing small amounts of Cs-137 generated at the reactor facilities was routinely discharged to the Sewage Treatment Plant (STP), resulting in low-level contamination of the STP and the Peconic River. In 2002/2003, under the Environmental Restoration Program, sand and its debris containing low levels of Cs-137, Sr-90, and heavy metals were removed, assuring that future discharges from the STP are free of these contaminants. Soil contaminated with Cs-137 is associated with the following areas that have been, or are being, addressed as part of the Environmental Remediation Program: former Hazardous Waste Management Facility, Waste Concentration Facility, Building 650 Reclamation Facility and Sump Outfall Area, and the Brookhaven Graphite Research Reactor (BGRR).

Strontium-90 – Sr-90 is a beta-emitting radionuclide with a half-life of 28 years. Sr-90 is found in the environment principally as a result of fallout from aboveground nuclear weapons testing. Sr-90 released by weapons testing in the 1950s and early 1960s is still present in the environment today. Additionally, nations that were not signatories of the Nuclear Test Ban Treaty of 1963 have contributed to the global inventory of fission products (Sr-90 and Cs-137). This radionuclide was also released as a result of the 1986 Chernobyl accident in the former Soviet Union.

Sr-90 is present at BNL in the soil and groundwater. As in the case of Cs-137, some Sr-90 at BNL results from worldwide nuclear testing; the remaining contamination is a byproduct of reactor operations. The following areas with Sr-90 contamination have been or are being addressed as part of the Environmental Remediation Program: former Hazardous Waste Management Facility, Waste Concentration Facility, Building 650 Reclamation Facility and Sump Outfall Area, the BGRR, Former and Interim Landfills, Chemical and Glass Holes Area, and the STP.

The information in SER tables is arranged by method of analysis. Because Sr-90 requires a unique method of analysis, it is reported as a separate entry. Methods for detecting Sr-90 using state-of-the-art equipment are quite sensitive (detecting concentrations less than 1 pCi/L), which makes it possible to detect background levels of Sr-90.

Tritium – Among the radioactive materials that are used or produced at BNL, tritium has received the most public attention. Approximately 4 million Ci (1.5E+5 TBq) per year are produced in the atmosphere naturally (NCRP 1979). As a result of aboveground weapons testing in the 1950s and early 1960s in the United States, the global atmospheric tritium inventory was increased by a factor of approximately 200. Other human activities such as consumer product manufacturing and nuclear power reactor operations have also released tritium into the environment. Commercially, tritium is used in products such as self-illuminating wristwatches and exit signs (the signs may each contain as much as 25 Ci [925 GBq] of tritium). Tritium also has many uses in medical and biological research as a labeling agent in chemical compounds, and is frequently used in universities and other research settings such as BNL and other national laboratories.

Of the sources mentioned above, the most significant contributor to tritium in the environment has been aboveground nuclear weapons testing. In the early 1960s, the average tritium concentration in surface streams in the United States reached a value of 4,000 pCi/L (148 Bq/L; NCRP 1979). Approximately the same concentration was measured in precipitation. Today, the level of tritium in surface waters in New York State is less than one-twentieth of that amount, below 200 pCi/L (7.4 Bq/L; NYSDOH 1993). This is less than the detection limit of most analytical laboratories.

Tritium has a half-life of 12.3 years. When an atom of tritium decays, it releases a beta particle, causing transformation of the tritium atom into stable (nonradioactive) helium. The beta radiation that tritium releases has a very low energy, compared to the emissions of most other radioactive elements. In humans, the outer layer of dead skin cells easily stops the beta radiation from tritium; therefore, only when tritium is taken into the body can it cause an exposure. Tritium may be taken into the body by inhalation, ingestion, or absorption of tritiated water through the skin. Because of its low energy radiation and short residence time in the body, the health threat posed by tritium is very small for most exposures.

Environmental tritium is found in two forms: gaseous elemental tritium, and tritiated water or water vapor, in which at least one of the hydrogen atoms in the H_2O water molecule has been replaced by a tritium atom (hence, its shorthand notation, HTO). Most of the tritium released from BNL sources is in the form of HTO, none as elemental tritium. Sources of tritium at BNL include the reactor facilities (all now non-operational), where residual water (either heavy or light) is converted to tritium via neutron bombardment; the accelerator facilities, where tritium is produced by secondary radiation interactions with soil and water; and facilities like the Brookhaven Linac Isotope Producer, where tritium is formed from secondary radiation interaction with cooling water. Tritium has been found in the environment at BNL as a groundwater contaminant from operations in the following areas: Current Landfill, BLIP, Alternating Gradient Synchrotron, and the High Flux Beam Reactor. Although small quantities of tritium are still being released to the environment through BNL emissions and effluents, the concentrations and total quantity have been drastically reduced, compared with historical operational releases as discussed in Chapters 4 and 5.

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Units of Measure and Half-Life Periods

UNITS OF RADIATION MEASUREMENT AND CONVERSIONS

U.S. System	International System	Conversion
curie (Ci)	becquerel (Bq)	1 Ci = 3.7 x 10^{10} Bq
rad	gray (Gy)	1 rad = 0.01 Gy
rem	sievert (Sv)	1 rem = 0.01 Sv

APPROXIMATE METRIC CONVERSIONS

When you know	multiply by	to obtain	When you know	multiply by	to obtain
centimeters (cm)	0.39	inches (in.)	in.	2.54	cm
meters (m)	3.28	feet (ft)	ft	0.305	m
kilometers (km)	0.62	miles (mi)	mi	1.61	km
kilograms (kg)	2.20	pounds (lb)	lb	0.45	kg
liters (L)	0.264	gallons (gal)	gal	3.785	L
cubic meters (m^3)	35.32	cubic feet (ft^3)	ft^3	0.03	m^3
hectares (ha)	2.47	acres	acres	0.40	ha
square kilometers (km^2)	0.39	square miles (mi^2)	mi^2	2.59	km^2
degrees Celcius (°C)	1.8 (°C) + 32	degrees Fahrenheit (°F)	°F	(°F - 32) / 1.8	°C

SCIENTIFIC NOTATION USED FOR MEASUREMENTS

Multiple	Decimal Equivalent	Notation	Prefix	Symbol
1 x 10^{12}	1,000,000,000,000	E+12	Tera-	T
1 x 10^{9}	1,000,000,000	E+9	giga-	G
1 x 10^{3}	1,000	E+03	kilo-	k
1 x 10^{-2}	0.01	E-02	centi-	c
1 x 10^{-3}	0.001	E-03	milli-	m
1 x 10^{-6}	0.000001	E-06	micro-	µ
1 x 10^{-9}	0.000000001	E-09	nano-	n
1 x 10^{-12}	0.000000000001	E-12	pico-	p

CONCENTRATION CONVERSIONS

1 ppm	=	1,000 ppb		
1 ppb	=	0.001 ppm	=	1µg/L*
1 ppm	=	1 mg/L	=	1000 µg/L*

* For aqueous fractions only.

HALF-LIFE PERIODS	
Am-241	432.7 yrs
C-11	~20 min
Co-60	5.3 yrs
Cs-137	30.2 yrs
N-13	~10 min
N-22	2.6 yrs
O-15	~2 min
PU-238	87.7 yrs
Pu-239	24,100.0 yrs
Pu-240	6,560.0 yrs
Sr-90	29.1 yrs
tritium	12.3 yrs
U-234	247,000.0 yrs
U-235	~700 million yrs (7.0004E8)
U-238	87.7 yrs

Federal, State, and Local Laws and Regulations Pertinent to BNL

DOE DIRECTIVES, REGULATIONS, AND STANDARDS

DOE O 231.1B	Order: Environment, Safety and Health Reporting 06/27/2011
DOE O 414.1D	Order: Quality Assurance 08/16/2001
DOE O 435.1	Order: Change 1: Radioactive Waste Management 07/09/1999
DOE P 450.5	Policy: Line Environment, Safety, and Health Oversight 06/26/1997
DOE O 458.1	Order: Radiation Protection of the Public and the Environment 02/11/2011
DOE O 436.1	Order: Departmental Sustainability 05/02/2011

FEDERAL LAWS AND REGULATIONS

EO 13148	Greening of the Government Through Leadership in Environmental Management
EO 13423	Strengthening Federal Environmental, Energy and Transportation Management
EO 13514	Federal leadership in Environmental, Energy, and Economic Performance
10 CFR 1021	National Environmental Protection Act, Implementing and Procedures
10 CFR 1022	Compliance with Floodplain/Wetlands Environmental Review Requirements
10 CFR 830	Subpart A: Quality Assurance Requirements
10 CFR 834	Radiation Protection of the Public and the Environment
16 USC 470	National Historic Preservation Act
36 CFR 60	National Register of Historic Places
36 CFR 63	Determination of Eligibility for Inclusion in the National Register of Historic Places
36 CFR 79	Curation of Federally Owned and Administered Archaeological Collections
36 CFR 800	Protection of Historic Properties
40 CFR 50-0	National Primary and Secondary Ambient Air Quality Standards
40 CFR 82	Protection of Stratospheric Ozone
40 CFR 109	Criteria for State, Local and Regional Oil Removal Contingency Plans
40 CFR 110	Discharge of Oil
40 CFR 112	Oil Pollution Prevention Act
40 CFR 113	Liability Limits for Small Onshore Storage Facilities
40 CFR 116	Designation of Hazardous Substances
40 CFR 117	Determination of Reportable Quantities for Hazardous Substances

40 CFR 121	State Certification of Activities Requiring a Federal License or Permit
40 CFR 122	National Pollution Discharge Elimination System (NPDES)
40 CFR 123	State Program Requirements
40 CFR 124	Procedures for Decision-making
40 CFR 125	Criteria and Standards for the National Pollutant Discharge Elimination System
40 CFR 129	Toxic Pollutant Effluent Standards
40 CFR 130	Water Quality Planning and Management
40 CFR 131	Water Quality Standards
40 CFR 132	Water Quality Guidance for the Great Lakes System
40 CFR 133	Secondary Treatment Regulation
40 CFR 135	Prior Notice of Citizen Suits
40 CFR 136	Guidelines Establishing Test Procedures for the Analysis of Pollutants
40 CFR 141	National Primary Drinking Water Regulations
40 CFR 142	National Primary Drinking Water Regulations Implementation
40 CFR 143	National Secondary Drinking Water Regulations
40 CFR 144	Underground Injection Control (UIC) Program
40 CFR 146	Underground Injection Control (UIC) Program: Criteria and Standards
40 CFR 148	Hazardous Waste Injection Restrictions
40 CFR 149	Sole Source Aquifers
40 CFR 167	Submissions of Pesticide Reports
40 CFR 168	Statements of Enforcement Policies and Interpretations
40 CFR 169	Books and Records of Pesticide Production and Distribution
40 CFR 170	Worker Protection Standard
40 CFR 171	Certification of Pesticide Applicators
40 CFR 260	Hazardous Waste Management Systems: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Special Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities

40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Program: The Hazardous Waste Permit Program
40 CFR 271	Requirements for Authorization of State Hazardous Waste Mgmt Programs
40 CFR 272	Approved State Hazardous Waste Management Programs
40 CFR 273	Standards for Universal Waste Management
40 CFR 279	Standards for the Management of Used Oil
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (USTs)
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 370	Hazardous Chemical Report: Community Right-to-Know
40 CFR 372	Toxic Chemical Release Report: Community Right-to-Know
40 CFR 700	Toxic Substances Control Act [TSCA]
40 CFR 702	Toxic Substances Control Act: General Practices and Procedures
40 CFR 704	Toxic Substances Control Act: Reporting and Recordkeeping Requirements
40 CFR 707	Chemical Imports and Exports
40 CFR 710	Inventory Reporting Regulations
40 CFR 712	Chemical Information Rules
40 CFR 716	Health and Safety Data Reporting
40 CFR 717	Records and Reports of Allegations that Chemical Substances Cause Significant Adverse Reactions to Health or the Environment
40 CFR 720	Premanufacture Notification
40 CFR 721	Significant New Users of Chemical Substances
40 CFR 723	Premanufacture Notification Exemptions
40 CFR 725	Reporting Requirements and Review Processes for Microorganisms
40 CFR 745	Lead-Based Paint Poisoning Prevention in Certain Residential Structures
40 CFR 747	Metalworking Fluids
40 CFR 749	Water Treatment Chemicals
40 CFR 750	Procedures for Rulemaking Under Section 6 of TSCA
40 CFR 761	PCBs Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
40 CFR 763	Asbestos
40 CFR 1500	Council on Environmental Quality: Purpose, Policy, and Mandate

40 CFR 1501	NEPA and Agency Planning
40 CFR 1502	Environmental Impact Statement
40 CFR 1503	Commenting
40 CFR 1504	Predecision Referrals to the Council of Proposed Federal Actions
40 CFR 1505	NEPA and Agency Decision-making
40 CFR 1506	Other Requirements of NEPA
40 CFR 1507	Agency Compliance
40 CFR 1508	Terminology and Index
50 CFR 17	Endangered and Threatened Wildlife and Plants

NEW YORK STATE LAWS, REGULATIONS, AND STANDARDS

6 NYCRR 182	Endangered and Threatened Species of Fish and Wildlife, Species of Special Concern
6 NYCRR 200	Environmental Conservation Law
6 NYCRR 201	Subpart 201-1: General Provisions
6 NYCRR 202	Subpart 202: Emissions Verification
6 NYCRR 203	Indirect Sources of Air Contamination
6 NYCRR 204	NO_x Budget Training Program
6 NYCRR 205	Architectural and Maintenance (AIM) Coatings
6 NYCRR 207	Control Measures for an Air Pollution Episide
6 NYCRR 208	Landfill Gas Collection and Control System for Certain Municipal Solid Waste Landfills
6 NYCRR 211	General Prohibitions
6 NYCRR 212	General Process Emission Sources
6 NYCRR 215	Open Fires
6 NYCRR 217	Environmental Conservation Rules and Regulations [Exhaust and Emission Standards]
6 NYCRR 218	Subpart 218-1 [More on Vehicle Exhaust]
6 NYCRR 221	Asbestos-Containing Surface Coating Material
6 NYCRR 225	Subpart 225-1: Fuel Composition and Use – Sulfur Limitations
6 NYCRR 227	Solvent Metal Cleaning Processes
6 NYCRR 228	Surface Coating Processes
6 NYCRR 229	Petroleum and Volatile Organic Liquid Storage and Transfer
6 NYCRR 230	Gasoline Dispensing Sites and Transport Vehicles
6 NYCRR 231	New Source Review in Nonattainment Areas and Ozone Transport Regions
6 NYCRR 234	Graphic Arts

6 NYCRR 237	Acid Deposition Reduction NO_x Budget Training Program
6 NYCRR 238	Acid Deposition Reduction SO_2 Budget Training Program
6 NYCRR 239	Portable Fuel Container Spillage Control
6 NYCRR 240	Conformity to State or Federal Implementation Plans
6 NYCRR 250	Miscellaneous Orders
6 NYCRR 256	Air Quality Classification System
6 NYCRR 257	Air Quality Standards
6 NYCRR 307	[Air Quality in] Suffolk County
6 NYCRR 320	Pesticides - General
6 NYCRR 325	Application of Pesticides
6 NYCRR 326	Registration and Certification of Pesticides
6 NYCRR 327	Use of Chemicals for the Control or Elimination of Aquatic Vegetation
6 NYCRR 328	Use of Chemicals for the Extermination of Undesirable Fish
6 NYCRR 329	Use of Chemicals for the Control or Elimination of Aquatic Insects
6 NYCRR 360-1	General Provisions: Solid Waste Management Facilities
6 NYCRR 361	Siting of Industrial Hazardous Waste Facilities
6 NYCRR 364	Waste Transporter Permits
6 NYCRR 370	Hazardous Waste Management Regulations
6 NYCRR 371	Identification and Listing of Hazardous Waste
6 NYCRR 372	Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities
6 NYCRR 373	Hazardous Waste Management Facilities
6 NYCRR 374	Standards for the Management of Specific Hazardous Wastes
6 NYCRR 376	Land Disposal Restrictions
6 NYCRR 595	Release of Hazardous Substances
6 NYCRR 596	Hazardous Substance Bulk Storage Regulations
6 NYCRR 597	List of Hazardous Substances
6 NYCRR 611	Environmental Priorities and Procedures in Petroleum Cleanup and Removal
6 NYCRR 612	Registration of Petroleum Storage Facilities
6 NYCRR 613	Handling and Storage of Petroleum
6 NYCRR 663	Freshwater Wetlands Permit Requirements
6 NYCRR 666	Regulation for Administration and Management of the Wild, Scenic, and Recreational Rivers System in New York State Excepting Private Land in the Adirondack Park

6 NYCRR 700	Part 700 Water Quality Regulations
6 NYCRR 701	Classification – Surface Waters and Groundwaters
6 NYCRR 702	Derivation and Use of Standards and Guidance Values
6 NYCRR 703	Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations
6 NYCRR 750	Obtaining a SPDES Permit
10 NYCRR 5	State Sanitary Code – Part 5

SUFFOLK COUNTY RULES, REGULATIONS, AND STANDARDS

SCSC Art. 12	Toxic and Hazardous Material Storage, Handling and Control


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