Brookhaven National Laboratory

2024 Site Environmental Report

VOLUME 1

Managed by Brookhaven Science Associates
on behalf of the U.S. Department of Energy

U.S. DEPARTMENT of ENERGY

The front and inside covers for this year's Site Environmental Report (SER) feature images of glossy ibises (*Plegadis falcinellus*) wading in a waterlogged field adjacent to the National Synchrotron Light Source II (NSLS-II). This small- to medium-sized wading bird measures approximately two feet in height with a wingspan of three feet and is known for its long, sickle-shaped bill. From a distance and in poor light, their plumage may look dark and drab, but up close the maroon wings gleam in metallic green, bronze, and violet tones.

The glossy ibis is one of three species of ibis commonly found in North America, but the glossy ibis is the only species that regularly appears on Long Island. In fact, it is only a fairly recent arrival to the western hemisphere, first recorded in Florida in the early 1900s and only seen breeding for the first time in New York in 1961. They originate from Africa, and in ancient Egypt, ibises were considered sacred and a representation of the god Thoth—the god of the moon, science, mathematics, and patron of scribes. It is thought that the glossy ibis rode the trade winds from Africa to the Caribbean or South America and gradually expanded its range north. On Long Island, it can be found along the south shore from April through August, but it is a rarity inland and at the Lab. In fact, in over 25 years of bird surveys that have been conducted at the Lab, it has only been found on two occasions.

New York is near the northern extent of their range as they breed along the Atlantic Coast. They frequent fresh water, brackish, and salt water wetlands, marshes, and estuaries, as well as wet fields where they forage in shallow waters and mud for small fish, insects, worms, mollusks, amphibians, and plants by using their curved bills to feel around for prey.

Glossy ibises nest in large, dense colonies, often with other species of wading birds. Their nests are bulky platforms composed of reeds and sticks about a foot in diameter. They are often constructed a few feet above water, although they will occasionally nest on the ground. They typically lay three to four pale blue or green eggs that hatch in about twenty days with both parents taking turns caring for the eggs and young. At six to seven weeks of age, the young can fly and will accompany their parents to feeding areas.

Glossy ibis are now widespread—they can be found on every continent except Antarctica and are considered a species of low conservation concern. Hopefully, they are a species we can enjoy for many years to come.

The Brookhaven National Laboratory 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 https://www.bnl.gov/esh/env/ser/. To obtain a copy of the report, please write or call:

Brookhaven National Laboratory Environmental Protection Division • Attention: SER Project Coordinator • Building 860 • P.O. Box 5000 • Upton, NY 11973-5000 • (631) 344-3248

Changes and Corrections

You are looking at the first published version of the Brookhaven National Laboratory 2024 Site Environmental Report, released October 2025.

The most recent version of this report will be published on our Environmental Reports website at https://www.bnl.gov/esh/env/ser/. To confirm that future versions of this report are the most recent, please look at this "Changes and Corrections" section in our online report. This page will be updated with the revision and description of updated for all revisions of this report after the publishing date of October 1, 2025.

Revision History

Description	Release Date	Reason for Update
SER 2024, Revision 0	October 1, 2025	First published version

Brookhaven National Laboratory

BNL-228932-2025-FORE

2024

SITE ENVIRONMENTAL REPORT

BROOKHAVEN NATIONAL LABORATORY

Volume I

October 2025

Prepared by
Brookhaven Science Associates, LLC
For the U.S. Department of Energy
Under Contract No. DE-SC0012704

Brookhaven National Laboratory
Brookhaven Science Associates, LLC
P.O. Box 5000
Upton, NY 11973-5000

Brookhaven National Laboratory

The text of this book has been copied on 100% post-consumer recycled paper, a move that saves approximately 20 trees compared to using its virgin equivalent.


PRINTED ON RECYCLED PAPER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe on privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency, contractor, or subcontractor thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency, contractor, or subcontractor thereof.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Executive Summary

Brookhaven National Laboratory (BNL) is managed on behalf of the Department of Energy (DOE) by Brookhaven Science Associates (BSA), a partnership between Stony Brook University and Battelle, and six core universities: Columbia, Cornell, Harvard, Massachusetts Institute of Technology, Princeton, and Yale. For over 75 years, the Laboratory has played a lead role in the DOE Science and Technology mission and continues to contribute to the DOE's missions in energy resources, environmental quality, and national security. BNL manages its world-class scientific research operations with sensitivity to environmental issues and community concerns. The Laboratory's Environmental, Safety, Security, and Health (ESSH) Policy reflects the commitment of BNL's management to fully integrate environmental stewardship into all facets of its mission and operations.

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

Volume II of the SER, the Groundwater Status Report, is also prepared annually to report on the status of groundwater protection and restoration efforts. Volume II includes detailed technical summaries of groundwater data and treatment system operations and is intended for regulators and other technically oriented stakeholders. A summary of the information contained in Volume II is included in Chapter 7, Groundwater Protection, of this volume.

Both reports are readily available as downloadable files on the BNL web page at www.bnl.gov/esh/env/ser.

Environmental Management System

The Laboratory's Integrated Safety Management System (ISMS) incorporates management of environment (i.e., environmental protection and pollution prevention), safety, health, and quality (ESH&Q) 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 the International Organization for Standardization (ISO) 14001 Standard for Environmental Management Systems (EMS). The standard requires 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.

An EMS was established at BNL and has been fully registered to the ISO Standard since 2001 to ensure that environmental issues are systematically identified, controlled, and monitored. The EMS also provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual environmental improvement. The cornerstone of the Laboratory's EMS is the ESSH Policy. The policy makes clear the Laboratory's commitment to environmental stewardship, the safety and health of its employees, and the security of the site. Specific environmental commitments in the policy include compliance, sustainability, conservation, community outreach, and continual improvement. The policy is posted throughout the Laboratory and on the BNL website. It is also included in all training programs for new employees, guests, and contractors. BNL continues to seek opportunities and implement efficient business practices into site operations and infrastructure.

The Laboratory achieves certification to the standard by undergoing annual audits by an accredited third-party registrar who ensures that the Lab's EMS is maintained and continually improved. In 2024, BNL's third-party registrar conducted a certification assessment of the Lab to the ISO 14001 Standard with no nonconformances identified. BNL was recertified as conforming to the ISO 14001 EMS Standard on September 20, 2024.

The Laboratory's Pollution Prevention (P2) Program is an essential element for the successful implementation of BNL's EMS. The P2 Program reflects national and DOE pollution prevention goals and policies and represents an ongoing effort to make pollution prevention and waste minimization an integral part of the Laboratory's operating philosophy. Pollution prevention and waste reduction goals have been incorporated as performance measures into the DOE contract with BSA and BNL's ESSH Policy. The overall goal of the P2 Program is to create a systems approach that integrates pollution prevention and waste minimization, resource conservation, recycling, and affirmative procurement into all planning and decision making. The implementation of pollution prevention opportunities, recycling programs, and conservation initiatives continues to reduce both waste volumes and management costs. In 2024, the P2 Program resulted in nearly $1.6 million in cost avoidance or savings and resulted in the reduction or reuse of approximately 1,500 tons of waste. The program has funded 14 new proposals reducing spill risk, plastic waste in laboratories, promoting the use of bio-friendly alternative products, and overall environmentally environmentally efficient business practices. As a testament to its strong environmental programs, BNL earned its first GreenSpace Silver Award for meeting environmental criteria in a Research Lab renovation project.

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 to reduce use of once-through cooling water for other systems. Water use was reduced by half over the last ten years—a reduction of nearly a half billion gallons per year.

In 2024, BNL used 296 million kilowatt hours (kWh) of electricity, 67,128 gallons of fuel oil, 15,118 gallons of propane, and 554 million cubic feet of natural gas. Also, in 2024 BNL's energy supply included 120,014 megawatts (MW) of clean, renewable hydropower energy, 552,447 kWh of on-site generated solar photovotaic (PV), and 24 million kWh of purchased renewable energy certificates (RECs). The Laboratory will consider seeking alternative energy sources pending directives and funding from the administration. BNL continues to address legacy environmental issues and openly communicates with neighbors, regulators, employees, and other interested parties on environmental issues and cleanup progress on-site. During 2024, BNL hosted in-person/virtual meetings of the Community Advisory Council (CAC), tours, a virtual speakers bureau, and monthly interagency calls with regulators. BNL is committed to transparency and open communication with its internal and external stakeholders.

Chapter 2 of this report further describes these and other energy efficiency efforts, as well as implementation of BNL's EMS and P2 Program, in more 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 2024 are provided below.

Compliance Monitoring Program

BNL has an extensive program in place to ensure compliance with all applicable regulatory and permit requirements. The Laboratory must comply with more than 100 sets of federal, state, and local environmental regulations; numerous site-specific permits; 11 equivalency permits for the operation of groundwater remediation systems; and several other binding agreements.

In 2024, the Laboratory was in compliance with most regulatory requirements. Instances of noncompliance were reported to regulatory agencies and corrected expeditiously, or a plan was put in place to come into compliance. Emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the Central Steam Facility (CSF) were well within permit limits in 2024. Recorded excess opacity measurements from CSF boilers were investigated and documented in quarterly Site-Wide Air Emissions and Monitoring Systems Performance Reports and submitted to the New York State Department of Environmental Conservation (NYSDEC).

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 2024. The last remaining portable fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as part of an ongoing program to phase out the use of chlorofluorocarbons.

BNL's drinking water system continues to remain in compliance with all applicable county, state, and federal regulations regarding drinking water quality, monitoring, operations, and reporting. The liquid effluents discharged to surface water and groundwater also met applicable New York State Pollutant Discharge Elimination System (SPDES) permit requirements with no noncompliance events occurring for any of the permitted outfalls.

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 implement release prevention measures and minimize impacts of spills of materials on a site-wide basis continued in 2024. There were ten spills in 2024, two of which met regulatory agency reporting criteria.

In 2024, there were eight site inspections by federal, state, or local regulators. These inspections included Sewage Treatment Plant (STP) operations, and all Lab-wide SPDES Discharge Outfalls, Resource Conservation and Recovery Act (RCRA) Department of Environmental Conservation (DEC) Part 373 Permitted Hazardous Waste Management Facilities, Underground Storage Tanks, and the potable water system. Immediate corrective actions were taken to address all compliance issues raised during these inspections.

The DOE Brookhaven Site Office (BHSO) performs routine inspections, assessments, and surveillances of BNL operations to ensure continual improvement and success in meeting the Laboratory's mission. In 2024, BHSO performed four surveillances of waste management activities with the purpose of evaluating performance in accordance with existing Technical Work Documents or Standard Operating Procedures (SOPs). BHSO also participated as an observer of the BSA Multi-Topic Assessment of BNL's management of hazardous and universal waste. BHSO participation comprised of observing BSA's scoping, assessment conduct, and reporting. Any findings were reviewed, analyzed, and were addressed, as appropriate, to prevent any future nonconformances.

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 to ensure compliance with the requirements of the Clean Air Act. Environmental Protection Agency (EPA) regulations require continuous monitoring of all sources that have the potential to deliver an annual radiation dose greater than 0.1 millirem (mrem) to a member of the public; all other facilities capable of delivering any radiation dose require periodic confirmatory sampling. During 2024,

BNL facilities released a total of 22,040 curies (Ci) of short-lived radioactive gases. Oxygen-15 and Carbon-11 emitted from the Brookhaven Linear Particle Accelerator (LINAC) Isotope Producer (BLIP) constituted 99.9% of the site's radiological air emissions.

Radiological emissions at the BLIP, High Flux Beam Reactor (HFBR), and Radionuclide Research and Production Laboratory (RRPL) are continuously monitored. The glass-fiber filtration system for BLIP captures samples of airborne particulate matter released, and the RRPL has a membrane-type filter suited for the capture and detection of alpha-emitting isotopes as well as beta-emitting isotopes. The filters are collected and analyzed for gross alpha and gross beta activity. At the decommissioned HFBR, monthly analysis of silica gel samples from continuous emissions monitoring is also conducted. The average gross alpha and beta airborne activity concentration levels for samples collected from the BLIP exhaust stack were 0.001 and 0.016 picocuries per cubic meter (pCi/m^3), respectively. Annual average gross alpha and beta airborne activity concentration levels for samples collected from the RRPL were 0.001 and 0.006 pCi/m^3, respectively, and well below standards. The Laboratory conducts ambient radiological air monitoring to verify local air quality and to assess possible environmental and health impacts from BNL operations. Samples collected from air monitoring stations around the perimeter of the site were analyzed for gross alpha and beta airborne activity. In 2024, average gross alpha and beta airborne activity levels for the four monitoring stations were 0.002 and 0.015 pCi/m^3, respectively.

Airborne tritium in the form of tritiated water (HTO) is monitored throughout the BNL site. In 2024, samples were collected from four site perimeter monitoring stations to assess the potential impacts from the Laboratory's two tritium sources. The average tritium concentrations at all the sampling locations were less than the typical minimum detection limits, ranging from 2.8 to 8.8 pCi/m^3.

Because natural gas prices were comparatively lower than fuel oil prices throughout the year, BNL's CSF used natural gas to meet 98% of the heating and cooling needs of the Laboratory's major facilities. As a result, emissions of particulates, oxides of nitrogen, sulfur dioxide, and volatile organic compounds were well below the respective regulatory permit criteria pollutant limits.

In 2024, there were two recorded excess opacity measurements at the CSF and one recorded excess nitrogen oxide (NO_x) measurement. The recorded excess opacity readings occurred on Boiler 6 and were due to fuel meter/fan auto control issues, while the recorded excess NO_x measurement was due to the restart of Boiler 6. During 2024, BNL upgraded cooling water systems as part of the program.

For a more in-depth discussion on the Laboratory's energy reduction efforts and BNL's Air Quality Program, monitoring data, and other GHG reduction efforts, refer to Chapter 2 and Chapter 4 of this report, respectively.

Water Quality Surveillance Program

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

Monitoring results for 2024 indicate that the average gross alpha and beta activity levels in the STP discharge (EA, Outfall 001) were well below New York State Drinking Water Standards (NYSDWS). Tritium was detected above the minimum detectable concentration (MDC) in the STP discharge in September 2024 with the annual average concentration being 98.3 ± 66.5 pCi/L; no cesium-137 (Cs-137), strontium-90 (Sr-90), or other gamma-emitting nuclides attributable to Laboratory operations were detected. Non-radiological monitoring of the STP effluent showed that all organic and inorganic parameters were within SPDES effluent limits or other applicable standards.

Stormwater and cooling water discharges to recharge basins are sampled throughout the year and analyzed for gross alpha and beta activity, gamma-emitting radionuclides, and tritium. The average gross alpha and beta concentrations in stormwater and cooling water discharged to recharge basins were within typical ranges, and no gamma-emitting radionuclides were detected. Disinfection byproducts continue to be detected at low concentrations in discharges to recharge basins due to the use of chlorine and bromine to control algae and bacteria in potable and cooling water systems. Inorganics (e.g., metals) were also detected; however, their presence is due primarily to sediment runoff in stormwater discharges.

Radiological data from Peconic River surface water sampling show that the average concentrations of gross alpha activity were indistinguishable from background. Gross beta activity from on-site locations were higher than control locations, however all detected levels were below the applicable NYSDWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the former STP outfall, and tritium was not detected above MDCs in any of the surface water samples.

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 (NRMP) 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 maintaining compliance with applicable regulations.

The goals of the program include protecting, monitoring, and, where possible, restoring the ecosystems, conducting research, and communicating with employees and the public on ecological issues. BNL focuses on protecting both Federal and 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 the program.

BNL has administrative processes in place to protect on-site habitats and natural resources. Activities to eliminate or minimize negative effects on endangered, threatened, or sensitive species are either incorporated into Laboratory procedures or into specific program or project plans. The Laboratory also monitors or manages other populations, including species of interest, to ensure that they are sustained and to control invasive species. The main goal of the NRMP is to ensure proper stewardship of BNL natural resources is established and maintained, and as a testament to the program the deer, vegetation, and soil sampling results were consistent with the previous years' results. To evaluate Cs-137 in deer, BNL has established a routine on- and off-site deer sampling program.

In 2024, a total of 15 deer were taken through fortuitous sampling from car-deer accidents both on- and off-site, and population reductions of the deer herd on the BNL site. The highest Cs-137 level in an on-site sample was 0.42 picocuries per gram (pCi/g), wet weight was twice that of the highest on-site sample reported in 2023 (0.21 pCi/g, wet weight) and 28 times lower than the highest level ever reported in 1996 (11.74 pCi/g, wet weight). Deer taken greater than one mile from the Lab were all non-detect for Cs-137.

The New York State Department of Health (NYSDOH) formally considered the potential public health risks associated with elevated Cs-137 levels in on-site deer and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999). In 2024, a total of 123 deer were taken during population reductions and representative samples were sent for analysis, of which all tested well below the 1.0 pCi/g, wet weight administrative limit for Cs-137 set by BNL for release of meat for consumption. A total of 2,623 pounds of meat was donated to the Island Harvest Food Pantry and a local wildlife rehabilitator.

Grassy vegetation samples were collected from ten locations around the Laboratory and a control location in Ridge, New York. All samples were analyzed for Cs-137. Nine vegetation samples were non-detect for Cs-137;

the remaining sample had a Cs-137 level of 0.35 pCi/g, dry weight. Five soil samples collected along with the vegetation samples were undetected or levels of Cs-137 indistinguishable from background. The remaining six samples had Cs-137 levels ranging from 0.04 to 0.64 pCi/g, dry weight. All values were consistent with historic monitoring and knowledge of cleanup areas. Monitoring results for grassy vegetation and soils were utilized for the annual dose to biota analysis reported in Chapter 8.

Mercury concentrations in precipitation have been measured at BNL since 2007. Analysis of mercury in precipitation is conducted to document mercury deposition that is attributable to off-site sources. This information is compared to Peconic River monitoring data and aids in understanding the distribution of mercury within the Peconic River watershed. During 2024, precipitation samples were collected quarterly at two air monitoring stations. Mercury was detected in all the precipitation samples, with concentrations ranging from 3.74 nanograms per liter (ng/L) to 13.3 ng/L. The 13.3 ng/L concentration is three times lower than the highest value of 45.1 ng/L, recorded in 2017.

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

In 2024, 13 interns completed projects related to bat acoustic monitoring, small mammal trapping, black turpentine beetle activity in pitch pine restoration treatments, fire and insect communities in pine barrens, wildlife camera trapping, and the impacts of fire and forest microclimates on tick populations. BNL continued its active support of ecological education programs by hosting the Day in the Life of a River Program which ran from September 19 to November 1, 2024. This program is a place-based educational experience where students and teachers collaborate with environmental professionals to collect scientific information to obtain a snapshot of the health of Long Island rivers and creeks. The Day in the Life of a River is a collaboration between the Central Pine Barrens Commission, the NYSDEC, and BNL, which is supported by experts from the U.S. Geological Survey, the Town of Brookhaven, Trout Unlimited, New York State Parks, and others.

The overriding goal of the Cultural Resource Management Program is to ensure that proper stewardship of BNL 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 for research and interpretation. The Cultural Resource Management Plan was updated in 2023 and guides the management for all the Laboratory's historical resources to include buildings, structures, World War I (WWI) earthwork features, the Camp Upton Historical Collection, scientific equipment, photo/audio/video archives, and institutional records.

In 2024, the Lab and DOE developed artwork and content for five kiosks to meet compliance with Memoranda of Agreement (MOA) for the Brookhaven Medical Research Reactor (BMRR) Stack Removal project, Discovery Park (which included the 1960s Era Apartments Demolition project), and the 1940s Water Tower Demolition project. New display cases were installed in Berkner Hall to exhibit objects relating to Camp Upton history, and new curatorial cabinets were purchased for the curation of objects and ephemera related to BNL's science history and its military history as Camp Upton. Public outreach included contributions to the Bellport-Brookhaven Historical Society's 2024 summer exhibit, *The Innovators: Inventors and Scientists of Bellport*, and history presentations at local libraries. The Lab also hired a new full-time Cultural Resource Manager to meet the growing regulatory needs for compliance with the National Historic Preservation Act.

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

Groundwater Protection Management Program

BNL implements aggressive pollution prevention measures to protect groundwater resources and uses an extensive groundwater monitoring well network to verify that prevention and restoration activities are effective. During 2024, BNL collected groundwater samples from 765 permanent monitoring wells and 41 temporary wells. Seven groundwater remediation systems removed 41 pounds of volatile organic compounds (VOCs) and returned approximately 753 million gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation in December 1996, the treatment systems have removed 7,914 pounds of VOCs by treating almost 33 billion gallons of groundwater.

In October 2022, BNL started the operation of the Current Firehouse Per- and Polyfluoroalkyl Substances (PFAS) Remediation System and the Former Firehouse PFAS Remediation System was started in January 2023. Since the start of their operations, the systems have removed approximately 1.3 pounds of total PFAS while treating 666 million gallons of groundwater. Also, one groundwater treatment system removed approximately 0.1 millicurie of Sr-90 while remediating approximately 7 million gallons of groundwater. Since 2003, BNL has removed approximately 34.9 millicuries of Sr-90 from the groundwater while remediating approximately 297 million gallons of groundwater. As a result of the successful operation of these treatment systems, significant reductions in contaminant concentrations have occurred in on- and off-site areas.

Chapter 7 of this report provides an overview of this program, and the SER Volume II, Groundwater Status Report, provides detailed descriptions, data, and maps relating to all groundwater monitoring and remediation performed in 2024.

Radiological Dose Assessment Program

The Laboratory routinely reviews its operations to ensure that any potential radiological dose to members of the public, workers, and the environment is “As Low As Reasonably Achievable” (ALARA). The potential radiological dose to members of the public is calculated at an off-site location closest to an emission source as the maximum dose that could be received by an off-site individual, defined as the “maximally exposed off-site individual” (MEOSI). The dose to the MEOSI is from direct and indirect dose pathways via air immersion, inhalation of particulates and gases, and ingestion of local fish and deer meat.

In 2024, the total effective dose (TED) to the MEOSI from Laboratory operations was less than 2.5% of the dose limit of 100 mrem in a year required by DOE Order 458.1, and well below all other EPA and U.S. DOE regulatory dose limits for the public, workers, and the environment. The effective dose equivalent (EDE) from air emissions is calculated using a dose modeling software program promulgated by the EPA. As such, the EDE from air emissions was estimated at 1.67 mrem (16.7 micro Sieverts [μSv]) to the MEOSI in 2024. The BNL dose level from the inhalation pathway was 16.7% of the EPA’s annual regulatory dose limit of 10 mrem (100 μSv). In addition, the dose from the ingestion pathway was estimated as 0.61 mrem (6.1 μSv) from the consumption of deer meat. The on-site portion of the Peconic River had water only sufficient to support a few fish. Therefore, no fish were collected. As a result, there was no measured dose attributed to BNL legacy Cs-137 levels in fish in the Peconic River. In summary, the total annual dose to the MEOSI from all pathways was estimated at 2.28 mrem (22.8 μSv), which is less than 2.5% of DOE’s 100-mrem limit. The aggregate population dose was 9.8 person-rem among approximately six million people residing within a 50-mile radius of the Laboratory. On average, this is equivalent to a fraction of an airport whole body scan per person.

Dose to the maximally exposed individual (MEI) on-site (outside of radiological controlled work areas), calculated from thermo-luminescent dosimeter (TLD) monitoring records, was 4 ± 2 mrem above natural background radiation levels, also well below the 100-mrem DOE dose limit. The average annual external dose from ambient sources on-site was 64 ± 8 mrem (640 ± 80 μSv), while the dose from off-site ambient sources was 62 ± 8 mrem (620 ± 80 μSv). 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 53 on-site TLDs and 16 off-site TLDs showed that there was no external dose contribution from BNL operations distinguishable from the natural background radiation level. Additional TLDs were used to measure on-site areas known to receive radiation dose slightly above the natural background radiation. Doses to aquatic and terrestrial biota were also evaluated and found to be well below DOE regulatory limits. In summary, the overall dose impact from all Laboratory activities in 2024 was comparable to that of natural background radiation levels.

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

Quality Asssurance Program

The multi-layered components of the BNL Quality Assurance/Quality Control (QA/QC) Program ensure that all environmental monitoring samples are representative, and data within this report are reliable and of high quality and meet quality assurance and quality control objectives. Samples are collected and analyzed in accordance with EPA methods and BNL SOPs that are designed to ensure samples are representative and the resulting data are reliable and defensible. QC at the analytical laboratories is maintained through daily instrument calibrations, efficiency, 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 2024, environmental samples were analyzed by five contract analytical laboratories, whose selection is discussed in Section 9.3.1 in Chapter 9. All samples were analyzed according to EPA-approved methods or by standard industry methods where no EPA methods are available (e.g., for Tolyltriazole). The most common QC issue encountered during 2024 was the detection of low-level contamination in the trip, field, and method blanks used in VOC analyses.

Environmental monitoring samples were collected as specified in the Environmental Monitoring Plan Update (BNL 2024) and project-specific work plans. BNL uses SOPs that are consistent with industry and regulatory standards for the collection of environmental samples, including groundwater, surface water, soil, sediment, air, flora, and fauna. During sample collection, field sampling technicians used calibrated field instrumentation for parameters such as conductivity, dissolved oxygen, pH, temperature, and turbidity. To ensure the integrity of samples, chain-of-custody (COC) was maintained and documented for all samples collected. These procedures are outlined in EM-SOP 109, “Chain-of-Custody, Storage, Packaging, and Shipment of Samples” (BNL 2020).

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. The data verification process involves checking for common errors associated with analytical data, while data validation involves a more extensive process. Validation includes all the verification checks, as well as checks for common errors, including instrument calibration that was not conducted as required, internal standard errors, transcription errors, and calculation errors.

The data validations, data verifications, and Data Quality Objectives (DQOs) checks conducted on analytical results at BNL are designed to eliminate any data that fails to meet the DQOs of each project. The results of the independent Performance Evaluation assessments and assessments of contractor laboratories summarized in this chapter are also used to assess the quality of the results. Therefore, the data used in this SER are of acceptable quality.

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

2024 Site Environmental Report

The SER Team thanks the many Lab employees who contributed to and assisted with this report.

The 2024 SER Team

(Back row, left to right) Larry Singh, Jason Remien, Douglas Paquette, Brian Barth.
(Middle row, left to right) Kathy Schwager, Doreen Carlson, Timothy Welty.
(Front row, left to right) Joy Haskins, Lindsey Brooks, Deborah Bauer, Kasey Corona-Borger, Allison McGovern.
(not pictured: Amy Engel, Jennifer Higbie)

The Environmental Protection Division Field Sampling Team

(From left to right) Amanda Chiappone, AJ Scheff, Richard Lagattolla, Nancy Shemet, Melissa Yost.

Acknowledgements

The production of the BNL 2024 Site Environmental Report (SER), Volume I, required the knowledge, skill, experience, and cooperation of many people and organizations at the Laboratory. The lead authors, co-authors, and other contributing staff involved in producing the report are listed below.

Lead Chapter Authors

ENVIRONMENTAL PROTECTION DIVISION

EXECUTIVE SUMMARY ..... Lindsey Brooks
CHAPTER 1..... Lindsey Brooks/Amy Engel
CHAPTER 2..... Deborah Bauer
CHAPTER 3..... Jason Remien
CHAPTER 4..... Doreen Carlson
CHAPTER 5..... Joy Haskins
CHAPTER 6..... Kathy Schwager
CHAPTER 7..... Brian Barth/Douglas Paquette
CHAPTER 8..... Tim Welty
CHAPTER 9..... Larry Singh

Co-authors and/or Key Contributors

ENVIRONMENTAL PROTECTION DIVISION
Amanda Chiappone
Jennifer Higbie
Richard Lagattolla
Robert Metz
AJ Scheff
Glen Todzia
Melissa Yost
Nancy Shemet
Kathy Schwager

STAKEHOLDER & COMMUNITY RELATIONS
Amy Engel

FACILITIES AND OPERATIONS
Chris Bruno

RADIOLOGICAL CONTROL DIVISION
Nate Foster

SER PROJECT COORDINATOR
Lindsey Brooks, Environment, Safety, & Health Division

EDITOR
Kasey Corona-Borger, Quality Management Office

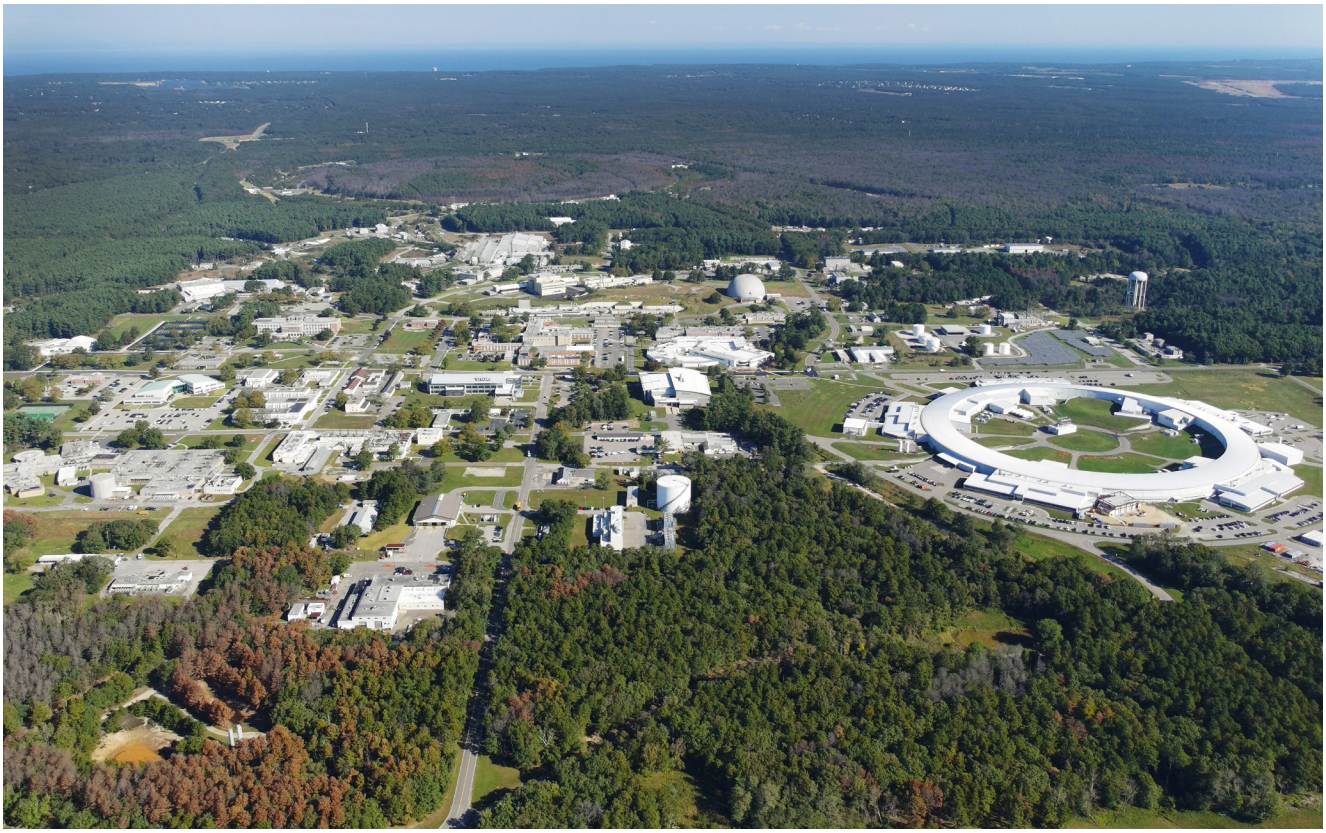
GRAPHIC DESIGNER
Jennifer Abramowitz, Stakeholder & Community Relations

“Thank you” to the staff and management of the following organizations who assisted the authors in the preparation of this report by providing technical peer reviews, sample and data collection, maps and diagrams, and other support necessary to make this report possible.

Stakeholder and Community Relations
Environment, Safety & Health Directorate
Environmental Protection Division
Environmental Information Management System Group
Groundwater Protection Group
Office of Educational Programs
Information Services Division
Media & Communications Office and Production Services
Facilities and Operations Directorate
Radiological Control Division
Quality Management Office

A Note from the Editor

Throughout the SER, 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 *https://www.bnl.gov/esh/env/ser/*.



Aerial view of Brookhaven National Laboratory.

Contents

Executive Summary iii
Acknowledgments xii
List of Tables xx
List of Figures xxi

Chapter 1: Introduction

1.1 Laboratory Vision and Mission 1-2
1.2 Major Initiatives 1-4
1.3 History and Overview of Major Scientific Facilities 1-6
1.4 Facilities and Operations 1-11
1.5 Location, Local Population, and Local Economy 1-14
1.6 Geology and Hydrology 1-15
1.7 Climate 1-17
1.8 Natural Resources 1-20
1.9 Cultural Resources 1-20
References and Bibliography 1-21

Chapter 2: Environmental Management System

2.1 Integrated Safety Management and ISO 14001 2-3
2.2 Environmental, Safety, Security, and Health Policy 2-4
2.3 Planning 2-4
2.3.1 Environmental Aspects 2-5
2.3.2 Compliance Obligations 2-5
2.3.3 Objectives and Targets 2-5
2.4 Environmental Management Programs 2-6
2.4.1 Compliance 2-6
2.4.2 Groundwater Protection 2-6
2.4.3 Waste Management 2-6
2.4.4 Pollution Prevention and Waste Minimization 2-9
2.4.5 Water Conservation 2-12
2.4.6 Energy Management and Conservation 2-13
2.4.6.1 Site Energy Usage 2-14
2.4.6.2 Current Conservation Efforts 2-15
2.4.7 Natural and Cultural Resource Management Programs 2-16
2.4.8 Environmental Restoration 2-16
2.5 Implementing the Environmental Management System 2-18
2.5.1 Structure and Responsibility 2-18
2.5.2 Communication and Community Involvement 2-18
2.5.2.1 Communication Forums 2-19
2.5.2.2 Community Involvement in Cleanup Projects 2-21

2.5.3 Monitoring and Measurement 2-21
2.5.3.1 Compliance Monitoring 2-23
2.5.3.2 Restoration Monitoring 2-24
2.5.3.3 Surveillance Monitoring 2-24
2.5.4 EMS Assessments 2-24
2.5.5 Best Practices 2-25
2.6 Environmental Stewardship at BNL 2-26
References and Bibliography 2-27

Chapter 3: Compliance Status

3.1 Compliance with Requirements 3-3
3.2 Compliance with Permits 3-7
3.2.1 Existing Permits 3-7
3.2.2 New or Modified Permits 3-7
3.2.2.1 New York State Wetlands and Wild, Scenic, Recreational Rivers Act 3-7
3.2.3. EPA's Enforcement & Compliance History Online (ECHO) 3-7
3.3 National Environmental Policy Act (NEPA) Assessments 3-10
3.4 National Historic Preservation Act (NHPA) 3-10
3.5 Clean Air Act (CAA) 3-10
3.5.1 Conventional Air Pollutants 3-11
3.5.1.1 Boiler Emissions 3-11
3.5.1.2 Ozone-Depleting Substances 3-12
3.5.2 Hazardous Air Pollutants 3-12
3.5.2.1 Maximum Available Control Technology 3-12
3.5.2.2 Asbestos 3-12
3.5.2.3 Radioactive Airborne Emissions 3-13
3.6 Clean Water Act (CWA) 3-13
3.6.1 Sewage Treatment Plant (STP) 3-14
3.6.2 Recharge Basins and Stormwater 3-18
3.7 Safe Drinking Water Act (SDWA) 3-20
3.7.1 Potable Water 3-20
3.7.2 Cross-Connection Control 3-27
3.7.3 Underground Injection Control 3-27
3.8 Preventing and Reporting Spills 3-27
3.8.1 Preventing Oil Pollution and Spills 3-27
3.8.2 Emergency Reporting Requirements 3-28
3.8.3 Spills and Releases 3-28
3.8.4 Major Petroleum Facility (MPF) License 3-29
3.8.5 Chemical Bulk Storage (CBS) 3-30
3.8.6 County Storage Requirements 3-30
3.9 Resource Conservation and Recovery Act (RCRA) Requirements 3-31
3.10 Polychlorinated Biphenyls (PCBs) 3-31

3.11 Pesticides 3-32
3.12 Wetlands and River Permits 3-32
3.13 Protection of Wildlife 3-33
3.13.1 Endangered Species Act 3-33
3.13.2 Migratory Bird Treaty Act 3-34
3.13.3 Bald and Golden Eagle Protection Act 3-34
3.14 Public Notification of Clearance of Property 3-35
3.15 External Audits and Oversight 3-35
3.15.1 Regulatory Agency Oversight 3-35
3.15.2 DOE Assessments/Inspections 3-35
3.15.3 Environmental Multi-Topic Assessment 3-36
3.15.4 Nevada National Security Site 3-36
3.16 Agreements, Enforcement Actions, and Other Environmental Occurrence Reports 3-37
References and Bibliography 3-39

Chapter 4: Air Quality

4.1 Radiological Emissions 4-2
4.2 Facility Monitoring 4-5
4.2.1 High Flux Beam Reactor (HFBR) 4-4
4.2.2 Brookhaven LINAC Isotope Producer (BLIP) 4-4
4.2.3 Radionuclide Research and Production Laboratory (RRPL) 4-5
4.2.4 Additional Minor Sources 4-5
4.2.5 Nonpoint Radiological Emission Sources 4-5
4.3 Ambient Air Monitoring 4-6
4.3.1 Gross Alpha and Beta Airborne Activity 4-7
4.3.2 Airborne Tritium 4-7
4.4 Non-radiological Airborne Emissions 4-9
4.5 Greenhouse Gas Emissions 4-11
4.5.1 Hydrofluorocarbons… 4-11
References and Bibliography 4-12

Chapter 5: Water Quality

5.1 Surface Water Monitoring Program 5-2
5.2 Sanitary System Effluents 5-4
5.2.1 Sanitary System Effluent – Radiological Analyses 5-5
5.2.2 Sanitary System Effluent – Non-radiological Analyses 5-7
5.3 Process-Specific Wastewater 5-7
5.4 Recharge Basins 5-7
5.4.1 Recharge Basins – Radiological Analyses 5-10
5.4.2 Basins – Non-Radiological Analyses 5-10
5.4.3 Stormwater Management 5-14

5.5 Peconic River Surveillance 5-14
5.5.1 Peconic River – Radiological Analyses 5-15
5.5.2 Peconic River – Non-radiological Analyses 5-15
References and Bibliography 5-19

Chapter 6: Natural and Cultural Resources

6.1 Natural Resource Management Program (NRMP) 6-2
6.1.1 Identification and Mapping 6-2
6.1.2 Habitat Protection and Enhancement 6-4
6.1.2.1 Salamander Protection Efforts 6-4
6.1.2.2 Banded Sunfish 6-5
6.1.2.3 Migratory Birds 6-5
6.1.2.4 Bald Eagle 6-6
6.1.2.5 Northern Long-eared Bat 6-6
6.1.3 Population Management 6-6
6.1.3.1 White-Tailed Deer 6-6
6.1.4 Compliance Assurance and Potential Impact Assessment 6-7
6.2 Upton Ecological and Research Reserve 6-7
6.3 Monitoring Flora and Fauna 6-8
6.3.1 Deer Sampling 6-8
6.3.1.1 Cesium-137 in White-Tailed Deer 6-10
6.3.2 Fish Sampling 6-14
6.3.2.1 Fish Population Assessment 6-14
6.3.3 Vegetation Sampling 6-14
6.3.3.1 Grassy Plants and Soil 6-14
6.4 Other Monitoring 6-16
6.4.1 Basin Sediments 6-16
6.4.2 Precipitation Monitoring for Mercury 6-16
6.5 Educational Programs 6-16
6.6 Cultural Resource Activities 6-17
References and Bibliography 6-18

Chapter 7: Groundwater Protection

7.1 The BNL Groundwater Protection Management Program 7-2
7.1.1 Protection 7-3
7.1.2 Monitoring 7-3
7.1.3 Remediation 7-3
7.1.4 Communication 7-3
7.2 Groundwater Protection Performance 7-4
7.3 Groundwater Monitoring Programs 7-4
7.3.1 Emerging Contaminants of Concern 7-5
7.4 Groundwater Monitoring Results 7-7

7.5 Groundwater Treatment Systems 7-13
References and Bibliography 7-16

Chapter 8: Radiological Dose Assessment

8.1 Introduction 8-3
8.2 Direct Radiation Monitoring 8-3
8.2.1 Ambient Radiation Monitoring 8-3
8.2.2 Facility Area Monitoring 8-8
8.2.2.1 Neutron Monitoring 8-9
8.3 Dose Modeling for Airborne Radionuclides 8-11
8.3.1 Dose Modeling Program 8-13
8.3.2 Dose Calculation Methods and Pathways 8-14
8.3.2.1 Maximally Exposed Off-Site and On-Site Individual 8-14
8.3.2.2 Dose Calculation: Fish Ingestion 8-14
8.3.2.3 Dose Calculation: Deer Meat Ingestion 8-14
8.4 Sources: Diffuse, Fugitive, “Other” 8-15
8.4.1 Remediation Work 8-15
8.5 Dose from Air Emission-Monitored Facilities 8-15
8.5.1 Brookhaven LINAC Isotope Producer (BLIP) 8-15
8.5.2 Radionuclide Research and Production Laboratory (RRPL) (formerly Target Processing Laboratory) 8-15
8.5.3 High Flux Beam Reactor (HFBR) 8-16
8.5.4 Waste Management Facility 8-16
8.5.5 Brookhaven Medical Research Reactor (BMRR) 8-16
8.5.6 Brookhaven Graphite Research Reactor (BGRR) 8-16
8.5.7 Unplanned Releases 8-16
8.6 Dose From Ingestion 8-16
8.7 Dose to Aquatic and Terrestrial Biota 8-17
8.8 Dose From All Pathways 8-17
References and Bibliography 8-19

Chapter 9: Quality Assurance

9.1 Quality Program Elements 9-2
9.2 Sample Collection and Handling 9-4
9.2.1 Field Sample Handling 9-4
9.2.1.1 Custody and Documentation 9-4
9.2.1.2 Preservation and Shipment 9-5
9.2.2 Field Quality Control Samples 9-5
9.2.3 Tracking and Data Management 9-8
9.3 Sample Analysis 9-8
9.3.1 Qualifications 9-8
9.4 Verification and Validation of Analytical Results 9-9

9.4.1 Checking Results 9-10
9.5 Contract Analytical Laboratory QA/QC 9-10
9.6 Performance or Proficiency Evaluations 9-10
9.6.1 Summary of Test Results 9-11
9.6.1.1 Radiological Assessments 9-12
9.6.1.2 Non-radiological Assessments 9-12
9.7 Audits 9-13
9.8 Conclusion 9-13
References and Bibliography 9-14

Appendix A: Glossary A-1
Acronyms and Abbreviations A-1
Technical Terms A-7
Appendix B: Understanding Radiation B-1
Appendix C: Units of Measure and Half-Life Periods C-1
Appendix D: Federal, State, and Local Laws and Regulations Pertinent to BNL D-1

List of Tables

Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2024 2-11
Table 2-2. Summary of BNL 2024 Environmental Restoration Activities 2-17
Table 2-3. Summary of BNL Sampling Program Sorted by Media, 2024 2-22
Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL 3-3
Table 3-2. BNL Environmental Permits. 3-8
Table 3-3. Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001 3-14
Table 3-4. Analytical Results for Wastewater Discharges to Outfalls 002, 005 - 008, and 010. 3-18
Table 3-5. Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value) 3-21
Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, Micro-Extractables, and Perflourinated Compounds 3-23
Table 3-7. Potable Water Wells and Potable Distribution System: Perfluorinated Compounds 3-26
Table 3-8. Applicability of EPCRA to BNL. 3-28
Table 3-9. Summary of Chemical and Oil Spill Reports. 3-29
Table 3-10. Existing Agreements and Enforcement Actions Issued to BNL With Status… 3-37
Table 3-11. Summary of Other Environmental Occurrence Reports, 2024 3-38
Table 4-1. Airborne Radionuclide Releases from Monitored Facilities. 4-2
Table 4-2. Gross Activity in Facility Air Particulate Filters. 4-4
Table 4-3. Gross Activity Detected in Ambient Air Monitoring Particulate Filters. 4-7
Table 4-4. Ambient Airborne Tritium Measurements in 2024. 4-8
Table 4-5. Central Steam Facility Fuel Use and Emissions (2015 – 2024). 4-10
Table 5-1. Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant for 2024. 5-6
Table 5-2. Radiological Analysis of Samples from On-Site Recharge Basins (2024) 5-10
Table 5-3. Water Quality Data for On-Site Recharge Basins (2024). 5-11
Table 5-4. Metals Analysis of Water Samples from BNL On-Site Recharge Basins (2024). 5-12
Table 5-5. Radiological Results for Surface Water Samples Collected Along the Peconic and Carmans River (2024) 5-15
Table 5-6. Water Quality Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans River (2024). 5-16
Table 5-7. Metals Analytical Results in Surface Water Samples Collected Along the Peconic and Carmans River (2024). 5-17
Table 6-1. Federal and New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL. 6-3
Table 6-2. Radiological Analysis of Deer Tissue (2024). 6-11
Table 6-3. Radiological Analysis of Grassy Vegetation and Associated Soils (2024) 6-14
Table 6-4 Precipitation Monitoring (Mercury) 6-16
Table 7-1. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2024 7-15
Table 8-1. Five-Year Annual On-Site Direct Ambient Radiation Measurements (2020 – 2024). 8-6
Table 8-2. Five-Year Annual Off-Site Direct Ambient Radiation Measurements (2020 – 2024) 8-8
Table 8-3. Facility Area Monitoring Measurements of Direct Ambient Radiation (2020 – 2024) 8-9

Table 8-4. Five-Year Annual Neutron Monitoring Results (2020 – 2024) 8-10
Table 8-5. Maximally Exposed Off-site Individual Effective Dose Equivalent from Facilities or Routine Processes, 2024 8-12
Table 8-6. Five-Year Annual Maximally Exposed On-Site Dose Summary (2020 – 2024) 8-14
Table 8-7. Five-Year Site Dose Summary (2020 – 2024) 8-18
Table 9.1. Summary of Detections in Trip, Field, and Equipment Blank Samples 9-7
Table 9.2. Summary Results of 2024 DOECAP Audits 9-11

List of Figures

Figure 1-1. Major Scientific Facilities at BNL 1-12
Figure 1-2. Major Support and Service Facilities at BNL 1-14
Figure 1-3. BNL Groundwater Flow Map 1-16
Figure 1-4. BNL Wind Rose (2024) 1-17
Figure 1-5. BNL 2024 Monthly Mean Temperature versus 75-Year Monthly Average 1-18
Figure 1-6. BNL 2024 Annual Mean Temperature Trend (75 Years) 1949 to 2024 1-18
Figure 1-7. BNL 2024 Monthly Precipitation versus 75-Year Monthly Average 1-19
Figure 1-8. BNL 2024 Annual Precipitation Trend (75 Years) 1-19
Figure 2-1a. Hazardous Waste Generation from Routine and Nonroutine Operations, 2020 – 2024 2-7
Figure 2-1b. Mixed Waste Generation from Routine and Nonroutine Operations, 2020 – 2043 2-8
Figure 2-1c. Radioactive Waste Generation from Routine and Nonroutine Operations, 2020 – 2024 2-8
Figure 2-2. Waste Disposal in Tons, 2020 – 2024 2-10
Figure 2-3. Waste Diversion in Tons, 2024 2-10
Figure 2-4. Annual Potable Water Use, 2007 – 2024 2-13
Figure 3-1. Maximum Concentrations of Copper Discharged from the BNL Sewage Treatment Plant, 2019 – 2024 3-15
Figure 3-2. Maximum Concentrations of Iron Discharged from the BNL Sewage Treatment Plant, 2019 – 2024 3-15
Figure 3-3. Maximum Concentrations of Lead Discharged from the BNL Sewage Treatment Plant, 2019 – 2024 3-16
Figure 3-4. Maximum Concentrations of Mercury Discharged from the BNL Sewage Treatment Plant, 2019 – 2024 3-16
Figure 3-5. Maximum Concentrations of Nickel Discharged from the BNL Sewage Treatment Plant, 2019 – 2024 3-17
Figure 3-6. Maximum Concentrations of Silver Discharged from the BNL Sewage Treatment Plant, 2019 – 2024 3-17
Figure 3-7. Maximum Concentrations of Zinc Discharged from the BNL Sewage Treatment Plant, 2018 – 2024 3-17
Figure 3-8. Spills Trend, 2020 – 2024 3-29
Figure 4-1. Radiological and Non-radiological Air Emission Release Points Subject to Monitoring 4-3
Figure 4-2. BNL On-Site Ambient Air Monitoring Stations 4-6

Figure 4-3. Airborne Gross Beta Concentration Trend Recorded at Station P7 in 2024 4-8
Figure 4-4. BNL Scope 3 Greenhouse Gases..... 4-11
Figure 5-1. Sampling Stations for Surface Water and Fish 5-3
Figure 5-2. An aerial photo of BNL's Sewage Treatment Plant (Recharge Basin Discharge)..... 5-4
Figure 5-3. BNL Recharge Basin/Outfall Locations. 5-8
Figure 5-4. Schematic of Potable Water Use and Flow at BNL 5-9
Figure 6-1. Deer Sample Locations, 2019 – 2024 6-9
Figure 6-2. Comparison of Cs-137 average values in deer flesh for on-site, near off-site, on-site + near off-site, off-site greater than 1 mile from the Laboratory, and from deer population reductions (cull). Ten-year average of on-site and near off-site deer flesh samples is 0.41 pCi/g, wet weight..... 6-13
Figure 6-3. Ten-Year Trend in Cs-137 in Deer Flesh for Samples Taken at BNL and within 1 mile of the Laboratory. Average before clean-up (dashed line) 2.57 pCi/g wet weight. Ten-year average (solid line) 0.41 pCi/g wet weight. 6-13
Figure 6-4. Vegetation Sample Locations 2024 6-15
Figure 7-1. Groundwater Table Elevation Map for August 2024 Showing Groundwater Flow Directions and Locations of Supply and Remediation Wells..... 7-6
Figure 7-2. VOC Plume Comparison Maps, 1997 and 2024 7-9
Figure 7-3. Radionuclide Plume Comparison Maps 2002 and 2024..... 7-10
Figure 7-4. Current Firehouse and Building 170 PFOS Plume Comparisons, 2020 – 2021 and 2024..... 7-11
Figure 7-5. Former Firehouse PFOS Comparisons, 2020 – 2021 and 2024 7-12
Figure 7-6. Locations of BNL Groundwater Remediation Systems..... 7-14
Figure 8-1. On-Site Background TLD Locations 8-4
Figure 8-2. Off-Site TLD Locations..... 8-5
Figure 8-3. Neutron TLD Area Monitors..... 8-10
Figure 9-1. Flow of Environmental Monitoring QA/QC Program Elements..... 9-3
Figure 9-2. Summary of Scores in the Radiological Proficiency Evaluation Programs..... 9-12
Figure 9-3. Summary of Scores in the Non-radiological Proficiency Evaluation Programs 9-12

Intentionally Left Blank

Aerial view of Brookhaven National Laboratory (BNL) showcasing the National Synchrotron Light Source II (NSLS-II).

Chapter 1

Introduction

Established in 1947, Brookhaven National Laboratory (BNL) is one of ten National Laboratories overseen and primarily funded by the U.S. Department of Energy's (DOE's) Office of Science (SC).

The only multi-program National Laboratory in the Northeast, the Laboratory is operated and managed by Brookhaven Science Associates (BSA), which was founded by the Research Foundation for the State University of New York on behalf of Stony Brook University, and Battelle, a non-profit applied science and technology organization. BNL is committed to longstanding partnerships with researchers, academic institutions, industry, students, teachers, and the surrounding community. 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 1921 during and after World War I and from 1940 to 1946 during and after World War II.

BNL Main Gate Sign.

BNL has a history of outstanding scientific achievements. For over 75 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 Vision and Mission

BNL's vision is accelerating pathways to scientific discovery and technological innovation that transform the world. Over the next decade, the Lab will build the Electron-Ion Collider (EIC) – the only new collider to be constructed worldwide during the next decade – for the pursuit of knowledge about the basic building blocks of matter; lead in discovery with light-enabled science at the National Synchrotron Light Source II (NSLS-II), a build out of its beamline suite, and a possible upgrade to the accelerator to drive advances in a broad range of science disciplines; enable an interdisciplinary approach to emergent information science and capabilities by taking advantage of the Lab's core expertise; and foster programs that address energy security and essential resources independence.

BNL carries out its mission in an environmentally responsible and safe manner, with the partnership of local, state, national, and international communities. BNL conceptualizes, designs, builds, and operates major scientific facilities in support of its DOE mission. These facilities serve DOE's basic research needs and reflect BNL/DOE stewardship of national research infrastructure critical for university, industry, and government researchers.

The Laboratory's high-level, enduring science and technology (S&T) priorities define and distinguish BNL. They fall broadly into the following areas:

- Nuclear and particle physics to gain a deeper understanding of matter, energy, space, and time;
- Recognized strengths in advanced materials, catalysis, bioenergy, environmental systems, and climate;
- Advanced computer science, applied math, data science, and computational science to transform scientific discovery at BNL's facilities and enhance its science programs;
- Advanced and emerging technology with demonstrated strengths in instrumentation, magnet, accelerator, and laser S&T;
- Transformational user facilities that position the Laboratory and the Nation for continued leadership roles in S&T. These facilities are enabled by advanced accelerator S&T; and
- Application of the results of BNL's discovery science to address emerging opportunities, including clean energy solutions, isotopes, national security solutions, and national emergencies.

In 2024, Brookhaven chemists developed an additive to lithium-metal batteries that help the batteries recharge faster while maintaining their cycle life. Research at the Lab's NSLS-II and Center for Functional Nanomaterials (CFN) is creating new opportunities for battery engineering.

Achieving the Laboratory's vision and mission requires simultaneous excellence in all aspects of BNL's work from science and operations to external partnerships with the local, state, and national communities, and beyond.

Realizing these goals is enabled by safe, efficient, and secure operations; workforce development and reaching out to the community; and a strong focus on renewed infrastructure that drives regional outreach and partnerships to address national needs. BNL is a world leader in scientific research and performs this work in an environmentally responsible and safe manner. Each employee, contractor, and guest is expected to take personal responsibility for adhering to BNL's Environmental, Safety, Security, and Health (ESSH) Policy. This policy states the Laboratory's commitment to environmental stewardship, the safety of the public and BNL employees, the security of the site, and continual improvement.

1.2
Major Initiatives

BNL has identified scientific initiatives that will help realize the larger vision and mission of the Lab. These initiatives align with the DOE Strategic Goals in Science, Energy, and Nuclear Security and build on the Laboratory's core strengths and capabilities. The breadth of BNL's core programs serves as the foundation for the seven initiatives. The initiatives are highly interconnected, utilizing the Lab's user facilities and the S&T capabilities across the BNL complex.

The seven initiatives are:

- **Nuclear Physics:** Uncover the structure of visible matter by constructing and operating the EIC at BNL to maintain international leadership in nuclear physics for decades;
- **Clean Energy and Climate:** Support fundamental research in basic energy and climate sciences to revolutionize grid-scale storage, renewable integration, and the study of atmospheric processes to improve climate predictability;
- **Quantum Information Science and Technology:** Discover new quantum materials to enhance quantum computers and develop an entanglement sharing quantum network as a prototype for the first quantum internet;
- **Artificial Intelligence and Data Science:** Revolutionize the operation of experiments across the sciences at user facilities and in core programs;
- **High Energy Physics:** Understand the origin of space, time, and matter with the ATLAS high luminosity upgrade at CERN and the future Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment;
- **Isotope Production:** Accelerate and expand isotope production to ensure the security of the Nation's supply; and
- **Accelerator Science and Technology:** Harness the accelerator science expertise at BNL to develop new facilities, improve and expand its user facilities, and promote the use of accelerators in industry.

In support of these initiatives, the Laboratory operates cutting-edge large-scale facilities for studies in physics, chemistry, biology, medicine, applied science, and a wide range of advanced technologies. BNL's world-class research facilities are also available to university, industry, and government personnel from around the world. The Laboratory integrates efficient operations and environmental stewardship into all facets of its research and operations and is committed to managing its programs in a manner that protects the local ecosystem and public health.

In addition to major research activities, the Laboratory provides expertise and other programs in a range of areas including accelerator S&T, biological imaging, homeland and national security, and advanced computation.

To date, researchers working at BNL have received seven Nobel Prizes, multiple National Medals of Science, National Medal of Technology and Innovation, National Academy of Sciences, Enrico Fermi Awards, Wolf Foundation Prizes, nearly 40 Research and Development (R&D) 100 Awards, as well as other recognitions for discoveries made wholly or partly at BNL. Some significant discoveries and developments made at the Laboratory include new forms of matter, subatomic particles, technologies that fuel leading experimental programs around the world, and lifesaving medical imaging techniques for diagnosis and treatment of disease.

BNL by the Decade

1940s

- **1947:** BNL is founded by the Atomic Energy Commission (AEC)
- **1948:** Environmental Monitoring begins

1950s

- **1950:** Brookhaven Graphite Research Reactor (BGRR) begins operation
- **1952:** High-energy particle physics research at BNL begins with the Cosmotron
- **1957:** T.D. Lee and C.N. Yang win Nobel Prize for work at the Cosmotron
- **1958:** Medical Research Center opens
- **1959:** Brookhaven Medical Research Reactor (BMRR) begins operation

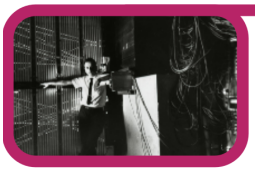
1960s

- **1960:** Alternating Gradient Synchrotron (AGS) becomes operational
- **1962:** BNL publishes the first Environmental Radiation Levels Report
- **1965:** The High Flux Beam Reactor (HFBR) begins operation
- **1968:** Magnetic Levitation, Mag-Lev, is patented by Gordon Danby and James Powell

1970s

- **1970:** The Tandem Van de Graaff accelerator begins operating
- **1971:** BNL publishes first Environmental Monitoring Report
- **1972:** Brookhaven Linac Isotope Producer (BLIP) produces commercially unavailable radioisotopes for medical community
- **1976:** Samuel C.C. Ting receives Nobel Prize using BNL's AGS for J-psi particle and charmed quark

1980s



- **1980:** BNL is placed on the NYSDEC list of Inactive Hazardous Waste Disposal Sites
- **1980:** James W. Gronin and Val L. Fitch share Nobel Prize in Physics for AGS work, CP violation
- **1982:** The National Synchrotron Light Source (NSLS) begins operations
- **1988:** Lederman, Schwartz and Steinberger receive Nobel Prize in physics for discovery of muon-neutrino
- **1989:** BNL site is on the CERCLA National Priorities List due to soil and groundwater contamination

1990s

- **1991:** Construction of the Relativistic Heavy Ion Collider begins
- **1992:** An Interagency Agreement is established between DOE, the USEPA and NYSDEC
- **1995:** G-2 Experiment begins

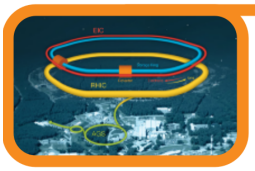
2000s

- **2000:** RHIC begins operation
- **2002:** Ray Davis wins Nobel Prize in Physics for detecting solar neutrinos
- **2003:** Roderick MacKinnon at BNL wins half of the Nobel Prize in Chemistry on how proteins help generate nerve impulses
- **2003:** NASA Space Radiation Laboratory becomes operational
- **2009:** Venkatraman Ramakrishnan shares Nobel prize on structure and function of the ribosome

2010s

- **2011:** The 32-megawatt Long Island Solar Farm at BNL is completed
- **2014:** National Synchrotron Light Source II begins operation

2020s



- **2020:** BNL is awarded the construction of the Electron-Ion Collider

CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
NASA = National Aeronautics and Space Administration
DOE = Department of Energy
USEPA = United States Environmental Protection Agency
NYSDEC = New York Department of Environmental Conservation

1.3
History and Overview of Major Scientific Facilities

BNL was founded in 1947 by the Atomic Energy Commission (AEC), a predecessor to the present DOE. The 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. In operation from 1950 to 1968, the reactor's primary mission was to produce neutrons for scientific experimentation and to refine reactor technology. Decommissioning of the BGRR was completed in June 2012, and the remaining structures are currently undergoing 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. The HFBR also allowed researchers to study the basic nature of chemical structures, including the hydrogen bond that holds much of our world together. In late 1996, workers discovered that a leak in the HFBR spent fuel storage pool had been releasing tritium to the groundwater (see Site Environmental Report [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.

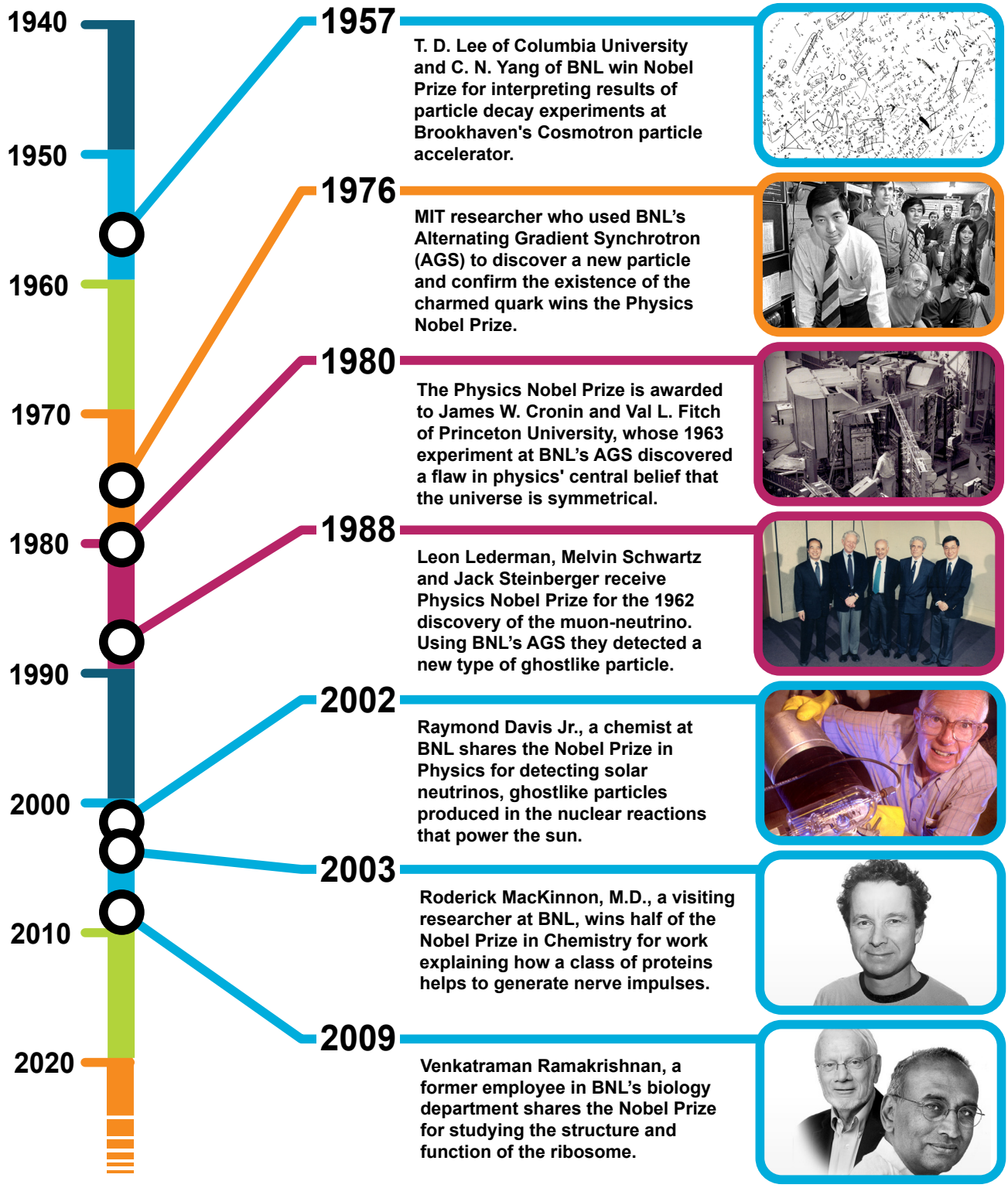
In November 1999, the DOE decided that the HFBR would be permanently shut down. With input from the community, a final Record of Decision was approved outlining the remedy for the HFBR's permanent decontamination and decommissioning. In February 2021, the adjacent Stack, which served as an exhaust for the HFBR and BGRR, was safely demolished.

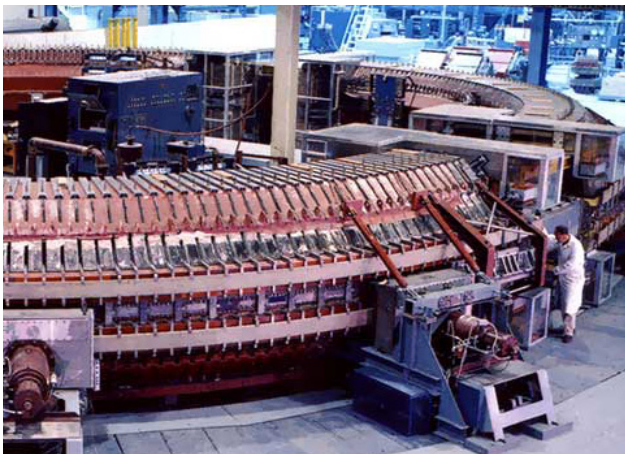
Medical research at BNL began in 1950 with the opening of one of the first hospitals devoted to nuclear medicine. It was followed by the Medical Research Center in 1958 and the Brookhaven Medical Research Reactor (BMRR) in 1959. The BMRR was the first nuclear reactor in the nation to be constructed specifically for medical research. Due to a reduction in research funding, the BMRR was shut down in December 2000. All spent fuel from the BMRR has been removed and transported off-site. The facility is currently in a "cold" shutdown mode as a radiological facility and has entered a period of surveillance and maintenance. In August 2022, the BMRR stack was safely demolished.

The Brookhaven Linac Isotope Producer (BLIP) has been in operation since 1972. Positioned at the forefront of research into radioisotopes used in cancer treatment and diagnosis, the BLIP produces commercially unavailable radioisotopes for use by the medical community and related industries. The BLIP consists of an accelerator beam line and target area for generating radioisotopes already in high demand and for developing those required at the frontiers of nuclear medicine. In conjunction with this mission, scientists also perform irradiations for non-isotope applications and explore opportunities for emerging radioisotope applications.

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 the first Nobel Prize attributed to work at BNL. In 1957 the Nobel Prize in Physics was awarded to T.D. Lee and C.N. Yang for Parity Violation. After 14 years of service, the Cosmotron ceased operation in 1966 and was dismantled in 1969.

BNL Nobel Prize Timeline





Cosmotron (1952-1966).

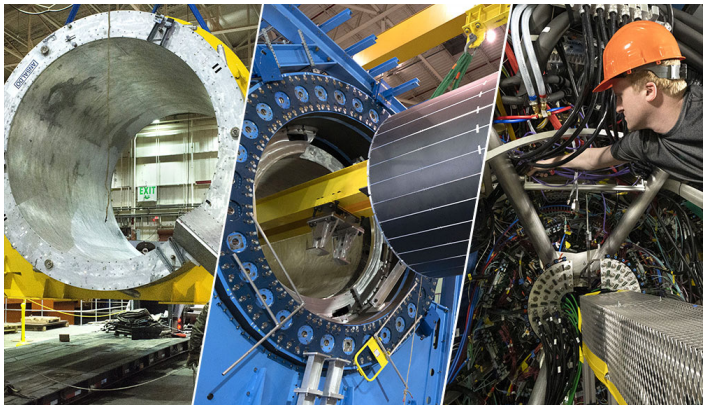
Knowledge gained from the Cosmotron led to design improvements and paved the way for construction of the Alternating Gradient Synchrotron (AGS). For the complete list of Nobel Prizes, see BNL Nobel Prize Timeline on page 1-7.

The AGS is a much larger particle accelerator that became operational in 1960. The AGS 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. The 1976 Nobel Prize in Physics was awarded to C.C. Ting and Burton Richter for the discovery of the J/psi particle; in 1980 James Cronin and Val Fitch were awarded the Nobel for work on CP violation, and in 1988 Leon Lederman, Melvin Schwartz, and Jack Steinberger received the Nobel for discovery of the muon-neutrino. 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 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, BNL began operating a new heavy ion beam source for use by RHIC and the National Aeronautics and Space Administration (NASA) Space Radiation Laboratory (NSRL), the Electron Beam Ion Source (EBIS). This large electrostatic accelerator can provide researchers with beams of more than 40 different types of ions ranging from hydrogen to uranium. By simulating the effects of radiation both in space and on the ground, scientists and engineers from several other laboratories and companies are improving the reliability of computers.

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. By smashing particles together to recreate the conditions of the early universe, scientists can explore the most fundamental building blocks of matter as they existed just after the Big Bang. This research unlocks secrets of the force that holds together 99% of the visible universe everything from stars to planets and people and triggers advances in science and technology that have applications in fields from medicine to national security.

RHIC has been continuously upgraded and its productivity now exceeds its initial design by 100 times. The most recent upgrade is the Low-Energy RHIC Electron Cooling project, which supports a new research program.



sPHENIX assembly.

In 2022, RHIC completed construction and installation of a brand-new house-sized particle detector. This new detector, known as sPHENIX – together with RHIC's newly enhanced STAR detector – greatly advances physicists' ability to study subtle details of quark-gluon plasma, a remarkable form of matter that filled the early universe. RHIC recreates tiny specks of this early universe particle "soup" thousands of times each second by colliding the nuclei of atoms at nearly the speed of light.

In 2020, the DOE awarded the construction of the next-generation accelerator, the EIC, to BNL. A collaboration between BNL and Thomas Jefferson Accelerator Laboratory, the EIC will be built by reusing one of the RHIC accelerators and the addition of an electron accelerator to allow collisions of electrons and ions, giving scientists a rare and exciting opportunity to explore and study the internal structures of atomic nuclei. What we learn from the EIC could power the technologies of tomorrow.

The NSRL became operational in 2003. It is jointly managed by DOE-SC and NASA's Johnson Space Center. The NSRL uses heavy ions to simulate space radiation to study the effects on biological specimens, such as cells, tissues, and DNA, as well as industrial materials and electronics. Studies are conducted to identify materials and methods that will reduce the risks astronauts face on future long-term space missions.

The National Synchrotron Light Source (NSLS) used 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. Using beams of very intense light in the x-ray, ultraviolet, and infrared spectra, the NSLS allowed scientists to study the structure of proteins, investigate the properties of new materials, and understand the fate of chemicals in the environment. Although the NSLS had been continually updated since its commissioning in 1982, the practical limits of its performance had been reached and operations permanently ceased in September 2014. Research at the NSLS was associated with two Nobel Prizes. The first was awarded in 2003 to Roderick MacKinnon for describing how proteins help generate nerve impulses. The second, awarded in 2009 to Venkatraman Ramakrishnan and Thomas Steitz for the structure of the ribosome.

National Synchrotron Light Source II.

To continue advances in these fields, the NSLS-II was constructed. The NSLS-II generates intense beams of x-ray, ultraviolet, and infrared light and offers an array of sophisticated imaging techniques to capture atomic-level "pictures" of a wide variety of materials, from biological molecules to semi-conductor devices. NSLS-II has a nanometer-scale resolution—a key resource for researchers at BNL's Center for Functional Nanomaterials (CFN)— that will enhance the development of next-generation sustainable energy technologies and improve imaging of complex protein structures. The NSLS-II has design space for up to 60 beamlines of which 29 have currently been built and are operational.

BNL's CFN is one of five Nanoscale Science Research Centers funded by DOE-SC and provides state-of-the-art tools for creating and exploring the properties of materials with dimensions spanning just billionths of a meter. CFN scientists are dedicated to atomic-level tailoring that addresses a wide range of energy challenges. CFN focus areas include improving solar cells and other electronic nanomaterials; designing more efficient catalysts; developing new capabilities and uses for electron microscopy; and nanofabrication based on soft and biological nanomaterials—all aided by theory and advanced computation. The CFN building has also been awarded Leadership in Energy and Environmental Design (LEED) Silver certification.

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 LEED Silver certification from the U.S. Green Building Council. This award was based on five categories: sustainability, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality.

The Long Island Solar Farm (LISF), located on the Brookhaven National Laboratory site, began delivering power to the grid in November 2011.

The 32-megawatt Long Island Solar Farm (LISF) at BNL was completed in the fall of 2011 in collaboration with BP Solar, Long Island Power Authority (LIPA), the State of New York, and other organizations. At the time it went into operation, it was the largest solar photo-voltaic (PV) electric generating plant in the eastern United States. The LISF plays a vital role in supporting peak electricity demands during the summer months, especially from summertime air conditioning use. It generates enough energy to power approximately 4,500 homes and is helping New York State meet its clean energy efficiency goals.

The Interdisciplinary Science Building (ISB), completed in 2013, is an energy-efficient building that provides labs, offices, and support functions to bring together a broad spectrum of researchers, including industry, universities, and other National Laboratories. The ISB fosters energy research, focusing on the effective uses of renewable energy through improved conversion, transmission, and storage. The ISB has been awarded LEED Gold certification. BNL is establishing itself as a global leader in tackling the challenges of Big Data, building on existing expertise, capabilities, and investments in computational science and data management, and enabling scientific discovery in large-scale experimental environments.

Based in the original NSLS facility, and established in 2016, the Computational Science Initiative (CSI) oversees the following areas: Computer Science and Applied Mathematics, Computing for National Security, Scientific Data and Computing Center, Computation and Data-Driven Discovery, and the Computational Science Lab. CSI takes a multidisciplinary, collaborative approach to its research, targeting challenges in cooperation with fellow researchers in science, national security, and industry, both at home and abroad. CSI has long focused on timely analysis and interpretation of high-volume, high-velocity heterogeneous data, providing solutions for the national and international scientific community. These efforts are now being augmented by CSI's growing high-performance computing capabilities.

While these facilities have set the stage for exciting and world-changing discoveries and innovations over the course of its more than 75-year history, BNL aims to continually improve and innovate its infrastructure. Efforts to improve the face of the Laboratory have been underway for years, by eliminating aging infrastructure and envisioning and constructing sophisticated new facilities.

One such exciting development is Discovery Park, a transformative vision for the Lab's entryway to welcome visitors, provide housing for facility users and guests, and offer new opportunities for private industry to collaborate. It will also provide an opportunity for economic and community development on Long Island,

New York State, and beyond. The Discovery Park concept is built upon responsible development that aligns with the interests of the DOE, BNL, and the regional New York and Long Island economies.

Plans for Discovery Park include Upton Square and a Technology Park, and the Science User Support Center (SUSC), the first building among several planned for Discovery Park. The SUSC is projected to be completed in Spring 2025. The SUSC and Discovery Park, more broadly, will help the Lab reach its mission support goal for a renewed research campus. Additionally, reducing the Lab's building footprint will help minimize costs for overall operations and maintenance. The SUSC will be the only federally funded building in Discovery Park. Other buildings planned for Discovery Park will be funded privately. For more information about Discovery Park, please visit https://discoverypark.bnl.gov/.

Another exciting development that will benefit both private industry in Discovery Park, as well as the Lab itself, is the upgraded Long Island Railroad Yaphank Station. The ground-breaking is planned for early 2025, with construction slated to take place throughout 2025 and the new station ready to be commissioned into service by the summer of 2026.

Newly built Science and User Support Center (SUSC).

Rendering of Long Island Railroad (LIRR) Yaphank Train Station.

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 consisting of the following:

- 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 (STP), ecology field, housing facilities, and fire breaks;
- 400 acres of roads, parking lots, and connecting areas; and
- 200 acres occupied by the LISF.

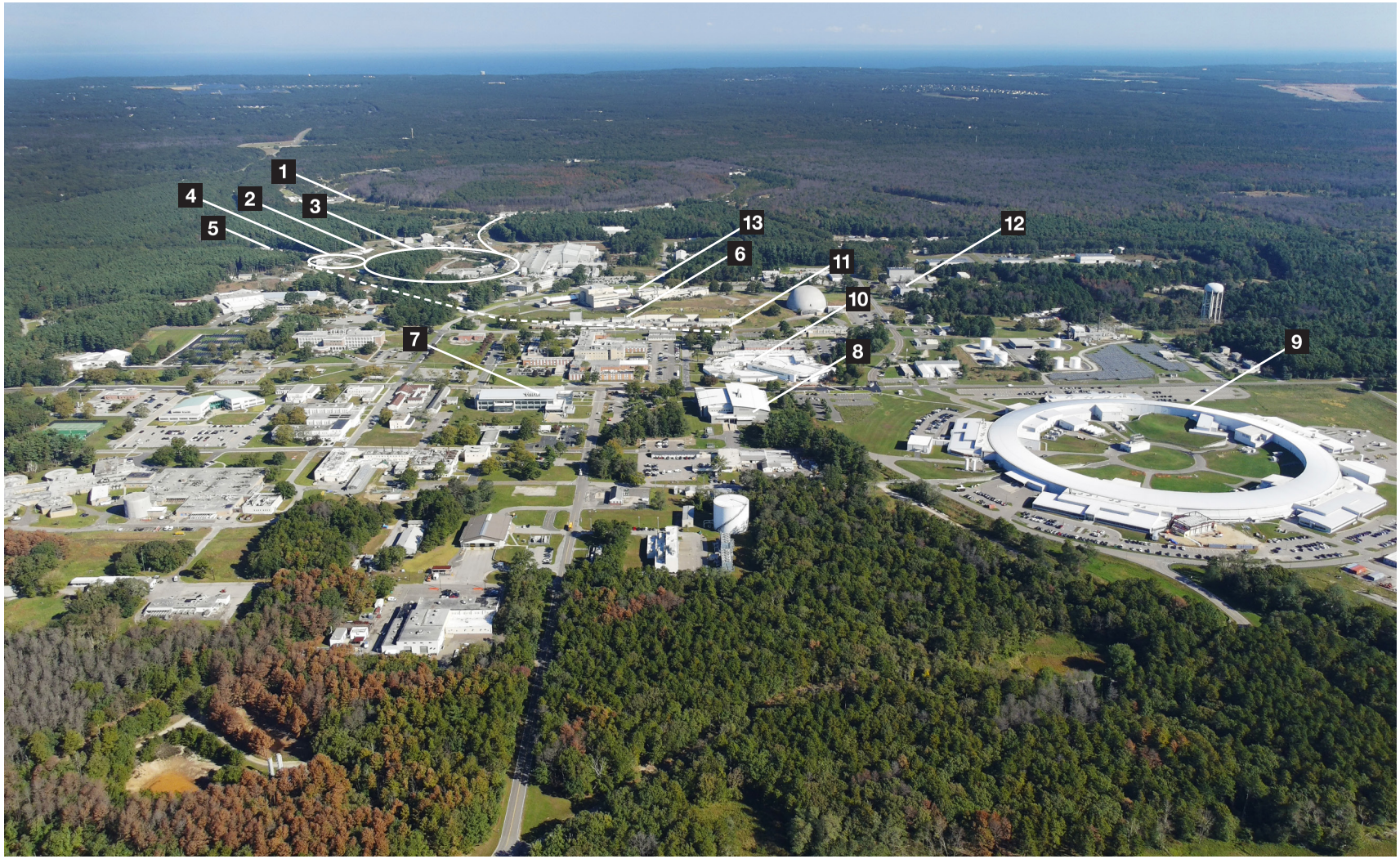


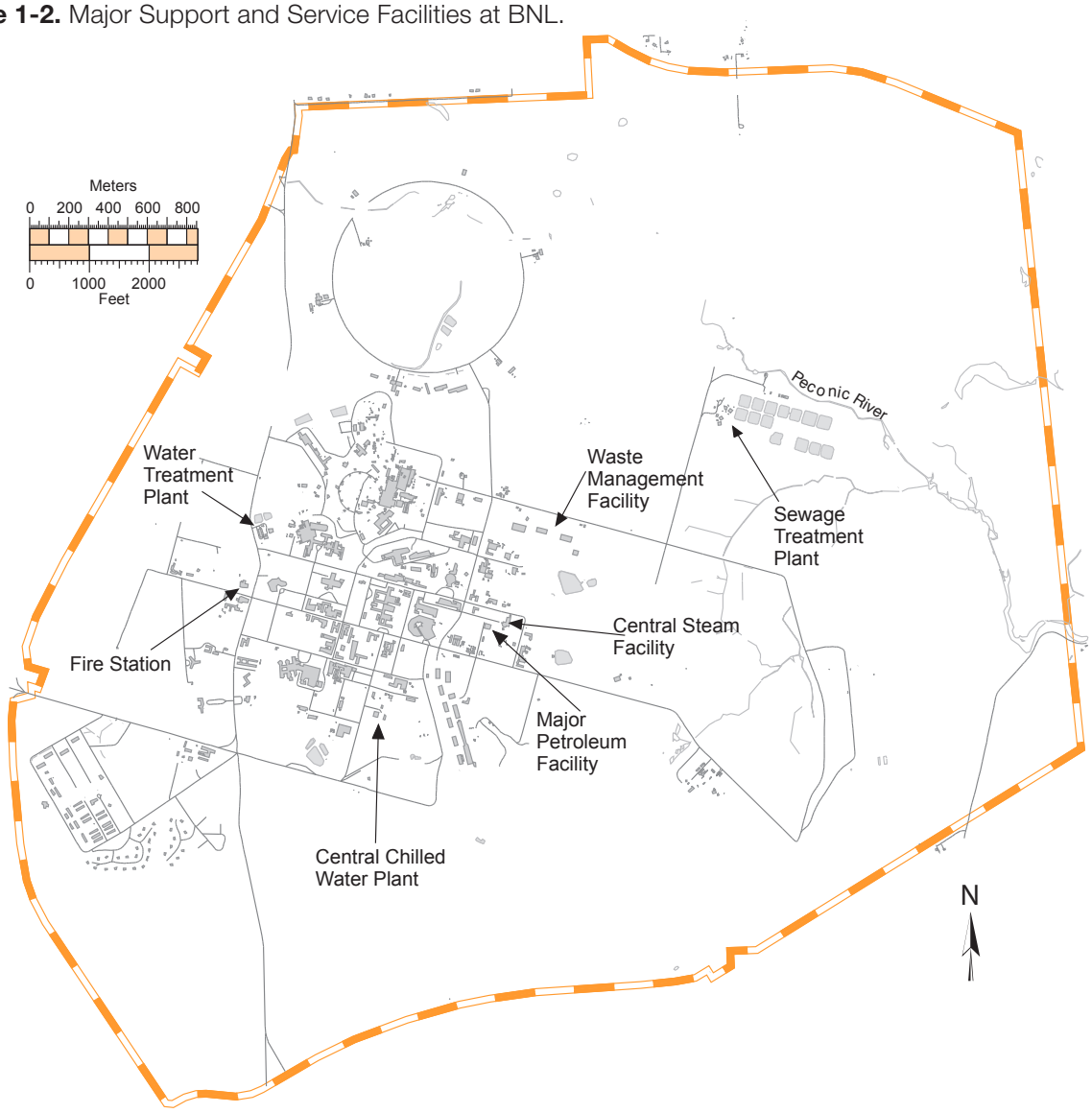
Figure 1-1. Major Scientific Facilities at BNL.

1. Relativistic Heavy Ion Collider
2. NASA Space Radiation Laboratory
3. Alternating Gradient Synchrotron
4. Alternating Gradient Synchrotron Booster
5. Brookhaven Linac Isotope Producer and Linear Accelerator
6. Tandem to Booster
7. Interdisciplinary Science Building
8. Center for Functional Nanomaterials
9. National Synchrotron Light Source II
10. Computational Science Initiative
11. Tandem Van de Graaff and Cyclotron
12. Accelerator Test Facilities
13. Medical Isotope Research Laboratories

The balance of the site, approximately 3,445 acres, is mostly wooded and represents the native pine barrens ecosystem. The location of the major scientific facilities at BNL are shown on Figure 1-1. Additional facilities, shown on Figure 1-2 and briefly described below, support BNL's science and technology mission by providing basic utility and environmental services.

- **Central Chilled Water Facility (CCWF).** 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 heating and site-wide processes. 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 boiler make-up 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 1.9 million gallons of capacity, the MPF stores different types of residual fuel (e.g., No. 2, 4, and 6). The 1997 conversion of CSF boilers to burn both natural gas and oil has significantly reduced the Laboratory's reliance on oil as a sole fuel source when other fuels are more economical, and the primary use of natural gas has significantly reduced greenhouse gas (GHG) emissions.
- **Sewage Treatment Plant (STP).** This plant treats sanitary and certain process wastewater from BNL facilities prior to discharge into groundwater recharge beds, similar to the operations of a municipal STP. The plant has a design capacity of 2.3 million gallons per day. Effluent is monitored and controlled under a permit issued by the New York State Department of Environmental Conservation.
- **Waste Management Facility (WMF).** This facility manages 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 five million gallons per day. Potable water is obtained from four on-site wells. Water pumped from a supply well located in the western section of the site is treated at the WTP to remove naturally occurring iron and then injected with lime to adjust the pH, and with sodium hypochlorite for bacterial control. The plant is also equipped with dual air towers to ensure that volatile organic compounds are at or below New York State drinking water standards. Water from the three supply wells located in the eastern section of the developed site is treated by the addition of sodium hydroxide to increase the pH of the water to make it less corrosive and also injected with sodium hypochlorite to control bacteria.

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



1.5
Location, Local Population, and Local Economy

BNL, the only multi-disciplinary scientific National Laboratory located in the Northeast and one of New York State's largest centers of scientific research, places special emphasis on growing the technology-based elements of the Long Island economy. The future competitiveness of New York's economy depends on its capacity for innovation, and Brookhaven represents a uniquely valuable resource both as a major science-based enterprise, and as a source of discoveries that drive entrepreneurs and innovators. 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 Town, approximately 65 miles east of midtown Manhattan. In 2024, BNL employed 2,687 full-time employees including scientists, engineers, technicians, and support staff. In addition, the Laboratory annually hosts more than 7,000 visiting scientists, facility users, and students from universities, industries, and government agencies, who often stay in apartments and

dormitories on-site or in nearby communities. BNL strengthens Long Island's position as a center of innovation in energy, materials sciences, nanotechnology, and other fields crucial to the growth of New York State's economy. With a fiscal year 2024 budget of $898 million, the Lab has a significant economic impact on New York State. In 2024, Lab employee salaries, wages, and fringe benefits accounted for approximately $504 million, or 56% of its total budget. Supporting local and state businesses whenever possible, the Lab spent $63 million in New York State with $50 million of that amount spent in Nassau and Suffolk counties.

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.

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 five feet near the Peconic River to approximately 80 feet in the higher elevations of the central and western portions of the site. Studies of Long Island hydrology and geology near 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, approximately half of the annual precipitation is lost to the atmosphere through evapotranspiration, and the other half percolates through the soil to recharge the groundwater (Franke & McClymonds, 1972; Aronson & Seaburn, 1974).

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 using 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 U.S. Environmental Protection Agency.

The Laboratory's four in-service drinking water wells withdraw almost one million gallons of water per day from the Upper Glacial aquifer to supply water for drinking, process cooling, and for fire protection. This water is treated to remove contaminants that may be present prior to its distribution. Most of the water is returned to the aquifer by way of on-site recharge basins.

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, Suffolk County, New York, 1994-97 (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.

Figure 1-3. BNL Groundwater Flow Map.

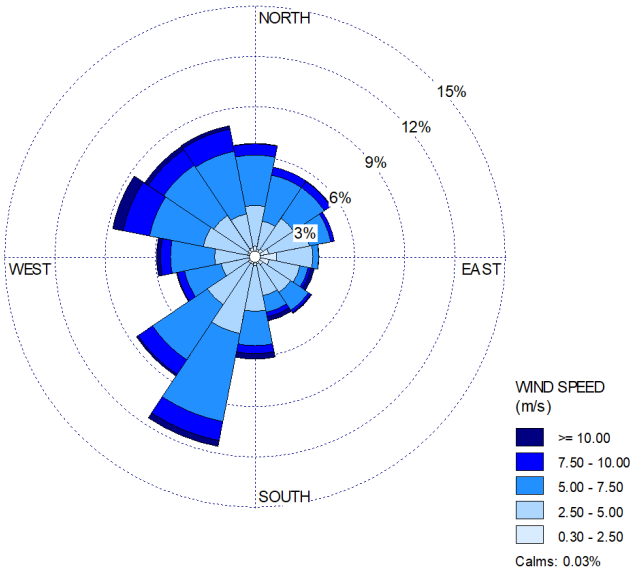
1.7
Climate

Meteorological Services (MET Services) at BNL has been recording on-site weather data since August 1948. MET Services is responsible for the maintenance, calibration, data collection, and data archiving for the weather instrumentation network at BNL. Measurements include wind speed, wind direction, temperature, rain fall, barometric pressure, relative humidity, and solar irradiance.

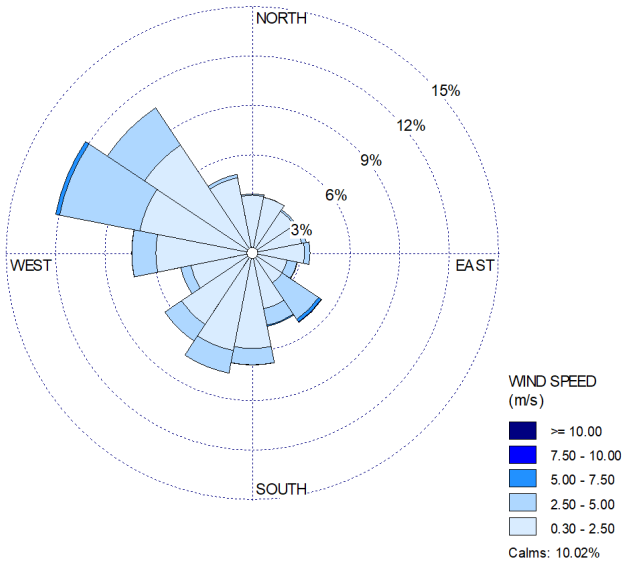
The Laboratory is broadly influenced by continental and maritime weather systems. Locally, the Long Island Sound, Atlantic Ocean, and associated bays influence wind directions and humidity and provide a moderating influence on extreme summer and winter temperatures.

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 2024 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.

Figure 1-4. BNL Wind Rose (2024).



Wind Rose for Jan 1 to Dec 31, 2024
taken at the 85m height.



Wind Rose for Jan 1 to Dec 31, 2024
taken at the 10m height.

In 2024, the average yearly temperature for this area of Long Island was 53.4°F. The coolest month of the year, January, had a monthly average temperature of 34.2°F while the warmest month of the year, July, had a monthly average temperature of 74.5°F. Figures 1-5 and 1-6 show the 2024 monthly mean temperatures and the historical annual mean temperatures, respectively.

Figure 1-5. BNL 2024 - Monthly Mean Temperature versus 75-Year Monthly Average.

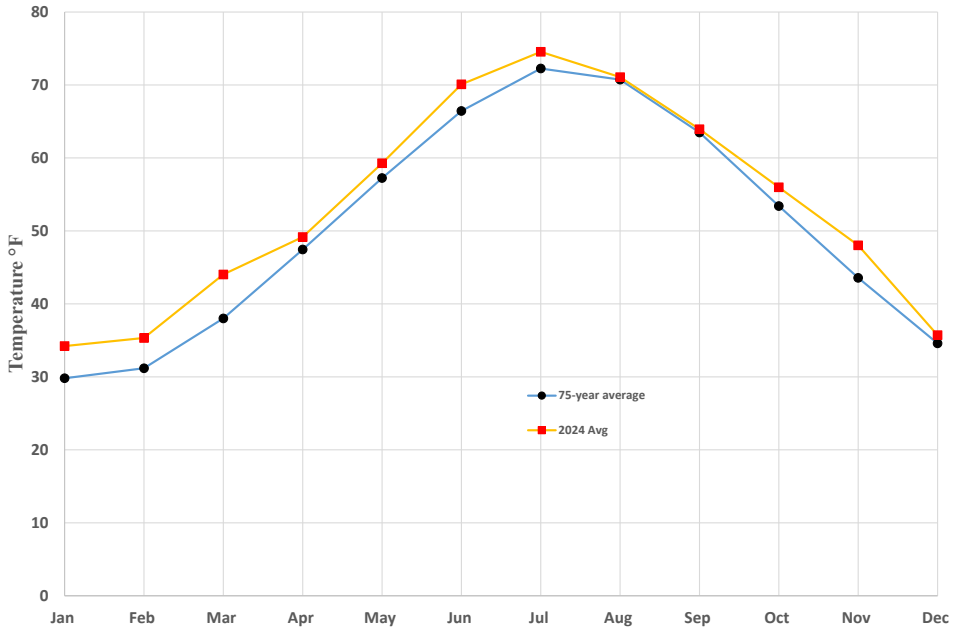
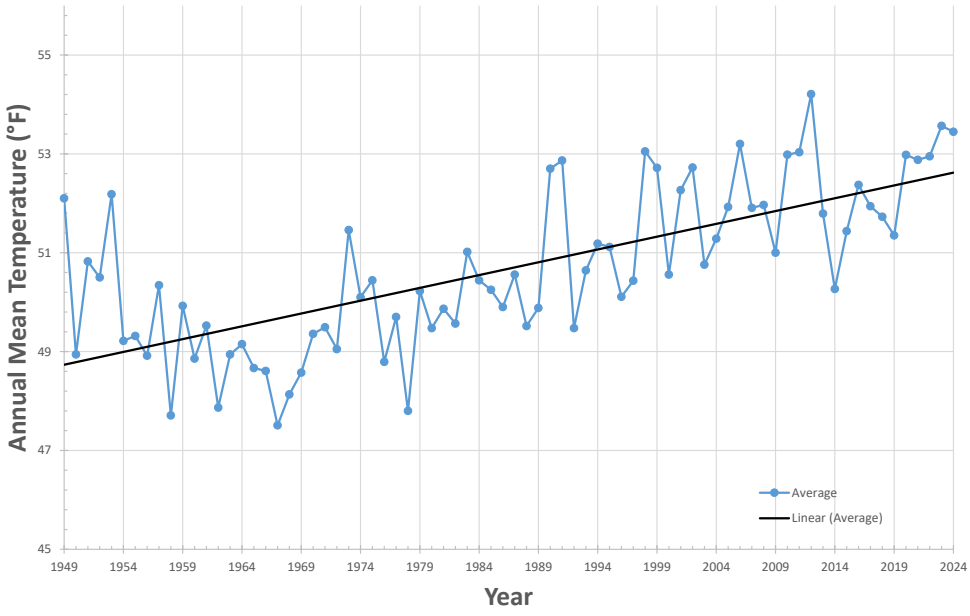


Figure 1-6. BNL Annual Mean Temperature Trend (75 Years) 1949 to 2024.



The total annual precipitation in 2024 was 56.08 inches. Figures 1-7 and 1-8 show the 2024 monthly and the 75-year annual precipitation data, respectively. The yearly total snowfall for 2024 was 11.6 inches, well below the 32.1 inches average yearly snowfall for this area of Long Island.

Figure 1-7. BNL 2024 Monthly Precipitation versus 75-Year Monthly Average.

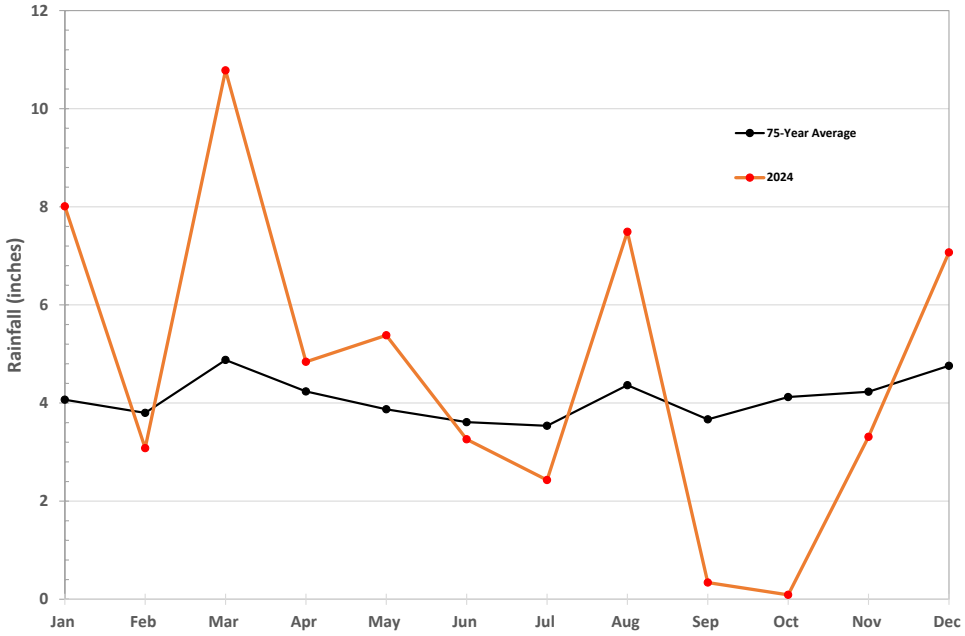
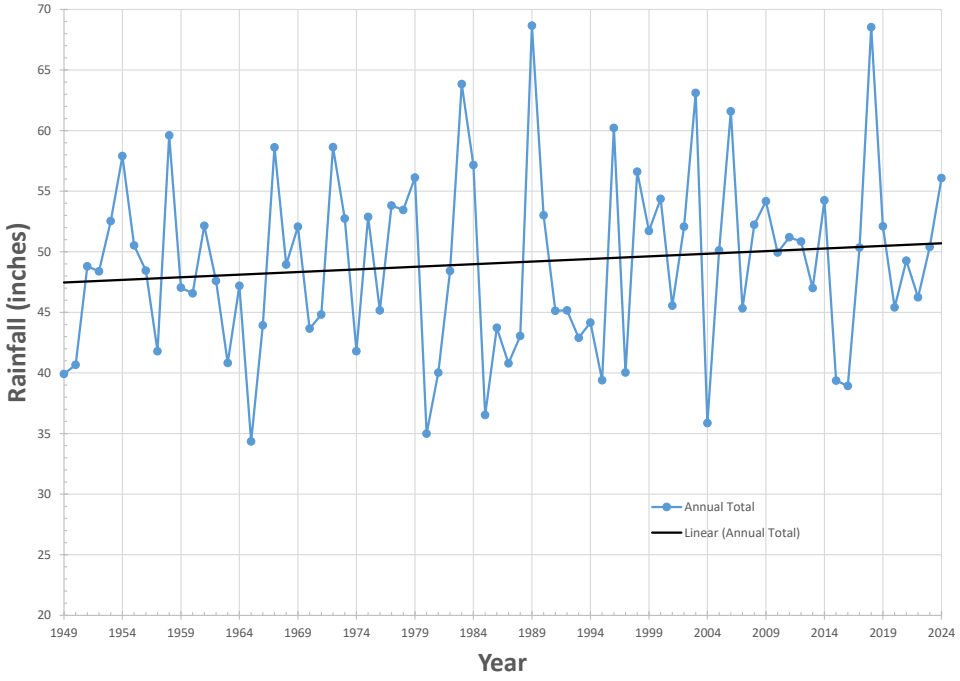


Figure 1-8. BNL 2024 Annual Precipitation Trend (75-Years).



1.8
Natural Resources

The Laboratory is located in the oak and chestnut forest region of the Coastal Plain and constitutes a little less than 5% of the 105,000-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 correlate with variations in topography and depth to the water table.

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 undeveloped areas of the site.

More than 350 plant, 30 mammal, 138 bird, 13 amphibian, 12 reptile, and 10 fish species have been identified on-site, some of which are New York State threatened, endangered, exploitably vulnerable, and species of special concern. To eliminate or minimize any negative effects that BNL operations might cause to these species, precautions are in place to protect habitats and natural resources at the Laboratory.

In November 2000, DOE established the Upton Ecological and Research Reserve (Upton Reserve) at BNL. The 530-acre Upton Reserve (10% of the Laboratory's property) is on the eastern portion of the site, in the Core Preservation Area of the 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 (IAA) 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. 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 (BNL 2021).

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 (BNL 2023). These resources include World War I trenches; Civilian Conservation Corps features; World War II barracks; and historic scientific buildings and features, structures, programs, and discoveries associated with high-energy physics, research reactors, and other science conducted at BNL. The Laboratory currently has approximately 30 resources classified as eligible for listing on the National Register of Historic Places, including numerous scientific buildings, facility complexes, support buildings, and the World War I training trenches associated with Camp Upton. Further information can be found in Chapter 6, section 6.6.

References and Bibliography

Aronson, D.A. and Seaburn, G.E. 1974. Appraisal of the operating efficiency of recharge basins on Long Island, NY in 1969. USGS Water Supply Paper 2001-D.

BNL. 2023. Cultural Resource Management Plan for Brookhaven National Laboratory. BNL-73839-2023. Brookhaven National Laboratory, Upton, NY.

BNL. 2021. Natural Resource Management Plan for Brookhaven National Laboratory. BNL-112669-2021. Brookhaven National Laboratory, Upton, NY.

Franke, O.L. and McClymonds, P. 1972. Summary of the hydrogeologic situation on Long Island, NY, as a guide to water management alternatives. USGS Professional Paper 627-F.

Geraghty and Miller, Inc. 1996. Regional Groundwater Model, Brookhaven National Laboratory, Upton, New York. A Report to Brookhaven National Laboratory. November 1996.

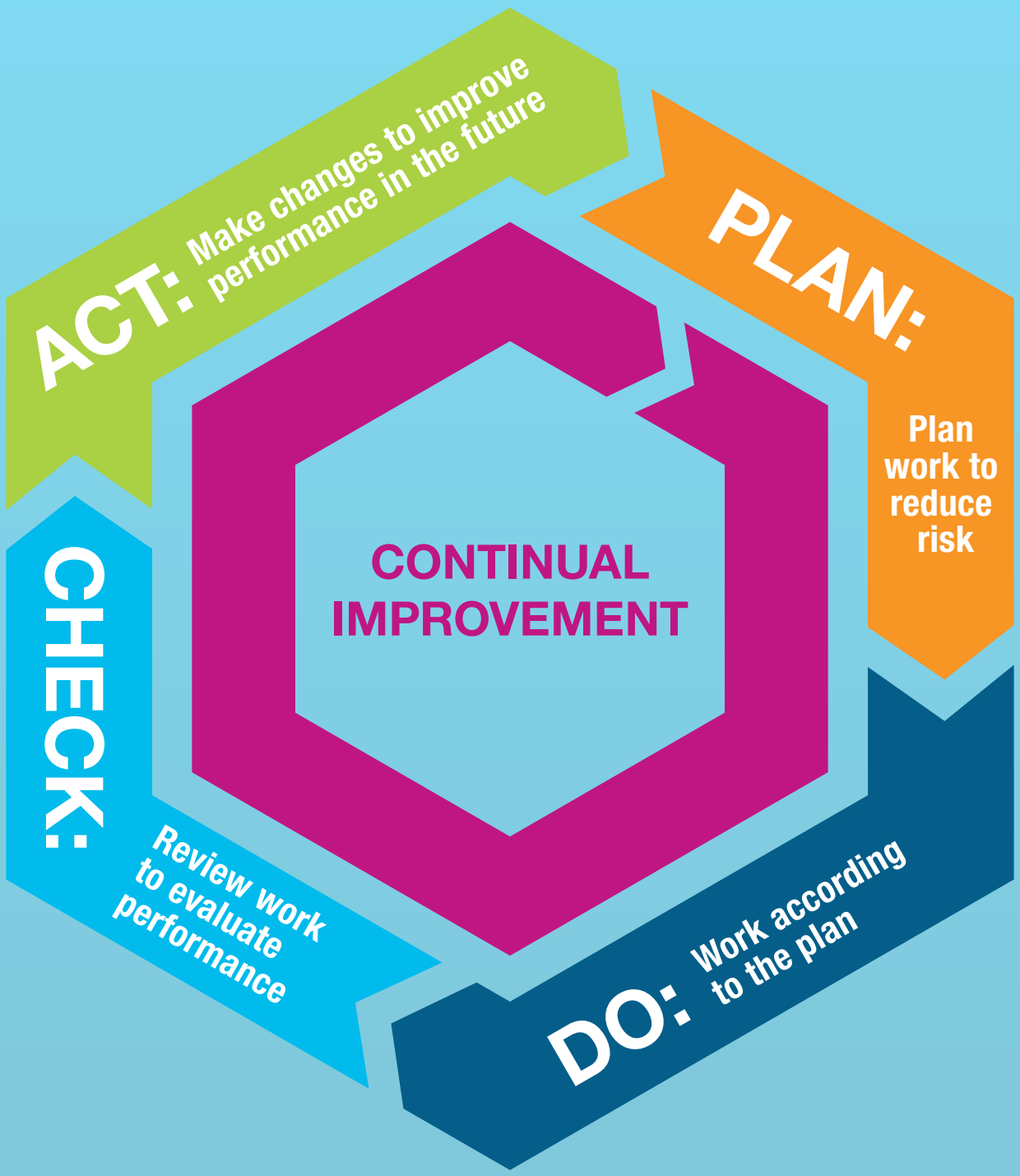
Koppelman, L.E. 1978. The Long Island Comprehensive Waste Treatment Management Plan (Long Island 208 Study), Vol. I and II. Long Island Regional Planning Board, Hauppauge, NY. July 1978.

Nagle, C.M. 1975. Climatology of Brookhaven National Laboratory: 1949–1973. BNL-50466. Brookhaven National Laboratory, Upton, NY. November 1975.

Nagle, C.M. 1978. Climatology of Brookhaven National Laboratory: 1974–1977. BNL-50857. Brookhaven National Laboratory, Upton, NY. May 1978.

Scorca, M.P., W.R. Dorsch, and D.E. Paquette. 1999. Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, New York, 1994–97. U.S. Geological Survey Water Resources Investigations Report 99-4086. 55 pp.

Warren, M.A., W. DeLaguna, and N.J. Lusczynski.1968. Hydrology of Brookhaven National Laboratory and Vicinity, Suffolk County, New York. U.S. Geological Survey Bulletin, 1156-C.



The "Plan-Do-Check-Act" improvement cycle.

Chapter 2

Environmental Management System

Brookhaven Science Associates (BSA), the contractor operating the Laboratory on behalf of the Department of Energy (DOE), is committed to being good stewards of the DOE's land and property, protecting and preserving it for future use.

As part of its commitment to environmentally responsible operations, BSA has established the Brookhaven National Lab (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, which provides a framework for efficient, clean and compliant operations, that consider the needs and expectations of various interested parties, both within and outside of the Laboratory. Annual audits by an independent third party are required to maintain registration, with a full recertification assessment of the entire EMS occurring every three years. During 2024, the Lab was recertified as conforming to the standard with no findings. BNL's conformance to the ISO 14001 Standard continues uninterrupted since 2001.

BNL continues to seek opportunities and implement efficient business practices into site operations and infrastructure. The areas of focus are water and energy conservation, waste reduction, recycling, purchase of environmentally friendly products, and greenhouse gas (GHG) management. In 2024, BNL's EMS and Pollution Prevention (P2) Program continued to contribute to the Laboratory's success in improving sustainable operations. The Lab provides strong support for the P2 Program, which seeks ways to eliminate waste and toxic materials on-site and promote other sustainable business activities. The program generates new ideas to grow the Lab's existing recycling program or otherwise improve sustainable operations. In 2024, the P2 Program resulted in nearly $1.6 million in cost avoidance or savings and resulted in the reduction or reuse of over 1,500 tons of waste. The program also funded 14 new proposals, investing approximately $17,900. Support was also provided in 2024 to line organizations for laboratory cleanouts and disposal of chemicals. As a testament to its strong environmental program, the Lab received the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT) Gold Award, its ninth DOE GreenBuy Gold Award, and fifth GreenBuy Superior Award. BNL also met 90% of the GreenSpace criteria product goals in a Research Laboratory renovation, thereby achieving its first GreenSpace Silver Award.

BNL continues to address legacy environmental issues and openly communicates with neighbors, regulators, employees, and other interested parties on environmental issues and cleanup progress on-site. During 2024, BNL hosted six in-person/virtual meetings of the Community Advisory Council (CAC), monthly interagency calls with regulators were held, as were tours, the Open House program, and other community events. BNL is committed to transparency and open communication with its internal and external stakeholders.

2.1
Integrated Safety Management and ISO 14001

The Laboratory's Integrated Safety Management System (ISMS) integrates environmental protection, pollution prevention, safety, health, and quality management into all work planning and execution. The purpose of BNL's ISMS is to integrate DOE's five Core Functions and seven Guiding Principles into all work processes. The five Core Functions, as defined by DOE P 450.4A, Chg 1, Integrated Safety Management Policy, are:

- **Define the scope of work:** Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.
- **Analyze the hazards:** 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 and 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 and continuous improvement:** Feedback information on the adequacy of controls is gathered; opportunities for improving the definition and planning of work are identified and implemented.

The seven Guiding Principles, also defined by DOE P 450.4A, Chg 1, are:

- **Line management responsibility for safety:** Line management is directly responsible for the protection of the workers, the public, and the environment.
- **Clear roles and responsibilities:** Clear and unambiguous lines of authority and responsibility for ensuring safety are established and maintained at all organizational levels within the Department and its contractors.
- **Competence commensurate with responsibilities:** Personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.
- **Balanced priorities:** Resources are effectively allocated to address safety, programmatic, and operational considerations. Protecting the workers, the public, and the environment is a priority whenever activities are planned and performed.
- **Identification of safety standards and requirements:** Before work is performed, the associated hazards are evaluated and an agreed upon set of safety standards and requirements is established which, if properly implemented, will provide adequate assurance that the workers, public, and environment are protected from adverse consequences.
- **Hazard controls tailored to work being performed:** 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 processes within ISMS contribute to BNL maintaining its ISO 14001 registration. The ISO 14001 Standard is globally recognized and defines the structure of an organization's EMS for purposes of improving environmental performance. The process-based structure of the ISO 14001 Standard is based on the "Plan-Do-Check-Act" improvement cycle. The ISO 14001 standard requires 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 has been officially registered to the ISO 14001 Standard since 2001 and was the first DOE Office of Science Laboratory to achieve this registration. The certification requires the Laboratory to undergo annual audits by an accredited, third-party registrar to assure that the system is maintained. BNL's external certification organization, Orion Registrars, Inc., conducted an external certification audit of BNL's conformance to the ISO 14001 Standard in July 2024 with no nonconformances. The assessment verified the Laboratory's continued conformance to the Standard. BNL's certification to the standard remains valid until September 26, 2027.

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 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 www.bnl.gov/esh/policy.php. The Policy's goals and commitments focus on compliance, pollution prevention, community outreach, and continual improvement:

- **Environment:** We protect the environment, conserve resources, and implement sustainable business practices that protect our future.
- **Safety:** We maintain a safe workplace. 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, the U.S. DOE, and other stakeholders, including historically marginalized, disadvantaged communities.
- **Continual Improvement:** We continually improve ESSH performance.

Environmental, Safety, Security, and Health Policy

Brookhaven National Laboratory (BNL) is a world leader in scientific research and performs this work in an environmentally responsible and safe manner.

Every employee, contractor, and guest is expected to take personal responsibility for adhering to the following principles:

Environment	We protect the environment, conserve resources, and implement sustainable business practices that protect our future.
Safety	We maintain a safe workplace. 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, the U.S. Department of Energy, and other stakeholders including historically marginalized, disadvantaged communities.
Continual Improvement	We continually improve ESSH performance.

In addition to my annual review of Brookhaven Lab's progress on ESSH goals and adherence to this policy, I invite all interested parties to provide me with input on our performance relative to this policy, and the policy itself.

Signed JoAnne Hewett, Director December 5, 2023

Brookhaven National Laboratory

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; evaluate applicable compliance obligations; establish objectives and targets; create action plans to achieve the objectives and targets; and identify and address risks and opportunities that can impact the success of the EMS.

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 and are incorporated into BNL work planning process so that they are identified and reviewed. A process assessment procedure can also be used for facilities and equipment or for deeper analysis of activities not sufficiently covered by work planning. Evaluations are documented on work plans and Process Assessment Forms (PAFs).

Environmental professionals work closely with Laboratory personnel to ensure that work plans, PAFs, and other related reviews thoroughly capture all aspects, requirements, and associated environmental controls. Aspects and impacts are evaluated annually to ensure that they continue to reflect stakeholder concerns and changes in regulatory requirements.

2.3.2 Compliance Obligations

To implement the compliance commitments of the ESSH Policy and meet its compliance obligations, BNL has systems in place to review changes in federal, state, or local environmental regulations and 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. BNL also answers to the DOE regarding its performance against these requirements in addition to how well BNL has implemented sustainable solutions where they will support BNL and DOE operations wherever possible.

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. At the very highest level, the system drives BNL's improvement agenda by establishing a prioritized set of key objectives, called the Performance Evaluation Management Plan (PEMP). BSA works closely with DOE to clearly define expectations and performance measures. Factors for selecting environmental priorities include:

- Meeting the intent and goals of relevant executive orders and other requirements;
- Significant environmental aspects;
- Risk and vulnerability (threat to, or from, the environment);
- Compliance obligations (e.g., laws, regulations, permits, enforcement actions, and memoranda of agreement);
- Commitments in the ESSH Policy to regulatory agencies and to the public;
- Importance to DOE, the public, employees, and other stakeholders.

Additional Laboratory-level objectives and targets are developed on a fiscal year (FY) schedule through the implementation of the business planning process. For FY24, BNL's environmental objectives included addressing emerging contaminants in drinking water, supporting the Lab's scientific mission by providing environmental support to significant research projects, supporting building demolition and legacy clean-up issues, maintaining ISO 14001 certification, and furthering progress on objectives relating to energy conservation, water conservation, fleet management, clean/renewable energy, sustainable buildings, green procurement, electronics stewardship, and organizational resilience.

2.4
Environmental Management Programs

The Environmental Protection Division (EPD) takes on the largest role for developing action plans for implementing institutional environmental priorities, while other organizations within BNL develop action plans as applicable to their operations. The plans detail how the organization will achieve its 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 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.

2.4.1 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 monitoring drinking water systems for emerging contaminants, establishing a wildland fire program, increasing on-site pollinator habitat, retrofitting or replacing air conditioning equipment refrigerants, and managing legacy facilities. See Table 3.1 in Chapter 3 for a list of regulatory programs to which BNL subscribes and a thorough discussion of these programs and their status.

2.4.2 Groundwater Protection

BNL's Groundwater Protection Program is designed to prevent negative impacts to groundwater and restore groundwater quality by integrating pollution prevention efforts, monitoring, groundwater restoration projects, and communicating performance. The Laboratory has developed a Groundwater Protection Contingency Plan that defines an orderly process for quickly verifying groundwater monitoring data and taking corrective actions in response to unexpected results (BNL 2024).

Key elements of the groundwater program are full, timely disclosure of off-normal occurrences and regular communication on the performance of the program. Chapter 7 and the Site Environmental Report (SER) Volume II, Groundwater Status Report, provide comprehensive details about this program, its performance, and monitoring results for 2024.

2.4.3 Waste Management

Due to 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 municipal solid waste (MSW) and non-hazardous construction and demolition (C&D) debris. Per Figure 2-2, BNL generated 291 tons of MSW and 1235 tons of C&D waste during 2023.

To a much smaller degree, the Laboratory's unique scientific activities also generate specialized waste streams that are subject to additional regulation and special handling, including radioactive, hazardous, industrial, and mixed waste. BNL's Waste Management Facility (WMF), operated by the EPD, is responsible for collecting, storing, transporting, and managing the disposal of these specialized wastes. This facility was designed for handling hazardous, industrial, radioactive, and mixed waste, and is comprised of two staging areas: a facility for hazardous, industrial, and mixed waste in Building 855, regulated by RCRA, and a reclamation building for

radioactive material in Building 865. The RCRA building is managed under a permit issued by the New York State Department of Environmental Conservation (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. Waste can either be generated from routine operations, defined as ongoing industrial and experimental operations, or from non-routine, defined by waste generated by remediation projects, facility decommissioning activities, or one-time events (e.g., lab cleanouts). In 2024, BNL generated the following types and quantities of waste from routine operations:

- Hazardous waste: 2.7 tons
- Mixed waste: 7 ft^3
- Radioactive waste: 1,226 ft^3
- Other Regulated Waste (e.g., petroleum products, wastewater): 28.9 tons

Hazardous waste generation from routine operations, which consists of a wide variety of chemical waste from routine research activities, remained within expectations in 2024. Nonroutine hazardous waste during 2024 consisted of a variety of unused, expired, or contaminated materials generated from maintenance activities and building cleanouts.

There were seven tons of mixed waste generated from facility maintenance during 2024 as shown in Figure 2-1b and fourteen tons of nonroutine mixed waste generated from the demolition of hazardous and radioactively contaminated facilities as part of site improvement activities.

Routine radioactive waste generated primarily from BNL's medical isotope research program trends down as shown in Figure 2-1c though more waste generation is expected in the future as isotope production increases. A minimal quantity of nonroutine radioactive waste from the demolition of Building 197 was also disposed during 2024.

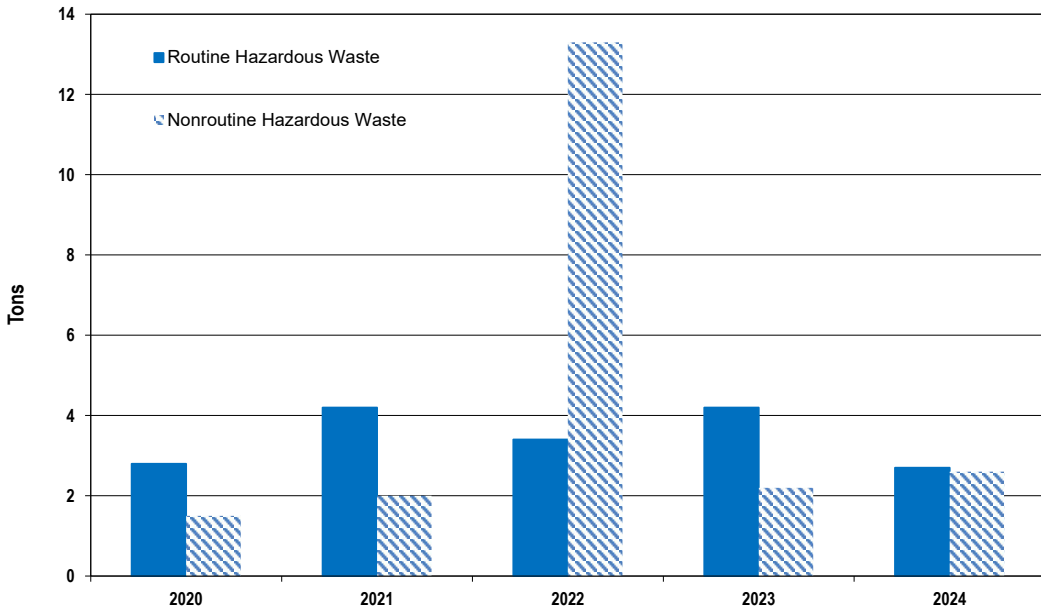


Figure 2-1a. Hazardous Waste Generation from Routine and Nonroutine Operations, 2020-2024.

Figure 2-1b. Mixed Waste Generation from Routine and Nonroutine Operations, 2020-2024.

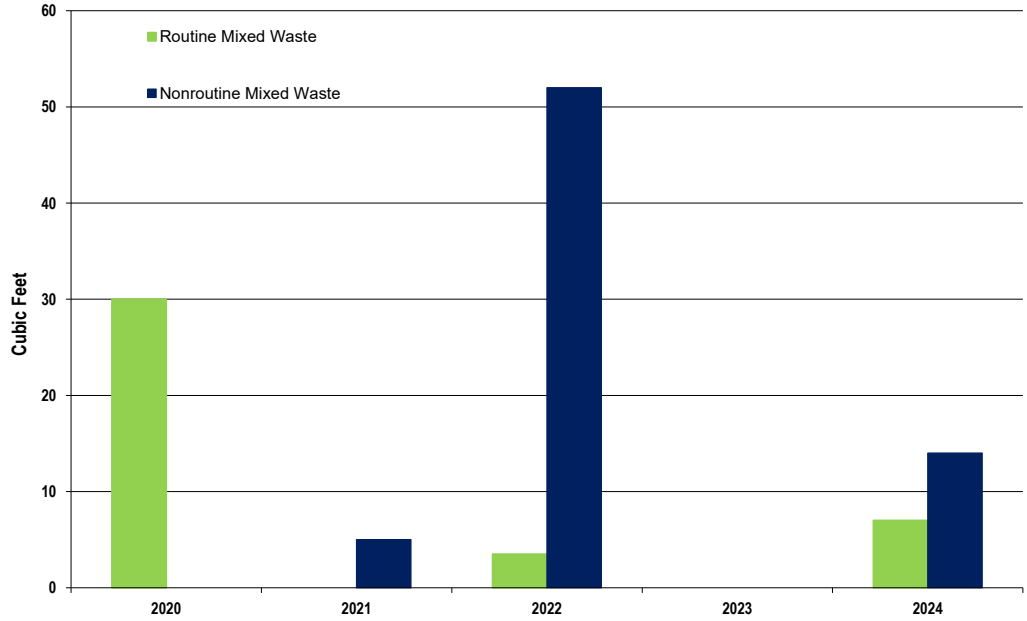
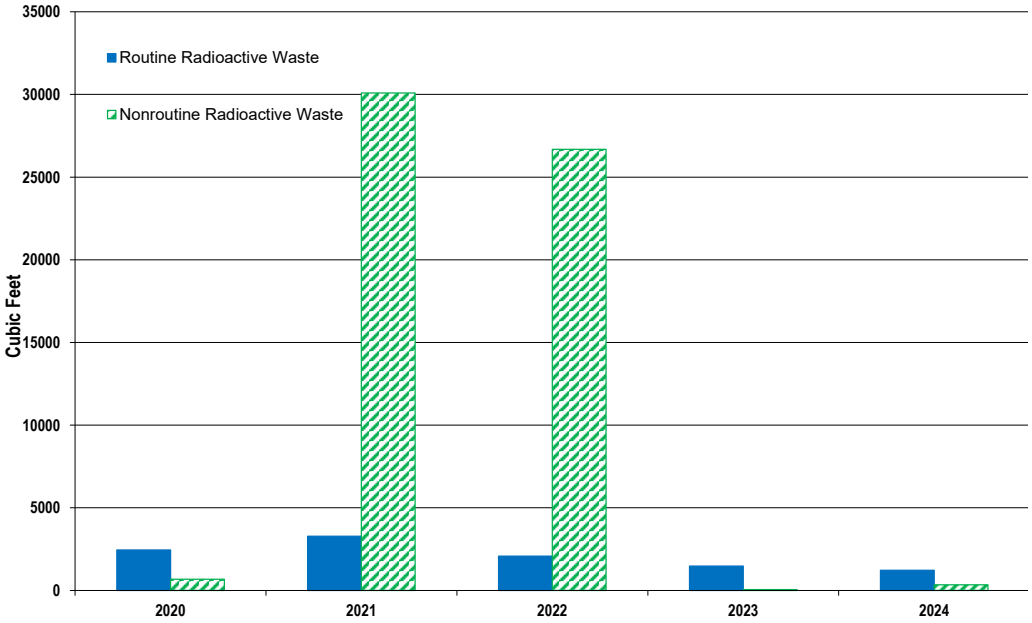


Figure 2-1c. Radioactive Waste Generation from Routine and Nonroutine Operations, 2020-2024.



2.4.4 Pollution Prevention and Waste Minimization

The BNL P2 Program reflects 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. P2 and waste reduction goals flow throughout the Laboratory via the EMS having been incorporated into the DOE contract with BSA, BNL's ESSH Policy, and BNL's efficient business practices. Key elements of the P2 Program include:

- Eliminate or reduce emissions, effluents, and waste at the source where possible, as practicable; Conserve natural resources and energy;
- Assess opportunities to evaluate other methods of power generation to determine best technology to fuel future growth;
- 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;
- Improve employee and community awareness of P2 goals, plans, and progress.

The BNL P2 and recycling programs have achieved long-term reductions in waste generated by routine operations. However, Lab population growth and site improvement activities will challenge this trend. Overall waste trends can be seen in Figure 2-2 with increases in C&D debris generated due to ongoing construction of the Science User Support Center (SUSC) and other site improvement activities. These activities will continue for the foreseeable future. Roughly 30% of staff work a hybrid home/office schedule with some fully remote employees. MSW generation shows a slight increase with expectations that volumes will continue to increase in the future without the identification and implementation of new diversion opportunities.

BNL's EMS establishes objectives and targets to drive pollution prevention and waste reduction as part of overall sustainable business practices, including the annual P2 Program that provides funds to purchase equipment or other materials to either reduce an environmental risk or reduce or eliminate a waste stream. Table 2-1 describes all the waste streams that were diverted from disposal as MSW during 2024, and provides the number of pounds of materials reduced, reused, or recycled, as well as the estimated cost benefit of each project.

BNL employee recycling gloves.

During 2024, the program funded 14 new proposals, investing approximately $17,900. The proposals involved reducing spill risk, reducing plastic waste in laboratories, promoting use of bio-friendly alternative products, and promoting overall environmentally sustainable business practices. The implementation of P2 opportunities, recycling programs, and conservation initiatives has reduced both waste volumes and management costs. In 2024, these efforts resulted in nearly $1.6 million in cost avoidance or savings and approximately 1,587 tons (over 3 million pounds) of materials being reduced, recycled, reused or sent for energy recovery.

Figure 2-2. Waste Disposal in Tons, 2020-2024.

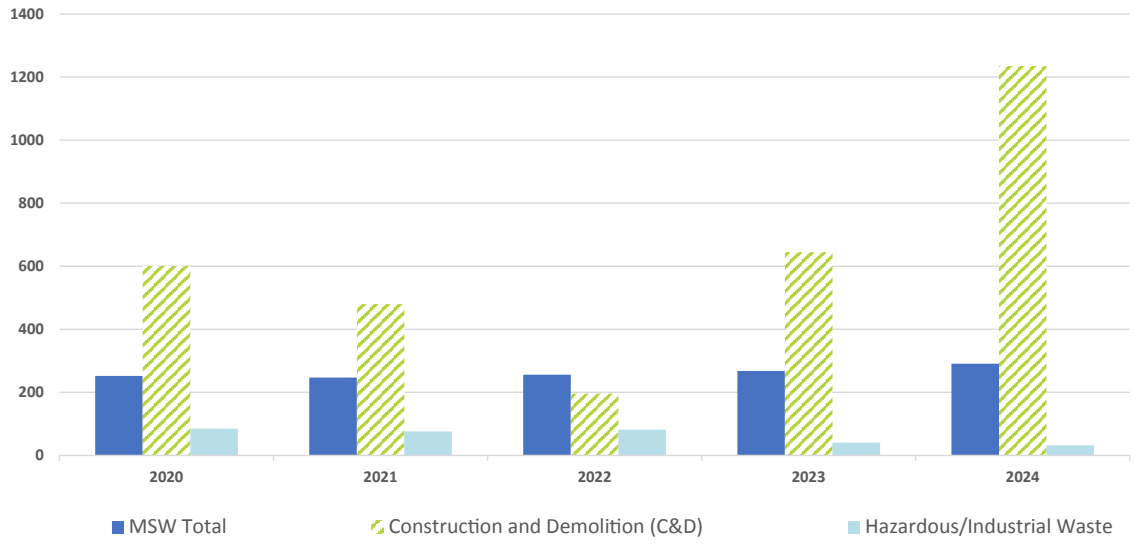
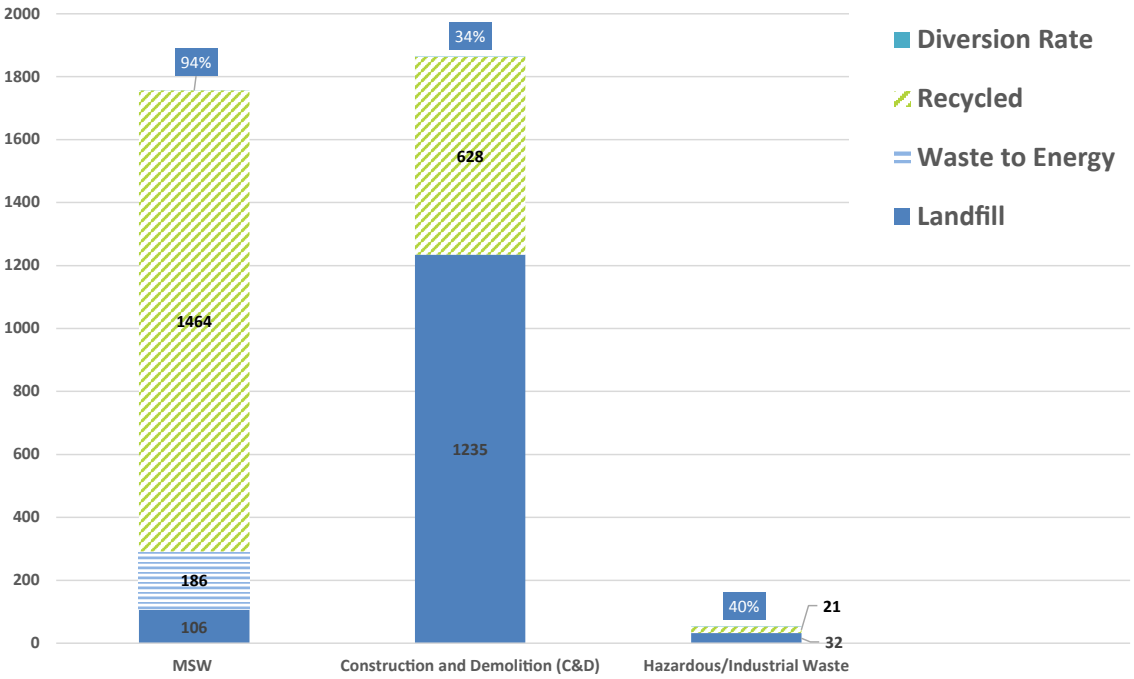


Figure 2-3. Waste Diversion in Tons, 2024.



In 2024, BNL collected approximately 1,272 tons of scrap metal for recycling which is over double the normal amount generated. The additional amount was generated out of the Collider-Accelerator Department (C-AD) as they begin to cleanout the facility in preparation for transition to the Electron Ion Collider (EIC). The transition will generate a large amount of metal for the following several years. Cardboard, office paper, bottles and cans, construction debris, motor oil, lead, automotive and uninterrupted power supply (UPS) batteries, electronic scrap, fluorescent light bulbs, and tires were also recycled. Table 2-1 shows the total number of tons of materials recycled. The baseline recycling rate goal for federal facilities is 50%. BNL's annual average recycling rate for MSW diversion from a landfill consistently outperforms the baseline. The 2024 annual recycling rate was 94%. The table also indicates other non-MSW waste streams such as used motor oil, lead scrap, lead batteries, and fluorescent bulbs which are regulated hazardous and industrial waste streams that are being recycled are shown, but not counted, in BNL's MSW recycling rate.

In 2024, BNL's P2 program was once again honored by receiving the Green Electronics Council's EPEAT Award for purchasing EPEAT-registered electronic products which meet strict environmental criteria that address the full product lifecycle, from energy conservation to toxic materials to product longevity and end-of-life management. BNL also received its ninth DOE GreenBuy Gold Award and fifth GreenBuy Superior Award. Additionally, BNL met 90% of the GreenSpace criteria product goals in a Research Laboratory renovation, thereby achieving its first GreenSpace Silver Award.

Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2024.

Municipal Solid Waste (MSW)	Tons	Estimated Revenue/ Cost Savings	Project Description Details
Office Paper	31	$11,000	Collected and transported to a transfer facility for recycling along with regular trash, daily construction and demolition debris (C&D) from daily maintenance activities, and other recyclables. Savings are based on cost to dispose of as trash at $240/ton vrs. recycling at a flat fee of $13K for all paper and cardboard and no cost/revenue for bottles and cans.
Cardboard	60		
Bottles/Cans	9		
Printer Toner Cartridges	1	$120	Savings are based on cost to dispose of as trash vrs. recycling at $0 cost/revenue.
Metals	1,272	$737,760	Cost avoidance was based on disposal as trash, plus revenue based on $0.17/lb.
Tires	8	$1,920	Truck tires were sent for recycling from the motor pool at $0 cost/revenue. Cost savings were based on cost to dispose of as trash at $240/ton.
Blasting Garnet	21	$4,140	Garnet used in machine shop shipped for recycling at a cost of $900 and cost avoidance for disposal as MSW at $240/ton
Electronic Waste	56	$69,440	Cost avoidance was based on disposal as trash, plus revenue based on $0.50/lb.
Wood Pallets	8	$800	Pallets in reusable condition are collected centrally on-site by the Facilities and Operations (F&O) Directorate and picked up by a local company at no cost/revenue. Eight tons represents 304 pallets, avoiding C&D disposal cost of $0.05/lb.
Subtotal: Tons of Material Recycled:	**1,464**	**$825,180**	**Total Savings Achieved**
Tons of MSW sent to a Waste to Energy (WtE) facility:	**186**		
Tons of MSW Landfilled:	**106**		**Total MSW diverted from a landfill = 94%**
Total tons MSW:	**1,758**		**Total rate of recylcing = 86%**

(continued on next page)

Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2024 *(concluded)*.

Construction and Demolition Debris Recycled	Tons	Estimated Revenue/ Cost Savings	Project Description Details
Total Tons of Material Recycled	628	$26,840	Demolition of multiple buildings. Revenue from metals plus cost savings from disposing as C&D waste.
Total Tons of C&D Waste Landfilled	1,235	($123,500)	34% Total Diverted from a C&D Landfill.

Other Regulated Waste Streams (Hazardous/Industrial Waste) Recycled	Tons	Estimated Revenue/ Cost Savings	Project Description Details
Used Oil (Motor Pool, Oil Skimmer) (Sent for Energy Recovery)	4	$3,414	Used motor oil from automobiles and compressor oil condensors is sent to a vendor for energy recovery. In 2024, they collected 1,030 gallons (4 tons) for $1,260, which avoided the costs for disposal as used oil at $51/drum plus the cost of 19 shipping drums at $195/drum.
Lead Acid Batteries (Recycled)	17	$19,040	Avoided universal waste disposal costs of $0.41/lb for lead & sulfuric acid batteries by sending directly for recycling at $0.15/lb revenue.
Fluorescent Light Bulbs	1	($1,422)	Waste management manages these bulbs as universal waste and has them recycled.
Total Tons of Material Diverted:	**22**	**$21,032**	**Total Cost/Savings Achieved**
Total Hazardous & Industrial Waste Disposed:	**32**	**41%**	**Total Diversion from Other Disposal/Treatment (Hazardous Waste, Used Oil, Waste Water)**

Materials Reused On-site (Not included in diversion calculations)	Tons	Estimated Revenue/ Cost Savings	Project Description Details
Carbon Reuse - GW Cleanup Systems	34	$63,000	Sent off-site for regeneration then returned for reuse. Savings is based on the cost to buy new carbon.
Electronic Reuse	4	$648,000	The Laboratory resues electronic equipment if possible. If not reused, the electronics would provide scrap metal revenue at $0.50/lb. Savings are based on the cost of purchasing the reused items as new items minus the scrap value.
Total Tons of Material Diverted:	**38**	**711,000**	**Total Cost Avoidance Achieved**

Total of All Material Recycled or Reused: 1,587 Tons
Total Savings and Cost Avoidance from Recycling and Reuse: $1.6 Million

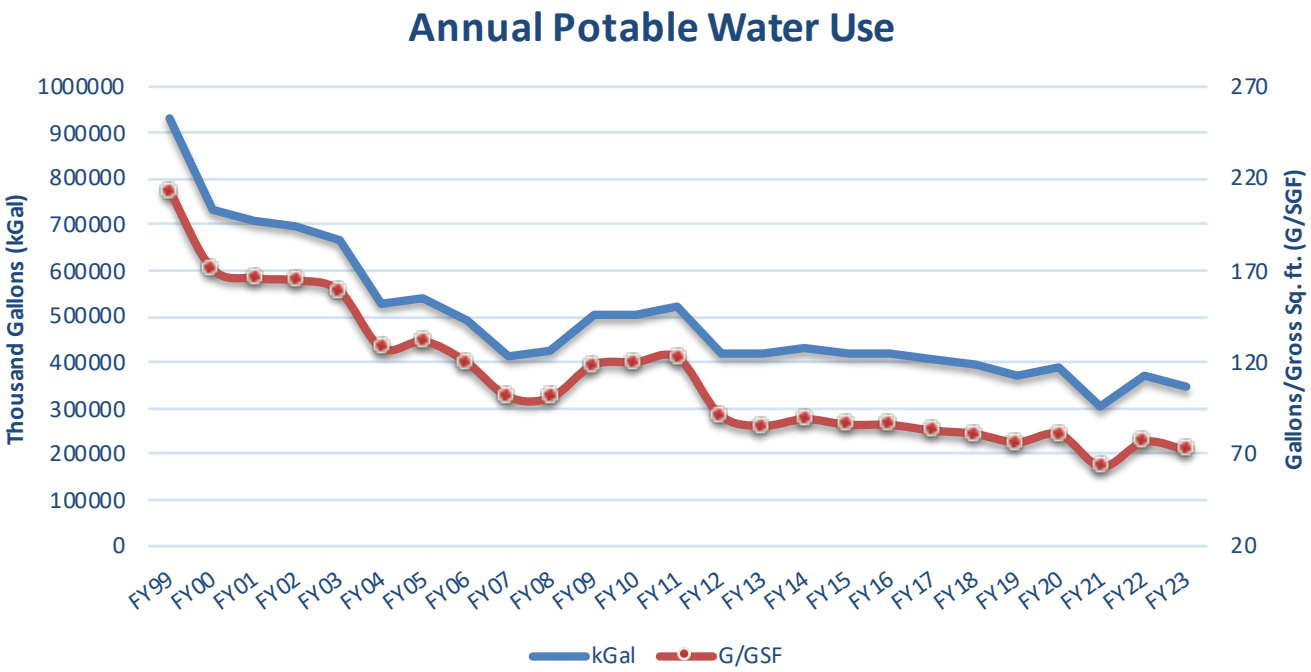
2.4.5 Water Conservation

BNL's water conservation program has achieved a dramatic 63% reduction in water use from the mid-1990's resulting in savings of half billion gallons of water every year. Much of that reduction was achieved in the early years prior to 2007. Figure 2-4 shows the 18-year water intensity (gallon/gross square foot) since the major reductions were achieved, which has stayed consistent with a drop in use during the COVID-19 period and increasing use since due to returning staff as well as Lab growth. Usage will continue to increase, with an anticipated bump expected in five years when the EIC begins operation based on that facility's projected cooling needs.

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 to reduce use of once-through cooling water for other systems. The Laboratory's goal is to continue to integrate water saving design into new facilities and maintain current reductions while ensuring the flow at the Sewage Treatment Plant (STP) is sufficient for efficient plant operations.

Moreover, BNL has shifted its wastewater treatment in recent years to primarily an aquifer recharge system. This method of wastewater rejection significantly reduces the Lab's impact on the depletion of the subsurface sole source aquifer that supplies Long Island's communities. This aquifer recharge also prevents run-off and the conveyance of surface pollutants to local waterways.

Figure 2-4. Annual Potable Water Use, 2007 - 2024.



2.4.6 Energy Management and Conservation

The Laboratory's Energy Management Group continues to reduce energy use and costs by 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 efforts.

2.4.6.1 Site Energy Usage

BNL's 3.2 million gallon chilled water storage tank used to reduce peak electric demand by producing and storing chilled water is getting cleaned remotely, via drone.

BNL has more than 4.8 million square feet of building space. Many scientific experiments at the Laboratory use particle beams generated and accelerated by electricity, with the particles controlled and aligned by large electromagnets. In 2024, BNL used 296 million kilowatt hours (kWh) of electricity, 57,312 gallons of No. 6 heavy fuel oil, 9,816 gallons of No. 2 light fuel oil, 15,118 gallons of propane, and 554 million cubic feet of natural gas. Fuel oil and natural gas are used to produce steam at the Central Steam Facility (CSF), with light fuel oil also being used in satellite boilers around campus. Responding to market conditions, fuel oil and natural gas have been historically used whenever each respective fuel is least expensive, or when the local utility requires a natural gas curtailment event to stabilize supply lines in the community. Given the price disparity between natural gas and oil, the Laboratory will continue to purchase natural gas over oil in the future. A side benefit is the reduction of greenhouse gas emissions that will result from burning natural gas over oil.

In 2024, natural gas prices once again continued to be lower than fuel oil prices. However, BNL continued to burn a significant amount of its supply of #6 fuel oil for heat in anticipation of the upcoming ban of the purchase of #6 fuel oil recently enacted by New York State. BNL plans to transition to No. 4 fuel oil as a primary fuel source after the remaining No. 6 fuel oil has been used over the course of 2025. Additional information on natural gas and fuel oil use can be found in Chapter 4.

New York State has electric load reduction curtailment programs that will activate when the New York Independent System Operator expects customer demand to meet or exceed the available supply. BNL could not participate in this program in 2024 as the Relativistic Heavy Ion Collider (RHIC) continued operation of the 25 megawatt (MW) RHIC throughout the summer.

In 2024, BNL's energy supply included 120,014 MWh of clean, renewable hydropower energy, 552,447 kWh of on-site generated solar photovoltaic (PV), and 24 million kWh of purchased renewable energy certificates (RECs). The Laboratory will consider seeking alternative renewable energy sources pending directives and funding from the new administration.

BNL is the site of the Long Island Solar Farm (LISF). The array is one of the largest solar PV arrays (32 MW) in the Northeast and spans 195 acres with more than 164,000 panels. The LISF was designed to produce an average of 44 million kWh of power for Long Island and has been performing over 50 million kWh/year. As an outcome of allowing this large array to be constructed on-site, the Laboratory has developed a solar research program that conducts research and development for solar power storage and inverter efficiencies.

2.4.6.2 Current Conservation Efforts

To reduce energy use and costs at non-research facilities, several activities were continued or undertaken by the BNL Energy Management Group in 2024:

- **BNL receives a 15 MW block allocation of renewable (nearly zero GHG) hydropower from the New York Power Authority:** The hydropower used in 2024 provided a net GHG reduction of 70,310 MT CO_2e.
- **Continued progress occurred on several energy efficiency initiatives, such as the following:** New electric, chilled water, and steam meter installations; funding for energy efficiency initiatives; the purchase of RECs in meeting Environmental Protection Act 2005 renewable electricity requirements; and training various parties on energy conservation initiatives.
- **Energy Conservation:** Energy and water evaluations are completed for 25% of the site each year. Cost-effective projects are identified and proposed for funding, as appropriate.
- **Renewable Energy:** Project support continues for the LISF and Northeast Solar Energy Research Center (NSERC) facilities and annual purchases of RECs to meet targeted goals.
- **Central Chilled Water Facility (CCWF):** The CCWF continues to utilize a 3.2-million-gallon chilled water storage tank to reduce peak electric demand by producing and storing chilled water during the night.
- **Natural Gas Purchase Contract:** BNL is currently saving over $2 million per year using natural gas compared to oil.
- **Energy Savings:** Work continues in the replacement of aging, inefficient metal halide lighting fixtures with new LED high bay and low bay fixtures, as appropriate. Typically, 200 to 300 fixtures are replaced annually, saving tens of thousands of kWhs each year and reducing costs by several thousand dollars.
- **Demand Response:** The Energy Management team has also performed an audit of the controls system with regards to demand response and has programmed the following demand response scenarios to curtail summer usage:
  - Tier 1 – Raising office area cooling set points by 1 °F.
  - Tier 2 – Raising office area cooling set points by an additional 1 °F and humidity setpoints by 10%.
  - Tier 3 – Raising office area cooling setpoints by a total of 4 °F and humidity setpoints an additional 10%.
- **Energy Savings Reinvestment Program:** In calendar year (CY) 2023, BNL completed its payments for its Utility Energy Service Contract (UESC) freeing up capital. This freed capital is now being used as part of a piloted energy savings reinvestment program focused on essential maintenance and upgrade projects that promote additional energy savings. In 2024, projects that were started included: replacement of the fill in the central chilled water south cooling towers, right sizing condenser water pumps in the chilled water plant to reduce energy consumption, and overhauling site cooling towers including B555 and B488. Projects continued in CY25.

2.4.7 Natural and Cultural Resource Management Programs

Through its Natural Resource Management Plan (BNL 2021), BNL continues to enhance its Natural Resource Management Program for the Lab and the Upton Ecological and Research Reserve. The Laboratory also continues to enhance its Cultural Resource Management Program. A BNL Cultural Resource Management Plan (BNL 2023) was developed to identify and manage properties that are determined to be eligible for inclusion on the National Register of Historic Places. See Chapter 6 for further information about these programs.

2.4.8 Environmental Restoration

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress in 1980. As part of CERCLA, the Environmental Protection Agency (EPA) established the National Priorities List, which identifies sites where clean-up 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) (USEPA 1992). Although not formal signatories of the IAG, the New York State Department of Health (NYSDOH) and the Suffolk County Department of Health Services (SCDHS) also play key roles 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 cleanup process, which includes the following steps:

- Identification of the presence or potential presence of a hazardous substance that may pose a threat to public health, welfare, or the environment;
- Conduct a preliminary assessment followed by a remedial investigation, if necessary, to characterize the nature and extent of contamination and assess the associated risks;
- Issue a Record of Decision (ROD), which is the corrective action agreed to by DOE, EPA, and NYSDEC with input from the public;
- Perform the Remedial Design/Remedial Action, which includes final design, construction specifications, and carrying out the selected corrective action; and
- Perform removal actions (time critical or non-time critical) under the CERCLA process as appropriate.

In 2024, BNL's 10 active groundwater treatment systems removed approximately 41 pounds of volatile organic compounds (VOCs), 0.1 millicurie (mCi) of strontium-90 (Sr-90), 0.7 pounds of per- and polyfluoroalkyl substances (PFAS), and returned approximately 1.1 billion gallons of treated water to the sole source aquifer. In accordance with a CERCLA Action Memorandum to conduct a Time Critical Removal Action, operation of two groundwater treatment systems to address PFAS contamination from the Former Firehouse and Current Firehouse/Building 170 source areas continued. Groundwater characterization data and modeling identified the need to modify the Operable Unit (OU) VI ethylene dibromide treatment system with additional extraction wells to capture deeper contamination. These two new deep extraction wells began operation in January 2024. These groundwater systems are operated in accordance with approved Operations and Maintenance manuals. In addition, as identified in the 2021 CERCLA Five Year Review, an in-situ chemical treatment was performed in the Building 96 residual source area to reduce the mobility of contaminants and enhance their degradation to improve the cleanup timeframe.

Institutional controls were 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 was submitted to the regulatory agencies. Furthermore, in 2024, BNL continued the surveillance and maintenance of the Brookhaven Graphite Research Reactor (BGRR) and the High Flux Beam Reactor (HFBR). Table 2-2 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.

Table 2-2. Summary of BNL 2024 Environmental Restoration Activities.

Project	Description	Environmental Restoration Actions
Soil Projects	Operable Unit (OU) I/II/III/VII/X	Performed inspections, monitoring, and maintenance of institutional controls for cleanup areas. Installed two soil borings in the OU X Current Firehouse source area to characterize subsurface soil for per and poly fluoroalkyl substances (PFAS) from ground surface to the groundwater table.
Groundwater Projects	OU I/III/V/VI	Continued operation of seven groundwater treatment systems that remove volatile organic compounds (VOCs) and one system that removes strontium-90 (Sr-90). Removed 41 pounds of VOCs and 0.1 mCi of Sr-90 during the treatment of approximately 759 million gallons of groundwater. Since the first groundwater treatment system started operating in December 1996, approximately 7,914 pounds of VOCs and 35 mCi of Sr-90 have been removed, while treating approximately 33 billion gallons of groundwater.
Groundwater Projects	OU I/III/V/VI	Collected and analyzed approximately 1,327 sets of groundwater samples from 657 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) monitoring wells. Installed 16 temporary wells and collected multiple samples from each location to delineate/track the OU I Sr-90 plume. The operation of two new extraction wells commenced in January 2024, to remediate ethylene dibromide in the deeper portion of the aquifer in the OU VI plume. An in-situ chemical treatment consisting of liquid carbon and zero valent iron (ZVI) was performed in the Building 96 residual source area to reduce the mobility of VOCs and enhance their degradation. Influent, effluent, and individual extraction wells were sampled for PFAS and 1,4-dioxane at eight groundwater treatment systems currently treating VOCs and Sr-90 for compliance monitoring with recently established New York State discharge stands for these analytes.
	OU X (PFOS/ PFOA/1,4-Dioxane	As part of the Time-Critical Removal Action (TCRA) under CERLCA, continued the operation of two PFAS groundwater treatment systems, the Current Firehouse/Building 170 system and the Former Firehouse system. Approximately 0.7 pounds of PFAS were removed from the aquifer and approximately 320 million gallons of treated groundwater were returned to the aquifer in 2024. Since the startup of the Current Firehouse/Building 170 system in October 2022 and the Former Firehouse system in January 2023, a total of approximately 1.3 pounds of PFAS have been removed and approximately 666 million gallons of groundwater have been treated. Installed and sampled eight temporary Geoprobe® wells to track an apparent shift in the Current Firehouse/Building 170 PFAS plume, and 15 temporary vertical profile wells to delineate PFAS and 1,4-dioxane downgradient of the Current Firehouse/Building 170. Four new permanent monitoring wells were installed based on the results of the temporary vertical profile wells to monitor the downgradient portions of the Current Firehouse/Building 170 plume. Collected groundwater samples from two soil borings installed in the Current Firehouse source area. A total of 17 monitoring wells from the Current Firehouse/Building 170 plume and 13 wells from the Former Firehouse plume were also monitored for 1,4-dioxane.
Peconic River	OU V	A population survey of fish in the on-site portion of the Peconic River was performed under BNL's Environmental Surveillance Program. In 2024, the fish population did not support sampling.

(continued on next page)

Table 2-2. Summary of BNL 2024 Environmental Restoration Activities *(Concluded.)*

Project	Description	Environmental Restoration Actions
Reactors	Brookhaven Graphite Research Reactor (BGRR)	Continued long-term surveillance and maintenance, including minor repairs and maintenance items.
	High Flux Beam Reactor (HFBR)	Continued long-term surveillance and maintenance, including minor repairs and maintenance items.
	Brookhaven Medical Research Reactor (BMRR)	The final BMRR Stack Demolition Closeout Report was issued to the regulators in January 2023.
Former Buildings 810/811	Former Radiological Liquid Processing Facility	Maintained institutional controls of the area.
Building 801	Inactive Radiological Liquid Holdup Facility	Performed routine surveillance and maintenance of the facility.
Former Building 650	Inactive Radiological Decontamination Facility	Maintained institutional controls of the area.

2.5
Implementing the Environmental Management System

2.5.1 Structure and Responsibility

All employees at BNL have clearly defined roles and responsibilities in key areas, including environmental protection. Supervisors are required to work with their employees to develop and document Roles, Responsibilities, Accountabilities, and Authorities (R2A2s). BSA has clearly defined expectations for management and staff which must be included in the R2A2 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. Environmental Compliance Representatives (ECRs) are deployed to organizations throughout the Laboratory as an effective means of integrating environmental planning and pollution prevention/waste minimization 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.

2.5.2 Communication and Community Involvement

In support of BNL's commitment to open communication and community involvement, the Stakeholder Relations Office (SRO) develops best-in-class communications, science education, government relations, and community involvement programs that advance the science and science education missions of the Laboratory. The SRO contributes to the public's understanding of science, enhances the value of the Laboratory as a community, and ensures that internal and external stakeholders are properly informed and have a voice in decisions of interest

and importance to them. The SRO also works to maintain relationships with BNL employees and external stakeholders, such as neighbors, business leaders, elected officials, and regulators to provide an understanding of the Laboratory's science and operations, including environmental restoration activities, and to incorporate community input into BNL's decision making process.

To facilitate stakeholder input, the SRO's Office of Community Engagement, in coordination with the EPD, participates in or conducts on- and off-site meetings which include discussions, presentations, and workshops. Community Engagement and EPD staff attend local civic association meetings, conduct Laboratory tours, and coordinate informal information sessions and formal public meetings, which are held during public comment periods for environmental projects.

The SRO's Media and 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.

The SRO's Office of Workforce Development and Science Education manages various education initiatives and programs that support the scientific mission at BNL and the DOE. Programs include Summer Science Explorations for grades four through twelve, the Science Learning Center, and the DOE's Workforce Development for Teachers and Scientists which sponsors various internship opportunities.

Student participating in an Office of Workforce Development and Science Education learning activity.

2.5.2.1 Communication Forums

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

- The 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 comprised of 26 member organizations and individuals representing civic, education, employee, community, environmental, business, and health interests. The CAC sets its own agenda in cooperation with the Laboratory and meets six times a year. The CAC is one of the primary ways the Laboratory keeps the community informed. Meetings are open to the public and are announced on the BNL homepage calendar and on the Stakeholder Relations website which links to the CAC webpage, meeting agendas, and past meeting presentations and minutes. An opportunity for public comment is provided at each meeting. 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 IAG and other federal, state, and local regulators to update them on project status. The calls also

provide the opportunity to gather input and feedback and to discuss emerging environmental findings and initiatives.

- Stakeholder Relations also manages several outreach programs that provide opportunities for stakeholders to become familiar with the Laboratory's facilities and research projects. Outreach programs include:
  - *Tour Program:* Opportunities to learn about BNL are offered to college and university groups. Tour groups visit the Laboratory's scientific machines and research facilities and meet with scientists to discuss research. Agendas are developed to meet the interests of the groups and often include environmental stewardship issues such as water quality and groundwater protection.
  - *Explore Brookhaven Open Houses:* Held on four Sundays each summer, these open houses enable the public to visit BNL science facilities, experience hands-on activities, and learn about the Lab's scientific research. In 2024, more than 5,000 visitors participated in the program.

PubSci, a science cafe event sponsored by BNL

The Laboratory also participates in and hosts various outreach events throughout the year such as Science in the Community programs, a science cafe called PubSci, a Science on Screen event at a local cinema, and the Port Jefferson Mini-Maker Faire. All Hands staff meetings are held throughout the year to keep employees apprised of Lab updates and new programs.

The SRO's Media & Communications Office issues press releases to news and media outlets and the Internal Communications Office publishes electronic and printed weekly employee newsletters, such as Brookhaven This Week and The Brookhaven Digest. In addition, a Director's Office web-based publication, Monday Memo, is issued bi-weekly to employees and focuses on 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.

Community members can subscribe to the weekly e-newsletter, Brookhaven This Week, found on the Media Communications webpage at www.bnl.gov, which keeps Lab employees and the community informed about happenings at BNL, explains some of the science behind Laboratory research, and invites subscribers to educational and cultural events. Additionally, a new email was established to facilitate easy communication with community members: community@bnl.gov.

2.5.2.2 Community Involvement in Cleanup Projects

In 2024, BNL updated stakeholders on the progress of environmental clean-up projects, additional initiatives, and health and safety issues via briefings, and presentations given at CAC meetings. These topics included the following:

- **Cyber Security at BNL:** was presented by the Chief Information Security Officer, Ian Ballantyne. Topics included the cyber organization at BNL, the regulatory, threat and operational environments and cyber responsibilities of the organization.
- **BNL's Commitment to Emission Reduction:** was presented by Deputy Director for Operations Ann Emrick, and Energy Manager, Benedetto Schiraldi. The presentation covered BNL's strategic energy objectives, reducing gas emissions and energy management moving forward.
- **Small Business and Procurement Opportunities at BNL:** including sustainable purchasing and the Green Buy Award program. The small business presentation was given by Mary Rogers, the Lab's Small Business Liaison Officer and discussed the Lab's small business engagement, eligibility requirements, and procurement opportunities. Debbie Bauer, Subject Matter Expert for Environmentally Preferred Purchasing for EPD, and Suhani Gandhi, Project Manager for the Modernization Project Office discussed the environmentally preferable purchasing program in relation to the EPA Comprehensive Procurement Guidelines.
- **BNL Strategy in Biopreparedness:** Martin Schoonen, Associate Lab Director for Environment, Biology, Nuclear Science and Nonproliferation presented about National Laboratory capabilities to address future biological crises.
- **Explore Brookhaven open houses:** Danielle Pontieri, from Stakeholder Relations, invited CAC members and their friends and families to participate and spread the word about the Lab's open houses taking place on four Sundays over the summer. The open houses are free and open to the public.
- **Results from the 2024 Survey of the CAC:** covered topics such as meeting time, topic, tour, and moderator preferences and feedback about scientific and environmental presentations.
- **Natural and Cultural Resources:** The CAC received updates on BNL's natural resources, such as deer and fire management, and the risk to the Long Island Pine Barrens from the southern pine beetle.
- **Environmental Updates:** In 2024, the CAC also received environmental updates such as the general status of the groundwater contaminant plumes and remediation systems; emerging contaminants PFAS and 1,4 Dioxane in groundwater; proposed New York State and EPA drinking water standards for these contaminants; and updates on the SER.

2.5.3 Monitoring and Measurement

BNL's EMS specifies requirements for conducting general surveillance to determine impact from site operations to the environment. DOE O 458.1 Admin Chg. 4, (2020), Radiation Protection of the Public and Environment, requires DOE sites to maintain surveillance monitoring for determining radiological impacts, if any, to the public and environment from site operations.

BNL's EMS includes an Environmental Monitoring Program (EMP) which is a comprehensive, site-wide 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 EMP defines how the Laboratory will monitor effluents and emissions to ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. The plan uses the EPA's 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. The monitoring programs are reviewed and revised, as necessary, 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 shown in Table 2-3, in 2024, there were 6,791 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges under the EMP. Specific sampling programs for the various media are described further in Chapters 3 through 8. The EMP addresses three components: compliance, restoration, and surveillance monitoring.

Table 2-3. Summary of BNL Sampling Program Sorted by Media, 2024.

Environmental Media	No. of Sampling Events (a)	Purpose
Groundwater	1468	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 Site Environmental Report (SER) Volume II, Groundwater Status Report, for further details.
On-Site Recharge Basins	56	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 details.
Potable Water	20 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 details.
Sewage Treatment Plant (STP)	121	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 details.
Precipitation	8	Precipitation samples are collected from two locations to determine levels of mercury present in rain to support long-term monitoring of atmospheric disposition of mercury.
Air – Tritium	249	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 details.
Air – Particulate	378 ES/C 49 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 as part of their program to assess radiological air concentrations statewide. See Chapter 4 for further details.
Fauna	31	Fish and deer are monitored to assess impacts on wildlife associated with past or current BNL operations. See Chapter 6 for further details.
Flora	12	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 details.
Soils	107	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.

(continued on next page)

Table 2-3. Summary of BNL Sampling Program Sorted by Media, 2024. *(Concluded.)*

Environmental Media	No. of Sampling Events (a)	Purpose
Miscellaneous	142	Samples are collected periodically from potable water fixtures and dispensers, manholes, and spills to assess process waters and to assess sanitary discharges.
Groundwater Treatment Systems Monitoring	1154	Samples are collected from groundwater treatment systems operated under the Comprehensive Environmental Response, Compensation, and Liability Act program. The Laboratory has ten operating groundwater treatment systems. See discussion in Chapter 7.
State Pollutant Discharge Elimination System (SPDES)	335	Samples are collected to ensure that the Laboratory complies with the requirements of the New York State Department of Environmental Conservation-issued SPDES permit. Samples are collected at the STP, recharge basins, and four process discharge sub-outfalls to the STP.
Flow Charts	520	Flowcharts are exchanged weekly as part of BNL's SPDES permit requirements to report discharge flow at the recharge basin outfalls.
Floating Petroleum Checks	97	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	482	Daily instrumentation checks are conducted on the radiation monitors located in Buildings 569 and 592. These monitors are located 30 minutes upstream of the STP and at the STP. Monitoring at these locations allows for diversion of wastes containing radionuclides before they are discharged to the STP recharge basins.
Quality Assurance / Quality Control Samples (QA/QC)	1306	To ensure that the concentrations of contaminants reported in the SER 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 laboratories to ensure their processes give valid, reproducible results.
Landfill gas	256	Soil gas monitoring of methane and hydrogen sulfide concentrations is conducted around each landfill. Soil gas monitoring data are evaluated for the potential for hazardous concentrations of gas near the landfill areas and the potential for off-site migration.
Total number of sampling events	**6791**	The total number of sampling events includes all samples identified in the Environmental Monitoring Plan (BNL 2024), 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.
C = Compliance
ES = Environmental Surveillance

2.5.3.1 Compliance Monitoring

Compliance monitoring is conducted to ensure that wastewater effluents, air emissions, and groundwater quality 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.

Air emissions monitoring is conducted at reactors no longer in operation, accelerators, and other radiological emission sources, as well as the 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 agencies. See Chapters 3 and 4 for details.

Wastewater monitoring is performed at the point of discharge to ensure that the effluent complies with release limits in the Laboratory's SPDES permits. Twenty point-source discharges are monitored—nine under BNL's SPDES Permit and eleven under equivalency permits issued to the Environmental Restoration Program for groundwater treatment systems. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly, and monitored for organic, inorganic, and radiological parameters. Monthly discharge monitoring reports that provide analytical results and an assessment of compliance for that reporting period are filed with the NYSDEC. 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, the RCRA permit for the Waste Management Facility, and the SPDES permit for the STP. Extensive groundwater monitoring is also conducted under the CERCLA program (described in Section 2.4.8 above). Additionally, to ensure that the Laboratory maintains a safe drinking water supply, BNL's potable water supply is monitored as required by the SDWA, which is administered by SCDHS.

2.5.3.2 Restoration Monitoring

The Groundwater Protection Group operates and maintains groundwater treatment systems to remediate contaminant plumes both on- and off-site. BNL maintains an extensive network of groundwater monitoring wells to verify the effectiveness of the remediation effort. Modifications to groundwater remediation systems are implemented, as necessary, based upon a continuous evaluation of monitoring data and system performance. Details on groundwater monitoring and restoration program are provided in Chapter 7 and in SER Volume II, Groundwater Status Report.

2.5.3.3 Surveillance Monitoring

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 (TLDs) (i.e., devices that 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-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.

2.5.4 EMS Assessments

To periodically verify that the Laboratory's EMS is operating as intended, assessments are conducted as part of BNL's Contractor Assurance Program. Self-assessment is the systematic evaluation of internal processes and performance. Two types of assessments are conducted: the ISO 14001 Standard conformance assessment and the regulatory compliance assessments.

The approach for the ISO 14001 program self-assessment includes evaluating programs and processes within organizations that have environmental aspects to verify conformance to the ISO 14001 Standard.

The assessment is performed by qualified external assessors or BNL staff members who do not have line responsibility for the work processes involved. Progress toward achieving environmental objectives is monitored, as are event-related metrics to determine the overall effectiveness of the EMS. The assessment determines if there are Laboratory-wide issues that require attention, and facilitates the identification and communication of best management practices used in one part of the Laboratory that could improve performance in other parts of the Lab.

Compliance assessments are also performed by BNL staff members who do not have line responsibility for the work processes involved to ensure that operations comply with Laboratory requirements that reflect external compliance 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 conducted to identify the root causes of events and identify corrective actions and lessons learned if regulatory noncompliance or impact occurs to correct the problem and prevent reoccurrence.

BNL management 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.

The Laboratory's Contractor Assurance Program is augmented by programmatic external audits conducted by DOE. BSA staff and subcontractors also perform periodic independent reviews, and an independent third-party conducts ISO 14001 registration audits of BNL's EMS. The Laboratory is 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.

2.5.5 Best Practices

As a follow-up to assessments, the Laboratory reviews areas that need improvement, as well as areas that are recognized for their best practices. BNL's Fire Management program has become one of the Lab's examples of best practices, especially in the 13 years following the 2012 Crescent Bow Fire. The Natural and Cultural Resource Program in particular, has made great strides in managing the forest, proactively utilizing mechanical treatments to prepare various forest management units for burns with the goal of mitigating wildland fuels to protect values at risk on both the Lab site and the adjacent Ridge community. The Lab coordinates closely with the NYSDEC, Long Island Central Pine Barrens Commission, and other partner agencies to execute safe and effective prescribed burns. The success of this fire management program has been heralded by the New York Wildfire and Incident Management Academy, who hosts its training academy at the Lab every year.

The Laboratory's Natural and Cultural Resources Program is also recognized for its best practices in the area of Cultural Resources with its careful stewardship of the Camp Upton historic collection for World War I and II, and artifacts showcasing its 78-year history. In fact, due to the unique nature of history and artifacts at the Lab, the last few years have seen local museums highlight the Lab's historic collections. In 2022, the Long Island Museum highlighted an "Atoms to Cosmos: The Story of Brookhaven National Laboratory" which featured an exhibit dedicated to the Lab's seven Nobel Prizes, and five National Medals of Science over its 75-year history, including Camp Upton's importance in

Atoms to Cosmos display at the Bellport Brookhaven Historical Society Exhibit.

preparing soldiers for World War I and II. In 2024, the Bellport-Brookhaven Historical Society featured an entire exhibit on "The Innovators: Inventors and Scientists of the Bellport Area" which showcased scientists who worked at Brookhaven Lab and lived in the hamlets of Bellport and Brookhaven. This exhibit included artifacts on loan to the Historical Society from Brookhaven Lab. Lab scientists met with the Museum curators over many months to ensure the accuracy of the exhibits and to highlight the cutting-edge discovery science at the Lab.

2.6
Environmental Stewardship at BNL

BNL has extensive knowledge of its potential environmental vulnerabilities and current operations due to its mature work planning and control system, and the management systems for groundwater protection, environmental restoration, carbon footprint reduction, and information management. Compliance assurance programs have improved the Laboratory's compliance status and P2 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.

Electric vehicle charging at a BNL charging port.

The Laboratory's environmental programs and projects have been recognized with international, national, and regional awards, and audits have consistently observed a high level of management involvement, commitment, and support for environmental protection and the EMS. To maintain stakeholder trust, the Laboratory will continue to deliver on commitments and demonstrate improvements in environmental performance.

The SER is an important communication mechanism, as it summarizes BNL's environmental programs and performance each year. BNL is often asked to share its experiences, lessons learned, and successes. Additional information about the Laboratory's environmental programs is available on BNL's website at http://www.bnl.gov.

For over 75 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.

References and Bibliography

BNL 2023. Cultural Resource Management Plan for Brookhaven National Laboratory. BNL-100708-2023. Brookhaven National Laboratory, Upton, NY. April 2023.

BNL 2021. Natural Resource Management Plan for Brookhaven National Laboratory. BNL-112669-2021. Brookhaven National Laboratory, Upton, NY.

BNL 2022. Brookhaven National Laboratory Environmental Monitoring Plan Update. Brookhaven National Laboratory, Upton, NY. January 2023.

BNL 2023. Groundwater Protection Contingency Plan– Response to Unexpected Monitoring Results. Environmental Monitoring Procedure EM-SOP-309. Brookhaven National Laboratory, Upton, NY. August 8, 2023.

ISO 14001: 2015. Environmental Management Systems – Requirements with Guidance for Use. Third Edition, 9-15-2015, International Organization for Standardization. Geneva, Switzerland.

Climate Leadership and Community Protection Act (CLCPA, 2019), New York State.

USEPA 1992. 1992 Interagency Agreement, Administrative Docket Number: II-CERCLA-FFA-00201. U.S. Environmental Protection Agency.

BNL 2024. Environmental Monitoring Plan for Brookhaven National Laboratory. for Brookhaven National Laboratory, Upton, NY.

Brookhaven National Laboratory (BNL) Field Sampling Technician collecting an environmental compliance groundwater sample.

Chapter 3

Compliance Status

Brookhaven National Laboratory (BNL) is subject to more than 100 sets of federal, state, and local environmental regulations; numerous site-specific permits; 11 equivalency permits for operation of groundwater remediation systems; and several other binding agreements.

In 2024, 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.

Emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the Central Steam Facility (CSF) were all well within permit limits in 2024. There were two recorded excess opacity measurements and no recorded excess nitrogen oxide measurements. The two excess opacity readings were recorded by Boiler 6 and were due to a fuel meter/fan automatic control issue. All excursions were documented in quarterly Site-Wide Air Emissions and Monitoring Systems Performance Reports submitted to the New York State Department of Environmental Conservation (NYSDEC).

There were no discharges of Halon 1211 from portable fire extinguishers or Halon 1301 from accidental or fire induced activation of fixed fire suppression systems. Halon portable fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as part of an ongoing program to phase out the use of chlorofluorocarbons as extinguishing agents. BNL's drinking water and the supply and distribution system were in compliance with all applicable county, state, and federal regulations regarding drinking water quality, monitoring, operations, and reporting in 2024. The liquid effluents discharged to surface water and groundwater also met applicable New York State Pollutant Discharge Elimination System (SPDES) permit requirements with no noncompliance events occurring for any of the permitted outfalls.

Groundwater monitoring at the Laboratory's Major Petroleum Facility (MPF) continued to demonstrate that current oil storage and transfer operations were not affecting groundwater quality. Efforts to implement release prevention measures and minimize impacts of spills of materials continued in 2024. There were ten spills in 2024 and two of those spills met regulatory agency reporting criteria.

BNL was inspected on eight occasions by regulatory authorities. These inspections included Sewage Treatment Plant (STP) operations and all Lab-wide SPDES Discharge Outfalls, Resource Conservation and Recovery Act (RCRA) Department of Environmental Conservation (DEC) Part 373 Permitted Hazardous Waste Management Facilities, Underground Storage Tanks, and the potable water system. Immediate corrective actions were taken to address all compliance 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. A list of all applicable environmental regulations is contained in Appendix D.

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 decommissioning [D&D]) of inactive hazardous waste disposal sites. Regulators include Environmental Protection Agency (EPA), Department of Energy (DOE), and the New York State Department of Environmental Conservation (NYSDEC).	In 1992, BNL became subject to a tri-party agreement among EPA, NYSDEC, and DOE. BNL site remediation is conducted by the Environmental Protection Division in accordance with milestones established under this agreement. The cleanup is currently in the long-term surveillance and maintenance mode for the groundwater treatment systems, former soil/sediment cleanup areas, and the reactors, and includes monitoring of institutional controls. The HFBR reactor vessel is scheduled for decontamination and decommissioning by 2072. All groundwater treatment systems operated as required in 2024. Management of the characterization and remediation of PFOS, PFOA, and 1,4-dioxane was formally included under the BNL CERCLA program.	2.4.8, Chapter 7
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 site-wide procedures for implementing 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 properties 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 administered by state historic preservation offices (SHPOs; in New York State, NYSHPO). At BNL, structures that are subject to NHPA include the High Flux Beam Reactor (HFBR) complex (Bldgs. 750 and 751), the Brookhaven Graphite Research Reactor (BGRR) complex (Bldgs. 701, 703, and 801), 1960's era Apartments (Bldgs. 364 and 365,), Bldg. 120, Berkner Hall (Bldg.488), Chemistry (Bldg. 555), Physics (Bldg. 510), Computational Sciences (Bldg. 515), Instrumentation (Bldg. 535), Medical (Bldgs. 490 and 491), WWII-era water tower (ST0-49), Accelerator Test Facility (Bldgs. 820, 820A, and 820B), Environment, Biology, Nuclear Science and Nonproliferation (EBNN) research (Bldg. 830), Magnet Division (Bldg. 902), Alternating Gradient Synchrotron complex (Bldgs. 901, 901A, 911, 912, 913, 913a-e, and 930), the Gamma Forest, and the WWI training trenches found throughout the site.	There are now multiple buildings and features at BNL that have been determined to be National Register Eligible (see list to the left). Any proposed activities involving these facilities must be identified through the NEPA/NHPA processes and evaluated to determine if the action would affect the features that make the facility eligible. BNL has a Cultural Resource Management Plan to ensure compliance with cultural resource regulations. Buildings that are 50 years old or older are reviewed under Section 106 of NHPA when proposed projects may significantly alter the structure or for building demolition. See Chapter 6 for detailed information on Cultural Resources.	3.4, Chapter 6

(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 50 40 CFR 60-61 40 CFR 63 40 CFR 80 40 CFR 82 40 CFR 98 NYSDEC: 6 NYCRR 200-202, 205, 207, 208, 211, 212, 215, 217, 218, 225, 226, 227-231, 239, 241, 248, 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). All applicable CAA and NYCRR regulations are incorporated into the BNL Title V permit. Radiological air emission sources are registered with the EPA.	3.5, Chapters 4 and 8
EPA: 40 CFR 109-136 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. Review of the analytical data shows that all parameters met their respective SPDES effluent limitations in 2024.	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) standards for public water supplies establish minimum drinking water standards and monitoring requirements. SDWA requirements are enforced by the Suffolk County Department of Health Services (SCDHS).	BNL maintains a site-wide public water supply. BNL's drinking water and the supply and distribution system were in compliance with all applicable county, state, and federal regulations regarding drinking-water quality, monitoring, operations, and reporting in 2024. Corrective actions for all identified operation and maintenance deficiencies identified during the annual SCDHS sanitary survey were established and communicated with SCDHS and are being addressed by the Laboratory's Energy and Utilities Division.	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 quantities, the Laboratory is subject to these requirements. BNL fully complied with all reporting and emergency planning requirements in 2024.	3.8.1 3.8.2 3.8.3
EPA: 40 CFR 280 NYSDEC: 6 NYCRR 596–598 6 NYCRR 613 SCDHS: SCSC Article 12 SCSC Article 18	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 protection, and leak detection. BNL complies with all federal and state requirements and continues to conform to county codes.	3.8.4 3.8.5 3.8.6
EPA: 40 CFR 260–280 NYSDEC: 6 NYCRR 360, 361, 363-365, 367,371-374, and 376	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, and is in compliance with all requirements.	3.10

(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 162–171 NYSDEC: 6 NYCRR 320 6 NYCRR 325–329	The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and corresponding New York State regulations govern the manufacture, use, storage, and disposal of pesticides, herbicides, biocides, rodenticides, fungicides, tickicides, as well as the pesticide containers and residuals.	BNL contracts and/or employs NYSDEC-certified pesticide applicators for specific pesticide categories to apply pesticides, herbicides, biocides, rodenticides, fungicides, and tickicides. Each applicator attends Continuing Education training, as needed, to maintain current category certifications and BNL (or the contractor that applies regulated materials) files an annual report to the NYSDEC Pesticide Bureau detailing the above applications including EPA Registration Nos., dates of applications, method of application, target organisms, types, locations, quantity, and dosage rates of pesticides applied.	3.11
DOE: 10 CFR 1022 NYSDEC: 6 NYCRR 663 6 NYCRR 666	DOE regulations require its facilities to comply with floodplain/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 locations in the north and east of the site requires NYSDEC permits and review for compliance under DOE wetland/floodplain regulations. BNL currently has no open wetland or scenic river permits.	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 species or cause adverse modification to a critical habitat.	BNL is host to numerous species of flora and fauna. Many species have been categorized by New York State as endangered, threatened, or of special concern; and one endangered species has been designated under the Endangered Species Act. The Laboratory's Natural Resource Management Plan outlines activities to protect these vulnerable species and their habitats (see Chapter 6 for details).	3.13, Chapter 6
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) implements 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, swallows, 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 construction activities, including demolition, are reviewed to ensure there are no impacts to nesting birds. Bald Eagles have been seen routinely at various locations on the BNL site. See Chapter 6 for more on migratory birds and bald eagles.	3.13, Chapter 6
DOE: Order 231.1B Chg.1	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 adversely affect the health and safety of the public, workers, the environment, the intended purpose of DOE facilities, or the credibility of the Department. 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, Occurrence Categorizer's Procedure, and the ORPS Office Procedure.	All chapters

(continued on next page)

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 414.1E 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/Rule, coupled with consensus standards, where appropriate, to ensure: 1) products and services meet or exceed customers' expectations; 2) management support for planning, organization, resources, direction, and control; 3) performance and quality improvement thorough rigorous assessment and corrective action and; and 4) environmental, safety, and health risks and impacts associated with work processes are minimized while maximizing reliability and performance of work products.	BNL has a Quality Assurance (QA) Program in place to implement quality management methodology throughout its management systems and associated processes to: (1) achieve and maintain compliance with applicable environmental, safety, security, and health (ESSH) requirements; (2) continue improvement in ESSH performance; (3) provide a safe and healthy workplace; (4) protect the environment and conserve resources; (5) prevent pollution; (6) provide services and products of the highest quality consistent with the needs, expectations, and resources of our customers; and (7) continuously improve processes, systems, and capabilities to improve operations and increase the value of research products delivered to customers. 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: DOE M 435.1-1 Chg. 3	The Radioactive Waste Management Program 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 timeframe 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 imple-mentation. The Laboratory's RWMB Program description describes the BNL policies, procedures, plans, and controls demonstrating that the Laboratory has the management systems, administrative controls, and physical controls to comply with DOE Order 435.1 Chg. 2 and DOE Manual 435.1-1 Chg. 3.	2.4.3
DOE: Order 458.1, Change 4	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 how facilities monitor their impacts on the public and environment. Full compliance with the Order was required by August 2012.	In accordance with the requirements of DOE Order 458.1, BNL maintains and implements several plans and programs for ensuring that the management of facilities, wastes, effluents, and emissions does not present a 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 BNL's Site Environmental Report, which is prepared in accordance with DOE O 231.1B Chg. 1. 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 the Laboratory meets these requirements. This document is reviewed annually and updated, as necessary to ensure compliance with this requirement.	Chapters 3, 4, 5, 6, and 8

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

3.2 Compliance with Requirements

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.

- SPDES permits, issued by NYSDEC;
- MPF license, issued by NYSDEC;
- RCRA permit, issued by NYSDEC for BNL's Waste Management Facility (WMF);
- Registration certificate from NYSDEC for tanks storing bulk quantities of hazardous substances (e.g., fuel oil);
- Eight radiological emission authorizations issued by the U.S. 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 12 emission units;
- Permit for the operation of six domestic water supply wells, one cooling water well, one irrigation well, and two fire protection wells issued by NYSDEC; and
- 11 SPDES 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 New York State Wetlands and Wild, Scenic, Recreational Rivers Act

The New York State Wild, Scenic, and Recreational Rivers Act was created by the state legislature in 1972 to protect and preserve certain rivers considered to have remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. The Laboratory had no open permits in 2024.

3.2.3 EPA's Enforcement & Compliance History Online (ECHO)

EPA's ECHO provides integrated compliance and enforcement information for more than one million regulated facilities nationwide. It allows users to search for facilities by media program (e.g., CAA, Clean Water Act [CWA], Safe Drinking Water Act [SDWA]), location, enforcement and compliance activity, or pollutant. The facility reports include three years of violation data and five years of compliance monitoring and enforcement data.

A detailed facility report for BNL including compliance status can be found in the ECHO database at: https://echo.epa.gov/. To access this report, use the following information:

ECHO Facility Name:
Brookhaven National Laboratory

Facility Registry Service (FRS) ID:
110000616726

Program Areas:
CAA, CWA, RCRA, SDWA

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[1]	None	NA	NA
EPA - NESHAPs	705	Tritium Evaporator	BNL-288-01[1]	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-388-01	None	NA	NA
EPA - NESHAPs	931	Brookhaven LINAC Isotope Producer	BNL-2009-01	None	NA	NA
EPA - NESHAPs	REF	Radiation Effects/Neutral Beam	BNL-789-01	None	NA	NA
EPA - NESHAPs	801	All-inclusive Production Hot Cells (RRPL)	BNL-2022-01	None	NA	NA
NYSDEC - Air Equivalency	517/518	South Boundary/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	B-96 Remediation System	1-52-009	NA	NA	NA
NYSDEC - Air Equivalency	644	Freon-11 Treatment System	1-52-009	NA	NA	NA
NYSDEC - SPDES Permit	Site	Brookhaven National Laboratory	NY0005835	31-Dec-30	NA	NA
NYSDEC - SPDES Equivalency	517/518	South Boundary/Middle Road System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	539	Western South Boundary System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	670	Sr-90 Treatment System - Chemical Holes	1-52-009	25-Feb-33	NA	NA
NYSDEC - SPDES Equivalency	OS-4	Airport/LIPA Treatment System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-5	North St./North St. East Treatment System	1-52-009	26-Mar-35	NA	NA
NYSDEC - SPDES Equivalency	OS-6	Ethylene Di-Bromide Treatment System	1-52-009	26-Mar-35	NA	NA
NYSDEC - SPDES Equivalency	855	Sr-90 Treatment System - BGRR/WCF	1-52-009	26-Mar-35	NA	NA
NYSDEC - SPDES Equivalency	TR 867	B-96 Remediation System	1-52-009	20-Mar-32	NA	NA
NYSDEC - SPDES Equivalency	OS-2	Industrial Park Treatment System	1-52-009	26-Mar-35	NA	NA
NYSDEC - SPDES Equivalency	492	Current Firehouse PFAS Treatment System	1-52-009	07-Sep-32	NA	NA
NYSDEC - SPDES Equivalency	492	Former Firehouse PFAS Treatment System	1-52-009	07-Sep-32	NA	NA
NYSDEC - Hazardous Substance	BNL	Bulk Storage Registration Certificate	1-000263	27-Jul-25	NA	NA
NYSDEC - LI Well Permit	BNL	Domestic Potable/Process Wells	1-4722-00032/00151	02-Apr-35	NA	NA
NYSDEC - Air Quality	423	Metal Parts Cleaning Tank	1-4722-00032/00115	30-Jan-25	U-METAL	42308
NYSDEC - Air Quality	423	Gasoline & E85 Storage and Fuel Pumps	1-4722-00032/00115	30-Jan-25	U-FUELS	42309-10
NYSDEC - Air Quality	423	Motor Vehicle A/C Servicing	1-4722-00032/00115	30-Jan-25	U-MVACS	MVAC2
NYSDEC - Air Quality	423	Motor Vehicle A/C Servicing	1-4722-00032/00115	30-Jan-25	U-MVACS	MVAC5
NYSDEC - Air Quality	244	Paint Spray Booth	1-4722-00032/00115	30-Jan-25	U-PAINT	24402
NYSDEC - Air Quality	244	Flammable Liquid Storage Cabinet	1-4722-00032/00115	30-Jan-25	U-PAINT	244AE
NYSDEC - Air Quality	734	Spin Coating Operation	1-4722-00032/00115	30-Jan-25	U-INSIG	734AA
NYSDEC - Air Quality	801	Target Processing Laboratory	1-4722-00032/00115	30-Jan-25	U-INSIG	80101
NYSDEC - Air Quality	Site	Aerosol Can Processing Units	1-4722-00032/00115	30-Jan-25	U-INSIG	AEROS

(continued on next page)

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	498	Aqueous Cleaning Facility	1-4722-00032/00115	30-Jan-25	U-METAL	49801
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25	U-61005	61005
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25	U-61006	61006
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25	U-61007	61007
NYSDEC - Air Quality	610	Metal Parts Cleaning Tray	1-4722-00032/00115	30-Jan-25	U-METAL	61008
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25	U-61005	6101A
NYSDEC - Air Quality	902	Epoxy Coating/Curing Exhaust	1-4722-00032/00115	30-Jan-25	U-COILS	90206
NYSDEC - Air Quality	922	Electroplating Operation	1-4722-00032/00115	30-Jan-25	U-INSIG	92204
NYSDEC - Air Quality	Site	Commercial Refrigeration Equipment	1-4722-00032/00115	30-Jan-25	U-RFRIG	COMRE
NYSDEC - Air Quality	Site	Packaged A/C Units (16)	1-4722-00032/00115	30-Jan-25	U-RFRIG	PKG01-16
NYSDEC - Air Quality	Site	Reciprocating Chillers (44)	1-4722-00032/00115	30-Jan-25	U-RFRIG	REC01-65
NYSDEC - Air Quality	Site	Rotary Screw Chillers (19)	1-4722-00032/00115	30-Jan-25	U-RFRIG	ROTO1-20
NYSDEC - Air Quality	Site	Split A/C Units	1-4722-00032/00115	30-Jan-25	U-RFRIG	SPL01-02
NYSDEC - Air Quality	Site	Centrifugal Chillers (17)	1-4722-00032/00115	30-Jan-25	U-RFRIG	CEN06-29
NYSDEC - Air Quality	463	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	46301
NYSDEC - Air Quality	490	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	49006
NYSDEC - Air Quality	515	Diesel Non-Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	51501
NYSDEC - Air Quality	555	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	55503
NYSDEC - Air Quality	635	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	63501
NYSDEC - Air Quality	734	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	73401
NYSDEC - Air Quality	735	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	73501
NYSDEC - Air Quality	740	Diesel Emergency Generators (2)	1-4722-00032/00115	30-Jan-25	U-GENER	74001-02
NYSDEC - Air Quality	801	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25	U-GENER	80102
NYSDEC - Air Quality	912	Diesel Emergency Generators (3)	1-4722-00032/00115	30-Jan-25	U-GENER	912A1-A3
NYSDEC - Air Quality	30	Combustion Unit	1-4722-00032/00115	30-Jan-25	U-SMBLR	030AB
NYSDEC - Air Quality	422	Combustion Unit	1-4722-00032/00115	30-Jan-25	U-SMBLR	422AF
NYSDEC - Air Quality	423	Combustion Unit	1-4722-00032/00115	30-Jan-25	U-SMBLR	42304
NYSDEC - Hazardous Waste	WMF	Waste Management	1-4722-00032/00102	06-Sep-27	NA	NA
NYSDEC - Water Quality	CSF	Major Petroleum Facility	01-1700	31-Mar-27	NA	NA

Notes:
[1]Source Facility Removed and awaiting EPA termination of NESHAPs authorization.
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
PFAS = Per and Poly Fluoroalkyl Substances
REF = Radiation Effects Facility
RHIC = Relativistic Heavy Ion Collidar
RRPL = Radionuclide Research and Production Laboratory
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

3.3
National Environmental Policy Act (NEPA) Assessments

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 2024, environmental evaluations were completed for 172 proposed projects at BNL. One hundred and sixty-eight projects were considered minor actions requiring no additional documentation. Three projects were addressed by submitting a notification form to the Department of Energy (DOE), which determined that the projects were covered by existing "Categorical Exclusions" (per 10 CFR 1021) or fell within the scope of a previous environmental assessment, and one Environmental Assessment was completed to evaluate potential impacts of the Clinical Alpha Radionuclide Production Facility which resulted in a Finding of No Significant Impact from BHSO.

3.4
National Historic Preservation Act (NHPA)

The Laboratory is subject to several cultural resource laws, most notably the NHPA. The NHPA requires federal agencies to establish programs for the identification and protection of cultural resources (including buildings, sites, artifacts, and documents), and consider the effects of proposed federal actions on those resources.

BNL has 34 structures or sites that are eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor (BGRR) complex (Buildings 701, 703, and 801), the High Flux Beam Reactor (HFBR) complex (Buildings 750, 750A, and 751), two 1960s-era efficiency apartments (Buildings 364 and 365), Berkner Hall (Building 488), the Medical Complex (Buildings 490 and 491), Chemistry (Building 555), Physics (Building 510), Computational Sciences (Building 515), Instrumentation (Building 535), Accelerator Test Facility (Buildings 820, 820A, and 820B), Environment, Biology, Nuclear Science & Nonproliferation Research (Building 830), Magnet Division (Building 902), the Alternating Gradient Synchrotron (AGS) Complex (Buildings 901, 901A, 911, 912, 913, 913A-E, and 930), the World War II (WWII) barracks portion of Building 120, the 1940s era Water Tower, the World War I (WWI) Army training trenches associated with Camp Upton, and the Gamma Forest.

Proposed activities are reviewed to determine potential adverse effects on these properties, and identify methods to avoid, mitigate, or minimize adverse effects or harm, in accordance with Section 106 and Section 110 of the NHPA. Most cultural resources reviews are integrated with the NEPA Environmental Review process to streamline the Section 106 review process. In 2024, no impacts were documented that would diminish the historic or archaeological significance of any BNL cultural resources.

Other regulations apply to BNL's cultural resource management obligations, including the Archaeological Resources Protection Act (ARPA) and 36 CFR 79 "Curation of Federally Owned and Administered Archaeological Collections." Cultural resource activities are described in Chapter 6.

3.5
Clean Air Act (CAA)

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 CSF that are subject to NYSDEC Reasonably Available Control Technology (RACT) requirements. Boilers 5, 6 and 7 are equipped to burn either residual fuel oil, distillate fuel oil, or natural gas; Boiler 1A can burn residual fuel oil or distillate fuel oil only. In 2024, 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 (NO_x). The NO_x RACT standard for the combustion of natural gas or fuel oil burned in the Laboratory's three large boilers (Nos. 5, 6, and 7) is 0.15 lbs/MMBtu. The NO_x RACT emission limit for the CSF's one mid-size boiler (No. 1A) is 0.20 lbs/MMBtu while burning residual fuel oil (No. 4 or No. 6) and 0.08 lbs/MMBtu while burning distillate fuel oil (No. 2).

Boilers with a maximum operating heat input between 25 and 250 MMBtu/hr. (7.3 and 73.2 MW) must demonstrate compliance with the NO_x standard either by using periodic emission tests (stack testing) or a continuous emissions monitoring system (CEMS). All four CSF boilers meet this criterion. Boilers 6 and 7 use CEMS to demonstrate compliance with NO_x standards, while Boilers 1A and 5 are periodically stack tested (once per permit term).

The most recent stack tests performed on Boilers 1A and 5 in December 2024/January 2025 demonstrated compliance with NO_x RACT limits while Boiler 1A operated on residual fuel oil and Boiler 5 operated on residual fuel oil, distillate fuel oil, or natural gas. Boiler 1A was unable to meet the NO_x RACT emission limit of 0.08 MMBtu/hr while operating on distillate fuel oil, however, the Lab does not anticipate burning distillate fuel in Boiler 1A in the foreseeable future.

CEMS reports for Boilers 6 and 7 have demonstrated compliance with NO_x RACT standards while operating on residual fuel oil or natural gas. Boilers 6 and 7 did not operate on distillate fuel oil during 2024. BNL uses an approved system averaging plan to demonstrate NO_x compliance in quarterly reports submitted to NYSDEC. Using the system averaging approach, actual weighted average NO_x emission rates for operating boilers for the first through fourth quarters were 0.108, 0.091, 0.106, and 0.095 lbs/MMBtu, respectively, which were below the corresponding quarterly permissible weighted average emissions rates of 0.150, 0.150, 0.173, and 0.150 lbs/MMBtu.

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%, calculated in six-minute averages, except for one period not to exceed 27% in any one hour. During 2024, there were two (2) 6-minute average opacity readings that exceeded 27% recorded by Boiler 6 on February 28, 2024. The exceedances were due to a fuel meter/fan automatic control issue that was rectified by the operator on the same day. There were no opacity exceedances recorded by Boiler 7 in 2024. NO_x and/or opacity excursions are documented in the quarterly Site-Wide Air Emissions and Monitoring Systems Performance Reports submitted to NYSDEC. Chapter 4 discusses CSF compliance with NO_x RACT standards and opacity limits in greater detail.

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 are 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 2024, 353 pounds of R-22 and 154 pounds of R-410A (a 50:50 blend of HFC-32 and HFC-125) were recovered and recycled from refrigeration equipment that was serviced. Meanwhile, 345 pounds of R-22 and 98 pounds of R-410A leaked from refrigeration and air conditioning equipment on-site. These leaks were subsequently reported as emissions in the Annual Emissions Statement transmitted to NYSDEC.

Halon: Halon 1211 and 1301 are extremely efficient fire suppressants that are being phased out due to their effect on the earth's ozone layer. Halon recovered from excessed systems is shipped to the Department of Defense Ozone Depleting Substances Reserve in accordance with the Class I Ozone Depleting Substances Disposition Guidelines prepared by the DOE Office of Environmental Policy and Guidance. Halon 1211, which was formerly used in portable fire extinguishers on-site, is no longer utilized. It was phased out and replaced with a EPA Significant New Alternative Policy (SNAP) approved alternative. There were no discharges of Halon 1301 in 2024. The one remaining fixed fire suppression system on-site is in the process of being decommissioned and arrangements are currently being made to have the remaining Halon 1301 removed from the Lab before the end of the year.

3.5.2 Hazardous Air Pollutants (HAPs)

In 1970, the CAA established standards to protect the public from HAPs that may lead to death or an increase in irreversible or incapacitating illnesses. The NESHAPs, a stationary source standard for hazardous air pollutants, were established in 1977 and the governing regulations were updated significantly in 1990. EPA developed NESHAPs to limit the emission of air pollutants. Since 1990, EPA has modified the list through rulemaking to include 187 hazardous 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, it was determined that 40 CFR 63 NESHAPs Subpart GGGGG: Site Remediation requires the Lab's Groundwater Protection Group to document the process it uses to prove that the sum total of HAPs emissions due to site remediation activities is less than 1 megagram (2,204.62 pounds) annually. In 2024 the Laboratory's groundwater treatment systems emitted an estimated total of 34 lbs of HAPs, which is well within acceptable limits.

3.5.2.2 Asbestos

In 2024 the Laboratory notified the EPA Region II office regarding the removal of materials containing asbestos. Throughout the year, 6,960 lbs of both scheduled and non-scheduled friable asbestos from maintenance operations materials and building demolition preparation (e.g., pipe insulation, sheetrock, popcorn ceiling, transite board, floor tiles, water main pipes) were removed. Disposal of this material occurred in May 2025 in accordance with EPA requirements.

3.5.2.3 Radioactive Airborne Emissions

Minor and major sources of radiological airborne emissions from BNL's facilities and activities are evaluated 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 2024 is provided in Chapter 4.

BNL transmitted all data pertaining to radioactive air emissions and dose calculations to EPA in fulfillment of its annual reporting requirement. As in past years, the maximum off-site dose due to airborne radioactive emissions from the Laboratory continued to be 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 maximally exposed off-site individual resulting from BNL's airborne emissions in 2024 was 1.67 mrem (16.7 μSv).

3.6
Clean Water Act (CWA)

The disposal of wastewater generated by Laboratory operations is regulated under the 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 that regulates wastewater effluents. The permit specifies monitoring requirements and effluent limits for nine of thirteen outfalls, as described below. See Figure 5-3 in Chapter 5 for the locations of the following BNL outfalls:

- Outfall 001 is used to discharge treated effluent from the STP to groundwater recharge basins.
- Outfalls 002, 002B, 003, 005, 006A, 006B, 008, 010, 011, and 012 are recharge basins used to discharge cooling tower blowdown, once-through cooling water, and/or stormwater. Because 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., cesspools) that receive predominantly sanitary waste and steam- and air-compressor condensate discharges. NYSDEC does not require monitoring of these disposal systems.

Each month, the Laboratory prepares Discharge Monitoring Reports (DMRs) that describe monitoring results, evaluate compliance with permit limitations, and identify corrective measures taken to address permit excursions. These reports are submitted electronically to EPA, NYSDEC central and regional offices, and Suffolk County Department of Health Services (SCDHS) through a Network DMR (NetDMR) system. Details of the monitoring program conducted for the groundwater treatment systems where SPDES equivalency permits are in effect are provided in the Site Environmental Report (SER) Volume II, Groundwater Status Report. Evaluation of the current effluent quality shows it to consistently meet groundwater effluent standards, and in most cases, ambient water quality standards for surface water. Details on monitoring results, evaluation of compliance with permit limits, and description of any corrective actions taken to address permit excursions are provided in the following sections.

3.6.1 Sewage Treatment Plant (STP)

Sanitary and process wastewater generated by BNL operations is conveyed to the STP for processing before discharge to groundwater recharge basins. The STP provides tertiary treatment of the wastewater and includes the following processes: settling/sedimentation, biological reduction of organic matter and nitrogen, and final filtration. 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, along with relevant SPDES permit limits. The Laboratory monitors the STP discharge for more than 100 parameters monthly and more than 200 parameters quarterly. BNL was 100% compliant with effluent limits in 2024.

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*
pH (SU)	6.9	8.3	Continuous Recorder	Min 5.8, Max. 8.5	0	100
Solids, Total Dissolved (mg/L)	39	487	Monthly	1000	0	100
Total nitrogen (mg/L)	1.1	7.9	Twice Monthly	10	0	100
Total phosphorus (mg/L)	0.24	1.21	Twice Monthly	NA	0	100
Cyanide (mg/L)	< 0.002	< 0.002	Twice Monthly	0.1	0	100
Copper (mg/L)	0.004	0.02	Twice Monthly	0.15	0	100
Iron (mg/L)	0.09	0.32	Twice Monthly	0.6	0	100
Lead (mg/L)	<0.001	0.001	Twice Monthly	0.025	0	100
Mercury (ng/L)	1.2	10.2	Twice Monthly	200	0	100
Methylene chloride (ug/L)	< 0.5	2.46	Twice Monthly	5	0	100
Nickel (mg/L)	< 0.002	0.004	Twice Monthly	0.1	0	100
Silver (mg/L)	< 0.0003	< 0.0003	Twice Monthly	0.015	0	100
Toluene (ug/L)	< 0.3	< 0.3	Twice Monthly	5	0	100
Zinc (mg/L)	0.02	0.09	Twice Monthly	2	0	100
1,1,1-trichloroethane (ug/L)	< 0.3	< 0.3	Twice Monthly	5	0	100
Max. Flow (MGD)	0.21	0.67	Continuous Recorder	2.3	0	100
Avg. Flow (MGD)	0.14	0.30	Continuous Recorder	NA	0	100
HEDP (mg/L)	< 0.05	< 0.05	Monthly	0.5	0	100
Tolytriazole (mg/L)	< 0.05	< 0.05	Monthly	0.05	0	100

Notes:
See Figure 5-3 for location of Outfall 001.
* % Compliance = total no. samples – total no. exceedances/total no. of samples x 100
HEDP = 1-hydroxyethylidene diphosphonic acid
MGD = million gallons per day
NA = Not Applicable
SPDES = State Pollutant Discharge Elimination System
SU = standard unit

Figures 3-1 through 3-7 plot the five-year trends for monthly concentrations of copper, iron, lead, mercury, nickel, silver, and zinc in the STP discharge.

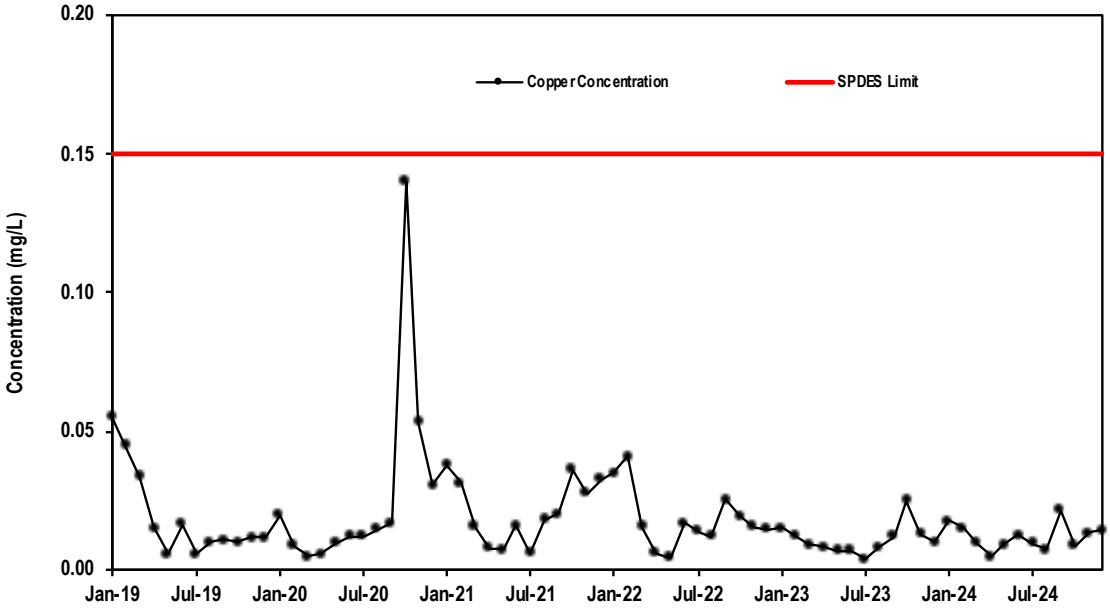


Figure 3-1. Maximum Concentrations of Copper Discharged From the BNL Sewage Treatment Plant, 2019–2024.

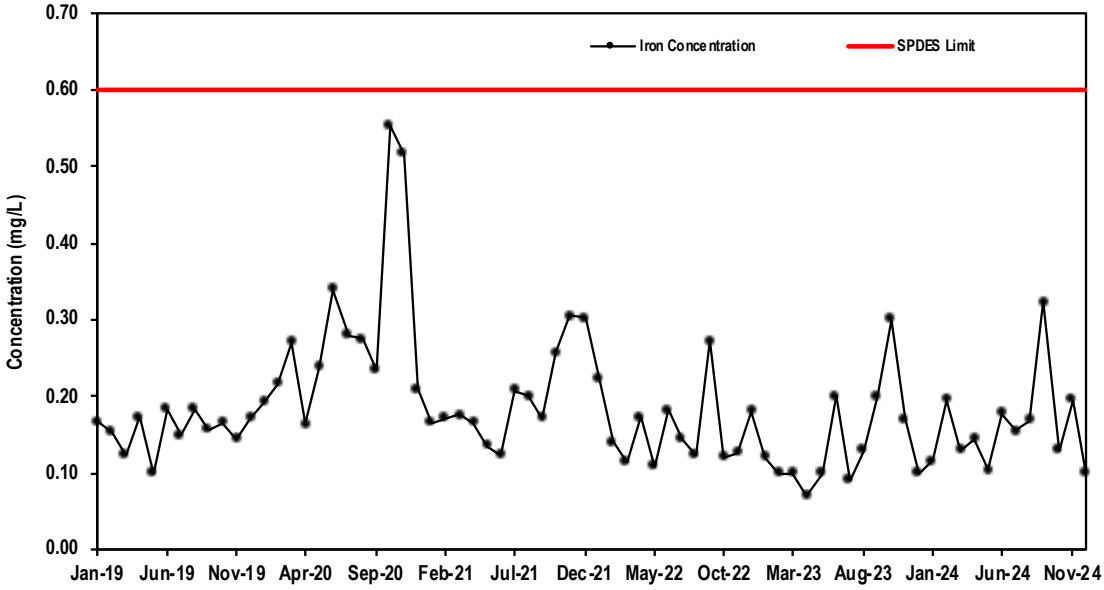


Figure 3-2. Maximum Concentrations of Iron Discharged From the BNL Sewage Treatment Plant, 2019–2024.

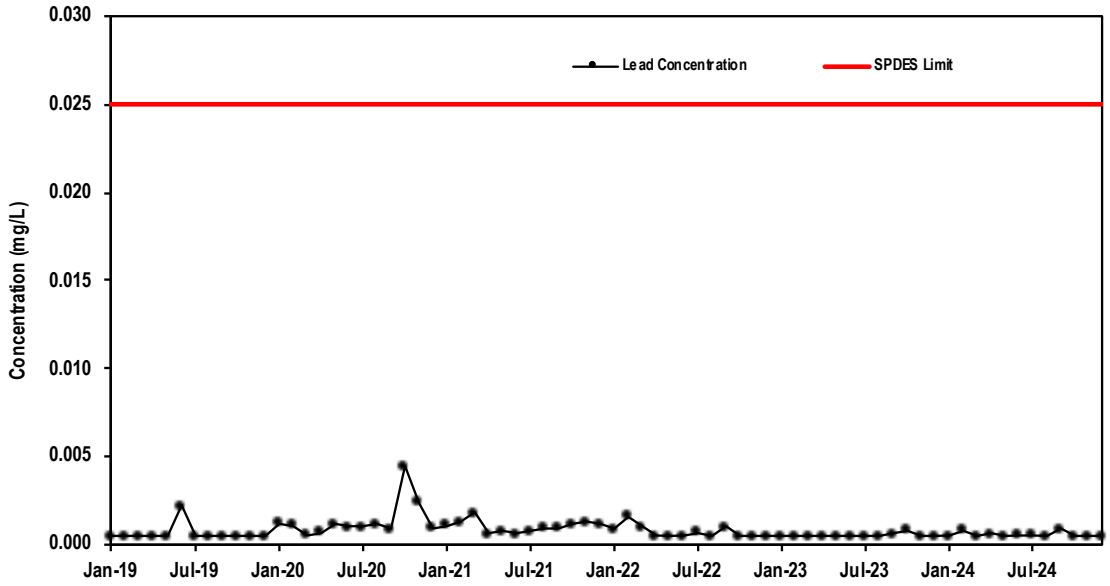


Figure 3-3. Maximum Concentrations of Lead Discharged From the BNL Sewage Treatment Plant, 2019–2024.

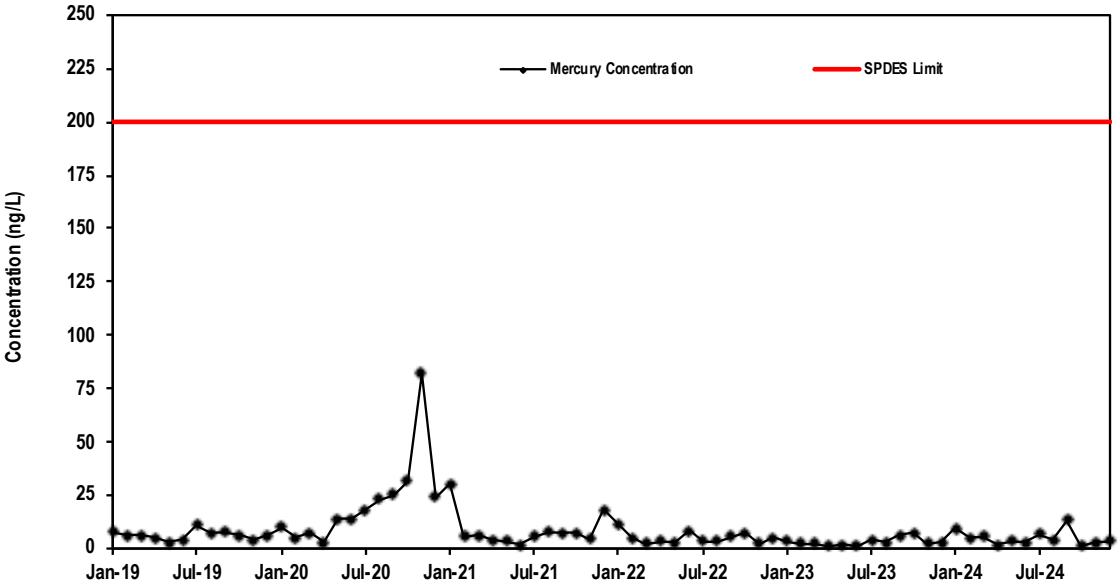


Figure 3-4. Maximum Concentrations of Mercury Discharged From the BNL Sewage Treatment Plant, 2019–2024.

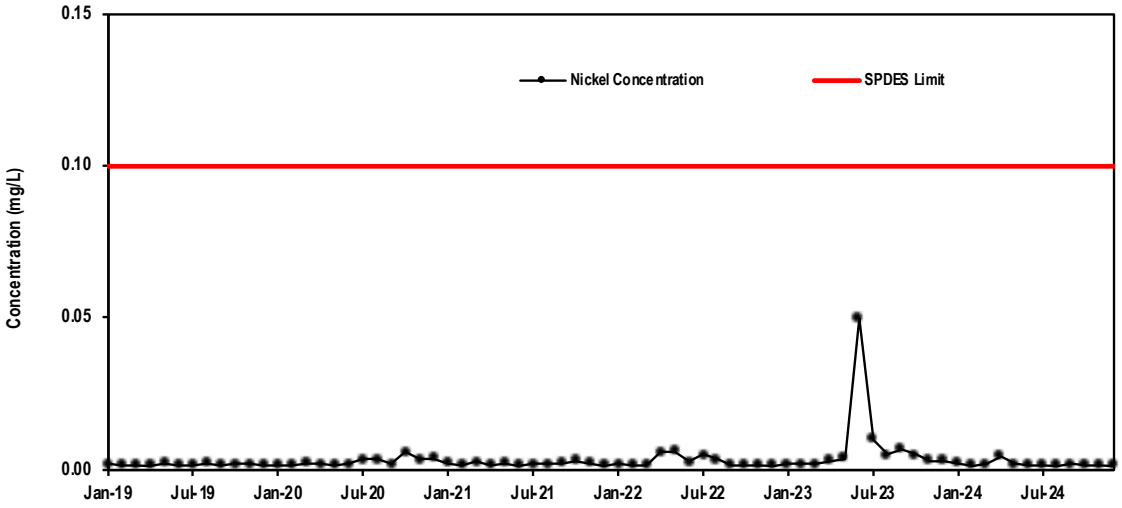


Figure 3-5. Maximum Concentrations of Nickel Discharged From the BNL Sewage Treatment Plant, 2019–2024.

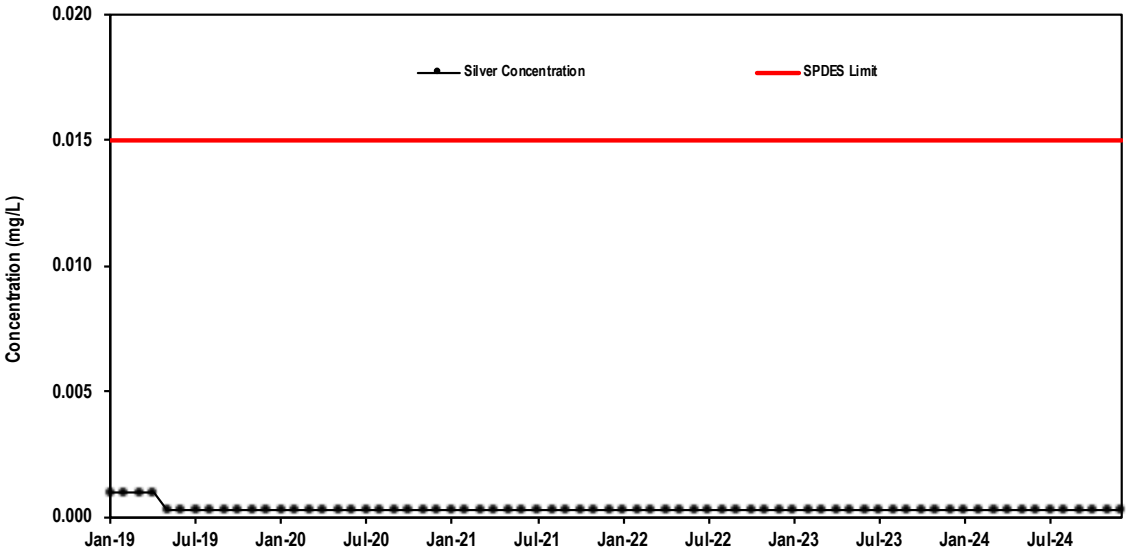


Figure 3-6. Maximum Concentrations of Silver Discharged From the BNL Sewage Treatment Plant, 2019–2024.

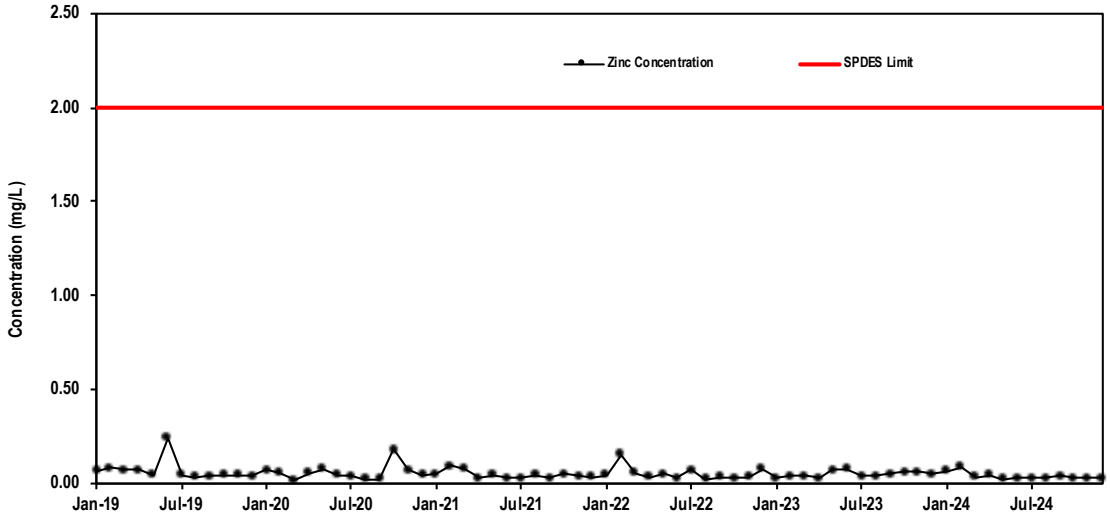


Figure 3-7. Maximum Concentrations of Zinc Discharged From the BNL Sewage Treatment Plant, 2019–2024.

3.6.2 Recharge Basins and Stormwater

Water discharged to Outfalls 002 through 008 and Outfalls 010 through 012 recharges to groundwater. 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.

In 2024, no noncompliance events occurred for any of the permitted recharge basin outfalls.

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	10	10		NA	NA
	Min.	0.35	0.001	0.07	0.07	0.02	0.04	0.002	0.001	NA		
	Max.	1.1	0.04	0.5	0.19	0.14	0.12	0.24	0.08	NA		
pH (SU)	Min.	6.4	7.6	6.4	7.6	7.2	7.5	7.2	7.0	NA	0	100
	Max.	8.3	8.7	8.5	8.5	8.6	8.8	8.3	8.5	8.5, 9.0 (a)		
Oil and Grease (mg/L)	N	12	11	10	12	11	NR	10	10		0	100
	Min.	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	NR	< 1.3	< 1.4	NA		
	Max.	2.1	5.7	2.6	1.4	2.8	NR	3.8	2.7	15		
Copper (mg/L)	N	NR	NR	4	NR	NR	NR	NR	4		0	100
	Min.	NR	NR	0.003(T)	NR	NR	NR	NR	0.001	NA		
	Max.	NR	NR	0.01 (T)	NR	NR	NR	NR	0.01	1.0		
Aluminum (mg/L)	N	4	NR	NR	NR	NR	NR	4	4		0	100
	Min.	< 0.07 (T)	NR	NR	NR	NR	NR	< 0.07 (D)	< 0.07 (D)	NA		
	Max.	0.09 (T)	NR	NR	NR	NR	NR	< 0.07 (D)	0.1 (D)	2.0		
Lead, Dissolved (mg/L)	N	NR	NR	NR	NR	NR	NR	NR	4		0	100
	Min.	NR	NR	NR	NR	NR	NR	NR	<0.0005	NA		
	Max.	NR	NR	NR	NR	NR	NR	NR	<0.0005	0.05		
Vanadium, Dissolved (mg/L)	N	NR	NR	NR	NR	NR	NR	NR	4		NA	NA
	Min.	NR	NR	NR	NR	NR	NR	NR	0.001	NA		
	Max.	NR	NR	NR	NR	NR	NR	NR	0.013	NPL		
Chloroform (µg/L)	N	4	NR	NR	NR	NR	NR	NR	NR		0	100
	Min.	< 0.3	NR	NR	NR	NR	NR	NR	NR	NA		
	Max.	0.8	NR	NR	NR	NR	NR	NR	NR	7		

(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*
Bromo-dichloro-methane (µg/L)	N	4	NR	NR	NR	NR	NR	NR	NR		0	100
	Min.	< 0.3	NR	NR	NR	NR	NR	NR	NR	NA		
	Max.	0.9	NR	NR	NR	NR	NR	NR	NR	50		
1,1,1-trichloro-ethane (µg/L)	N	5	NR	NR	NR	NR	NR	10	NR		0	100
	Min.	< 0.3	NR	NR	NR	NR	NR	< 0.3	NR	NA		
	Max.	< 0.3	NR	NR	NR	NR	NR	< 0.3	NR	5		
1,1-dicloro-ethane (µg/L)	N	NR	NR	NR	NR	NR	NR	10	NR		0	100
	Min.	NR	NR	NR	NR	NR	NR	< 0.3	NR	NA		
	Max.	NR	NR	NR	NR	NR	NR	< 0.3	NR	5		
Hydroxy-ethylidene-diphos-phonic acid (mg/L)	N	4	NR	4	4	4	NR	NR	NR		0	100
	Min.	<0.05	NR	<0.05	<0.05	<0.05	NR	NR	NR	NA		
	Max.	<0.05	NR	<0.05	<0.05	<0.05	NR	NR	NR	0.5		
Tolyltriazole (mg/L)	N	4	NR	4	4	4	NR	NR	NR		0	100
	Min.	<0.05	NR	<0.05	<0.05	<0.05	NR	NR	NR	NA		
	Max.	<0.05	NR	<0.05	<0.05	<0.05	NR	NR	NR	0.05		

Notes:
See Figure 5-3 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
(a) pH limit is 8.5 for Outfalls 005, 008, and 010; pH limit is 9.0 for Outfalls 002, 002B, 006A, 006B, and 007
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
SPDES = State Pollutant Discharge Elimination System
SU = standard unit
T = total recoverable

3.7 Safe Drinking Water Act (SDWA)

The extraction and distribution of drinking water are regulated under the federal 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 (Bruno, 2024) is prepared by the Laboratory to comply with these requirements.

3.7.1 Potable Water

The Laboratory has six water supply wells for on-site distribution of potable water, four of which were active during 2024. 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, 3-6 and 3-7 provide potable water supply monitoring data. BNL's drinking water and the supply and distribution system were in full compliance with all applicable county, state, and federal regulations regarding drinking water quality, monitoring, operations, and reporting in 2024.

In 2013, the EPA required large water providers to start testing for six common Per- and Polyfluoroalkyl Substances (PFAS) chemicals under the third Unregulated Contaminant Monitoring Rule (UCMR 3). As a medium-size system, BNL was not required to participate in this testing program. In 2017, SCDHS began routine testing of all water supply systems for PFAS, including BNL. PFAS chemicals were detected in three of BNL's active water supply wells. In these initial tests, Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) were detected at concentrations below the 2016 EPA Health Advisory Level of 70 ng/L (ppt) that was established specifically for the combined concentration of these two chemicals. Following repeated confirmed detections of PFAS in the supply wells, the Lab started routine quarterly testing for PFAS in 2018. The results for 2024 are provided in Table 3-7.

In 2020, New York State established enforceable drinking water standards for PFOS and PFOA at concentrations of 10 ng/L (ppt). The other four PFAS chemicals would continue to be regulated under the current New York State limit of 50 µg/L (ppb) for unregulated contaminants. In May 2020, Granular Activated Carbon (GAC) filters were restored on Well 11 to remove PFOS and low levels of the other PFAS chemicals that may be present. In May 2021, GAC filters were restored on Well 10 and construction for the restoration of Well 12 and its GAC filters was completed in 2022. In 2024, the GAC filters were changed out on Well 11 to ensure continued removal of PFAS chemicals and compliance with drinking water standards.

On July 1, 2024, a Notice of Violation (NOV) was received by BNL for failing to submit a Completed Works application to the SCDHS before the relocated water main was placed into service to accommodate the construction of Building 748 in March 2020. This was a violation of Section 5-1.22 of the New York State Sanitary Code. In order to satisfy the violation, BNL provided the necessary Completed Works application within 60 days and coordinated a final inspection with SCDHS.

2025 BROOKHAVEN NATIONAL LABORATORY
Water Quality
CONSUMER CONFIDENCE REPORT

BNL publishes an annual water quality report to provide on-site drinking water consumers with an overview of the Lab's water quality during the previous calendar year. The purpose of this report is to inform you about where your water comes from; what analytical tests are conducted; what they reveal; how the results compare to New York State standards; and to educate you about the importance of preventative measures. Educated consumers are more likely to help protect their drinking water sources.

BNL's drinking water supply and distribution system were in full compliance with all county, state, and federal regulations regarding drinking water quality, monitoring, operations, and reporting in 2024.

BNL's Energy & Utilities (EU) Division is committed to providing over 3,000 employees, facility users, contractors, and guests annually with safe drinking water.

BNL's drinking water is regularly tested using an independent laboratory approved by the New York State Department of Health (NYSDOH). Analytical data are reviewed by the Lab's Environmental Protection Division (EPD) to ensure that testing results comply with all applicable regulatory standards. In addition, EU and EPD work with BNL's Groundwater Protection Group to make sure our potable water supply is not adversely impacted by possible groundwater contamination or remediation operations.

Water Treatment Facility Staff
(L-R) Water Operators – R. Kelley, N. Risi, P. Halpin, S. Kelvas, W. Jensen, J. Stanisci Jr.

Where Does Our Water Come From?

The Long Island aquifer system is made up of three primary formations. From the surface to approximately 150 feet below is the Upper Glacial aquifer, from 150 to 1,000 feet below is the Magothy aquifer, and from 1,000 to about 1,600 feet below is the Lloyd aquifer. As designated by the U.S. Environmental Protection Agency (EPA), Long Island's aquifer system is one of 78 "sole source" aquifers in the nation recognized under the aquifer protection program authorized by the U.S. Safe Drinking Water Act (SDWA).

Four of the Lab's six drinking water wells are in-service and draw up to 1,000 gallons per minute, or about 1.34 million gallons of water per day from the Upper Glacial aquifer to supply drinking water, process cooling water, and fire protection. The water from Well 7 is processed at BNL's on-site Water Treatment Plant. Well 10, Well 11, and Well 12 are treated with a granular activated carbon (GAC) filter, then treated for pH adjustment and disinfection prior to entering the distribution system. Last year, BNL pumped approximately 409 million gallons of water.

For questions about this report, or to speak with someone regarding your drinking water, please contact:

Christopher Bruno, P.E.
Manager
Energy & Utilities Division
(631) 344-8262

Jason Remien
Manager
Environmental Protection Division
(631) 344-3477

Suffolk County Department of Health Services
(631) 852-5810

To ensure that consumers are informed about the quality of Laboratory-supplied potable water, BNL publishes a Consumer Confidence Report (CCR) in May of each year, a deadline stipulated by the SDWA. This report provides information regarding source water supply system, the analytical tests conducted and the detected contaminants which are then 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 form or electronically at http://www.bnl.gov/water/.

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

Compound	Well No. 7	Well No. 10	Well No. 11	Well No. 12	Potable Distribution Sample	NYS DWS
Water Quality Indicators						
Ammonia (mg/L)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	SNS
Chlorides (mg/L)	69.1	75	66.9	45.9	65.9	250
Color (units)	30*	<5	<5	<5	<5	15
Conductivity (mmhos/cm)	291	411	389	322	390	SNS
Cyanide (mg/L)	< 10	< 10	< 10	< 10	< 10	SNS
MBAS (mg/L)	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	SNS
Nitrates (mg/L)	0.5	0.6	0.56	0.67	0.58	10
Nitrites (mg/L)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	1
Odor (units)	0	0	0	0	0	3
pH (Standard Units)	6.2	8.5	8.6	8.6	8.7	SNS
Sulfates (mg/L)	10.5	9.5	10.4	11.3	11.2	250
Total coliform	ND	ND	ND	ND	ND	Negative
Metals						
Antimony (mg/L)	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	6
Arsenic (mg/L)	1.2	<1.0	<1.0	< 1.0	< 1.0	50
Barium (mg/L)	0.04	0.045	0.04	0.035	0.034	2
Beryllium (mg/L)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	4
Cadmium (mg/L)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5
Chromium (mg/L)	< 0.007	< 0.007	< 0.007	< 0.007	< 0.007	0.1
Copper (mg/L)	0.0031	0.003	0.006	<0.002	0.007	1.3
Fluoride (mg/L)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	2.2
Hexavalent Chromium (mg/L)	NR	0.89	0.48	0.45	0.32	SNS
Iron (mg/L)	2.9*	<0.02	<0.02	<0.02	0.025	0.3
Lead (mg/L)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	15
Manganese (mg/L)	0.063	<0.01	<0.01	< 0.01	< 0.01	0.3
Metals *(continued)*						
Mercury (mg/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2
Nickel (mg/L)	0.004	<0.0005	0.002	<0.0005	0.001	SNS
Selenium (mg/L)	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	50
Sodium (mg/L)	39.1	47.1	39.7	26.9	53	SNS
Silver (mg/L)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	100
Thallium (mg/L)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	2
Zinc (mg/L)	<0.02	<0.02	<0.02	<0.02	<0.02	5

(continued on next page)

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

Compound	Well No. 7	Well No. 10	Well No. 11	Well No. 12	Potable Distribution Sample	NYS DWS
Radioactivity						
Cesium-137 (pCi/L)	<6.94	<8.04	<8.09	<9.2	NR	200
Gross alpha activity (pCi/L)	<1.9	<1.88	<1.88	<1.8	NR	15
Gross beta activity (pCi/L)	2.94±1.34	<1.82	4.62±1.54	2.87±1.15	NR	(a)
Strontium-90 (pCi/L)	<0.78	<0.79	<0.77	<0.78	NR	8
Tritium (pCi/L)	<417	<416	<402	<404	NR	20,000
Other						
Alkalinity (mg/L)	14.7	39.8	30.8	19.9	63	SNS
Asbestos (MFL)	NR	NR	NR	NR	< 0.2	7
Calcium (mg/L)	7.7	12.6	9.4	7.4	23.7	SNS
HAA5 (mg/L)	NR	NR	NR	NR	0.002	0.06**
Residual chlorine - MRDL (mg/L)	NR	NR	NR	NR	1.4	4
Tolytriazole (mg/L)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05
TTHM (mg/L)	NR	NR	NR	NR	0.022	0.08**

Notes:
See Figure 7-1 for well locations.
HAA5 = five haloacetic acids
MBAS = methylene blue active substances
MRDL = maximum residual disinfectant level
MFL = Million Fibers per Liter
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 this well is treated at the Water Treatment Plant for color and iron reduction prior to distribution.
** Limit imposed on distribution samples only.
(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.

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

Compound	WTP Effluent	Well No. 7	Well No. 10	Well No. 11	Well No. 12	NYS DWS
	µg/L					
Dichlorodifluoromethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Chloromethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Vinyl Chloride	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	2
Bromomethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Chloroethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Trichlorofluoromethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,1-dichloroethene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Methylene Chloride	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
trans-1,2-dichloroethene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,1-dichloroethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
cis-1,2-dichloroethene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
2,2-dichloropropane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Bromochloromethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,1,1-trichloroethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Carbon Tetrachloride	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,1-dichloropropene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,2-dichloroethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Trichloroethene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,2-dichloropropane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Dibromomethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
trans-1,3-dichloropropene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
cis-1,3-dichloropropene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,1,2-trichloroethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,3-dichloropropane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Chlorobenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,1,1,2-tetrachloroethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Bromobenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,2,3-trichloropropane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
2-chlorotoluene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
4-chlorotoluene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,3-dichlorobenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,4-dichlorobenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,2-dichlorobenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,2,4-trichlorobenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Hexachlorobutadiene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Tetrachloroethene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,1,2,2-Tetrachloroethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,2,3-trichlorobenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Benzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Toluene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5

(continued on next page)

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

Compound	WTP Effluent	Well No. 7	Well No. 10	Well No. 11	Well No. 12	NYS DWS
	µg/L					
Ethylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
m,p-xylene	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5
o-xylene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Styrene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Isopropylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
n-propylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
1,3,5-trimethylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Chlorodifluoromethane	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Tert-butylbenzene	< 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	5
sec-butylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
4-Isopropyltoluene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
n-butylbenzene	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	5
Chloroform	< 0.5	< 0.5	0.6	1.1	1.2	50
Bromodichloromethane	1.3	< 0.5	< 0.5	< 0.5	< 0.5	50
Dibromochloromethane	3.4	< 0.5	< 0.5	< 0.5	< 0.5	50
Bromoform	2.3	< 0.5	< 0.5	< 0.5	< 0.5	50
Methyl tert-butyl ether	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	50
Toxaphene	< 1	< 1	< 1	< 1	< 1	3
Total PCB's	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	0.5
2,4,5,-TP (Silvex)	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	10
Dinoseb	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	50
Dalapon	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	50
Pichloram	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	50
Dicamba	<1	<1	<1	<1	<1	50
Pentachlorophenol	< 0.04	<0.04	< 0.04	< 0.04	< 0.04	1
Hexachlorocyclopentadiene	< 0.1	0.02	< 0.1	< 0.1	< 0.1	5
Bis(2-ethylhexyl)Phthalate	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	50
Bis(2-ethylhexyl)Adipate	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	50
Hexachlorobenzene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	5
Benzo(A)Pyrene	0.03	< 0.02	< 0.02	< 0.02	< 0.02	50
Aldicarb Sulfone	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	SNS
Aldicarb Sulfoxide	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	SNS
Aldicarb	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	SNS
Oxamyl	< 1	< 1	< 1	< 1	< 1	50
3-Hydroxycarbofuran	<1	< 1	< 1	< 1	< 1	50
Carbofuran	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	40
Carbaryl	< 1	< 1	< 1	< 1	< 1	50
Methomyl	< 1	< 1	< 1	< 1	< 1	50
Glyphosate	< 6	< 6	< 6	<6	< 6	50

(continued on next page)

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

Compound	WTP Effluent	Well No. 7	Well No. 10	Well No. 11	Well No. 12	NYS DWS
	µg/L					
Diquat	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	50
1,2-dibromoethane (EDB)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05
1,2-dibromo-3-chloropropane	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.2
Lindane	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.2
Heptachlor	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	0.4
Aldrin	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	5
Heptachlor Epoxide	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.2
Dieldrin	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	5
Endrin	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.2
Methoxychlor	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	40
Chlordane	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2
2,4,-D	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	50
Alachlor	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2
Simazine	< 0.07	< 0.07	< 0.07	< 0.07	< 0.07	50
Atrazine	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	3
Metolachlor	< 1	< 1	< 1	< 1	< 1	50
Metribuzin	< 0.5	< 0.15	< 0.15	< 0.15	< 0.15	50
Butachlor	< 1	< 1	< 1	< 1	< 1	50
Endothall	< 9	< 9	< 9	< 9	< 9	100
Propachlor	< 1	< 1	< 1	< 1	< 1	50
Freon-113	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	50
1,4-Dioxane	0.09	0.12	0.06	0.04	0.04	1

Notes:
See Figure 7-1 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 Pace Labs, a New York State-certified contractor laboratory.
The minimum detection limits for principal organic compound analytes are 0.5 mg/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.
SNS = drinking water standard not specified
NYS DWS = New York State Drinking Water Standard
WTP = Water Treatment Plant

Table 3-7. Potable Water Wells and Potable Distribution System: Perflourinated Compounds.

Compound	Well No. 7	Well No. 10	Well No. 11	Well No. 12	Water Treatment Facility	NYS DWS
	ng/L					
Perfluorooctanesulfonate (PFOS)	1.73	<1.95	0.78	<1.88	1.74	10
Perfluoroundecanoic acid (PFUnDA)	<1.88	<1.95	<1.87	<1.88	<1.89	NS
Perfluoropentanoic acid (PFPeA)	1.35	0.81	3.38	0.68	1.06	NS
Perfluoropentanesulfonate (PFPeS)	<1.77	<1.83	<1.76	<1.77	<1.78	NS
Fluorotelomer sulfonate 6:2 (6:2 FTS)	<14.1	<14.6	<14.1	<14.1	<14.2	NS
Perfluorohexanoic acid (PFHxA)	1.09	<1.95	2.80	0.99	1.05	NS
Perfluorododecanoic acid (PFDoA)	<1.88	<1.95	<1.87	<1.88	<1.89	NS
Perfluorooctanoic acid (PFOA)	1.57	<1.95	1.35	0.78	1.64	10
Perfluorodecanoic acid (PFDA)	<1.88	<1.95	<1.87	<1.88	<1.89	NS
Perfluorohexanesulfonate (PFHxS)	<1.71	<1.78	1.64	0.88	<1.72	NS
Perfluorobutyric acid (PFBA)	0.86	131.00	39.80	2.69	6.51	NS
Perfluorobutanesulfonate (PFBS)	<1.87	<1.74	1.12	<1.68	<1.68	NS
Perfluoroheptanoic acid (PFHpA)	0.65	<1.95	0.71	<1.88	0.74	NS
Perfluoroheptanesulfonate (PFHpS)	<1.79	<1.85	<1.78	<1.79	<1.80	NS
Perfluorononanoic acid (PFNA)	<1.88	<1.95	<1.87	<1.88	<1.89	NS
1H, 1H, 2H, 2H-Perfluorodecane sulfonic acid (8:2 FTS)	<3.62	<3.75	<3.6	<3.62	<3.63	NS
Fluorotelomer sulfonate 4:2 (4:2 FTS)	<3.54	<3.67	<3.52	<3.54	<3.56	NS
Hexafluoropropyleneoxide dimer acid (HFPO-DA)(Gen-X)	<1.88	<1.95	<1.87	<1.88	<1.89	NS
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	<1.88	<1.95	<1.87	<1.88	<1.89	NS
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11-Cl-PF3OUdS)	<1.77	<1.84	<1.77	<1.77	<1.78	NS
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9-Cl-PF3ONS)	<1.76	<1.82	<1.75	<1.76	<1.76	NS
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	<3.77	<3.90	<3.75	<3.77	<3.78	NS
Perfluoro-3-methoxypropanoic acid (PFMPA)	<3.77	<3.90	<3.75	<3.77	<3.78	NS
Perfluoro-4-methoxybutanoic acid (PFMBA)	<3.77	<3.96	<3.75	<3.77	<3.78	NS
4,8-Dioxa-3H-perfluorononanoic acid (DONA)	<1.88	<1.95	<1.87	<1.88	<1.89	NS
N-Methylperfluorooctane sulfonamido acetic acid (NMeFOSAA)	<3.36	<3.42	<3.32	<3.35	NR	NS
Perfluorotetradecanoic acid (PFTDA)	<1.68	<1.71	<1.66	<1.68	NR	NS
Perfluorotridecanoic acid (PFTrDA)	<1.68	<1.71	<1.66	<1.68	NR	NS
N-Ethylperfluorooctane sulfonamido acetic acid (NEtFOSAA)	<3.36	<3.42	<3.32	<3.35	NR	NS

Notes:
NS - No Standard. NYS currently does not have a drinking water standard for these compounds. Compounds are subjected to the 50 ug/L limit for nonregulated contaminants.
NR - Not Required. Samples were not required at this location.
Results from wells 10,11,and 12 are post Granulated Active Carbon treatment except for N-Methylperfluorooctane sulfonamido acetic acid (NMeFOSAA), Perfluorotetradecanoic acid (PFTDA), Perfluorotridecanoic acid (PFTrDA) and N-Ethylperfluorooctane sulfonamido acetic acid (NEtFOSAA) which are untreated water analyses.

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. 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 accidental introduction into the domestic water system, especially under low-pressure conditions. In addition, secondary cross-connection controls at the point of use are recommended to protect users within a specific facility from hazards that may be posed by intrafacility operations.

During 2024, the Laboratory inspected 289 cross-connection control devices, including primary devices installed at interfaces to the potable water main and secondary control devices at the point of use. 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 each year.

3.7.3 Underground Injection Control

Underground Injection Control (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 are authorized by rule and must be included in an inventory maintained with the agency.

In addition to the UICs maintained for routine Laboratory discharges of sanitary waste and stormwater, 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 also 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.

No UIC installations occurred in 2024. BNL's total UIC inventory at the end of 2024 was 133.

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 (Bruno, 2024). 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 is filed with NYSDEC, EPA, and DOE, and must be updated every five years. BNL remained in full compliance with SPCC requirements in 2024.

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 require that facilities report inventories and releases of certain chemicals that exceed specific release thresholds. Community Right-to-Know requirements are codified under 40 CFR Parts 355, 370, and 372. Table 3-8 summarizes the applicability of the regulations to BNL.

The Laboratory complied with these requirements through the submittal of Tier II and Tier III Reports required under EPCRA Sections 302, 303, 311, 312, and 313. In fulfillment of the Tier II requirements, BNL submitted an inventory of 41 on-site chemicals (with thresholds greater than 10,000 pounds or 500 pounds for acutely toxic materials) via E-Plan, the New York State-approved computer-based submittal program.

Table 3-8. Applicability of EPCRA to BNL.

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 [ ]

Notes:
EHS: Extremely Hazardous Substance
SDS: Safety Data Sheet
TRI: Toxic Release Inventory

To satisfy the requirements of the Tier III submittal, the Laboratory submitted its data via the EPA-approved TRI-ME computer-based submittal program. During 2024, BNL reported releases of lead (about 34,000 pounds), mercury (about 50 pounds), polychlorinated biphenyls (PCBs) (about one pound), benzo(g,h,i)perylene (less than one pound), and polycyclic aromatic compounds (less than one pound). No friable asbestos was sent off-site for disposal in 2024. Releases of lead, PCBs, and mercury were 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 byproducts of the combustion of fuel oils and were well below any regulatory limits. In 2024, there were no releases of extremely hazardous substances reportable under Part 304.

3.8.3 Spills and Releases

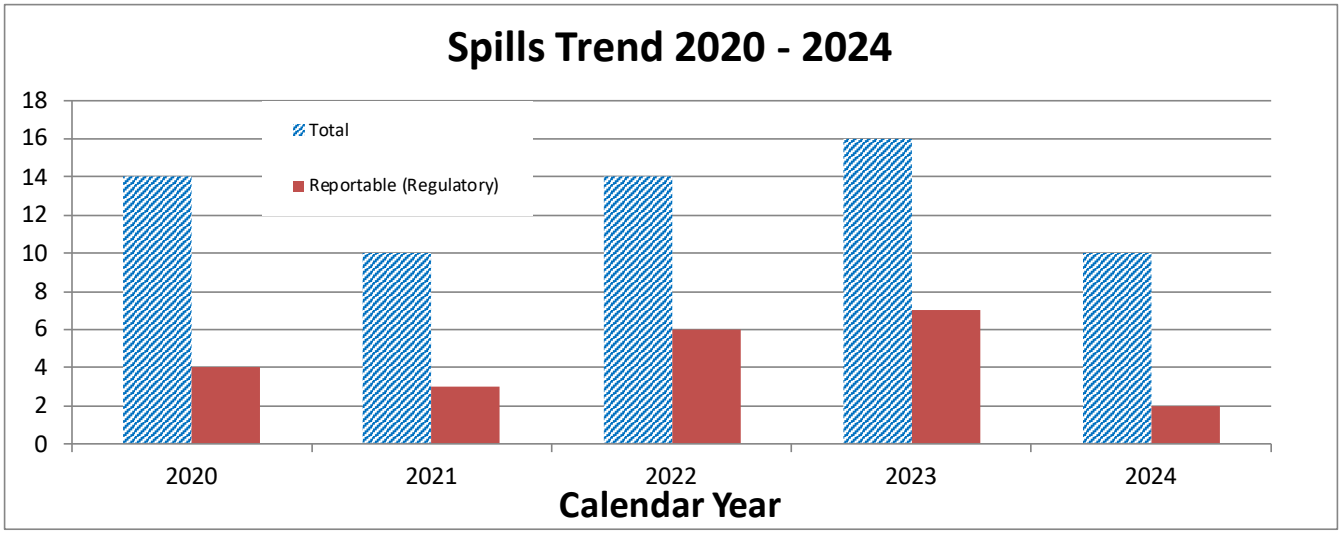
When a spill of hazardous material occurs, Laboratory and contractor personnel are required to immediately notify the BNL Fire Rescue Group, whose members are trained to respond to such releases. Fire Rescue's initial response is to contain and control any release and to notify additional response personnel (e.g., 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 five 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 spills is conducted, as necessary, to prevent impacts to the environment, minimize human health exposures, and restore the site.

Table 3-9. Summary of Chemical and Oil Spill Reports.

BNL Spill No. and Date	Material/ Quantity	ORPS Report	Source/Cause and Corrective Actions
24-05 (4/15/24)	Hydraulic fluid 1 quart	No	Leak observed by Public Service Enterprise Group (PSEG) Contractor coming from boom on tree trimming vehicle (NYS Plate: ZVG5022). Boom was enclosed and leak was not observed until hydraulic oil travelled down from the top of the boom enclosure and sprayed onto grass below vehicle. Contractor wiped down sprayed oil on the vehicle's roof and walking surface. Vehicle's boom was retracted to its normal highway condition and was re-positioned in order to facilitate cleanup. Contractors removed and bagged the top layer of oil-stained grass and then dug up the base grass and soil below the grass. Oil-contaminated grass/soil was containerized into 55-gallon drums and was properly disposed of at an off-site Treatment, Storage, and Disposal Facility (TSDF) by PSEG Contractors.
24-06 (4/30/24)	Hydraulic fluid 3 gallons	No	A hydraulic line failed on a BNL-owned dump trailer releasing ~3 gallons of hydraulic fluid to nearby soil adjacent to the roadway. BNL Grounds Department staff placed the contaminated soil into two (2) 55-gallon drums. Environmental Protection Division personnel managed the drums for proper off-site disposal.

There were 10 spills in 2024 and two of those spills met regulatory agency reporting criteria. The remaining spills were small-volume releases either to containment areas or to other impermeable surfaces that did not exceed a reportable quantity. Table 3-9 summarizes each of the two reportable events, including a description of the cause and corrective actions taken. Figure 3-8 is a five-year trend of spills that have occurred at BNL. The decreased trend in the number of spills over the last year is due to a decrease in major exterior construction activities and more staff awareness. There were no long-term effects from these releases and no significant impact on the environment. In all instances, 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 inspector and containerized for off-site disposal.

Figure 3-8. Spills Trend 2020-2024.



3.8.4 Major Petroleum Facility (MPF) License

The storage and transfer of 1.9 million gallons of fuel oil (principally No. 6 oil and No. 2 oil) subjects the Laboratory to MPF licensing by NYSDEC. The fuel oil used at the CSF to produce high-pressure steam to heat and cool BNL facilities is stored in five tanks with capacities ranging from 300,000 to 600,000 gallons.

The remaining storage facilities at BNL have capacities that range from 100 to 10,000 gallons and are located throughout the site where there is a need for building heat, emergency power, fuel, or other miscellaneous petroleum needs (e.g., motor oil, used oil, lube oil, biodiesel).

There are currently 56 active petroleum storage facilities listed on the license. BNL remained in full compliance with MPF license requirements in 2024, which includes monitoring groundwater near five active above-ground storage tanks at the MPF. The license also requires the Laboratory to inspect the storage facilities monthly, test the tank leak detection systems, and ensure high-level monitoring and secondary containment is functional. Tank integrity is also checked periodically. Groundwater monitoring consists of monthly checks for the presence of floating products and twice-yearly analyses for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). In 2024, no VOCs or floating products attributable to MPF activities were detected above detectable limits. Low level (estimated) concentrations of several SVOCs (e.g., Bis(2-ethylhexyl) phthalate, Di-n-butyl phthalate, and Phenol) were reported for samples collected from the upgradient well and all seven downgradient wells. Bis(2-ethylhexyl) phthalate and Phenol were found just above New York State Ambient Water Quality Standards. See SER Volume II, Groundwater Status Report, for additional information on groundwater monitoring results in areas where bulk petroleum products are being stored.

In August 2024, five inspectors from U.S. EPA Region 2 performed a 40 CFR Part 280 regulatory inspection of the Lab's Underground Storage Tanks (USTs). The inspection included review of records and field inspections of the UST sumps, piping, overfill and leak detection, and Automatic Tank Gauge Systems. The final UST Compliance Evaluation Inspection letter indicated that no concerns were uncovered. A NYSDEC bulk storage tank inspection did not occur in 2024; however, there is an inspection scheduled for March 2025.

3.8.5 Chemical Bulk Storage (CBS)

Title 6 of the Official Compilation of the Codes, Rules, and Regulations of the State of New York (NYCRR) Part 596 requires that all aboveground tanks larger than 185 gallons and all underground tanks that store specific chemicals are 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. There were no NYSDEC CBS Facility inspections in 2024; however, the NYSDEC scheduled a regulatory inspection for March of 2025.

3.8.6 County Storage Requirements

Article 12 of the Suffolk County Sanitary Code (SCSC) 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 its sole jurisdiction over petroleum storage at Major Oil Storage Facilities, SCDHS notified BNL that it will cease permitting activities (e.g., 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 125 active storage facilities that are not regulated by NYSDEC that 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 continues to meet Article 12 requirements, BNL continues 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. Although the Laboratory will no longer submit new design plans for SCDHS review and approval or continue to perform other administrative activities such as registration of exempt facilities and updates of shared databases, it will continue to inspect all storage facilities to ensure operational requirements of SCSC Article 12 are maintained.

3.9 Resource Conservation and Recovery Act (RCRA) Requirements

The RCRA regulates hazardous waste 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, U.S. EPA delegates the RCRA program to NYSDEC with U.S. 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 one year before shipping the wastes off-site to licensed treatment and disposal facilities.

As noted in Chapter 2, BNL also has several satellite accumulation and 90-Day Hazardous Waste Accumulation Areas. Included with the hazardous wastes regulated under RCRA are mixed wastes which are typically generated in small quantities from research activities at BNL. Mixed wastes are materials that are both hazardous (under RCRA guidelines) and radioactive.

During 2024, BNL completed the RCRA Closure of four 90-Day Hazardous Waste Storage Areas. This required the sampling and analysis of surfaces where wastes were stored to demonstrate the absence of contamination. These closures were witnessed and certified completed by the NYSDEC.

In June 2024, the U.S. EPA conducted a hazardous waste compliance evaluation inspection (CEI) at BNL to fulfill the statutory requirement under RCRA to annually inspect all federally owned and/or operated hazardous waste treatment, storage, and disposal facilities (TSDFs). The inspection involved the review of shipping manifests, the WMF's Part 373 RCRA Permit, inspection and training records, and a visit to the NYSDEC Permitted TSDF and site 90-Day and Satellite Accumulation hazardous waste storage areas. A letter documenting an inspection in June was received from the U.S. EPA on September 16, 2024, indicating that the review of information provided by the facility uncovered no concerns.

3.10 Polychlorinated Biphenyls (PCBs)

The storage, handling, and use of PCBs are regulated under the Toxic Substance and Control Act. Capacitors manufactured before 1979 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 three 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 2024 and disposed of 22 pounds of PCB-contaminated oil, debris, and other equipment comprised predominantly of lighting ballasts and small capacitors.

The Laboratory has aggressively approached a reduction in its PCB inventory, reducing it by more than 99% 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 (e.g., insecticides, rodenticides, herbicides, and algicides) are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act and the NYSDEC Pesticide Regulations. BNL uses an Integrated Pest Management approach that was developed over a decade ago and was assessed in 2021 by a third-party (Cornell Cooperative) and is scheduled for an assessment in January of 2025. Pesticides are used at the Laboratory to control undesirable insects and mice and 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 on greenhouses on-site and the Biology Field. Herbicide use is minimized wherever possible (e.g., through spot treatment of weeds). Pesticides are applied by BNL-employed, NYSDEC pesticide-certified applicators. On an infrequent basis and for special projects, an outside vendor who also possesses the required NYSDEC application licenses applies pesticides. Cooling towers are regularly treated by another vendor that has NYSDEC-licensed pesticide applicators using NYSDEC approved biocides, corrosion inhibitors, and disinfectants to prevent corrosion and to disinfect the towers on-site.

In 2024, BNL-licensed pesticide applicators, in conjunction with the Environmental Protection Division (EPD) subject matter experts, reduced the amount of corn being placed inside the 4-Poster™ Tick Control Devices to 100 lbs per week (see Chapter 6 for more details on these devices) to more effectively treat the target species (deer) and to minimize non-target species corn consumption. This strategy has resulted in the reduction of the amount of pesticide applied to the rollers on the devices. The amount of overall pesticide usage in 2024 versus previous years has decreased while maintaining effectiveness at a 75% reduction in the number of ticks compared to when the Lab began using the devices in 2013. Prior to February 1 of every year, each BNL pesticide applicator submits application records to EPD staff for review and electronic submittal using a NYSDEC-approved software application. This annual report details insecticide, rodenticide, algaecide, and herbicide use for the previous year by licensed BNL staff members. Contractors who apply pesticides and cooling tower biocides are responsible for filing their own reports.

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 New York Wild, Scenic, and Recreational River Systems Act. The Laboratory also has six areas regulated as wetlands and several 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 (BNL 2021 and BNL 2023a) 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. There were no open permits in 2024.

3.13 Protection of Wildlife

3.13.1 Endangered Species Act

BNL updates its list of species that are endangered, threatened, and/or of special concern (see Table 6-1 in Chapter 6) as data from state and federal sources are provided. The northern long-eared bat *(Myotis septentrionalis)* is the first federally listed species known to be present at the Laboratory. This species is known historically to utilize the site at least during the summer months, and management options have been established for the protection of this species on-site.

State-recognized endangered (E) or threatened (T) species that have historically been found at BNL include: eastern tiger salamander (E), peregrine falcon (E), persius dusky-wing (E), bracken fern (E), crested fringed orchid (E), Engelman spikerush (E), dwarf huckleberry (E), prostrate knotweed (E), possum haw (E), ipecac spurge (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), eastern showy aster (T), and stiff-leaved goldenrod (T).

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 BNL Natural Resource Management Plan (NRMP) (BNL 2021) 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.

Peregrine falcons are listed as endangered in New York State due to historic declines associated with dichlorodiphenyltrichloroethane (DDT). While falcons have been documented in the past (2021 and 2022), there was no indication of nesting in 2024.

Banded sunfish and swamp darter have historically been 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 to the Peconic River; monitoring populations and water quality to ensure that habitat remains viable; and minimizing disturbances to the river and adjacent banks. Due to an extended drought from 2015 through mid-2023, these two fish are not likely to be found on-site. Should NYSDEC establish a recovery plan, fish may be restored to historic habitats in the future.

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. Limited habitat for the frosted elfin and persius duskywing exists on Laboratory property and the mottled duskywing may exist on-site; therefore, the need to manage habitat and surveys for the three butterflies has been added to the NRMP.

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. The pine barrens bluet, a threatened species, has been documented at one of the many coastal plain ponds at BNL.

The Laboratory is also home to 12 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, whippoorwill, vesper sparrow, redheaded woodpecker, osprey, sharp-shinned hawk, 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. The Laboratory continues to evaluate bird populations as part of the management strategy outlined in the NRMP.

The Laboratory has 33 plant species that are protected under state law: eight are endangered; three are threatened (as listed above); and four are rare plants: the small-flowered false foxglove, narrow-leaved bush clover, wild lupine, and long-beaked bald rush. The other 18 species are "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. Five species on the BNL list are likely present or possible due to the presence of correct habitat. As outlined in the NRMP, locations of these rare plants must be determined, populations estimated, and management requirements established. 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 84 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 birds' 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 (e.g., access to nesting is closed or repaired, and/or deterrents to nesting are installed). 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 ongoing or planned construction activities. When this occurs, the United States Department of Agriculture, Animal Plant Health Inspection Service, Division of Wildlife Services (USDA-APHIS-WS) 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.

Peregrine falcon sitting on ledge at Center for Functional Nanomaterials.

3.13.3 Bald and Golden Eagle Protection Act

While BNL does not have bald or golden eagles nesting on-site, these birds are occasionally observed visiting the area during migration. Since the first documented nesting on Long Island in 2013, bald eagles have become a common site on Long Island and at BNL. Bald eagles are seen at numerous locations on the BNL site throughout the year. Further information on bald eagles is presented in Chapter 6.

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 the Laboratory 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 from these areas 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 BNL Site Radiological Control Manual (BNL 2023 Rev. 13) and are consistent with the pre-approved authorized release limits set by DOE Order 458.1.

In 2024, excess materials not identified as radioactive, such as scrap metal and electronics equipment resulting from normal operations, 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 the DOE pre-approved authorized release limits. There were no releases of real property in 2024.

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 2024, BNL was inspected by federal, state, or local regulators on eight occasions. These inspections included:

- **Potable Water.** On July 29, SCDHS performed the Annual Water Supply Sanitary Survey of the BNL potable water system. There were no violations identified; corrective actions for any minor deficiencies were established and communicated with SCDHS and were addressed by the Laboratory's Energy & Utilities Division.
- **STP.** SCDHS conducts quarterly inspections of the Laboratory's STP to evaluate operations and sample the effluent for SPDES compliance. No performance or operational issues were identified. SCDHS also visited the site in June to collect samples and perform SPDES inspections of other permitted outfalls. No issues were identified.
- **RCRA.** In June, the U.S. EPA conducted an inspection of RCRA hazardous waste activities. A closeout letter received in September indicated that there were no violations/concerns resulting from the inspection.
- **UST.** In August, U.S. EPA performed an inspection of the Lab's Federally-regulated USTs. A letter documenting the inspection from the EPA was received declaring that no violations were observed.

3.15.2 DOE Assessments/Inspections

The DOE Brookhaven Site Office (BHSO) performs routine inspections, assessments, and surveillances of BNL operations to ensure continual improvement and success in meeting the Laboratory's mission. In 2024, BHSO performed four surveillances of waste management activities with the purpose of evaluating performance in

accordance with existing Technical Work Documents (TWDs) or Standard Operating Procedures (SOPs). They included surveillances of the pump out operation of the underground storage tank in Building 931 (Technical Work Document WM-TWD-19-002, "Pumping Building 931 BLIP Tank water into IBC containers"), WMF Weekly Inspections (WM-SOP-760, "Resource Conservation and Recovery Act [RCRA] and Safety Inspections at the Waste Management Facility"), High Dose Waste Transfer (WM-SOP-581, "High Dose IP Waste Transfer"), and On-The-Job Training procedure (WMP-005, "Waste Management Training Program").

All surveillances resulted in no findings being identified except for BHSO's review of Waste Management personnel performing a weekly inspection in accordance with WM-SOP-760. This surveillance identified two Level 3 Findings. A Level 3 Finding is defined as a singular, isolated regulatory noncompliance where there is a process in place. The Findings were reviewed and analyzed by Brookhaven Science Associates (BSA) and were addressed, as appropriate, to prevent any future nonconformances.

BHSO also participated as an observer of the BSA Multi-Topic Assessment of BNL's environmental protection program described below. BHSO participation comprised of observing BSA's scoping, assessment conduct, and reporting.

3.15.3 Environmental Multi-Topic Assessment

The BNL EPD conducts routine programmatic assessments. The determination of topics for these assessments is based upon past regulatory findings, results of environmental, safety, and health inspections and/or other routine self-assessments, and frequency of past assessments.

In 2024, EPD planned for and executed a programmatic self-assessment on the Lab's management of hazardous and universal waste. The objectives of the assessment were to assess the effectiveness of BNL's hazardous/universal waste program and its compliance with the Standards Based Management System (SBMS) Waste Subject Area and Waste Management procedural requirements. Based on the assessed organizations, BNL's management of Hazardous and Universal Waste Accumulation areas and its review of waste control forms was found in general to be compliant with the relevant requirements. The assessment resulted in identifying four (4) Strengths, six (6) Level 2 (minor) Findings, and nine (9) Opportunities for Improvement (OFIs). Most of the minor Findings were corrected immediately and corrective actions were identified for the OFIs and tracked to closure.

3.15.4 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 regular (typically annual) assessments of generator Waste Certification Programs (WCP).

BNL's WCP Program was last assessed in October 2023 by staff from Navaro (NNSS Management and Operations [M&O] Contractor) in the areas of waste traceability and packaging and transportation. The assessment resulted in no findings, observations, or OFIs, enabling BNL continued access to the NNSS for radioactive waste disposal.

3.16
Agreements, Enforcement Actions, and Other Environmental Occurrence Reports

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 one NOV assessed in 2024 (see Table 3-10). There was also an environmental event that was reported in accordance with BNL's Event/Issues Management Subject Area and documented in the Integrated Operational Performance System (IOPS). Details of the event is summarized in Table 3-11.

Table 3-10. Existing Agreements and Enforcement Actions Issued to BNL With Status.

Number	Title	Parties	Effective Date	Status
Agreements				
No Number	Suffolk County Agreement	BNL, DOE, SCDHS	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 CERCLA Section 120 (also known as the Interagency Agreement or "IAG" of the Environmental Restoration Program)	DOE, EPA, NYSDEC	02/28/92	This agreement provides the framework, including schedules, for assessing the extent of contamination and conducting cleanup at BNL. Work is performed either as an Operable Unit or a Removal Action. The IAG integrates the requirements of CERCLA, RCRA, and NEPA. Cleanup is currently in long-term surveillance and maintenance mode for the groundwater treatment systems, former soil/sediment cleanup areas, and the reactors; this includes monitoring of institutional controls. The HFBR reactor vessel is scheduled for decontamination and decommissioning by 2072. All groundwater treatment systems operated as required in 2024. Management of the characterization and remediation of PFOS, PFOA and 1,4-dioxane was formally included under the BNL CERCLA program.
Notices of Violation/Enforcement Actions in 2024.				
No Number	Notice of Violation (NOV)	NYSDEC	7/1/24	On July 1, 2024, a Notice of Violation was received by the SCDHS for failing to submit a Completed Works application to the SCDHS before the relocated water main was placed into service to accommodate the construction of Building 748 in March 2020. This was a violation of Section 5-1.22 of the New York State Sanitary Code. In order to satisfy the violation, BNL provided the necessary Completed Works application within 60 days and coordinated a final inspection with SCDHS.

Notes:
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
EPA = Environmental Protection Agency
HFBR= High Flux Beam Reactor
NEPA = National Environmental Policy Act
NYSDEC = New York State Department of Environmental Conservation
PFOA= perfluorooctanoic acid
PFOS= perfluorooctanesulfonic acid
RCRA = Resource Conservation and Recovery Act
SCDHS = Suffolk County Department of Health Services

Table 3-11. Summary of Other Environmental Occurrence Reports, 2024.

IOPS* Event #: E-01774	Date: 1/3/2024
On January 2, 2024, the Collider Accellerator Department (CAD) Water Group discovered water dripping from a pipe flange in the Alternate Gradient Syncrotron (AGS) Main Magnet Cooling System (tritiated system with concentration of tritium approximately 25,000 pCi/L, which is above the drinking water standard of 20,000 pCi/L) onto the roof of building 911. The estimated total volume leaked was less than 94 gallons, over a period of approximately three weeks. Upon discovery, a container was placed to collect the leaking water. There was the potential that a small volume of the leaked water could have reached a roof drain before the leak was discovered. Water entering the roof drain mixes with a large volume of stormwater before reaching the environment via an outfall. There was no expected environmental impact and samples collected at the outfall after discovery of the release was non-detect for tritium. In response to this event and other similar previously reported events over the past several years, BNL Leadership determined additional evaluation was warranted. As such, an independent qualified cause analyst was asked to lead a team to determine commonalities and provide recommendations or opportunities for improvement to BNL Leadership. The team identified both short-term and long-term opportunities for improvement to address the commonalities identified. These opportunities were communicated to BNL Leadership in an outbrief meeting on September 6, 2024, and included actions like ensuring potential leak flow paths from tritiated water systems are understood and documented, twice-daily inspections of system, flushing and evaporating the AGS Main Magnet Cooling System to maintain water system contents below the drinking water standard for tritium, and redesign of water piping system to reduce the number of potential failure points and locate them indoors or design containment systems for outside portions of water systems. Many of the mitigating actions have been completed or planned for 2025 or during the construction period for the Electron Ion Collider following the end of the 2025 RHIC run.	Status: The C-AD Water Group completed repairs for the leaking component.

Notes:
* Reported in accordance with BNL's Event/Issues Management Subject Area and documented in the Integrated Operational Performance System (IOPS).

Field Sampling Team in front of BNL Geoprobe®.

References and Bibliography

BNL 2023a. Cultural Resource Management Plan for Brookhaven National Laboratory. Brookhaven National Laboratory, Upton, NY. BNL-100708-2023. April 2023.

BNL 2021. Natural Resource Management Plan for Brookhaven National Laboratory. BNL-112669-2021. Brookhaven National Laboratory, Upton, NY.

BNL 2023. Brookhaven National Laboratory Site Radiological Control Manual, Rev. 13. Brookhaven National Laboratory, Upton, NY.

Bruno, C. 2024. Brookhaven National Laboratory Spill Prevention Control and Countermeasure Plan. Brookhaven National Lab- oratory, Upton, NY.

Bruno, C. 2024. Brookhaven National Laboratory 2020 Annual Potable Water Sampling Plan. Brookhaven National Laboratory, Upton, NY.

DOE Order 458.1 Chg 4 (LtdChg) 2011. Radiation Protection of the Public and the Environment. U.S. Department of Energy, Washington, DC. February 11, 2011.

SCDHS. 1993. Suffolk County Sanitary Code Article 12: Toxic and Hazardous Material Storage and Handling Controls. Suffolk County Department of Health Services, NY.

Central Steam Facility: Boiler # 7 – Flames observed through the sight glass.

Chapter 4

Air Quality

Brookhaven National Laboratory (BNL) monitors both radioactive and nonradioactive emissions at several facilities on-site to ensure compliance with the requirements of the Clean Air Act (CAA). BNL also conducts ambient air monitoring to verify local air quality and detect possible environmental impacts from Laboratory operations.

During 2024, BNL facilities released a total of 22,040 curies (Ci) of short-lived radioactive gases. Oxygen-15 and Carbon-11 emitted from the Brookhaven Linac Isotope Producer (BLIP) constituted 99.9% of the site's radiological air emissions.

Because natural gas prices were comparatively lower than fuel oil prices throughout the year, BNL's Central Steam Facility (CSF) used natural gas to meet 98% of the heating and cooling needs of the Laboratory's major facilities in 2024. As a result, emissions of particulates, oxides of nitrogen, sulfur dioxide, and volatile organic compounds were well below the respective regulatory permit criteria pollutant limits.

Laboratory operations contributed to a increase in greenhouse gas (GHG) emissions due to the continued increase in commuting from 2023 to 2024 as employees return to work in-person. Commuting GHG emissions rose 24.1% as the average number of employees working on-site increased from 1,600 to 1,939 employees. In fiscal year 2024 (October 1, 2023 through September 30, 2024), air travel GHG emissions decreased by 7% to 2,716 metric tons (MT) of carbon dioxide equivalent (CO_2e).

4.1 Radiological Emissions

Federal air quality laws and U.S. Department of Energy (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 CAA, and DOE Order 458.1, Chg. 4 (DOE 2020), Radiation Protection of the Public and the Environment. Under NESHAPs Subpart H, facilities must continuously monitor emissions if they have the potential to cause an annual radiation dose greater than 0.1 mrem (1.0 µSv) to a member of the public off-site. Facilities capable of delivering radiation doses below that limit require periodic, confirmatory sampling.

BNL has two active facilities: the BLIP and the Radionuclide Research Processing Laboratory (RRPL), for which emissions are continuously monitored with in-line detection systems. BNL also has one inactive facility, the High Flux Beam Reactor (HFBR), where periodic emissions monitoring is conducted. Figure 4-1 provides the locations of these monitored facilities and Table 4-1 presents airborne release data from each facility. Annual emissions are discussed in the following sections of this chapter. The associated radiation dose estimates are presented in Table 8-5 in Chapter 8.

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

Facility	Nuclide	Half-Life	Ci Released
HFBR	Tritium	12.3 years	2.90E-01
BLIP	C-11	20.38 minutes	7.34E+03
	O-15	122 seconds	1.47E+04
	Tritium	12.3 years	7.16E-02
RRPL	Various	Various	See Note*
Total			**2.20E+04**

Notes:
1 Ci = 3.7E+10 Bq
BLIP = Brookhaven Linac Isotope Producer
HFBR = High Flux Beam Reactor (operations were terminated in November 1999)
RRPL = Radionuclide Research Processing Laboratory
* < 1.5 µCi - No MEOSI Dose Impact (See Section 4.2.3)

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

4.2
Facility Monitoring

Gross alpha and beta activity emissions are monitored at the BLIP and RRPL. The BLIP's sampling point, located in the exhaust stack, is equipped with a glass-fiber filter that captures samples of airborne particulate matter released from this facility. At the RRPL, a membrane-type filter is utilized to capture samples because it is better suited to capture and detect alpha-emitting isotopes, which are the type of radionuclides predominantly being generated at the RRPL. The BLIP and RRPL filters are collected weekly by BNL personnel and analyzed by an off-site contract laboratory. The average gross alpha and beta airborne activity concentration levels for samples collected from the BLIP exhaust stack were 0.001 and 0.016 pico-curies per cubic meter (pCi/m^3), respectively. Annual average gross alpha and beta airborne activity concentration levels for samples collected from the RRPL were 0.001 and 0.006 pCi/m^3, respectively. The 2024 analytical results are summarized in Table 4-2.

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

Monitored Facility		Gross Alpha (pCi/m^3)	Gross Beta (pCi/m^3)
BLIP	N	52	52
	Max.	0.0034 ± 0.0013	0.0736 ± 0.0051
	Avg.	0.0009 ± 0.0005	0.0162 ± 0.0020
	MDL	0.0008	0.0015
RRPL - Bldg. 801	N	52	52
	Max.	0.0083 ± 0.0030	0.0357 ± 0.0073
	Avg.	0.0010 ± 0.0005	0.0055 ± 0.0013
	MDL	0.0008	0.0014

Notes:
See Figure 4-1 for monitored facility locations.
All values shown with a 95% confidence interval.
BLIP = Brookhaven Linac Isotope Producer
MDL = Minimum Detection Limit (Average of validated samples at this location)
N = Number of validated samples collected
RRPL = Radionuclide Research Processing Laboratory

4.2.1 High Flux Beam Reactor (HFBR)

The HFBR was permanently shut down in 1999. Residual tritium in water in the reactor vessel and piping systems continue to diffuse into the building's air through valve seals and other system penetrations, though emission rates are much lower than during the years of operation. In 2010, the HFBR was disconnected from the former 100-meter stack, and a new HFBR exhaust system was installed in 2011. As part of the HFBR Long-Term Surveillance Program (BNL 2023), air samples are collected from outside the HFBR confinement structure using a permanently installed sample port. Samples are analyzed for tritium to evaluate facility emissions and to ensure that air quality within the building is acceptable to permit staff entry for inspections and routine maintenance. Samples for tritium are collected over a three- or four-week collection period using a standard desiccant sampling system, and analyzed monthly by an off-site contract laboratory.

P-2 Air Monitoring Station.

4.2.2 Brookhaven LINAC Isotope Producer (BLIP)

Protons from the Liner Accelerator (LINAC) Complex 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 RRPL 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 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). During target irradiations, both isotopes are released as gaseous, airborne emissions through the facility's 33-foot-tall stack. Emission levels of these radionuclides are dependent on the current and energy of the proton beam used to produce the radioisotopes.

In 2024, BLIP operated over a period of 39.14 weeks, during which 7,340 Ci of C-11 and 14,700 Ci of O-15 were released, totaling 22,040 Ci (see Table 4-1). In 2024, BLIP's combined emissions of C-11 and O-15 were lower than 2023 levels of 29,813 Ci. The decrease in released Curies resulted from a decrease in beam current hours and a decrease in recorded average stack flow rate. The 2024 release of tritium produced from activation of target cooling water was 0.071 Ci compared to 0.059 Ci of tritium released in 2023.

4.2.3 Radionuclide Research and Production Laboratory (RRPL)

As mentioned above in Section 4.2.2, metal targets irradiated at the BLIP are transported to the RRPL in Building 801, where isotopes are chemically extracted for radiopharmaceutical production. Airborne radionuclides released during the extraction process are drawn through a multistage high-efficiency particulate air (HEPA) and high efficiency gas adsorption (HEGA) filter system where the filtered air is then vented to the atmosphere. The types of radionuclides that are produced 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 microcurie (μCi) to mCi range. Historical analytical results of RRPL particulate filters have shown gross alpha/beta levels to be minimal, and the few radionuclides detected in emissions were at levels that had no impact on the potential radiological dose to members of the public, which is further explained in Chapter 8: Radiological Dose Assessment.

4.2.4 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. 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 significant quantities of radioactive materials. Compliance with NESHAPs Subpart H is demonstrated using an inventory system that utilizes upper estimates to conservatively calculate potential releases.

Facilities that demonstrate compliance using inventory methodology include Buildings 463, 490, 535, 555, 734, 745, 801, 815, and 817, where research is conducted in the fields of nuclear safety, nuclear science, biology, chemistry, high energy physics, photon science, advanced technology, environmental chemistry, and synthetic biology. Dose estimates from these facility emissions can be found in Chapter 8 on Table 8-5.

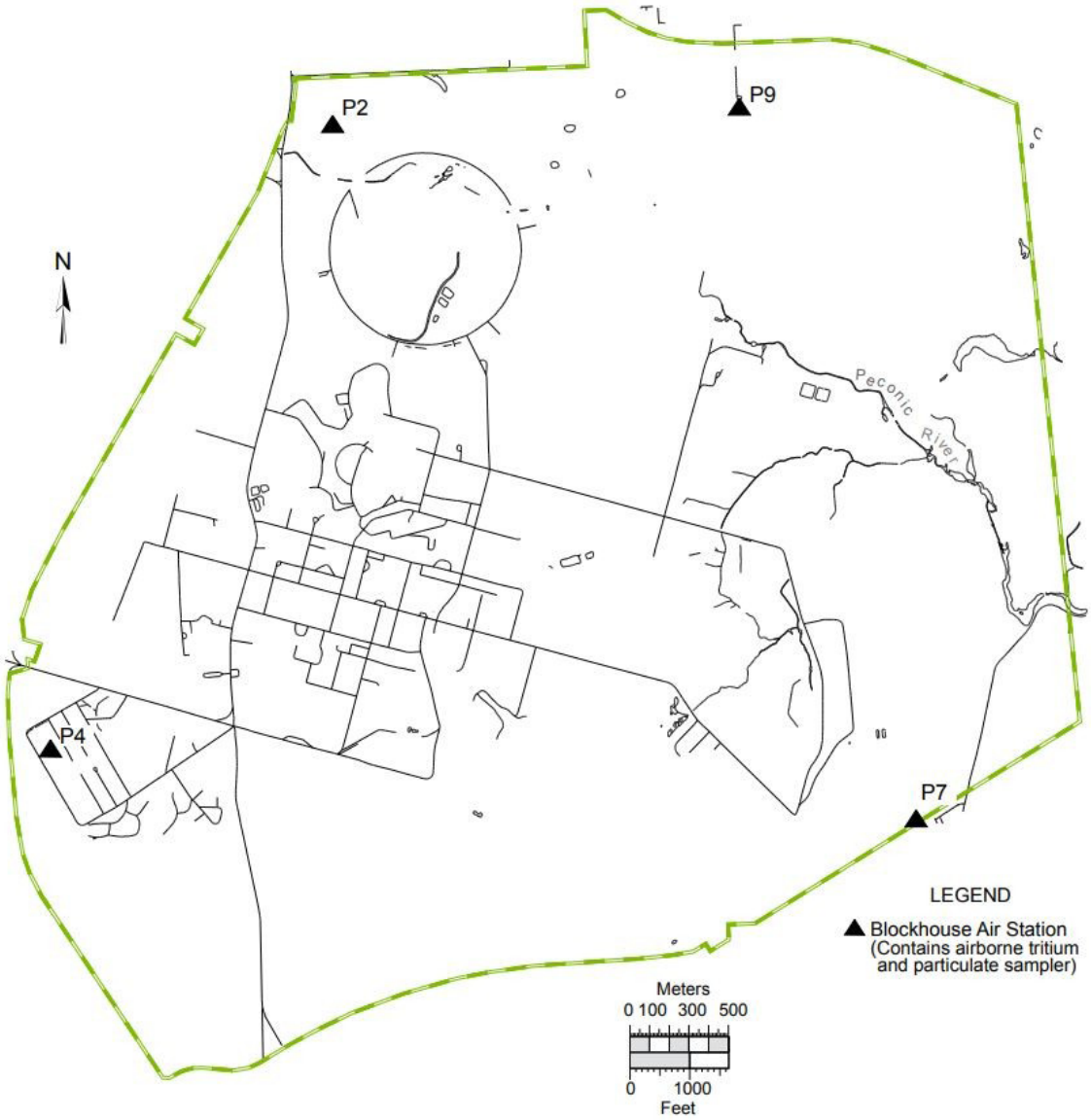
4.2.5 Nonpoint Radiological Emission Sources

Nonpoint radiological emissions from a variety of diffuse sources may be evaluated for compliance with NESHAPs Subpart H. A diffuse source is a pollution source that does not have a single identifiable point, such as a landfill or excavation. Diffuse sources are evaluated often and include planned research, planned waste management activities, and planned decontamination and decommissioning activities. Evaluations determine whether NESHAPs authorization and monitoring requirements apply, or periodic confirmatory sampling is needed to ensure compliance with Subpart H standards for radionuclide emissions. Chapter 8 discusses the NESHAPs evaluations of diffuse sources in 2024.

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 4-2). There are four blockhouse stations equipped for air sampling. At each blockhouse, vacuum pumps draw air through columns where airborne particulate matter is captured on a glass-fiber filter. Particulate filters are normally collected weekly and analyzed for gross alpha and beta activity using a gas-flow proportional counter. Also, every two weeks, water vapor for tritium analysis is collected on silica-gel adsorbent material for processing by liquid scintillation analysis.

Figure 4-2. BNL On-site Ambient Air Monitoring Stations.



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. Ambient air samples are collected weekly from site perimeter monitoring stations P2, P4, P7, and P9. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., sample air volumes were not acceptable).

In 2024, the annual average gross alpha and beta airborne activity levels for the four monitoring stations were 0.002 and 0.015 pCi/m^3, respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 4-3. The New York State Department of Health (NYSDOH) utilizes their own sampling equipment to collect duplicate filter samples from Station P7. These samples are collected weekly and analyzed by the NYSDOH laboratory for gross beta activity. The analytical results were comparable to the Station P7 samples analyzed by BNL's contracted lab. New York State's analytical results for gross beta activity at the Laboratory were between 0.001 and 0.017 pCi/m^3, with an average concentration of 0.008 pCi/m^3. BNL results ranged from 0.002 to 0.021 pCi/m^3, with an average concentration of 0.006 pCi/m^3.

As part of a state-wide monitoring program, NYSDOH also collects air samples in Albany, New York, a control location with no potential to be influenced by radiological facility emissions. In 2024, NYSDOH reported that airborne gross beta activity at that location varied between 0.001 and 0.026 pCi/m^3 and had an average concentration of 0.010 pCi/m^3. All of the BNL samples were less than the maximum concentration collected at the NYSDOH control location, demonstrating that on-site radiological air quality was consistent 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 tritiated water (HTO) is monitored throughout the BNL site. In 2024, samples were collected from Stations P2, P4, P7, and P9 to assess the potential impacts from the Laboratory's two tritium sources.

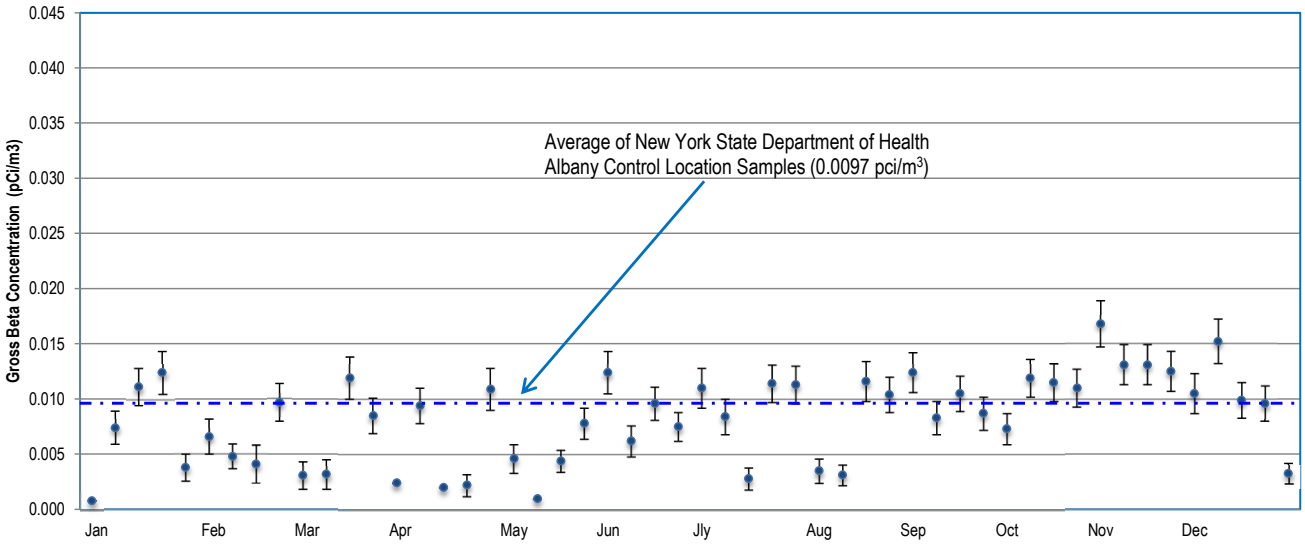
Table 4-3. Gross Activity Detected in Ambient Air Monitoring Particulate Filters.

Sample Station		Gross Alpha (pCi/m^3)	Gross Beta (pCi/m^3)
P2	N	52	52
	Max	0.003 ± 0.001	0.018 ± 0.002
	Avg.	0.001 ± 0.001	0.009 ± 0.002
	MDL*	0.0006	0.0011
P4	N	50	50
	Max	0.006 ± 0.002	0.033 ± 0.005
	Avg.	0.002 ± 0.001	0.010 ± 0.002
	MDL*	0.0007	0.0013
P7	N	52	52
	Max	0.002 ± 0.001	0.021 ± 0.002
	Avg.	0.001 ± 0.0004	0.006 ± 0.001
	MDL*	0.0004	0.0008
P9	N	50	50
	Max	0.003 ± 0.001	0.014 ± 0.002
	Avg.	0.001 ± 0.001	0.007 ± 0.001
	MDL*	0.0005	0.0010
Grand Average		**0.002 ± 0.001**	**0.015 ± 0.002**

Notes:
See Figure 4-2 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 samples taken at this location.

Emissions at RRPL.

Figure 4-3. Airborne Gross Beta Concentration Trend Recorded at Station P7 in 2024.



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

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). Samples for airborne tritium were collected every two weeks from each sampling station during 2024. The average tritium concentrations at the four sampling locations ranged from 2.78 to 8.77 pCi/m^3 and were less than the contracted analytical lab's typical minimum detection limits.

Table 4-4. Ambient Airborne Tritium Measurements in 2024.

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m^3)	Average (pCi/m^3)
P2	NNW	25	16.50 ± 6.92	6.50 ± 3.43
P4	WSW	23	25.10 ± 14.20	7.21 ± 3.89
P7	ESE	22	19.48 ± 9.46	8.77 ± 4.36
P9	NE	25	12.9 ± 7.55	2.78 ± 1.60
Grand Average				**6.221 ± 3.27**

Notes:
See Figure 4-2 for station locations.
Wind sector is the downwind direction of the sample station from the center of the site.
All values reported with a 95% confidence interval.
Typical minimum detection limit for tritium is between 0.68 and 12.3 pCi/m^3.

4.4
Non-Radiological Airborne Emissions

Various state and federal regulations governing non-radiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The CSF is the only BNL facility that requires monitoring for non-radiological 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 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 capacity of 16.4 MW (56.7 million British thermal units per hour [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 capacity 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 385 MW (1,315 MMBtu/hr).

Since the CSF boilers have the potential to emit more than 100 tons per year of oxides of nitrogen (NO_x), the CSF is considered a major facility, and all four of its boilers are subject to the Reasonably Available Control Technology (RACT) requirements of Title 6 of the New York Code, Rules, and Regulations (NYCRR) Subpart 227-2 (NYC 2019). Boilers 6 and 7 are also subject to the Federal New Source Performance Standard (40 CFR 60, Subpart Db: Standards of Performance for Industrial-Commercial-Institutional Steam Boilers) (CFR 2019) because of their design, heat inputs, and dates of installation. Both boilers are equipped with continuous emission monitoring systems (CEMS) to demonstrate compliance with the NO_x standards of these subparts, 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 monoxide (CO). Following the end of each calendar quarter, facilities with boilers equipped with CEMS must tabulate and summarize emissions, monitoring, and operating parameter measurements recorded during the preceding three months. CEMS results from the two boilers are reported to the Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC).

The Subpart 227-2 NO_x RACT emission limit for the combustion of natural gas and the combustion of No. 6 oil burned in the CSF three large boilers is 0.15 lbs/MMBtu. The NO_x RACT emission limit for the CSF's one mid-size boiler (Boiler 1A) is 0.20 lbs/MMBtu. From May 1 to September 30 of each year, the peak ozone period, owners and operators of boilers equipped with CEMS must demonstrate compliance with Subpart 227-2 NO_x RACT limits by calculating the 24-hour average emission rate from CEMS readings and comparing the value to the emission limit. During the remainder of the year, the calculated 30-day rolling average emission rate is used to establish compliance. Owners and operators of boilers not equipped with CEMS must demonstrate compliance with NO_x RACT limits via periodic emissions testing.

Control monitors located at CSF.

BNL uses an approved system averaging plan to demonstrate compliance in quarterly reports submitted to NYSDEC. This plan utilizes a NO_x ledger, where NO_x rate credits accumulated during quarterly periods when natural gas is burned at levels below the NO_x RACT limits offset ledger debits that may occur when fuel oil is burned. The ledger must indicate that the actual NO_x weighted average emission rate of operating boilers is less than the Subpart 227-2 permissible NO_x weighted average rate for the quarter. The actual NO_x weighted average emission rates for operating boilers in the first, second, third, and fourth quarters, respectively, were 0.150, 0.150, 0.173, and 0.150 lbs/MMBtu. The corresponding permissible weighted average emissions rates were 0.108, 0.091, 0.106, 0.095 lbs/MMBtu.

In 2024, there were two (2) six-minute average opacity readings that exceeded 27% recorded by Boiler 6 on February 28, 2024. The exceedances were due to a fuel meter/fan automatic control issue that was rectified by the operator on the same day. There were no opacity exceedances recorded by the Boiler 7 CEMS in 2024. 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 on days when the boilers were operating.

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 2024. The results of the RATA demonstrated that the Boiler 6 and 7 NO_x and CO_2 continuous emissions monitoring systems met RATA acceptance criteria, which are defined in 40 CFR 60, Appendix B, Specifications 2 and 3.

Fuel oil prices exceeded those of natural gas for most of the year resulting in utilizing natural gas to supply 98% of BNL's major facility heating and cooling needs. By comparison, in 2016, residual fuel satisfied 21% of the major facility heating and cooling needs. Consequently, 2024 emissions of particulates and sulfur dioxide (SO_2) were significantly less than the respective totals for 2016. Table 4-5 shows fuel use and emissions since 2014.

Table 4-5. Central Steam Facility Fuel Use and Emissions (2015–2024).

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)
2015	9.66	1,449	0.00	0	619.98	638,209	2.4	30.3	0.4	1.7
2016	804.38	120,712	0.00	0	441.98	453,348	3.7	33.6	19.0	1.7
2017	65.07	9,765	0.00	0	564.96	579,559	2.3	28.2	1.7	1.6
2018	36.04	5,409	0.04	6	642.33	662,242	2.5	31.5	1.0	1.8
2019	15.56	2,335	0.13	17.94	588.49	649,343	2.3	28.5	0.5	1.6
2020	44.20	6,455	0.00	0	553.70	610,905	2.2	28.9	1.2	1.5
2021	46.24	6,713	0.00	0	583.99	603,606	1.9	19.5	1.2	1.3
2022	342.45	49,522	40.43	5,560	567.51	587,343	2.8	36.1	8.3	1.8
2023	70.28	10,163	310.56	42,706	511.34	528,557	2.4	29.9	5.6	1.5
2024	57.31	8,288	9.82	1,350	554.14	573,502	2.2	30.8	1.4	1.5
Permit Limit (tons)							**113.3**	**159.0**	**445.0**	**39.7**

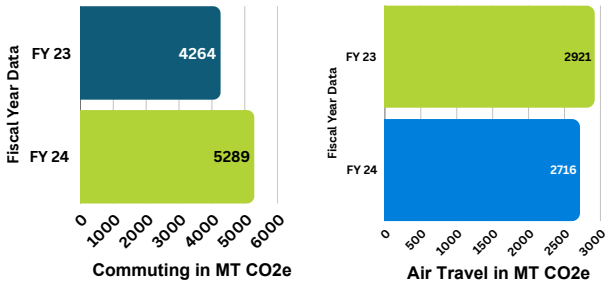
Notes:
NO_x = Oxides of Nitrogen
SO_2 = Sulfur Dioxide
TSP = Total Suspended Particulates
VOCs = Volatile Organic Compounds

4.5
Greenhouse Gas Emissions

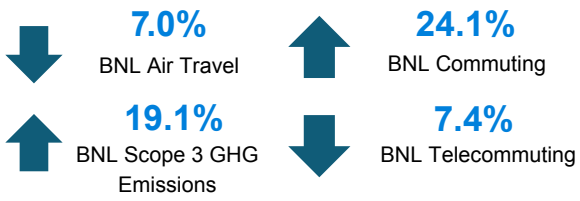
Chapter 2 includes discussion on energy reduction efforts, which addresses BNL's approach for reducing Scope 1 and 2 GHG emissions. Please see Chapter 2 for more information. To meet the 2025 Scope 3 GHG emissions reduction goal, Scope 3 emissions must be reduced by 25% from the FY08 baseline. Overall, Scope 3 GHG emissions in 2024 increased by 1,989 MT CO2e, up 19.1% from FY23. Total emissions for FY24 are 37% less than the FY08 baseline value. The GHG emissions increase from FY23 is mainly due to an increase in employee commuting and decrease in telecommuting. Laboratory air travel and commuting GHG emissions are noted in Figure 4-4.

Figure 4-4. BNL Scope 3 Greenhouse Gases.

BNL Greenhouse Gases



2023-2024 BNL Impacts



4.5.1 Hydrofluorocarbons

In continued preparation for anticipated decreases in the availability of certain hydrofluorocarbons (HFCs) as EPA implements the HFC phasedown requirements of the American Innovation and Manufacturing Act, the Laboratory regularly examines its operations and activities that use HFCs. Regulated HFC refrigerants in existing air conditioning and refrigeration equipment account for 40% of the 45,347 pounds of refrigerants in use and have been the target of reduction efforts. Based on a review of leaks associated with Laboratory HFC refrigeration and air conditioning equipment over the last five years, current supplies of regulated HFCs are sufficient to meet anticipated future needs for system leaks.

References and Bibliography

CFR 2014. 40 CFR 60 Subpart Db. Standards of Performance for Industrial-Commercial-Institutional Steam Boilers, 72 FR 32742, Jun. 13, 2007, as amended by 79 FR11249, February 27, 2014.

CFR 2002. 40 CFR 61 Subpart H. National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities. 54 FR 51695, Dec. 15, 1989, as amended by 67 FR 57166, September 9, 2002.

BNL 2023. Long-Term Surveillance and Maintenance Manual for the High Flux Beam Facility, Brookhaven National Laboratory, Upton, NY. (Rev 6) September 2023.

DOE 2020. DOE Order 458.1. Radiation Protection of the Public and the Environment. U.S. Department of Energy, Washington, DC. Admin Chg. 4, September 15, 2020.

NYC 2019. NYCRR Subpart 227-2, Title 6. Reasonably Available Control Technology for Oxides of Nitrogen. New York State Department of Environmental Conservation, Albany, NY., Amended November 11, 2019.

Shlein, Bernard, et al., (eds). 1998. Handbook of Health Physics and Radiological Health, Third Edition. Williams and Wilkins, Baltimore, MD.

Intentionally Left Blank

Sewage Treatment Plant operator and staff conducting monitoring activities.

Chapter 5

Water Quality

Wastewater generated from operations at Brookhaven National Laboratory (BNL) is treated at the Sewage Treatment Plant (STP) before it is discharged to nearby groundwater recharge basins.

Some wastewater may contain very low levels of radiological, organic, or inorganic contaminants. Monitoring, pollution prevention, and vigilant operation of treatment facilities ensure that these discharges comply with all applicable regulatory requirements and that the public, employees, and the environment are protected.

Analytical data for 2024 shows that the average gross alpha and beta activity levels in the STP discharge (Station EA, Outfall 001) were within the typical range of historical levels and were well below New York State Drinking Water Standards (NYSDWS). Tritium (H-3) was detected above the minimum detectable concentration (MDC) in the STP discharge in September 2024; no cesium-137 (Cs-137), strontium-90 (Sr-90), or other gamma-emitting nuclides attributable to Laboratory operations were detected. Non-radiological monitoring of the STP effluent showed that all organic and inorganic parameters were within State Pollutant Discharge Elimination System (SPDES) effluent limits or other applicable standards.

The average concentrations of gross alpha and beta activity in stormwater and cooling water discharged to recharge basins were within typical ranges and no gamma-emitting radionuclides were detected. Disinfection by-products continue to be detected at low concentrations above the minimum detection limit (MDL) 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 (e.g., metals) were detected; however, their presence is due primarily to sediment runoff in stormwater discharges.

Radiological data from Peconic River surface water sampling show that the average concentrations of gross alpha activity were indistinguishable from background. Gross beta activity from on-site locations were higher than control locations, however all detected levels were below the applicable NYSDWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the former STP outfall, and H-3 was not detected above MDCs in any of the surface water samples.

5.1
Surface Water Monitoring Program

In addition to monitoring discharges to surface waters under the SPDES program described in Chapter 3, BNL routinely monitors surface water quality (including radionuclides) as part of its site Surveillance Program.

Although discharges of treated wastewater from the Laboratory's STP into the headwaters of the Peconic River ceased in October 2014, the Laboratory continues to monitor surface water at several locations along the Peconic River to assess the impact that site operations may have on surface water quality.

On-site monitoring station HY is located upstream of all Laboratory operations and data provides information on the background water quality of the Peconic River for comparison to other sampling points that may show impact from Laboratory operations (see Figure 5-1). The Carmans River is monitored as a geographic control location for comparative purposes, as it is not affected by operations at BNL and is not connected to the Peconic River watershed. On the Laboratory site, the Peconic River is an intermittent, groundwater-fed stream.

Off-site flow occurs only after periods of sustained precipitation and a concurrent rise in the water table, typically in the spring. The Peconic River did have a period of off-site flow after heavy rains during the spring in 2024. The fluctuating cycles with periods of flow and no-flow are indicative of the combined influences of precipitation and groundwater. The cycles can sometimes occur over short periods of time, but low groundwater levels often result in several years where no or little flow occurs.

Monitoring data continues to indicate no significant variations in water quality throughout the Peconic River system on-site, and pollution prevention efforts at the Laboratory have significantly reduced the risk of accidental releases. The following sections describe BNL's surface water monitoring and surveillance program.

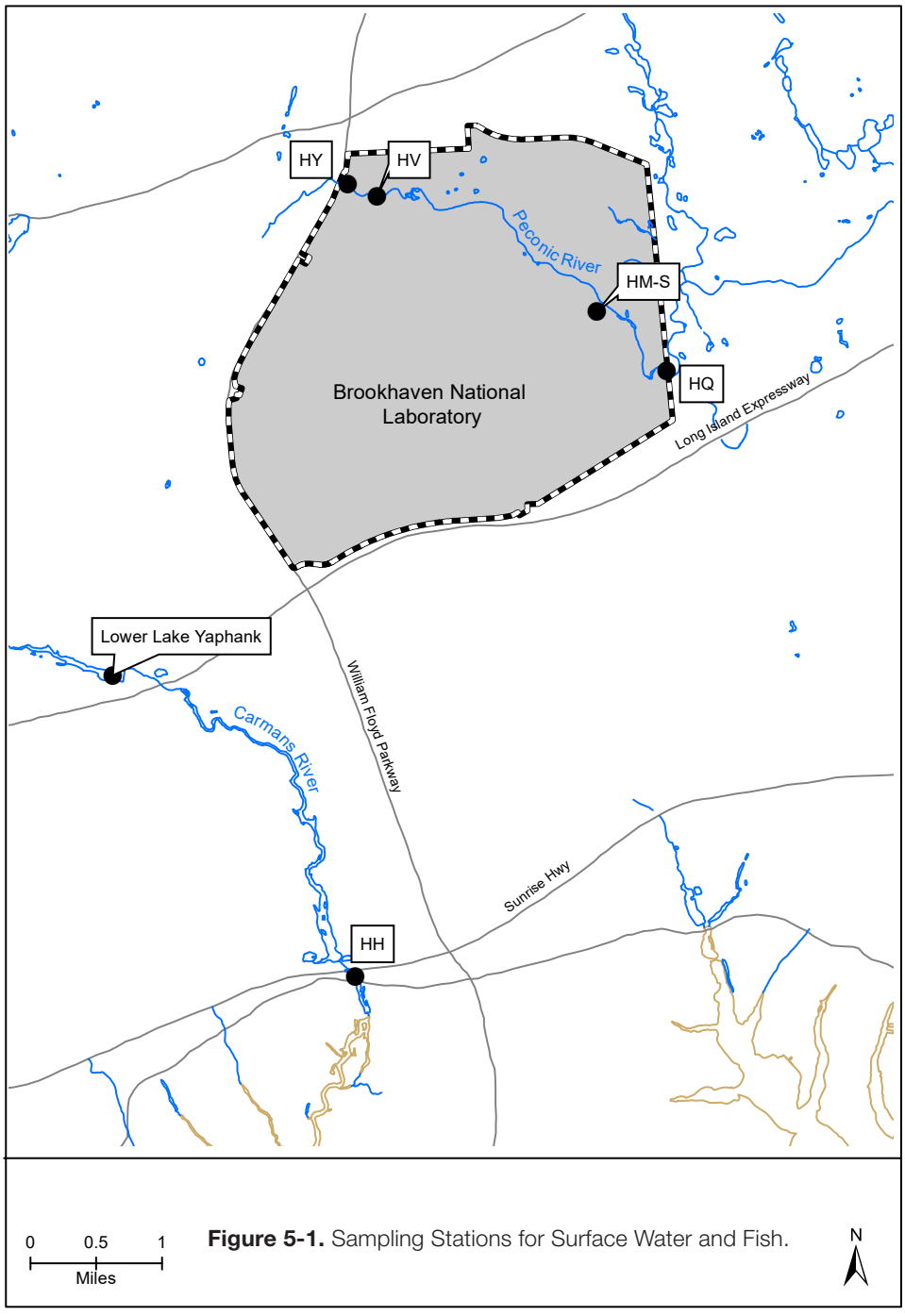
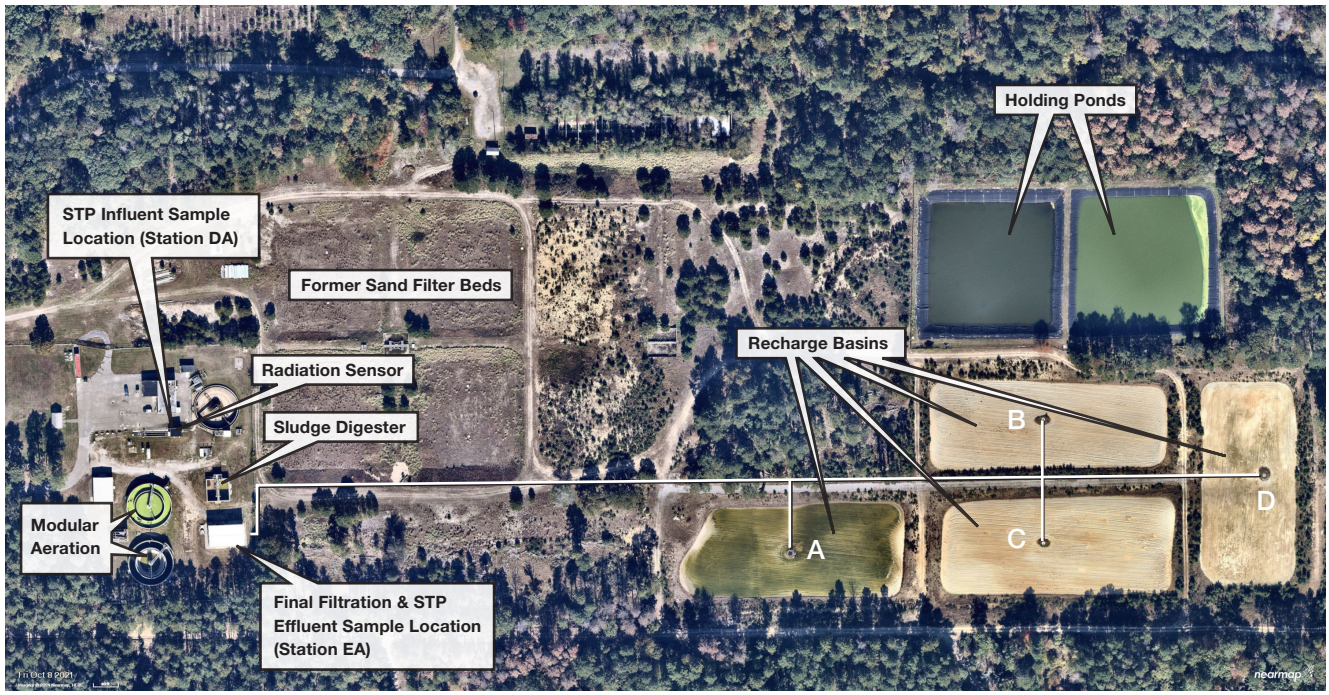


Figure 5-1. Sampling Stations for Surface Water and Fish.

5.2
Sanitary System Effluents

The STP effluent (Outfall 001/Station EA) is a discharge point authorized under BNL's SPDES permit that is issued by the New York State Department of Environmental Conservation (NYSDEC) (Section 3.6.1). Figure 5-2 shows an aerial photo of the STP with discharge of treated STP effluent to nearby groundwater recharge basins (Recharge Basins A-D). The Laboratory's STP treatment process includes three principal steps: 1) aerobic oxidation for secondary removal of biological matter and nitrification of ammonia, 2) secondary clarification, and 3) filtration for final solids removal. Tertiary treatment for nitrogen removal is also provided by controlling the oxygen levels in the aeration tanks. During the aeration process, the oxygen levels are allowed to drop to the point where micro-organisms use nitrate-bound oxygen for respiration, which liberates nitrogen gas and consequently reduces the concentration of nitrogen in the STP discharge.

Figure 5-2. An aerial photo of BNL's Sewage Treatment Plant (Recharge Basin Discharge).



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%, 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.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity occurs at two locations. The first site, MH-192, is approximately one mile upstream of the STP and provides a minimum of 30 minutes to warn the STP operators that wastewater exceeding SPDES limits or BNL administrative effluent release criteria is enroute to the STP. The second monitoring 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 can be diverted to two double-lined holding ponds. The total combined capacity of the two holding ponds exceeds six million gallons, or approximately 18 days of flow. Diversion would continue until the influent water quality would allow for the permit limits and release criteria to be met. Wastewater diverted to the holding ponds 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 non-radiological parameters or BNL effluent release criteria for radiological parameters. In 2024, there were no instances where influent water quality required diversion of wastewater to the holding ponds due to SPDES limits or BNL effluent release criteria. Wastewater is occasionally diverted to allow for optimum operation of the STP.

5.2.1 Sanitary System Effluent - Radiological Analyses

Wastewater at the STP is sampled at the inlet to the treatment process, Station DA, and at the STP outfall, Station EA, as shown in Figure 5-2. At each location, samples are collected on a flow-proportional basis; that is, for every 1,000 gallons of water treated, approximately four fluid ounces of sample are collected and composited into a five-gallon collection container. These samples are analyzed weekly for gross alpha and gross beta activity and for H-3. Samples collected from these locations are also composited and analyzed monthly for gamma-emitting radionuclides and Sr-90 (half-life: 29 years).

Although the STP discharge is not used as a direct source of potable water, the Laboratory applies the more stringent Safe Drinking Water Act (SDWA) standards for comparison purposes when monitoring the effluent, in lieu of Department of Energy (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 H-3 (half-life: 12.3 years), 8 pCi/L for Sr-90, 5 pCi/L for Ra-226 and Ra-228 (half-life: 5.75 years), and 30 μg/L for uranium. Gross alpha and beta activity 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 H-3 concentrations for the STP influent and effluent during 2024. Annual average gross alpha and beta activity levels in the STP effluent were 1.2 ± 0.4 pCi/L and 5.0 ± 0.8 pCi/L, respectively. Both gross alpha and gross beta average concentrations were higher than those measured at the Carmans River control location (HH) reported in Table 5-5; however, they were well below the SDWA standards of 15 pCi/L and 50 pCi/L respectively, that are used for comparison purposes. H-3 was detected above the MDC in the discharge of the STP (EA, Outfall 001) in September 2024 with the average concentration being 98.3 ± 66.5 pCi/L, well below the SDWA standard of 20,000 pCi/L. Conservative estimates of total release based on H-3, gross-alpha, and gross-beta in millicuries is provided in Table 5-1. In 2024, there were no gamma-emitting nuclides detected in the STP effluent.

Table 5-1. Tritium and Gross Activity in Water at the Sewage Treatment Plant for 2024.

		Flow	Tritium (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)	
		(liters)	max.	avg.	max.	avg.	max.	avg.
January	*influent*	2.98E+07	< 437	< MDC	< 6.5	< MDC	4.3 ± 1.1	3.4 ± 0.8
	effluent	2.92E+07	< 429	< MDC	< 4.4	< MDC	5.1 ± 1.4	3.8 ± 0.9
February	*influent*	1.52E+07	< 486	< MDC	< 7.7	< MDC	8.8 ± 2.2	4.9 ± 2.6
	effluent	1.70E+07	< 485	< MDC	< 5.7	< MDC	6.8 ± 1.8	3.7 ± 2.2
March	*influent*	1.90E+07	< 506	< MDC	< 5.0	< MDC	4.0 ± 1.8	2.3 ± 1.2
	effluent	2.37E+07	< 507	< MDC	< 6.2	< MDC	4.5 ± 2.6	4.0 ± 0.5
April	*influent*	2.13E+07	< 469	< MDC	< 4.0	< MDC	6.4 ± 2.2	4.1 ± 1.8
	effluent	2.53E+07	< 471	< MDC	< 5.0	< MDC	9.6 ± 2.9	5.0 ± 2.4
May	*influent*	1.92E+07	< 491	< MDC	7.4 ± 2.1	< MDC	27.2 ± 3.4	10.4 ± 11.0
	effluent	1.50E+07	< 494	< MDC	< 3.0	< MDC	9.9 ± 2.0	4.4 ± 3.8
June	*influent*	2.78E+07	< 509	< MDC	< 5.5	< MDC	10.5 ± 4.7	7.2 ± 3.5
	effluent	2.45E+07	< 511	< MDC	< 5.4	< MDC	10.3 ± 4.5	6.5 ± 3.0
July	*influent*	3.08E+07	< 515	< MDC	< 8.4	< MDC	14.1 ± 1.8	8.2 ± 5.4
	effluent	3.05E+07	< 510	< MDC	< 4.6	< MDC	13.6 ± 2.2	7.4 ± 4.7
August	*influent*	3.22E+07	< 463	< MDC	3.1 ± 1.3	< MDC	12.5 ± 3.0	5.7 ± 4.5
	effluent	2.96E+07	< 466	< MDC	< 4.2	< MDC	12.8 ± 3.1	6.5 ± 3.7
September	*influent*	2.38E+07	1128.9 ± 302.0	696.6 ± 281.7	< 4.5	< MDC	9.2 ± 2.8	5.0 ± 2.8
	effluent	2.78E+07	1018.8 ± 298.1	564.3 ± 313.3	< 4.8	< MDC	6.3 ± 3.5	4.3 ± 1.4
October	*influent*	1.81E+07	< 482	< MDC	< 3.4	< MDC	5.2 ± 1.7	4.0 ± 1.2
	effluent	2.05E+07	< 480	< MDC	< 3.4	< MDC	4.6 ± 1.8	3.3 ± 1.3
November	*influent*	1.61E+07	< 491	< MDC	< 5.5	< MDC	7.7 ± 1.8	5.3 ± 1.7
	effluent	1.75E+07	< 478	< MDC	< 3.3	< MDC	10.8 ± 2.1	5.8 ± 3.4
December	*influent*	2.10E+07	< 548	< MDC	< 4.2	< MDC	4.9 ± 1.7	3.9 ± 1.0
	effluent	2.23E+07	< 533	< MDC	< 4.1	< MDC	7.0 ± 1.9	4.9 ± 1.4
Annual Avg.	*influent*			78.9 ± 74.3		1.5 ± 0.5		5.3 ± 1.1
	effluent			98.3 ± 66.5		1.2 ± 0.4		5.0 ± 0.8
Total Release		**2.83E+08**		**28 mCi (a)**		**0.3 mCi**		**1.5 mCi**
Average MDC (pCi/L)				**442.3**		**3.5**		**3.4**
SDWA Limit (pCi/L)				**20000**		**15**		**(b)**

Notes:
All values are reported with a 95% confidence interval.
To convert values from pCi to Bq, divide by 27.03.
MDC=minimum detected concentration
SDWA = Safe Drinking Water Act
(a) The total released value for tritium is a conservative calculation that is based on an average of the 95% confidence interval positive averages as estimates of monthly average release concentrations. The majority of the effluent samples showed average concentrations less than zero.
(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.

5.2.2 Sanitary System Effluent – Non-radiological Analyses

Monitoring of the STP effluent for volatile organic compounds (VOCs), inorganics, and anions is conducted as part of the SPDES Compliance Program, which is discussed in further detail in Chapter 3.

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 only 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, potentially impact groundwater quality (BNL 2025).

The Laboratory's SPDES permit includes requirements for quarterly sampling and analysis of process-specific wastewater discharged from 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 semi-VOCs. In 2024, there were no wastewater discharges from Building 498. Analyses of Building 902 wastewater 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 are not expected to be of consistent quality and are not routinely generated are held for characterization before release to the sanitary system. The process wastewaters typically include 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 are analyzed for contaminants specific to the process, and the concentrations are compared to the SPDES effluent limits and BNL's effluent release criteria (BNL 2025). If the concentrations are within limits, authorization for sewer system discharge is granted; if not, alternate means of disposal are used. Any waste that contains elevated levels of hazardous or radiological contaminants in concentrations that exceeded Laboratory effluent release criteria are 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 of "clean" wastewater, including once-through cooling water, stormwater runoff, and cooling tower blowdown. These wastewaters are suitable for direct replenishment of the groundwater aquifer. Figure 5-3 shows the locations of the Laboratory's discharges to recharge basins (also called "outfalls" under BNL's SPDES permit). Figure 5-4 presents an overall schematic of potable water use at the Laboratory, and how much of this water is discharged to the 12 on-site recharge basins:

- Basin HZ receives stormwater and cooling water discharges from Bldg. 902.
- Basins HN, HT-W, and HT-E receive once-through cooling water discharges generated at the Alternating Gradient Synchrotron (AGS), Linear Accelerator, 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 Computational Science Initiative facility (Bldg. 725).
- Basin HX receives Water Treatment Plant filter backwash water.
- Basin HO receives cooling water discharges from the AGS and stormwater runoff from the area surrounding the High Flux Beam Reactor (HFBR) (Bldg. 750).

Figure 5-3. BNL Recharge Basin/Outfall Locations.

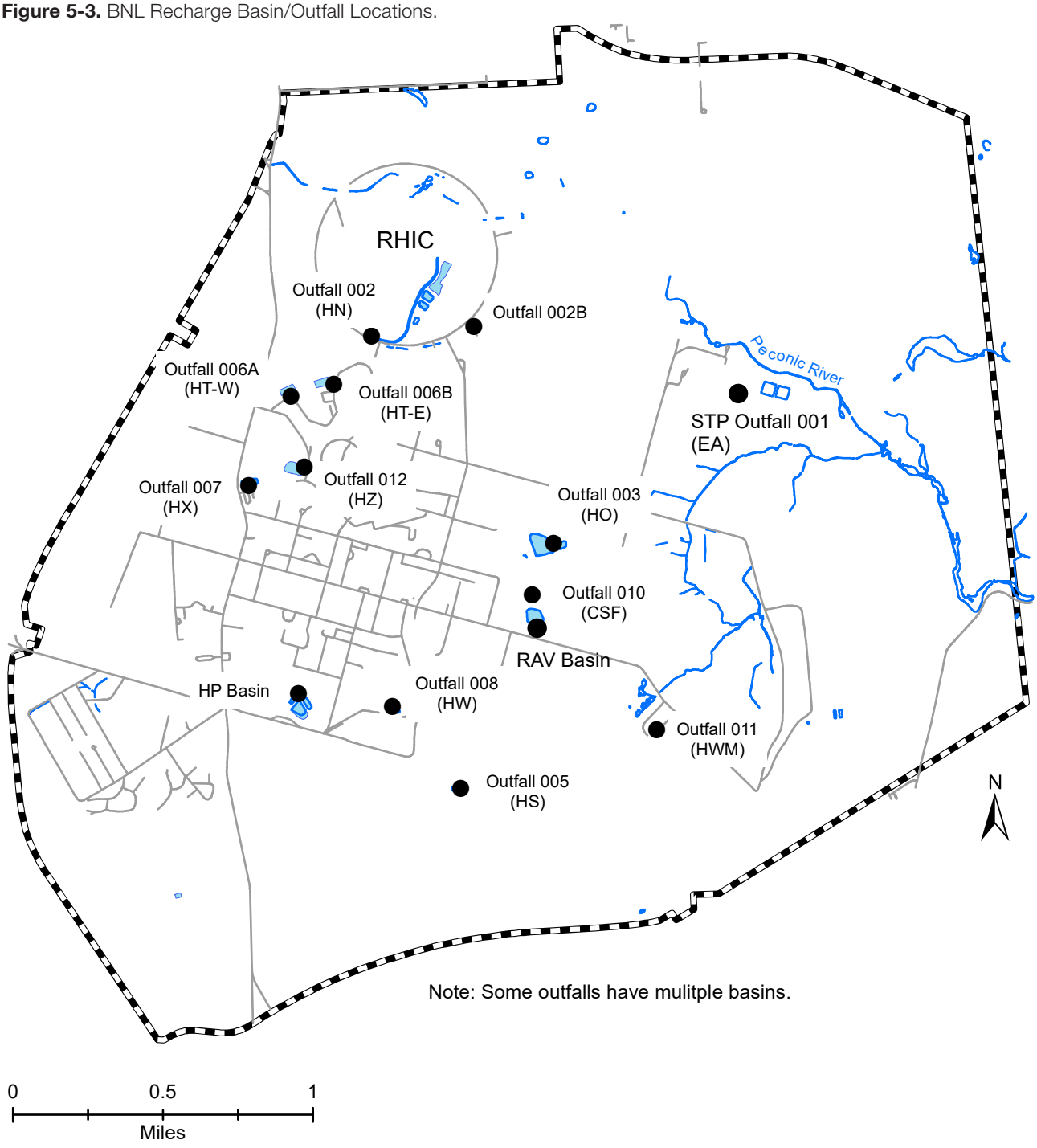
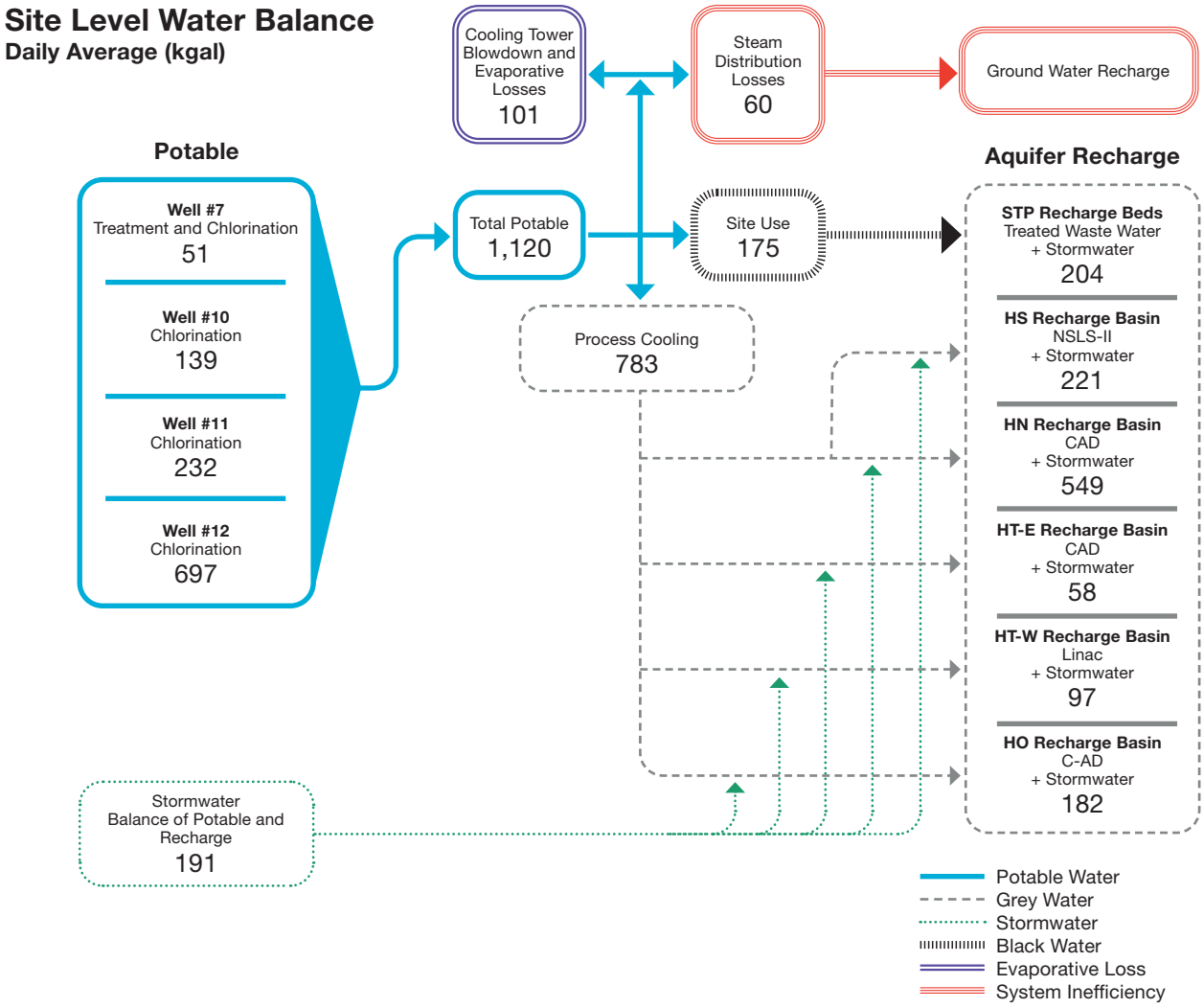


Figure 5-4. Schematic of Potable Water Use and Flow at BNL.



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) site, Basin CSF at the Central Steam Facility (CSF), and Basin HW-M at the Former Hazardous Waste Management Facility (FHWMF). Recharge Basins HP and RAV are used for discharge of treated water from the groundwater remediation systems and are monitored under BNL's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) equivalency permits.

Each of the recharge basins is a permitted point-source discharge under the Laboratory's SPDES permit and equivalency permits under the CERCLA program. Where required by the permit, the basins are equipped with a flow monitoring station, allowing for weekly recordings of flow rates. 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 2024, water samples were collected semi-annually from all the basins listed above except for recharge Basin HX at the Water Treatment Plant (due to previously documented non-impact to groundwater from plant operations) and a recharge basin at the FHWMF (due to absence of operations at the FHWMF that could lead to the contamination of runoff).

5.4.1 Recharge Basins – Radiological Analyses

Discharges to recharge basins with the potential for radiological contamination were sampled semi-annually and analyzed for gross alpha and beta activity, gamma-emitting radionuclides, and H-3. The results are summarized in Table 5-2. Gross alpha values were below the MDCs and gross beta activity ranged from non-detect to 9.41 ± 2.02 pCi/L. Low-level detections of beta activity are attributable to naturally occurring radionuclides, such as potassium-40 (K-40) (half-life: 1.3E+09 years). No gamma-emitting nuclides attributable to BNL operations or H-3 were detected in any discharges to recharge basins.

5.4.2 Recharge Basins – Non-Radiological Analyses

During 2024, discharge samples were collected semi-annually for water quality parameters, metals, and VOCs. Field-measured parameters (e.g., pH, conductivity, and temperature) were routinely monitored and recorded. The water quality and metals analytical results are summarized in Tables 5-3 and 5-4, respectively. The non-radiological analytical results are compared to groundwater discharge standards promulgated under Title 6 of the New York Codes, Rules, and Regulations (NYCRR), Part 703.6.

Table 5-2. Radiological Analysis of Samples From On-Site Recharge Basins (2024).

Basin		Gross Alpha	Gross Beta	Tritium
		(pCi/L)		
No. of Samples		**2**	**2**	**2**
HN	Max.	< 1.80	2.56 ± 0.80	< 448
	Avg.	< MDC	1.57 ± 1.94	< MDC
HO	Max.	< 2.08	0.98 ± 0.68	< 454
	Avg.	< MDC	0.89 ± 0.60	< MDC
HS	Max.	< 1.80	1.00 ± 0.73	< 448
	Avg.	< MDC	0.96 ± 0.66	< MDC
HT-E	Max.	< 17.00	7.25 ± 4.25	< 454
	Avg.	< MDC	7.09 ± 3.36	< MDC
HT-W	Max.	< 1.75	1.67 ± 0.67	< 448
	Avg.	< MDC	1.16 ± 0.55	< MDC
HW	Max.	< 6.86	9.41 ± 2.02	< 444
	Avg.	< MDC	5.20 ± 1.38	< MDC
HZ	Max.	< 2.26	2.72 ± 0.81	< 431
	Avg.	< MDC	1.73 ± 0.65	< MDC
SDWA Limit		**15**	**(a)**	**20,000**

Notes:
See Figure 5-3 for recharge basin/outfall locations.
All values reported with a 95% confidence interval.
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.
MDC = minimum detected concentration
SDWA = Safe Drinking Water Act

Low concentrations of disinfection byproducts were periodically detected above the MDLs 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, can break down to various products including bromoform, chloroform, bromodichloromethane, and dibromochloromethane. Concentrations were above the 5 µg/L MDL for bromoform at Basin HT-W, the highest value being 5.4 µg/L, below the 50 µg/L drinking water standard. All other values were below the 5 µg/L MDL.

The analytical data presented in Table 5-3 show that, for 2024, the concentrations of all analytes were within effluent standards. Historically, 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. High chloride values, which can also result in high conductivity, continued to persist in results in 2024. The data in Table 5-4 show that all parameters complied with the respective water quality or groundwater discharge standards.

Table 5-3. Water Quality Data for On-site Recharge Basins (2024).

Analyte		Recharge Basin								NYSDEC Effluent Standard	Typical MDL
		HN (RHIC)	HO (AGS/ HFBR)	HS (S)	HT-W (Linac)	HT-E (AGS)	HW (S)	CSF (S)	HZ (S)		
No. of Samples		**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**		
pH (SU)	Min.	7.6	8.0	7.2	8.2	7.5	7.2	7.3	7.3	**6.5 - 8.5**	**NA**
	Max.	7.8	8.3	8.0	8.3	8.4	7.5	7.7	8.1		
Conductivity (µS/cm)	Min.	317	340	75	403	1000	87	80	404	**SNS**	**NA**
	Max.	1212	364	404	738	6482	496	498	479		
	Avg.	764.5	352	239.5	570.5	3741	291.5	289	441.5		
Temperature (Deg. C)	Min.	8.1	14.4	7.0	6.8	12.0	6.2	6.0	13.3	**SNS**	**NA**
	Max.	22.1	24.7	21.8	26.7	26.6	21.2	22.2	25.6		
	Avg.	15.1	19.6	14.4	16.8	19.3	13.7	14.1	19.5		
Dissolved Oxygen (mg/L)	Min.	8.5	8.4	8.0	7.9	9.8	8.0	8.7	7.6	**SNS**	**NA**
	Max.	9.4	9.8	10.6	9.8	10.0	9.9	10.1	9.8		
	Avg.	8.9	9.1	9.3	8.8	9.9	9.0	9.4	8.7		
Chlorides (mg/L)	Min.	19	56	6.8	43	270	10	2.8	73	**SNS**	**0.2**
	Max.	67	76	130	59	2400	800	1500	74		
	Avg.	43	66	68.4	51	1335	405	751.4	73.5		
Sulfate (mg/L)	Min.	4.8	11	3.6	8.2	22	3.4	2.0	10	**500**	**0.5**
	Max.	8.0	13	9.8	12	39	7.0	8.9	14		
	Avg.	6.4	12	6.7	10.1	30.5	5.2	5.5	12.0		
Nitrate as Nitrogen (mg/L)	Min.	0.3	0.5	0.2	0.4	0.2	0.3	0.3	1.1	**10**	**0.1**
	Max.	0.4	0.6	0.5	0.6	0.6	0.4	0.3	1.4		
	Avg.	0.4	0.6	0.3	0.5	0.4	0.3	0.3	1.3		

Notes:
See Figure 5-3 for recharge basin/outfall locations.
S = stormwater
AGS = Alternating Gradient Synchrotron
HFBR = High Flux Beam Reactor
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

Table 5-4. Metals Analysis of Water Samples From BNL On-Site Recharge Basins (2024).

Metal		Recharge Basin								NYSDEC Effluent LIMIT or AWQS	Typical MDL
		HO (AGS)		HT-E (AGS)		HT-W (Linac)		HZ (Stormwater)			
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F		
No. of Samples		2	2	2	2	2	2	2	2		
Ag Silver (µg/L)	Min.	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	50	1
	Max.	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
	Avg.	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
Al Aluminum (µg/L)	Min.	45	15	87	8.3	41	19	47	23	2000	15
	Max.	150	19	260	24	190	24	240	33		
	Avg.	97.5	17	173.5	16.2	115.5	21.5	143.5	28		
As Arsenic (µg/L)	Min.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	50	2
	Max.	< 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		
Ba Barium (µg/L)	Min.	38	40	100	100	29	32	29	31	2000	0.8
	Max.	41	42	110	110	42	39	54	41		
	Avg.	39.5	41	105	105	35.5	35.5	41.5	36		
Be Beryllium (µg/L)	Min.	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	SNS	0.3
	Max.	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3		
	Avg.	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3		
Cd Cadium (µg/L)	Min.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	10	0.5
	Max.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		
	Avg.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		
Co Cobalt (µg/L)	Min.	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5	1
	Max.	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
	Avg.	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
Cr Chromium (µg/L)	Min.	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	100	3
	Max.	< 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	< 3.0	< 3.0	< 3.0	< 3.0		
Cu Copper (µg/L)	Min.	1.0	2.0	6.0	4.8	2.5	1.4	12	11	1000	1
	Max.	5.5	2.2	10	4.8	9.6	1.7	75	27		
	Avg.	3.25	2.1	8.0	4.8	6.1	1.55	43.5	19		
Fe Iron (µg/L)	Min.	< 200	< 200	420	< 200	< 200	< 200	< 200	< 200	600	200
	Max.	440	< 200	580	200	300	< 200	340	< 200		
	Avg.	320	< 200	500	< 200	250	< 200	270	< 200		

(continued on next page)

Table 5-4. Metals Analysis of Water Samples From BNL On-Site Recharge Basins (2024) *(concluded).*

Metal		Recharge Basin								NYSDEC Effluent LIMIT or AWQS	Typical MDL
		HO (AGS)		HT-E (AGS)		HT-W (Linac)		HZ (Stormwater)			
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F		
No. of Samples		2	2	2	2	2	2	2	2		
Hg Mercury (µg/L)	Min.	< 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		
	Avg.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	Min.	< 3.0	< 3.0	23	16	< 3.0	< 3.0	4.2	3.1	**600**	**1.5**
	Max.	21	< 3.0	85	84	8.4	< 3.0	16	5.4		
	Avg.	12	< 3.0	54	50	5.7	< 3.0	10.7	4.3		
Na Sodium (mg/L)	Min.	32	32	180	190	23	25	43	46	**SNS**	**0.07**
	Max.	42	44	1300	1300	35	36	48	51		
	Avg.	37	38	740	745	29	30.5	45.5	48.5		
Ni Nickel (µg/L)	Min.	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	**200**	**10**
	Max.	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10		
	Avg.	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10		
Pb Lead (µg/L)	Min.	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.8	< 1.0	**50**	**0.5**
	Max.	< 1.0	< 1.0	2.2	< 1.0	1.4	< 1.0	19	5.0		
	Avg.	< 1.0	< 1.0	1.6	< 1.0	1.2	< 1.0	10.4	3.0		
Sb Antimony (µg/L)	Min.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	**6**	**2**
	Max.	< 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		
Se Selenium (µg/L)	Min.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	**20**	**5**
	Max.	< 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		
Tl Thallium (µg/L)	Min.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	**SNS**	**0.5**
	Max.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		
	Avg.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		
V Vanadium (µg/L)	Min.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	**SNS**	**2**
	Max.	< 2.0	< 2.0	2.3	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	Avg.	< 2.0	< 2.0	2.15	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Zn Zinc (µg/L)	Min.	< 10	< 10	61	17	18	< 10	43	23	**5000**	**10**
	Max.	< 10	< 10	81	67	58	23	54	40		
	Avg.	< 10	< 10	71	42	38	16.5	48.5	31.5		

Notes:
See Figure 5-3 for recharge basin/outfall locations.
AGS = Alternating Gradient Synchrotron
AWQS = Ambient Water Quality Standards
Linac = Linear Accelerator
MDL = minimum detection limit
NYSDEC = New York State Department of Environmental Conservation
SNS = Standard Not Specified

5.4.3 Stormwater Management

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 the Collider-Accelerator complex. Basin HO receives runoff from the area surrounding the HFBR. Basin CSF receives runoff from the CSF area and along Cornell Avenue east of Renaissance Road. Basin HW receives runoff from the NSLS-II site, and HW-M receives runoff from the fenced area at the FHWMF.

Stormwater runoff at the Laboratory typically has elevated levels of inorganics (e.g., metals) and has a 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 on-site, BNL has formal procedures for managing and maintaining outdoor work and storage areas. The requirements include covering of equipment and materials (e.g., road salt storage and bins/containers with potential to leak residual oils or any other hazardous materials) 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 five-year testing cycle to ensure these discharges comply with regulatory requirements. Basin sediments were sampled in 2022 and the next sampling event will occur in 2027.

5.5
Peconic River Surveillance

Several locations are monitored along the Peconic River to assess the overall water quality of the river and assess any impact from BNL operations. Sampling points along the Peconic River are identified in Figure 5-1. In total, four stations (two upstream and two downstream of the former STP discharge) were sampled in 2024. A sampling station along the Carmans River (HH) was also monitored as a geographic control location not affected by Laboratory operations or located within the Peconic River watershed. The following locations were monitored for radiological and non-radiological parameters:

Upstream sampling station:

- HY, on-site, immediately east of William Floyd Parkway
- HV, on-site, just east of the 10 o'clock experimental hall in the RHIC Ring, radiological only

Downstream sampling stations:

- HM-S, on-site, at east firebreak south of main stem of Peconic
- HQ, on-site, at east boundary of BNL

Control location:

- HH, Carmans River

5.5.1 Peconic River – Radiological Analyses

During 2024, radionuclide analyses were performed on surface water samples collected from the four Peconic River sampling locations and the Carmans River control location. Stations HY and HV on the Peconic River allow for radiological assessment of potential RHIC impacts and no other contributions from potential BNL operations enter the river until the tributary monitoring at HM-S. HQ sampling station is the final monitoring location before the river flows off-site and, when flowing, is representative of all surface water flows from the BNL site.

Table 5-5. Radiological Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (2024).

Sampling Station		Gross Alpha	Gross Beta	Tritium	Strontium-90
		---------- (pCi/L) ----------			
HY (headwaters) on site, west of the RHIC ring.	N	2	2	2	2
	Max.	< 1.11	3.17 ± 0.80	< 440	< 0.63
	Avg.	< MDC	2.52 ± 0.75	< MDC	< MDC
HV (headwaters) on site, inside the RHIC ring.	N	1	1	1	NS
	Max.	< 1.19	< 0.92	< 400	NS
	Avg.	-	-	-	NS
HM-S tributary, on-site	N	1	1	1	1
	Max.	< 1.22	< 0.92 ± 0.56	< 381	< 0.46
	Avg.	-	-	-	-
HQ BNL site boundary	N	1	1	1	1
	Max.	< 1.39	< 1.81 ± 1.32	< 445	< 0.77
	Avg.	-	-	-	-
Carmans River HH control Location, off-site	N	2	2	2	2
	Max.	< 1.81	< 1.9 ± 1.28	< 374	< 0.75
	Avg.	< MDC	< MDC	< MDC	< MDC
SDWA Limit		**15**	**(a)**	**20,000**	**8**

Notes:
See Figure 5-1 sampling station locations.
All values reported with a 95% confidence interval.
To convert values from pCi to Bq, divide by 27.03.
MDC=minimum detected concentration
N = number of samples analyzed
NS = sample not taken due to dry conditions
RHIC = Relativistic Heavy Ion Collider
SDWA = Safe Drinking Water Act
(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.
- = only one sample taken due to dry conditions

In 2024, the Peconic River flow continued to be low. Two samples were able to be taken at the uppermost sampling location HY during or immediately after precipitation. One sample was able to be taken at the remaining three sampling locations, HV, HM-S, and HQ. The radiological data from Peconic River surface water samples are summarized in Table 5-5. Radiological analysis of water samples collected from HY had very low concentrations of gross beta activity that were attributed to natural sources. All other gross beta values were below MDCs, and all detected levels were below the applicable NYSDWS. H-3, gross alpha, and Sr-90 values were below MDCs at all locations on the Peconic and Carmans Rivers.

5.5.2 Peconic River – Non-radiological Analyses

River water samples collected in 2024 were analyzed for water quality parameters (e.g., pH, temperature, conductivity, and dissolved oxygen), anions (e.g., chlorides, sulfates, and nitrates), metals, and VOCs. The analytical data for the Peconic River and Carmans River samples are summarized in Table 5-6 (water quality) and Table 5-7 (metals). No VOCs were found in any samples collected from the Peconic and Carmans Rivers in 2024. Water quality parameters measured at the Peconic River Location (HY) and the Carmans River control location (HH) show that temperature, conductivity, and dissolved oxygen levels were all within applicable NYS standards. Peconic River pH values were lower than the NYS effluent standards. Low pH values are natural on Long Island due to the presence of organic materials (e.g., leaf litter).

Ambient water quality standards (AWQS) 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 2024, the BNL monitoring program continued to assess water samples for both the 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, copper, iron, and lead were present in concentrations at Peconic River locations that exceeded New York State Ambient Water Quality Standards (NYS AWQS). Aluminum was detected at concentrations exceeding the NYS AWQS at locations on the Peconic River for unfiltered and filtered samples. Iron was detected at both Peconic and Carmans River sampling stations at concentrations that were at or slightly exceeding the NYS AWQS in unfiltered samples, with dissolved levels falling below NYS AWQS; iron and aluminum are found in high concentrations in native Long Island soil and, for iron, at high levels in groundwater. Copper and lead at concentrations greater than the NYS AWQS were found in samples collected at stations HY and HM-S (lead only) on the Peconic River. Filtration of samples reduced concentration for some metals to below the detection level, suggesting that suspended sediment was responsible for metals in those samples.

Table 5-6. Water Quality Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (2024).

Analyte		Peconic River Locations HY	HM-S	HQ	Carmans River HH (Control)	NYSDEC Effluent Standard	Typical MDL
No. of Samples		**2**	**1**	**1**	**2**		
pH (SU)	Min.	5.6	-	-	7.9	**6.5 - 8.5**	**NA**
	Max.	5.8	6.3	6.2	8.0		
	Avg.	5.7	-	-	7.9		
Conductivity (µS/cm)	Min.	4.0	-	-	109.0	**SNS**	**NA**
	Max.	55.0	53	50	247.0		
	Avg.	29.5	-	-	178.0		
Temperature (deg C)	Min.	10.3	-	-	13.2	**SNS**	**NA**
	Max.	13.5	12.2	13.5	13.2		
	Avg.	11.9	-	-	13.2		
Dissolved Oxygen (mg/L)	Min.	9.8	-	-	9.6	**SNS**	**NA**
	Max.	10.5	10.1	7.4	9.9		
	Avg.	10.2	-	-	9.7		
Chlorides (mg/L)	Min.	2.1	-	-	39.6	**250**	**0.67**
	Max.	12.0	3.7	5.1	41.8		
	Avg.	7.1	-	-	40.7		
Sulfate (mg/L)	Min.	0.7	-	-	12.6	**250**	**0.5**
	Max.	4.0	7.3	4.8	13.0		
	Avg.	2.4	-	-	12.8		
Nitrate as Nitrogen (mg/L)	Min.	< MDL	-	-	2.1	**10**	**0.1**
	Max.	< MDL	< MDL	< MDL	2.9		
	Avg.	< MDL	-	-	2.5		

Notes:
See Figure 5-1 for monitoring locations.
HY = Peconic River headwaters, on site, east of Wm Floyd Pkwy
HQ = Peconic River on-site at east boundary
HM-S = Peconic River tributary at east firebreak
HH = Carmans River control location, off-site
MDL = minimum detection limit
NYSDEC = New York State Department of Environmental Conservation
SNS = effluent standard not specified
- = only one sample taken due to dry conditions

Table 5-7. Metals Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (2024).

Metal		Peconic River Locations						Carmans River HH (Control)		NYSDEC AWQS (a)	Typical MDL
		HY		HM-S		HQ					
Total (T) or Dissolved (D)		T	D	T	D	T	D	T	D		
No. of Samples		2	2	1	1	1	1	2	2		
Ag Silver (µg/L)	Min.	< 1	< 1	-	-	-	-	< 1	< 1	**0.1**	**1**
	Max.	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1		
	Avg.	< 1	< 1	-	-	-	-	< 1	< 1		
Al Aluminum (µg/L)	Min.	370	26	-	-	-	-	< 15	< 15	**100**	**15**
	Max.	390	340	540	350	239	249	< 15	< 15		
	Avg.	380	183	-	-	-	-	< 15	< 15		
As Arsenic (µg/L)	Min.	2	< 2	-	-	-	-	< 2	< 2	**150**	**2**
	Max.	3.3	< 2	< 2	< 2	< 2	< 2	< 2	< 2		
	Avg.	2.7	< 2	-	-	-	-	< 2	< 2		
Ba Barium (µg/L)	Min.	7.4	4	-	-	-	-	38.4	35.2	**SNS**	**1**
	Max.	12	7.7	6.8	7.7	6.9	7.2	43.4	42.2		
	Avg.	9.7	5.9	-	-	-	-	40.9	38.7		
Be Beryllium (µg/L)	Min.	< 1	< 1	-	-	-	-	< 1	< 1	**11**	**1**
	Max.	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1		
	Avg.	< 1	< 1	-	-	-	-	< 1	< 1		
Cd Cadmium (µg/L)	Min.	< 1	< 1	-	-	-	-	< 1	< 1	**1.1**	**1**
	Max.	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1		
	Avg.	< 1	< 1	-	-	-	-	< 1	< 1		
Co Cobalt (µg/L)	Min.	< 2.5	< 2.5	-	-	-	-	< 2.5	< 2.5	**5**	**2.5**
	Max.	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5		
	Avg.	< 2.5	< 2.5	-	-	-	-	< 2.5	< 2.5		
Cr Chromium (µg/L)	Min.	< 1.5	< 1.5	-	-	-	-	< 1.5	< 1.5	**34**	**1.5**
	Max.	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5		
	Avg.	< 1.5	< 1.5	-	-	-	-	< 1.5	< 1.5		
Cu Copper (µg/L)	Min.	1.8	1.9	-	-	-	-	< 5	< 5	**4**	**5**
	Max.	4.1	3.7	1.1	1.9	6.32	5.6	< 5	< 5		
	Avg.	3.0	2.8	-	-	-	-	< 5	< 5		
Fe Iron (µg/L)	Min.	0.2	< 0.2	-	-	-	-	0.2	< 0.2	**0.3**	**0.2**
	Max.	0.6	< 0.2	< 0.2	< 0.2	0.5	0.05	0.3	< 0.2		
	Avg.	0.4	< 0.2	-	-	-	-	0.2	< 0.2		
Hg Mercury (µg/L)	Min.	< 0.2	< 0.2	-	-	-	-	< 0.2	< 0.2	**0.2**	**0.2**
	Max.	< 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		

(continued on next page)

Table 5-7. Metals Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (2024) *(concluded)*.

Metal		Peconic River Locations						Carmans River HH (Control)		NYSDEC AWQS (a)	Typical MDL
		HY		HM-S		HQ					
Total (T) or Dissolved (D)		T	D	T	D	T	D	T	D		
No. of Samples		2	2	Dry	Dry	Dry	Dry	2	2		
Mn Manganese (µg/L)	Min.	12	< 1.5	-	-	-	-	50.4	41.3	**SNS**	**1.5**
	Max.	42	43	18	47	24.9	26.6	58	61.4		
	Avg.	27	23	-	-	-	-	54.2	51.4		
Na Sodium (mg/L)	Min.	4.1	2.7	-	-	-	-	25.6	24.8	**SNS**	**0.1**
	Max.	6.2	6.5	2.2	7	4.7	5.29	25.9	25.4		
	Avg.	5.2	4.6	-	-	-	-	25.8	25.1		
Ni Nickel (µg/L)	Min.	< 10	< 10	-	-	-	-	< 10	< 10	**23**	**10**
	Max.	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10		
	Avg.	< 10	< 10	-	-	-	-	< 10	< 10		
Pb Lead (µg/L)	Min.	1.6	< 0.5	-	-	-	-	< 0.5	< 0.5	**0.1**	**0.5**
	Max.	2.6	1.4	1.2	1.8	< 0.5	< 0.5	< 0.5	< 0.5		
	Avg.	1.8	1.2	-	-	-	-	< 0.5	< 0.5		
Sb Antimony (µg/L)	Min.	< 3.5	< 3.5	-	-	-	-	< 3.5	3.8	**SNS**	**3.5**
	Max.	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5	3.7	4.4		
	Avg.	< 3.5	< 3.5	-	-	-	-	3.6	4.1		
Se Selenium (µg/L)	Min.	< 1.5	< 1.5	-	-	-	-	< 1.5	< 1.5	**4.6**	**1.5**
	Max.	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5		
	Avg.	< 1.5	< 1.5	-	-	-	-	< 1.5	< 1.5		
Tl Thallium (µg/L)	Min.	< 0.6	< 0.6	-	-	-	-	< 0.6	< 0.6	**8**	**0.6**
	Max.	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6		
	Avg.	< 0.6	< 0.6	-	-	-	-	< 0.6	< 0.6		
V Vanadium (µg/L)	Min.	< 2	< 2	-	-	-	-	< 2	< 2	**14**	**2**
	Max.	2.4	< 2	< 2	< 2	< 2	< 2	< 2	< 2		
	Avg.	2.2	< 2	-	-	-	-	< 2	< 2		
Zn Zinc (µg/L)	Min.	11	*	-	-	-	-	< 10	< 10	**37**	**10**
	Max.	31	*	< 10	< 10	< 10	< 10	< 10	< 10		
	Avg.	20.5	*	-	-	-	-	< 10	< 10		

Notes:
See Figure 5-1 sampling station locations.
AWQS = Ambient Water Quality Standards
MDL = minimum detection limit
SNS = effluent standard not specified for these elements in Class C surface waters
(a) NYS AWQS for Class C surface waters
- = only one sample taken due to dry conditions
* = sample taken but not usable

References and Bibliography

BNL. 2025. Standards Based Management System Subject Area: Liquid Effluents. Brookhaven National Laboratory, Upton, NY. January 2025.

NYCRR Part 703.6. Title 6. 2023 Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations. New York State Department of Environmental Conservation. Albany, NY

Zeke's Pond within the Upton Ecological Research Reserve at BNL.

Children participating in Take Your Children to Work Day hosted by the Office of Educational Programs.

Chapter 6

Natural and Cultural Resources

The Brookhaven National Laboratory (BNL) Natural Resource Management Program (NRMP) 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 maintaining compliance with applicable regulations. The goals of the program include protecting, monitoring, and, where possible, restoring the ecosystems, conducting research, and communicating with personnel and the public on ecological issues. BNL focuses on protecting both Federal and 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 the program. In 2024, deer, vegetation, and soil sampling results were consistent with previous years' results. The program is described in the Natural Resource Management Plan (BNL 2021).

The overriding goal of the Cultural Resource Management Program is to ensure that proper stewardship of BNL 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 for research and interpretation. The Cultural Resource Management Plan (CRMP) (BNL 2023) was updated in 2023 and reporting in this chapter fulfills reporting requirements specified in the CRMP.

6.1
Natural Resource Management Program (NRMP)

The NRMP at BNL promotes stewardship of the natural resources found at the Laboratory and integrates natural resource management and protection with BNL's scientific mission. The NRMP describes the program strategy, elements, and planned activities for managing the various natural resources found on-site. The NRMP is updated every five years, with the most recent update completed in 2021 (BNL 2021).

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.

Mapping associated with tracking impacts from the operation of the Long Island Solar Farm (LISF) at BNL continues to use GPS and GIS as tools to analyze changes to wildlife populations and vegetation. The Lab also has a contract with an aerial imaging service that provides high-definition images that are updated three times each year. This service allows tracking of visually evident changes in vegetation, hydroperiod, and infrastructure. The service includes aerial imagery dating back to 2014.

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the BNL site. Through implementation of the NRMP, endangered and threatened species, as well as 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 (see Table 6-1). New York State endangered animal species confirmed as currently inhabiting Laboratory property include the eastern tiger salamander (*Ambystoma t. tigrinum*) and the peregrine falcon (*Falco peregrinus*).

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

Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need			
Common Name	***Scientific Name***	**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	Likely
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
Pine barrens zanclognatha	*Zanclognatha martha*	SGCN	Confirmed
Black-bordered lemon moth	*Marimatha nigrofimbria*	SGCN	Confirmed
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
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	*Setophaga discolor*	SGCN	Confirmed
Perigrine Falcon	*Falco peregrinus*	E	Confirmed
Bald Eagle	*Haliaeetus leucocephalus*	T	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

(continued on next page)

Endangered plants that have been confirmed on the BNL site include Engelman spikerush (*Eleocharis engelmannii*), Ipecac spurge (*Euphorbia ipecacuanhae*), and dwarf huckleberry (*Gaylussacia bigeloviana*). Five other New York State endangered species have been identified at BNL in the past or are possibly present including: Persius duskywing (*Erynnis p. persius*), crested fringed orchid (*Plantathera cristata*), prostrate knotweed (*Polygonum aviculare ssp. buxiforme*), bracken fern (*Pteridium alquilinum var. pseudocaudatum*), and possum haw (*Viburnum nudum var. nudum*). Eight threatened species in New York State have been positively identified on-site and three other species are considered likely to be present. Threatened species include: two fish (banded sunfish [*Enneacanthus obesus*] and swamp darter (*Etheostoma fusiforme*); three plants (stiffleaved goldenrod (*Oligoneuron rigida*), stargrass (*Aletris farinosa*), and eastern showy aster (*Eurybia spectabilis*); the northern harrier (*Circus cyaneus*) is periodically seen in the fall; and the bald eagle (*Haliaeetus leucocephalus*) is routinely seen visiting the site. Insects listed as threatened include the Pine Barrens bluet (*Enallagma recurvatum*), a damselfly, which was confirmed at one of the many coastal plain ponds located on-site. Two other 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 historically present on-site due to its preferred habitat and host plant, wild lupine (*Lupinus perennis*); however, little lupine remains, and it is therefore unlikely this species can be found on-site. 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. BNL has one federally

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

Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need			
Common Name	***Scientific Name***	**Status**	**BNL Status**
Mammals			
Northern long-eared bat*	*Myotis septentrionalis*	FE	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
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
Ipecac spurge	*Euphorbia ipecacuanhae*	E	Confirmed
Eastern showy aster	*Eurybia spectabilis*	T	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 orchid	*Platanthera lacera*	V	Confirmed
Prostate knotweed	*Polygonum aviculare ssp. buxiforme*	E	Possible
Bracken fern	*Pteridium alquilinum var. pseudocaudatum*	E	Possible
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
Possum haw	*Viburnum nudum var. nudum*	E	Possible
Virginia chain-fern	*Woodwardia virginica*	V	Confirmed

Notes: Information based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data.
E = endangered, T = threatened, SC = species of special concern, R = rare, V = exploitably vulnerable, SGCN = species of greatest conservation need, FT = federally threatened, FE = federally endangered, *NLEB up-listed to federally endangered 03/31/23

endangered species, the northern long-eared bat (*Myotis septentrionalis*), that has historically been found within the forests of the Lab.

6.1.2 Habitat Protection and Enhancement

BNL has administrative processes in place to protect on-site habitats and natural resources. Activities to eliminate or minimize negative effects on endangered, threatened, or sensitive species are either incorporated into Laboratory procedures or into specific programs or project plans. Human access to critical habitats, when necessary, is limited, and habitats are enhanced to improve survival or increase populations. Routine activities, such as road maintenance, are not performed until the planned activities have been evaluated and determined to be unlikely to affect habitat.

Efforts are being made to restore on-site pine barrens through the use of prescribed fire and mechanical treatments. Sixty-nine acres have been mechanically treated and twenty-six acres burned in the northern portion of the Lab through 2024 in preparation for prescribed fire. Due to limitations in the number of suitable burn days and trained resources, it is difficult to burn at a large scale so areas adjacent to communities are prioritized as fuels mitigation can benefit the overall ecosystem and the wildlife that depend on it. One prescribed burn was attempted in 2024 but had to be shut down due to control issues and only 3.5 acres were burned.

6.1.2.1 Salamander Protection Efforts

Many safeguards are in place to protect eastern tiger salamander breeding areas. BNL natural resource staff must review any project planned near eastern tiger salamander habitats

and every effort is made to minimize impacts. A map of the breeding areas is reviewed when new projects are proposed. The current map incorporates buffer areas around tiger salamander habitats of 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. Water quality testing is conducted as part of the routine monitoring of recharge basins, as discussed in Chapter 5. In cooperation with the NYSDEC, habitat surveys have been routinely conducted since 1999. Biologists conducting egg mass and larval surveys have confirmed that 26 on-site ponds are used by eastern tiger salamanders. Significant winter rains in December 2023 resulted in several ponds holding enough water to trigger salamander movements. Egg mass surveys for winter 2023-2024 were conducted in January and a total of 88 egg masses were documented in seven ponds. Other ponds were covered in ice or had insufficient water.

6.1.2.2 Banded Sunfish

Banded sunfish protection efforts include observing whether adequate water is present within areas currently identified as sunfish habitat, ensuring that vegetation in their habitat is not disturbed, and evaluating all activities taking place in ponds and the Peconic River on-site for potential impacts on these habitats. Drought conditions that lasted from 2015 through fall of 2023 likely resulted in the extirpation of the banded sunfish from the BNL site. The single known habitat held water throughout 2018 and by 2019 the pond had completely dried. A short survey by NYSDEC personnel in 2019 did not find sunfish in the pond. No additional effort has been made regionally with regard to the banded sunfish in 2024.

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.

In 2024, monthly surveys were conducted starting at the end of April and extending through the end of August. These surveys identified 74 bird species which fell short of the 81 species identified in 2023. A total of 138 bird species have been identified in surveys in the past 25 years. Variations in the number and species identified during each survey may reflect the time of observation, variations in weather patterns between years, experience level and number of survey personnel, and possible changes in the environment.

The three most diverse transects on-site are by the LISF, the Peconic River, and through the eastern forested portion of the BNL property. The transects passing through the various forest types on-site (e.g., white pine, pine oak forest, and red maple-mesic heath forest) showed a less diverse bird community. Bird survey data are stored in an electronic database for future reference and study. Little data on the effects of a large, utility scale solar array such as the LISF are present within scientific literature. To assess the effects of the LISF on local bird populations, the collection of migratory bird data in both the Biology Field and Solar Farm transects is important. The LISF vegetation and the way it is managed may play a key role as habitat for migratory birds. The eastern bluebird (*Sialia sialis*) has been identified as a declining species of migratory birds in North America. This is due to loss of habitat and 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 60 nest boxes around open grassland areas on-site to enhance their population. The LISF created nearly 200 acres of suitable habitat for the eastern blue bird. Forty boxes were installed around the northern-most portions of the LISF and are routinely used by bluebirds, house wrens, and tree swallows. Bluebirds have also benefited from natural nesting habitat resulting from the 2012 wildland fire that led to significant tree mortality. Bluebirds have been documented annually within the burned area since 2019.

Migratory birds occasionally cause safety and health concerns, particularly Canada geese (*Branta canadensis*) and several species of migratory birds that occasionally nest on buildings or in construction areas on-site. To control the goose population, the Laboratory manages nesting through egg oiling under an annual permit from the U.S. Fish & Wildlife Service. The population was estimated at approximately 60 birds in spring 2024 going into nesting season; however, a number of nests were missed in 2024 due to some limitations in staffing resulting in an increase in the population totals at the end of 2024.

6.1.2.4 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) has been increasing in population locally with more than a dozen known nest sites on Long Island. In 2024, bald eagles continued to be sighted in the area of the Sewage Treatment Plant (STP), the cell tower, near the National Weather Service offices, and other areas around the site. As the eagle population increases on Long Island, the potential for them to nest on the BNL site will increase as well.

6.1.2.5 Northern Long-eared Bat

As discussed in Section 6.1.1, the northern long-eared bat was federally listed as endangered in 2023. The activities most likely to impact this bat on the BNL site are building demolitions, any project involving tree clearing, and forest management activities such as prescribed fires, mechanical treatments, and forest thinning. Inspections for the presence of bats in buildings are typically conducted via visual surveys approximately 24 hours prior to demolition to verify the absence of bats.

In 2024, three buildings were demolished, and no bats were found prior to demolition. Four projects required formal consultation with the U.S. Fish & Wildlife Service because they involved tree removal and resulted in the issuance of a Biological Opinion and Statement of Incidental Take. One prescribed fire was attempted in 2024 but shut down due to control issues. Approximately 3.5 acres were burned. In addition, 23 acres were mechanically treated during the dormant season.

Five nights of mist netting were conducted during July 2024 in the areas where forest management is being conducted. No northern long-eared bats were captured. Acoustic surveys conducted around the Lab site also did not yield any northern long-eared bat detections. The need to continue bat monitoring will likely increase in the future as the little brown bat (*Myotis lucifugus*) and tri-colored bat (*Perimyotis subflavus*) have also been petitioned for listing.

6.1.3 Population Management

6.1.3.1 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 not permitted at the Laboratory, there are no significant pressures on the population to migrate beyond their typical home range of approximately one 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 BNL property under optimal 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 routine population surveys of white-tailed deer since 2000.

4-poster™ tick management system.

Deer overpopulation can affect animal and human health (e.g., animal starvation, Lyme disease from deer ticks, and collision injuries to both humans and animals), species diversity (e.g., songbird species reduction due to selective grazing and destruction of habitat by deer), and property damage (e.g., collision damage to autos and browsing damage to ornamental plantings). Deer-related collisions on-site continued to be low in 2024, presumably due to deer management which, in addition to decreasing numbers, has also made deer more wary of humans causing them to avoid the central campus area more. High deer populations are a regional problem, and the Laboratory is just one area on Long Island with such an issue. Multiple east end towns are now managing deer populations either through culls (also known as deer harvests), hunting, or sterilization programs. Under BNL's permit for deployment of the 4-Poster™ tick management system issued by NYSDEC, the Laboratory is required to implement a deer management program. BNL has been implementing deer management since 2015 and conducting herd reductions annually since 2019.

In 2024, the herd was estimated at approximately 350 individuals at the beginning of the year and a cull was planned for two separate weekends in February and March 2024. A total of 123 animals were taken, which effectively brought the population to approximately 227 animals and succeeded in meeting the reduction goals of getting below 250 deer. With a reproductive rate at approximately 50%, however, the population at the end of 2024 was expected to be back up to nearly 350 individuals.

6.1.4 Compliance Assurance and Potential Impact Assessment

The National Environmental Policy Act (NEPA) review process at BNL ensures that environmental impacts of a proposed action or activity are adequately evaluated and addressed. The Laboratory uses NEPA reviews when identifying potential environmental impacts associated with site activities, especially projects that may result in physical alterations to the landscape and structures. As appropriate, stakeholders such as the Environmental Protection Agency (EPA), NYSDEC, Suffolk County Department of Health Services (SCDHS), and BNL's Community Advisory Council (CAC) 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. An Environmental Assessment for the proposed modification of Building 870 to create the Clinical Alpha-Radionuclide Production facility was completed in 2024. See Chapter 3, Section 3.3 for more information.

6.2 Upton Ecological and Research Reserve

The Upton Ecological and Research Reserve (Upton Reserve) consists of 530 acres located on the eastern boundary of the BNL site. The reserve has been designated as an area for the protection of sensitive habitats and a place where researchers can study local ecosystems. The Upton Reserve 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). The Upton Reserve is managed by BNL which also coordinates research projects that occur within the reserve and the larger Pine Barrens. After successfully establishing a Memorandum of

Understanding (MOU) with the State University of New York's School of Environmental Science and Forestry (SUNY-ESF), efforts to revisit the 2005-2006 forest health monitoring program resulted in the completion of monitoring during summer 2020 (see education programs below). The MOU with SUNY-ESF allows for greater levels of research within the Central Pine Barrens and the Upton Reserve. In 2023, a PhD student working with the Department of Sustainable Resources Management at SUNY-ESF began collecting data looking at the effects of fire on tick populations which is expected to continue through 2025.

Samuel Gilvarg, a graduate student from the State University of New York's College of Environmental Science and Forestry (SUNY ESF), holding an ethanol vial containing a tick specimen.

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. Because soil contaminated with a radioactive isotope of cesium (Cs-137) was mistakenly used in some BNL landscaping projects in the past, traces of Cs-137 attributable to past practices and worldwide fallout from above-ground nuclear bomb testing can be found in deer and other animals and plants. At the cellular level, Cs-137 takes the place of potassium (K), an essential nutrient. Most tables in this chapter listing Cs-137 also list analytical results for potassium-40 (K-40), a naturally occurring radioisotope of potassium that is commonly found in flora and fauna. Studies indicate that Cs-137 out-competes potassium when potassium salts are limited in the environment, which is typical on Long Island. Including K-40 in tables allows for a comparison with Cs-137 levels and is used, in part, to determine the accuracy of analytical results. The results of the annual sampling conducted under the flora and fauna monitoring program are described in the following sections.

6.3.1 Deer Sampling

White-tailed deer in New York State are typically large, with males weighing on average approximately 150 pounds; females typically weigh approximately 100 pounds. However, white-tailed deer on Long Island tend to be much smaller, weighing an average of 80 pounds. The meat available for consumption from local deer ranges from 20 to 40 pounds per animal. Samples of meat and liver are taken from each deer, when possible, and are analyzed for Cs-137. Data are reported on a wet-weight basis, as that is the form most likely used for consumption.

Since 1996, BNL has routinely collected deer samples from on- and off-site areas. Most off-site samples are the result of car/deer accidents. The number of samples obtained each year varies depending on accidents between vehicles and deer and people reporting dead deer available for retrieval. In 2024, a total of 15 deer were taken both on and off the BNL site. Figure 6-1 shows the location of all deer samples taken within a five-mile radius of the Laboratory between 2019 and 2024. Most of the off-site samples are concentrated along Route 25 just north of BNL, whereas historically most on-site samples are collected near the Laboratory's main entrance gate and the developed portions of the site. The distribution of deer samples on-site is becoming more uniform across the site due to obtaining samples during annual deer population reduction efforts. Historically, samples tended to be from near the front gate due to collisions with cars entering or leaving the site. Based on more than two decades of sampling, deer taken from more than one mile from BNL are used for comparison with populations on and near the Laboratory that could acquire Cs-137 from a BNL source.

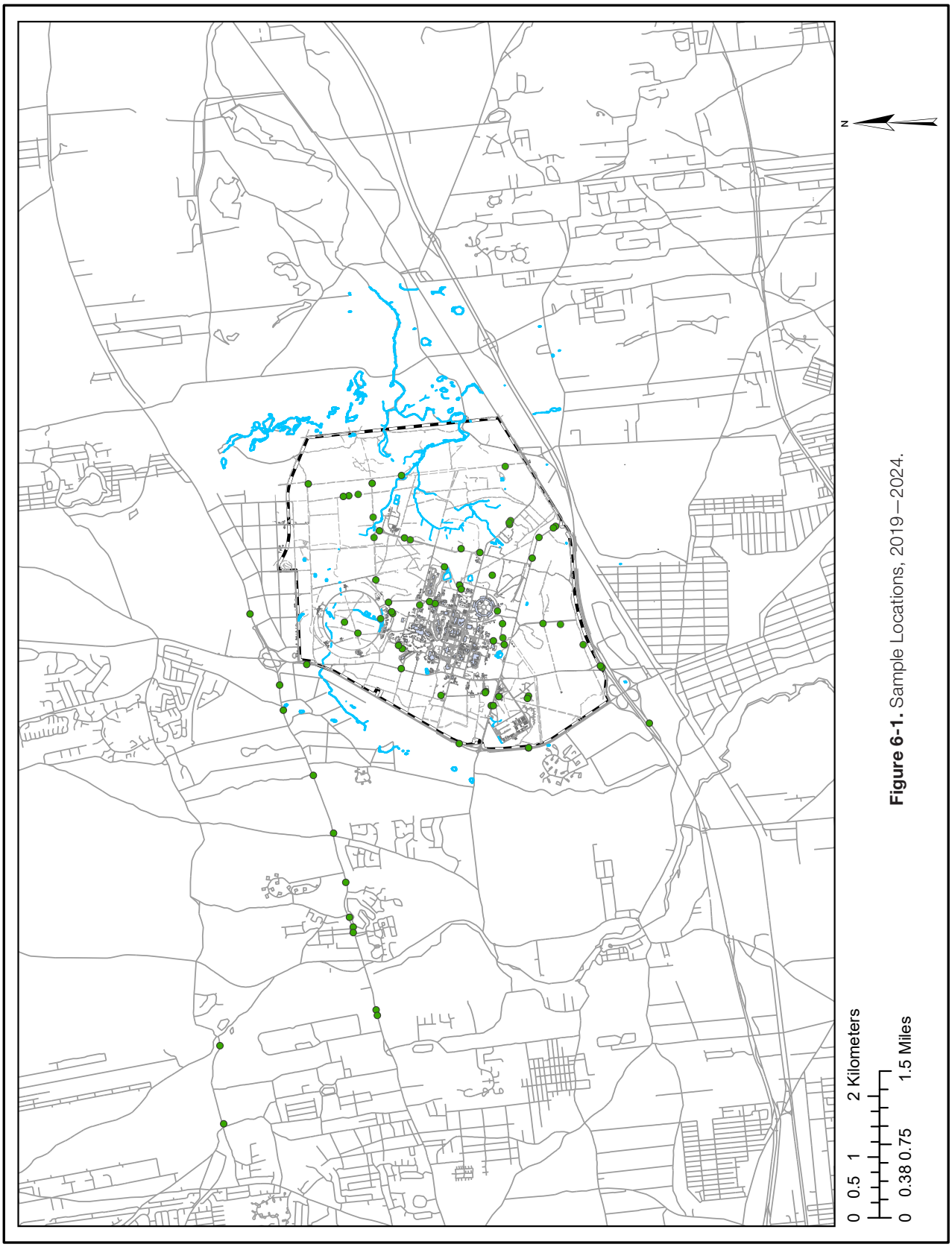


Figure 6-1. Sample Locations, 2019—2024.

In 2024, thirteen deer were obtained on-site, of which twelve were sampled as part of deer management efforts; there were no deer taken from off-site less than a mile from BNL, and two deer were taken greater than a mile from BNL. The two off-site deer and one of the on-site deer were due to deer/vehicle collisions. The analytical results of deer sampling are shown in Table 6-2. The samples taken as part of deer population reductions serve a dual purpose to provide data for surveillance and to determine the safe release of meat for consumption. During deer culling activities, every tenth deer taken is sampled for Cs-137 content in both meat and liver.

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 one mile off-site. This is most likely because the deer graze on vegetation growing in soil where elevated Cs-137 levels are known to exist. Cs-137 in soil can be transferred to above-ground plant matter via root uptake, where it then becomes available to browsing and grazing animals or is consumed directly with soil while the animal is grazing. Remediation of contaminated soil areas on-site occurred under the Laboratory's Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) program, with all major areas of contaminated soil being remediated by September 2005.

In 2024, Cs-137 concentrations in deer meat samples were obtained from 13 deer on-site with a range of values from 0.07 pCi/g to 0.42 pCi/g, wet weight, and an arithmetic average of 0.22 pCi/g, wet weight, as shown in Table 6-2. 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 2024 (0.42 pCi/g, wet weight) was twice that of the highest on-site sample reported in 2023 (0.21 pCi/g, wet weight) and 28 times lower than the highest level ever reported in 1996 (11.74 pCi/g, wet weight). Higher values in deer are usually seen during the fall months immediately after plants stop growing and uptake ceases. By January, Cesium has usually been excreted.

Cs-137 concentrations in off-site deer meat samples are typically separated into two groups: samples taken within one mile of BNL and samples taken farther away (two samples in 2024) shown in Table 6-2, however no samples were collected within one mile of the Lab in 2024. Deer taken greater than one mile from the Lab were all non-detect for Cs-137.

Deer visiting a 4-poster™ device.

Table 6-2. Radiological Analysis of Deer Tissue (2024).

Location	Date	Distance Miles	Organ	K-40 pCi/g (wet)±95% C.I.	Cs-137 pCi/g (wet)±95% C.I.
BNL					
BNL Cull Sample 1 - Weaver Rd.	2/23/24	0	tissue	2.78±0.57	0.25±0.04
			liver	3.86±0.56	0.09±0.04
BNL Cull Sample 2 - East Margin Path	2/24/24	0	tissue	3.28±0.50	0.37±0.04
			liver	1.95±0.20	0.08±0.01
BNL Cull Sample 3 - Former Haz Waste Facility	2/24/24	0	tissue	2.94±0.57	0.31±0.04
			liver	3.02±0.22	0.09±0.01
BNL Cull Sample 4 - First St., south of STP	2/25/24	0	tissue	2.57±0.56	0.18±0.04
			liver	1.90±0.16	0.04±0.01
BNL Cull Sample 5 - Fawn Path	2/25/24	0	tissue	3.12±0.46	0.32±0.04
			liver	2.63±0.17	0.09±0.01
BNL Cull Sample 6 - East Fifth Ave.	2/26/24	0	tissue	3.29±0.62	0.20±0.04
			liver	2.62±0.17	0.04±0.01
BNL Cull Sample 7 - Former Haz Waste Facility	3/15/24	0	tissue	3.07±0.37	0.07±0.02
			liver	2.26±0.19	0.02±0.01
BNL Cull Sample 8 - South Boundary Rd.	3/16/24	0	tissue	3.56±0.38	0.22±0.03
			liver	2.4±0.11	0.05±0.01
BNL Cull Sample 9 - Forest Path	3/16/24	0	tissue	2.76±0.34	0.10±0.03
			liver	2.13±0.10	0.03±0.01
BNL Cull Sample 10 - Center of RHIC	3/17/24	0	tissue	2.55±0.57	0.16±0.04
			liver	1.80±0.11	0.03±0.00
BNL Cull Sample 11 - East Fire Break	3/18/24	0	tissue	2.6±0.57	0.42±0.05
			liver	2.73±0.25	0.13±0.01
BNL Cull Sample 12 - Forest Path	3/18/24	0	tissue	3.05±0.42	0.13±0.03
			liver	2.39±0.25	0.03±0.01
Renaissance Rd North of Rochester Ave.	6/14/24	0	tissue	3.12±0.61	0.07±0.04
			liver	2.15±0.16	0.03±0.01
< 1 Mile from BNL					
No samples taken				NA	NA
> 1 Mile from BNL					
West End of Artist Lake on Rt. 25	5/3/24	> 1 mile	tissue	3.30±0.37	ND
			liver	2.11±0.36	ND
Whiskey Rd. east of Coram Sweezeytown Rd.	12/4/24	> 1 mile	tissue	2.54±0.22	ND
			liver	2.36±0.20	ND
Tissue Averages					
All Samples (15)				2.97±0.48	0.19±0.03
BNL Average (13)				2.98±0.50	0.22±0.04
< 1 Mile Average (0)				NA	NA
> 1 Mile Average (2)				2.92±0.30	0.00±0.01
Cull Average (12)				2.96±0.49	0.23±0.04
Liver Averages					
All Samples (15)				2.42±0.21	0.05±0.01
BNL Average (13)				2.45±0.20	0.06±0.01
< 1 Mile Average (0)				NA	NA
> 1 Mile Average (2)				2.24±0.28	0.01±0.01
Cull Average (12)				2.24±0.21	0.06±0.01

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 with confidence limits using a 2 sigma (95%) propogated error.
ND=non-detect

Figure 6-2 compares the average values of Cs-137 concentrations in meat samples collected in 2024 from on-site, within one mile, combined on-site and within one mile, greater than one mile, and deer taken from culling. Figure 6-3 presents the ten-year trend of on-site and near off-site Cs-137 averages in deer meat. The 2024 average (0.19 pCi/g) is slightly higher than the 2023 value of 0.09 pCi/g, wet weight, and is significantly lower than the ten-year average. The higher averages shown for 2017 and 2018 are reflective of a significant number of samples taken in the fall when Cs-137 levels are typically higher. These sample results continue to indicate the effectiveness of cleanup actions across the Laboratory, with the overall trend being downward from 2014 to 2024, and the ten-year average being 0.41 pCi/g.

The effectiveness of the BNL soil cleanup program and the reduction of Cs-137 in deer meat was evaluated by Rispoli, et al. (2014). The average Cs-137 content was shown to be statistically lower than before cleanup. Samples taken at distances greater than one mile from the BNL site were shown to remain consistent before and after cleanup, while the on-site and near off-site values were shown to decline. In 2017, while preparing for monitoring associated with the reduction of the deer population, the 10-year average for on-site deer samples was calculated to be 1.0 pCi/g, wet weight, and this value was used to establish an administrative release criterion for deer meat made available for donation. When possible, liver samples are taken concurrently with meat samples. The 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 2024, Cs-137 concentrations ranged from 0.02 to 0.13 pCi/g, wet weight, with an average of 0.06 pCi/g, wet weight. Cs-137 concentrations in liver samples taken from deer greater than one mile from site were determined to be non-detect. 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 risks associated with elevated Cs-137 levels in on-site deer and determined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999).

As mentioned above, BNL has established an administrative release criterion of 1.0 pCi/g, wet weight, for meat from deer removed from the Laboratory and donated for consumption. A total of 123 deer were taken during population reductions in 2024. Meat samples were obtained from every tenth deer. Samples were sent for analysis and are included in Table 6-2.

The results ranged from 0.07 to 0.42 pCi/g, wet weight, with the arithmetic average being 0.23 pCi/g, wet weight. Since all samples were well below the 1.0 pCi/g, wet weight administrative limit, all 2,623 pounds of meat were donated to Island Harvest Food Pantry and to a local wildlife rehabilitator. 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 three millirad per day, which is only 3% of the IAEA threshold. The deer observed and sampled on-site appear to have no health effects from the level of Cs-137 found in their tissues.

Figure 6-2. Comparison of Cs-137 average values in deer flesh for on-site, near off-site, on-site + near off-site, off-site greater than 1 mile from the Laboratory, and from deer population reductions (cull). Ten-year average of on-site and near off-site deer flesh samples is 0.41 pCi/g, wet weight.

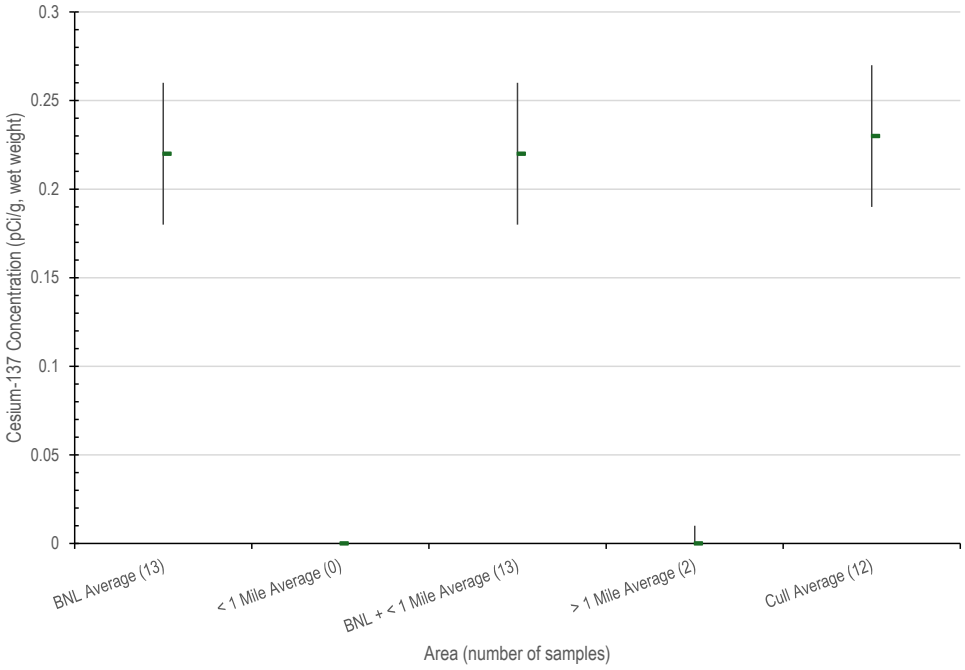
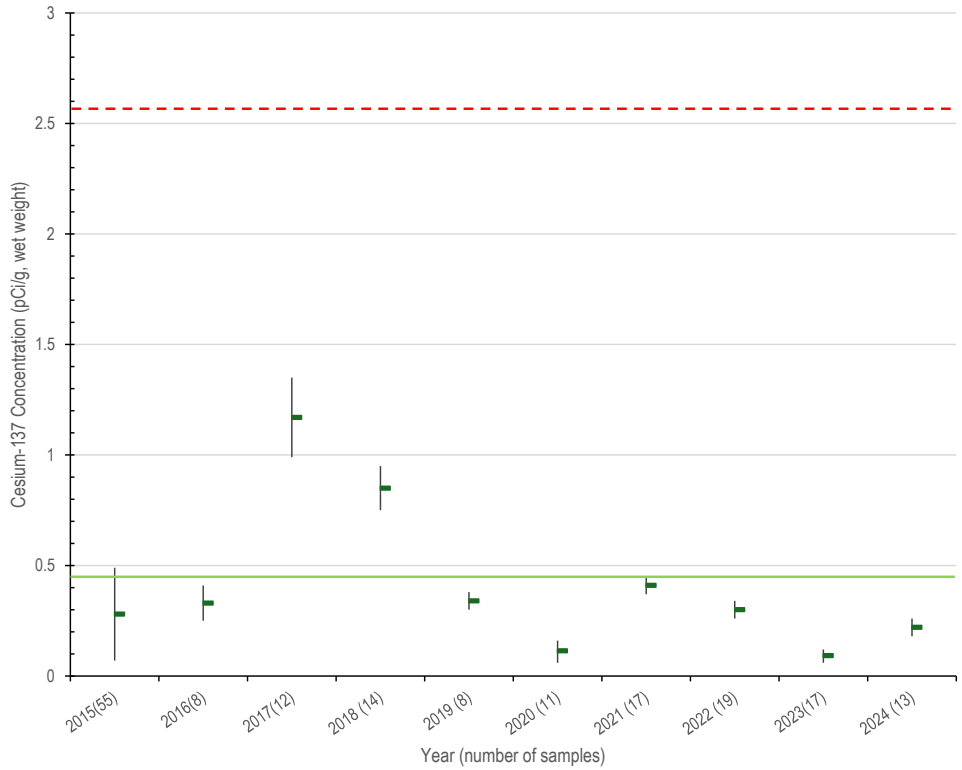


Figure 6-3. Ten-year trend in Cs-137 in deer flesh for samples taken at BNL and within 1 mile of the Laboratory. Average before clean-up (dashed line) 2.57 pCi/g wet weight. Ten-year average (solid line) 0.41 pCi/g wet weight.



6.3.2 Fish Sampling

BNL maintains an ongoing program for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. Fish are only sampled under the surveillance program when there is enough water to support a sufficient population of fish that can be sampled without harm to their population and that are of sufficient size for analysis. Based upon the 2021 CERCLA Five-Year Review (BNL 2021a) of the effectiveness of the environmental cleanup and the final supplemental cleanup of a small area within the river during 2017, the Laboratory has discontinued fish monitoring under the CERCLA program. In 2024, the fish population did not support sampling.

6.3.2.1 Fish Population Assessment

The relative sizes of fish caught during 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. The combination of discontinuing STP discharges to the Peconic River and drought conditions results in high variability in the presence of water and flow sufficient enough to reach off-site portions of the river. On-site, water levels have receded, resulting in water being retained only in deeper open water areas. There was no documented off-site flow in 2024. For fish populations to survive and flourish, water levels must be substantial enough to allow migration of fish and maintain their presence for an extended period to replenish populations. As mentioned above, new criteria for the collection of fish samples have been developed. These criteria will guide the environmental monitoring approach for fish in the future. To determine if enough fish are present to support sampling, population assessments are conducted. In 2024, a population assessment was conducted in early June and resulted in no captures of any fish.

6.3.3 Vegetation Sampling

6.3.3.1 Grassy Plants and Soil

Table 6-3. Radiological Analysis of Grassy Vegetation and Associated Soils (2024).

Location/ Matrix	K-40 pCi/g±95% C.I.	Cs-137 pCi/g±95% C.I.
No-mow Area behind Berkner Hall		
Vegetation	4.70±0.79	ND
Soil*	6.03±1.05	0.17±0.06
Between East Saddle & East Margin Paths		
Vegetation	3.03±0.79	0.35±0.07
Soil*	5.40±0.72	0.17±0.04
North of North Fire Break & East Margin Path		
Vegetation	5.19±1.38	ND
Soil	3.53±0.59	0.64±0.08
Z-Path		
Vegetation	3.15±0.80	ND
Soil	3.86±0.83	ND
South Boundary between Upton & Fawn Path		
Vegetation	2.30±0.92	ND
Soil*	6.01±0.70	0.04±0.03
Field North of Bldg. 528		
Vegetation	3.52±0.67	ND
Soil	8.83±0.99	ND
RHIC North Pond		
Vegetation	4.33±0.94	ND
Soil	3.44±0.55	N2
No Mow Area corner of Renaissance & Rutherford		
Vegetation	3.92±0.89	ND
Soil	5.79±1.09	N2
South Boundary Rd. & Powerline Rd.		
Vegetation	4.16±0.93	ND
Soil	7.80±0.92	N2
Wetland South of East Fifth East of First Path		
Vegetation	3.31±0.83	ND
Soil*	5.58±0.93	0.18±0.06
NYSDEC Check Station (Control)		
Vegetation	3.39±0.83	N2
Soil	4.79±0.91	0.05±0.04

Notes: All values are shown with a 95% confidence interval.
Radiological values for soils are on a 'dry weight' basis.
K-40 occurs naturally in the environment and is presented as a comparison to Cs-137.
Cs-137 = cesium-137
K-40 = potassium-40
ND = not detected
N2 = Data qualified as Not Useable, indistinguishable from background.
* = estimated value for Cs-137 based on laboratory qualifiers.

During 2024, grassy vegetation samples were collected from ten locations around the Laboratory (Figure 6-4) and a control location at the NYSDEC hunter check station in Ridge, New York. All samples were analyzed for Cs-137 (see Table 6-3). Nine vegetation samples were undetected or indistinguishable from background

for Cs-137, and the remaining sample had a Cs-137 level of 0.35 pCi/g, dry weight. Five soil samples were undetected or levels of Cs-137 indistinguishable from background. The remaining six samples had Cs-137 levels ranging from 0.04 to 0.64 pCi/g, dry weight. All values were consistent with historic monitoring and knowledge of cleanup areas. Monitoring results for grassy vegetation and soils were utilized for the annual dose to biota analysis reported in Chapter 8.

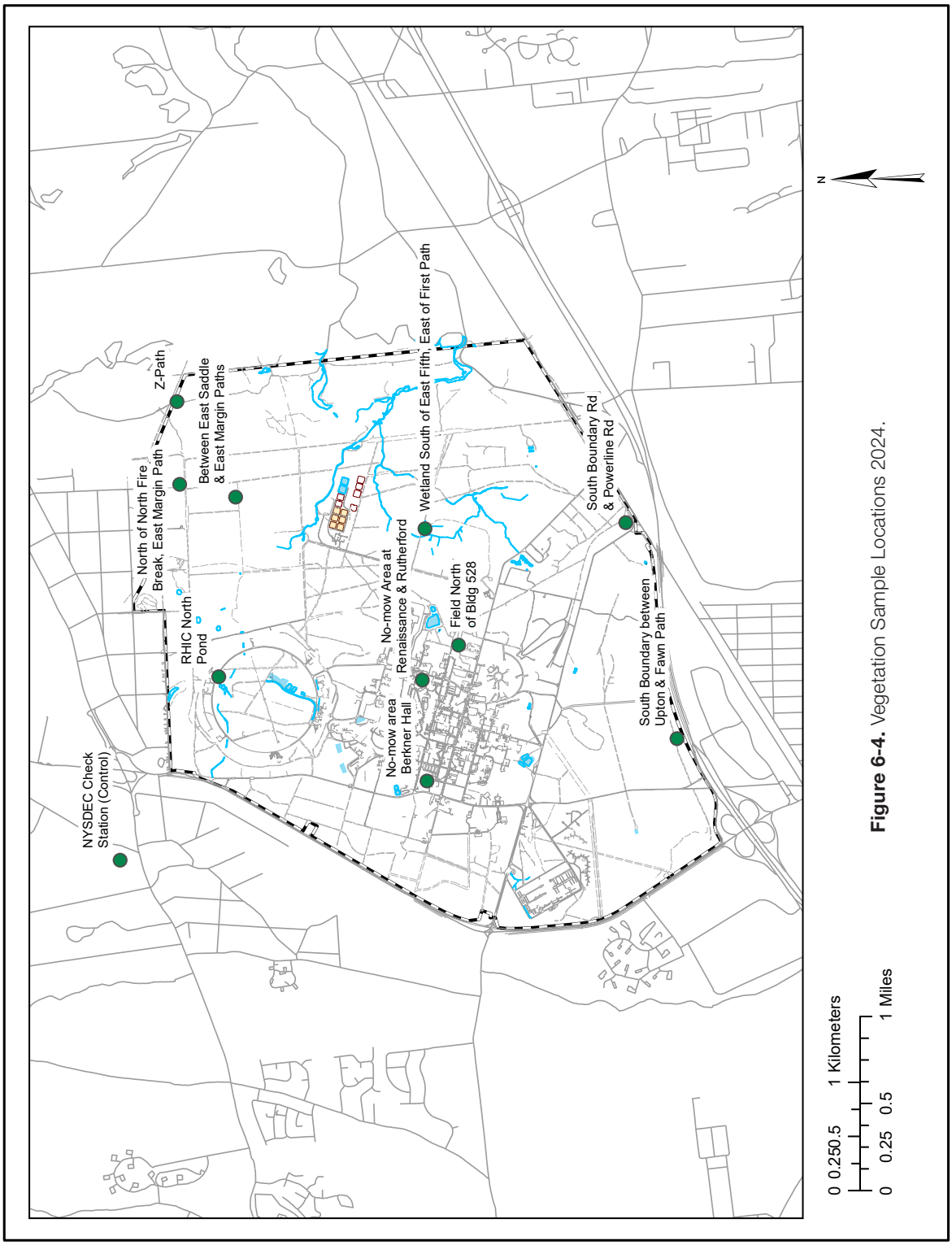


Figure 6-4. Vegetation Sample Locations 2024.

6.4 Other Monitoring

6.4.1 Basin Sediments

A five-year cycle for the collection of recharge basin sediment samples was established in 2003. There are 11 recharge basins that receive water discharges that are permitted under the Laboratory's State Pollutant Discharge Elimination System (SPDES) permit (see Figure 5-3 for outfall locations). The 11 basins were sampled in 2022, and the results were published in the 2022 Site Environmental Report. The next round of basin sediment sampling based on the five-year schedule will occur in 2027.

6.4.2 Precipitation Monitoring for Mercury

During 2024, precipitation samples were collected quarterly at air monitoring Stations P4 and S5 (Figure 4-2 for station locations). The samples were analyzed for total mercury (Table 6-4) using low-level mercury analysis. Mercury concentrations in precipitation have been measured at BNL since 2007. Analysis of mercury in precipitation is conducted to document mercury deposition that is attributable to off-site sources. This information has been used as a comparison to Peconic River monitoring data and aids in understanding the distribution of mercury within the Peconic River watershed. Mercury was detected in all the precipitation samples collected at both sampling stations. Mercury ranged from 3.74 ng/L at station S5 in January 2024 to 13.3 ng/L at station P4 in October 2024. The 13.3 ng/L concentration is three times lower than the highest value of 45.1 ng/L, recorded in 2017.

Table 6-4. Precipitation Monitoring (Mercury).

Location/Period	Mercury ng/L
P4	
1/8/24	4.11
4/3/24	7.03
7/12/24	11
10/9/24	13.3
S5	
1/8/24	3.74
4/3/24	8.61
7/12/24	11
10/9/24	11

Notes: Method detection limit for mercury is 0.2 ng/L.
P4 = precipitation sampler near BNL Apartment area.
S5 = precipitation sampler near BNL Sewage Treatment Plant.

6.5 Educational Programs

BNL sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants gain an understanding of the local ecosystems, foster an interest in science, and provide a meaningful experience for interns in preparation for further studies or a career. Wildlife programs are conducted at the Laboratory in collaboration with the Department of Energy (DOE), local agencies, colleges, and high schools. Ecological research is also conducted on-site to routinely update the natural resource inventory records, improve our understanding of the ecosystem, and guide management planning.

In FY24, eleven undergraduate interns and two graduate interns completed projects during the summer. Projects included bat acoustic monitoring, small mammal trapping, black turpentine beetle activity in pitch pine restoration treatments, fire and insect communities in pine barrens, wildlife camera trapping, and the impacts of fire and forest microclimates on tick populations.

Students trekking through the Long Island Pine Barrens to sample ticks on an experimental plot.

BNL participates in, coordinates, or hosts activities that support ecological education on Long Island. In 2024, the following programs were completed, or involved participation:

- Long Island Natural History Conference
- Open Space Stewardship Symposium (150 students, 40 posters)
- New York Wildfire & Incident Management Academy

The Day in the Life of a River program ran from September 19 to November 1, 2024. The Day in the Life of a River Program is a place-based educational experience where students and teachers collaborate with environmental professionals to collect scientific information capturing a snapshot of the health of the Long Island rivers and creeks. The Day in the Life of a River is a collaboration between the Central Pine Barrens Commission, the NYSDEC, and BNL, and supported by experts from the US Geological Survey, the Town of Brookhaven, Trout Unlimited, New York State Parks, and others. Approximately 2,500 students and teachers across five elementary, and 32 middle and high schools participated in the collection of environmental sample data and conducted real time scientific analyses for 11 rivers across Long Island.

6.6
Cultural Resource Activities

The BNL Cultural Resource Management Program ensures that the Laboratory fully complies with numerous cultural resource regulations. The BNL Cultural Resource Management Plan (CRMP) outlines those regulations and provides guidance for the protection and management of historic and cultural resources (BNL 2023). BNL's cultural resources include 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. The Cultural Resource Management Program ensures that the contributions BNL and the site have made to local and national history and culture are documented and available for interpretation.

In 2024, BNL hired its first full-time Cultural Resources Manager to meet the growing regulatory needs for compliance with the National Historic Preservation Act (NHPA) and for managing the historical collections relating to Camp Upton history and the scientific history at BNL. The cultural resource program purchased 14 new cabinets to support improved storage of scientific items in the collections, and four new museum quality display cases for the exhibition of objects and artifacts. Two of the museum display cases have been installed in the lobby of Berkner Hall and feature artifacts from the Camp Upton Collection.

WWI-era gas mask exhibited in new museum case in Berkner Hall.

Several kiosks were developed for compliance with Memoranda of Agreement (MOA) for the Brookhaven Medical Reactor (BMRR) Stack Removal project, Discovery Park (which included the 1960s Era Apartments Demolition project), and the 1940s Water Tower Demolition project. The kiosks provide historical information and imagery highlighting several aspects of BNL site history, including the WWI and II hospital area, roadways through the Camp Upton property, and medical research that took place at the BMRR and Medical Department. These kiosks are expected to be installed in 2025 around the Science and User Support Center (SUSC) and outside of Building 490. Completion of the artwork for the Water Tower kiosk is pending completion of the painting of the new tower.

Community outreach in 2024 included support for an exhibit and programming at the Bellport-Brookhaven Historical Society. Their 2024 summer exhibit, entitled *The Innovators: Inventors and Scientists of Bellport*, featured the histories of several scientists and inventors of Brookhaven National Laboratory and their families, particularly those that settled in the Bellport-Brookhaven area. BNL supported the exhibit with a loan of historic materials and with a lecture about BNL history entitled *Technology and the Future of Medicine*. In addition, two public-facing presentations were made in 2024 on the history of Camp Upton at the Sayville Library and the Middle Country Library. The Cultural Resource Management Program hosted one intern participating in the Science Undergraduate Laboratory Internship program in the summer of 2024. The undergraduate intern conducted historical research on magnet development for accelerator science at the Cosmotron, the Alternating Gradient Synchrotron (AGS), and the Relativistic Heavy Ion Collider (RHIC).

Inductees, preparing for World War I, train with bayonets at Camp Upton.

References and Bibliography

BNL. 2023. Cultural Resource Management Plan for Brookhaven National Laboratory. BNL-100708-2023. Brookhaven National Laboratory, Upton, NY. April 2023.

BNL. 2021. Natural Resource Management Plan for Brookhaven National Laboratory. BNL-112669-2021. Brookhaven National Laboratory, Upton, NY.

BNL. 2021a. Five-Year Review Report for Brookhaven National Laboratory Superfund Site, April 2021.

Dwyer, Norval. 1966. Brookhaven National Laboratory. Long Island Forum (reprint), West Islip, NY.

IAEA. 1992. Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards. Technical Report Series No. 332. International Atomic Energy Agency, Vienna.

LMS. 1995. Phase II Sitewide Biological Inventory Report, Final. Lawler, Matusky & Skelly Engineers. Pearl River, NY.

NYSDOH. 1999. Deer Meat Contaminated with Cesium-137 at Brookhaven National Laboratory. Bureau of Environmental Radiation Protection, New York State Department of Health, Albany, NY.

Rispoli, Fred J., Green Timothy, Fasano, Thomas A., Shah, Vishal, 2014. The effect of environmental remediation on the cesium-137 levels in white-tailed deer. Environmental Science and Pollution Research Oct. 2014, 21(19):11598-11602.

Intentionally Left Blank

Granular Activated Carbon Filter Vessels at Former Firehouse Per- and Poly-fluoroalkyl Substances (PFAS) Plume Treatment System Building.

Chapter 7

Groundwater Protection

Brookhaven National Laboratory (BNL) implements aggressive pollution prevention measures to protect groundwater resources and uses an extensive groundwater monitoring well network to verify that prevention and restoration activities are effective.

During 2024, BNL collected groundwater samples from 765 permanent monitoring wells and 41 temporary wells. Seven groundwater remediation systems removed 41 pounds of volatile organic compounds (VOCs) and returned approximately 753 million gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation in December 1996, the treatment systems have removed 7,914 pounds of VOCs by treating almost 33 billion gallons of groundwater. BNL started the operation of the Current Firehouse Per- and Poly-fluoroalkyl Substances (PFAS) Remediation System and the Former Firehouse PFAS Remediation System in October 2022 and January 2023, respectively. Since the start of their operations, the systems have removed approximately 1.3 pounds of total PFAS while treating 666 million gallons of groundwater. Also, one groundwater treatment system removed approximately 0.1 millicurie of strontium-90 (Sr-90) while remediating approximately 7 million gallons of groundwater. Since 2003, BNL has removed approximately 34.9 millicuries of Sr-90 from the groundwater while remediating approximately 297 million gallons of groundwater. As a result of the successful operation of these treatment systems, significant reductions in contaminant concentrations have occurred in both on-site and off-site areas.

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 remediation 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 and applicable Executive Orders (EO) and DOE Orders (DOE O). This program also satisfies the monitoring and remediation requirements defined in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Records of Decision (RODs). The program consists of four interconnecting elements: 1) protecting groundwater resources, 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 remediating existing contaminated groundwater. A general description of the site hydrogeology is provided in Chapter 1, Section 1.6. Detailed information on the site's hydrogeology is presented in Site Environmental Report (SER) Volume II, Groundwater Status Report, and in Scorca et al. (1999).

7.1.1 Protection

As part of BNL's Environmental Management System, the Laboratory has implemented several pollution prevention activities that are designed to protect groundwater resources (see Chapter 2, Section 2.4.2). 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, Sections 3.6 through 3.8). 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 remediation 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) (USEPA 1992).

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 Remediation

BNL was added to the National Priorities List in 1989. To help manage the restoration effort, 34 separate Areas of Concern are grouped into 11 Operable Units (OUs). Remedial and/or removal actions have been implemented for each OU. Contaminant sources for VOCs and radionuclides (e.g., contaminated soil and underground storage tanks) have been removed or remediated to prevent further contamination of groundwater. However, BNL continues to conduct groundwater and soil characterization efforts to fully identify the sources and extent of PFAS and 1,4-dioxane contamination. Beginning in late 2022, BNL has been remediating PFAS plumes originating from three former firefighter training locations. All groundwater characterization and remediation work are carried out under the FFA involving the U.S. Environmental Protection Agency (USEPA), the New York State Department of Environmental Conservation (NYSDEC), and DOE (USEPA 1992).

7.1.4 Communication

BNL's Stakeholder & Community Relations Office works with the Groundwater Protection Program to ensure that the Laboratory communicates groundwater protection issues and cleanup progress with its stakeholders in a consistent, timely, and accurate manner. This communications process is described in BNL's Community Involvement Plan (BNL 2024a). Several 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 (see Chapter 2, Section 2.5.2.1). 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 2023) 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 33 years and continues to make progress in achieving its goal of preventing new impacts to groundwater quality and remediating previously contaminated groundwater. The Laboratory will continue efforts to prevent new groundwater impacts and is vigilant in measuring and communicating its performance. During 2024, monitoring conducted at BNL's active research and support facilities did not identify any new impacts to groundwater quality.

Brookhaven Graphite Research Reactor Sr-90 Groundwater Remediation System Ion-Exchange vessels.

7.3 Groundwater Monitoring Programs

BNL maintains an extensive network of groundwater monitoring wells that are located on-site and off-site. During 2024, the Laboratory collected groundwater samples from 765 of the wells to test for various contaminants that may be in the groundwater. Water levels were measured in about 185 of the wells to assess variations in the direction and velocity of groundwater flow. Groundwater flow directions near the Laboratory are shown on Figure 7-1. Elements of the groundwater monitoring program include installing permanent and temporary 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, comply with regulatory permit requirements, monitor active research and support facilities, and 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 aquifers beneath the site are classified as a USEPA Sole Source Aquifer System,

and the groundwater is also classified by New York State as Class GA, which is defined as a source of potable water. As a result of these designations, Federal and New York State drinking water standards (DWS) also referred to as Maximum Contaminant Levels (MCLs), and New York State Ambient Water Quality Standards for Class GA groundwater are used as goals for groundwater protection and remediation. BNL evaluates the potential impact of radiological and non-radiological contamination by comparing analytical results to the regulatory 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 even low concentrations of facility-specific chemicals or radionuclides may provide important early indications of a contaminant release and allow for timely identification and remediation of the source.

7.3.1 Emerging Contaminants of Concern

During 2017, several PFAS were detected in water samples collected from three BNL water supply wells. Since that time, BNL identified nine areas where PFAS containing aqueous film forming foam (AFFF) had been used for firefighter training or fire suppression system maintenance from 1966 through 2008. Groundwater characterization confirmed the presence of PFAS in each of the nine areas. In each area, the PFAS chemicals perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) concentrations were found to exceed the 10 ng/L drinking water standards that were adopted for these chemicals by New York State in August 2020. The highest PFAS concentrations in groundwater are associated with firefighter training that occurred at the Former Firehouse (in operation from 1947-1985), the Current Firehouse, and the Building 170 areas. At the Former Firehouse area, the maximum PFOS and PFOA concentrations detected to date in the groundwater were 24,000 ng/L and 1,600 ng/L, respectively. At the Current Firehouse area, the maximum PFOS and PFOA concentrations detected to date were 16,000 ng/L and 1,200 ng/L, respectively. Near the Building 170 source area, the maximum PFOS and PFOA concentrations detected to date were 8,470 ng/L and 66 ng/L, respectively.

BNL operates two groundwater treatment systems to remediate the high concentration PFAS plumes associated with the former firefighter training areas. The Current Firehouse PFAS Treatment System (which also treats the Building 170 PFAS plume) went into operation in December 2022 and the Former Firehouse PFAS Treatment System went into operation in January 2023. BNL also installed 99 new monitoring wells to verify the effectiveness of the PFAS treatment systems.

Since 2017, BNL has also been characterizing the extent of 1,4-dioxane contamination in groundwater. 1,4-Dioxane was used as a chemical stabilizer for the solvent 1,1,1-trichloroethane (TCA). BNL has confirmed the presence of 1,4-dioxane in several on-site and off-site areas that have been impacted by TCA contamination, with a maximum concentration of 23.9 µg/L in a Western South Boundary area monitoring well. In August 2020, New York State adopted a drinking water standard for 1,4-dioxane of 1.0 µg/L. Long-term characterization and remedial actions for PFOS, PFOA, and 1,4-dioxane will be conducted under the CERCLA program as Operable Unit X.

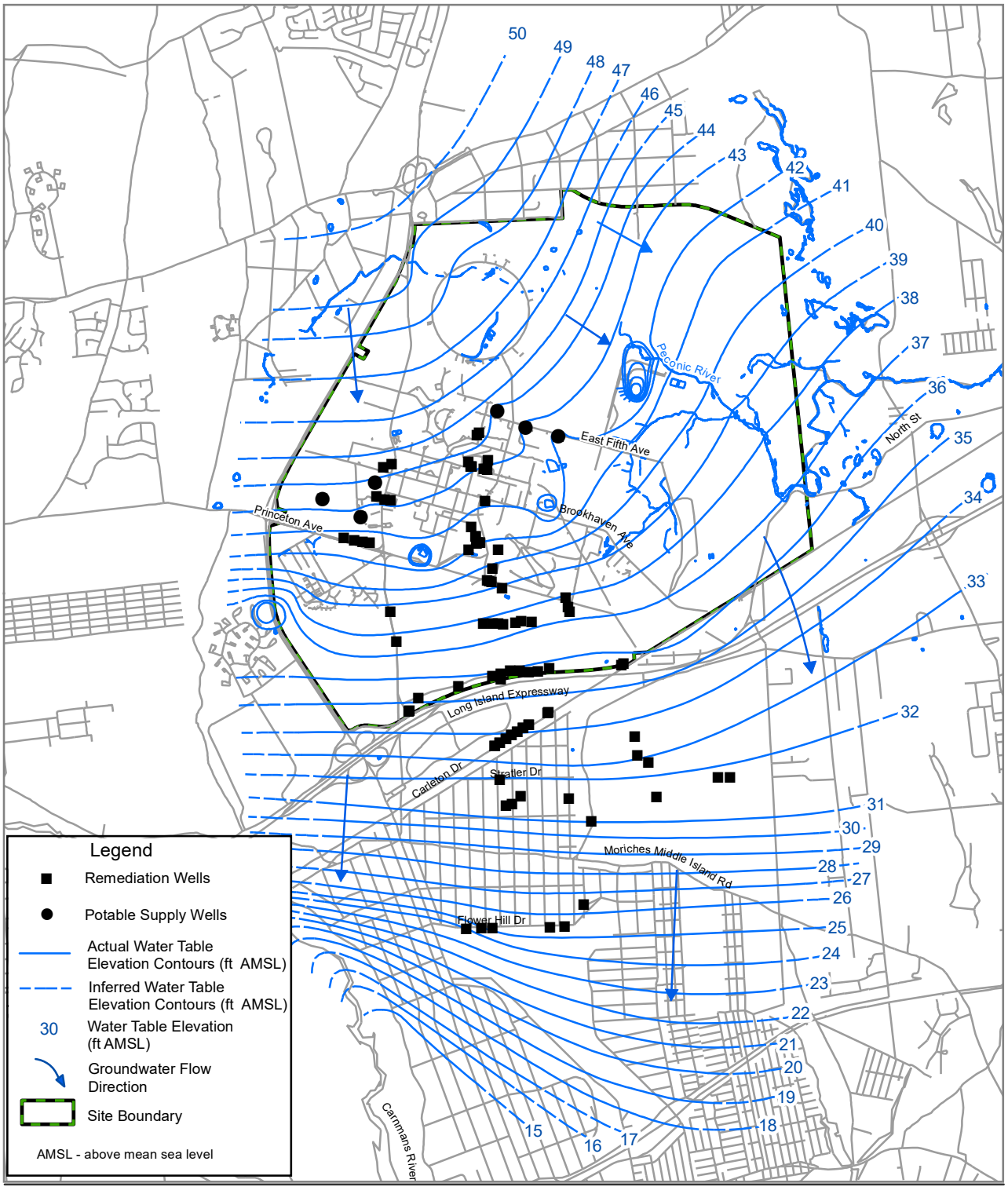


Figure 7-1. Groundwater Table Elevation Map for August 2024 Showing Groundwater Flow Directions and Locations of Supply and Remediation Wells.

7.4
Groundwater Monitoring Results

During 2024, the Facility Monitoring program monitored 108 permanent wells during 141 individual sampling events. The CERCLA groundwater monitoring program monitored 657 permanent wells during 1,327 individual groundwater sampling events. Forty-one temporary wells were also installed as part of the CERCLA program, for the continued characterization of several VOC, Sr-90, and PFAS plumes. Detailed descriptions and maps related to the groundwater monitoring programs can be found in SER Volume II, Groundwater Status Report. Maps that show changes over time of the main VOC plumes, radionuclide plumes, Current Firehouse PFAS plume, and Former Firehouse PFAS plume are provided as Figures 7-2 through 7-5, respectively.

Highlights of the groundwater monitoring programs for 2024 include the following:

- Monitoring conducted at BNL's major research facilities (e.g., Alternating Gradient Synchrotron, Brookhaven Linac Isotope Producer, Relativistic Heavy Ion Collider, and National Synchrotron Light Source II) and support facilities (e.g., Sewage Treatment Plant, Major Petroleum Facility and Waste Management Facility) did not identify any new impacts to groundwater quality resulting from current operations.
- As recommended in the 2021 CERCLA Five-Year Review (BNL 2021), BNL completed the planned injection of liquid carbon and zero-valent iron for in-situ treatment of residual tetrachloroethylene (PCE) contaminated soil at the Building 96 source area. Initial monitoring results indicate that the treatment is successfully reducing the mobility of the PCE. Long-term monitoring will be used to verify that the treatment is successfully degrading the residual contamination.
- Groundwater monitoring results for the OU III Middle Road and South Boundary treatment systems indicate that VOC concentrations are not declining at a rate that will definitively meet the ROD cleanup goal of meeting MCLs by 2030. In response, BNL has been performing groundwater model simulations to evaluate whether modifications to the system are required. The modeling results indicate that three additional extraction wells may be required.
- The Western South Boundary VOC groundwater treatment system was modified in 2019 with the addition of four new extraction wells. As a result of this effort, VOC concentrations and the extent of the plume have decreased significantly. During 2024, total VOC (TVOC) concentrations in plume core monitoring wells were below the treatment system capture goal of 20 µg/L. The concentrations of individual VOCs have also declined to below the applicable MCLs. As a result, BNL will prepare a petition for shutdown.
- Groundwater monitoring results for the off-site North Street East treatment system indicate that ethylene dibromide (EDB) concentrations and the extent of the EDB plume have decreased significantly following four years of groundwater remediation. During 2024, EDB concentrations in plume core wells continued to be below the 0.05 µg/L MCL. As a result, BNL will prepare a petition for shutdown.
- EDB concentrations in a number of the off-site OU VI treatment system monitoring wells continue to exceed the 0.05 µg/L MCL, with a maximum concentration of 1.0 µg/L. The two new extraction wells installed in 2023 to enhance the operations of the treatment system were operational throughout 2024. Additional monitoring will be required to evaluate the long-term effectiveness of the new extraction wells.
- Total VOC concentrations in plume core wells associated with the off-site Industrial Park and Long Island Power Authority (LIPA) treatment systems have remained below the 50 µg/L capture goals for each system. Furthermore, individual VOC concentrations in LIPA monitoring wells have

decreased to below their applicable MCLs. In 2024, a petition for closure for the LIPA treatment system (BNL 2024b) was approved, and a petition for closure of the Industrial Park system is anticipated to be submitted in 2025.

- High levels of PFAS continue to be detected in the groundwater near the Former Firehouse, Current Firehouse, and Building 170 PFAS source areas. In the Former Firehouse area, PFOS and PFOA were detected at concentrations up to 24,000 ng/L and 1,600 ng/L, respectively. In the Current Firehouse area, PFOS and PFOA were detected at concentrations up to 16,000 ng/L and 1,200 ng/L, respectively. Whereas at the Building 170 source area, PFOS, and PFOA were detected at concentrations up to 5,050 ng/L and 65 ng/L, respectively. Effluent monitoring results for the two PFAS treatment systems showed that the granular activated carbon filters were reducing PFOS and PFOA to non-detectable levels. During 2024, BNL installed 15 temporary wells to further characterize the downgradient migration of the Current Firehouse PFAS plume. The monitoring results confirmed that the PFAS contamination has migrated to the BNL southwestern boarder (Figure 7-4). Furthermore, analytical results from existing OU III monitoring wells confirmed that the Former Firehouse PFAS plume extends off-site to the Industrial Park area (Figure 7.5).
- Low levels of PFOS and PFOA continued to be detected in the southwest portion of the BNL site that is within the source water contributing area of the Suffolk County Water Authority's William Floyd Well Field. During 2024, PFOS and PFOA were detected in several permanent and temporary monitoring wells at concentrations up to 21 ng/L and 10 ng/L, respectively.

Detailed groundwater monitoring results including plume maps, hydrogeological cross sections, and trend charts are presented in SER Volume II, Groundwater Status Report.

Sampling a Groundwater Monitoring Well.

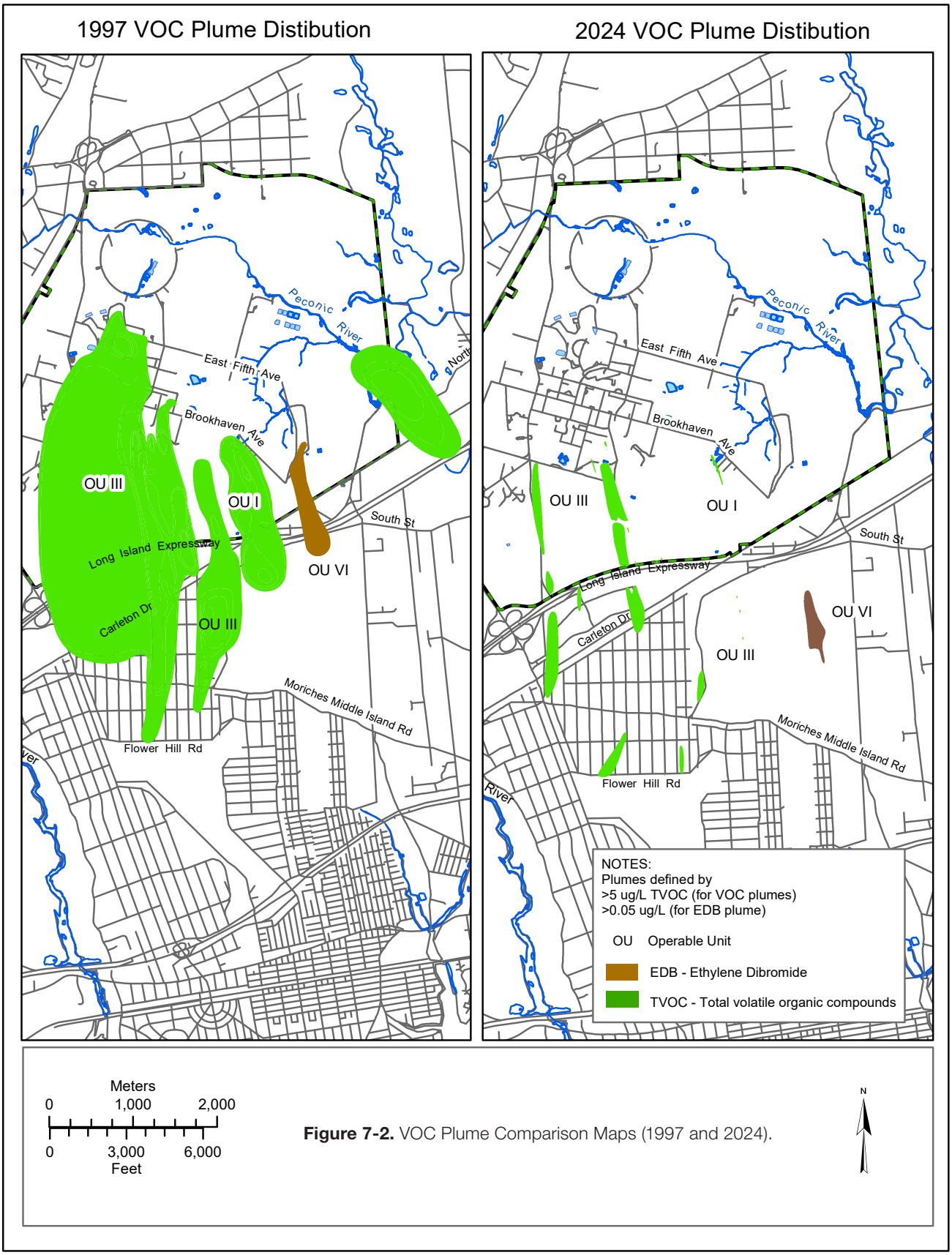


Figure 7-2. VOC Plume Comparison Maps (1997 and 2024).

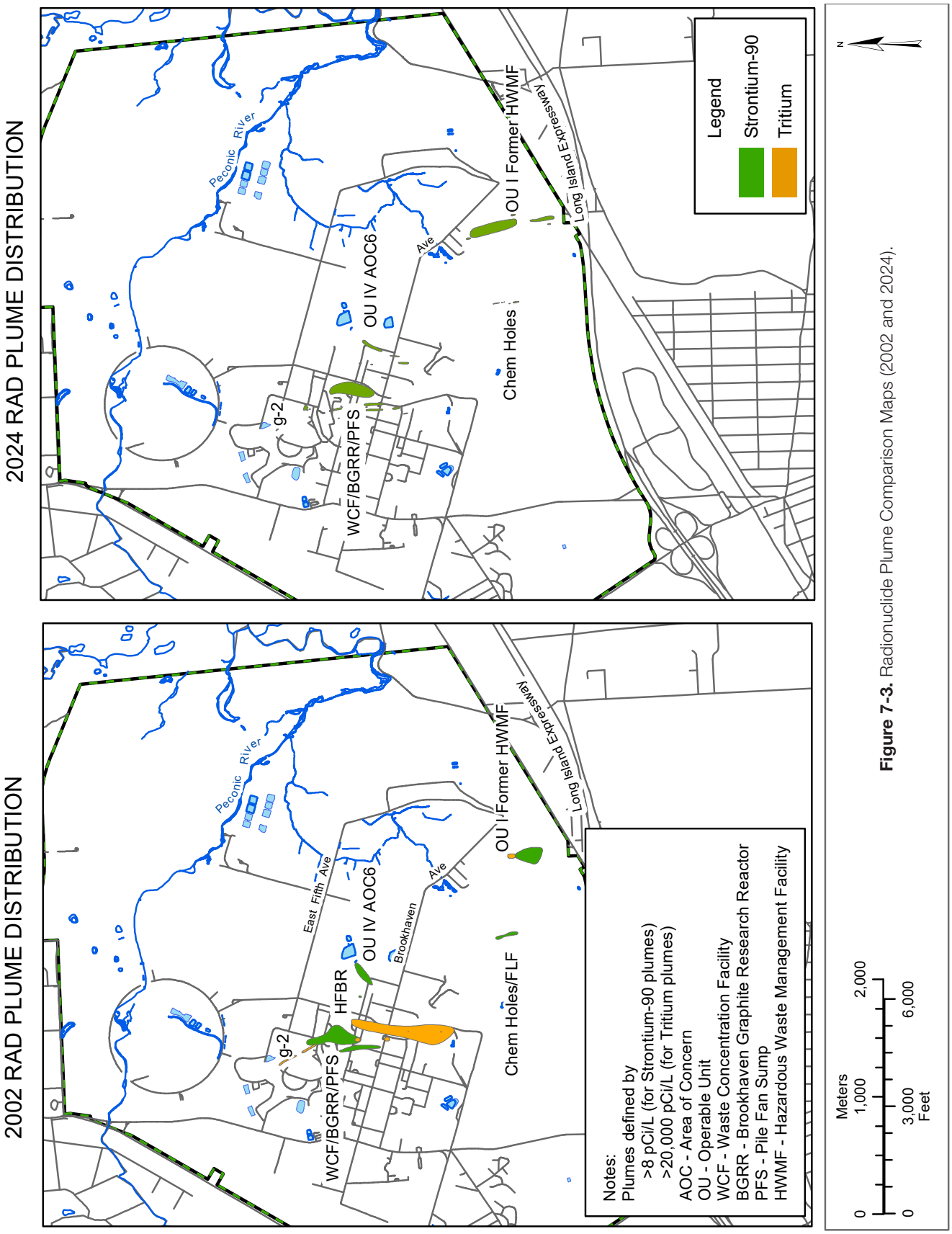


Figure 7-3. Radionuclide Plume Comparison Maps (2002 and 2024).

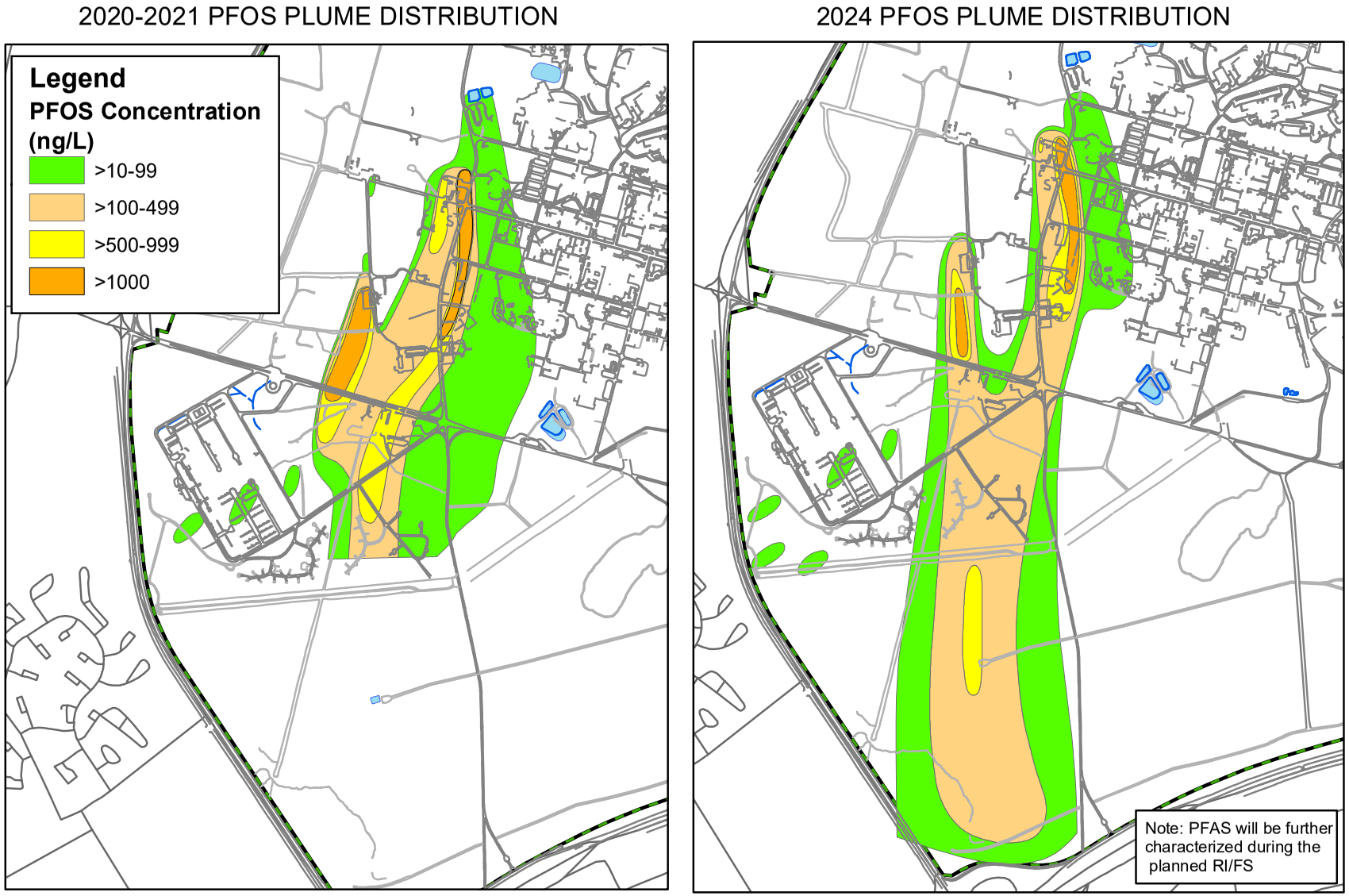


Figure 7-4. Current Firehouse and Building 170 PFOS Plume Comparisons (2020/21 and 2024).

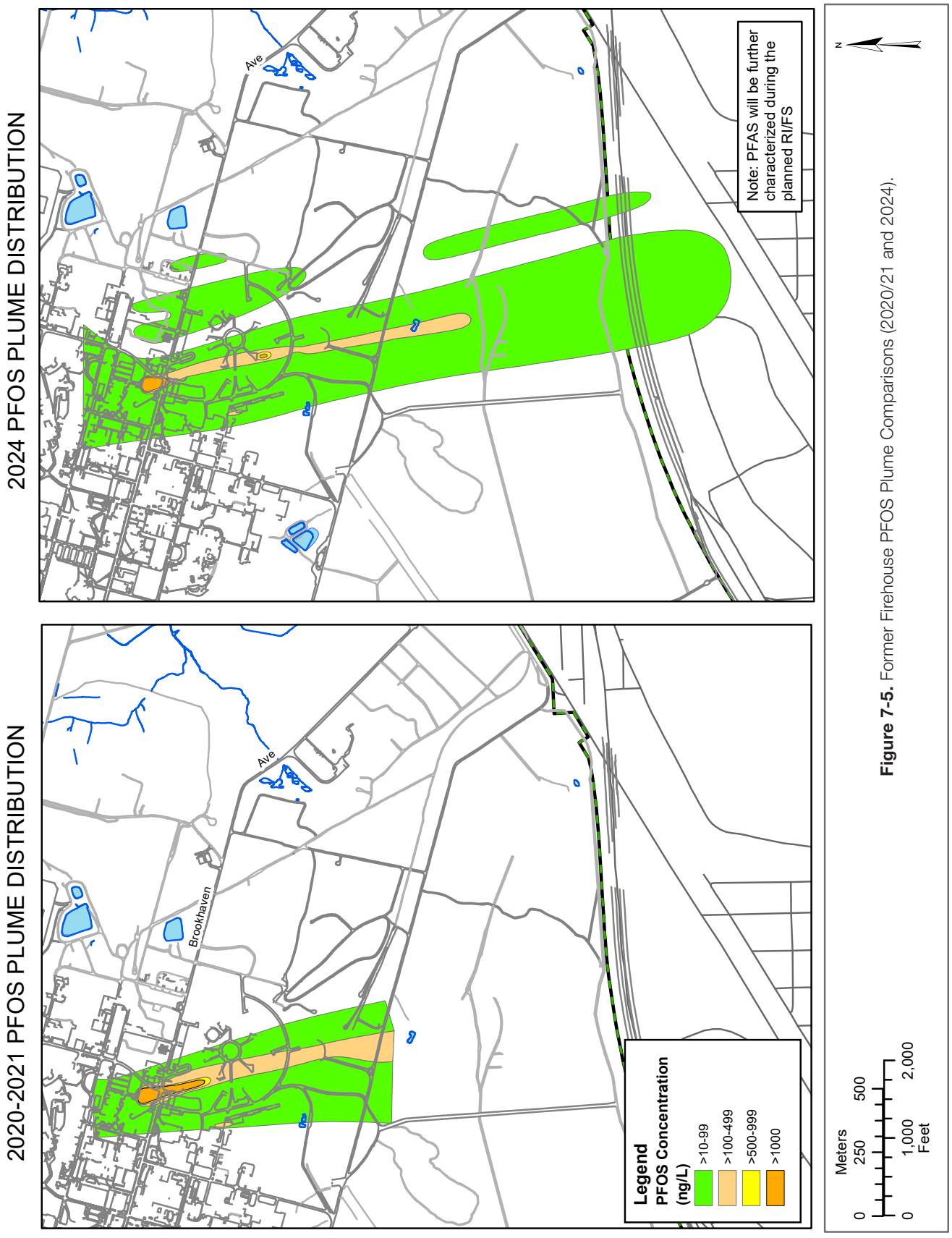


Figure 7-5. Former Firehouse PFOS Plume Comparisons (2020/21 and 2024).

7.5
Groundwater Treatment Systems

The primary mission of the CERCLA program is to operate and maintain groundwater treatment systems to remediate contaminant plumes both on- and off-site. Modifications to groundwater remediation systems are implemented, as necessary, based upon a continuous evaluation of monitoring data and system performance. The cleanup objectives that are defined in CERCLA RODs will be met by a combination of active treatment and natural attenuation. The specific cleanup goals are as follows:

- Achieve MCLs for VOCs in the Upper Glacial aquifer by 2030. The MCLs for most of the VOCs detected in the groundwater are typically 5.0 µg/L, whereas the MCL for EDB is 0.05 µg/L.
- Achieve MCLs for VOCs in the Magothy aquifer by 2065.
- Achieve the 8 pCi/L MCL for Sr-90 at the Brookhaven Graphite Research Reactor (BGRR) in the Upper Glacial aquifer by 2070.
- Achieve the MCL for Sr-90 at the Chemical Holes in the Upper Glacial aquifer by 2040.
- The cleanup goals for PFAS and 1,4-dioxane will be defined in the OU X ROD that will be prepared at the completion of a planned Remedial Investigation/Feasibility Study (RI/FS).

During 2024, BNL continued to make significant progress in restoring groundwater quality in several on-site and off-site areas (see Figures 7-2 through 7-5). Figure 7-6 shows the locations of the ten groundwater treatment systems currently in operation. Table 7-1 provides a summary of the amounts of VOCs, PFAS, and Sr-90 removed from the aquifer since the start of active remediation in December 1996. During 2024, approximately 41 pounds of VOCs, 0.7 pounds of total PFAS, and 0.1 mCi of Sr-90 were removed from the groundwater and nearly 1.1 billion gallons of treated groundwater were returned to the aquifer. To date, 7,914 pounds of VOCs have been removed from the aquifer and noticeable improvements in groundwater quality are evident in several on-site and off-site areas. Furthermore, two of the treatment systems have removed approximately 34.9 mCi of Sr-90, and two other systems have removed approximately 1.3 pounds of PFAS. Detailed information on the groundwater contaminant plumes and treatment systems can be found in SER Volume II, Groundwater Status Report.

Measuring depth to groundwater in a monitoring well.

In March 2023, New York State established Ambient Groundwater Quality Guidance Values for PFOS (2.7 ng/L), PFOA (6.7 ng/L), and 1,4-dioxane (0.35 µg/L) that are lower than the previously established drinking water standards. New York State is applying these values as Effluent Limitations for BNL's groundwater treatment systems. Monitoring conducted to date indicates that 1,4-dioxane concentrations exceed the 0.35 µg/L discharge standard at one on-site and two off-site groundwater treatment systems. Additionally, PFOS concentrations in the effluent from one on-site treatment system exceed the 2.7 ng/L standard. With the goal of bringing the discharges into compliance, BNL evaluated several commercially available treatment technologies. Because PFAS can be readily treated using granular activated carbon (GAC) filtration, the focus was on the treatment of 1,4-dioxane. The selected treatment technology was advanced oxidation process (AOP). BNL is continuing to monitor these systems for PFAS and 1,4-dioxane and in late 2024 BNL provided the regulatory agencies with a plan that outlines the proposed treatment system modifications.

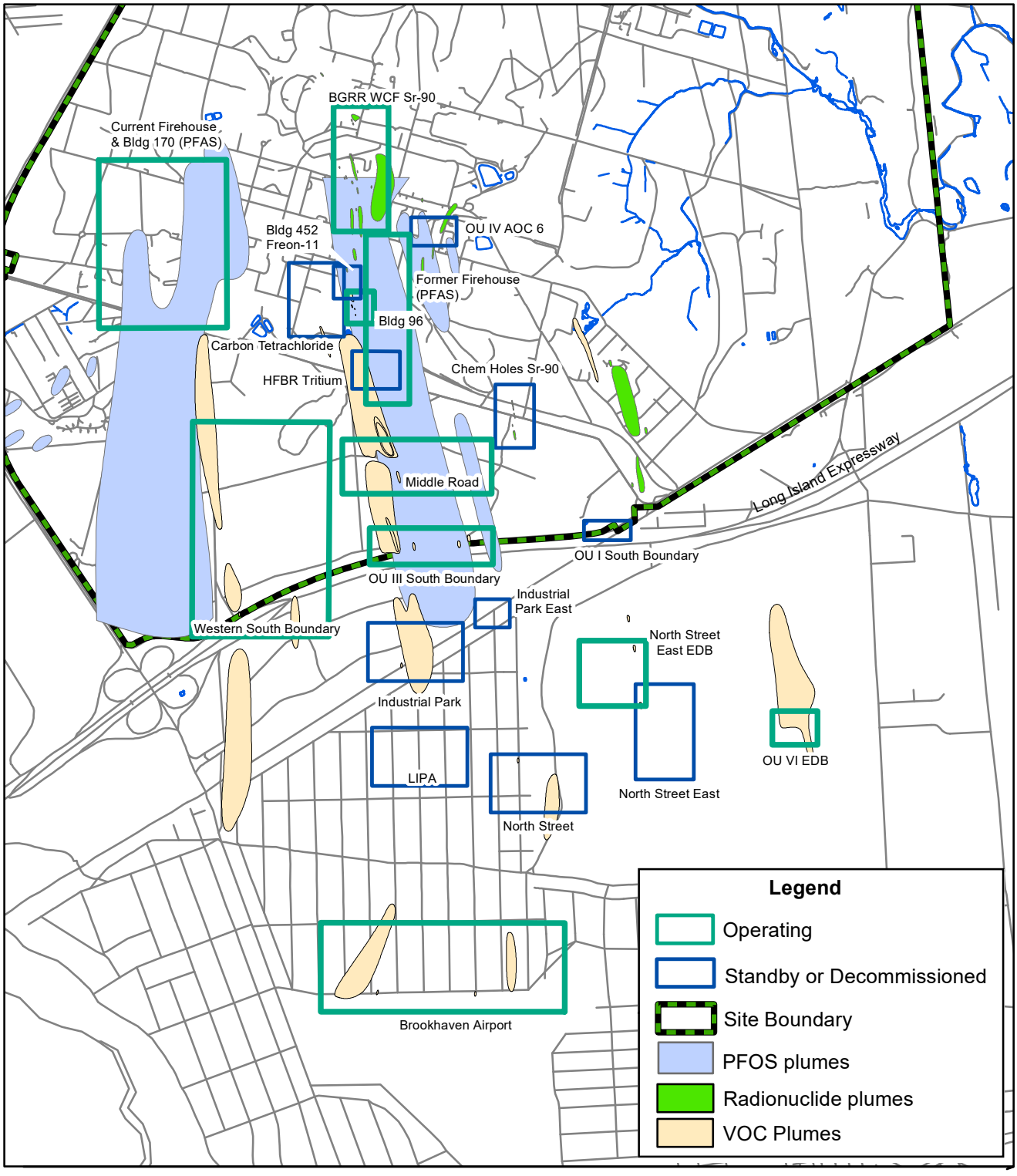


Figure 7-6. Locations of BNL Groundwater Remediation Systems.

Table 7-1. BNL Groundwater Remediation System Treatment Summary for 1997 through 2024.

VOC Remediation (start date)	1997-2023		2024	
	Water Treated (gallons)	VOCs Removed (pounds)(c)	Water Treated (gallons)	VOCs Removed (pounds)(c)
OU I South Boundary (Dec. 1996) (a)	4,177,473,000	369	(Closed)	0
OU III Carbon Tetrachloride (Oct. 1999) (e)	153,538,000	349	(Decommissioned)	0
OU III Building 96 (Feb. 2001)	620,697,000	147	6,512,800	0.1
OU III Building 452 Freon-11 (March 2012) (a)	124,997,000	106	(Closed)	0
OU III Middle Road (Oct. 2001)	4,272,547,000	1,378	186,000,000	21
OU III South Boundary (June 1997)	5,632,151,000	3,084	53,000,000	6
OU III W. South Boundary (Sept. 2002)	2,687,555,000	212	89,000,000	7
OU III Industrial Park (Sept. 1999)	2,577,662,000	1,077	(Standby)	0
OU III Industrial Park East (May 2004) (f)	357,192,000	38	(Decommissioned)	0
OU III North Street (June 2004)	1,680,942,000	342	(Closed)	0
OU III North Street East (June 2004) (g)	1,331,454,000	50	74,656,000	1
OU III LIPA/Airport (June 2004) (h)	4,377,067,620	505	209,922,620	6
OU III HFBR Tritium Plume (May 1997) (a)	721,795,000	180	(Closed)	0
OU IV AS/SVE (Nov. 1997)	NA (b)	35	(Decommissioned)	0
OU VI EDB (August 2004)	2,959,657,000	(d)	133,600,000	0.5 (d)
Totals	**31,674,727,620**	**7,873**	**752,691,420**	**41.1**
Sr-90 Remediation (start date)	**2003-2023**		**2024**	
	Water Treated (gallons)	Sr-90 Removed (mCi)	Water Treated (gallons)	Sr-90 Removed (mCi)
OU III Chemical Holes (Feb. 2003)	65,663,000	4.94	(Shutdown)	0.0
OU III BGRR (June 2005)	224,603,000	29.85	6,600,000	0.1
Totals	**290,266,000**	**34.79**	**6,600,000**	**0.1**
PFAS Remediation (start date)	**2022-2023**		**2024**	
	Water Treated (gallons)	PFAS Removed (lbs)	Water Treated (gallons)	PFAS Removed (lbs)
OU X Current Firehouse (Oct. 2022)	238,144,000	0.42	215,000,000	0.53
OU X Former Firehouse (Jan. 2023)	108,204,000	0.17	105,314,000	0.17
Totals	**346,348,000**	**0.59**	**320,314,000**	**0.70**

Notes:
(a) System was approved for closure in 2019.
(b) Air Sparging/Soil Vapor Extraction (AS/SVE) system performance measured by pounds of volatile organic compounds (VOCs) removed. System was decommissioned in 2003.
(c) Values rounded to the nearest whole number.
(d) Ethylene dibromide (EDB) cumulative mass removal calculation began with the startup of extraction wells EW-3E and EW-4E in January 2024.
(e) System was decommissioned in 2010.
(f) System was decommissioned in 2014.
(g) The North Street East System was restarted in July 2020 for treatment of the EDB plume. Pounds removed in 2020 include EDB and VOCs.
(h) The LIPA portion of the system was approved for closure in December 2024.
NA – Not applicable

Reference and Bibliography

BNL 2021. 2021 CERCLA Five-Year Review for Brookhaven National Laboratory Superfund Site (NY7890008975), Town of Brookhaven, Halmet of Upton, Suffolk County, New York. June 1, 2021.

BNL 2023. Groundwater Protection Contingency Plan – Response to Unexpected Monitoring Results. Environmental Monitoring Procedure EM-SOP-309. Brookhaven National Laboratory, Upton, NY. August 8, 2023.

BNL 2024a. Community Involvement Plan, Brookhaven National Laboratory Superfund Site, Upton, New York 2024.

BNL 2024b. Petition for Closure – OU III LIPA Groundwater Treatment System. Brookhaven National laboratory, Upton, New York.

Scorca, M.P., W.R. Dorsch, and D.E. Paquette. 1999. Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, New York, 1994-1997. U.S. Geological Survey Water Resources Investigation Report 99-4086. 55 pp.

USEPA 1992. 1992 Interagency Agreement, Administrative Docket Number: II-CERCLA-FFA-00201. U.S. Environmental Protection Agency.

Intentionally Left Blank

Ventilation exhaust duct for High Flux Beam Reactor (HFBR) ambient air, which is continuously sampled before going up the stack.

Chapter 8

Radiological Dose Assessment

Brookhaven National Laboratory's (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 and the environment are protected.

The potential radiological dose to members of the public is calculated at an off-site location where models indicate that emissions from a site source could result in the maximum dose to an off-site individual, defined as the "maximally exposed off-site individual" (MEOSI). Based on MEOSI dose calculation criteria, members of the public would receive a dose less than the MEOSI. The dose to the MEOSI is the total dose from direct and indirect dose pathways via air immersion, inhalation of particulates and gases, and ingestion of local fish and deer meat. In 2024, the total effective dose (TED) to the MEOSI from Laboratory operations was less than 2.5% of the dose limit of 100 mrem in a year required by Department of Energy (DOE) Order 458.1 and well below all other U.S. Environmental Protection Agency (EPA) and U.S. DOE regulatory dose limits for the public, workers, and the environment.

The dose estimates for 2024 were calculated using dose modeling software promulgated by the EPA. All data in this chapter are reported with uncertainties at the 95% (2-sigma) confidence level. As such, the effective dose equivalent (EDE) from air emissions in 2024 was estimated at 1.67 mrem (16.7uSv) to the MEOSI. This BNL dose level from the inhalation pathway was 16.7% of the EPA's annual regulatory dose limit of 10 mrem (100 μSv). In addition, the dose from the ingestion pathway was estimated as 0.61 mrem (6.1 μSv) from the consumption of deer meat. The on-site portions of the Peconic River had minimal amounts of water, which did not support a fish population, so no samples were available for surveillance monitoring and there was no measured dose attributable to BNL legacy Cesium-137 (Cs-137) levels in fish in the Peconic River. In summary, the total annual dose to the MEOSI from all pathways was estimated at 2.28 mrem (22.8 μSv), which is less than 2.5% of DOE's 100-mrem limit. The aggregate population dose was 9.8 person-rem among approximately six million people residing within a 50-mile radius of the Laboratory. On average, this is equivalent to a fraction of an airport whole body scan per person. Five years of measurement data are shown in the data tables to present the recent history of measured ambient radiation dose at BNL. In 2024, the ambient dose remained indistinguishable from background.

Dose to the maximally exposed individual (MEI) on-site and outside of controlled areas, calculated from thermoluminescent dosimeter (TLD) monitoring records, was 4 ± 2 mrem above natural background radiation levels, also well below the 100-mrem DOE limit on dose. The average annual external dose from ambient sources on-site was 64 ± 8 mrem (640 ± 80 μSv), while the dose from off-site ambient sources was 62 ± 8 mrem (620 ± 80 μSv). 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 53 on-site TLDs and 16 off-site TLDs showed that there was no external dose contribution from BNL operations distinguishable from the natural background radiation level. Additional TLDs were used to measure on-site areas known to receive radiation dose slightly above the natural background radiation. Doses to aquatic and terrestrial biota were also found to be well below DOE regulatory limits. In summary, the overall dose impact from all Laboratory activities in 2024 was comparable to that of natural background radiation levels.

8.1
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 radiation exposure levels to the public and workers, as well as to the environment, fauna, and flora. To this end, the Laboratory's routine operations, scientific experiments, and new research projects are evaluated for their radiological dose risk. Dose risks from demolishing decommissioned facilities and decontamination work are also evaluated. All environmental pathway scenarios with potential for dose to humans, aquatic life, plants, and animals are evaluated to estimate the dose risks on-site.

Because all research reactors at BNL have been shut down, defueled, and partly or fully decommissioned for several years, the dose risk from these facilities was trivial in 2024. The Laboratory's current radiological risks are from very small quantities of radionuclides used in science experiments, production of radiopharmaceuticals at the Brookhaven Linear Accelerator (LINAC) Isotope Producer (BLIP),the Radionuclide Research and Production Laboratory (RRPL), and small amounts of air activation produced at the BNL accelerators: Alternating Gradient Synchrotron (AGS), Relativistic Heavy Ion Collider (RHIC), the National Aeronautics and Space Administration (NASA) Space Radiation Lab (NSRL), and the National Synchrotron Light Source II (NSLS-II). These radiological dose evaluations 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.

8.2
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 based on the premise that off-site exposures represent true natural background radiation levels, with contributions from cosmic and terrestrial sources, and with no contributions from Laboratory operations.

On- and off-site external dose measurements are averaged separately and then compared using standard statistical methods to assess the contribution, if any, from Laboratory operations.

Photo 8-1. Thermoluminescent dosimeter (TLD) at P-4 Perimeter Station.

8.2.1 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 (see Photo 8-1). On- and off-site land areas are divided into numbered grids, and each TLD is assigned a unique identification code based on those grids.

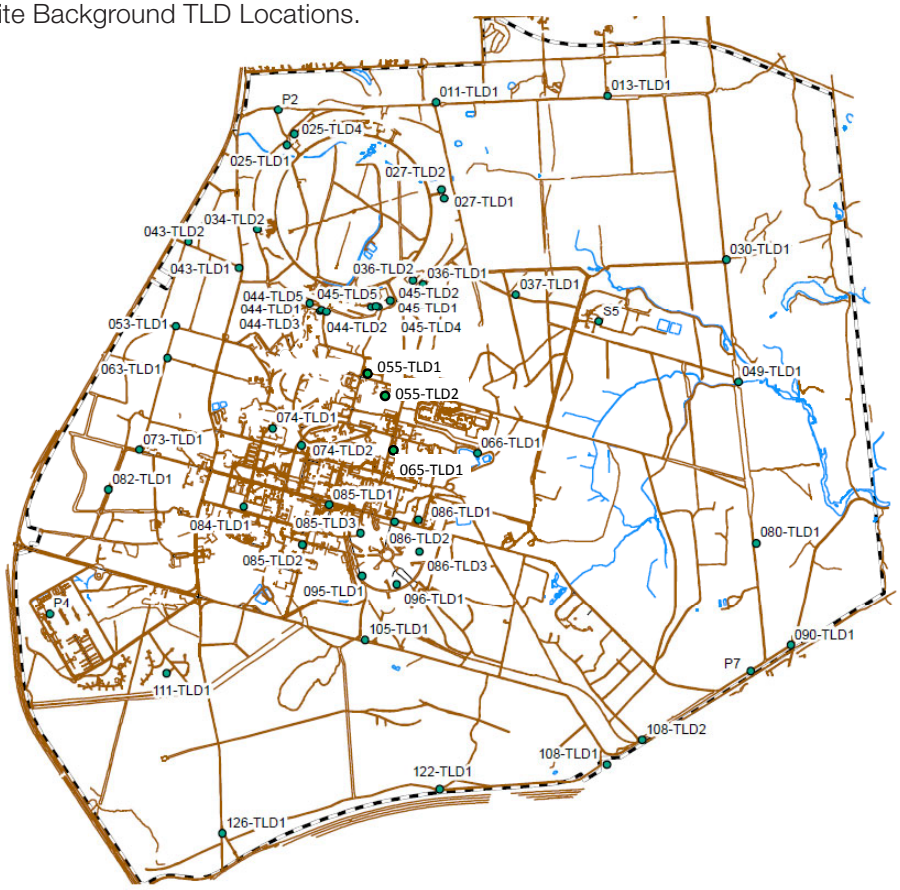
In 2024, a total of 63 environmental TLDs were deployed on-site. Fifty-three TLDs, as listed in Table 8-1, were deployed on-site (see Figure 8-1) to measure on-site background. Ten TLDs were placed in areas known to see dose rates higher than background due to the nature of the nearest facility (see Table 8-3).

A total of 16 environmental TLDs, listed in Table 8-2, were deployed at off-site locations (see Photo 8-2) to measure off-site background. In 2024, all 16 wind sectors around the Laboratory (see Fig. 8-2) had at least one TLD location.

Photo 8-2. TLD in a tree at the Longwood Estate.

An additional 30 TLDs were stored on-site in a lead-shielded container for use as reference and control TLDs for comparison purposes. The annual total of the control TLD dose values for 2024, reported as 075-TLD4 in Tables 8-1 and 8-2, was 27 ± 4 mrem (270 +/- 40 uSv). This dose accounts for any small residual dose not removed from TLDs during the annealing process and the natural background and cosmic radiation sources that are not completely shielded. It is noted that only the TLDs active in 2024 are shown in Figure 8-2. To display historical trends, dose data for TLDs are listed in Table 8-2 until no data has been reported for five consecutive years. For example, three TLDs are listed in Table 8-2 that are not shown on Fig. 8-2, but their data through 2023 is shown in Table 8-2. In addition, TLD 600-TLD3 will disappear from Table 8-2 when two more years pass with No Data.

Figure 8-1. On-site Background TLD Locations.



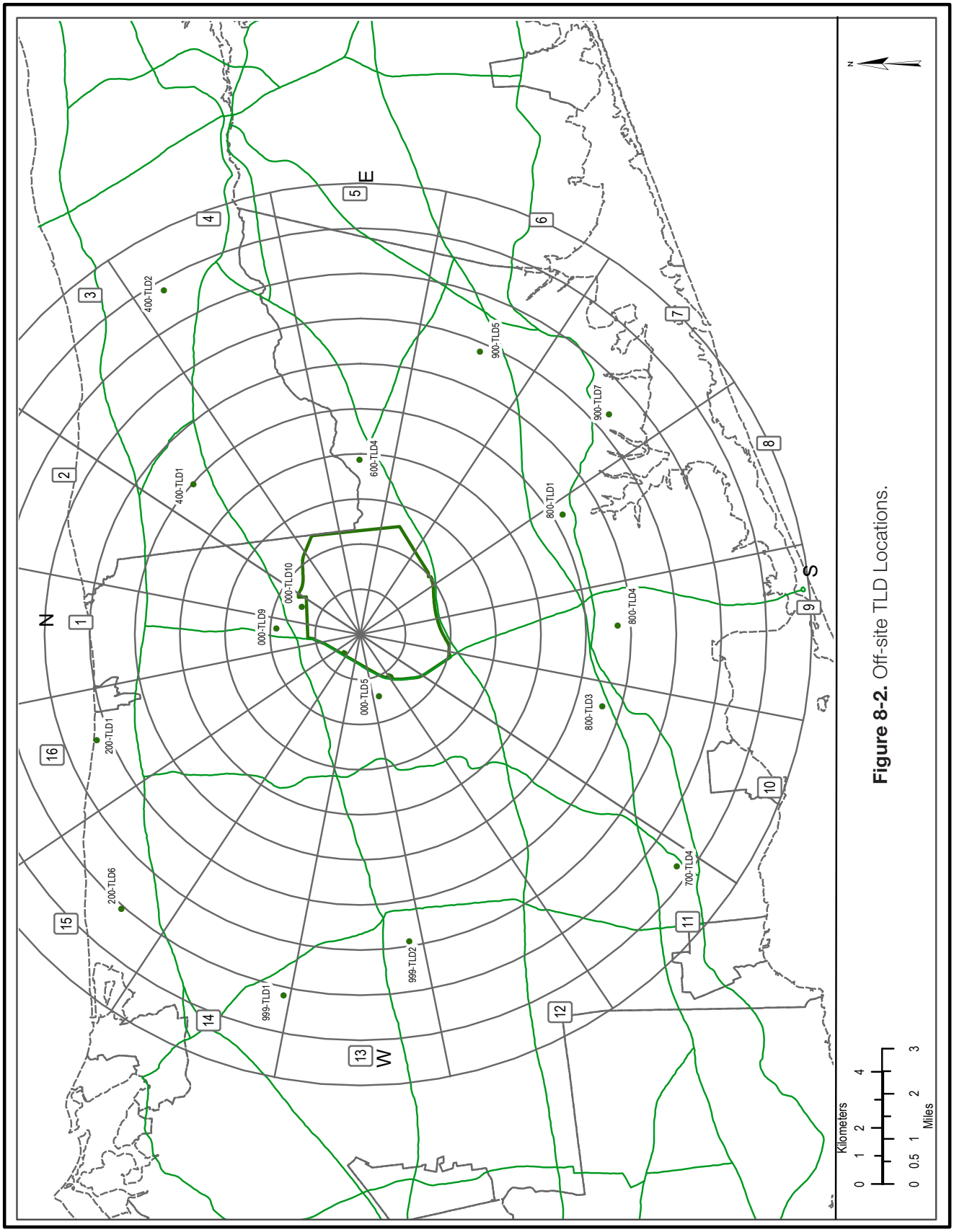


Figure 8-2. Off-site TLD Locations.

The on- and off-site TLDs were collected and read quarterly to determine the annual total external radiation dose measured. Table 8-1 shows the annual on-site radiation dose measurements from 2020 to 2024. For 2024, the average on-site external dose from all potential environmental sources, including cosmic and terrestrial radiation sources, was 64 ± 8 mrem (640 ± 80 μSv). The on-site measurements in this table generally exhibit year-to-year variation within 10% or less of their average. The same can be said about the off-site measured doses in Table 8-2, which shows the annual off-site radiation dose measurements from 2020 to 2024. The average off-site total ambient dose in 2024 from all potential environmental sources, including cosmic and terrestrial radiation sources, was 62± 8 mrem (620 ± 80 μSv).

To determine the BNL contribution to the external direct radiation dose, a statistical test between the measured on- and off-site external doses was conducted. The test showed no significant difference between the off-site dose (62 ± 8 mrem) and on-site dose (64 ± 8 mrem) at the 95% confidence level. From the measured TLD doses, it can be safely concluded that there was no measurable external dose contribution to on- or off-site locations from Laboratory operations in 2024.

Table 8-1. Five-Year Annual On-Site Direct Ambient Radiation Measurements (2020-2024).

		Annual Total Dose, mrem (±2σ, 95% conf. interval)				
TLD#	**Location**	**2020**	**2021**	**2022**	**2023**	**2024**
011-TLD1	North Firebreak	58±3	61±8	52±4	53±15	56±8
013-TLD1	North Firebreak	61±4	68±10	59±7	58±8	60±8
025-TLD1	Bldg. 1010, Beam Stop 1	63±19	70±12	56±8	57±9	63±7
025-TLD4	Bldg. 1010, Beam Stop 4	60±11	64±11	57±6	59±13	60±7
027-TLD1	Bldg. 1002A South	57±9	62±13	55±7	54±9	57±8
027-TLD2	Bldg. 1002D East	56±9	62±14	53±3	53±10	56±5
030-TLD1	Northeast Firebreak	64±9	65±13	61±6	60±11	65±8
034-TLD2	Bldg. 1008, Collimator 4	66±10	71±10	59±9	62±9	67±8
036-TLD1	Bldg. 1004B, East	56±12	62±8	54±6	58±6	57±8
036-TLD2	Bldg. 1004, East	58±4	66±12	56±6	58±7	61±7
037-TLD1	S-13	62±7	67±12	58±3	59±9	60±5
043-TLD1	North Access Road	66±10	72±15	66±4	65±6	65±4
043-TLD2	North of Meteorology Tower	67±6	71±12	63±3	66±2	67±11
044-TLD1	Bldg. 1006	61±8	67±10	61±4	62±13	64±7
044-TLD2	South of Bldg. 1000E	62±9	70±10	62±6	63±7	69±11
044-TLD3	South of Bldg. 1000P	59±8	64±10	59±4	62±10	62±10
044-TLD5	North of Bldg. 1000P	63±7	66±19	62±8	62±13	66±6
045-TLD1	Bldg. 1005S	61±10	69±10	57±3	59±8	62±9
045-TLD2	East of Bldg. 1005S	63±16	67±11	61±7	61±12	62±8
045-TLD4	Southwest of Bldg. 1005S	62±6	68±7	58±5	61±11	62±9
045-TLD5	West-Southwest of Bldg. 1005S	61±5	70±11	60±7	59±8	62±8
049-TLD1	East Firebreak	66±16	55±13	62±2	64±9	66±14
053-TLD1	West Firebreak	72±6	74±17	65±9	67±8	70±8
055-TLD1	Thomson and Fifth	NYP	NYP	59±8	63±10	63±3
055-TLD2	Building 935	NYP	NYP	59±8	62±10	65±7
063-TLD1	West Firebreak	71±4	74±9	65±6	71±9	72±8
065-TLD1	Building 820	NYP	NYP	63±7	62±13	63±7

(continued on next page)

Table 8-1. Five-Year Annual On-Site Direct Ambient Radiation Measurements (2020-2024) *(concluded)*.

		Annual Total Dose, mrem (±2σ, 95% conf. interval)				
TLD#	**Location**	**2020**	**2021**	**2022**	**2023**	**2024**
066-TLD1	Waste Management Facility	55±5	64±13	58±14	54±5	54±9
073-TLD1	Meteorology Tower	69±10	68±11	64±3	70±14	65±5
074-TLD1	Bldg. 560	65±10	73±13	69±5	64±5	71±4
074-TLD2	Bldg. 907	62±9	69±12	58±6	60±14	63±5
080-TLD1	East Firebreak	66±5	75±11	67±7	68±9	67±9
082-TLD1	West Firebreak	74±9	82±8	68±4	71±12	73±7
084-TLD1	Tennis Courts	65±8	70±7	66±6	65±6	67±6
085-TLD1	Bldg. 735	65±12	69±14	63±10	58±12	61±9
085-TLD2	Upton Gas Station	67±9	69±10	63±6	64±10	67±7
085-TLD3	NSLS-II LOB 745	66±6	72±7	64±12	64±11	67±7
086-TLD1	Baseball Fields	66±8	69±9	62±13	63±8	63±5
086-TLD2	NSLS-II LOB 741	61±17	65±9	58±8	55±11	58±11
086-TLD3	NSLS-II LOB 742	62±12	66±12	56±10	57±11	61±7
090-TLD1	North St. Gate	61±8	49±7	59±7	61±7	61±8
095-TLD1	NSLS-II LOB 744	70±13	77±19	69±8	68±15	71±9
096-TLD1	NSLS-II LOB 743	58±8	64±15	56±7	56±11	61±8
105-TLD1	South Firebreak	69±10	73±10	66±6	63±13	66±15
108-TLD1	Water Tower	64±5	68±9	64±5	63±6	74±15
108-TLD2	Tritium Pole	78±9	85±5	78±8	74±13	74±11
111-TLD1	Trailer Park	66±9	73±6	64±7	61±5	68±11
122-TLD1	South Firebreak	61±6	68±12	55±2	58±10	65±12
126-TLD1	South Gate	72±13	76±10	68±2	69±11	74±9
P2	NW Corner Site Perimeter Station	56±5	60±10	50±5	55±8	54±6
P4	SW Corner Site Perimeter Station	59±10	68±9	57±5	55±10	63±16
P7	SE Corner Site Perimeter Station	66±10	71±15	62±11	63±11	64±6
S5	Sewage Treatment Plant	61±9	67±11	60±6	60±9	59±6
On-site average		**64±9**	**68±11**	**61±7**	**62±10**	**64±8**
Off-site average (Table 8-2)		**61±14**	**68±11**	**58±6**	**61±10**	**62±8**
075-TLD4	**Control TLD Average**	**29±4**	**35±12**	**26±3**	**25±3**	**27±4**

See Fig. 8-1 for TLD Locations
NYP = Not Yet Posted. TLDs were added at these locations for additional major facility emissions monitoring in the vicinity.

Table 8-2. Five-Year Annual Off-Site Direct Ambient Radiation Measurements (2020-2024).

		Annual Total, mrem (±2σ, 95% Conf. Interval)				
TLD#	Location	2020	2021	2022	2023	2024
000-TLD5	Longwood Estate	58±7	60±14	50±4	56±12	58±4
000-TLD9	Private property	61±13	74±21	60±18	81±20	78±33
000-TLD10	Private property	61±16	69±8	60±3	65±9	62±5
200-TLD1	Private property	70±20	78±25	60±8	59±9	63±8
200-TLD5	Private property	69±38	80±14	74±6	75±24	ND
200-TLD6	Private property	ND	ND	ND	ND	53±9
400-TLD1	Calverton Nat. Cemetery	67±8	72±6	64±6	65±11	68±6
400-TLD2	Private property	ND	ND	ND	ND	62±7
600-TLD3	Private property	65±10	69±7	ND	ND	ND
600-TLD4	Maples B&G	59±10	64±5	58±4	60±8	61±2
700-TLD4	Private property	56±9	65±7	57±9	57±8	60±8
800-TLD1	Private property	63±11	69±11	58±5	55±7	60±7
800-TLD3	Suffolk County CD	63±12	62±6	57±6	60±12	59±9
800-TLD4	LI Nat'l Wildlife Refuge	59±10	64±12	54±7	56±2	56±5
900-TLD2	Private property	56±14	64±11	55±9	62±9	ND
900-TLD5	Private property	49±8	55±14	41±5	47±2	59±9
900-TLD7	Private property	64±18	72±12	56±3	61±20	62±8
999-TLD1	Private property	64±18	65±14	59±1	60±7	58±4
999-TLD2	Private property	61±13	73±7	64±8	63±5	67±7
Off-site average		**61±14**	**68±11**	**58±6**	**61±10**	**62±8**
075-TLD4 : Control TLD Average		**29±4**	**35±12**	**26±3**	**25±3**	**27±4**

See Fig. 8-2 for TLD Locations
Note: TLDs are placed by volunteers or other entities. Year-to-year, willingness to participate varies among owners at these locations.
ND = Not Deployed
Locations are no longer shown here if no history in five years.

8.2.2 Facility Area Monitoring

Ten on-site TLDs are designated as facility area monitors (FAMs) because they are posted in areas known to present slightly elevated radiation levels (i.e., near facilities). Table 8-3 shows the external doses measured with the FAM TLDs from 2020 to 2024. Environmental TLDs 088-TLD1 through 088-TLD4 are posted at and near the S6 blockhouse location on the fence of the Former Waste Management Facility (FWMF). Except for the doses at S6 and 088-TLD4, which were closer to the site average dose, the TLDs measured external doses that were slightly elevated compared to the normal natural background radiation doses measured in other areas on-site. This can be attributed to the presence of small amounts of contamination in the soil. As shown in Table 8-3, overall dose levels near the FWMF have been fairly consistent. Access to the FWMF is controlled by fencing.

Two TLDs, 075-TLD3 and 075-TLD5, near Building 356 showed an annual dose of 76 ± 12 mrem (760 ± 120 µSv) and 74 ± 21 mrem (740 +- 210 uSv), respectively. These doses are 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 printed circuit boards, and its collimators were removed in 2018 to allow targets to be placed closer to the source due to source decay. In addition, the source is exposed for longer periods, sometimes overnight, and generates “skyshine.” However, in 2024 the doses were once again lower due to a demand-related drop in usage. Although it is conceivable for individuals who use the parking lot adjacent to Building 356 to receive a dose from these sources, the dose would be small due to the low occupancy factor.

Three FAM TLDs near Building 914 and placed on fence sections northeast and northwest of Building 913B (the AGS tunnel access) showed slightly elevated ambient external dose levels. The full-year doses at these sites were measured at 88±30 mrem (880+/-300 uSv) for 054-TLD1, 86±25 mrem (860+/-250 uSv) for 054-TLD2, and 81±24 mrem (810+/-240 uSv) for 054-TLD3 (compared to the on-site dose of 64 ± 8 mrem and off-site dose of 62 ± 8 mrem). The slightly higher levels of the first and second quarters (not shown) are expected because the operating period for the AGS is typically in the first half of the calendar year.

Table 8-3. Facility Area Monitoring Measurements of Direct Ambient Radiation (2020-2024).

		Annual Total, mrem (±2σ, 95% Conf. Interval)				
TLD#	Location	2020	2021	2022	2023	2024
054-TLD1	Bldg. 914	65±12	79±25	87±12	90±12	88±30
054-TLD2	NE of Bldg. 913B	66±13	77±26	84±6	82±6	86±25
054-TLD3	NW of Bldg. 913B	66±13	77±30	79±9	80±12	81±24
S6	FWMF	69±11	73±10	64±6	67±7	69±10
088-TLD1	FWMF, 50' East of S6	79±7	87±12	73±1	73±7	78±7
088-TLD2	FWMF, 50' West of S6	77±14	76±14	68±2	75±11	73±11
088-TLD3	FWMF, 100' West of S6	74±11	80±11	70±7	74±12	75±6
088-TLD4	FWMF, 150' West of S6	66±11	71±12	62±2	65±8	66±2
075-TLD3	Bldg. 356	99±9	83±11	84±26	79±8	76±12
075-TLD5	North Corner of Bldg. 356	107±14	92±23	92±34	77±5	74±21

See Figure 8-1 for TLD Locations.
FWMF = Former Waste Management Facility

8.2.2.1 Neutron Monitoring

The AGS accelerates protons to energies up to 30 GeV and heavy ions up to 15 GeV/amu. 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 for ions. Under these high-energy conditions, such accelerated particles have the potential to generate high-energy neutrons when the particles leave the walls of the accelerator and produce nuclear fragments along their path or as they collide with matter. In 2024, 11 pairs of neutron monitoring TLDs (Harshaw Badge 8814) were posted at strategic locations to measure the dose contribution from the high-energy neutrons (see Figure 8-3 for locations).

Photo 8-3. Neutron TLDs in Monitored Area.

The placement of neutron TLDs is based on facility design aspects such as the thickness of the berm shielding, location of soil activation areas, beam stop areas, beam collimators, and proximity to the site boundary. The neutron TLDs are placed on polyethylene cylinders so that incident neutrons, which are at a high enough energy to pass through the TLD undetected, are thermalized by the hydrocarbons in the polyethylene and reflected back out, where the TLD can detect them. The neutron TLDs are mounted in pairs, for three reasons: the dose registered on these TLDs is low, so a matching number on the second TLD adds confidence to the dose measured by the first one; two neutron TLDs side-by-side decreases the potential dependence of measured dose on mounting orientation; and the reflected neutron could strike either neutron TLD and be counted (see Photo 8-3).

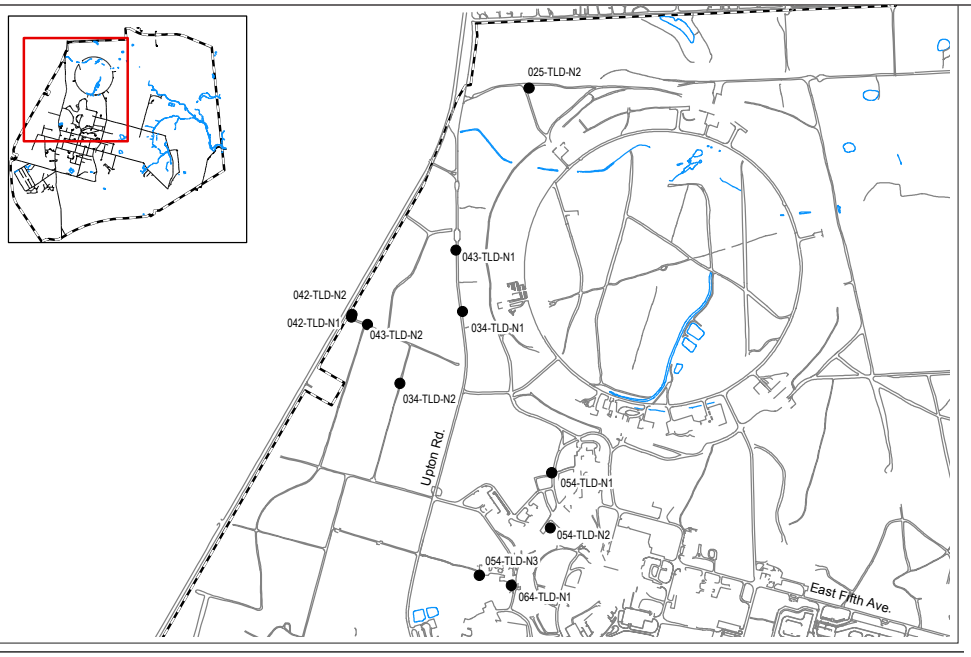


Figure 8-3. Neutron TLD Area Monitors.

Table 8-4. Five-Year Annual Neutron Monitoring Results (2020-2024).

Neutron TLD #	Location ID No.	Annual Total, mrem neutron				
		2020	2021	2022	2023	2024
TK277	025-TLD-N2	2	2	3	3	0
TK278	"	0	1	1	1	2
TK279	034-TLD-N1	1	0	2	2	1
TK280	"	0	2	1	3	0
TK281	034-TLD-N2	0	0	2	1	1
TK282	"	0	1	2	1	1
TK283	043-TLD-N1	1	2	2	2	1
TK284	"	0	1	1	0	0
TK285	043-TLD-N2	0	1	1	2	3
TK286	"	0	1	0	1	1
TK287	042-TLD-N1	1	1	1	2	2
TK288	"	0	2	2	2	1
TK289	042-TLD-N2	0	1	1	1	1
TK290	"	0	1	2	0	2
TK291	054-TLD-N1	2	0	0	0	1
TK292	"	0	0	2	1	0
TK293	054-TLD-N2	0	3	2	0	1
TK294	"	0	3	0	0	2
TK295	054-TLD-N3	0	1	1	0	2
TK296	"	2	1	0	0	2
TK297	064-TLD-N1	0	0	0	0	0
TK298	"	1	0	0	0	1
PM-bkg		1	2	2	4	3

"PM-bkg" = The background dose-rate levels in the Personnel Monitoring (PM) counting room where the TLDs are stored and prepared for issue.

Table 8-4 shows the measured ambient neutron doses recorded from 2020 to 2024. In 2024, ten neutron TLDs showed 1 mrem, six showed 2 mrem, and one showed 3 mrem. Five neutron TLDs showed no dose. All of these low-level neutron doses indicate that engineering controls (i.e., berm shielding) in place at AGS and RHIC are effective.

8.3
Dose Modeling for Airborne Radionuclides

The EPA regulates radiological emissions from DOE facilities under the requirements set forth in 40 CFR 61, Subpart H, National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities. 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 receive a dose greater than 10 mrem (100 μSv) in a year from airborne emissions from DOE facilities.

Sampling station for airborne tritium in the HFBR building exhaust.

The emission monitoring requirements include the use of a reference method for continuous monitoring at major release points (defined as those with a potential to exceed 1% of the 10 mrem standard) and periodic confirmatory measurements for all other release points. The regulations also require DOE facilities to submit an annual National Emission Standards for Hazardous Air Pollutants (NESHAPs) report to the EPA that describes the major and minor emission sources, their releases, and their resultant dose to the MEOSI. The dose estimates from various facilities are provided in Table 8-5, and the actual air emissions for 2024 are discussed in detail in Chapter 4.

As a part of the NESHAPs review process at BNL, any emission source, such as a stack, that has the potential to release airborne radioactive materials is evaluated for regulatory compliance. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), certain remediation activities are also monitored and assessed for any potential to release airborne 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 the EPA's approved dose modeling software (see Section 8.2.1 for details). Because this model is designed to treat radioactive emission sources as continuous over the course of a year, it is not well-suited for estimating the dose from short-term or acute releases. Consequently, the modeling software overestimates potential dose contributions from short-term projects and area sources. For that reason, such modeling results are conservative.

Table 8-5. Maximally Exposed Off-site Individual Effective Dose Equivalent From Facilities or Routine Processes, 2024.

Building No.	Facility or Process (f)	Construction Permit No.	MEOSI Dose (mrem) (a)	Notes
120	Radiological Control Division	None	ND	(e)
348	Instrumentation & Calibration	None	ND	(e)
463	Biology	None	4.40E-08	(b)
480	Condensed Matter Physics	None	ND	(e)
490/490A	Personnel Monitoring	None	6.70E-05	(b)
463	DJ / EBNN	None	1.08E-15	(b)
510	Physics	None	ND	(e)
535	Instrumentation	None	1.02E-13	(b)
555	Chemistry Facility	None	7.68E-11	(b)
734	Interdisciplinary Science Building	None	9.07E-15	(b)
735	Center for Functional Nanomaterials	None	ND	(e)
745	NSLS-II	None	1.17E-04	(b)
750	HFBR	None	6.71E-05	(c)
801	RRPL	BNL-2022-01	1.79E-04	(b,c)
815	Nonproliferation & National Security	None	2.39E-11	(b)
817	Nuclear Science & Technology	None	9.10E-09	(b)
820	Accelerator Test Facility	BNL-589-01	ND	(e)
830	Environmental Science Department	None	ND	(e)
865	Waste Managerment Facility	None	ND	(e)
902	Superconducting Magnet Division	None	ND	(e)
906	Imaging Lab	None	ND	(e)
911	Collider- Accelerator	None	ND	(e)
925	RF Systems	None	ND	(e)
931	BLIP	BNL-2009-01	1.67E+00	(c)
938	REF / NBTF	BNL-789-01	ND	(e)
942	AGS Booster	BNL-188-01	ND	(d)
---	RHIC	BNL-388-01	ND	(e)
Total Potential Dose from BNL Operations			**1.67E+00**	
EPA Limit (Air Emissions)			**10**	

Notes:
MEOSI = Maximally Exposed Off-site Individual
ND = No Dose
(a) "Dose" in this table means effective dose equivalent to MEOSI in mrem.
(b) Dose is based on emissions calculated using 40CFR61, Appendix D methodology.
(c) Emissions are continuously monitored at the facility.
(d) Booster ventilation system prevents air release through continuous air recirculation.
(e) No radiological dispersible material inventory in 2024.
(f) Sealed sources were excluded from this inventory – no emission.

8.3.1 Dose Modeling Program

Compliance with NESHAPs regulations is demonstrated using EPA dose-modeling software and the Clean Air Act Assessment Package 1988 (CAP88-PC). This computer program uses a Gaussian plume model to characterize the average dispersion of airborne radionuclides released from elevated stacks or diffuse sources. CAP88-PC then calculates the EDE to the MEOSI from the airborne radionuclides released to the environment. Site-specific meteorology data is used to calculate annual emission dispersions for the midpoint of a given wind sector and distance.

Facility-specific radionuclide emission 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. CAP88-PC calculated the EDE at the MEOSI location from the immersion, inhalation, and ingestion pathways, and also calculated the collective population dose within a 50-mile radius of the emission source.

These dose and risk calculations to the MEOSI are based on low-level emissions and chronic intakes. In most cases, the CAP88-PC model provides conservative dose estimates. For the purpose of modeling their dose to the MEOSI, all emissions except those from Building 801 are treated as having been released from the BLIP Facility (see Figure 4-1 in Chapter 4, section 4.2), which is used to represent 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 also factored into the dose assessment. As mentioned earlier, weather data are supplied by measurements from the Laboratory's meteorological towers. Such measurements include wind speed, direction, and frequency, as well as air temperature and precipitation amount (see Chapter 1 for details). Solar radiation effects are also accounted for. A population of six million people surrounding BNL, based on the 2020 U.S. Census and the Geographical Information System design population survey performed in 2021 by Oak Ridge National Laboratory for BNL, was used in the model.

The 2024 effective dose equivalents were estimated using Version 4.0.1.17 of CAP88-PC. The following approaches and assumptions supported the dose estimates in this annual report:

- A conservative approach is used for agricultural data input to the CAP88 modeling program, with 92% of vegetables, 100% of milk, and 99% of meat assumed to originate from the assessment area. The nearest farm is 5.4 km southeast of the BLIP facility.
- The velocity of the exhaust from the BLIP facility stack was updated to reflect 2024's operation. The average volumetric flow rate of the BLIP exhaust system in 2024 was 466 cfm, or 0.220 m^3/sec. With an exit diameter of 0.1 m, the exit velocity was 28.0 m/sec, down slightly from last year's 30.83 m/sec.
- The method of characterizing atmospheric stability for purposes of estimating effluent dispersion was the Solar Radiation/Delta Temperature method for conservatism. This is because the method takes into account the greatest range of variations in atmospheric conditions, such as solar radiation heating and cooling, and results in the highest dose in comparison to the other known methods.

8.3.2 Dose Calculation Methods and Pathways

8.3.2.1 Maximally Exposed Off-Site and On-Site Individual

The MEOSI is defined as a person who resides at a residence, office, or school located beyond the BNL site boundary such that no other member of the public could receive a higher dose. This person is assumed to reside 24 hours a day, 365 days a year, off-site, and close to the emission point nearest to the BNL site boundary. The MEOSI is also assumed to consume significant amounts of fish and deer containing radioactivity assumed to be attributable to Laboratory operations, based on projections from the New York State Department of Health (NYSDOH). 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 dose and risk to members of the public. The dose to the on-site MEI who could receive any dose outside of BNL's controlled areas was determined by TLD measurements (see Table 8-6). The dose to the MEI on-site (near Building 356) was measured at 4 mrem in 2024. The decrease in MEI dose in 2024 was due to a decrease in research irradiation conducted with a Co-60 source in Building 356 during the year, as discussed in section 8.1.2. The 4-mrem dose to the on-site MEI is less than the dose expected from two round-trip flights from Los Angeles, California to New York, New York, and equal to about 1.3% of the average annual natural background in the U.S. of 310 mrem.

Table 8-6. Five-Year Annual Maximally Exposed On-site Individual Dose (2020-2024).

		Annual Total, mrem				
TLD#	Location	2020	2021	2022	2023	2024
TK154	2nd Floor, B120	27	3	26	8	4
TK155	1st Floor, B120	18	7	21	3	3

8.3.2.2 Dose Calculation: Fish Ingestion

To calculate the EDE from fish consumption, the annual intake is estimated first, which is defined at BNL as the average weight of fish consumed in a year by a Reference Person engaged in recreational fishing on the Peconic River. Based on a NYSDOH study, that annual 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 is converted to pico-Curies per gram (pCi/g) wet weight, since wet weight is the form in which fish are caught and consumed. A committed effective dose coefficient for water or milk ingested by an adult, as listed in DOE-STD-1196-2022, Table A-1, is used for each radionuclide to convert the activity concentration to the EDE. The dose is calculated as: dose in (rem/yr) = intake (kg/yr) × activity in flesh (μCi/kg) × dose coefficient (rem/μCi). For BNL's case, the committed effective dose coefficient for Cs-137 is 5.03E-02 rem/μCi.

8.3.2.3 Dose Calculation: Deer Meat Ingestion

The dose calculation for deer meat ingestion is the same as for fish consumption. The same Cs-137 committed effective dose coefficient was used to estimate dose. No other radionuclides associated with Laboratory operations have been detected in deer meat. The total quantity of deer meat ingested during a year has been estimated by the NYSDOH at 64 pounds (29 kg) (NYSDOH 1999).

8.4
Sources: Diffuse, Fugitive, "Other"

Diffuse sources, also known as non-point or area sources, are described as sources of radionuclides which diffuse into the atmosphere but do not have well-defined emission points. Fugitive sources include leaks through window and door frames, as well as unintended releases to the air through vents (i.e., leaks from vents are fugitive sources). As 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 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 potential dose impact to members of the public.

8.4.1 Remediation Work

There was no remediation work with the potential for radiological air emissions performed at BNL in 2024.

8.5
Dose from Air Emission-Monitored Facilities
Actively Monitored Facilities

8.5.1 Brookhaven LINAC Isotope Producer (BLIP)

Source term descriptions for point sources are given in Chapter 4. In 2024, the BLIP facility was the only emission source with the potential to contribute dose to members of the public greater than 1% of the EPA limit (0.1 mrem or 1.0 μSv). The BLIP facility is considered a major emission source in accordance with the ANSI N13.1-2011 standard's graded approach, specifically a Potential Impact Category (PIC) of II.

The gaseous emissions from BLIP are directly and continuously measured in real time with an inline, low-resolution Sodium Iodide (NaI) gamma spectrometer. The spectrometer system is connected to a computer workstation that is used to continuously record and display emission levels. The particulate emissions are sampled for gross alpha and gross beta activity weekly, using a conventional glass-fiber filter which is analyzed at an off-site contract analytical laboratory. Likewise, exhaust samples for tritium are also collected continuously using a silica gel adsorbent which is then analyzed at an off-site contract analytical laboratory on a weekly basis.

In 2024, the BLIP facility was active for 39.14 weeks. Therefore, typical isotopes Carbon-11 (C-11) (half-life: 20.4 minutes) and Oxygen-15 (O-15) (half-life: 122 seconds) were released during operation. A small quantity (7.16E-02 Ci) of residual tritiated water vapor from activation of the targets' cooling water was released since the exhaust system ran continuously, as well. The EDE to the MEOSI from BLIP operations was calculated to be 1.67 mrem (16.7 μSv) in a year.

8.5.2 Radionuclide Research and Production Laboratory (RRPL) (formerly Target Processing Laboratory)

In 2024, there were minor amounts of Iodine-131 on two occasions emitted from the RRPL that had an insignificant impact on the MEOSI dose for the site. See Table 8-5 for the dose from the RRPL.

8.5.3 High Flux Beam Reactor (HFBR)

In 2024, the residual tritium emissions from the HFBR facility were measured at 0.29 Ci, and the estimated dose attributed to those emissions was 6.71E-5 mrem (6.71E-4 μSv) in a year.

8.5.4 Waste Management Facility

In 2024, there were no detectable levels of emissions from the Waste Management Facility.

Inactive Facilities

8.5.5 Brookhaven Medical Research Reactor (BMRR)

In 2024, the BMRR facility remained in a cold shut-down mode as a radiological facility with institutional controls in place. The stack for the BMRR was demolished and removed in August 2022. There was no dose contribution from the BMRR in 2024.

8.5.6 Brookhaven Graphite Research Reactor (BGRR)

In 2024, long-term surveillance of the BGRR continued, as well as the maintenance and periodic refurbishment of structures, systems, and components. This status will continue throughout the period of radioactive decay. There were no radionuclides released to the environment from the complex in 2024.

8.5.7 Unplanned Releases

There were no unplanned releases at BNL in 2024.

8.6 Dose From Ingestion

Radionuclides in the environment may bioaccumulate in deer and fish tissue, bones, and organs. Consequently, samples collected from deer and fish are analyzed to evaluate the contribution of dose to humans from the ingestion pathway.

As discussed in Chapter 6, section 6.3.1, deer meat samples collected on- and off-site near the BNL boundary were used to assess the potential dose impact of deer meat ingestion to the MEOSI. For annual reporting, the maximum tissue concentration in the deer meat collected for sampling is used to calculate the potential dose to the MEOSI. At BNL, Potassium-40 (K-40) and Cs-137 are historically detected in the tissue samples, but K-40 is a naturally occurring radionuclide unrelated to BNL operations.

In 2024, BNL collected samples from 15 deer, 12 of those from a managed cull, and analyzed them for K-40 and Cs-137. It should be noted that, since the site boundaries are not fenced, deer are able to travel back and forth across the site boundary, so the sample data is gathered from the entire aggregate of sample analyses.

From Table 6-2, the average K-40 concentration in all deer tissue samples (All Samples) was 2.97 ± 0.48 pCi/g (wet weight) in the tissue (i.e., meat) and 2.42 ± 0.21 pCi/g (wet weight) in the liver. The average K-40 concentration in culled deer tissue samples (managed cull) was 2.96 ± 0.49 pCi/g (wet weight). The average K-40 concentration in culled deer liver samples was 2.24 ± 0.21 pCi/g (wet weight). The maximum Cs-137 tissue concentration in all samples (non-culled and culled) was 0.42 ± 0.05 pCi/g (wet weight). This Cs-137

tissue concentration was used for MEOSI dose calculations. Therefore, the maximum estimated dose to humans from consuming deer meat containing the maximum Cs-137 concentration was estimated to be 0.61 mrem (6.10 µSv) in a year. This dose is below the health advisory limit of 10 mrem (100 µSv) established by NYSDOH.

The Laboratory maintains an ongoing program of collecting and analyzing fish from the on-site portions of the Peconic River and surrounding freshwater bodies. However, the Peconic River is an intermittent stream, with flow occurring predominantly via groundwater discharge in the Spring and Fall (i.e., a "gaining" stream) and completely drying up during dry periods (i.e., a "losing" stream). In 2024, the Peconic River on-site had water only sufficient to support a few fish. Therefore, no fish were collected. As a result, there was no measured dose attributed to BNL legacy Cs-137 levels in fish in the Peconic River.

8.7 Dose to Aquatic and Terrestrial Biota

DOE-STD-1153-2019, 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 1.8, 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.

In 2024, the terrestrial animal and plant doses were evaluated based on 0.64 ± 0.08 pCi/g of Cs-137 (see Table 6-3) found in soil north of the North Fire Break and East Margin Path, and a Strontium-90 (Sr-90) concentration of 0.77 pCi/L (see Table 5-5) in the surface water collected from the HQ BNL Site Boundary station on-site. The resultant dose to terrestrial animals was calculated to be 0.031 mGy/day, and to plants to be 0.0029 mGy/day. The dose to terrestrial animals was well below the biota dose limit of 1 mGy/day, and the dose to plants was below the limit of 10 mGy/day for terrestrial plants.

To calculate the dose to aquatic and riparian animals in 2024, the surface-water Sr-90 concentration mentioned above, 0.77 pCi/L, was used. A Cs-137 concentration of 0.35 ± 0.07 pCi/g was detected in vegetation between East Saddle and East Margin Paths. Using these concentrations, the calculated estimate of dose to aquatic animals was 0.214E-3 mGy/day, and the dose to riparian animals was 2.87E-3 mGy/day. Therefore, the dose to aquatic animals was well below the limit of 10 mGy/day, and the dose to riparian animals was also well below the 1 mGy/day limit specified by the Order.

8.8 Dose From All Pathways

Table 8-7 summarizes the estimated dose to the MEOSI from the inhalation, immersion, and ingestion pathways, the percentage of the 100-mrem annual allowable dose limit posed by the estimated MEOSI dose by pathway, and the potential cumulative population dose to the surrounding population via the inhalation pathway from the BNL site, all for the years 2020 through 2024. The total dose to the MEOSI from the inhalation and ingestion pathways in 2024 was estimated at 2.28 mrem (22.8 µSv). In comparison, the DOE limit on dose from all pathways is 100 mrem (1 mSv). The cumulative population dose from airborne emissions was 9.8 person-rem (9.8E-2 person-Sv) in 2024. There is no current regulatory limit on cumulative population dose. However, BNL strives to maintain all doses received ALARA.

In conclusion, the effective dose from all pathways due to BNL operations in 2024 was well below the DOE and EPA regulatory limits, and the ambient off-site TLD dose was within limits of 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 estimated doses from other sources of radiation. The average annual dose from all natural background sources and radon in the United States is approximately 310 mrem (3.10 mSv) (from the Ionizing Radiation Dose Range Chart, Department of Energy Office of Public Radiation Protection). A mammogram gives a dose of approximately 250 mrem (2.5 mSv) and a dental x-ray leads to a dose of approximately 70 mrem (0.7 mSv) to an individual. Therefore, a dose of 2.28 mrem from all environmental pathways from BNL is a minute fraction of the dose from that of several routine diagnostic procedures, as well as natural background radiation.

Table 8-7. Five-Year Site Dose Summary, (2020-2024).

Pathway	2020	2021	2022	2023	2024
	Annual Maximally Exposed Off-Site Individual Dose, mrem				
Inhalation					
Air[1]	5.60E-05	0.71	1.19	2.57	1.67
Ingestion					
Drinking Water[3]	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Fish[2]	Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled
Deer	0.913	2.9	3.82	0.35	0.61
All Pathways	**0.91**	**3.61**	**5.01**	**2.92**	**2.28**
Pathway	**Percent of DOE 100-mrem/yr Dose Limit, %**				
Inhalation					
Air[1]	<0.001	<1.0	<1.5	<2.6	<1.7
Ingestion					
Drinking Water[3]	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Fish[2]	Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled
Deer	<1.0	<3.0	<4	<0.4	<0.7
All Pathways	**<1.0**	**<4.0**	**<5.5**	**<3**	**<2.5**
Pathway	**Estimated Population Dose Per Year, person-rem**				
Inhalation					
Air[1]	2.05E-03	0.773	5.6	12.5	9.8
Ingestion					
Drinking Water[3]	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Fish[2]	Not Tracked	Not Tracked	Not Tracked	Not Tracked	Not Tracked
Deer	Not Tracked	Not Tracked	Not Tracked	Not Tracked	Not Tracked
All Pathways	**2.05E-03**	**0.773**	**5.6**	**12.5**	**9.8**

Notes:
1 - Immersion dose is included in the air dose estimate for inhalation.
2 - Source River remained dried up in 2024, so no fish data was available to represent magnitude since sampling was not possible in 2024.
3 - 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.

References and Bibliography

40 CFR 61, Subpart H. National Emission Standards for Hazardous Air Pollutants. U.S. Environmental Protection Agency, Washington, DC. December 15,1989.

ANSI/HPS, 2011. Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities. N13.1-2011.

DOE, 2019. A Graded Approach for Evaluation of Radiation Doses to Aquatic and Terrestrial Biota. DOE-STD-1153-2019. U.S. Department of Energy, Washington, DC. February 12, 2019.

DOE, 2025. Radiation Protection of the Public and the Environment. DOE Order 458.1. U.S. Department of Energy, Washington, DC. January 30, 2025.

DOE, 2022. Derived Concentration Technical Standard, DOE-STD-1196-2022. U.S. Department of Energy, Washington, DC. December 2022.

Collection of groundwater samples using one of the Lab's drilling rigs.

Chapter 9

Quality Assurance

Quality Assurance is an integral part of every activity at Brookhaven National Laboratory (BNL).

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. Most analyses are performed by contract laboratories that are state certified and routinely participate in independent performance testing. QC at the analytical laboratories is maintained through daily instrument calibration, efficiency, 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 2024 Site Environmental Report (SER) are reliable and of acceptable quality.

9.1 Quality Program Elements

As required by the Department of Energy (DOE), 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, Subpart A, Quality Assurance Requirements, and DOE Order 414.1D, Quality Assurance. The responsibility for quality at BNL starts with the Laboratory Director, who approves the policies and standards of performance governing work that extends throughout the entire organization. The purpose of the BNL QA Program is to implement QA methodology throughout the various Laboratory management systems and associated processes to do the following:

- Plan and perform operations in a reliable and effective manner to minimize any impact on the environment, safety, security, and health of the staff and public.
- Standardize processes and support continual improvement.
- Enable the delivery of products and services that meet customers' requirements and expectations.
- Support an environment that facilitates scientific and operational excellence.

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 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 Environmental Protection Agency (EPA) Data Quality Objective (DQO) process (USEPA 2006), or its equivalent.

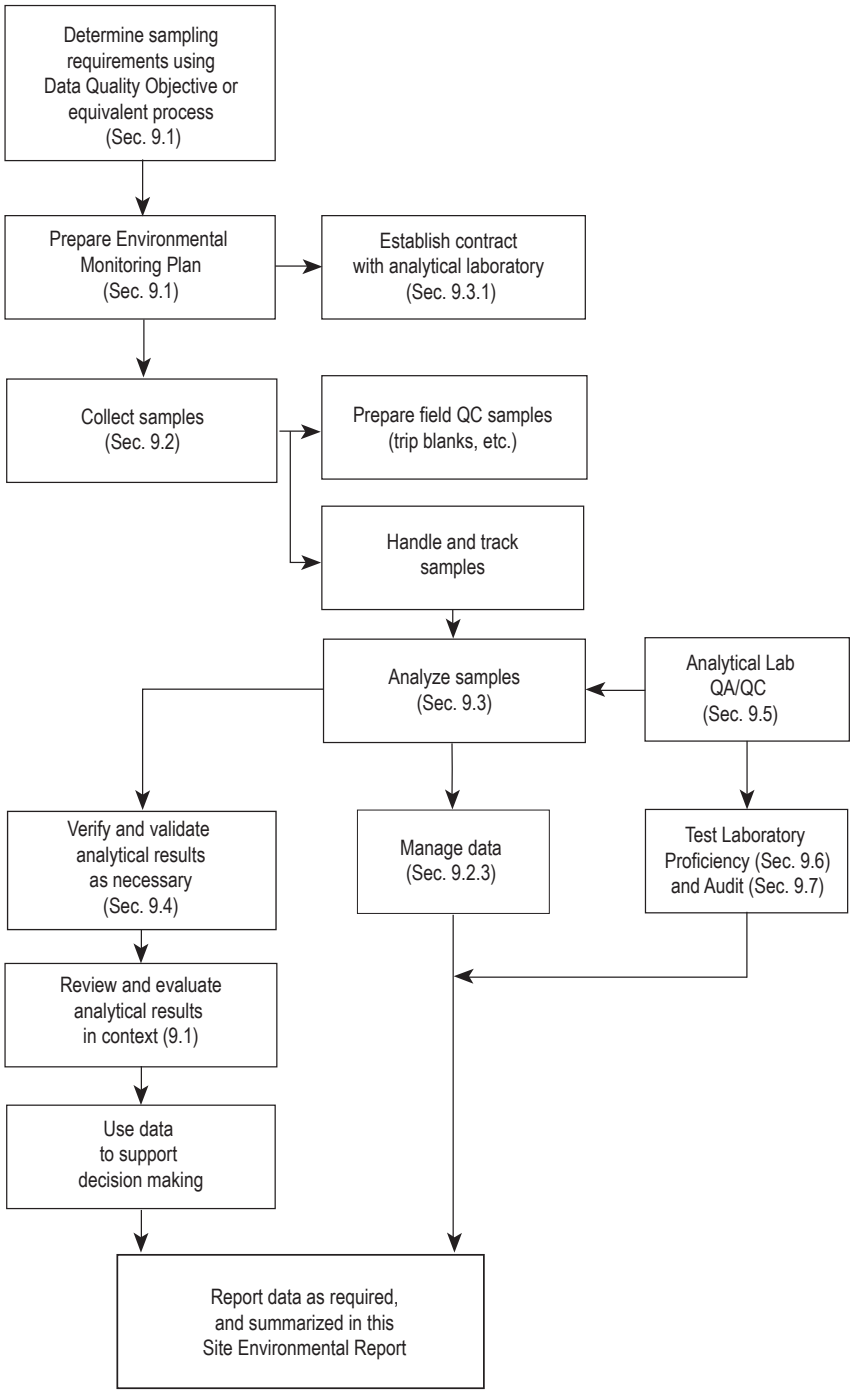


Figure 9-1.
Flow of Environmental Monitoring QA/QC Program Elements.

During this process, the project manager for each environmental program determines the type, amount, and quality of data needed to support decision making, legal requirements, and stakeholder expectations. An environmental monitoring plan or project-specific sampling plan is then prepared, specifying the location, frequency, type of sample, analytical 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 sample analysis. The EM-SOPs direct sampling technicians on proper sample collection, preservation, and handling requirements. Field QC samples are prepared as necessary and analyzed in the field or at a certified contract analytical laboratory. The results are then validated or verified in accordance with published procedures.

Finally, the 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.). The data are used to support decision making, reported as required, and summarized in this annual report.

9.2
Sample Collection and Handling

In 2024, environmental monitoring samples were collected as specified in the Environmental Monitoring Plan Update (BNL 2024a) and project-specific work plans. BNL uses SOPs that are consistent with industry and regulatory standards for the collection of environmental samples, including groundwater, surface water, soil, sediment, air, flora, and fauna. These procedures contain detailed information on the sample collection process, including what types of equipment to use; equipment calibration; how to properly collect, handle, and preserve samples; sample handling and shipment; and how to manage any wastes generated during sampling. QC checks of sampling processes include the collection of field duplicates, matrix spike samples, field blanks, trip blanks, and equipment blanks.

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 2024. 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 2020).

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 are 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 2024b), field sampling technicians are also required to maintain bound, weatherproof field logbooks and electronic tablets, which are used to record sample identification (ID) numbers, collection times, descriptions, collection methods, and COC numbers. Daily weather conditions, field measurements, and other appropriate site-specific observations are also recorded in the logbooks.

Groundwater monitoring well sampling in accordance with standard operating procedures.

9.2.1.2 Preservation and Shipment

Before sample collection, field sampling technicians prepare all bottle labels and affix them to the appropriate containers, as defined in the applicable EM-SOPs. Appropriate chemical preservatives are added to the containers before or immediately after collection, and samples are refrigerated as necessary. Sample preservation is maintained, as required, throughout the shipping of the samples to the analytical laboratory.

If samples are sent via a commercial carrier, a bill-of-lading is used. COC seals are placed on the shipping containers and their intact status upon receipt indicates that custody was maintained during shipment.

Upon receipt of the samples, the contract laboratory verifies that proper preservation requirements have been met. BNL is notified as soon as practical if a sample arrives unpreserved, improperly preserved, or at the wrong temperature.

Sample preservations, including incorrect preservation, are noted on the sign-in documentation, and included with every data package. If the BNL Project Manager, with the help of a QC chemist and/or radiochemist, determines that an incorrect preservation issue would result in data that does not meet the data quality objectives of the project, the analysis would be cancelled, and new samples would be collected, as necessary.

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 (MS)/matrix spike duplicate (MSD) 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, “Collection and Frequency of Field Quality Control Samples” (BNL 2022a). Field blanks and trip blanks were collected for all appropriate media in 2024.

An equipment blank is a volume of solution (in this case, laboratory-grade water) that is used to rinse a sampling tool after decontamination. Equipment blank samples are used 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 container occurred during shipment from the manufacturer,

while the container was in storage, during shipment to a contract analytical laboratory, or during analysis of a sample at a contract analytical laboratory. Trip blanks consist of an aliquot of laboratory-grade water sealed in a sample bottle, prepared by the contract analytical laboratory or manufacturer prior to shipping the sample bottles to BNL. Trip blanks were included with all shipments of aqueous samples for VOC analysis in 2024.

Field blanks are collected to check for cross-contamination that may occur during sample collection. A field blank consists of an aliquot of laboratory-grade water that is poured into a sample container in the field. 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. A Field Reagent Blank (FRB) is collected when analyzing for Per- and Polyfluoroalkyl Substances (PFAS) in groundwater or potable water analyzed using EPA Method 537.1. The FRB must use the same preservative as the samples and is handled the same way as a Field Blank. For other programs, the frequency of field blank collection is based on their specific DQOs.

In 2024, the most common contaminant detected above reporting limit (RL) in the trip, field, and equipment blanks was traced to low levels of styrene, acetone, and methylene chloride (Table 9-1). These commonly observed VOCs are likely due to minor cross contamination of the samples at the analytical laboratory, and their detection does not indicate significant problems with the reliability of the analytical results.

Several other commonly observed compounds were also detected at low levels. When contaminants are detected, validation or verification procedures are used, where applicable, to qualify the associated data as “non-detects” (see Section 9.4). No contamination was detected in the FRBs during 2024. The results from blank samples collected during 2024 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 (USEPA 2024). For example, in the groundwater monitoring program, duplicates are collected for 5% of the total number of samples collected for a project per sampling round.

During 2024, a total of 167 duplicate samples were collected for non-radiological analyses and 101 duplicates were collected for radiologic analyses. Not all parameters were analyzed in every duplicate. The parameters in each duplicate were consistent with those required for the specific program the duplicate was monitoring. Of the 7,981 non-radiologic parameters analyzed, 279 parameters (less than 4%) were above 50% Relative Percent Difference (RPD). For the radiologic parameters, 19 of the 272 parameters (7%) failed to meet criteria. These results are indicative of analytical method consistency within the laboratory, and that consistency within the sample collection process results in valid, reproducible data.

MSs and MSDs are used to determine whether the sample matrix (e.g., water, soil, air, vegetation, or oil) adversely affected the sample analysis. A spike is a known amount of analyte added to a sample. MSs are performed at a rate specified by each environmental program’s DQOs. The rate is typically one per twenty samples collected per project. For 2024, a total of 268 MS/MSD samples were collected for non-radiological analyses and 213 MS/MSD samples were collected for radiological analyses. Not all parameters were analyzed for every MS/MSD pair. Of the 15,447 non-radiological parameters analyzed, 925 parameters (5%) were outside of the QA criteria. For the radiological parameters, 373 of the 503 parameters (74%) meet QA criteria. These overall non-radiological results are indicative of consistent measuring reproducibility with the laboratories and field sampling teams. Radiological results indicate some matrix interference and require more attention to the reported sample results.

Table 9-1. Summary of Detections in Trip, Field, and Equipment Blank Samples.

Constituent	Number of Analyses	Number of Detects	Minimum	Maximum	Typical Reporting Limit	Units
Trip Blank Results						
Methylene chloride	84	8	0.56	2.14	0.5	µg/L
Styrene	84	8	0.18	0.3	0.5	µg/L
Methyl bromide	84	2	0.35	0.37	0.5	µg/L
Naphthalene	84	2	0.38	0.44	0.5	µg/L
1,1,1-Trichloroethane	84	1	0.38	0.38	0.5	µg/L
1,2,3-Trichlorobenzene	84	1	0.37	0.37	0.5	µg/L
Toluene	84	1	0.34	0.34	0.5	µg/L
Field Blank Results						
Organic Compounds						
Methylene chloride	58	8	0.51	1.52	0.5	µg/L
Styrene	58	4	0.3	0.42	0.5	µg/L
Chloroform	58	3	0.26	0.48	0.5	µg/L
cis-1,2-Dichloroethylene	58	1	0.37	0.37	0.5	µg/L
Methyl bromide	58	1	0.28	0.28	0.5	µg/L
Methyl chloride	58	1	0.2	0.2	0.5	µg/L
Metals						
Iron	2	1	32	32	200	µg/L
General Chemistry Parameters						
Ammonia (as N)	2	1	0.05	0.05	0.1	mg/L
Nitrogen	2	1	0.085	0.085	0.1	mg/L
Total Kjeldahl Nitrogen	4	1	0.085	0.085	1	mg/L
Equipment Blank Results						
Organic Compounds						
Perfluorobutyric acid (PFBA)	19	2	0.42	0.71	3.4	ng/L
Perfluorooctanoic acid (PFOA)	19	2	0.61	0.83	1.6	ng/L
Perfluoroheptanoic acid (PFHpA)	19	1	0.84	0.84	1.6	ng/L
Perfluoropentanoic acid (PFPeA)	19	1	1.1	1.1	1.6	ng/L
Acetone	3	3	1.82	3.66	0.5	µg/L
1,4-Dioxane	17	1	0.1	0.1	0.2	µg/L
Metals						
Barium	6	2	3.16	3.97	1	µg/L
Calcium	3	2	89.3	151	50	µg/L
Mercury	30	2	0.28	0.31	0.2	µg/L
Aluminum	3	1	139	139	68	µg/L
Iron	3	1	39.7	39.7	30	µg/L
Lead	6	1	0.0383	0.0383	0.5	µg/L
Potassium	3	1	90.1	90.1	50	µg/L
Zinc	3	1	4.26	4.26	3.3	µg/L

µg/L Micrograms per liter.
mg/L Milligrams per liter.
ng/L Nanograms per liter.

9.2.3 Tracking and Data Management

Most environmental monitoring samples and analytical results were tracked in BNL's Environmental Information Management System (EIMS), a database system used to store, manage, verify, protect, retrieve, and archive BNL's environmental data. Tracking is initiated when a sample is recorded on a COC form. Copies of the COC forms and supplemental forms are provided to the data coordinator to be entered into the EIMS. Each contract analytical laboratory also maintains its own internal sample tracking system (also known as a Laboratory Information Management System).

Following sample analysis, the contract analytical laboratory sends the results to the BNL chemist and project manager for initial review. When required by project-specific DQOs, the analytical data may also be sent to an independent contract chemist for full data validation. Once the results of the analyses are determined to be complete and of acceptable quality, the data are entered into the EIMS. Once entered into EIMS, reports can be generated using a web-based data query tool.

9.3
Sample Analysis

In 2024, environmental samples were analyzed by five contract analytical laboratories, whose selection is discussed in Section 9.3.1. All samples were analyzed according to EPA-approved methods or by standard industry methods where no EPA methods are available (e.g., for tolyltriazole). In addition, during sample collection, field sampling technicians used calibrated field instrumentation for parameters such as conductivity, dissolved oxygen, pH, temperature, and turbidity.

9.3.1 Qualifications

BNL used the following five contract analytical laboratories for analysis of environmental samples in 2024:

1. Chemtex Lab in Port Arthur, Texas, for select non-radiological analytes;
2. General Engineering Lab (GEL) in Charleston, South Carolina, for radiological and non-radiological analytes;
3. PACE Lab in Melville, New York, for non-radiological analytes;
4. Eurofins-Test America (TA), based in Denver, Colorado, for non-radiological analytes; Non-radiological samples were also subcontracted out to TA-Buffalo and TA-Sacramento; Radiological samples from BNL were subcontracted out to TA-St. Louis for radiological analysis; and
5. Eberline Analytical in Oak Ridge, Tennessee, for radiological analytes.

The process of selecting contract analytical laboratories involves the following factors:

- Maintaining required New York State Department of Health (NYSDOH) certifications for the specific analyses to be performed, as applicable;
- Their record on performance evaluation (PE) tests;
- Their contract with the DOE Integrated Contract Procurement Team;
- Pre-selection bidding; and
- 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. Four of the five contract laboratories used by BNL in 2024 were certified by the NYSDOH for the relevant analytes, where such certification existed. NYSDOH does not currently certify for the specific analytes tested by Chemtex Lab (e.g., tolyltriazole), which has Texas National Environmental Laboratory Accreditation Program (NELAP) accreditation. 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.

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 was not initiated, or the sample was not extracted, within the time frame required by EPA or by the contract.
- **Incorrect test method** – The analysis was not performed according to a method required by the contract.
- **Poor recovery** – The chemical compounds or radioisotopes added to the sample before laboratory processing were not recovered at the ratio required by the applicable analytical method/performance criteria.
- **Insufficient QA/QC data** – Supporting data received from the contract analytical laboratory were insufficient to allow for the verification or validation of results.
- **Incorrect minimum detection limit (MDL)** – The contract analytical laboratory reported extremely low levels of analytes as "less than minimum detectable," but the contractually required limit is not used.
- **Invalid COC** – There was a failure to maintain proper custody of samples as documented on COC forms.
- **Instrument failure** – The analytical instrument did not perform correctly.
- **Preservation requirements not met** – The preservation requirements identified by the specific analytical method were not met or properly documented.
- **Contamination of samples from outside sources** – Possible sources include sampling equipment, personnel, and the contract analytical laboratory.
- **Matrix interference** – Analysis was 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 common errors, including instrument calibration that was not conducted as required, internal standard errors, transcription errors, and calculation errors. The amount of data that is subjected to the validation process 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.

The results of the verification and/or validation process are entered into the EIMS. When analyses are determined to be outside of QC parameters, a qualifier is applied to the result stored in the EIMS. Results that have been rejected are qualified with an "R." Rejected results are not used in the preparation of this report.

The most common QC issue encountered during 2024 was the detection of low-level contamination in the trip, field, and method blanks used in VOC analyses. Results for the trip, equipment, and field blanks are summarized in Table 9-1. This issue resulted in minor qualifications of sample results. Also, minor violations of laboratory control sample results were also common. In most cases, the violations do not result in qualified sample results.

9.4.1 Checking Results

Non-radiological data analyzed in 2024 were verified and/or validated when required by project DQOs, BNL EM-SOPs, and/or EPA contract laboratory program guidelines (USEPA 2000). Radiological packages were verified and/or validated using BNL and DOE guidance documents (BNL 2022b). During 2024, the verifications were conducted using a combination of manually checking data packages and by the use of a computer program developed by BNL to verify the completeness of electronic data deliverables (EDDs) before the data are entered into BNL's EIMS.

9.5
Contract Analytical Laboratory QA/QC

In 2024, 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. Nonconformance reports are generated when discrepancies are found in field sampling designs, documented procedures, COC forms, data analyses, data processing systems, and QA software, or when failures in Proficiency Evaluation (PE) testing occur. Following investigation into the root causes, corrective actions are taken and tracked to closure.

9.6
Performance or Proficiency Evaluations

All the contract analytical laboratories (Chemtex, Eberline, GEL, PACE, and TA) participated in several national and state PE testing programs in 2024. Chemtex Lab participated in PE testing for total phosphorus, which is used to determine one of the specific analytes Chemtex analyzed for BNL (specifically for tolyltriazole, 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 DOE Mixed Analyte Performance Evaluation Program (MAPEP), Resource Technology Corporation, Phenova, and the NYSDOH Environmental Laboratory Accreditation Program (ELAP). The results from these tests are summarized in Section 9.6.

9.6.1 Summary of Test Results

As shown by Figures 9-2 and 9-3, test 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.

Table 9-2 provides a summary of the DOE's Consolidated Audit Program (DOECAP) audit results. The TA-St. Louis lab had one Priority II finding; Eberline had 1 Priority II finding; GEL had 1 Priority I finding. Chemtex, GEL, and PACE were not audited for 2024 for DOECAP. Priority II findings are deviations from a requirement. Priority I findings are issues that present substantial risk if not resolved in an expedited manner. Resolution/impacts of these findings are discussed in Section 9.7.

Table 9-2. Summary Results of 2024 DOECAP Audits.

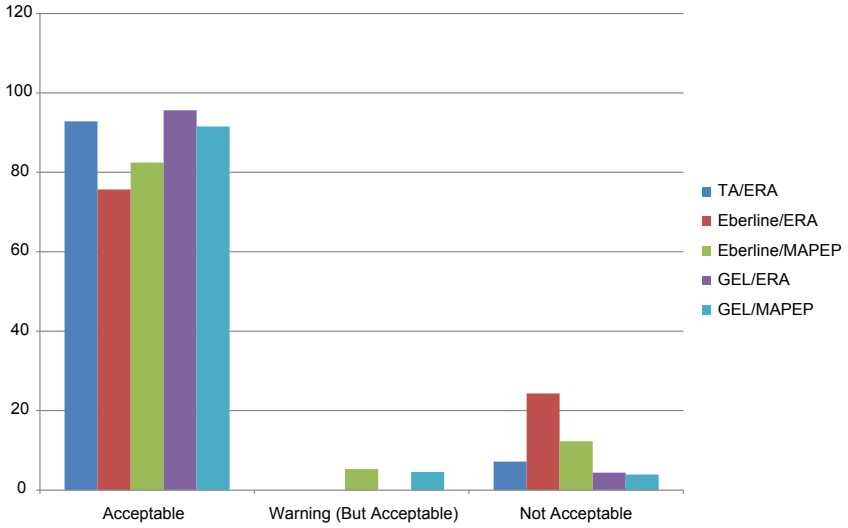
Laboratory	Finding Priority	Area of Concentration	Number of Findings
Eurofins/Test America, St. Louis, Missouri December 6-8, 2023	II	Radiochemistry	2
	NA	Quality Assurance	NA
	NA	Organic Analyses	NA
	NA	Inorganic Analyses and Wet Chemistry	NA
	NA	Laboratory Information Management Systems	NA
	NA	Materials Management	NA
GEL Laboratories, Charleston, South Carolina February 20-21, 2024	NA	Radiochemistry	NA
	NA	Quality Assurance	NA
	I	Organic Analyses	1
	NA	Inorganic Analyses and Wet Chemistry	NA
	NA	Laboratory Information Management Systems	NA
	NA	Materials Management	NA
Eberline Analytical Corp., Oak Ridge, Tennessee May 29-31, 2024	NA	Radiochemistry	NA
	II	Quality Assurance	1
	NA	Organic Analyses	NA
	NA	Inorganic Analyses and Wet Chemistry	NA
	NA	Laboratory Information Management Systems	NA
	NA	Materials Management	NA

NA Not applicable.

9.6.1.1 Radiological Assessments

Figure 9-2 summarizes radiological performance scores in the ERA and MAPEP programs for 2024. Eberline, GEL and TA participated in the ERA radiological PE studies with Eberline having an average overall score of 76%. GEL had an average overall score of 96%. TA also had an overall score of 93%. GEL scored 92% in the MAPEP program, while Eberline had 82%. TA no longer participates in the MAPEP tests. Chemtex and PACE did not analyze radiological samples for BNL.

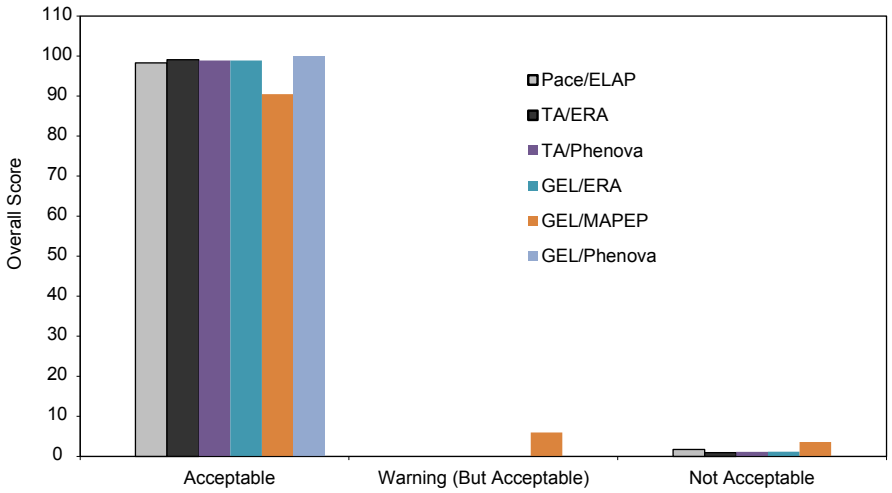
Figure 9-2.
Summary of Scores in the Radiological Proficiency Evaluation Programs.



9.6.1.2 Non-radiological Assessments

Figure 9-3 summarizes the non-radiological performance results of three participating laboratories (GEL, Pace, and TA) in the ERA, MAPEP, Phenova, and ELAP tests. During 2024, PACE participated in the NYSDOH ELAP evaluations of performance on tests of non-potable water, potable water, and solid wastes. NYSDOH found 98% of PACE's non-radiological tests to be in the Acceptable range. GEL participated in the ERA program for non-potable water, potable water, and solid wastes and received a score of 99%. GEL also scored 90% in the MAPEP TA participated in the ERA and Phenova programs for non-potable water, potable water, and solid wastes with scores of 99% and 99%, respectively.

Figure 9-3.
Summary of Scores in the Non-radiological Proficiency Evaluation Programs.



9.7 Audits

As part of DOECAP, TA-St. Louis was audited in December 2023 (ANAB 2023) by American National Standards Institute-American Society for Quality (ANSI-ASQ) National Accreditation Board (ANAB). During the audits, one nonconformity was cited in radiochemistry. This finding did not affect the quality of BNL's data.

GEL was re-audited in February 2024 (ANAB 2024a) by ANSI-ASQ ANAB. This was a follow up of the 2023 DOECAP audit. One nonconformity in Organics was found. This finding did not affect the quality of BNL's data.

Eberline was audited in May 2024 (ANAB 2024b) by ANSI-ASQ ANAB. During the audits, one nonconformity was cited in Quality Control. This finding did not affect the quality of BNL's data.

Chemtex and PACE were not assessed for DOECAP during the 2024 calendar year. Based on the audit, assessments, and corrective action response, the analytical laboratories met the criteria of the audit programs for Acceptable status.

9.8 Conclusion

The data validations and data verifications conducted on analytical results are designed to eliminate data that fails to meet the DQOs of each project. The results of the independent PE assessments and assessments of contractor laboratories summarized in this report are also used to assess the quality of the results. As a result of these assessments, BNL has determined that the data used in this SER are of acceptable quality.

References and Bibliography

USEPA. 2006a. Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4, EPA/240/B-06/001, U.S. Environmental Protection Agency, Office of Environmental Information, Washington DC

USEPA 2024, Region 2 Quality Assurance Guidance and Standard Operating Procedures, Retrieved September 6, 2024, from https://www.epa.gov.

10CFR 830 Subpart A. U.S. Department of Energy. Quality Assurance Requirements. U.S. Code of Federal Regulations. 2000.

ANAB 2023. 2023 DOECAP Accreditation Program Assessment Report for Eurofins Test America Laboratories, Inc.-St. Louis, Missouri, December 2023

ANAB 2024a. 2024 DOECAP Accreditation Program Assessment Report for GEL Laboratories, LLC.-Charleston, South Carolina, February 2024

ANAB 2024b. 2024 DOECAP Accreditation Program Assessment Report for Eberline Analytical Corporation.-Oak Ridge, Tennessee, May 2024

BNL 2020. EM-SOP 109. Chain-of-Custody, Storage, Packaging, and Shipment of Samples. Brookhaven National Laboratory. Upton, NY.

BNL 2022a. EM-SOP 200. Collection and Frequency of Field Quality Control Samples. Brookhaven National Laboratory, Upton, NY

BNL 2022b. EM-SOP 209. Radiochemical Data Validation. Brookhaven National Laboratory, Upton, NY.

BNL 2024a. Brookhaven National Laboratory Environmental Monitoring Plan Update. Brookhaven National Laboratory, Upton, NY. January 2024.

BNL 2024b. EM-SOP-201 Documentation of Field Activities. Brookhaven National Laboratory, Upton, NY.

DOE Order 414.1D. Quality Assurance. U.S. Department of Energy. Washington, DC. August 16, 2011.

DOE Order 458.1. Radiation Protection of the Public and Environment. U.S. Department of Energy. Washington, DC. February 11, 2011.

APPENDIX A
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.

AEC	Atomic Energy Commission
AFV	Alternative Fuel Vehicles
AGS	Alternating Gradient Synchrotron
ALARA*	"As Low As Reasonably Achievable"
AMSL	above mean sea level
AMU	atomic mass unit
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
ATF	Accelerator Test Facility
AWQS	Ambient Water Quality Standards
BAF	Booster Applications Facility
BER	Brookhaven Executive Roundtable
BGD	belowground duct
BGEPA	Bald and Golden Eagle Protection Act
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
CAFE	Corporate Average Fuel Economy
CAP	Clean Air Act Assessment Package
CBS	chemical bulk storage
CCR	Consumer Confidence Report
CCWF	Central Chilled Water Facility
CEDR	Consolidated Energy Data Report
CEMS	continuous emission monitoring systems
CERCLA*	Comprehensive Environmental Response, Compensation and Liability Act
Cf-252	californium-252
CFC-11	chloroflourocarbon an ozone- depleting refrigerant
cfm, cfs	cubic feet per minute, per second
CFN	Center for Functional Nanomaterials
CFR	U.S. Code of Federal Regulations
CHP	combined heat and power
Ci*	curie
CLCP	Climate Leadership and Community Protection Act
CO COC*	certificate to operate chain-of-custody
CRM	Cultural Resource Management
CRMP	Cultural Resource Management Plan
Cs	cesium
CSF	Central Steam Facility
CSI	Computational Science Initiative
CTN	Center for Transitional Neuroimaging
CVO	Contractor Vendor Orientation
CWA*	Clean Water Act
CXs	categorical exclusions
CY	calendar year
D2O*	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
E	Endangered
EA*	Environmental Assessment
EBIS	Electron Beam Ion Source
ECM	Energy Conservation Measures
ECR	Environmental Compliance Representative
EDB*	ethylene dibromide
EDE*	Effective Dose Equivalent
EDTA	ethylenediaminetetraacetic acid
EE/CA	Engineering Evaluation/Cost Analysis
EE-OICPA	Energy Employees Occupational Illness Compensation Program Act
EIC	Electron Ion Collider
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 Purchasing
ERP	Environmental Restoration Projects
ERPP	Environmental Radiation Protection Program
ERA	Environmental Resource Associates
ERD	Environmental Restoration Division
ES*	environmental surveillance
ESF	SUNY School of Environmental Science and Forestry
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
FCA	Facility Condition Assessment
FCM	Facility Complex Manager
FEMP	Federal Emergency Management Program
FERN	Foundation for Ecological Research in the Northeast
FFCA*	Federal Facilities Compliance Act
FFA	Federal Facilities Agreement
FHWMF	Former Hazardous Waste Management Facility
FIFRA*	Federal Insecticide, Fungicide, and Rodenticide Act
FM	Facility Monitoring
FPM	Facility Project Manager
FRP	Facility Response Plan
FWS*	U.S. Fish & Wildlife Service
FY	fiscal year
GAC	Granular Activated Carbon
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
GSA	US General Services Administration
GSF	gross square feet
GWh	gigawatt hour
GWP	Global warming potential
HAA5	five haloacetic acids
HAP	Hazardous Air Pollutant
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
IAEA	International Atomic Energy Agency I
IAG	Interagency Agreement
IC	ion chromatography
ICP/MS	inductively coupled plasma/mass spectrometry
IGA	Investment Grade Audit
ILA	industrial, landscaping, and agricultural
IOPS	Integrated Operational Performance System
IPM	Integrated Pest Management
ISB	Interdisciplinary Science Building
ISMS	Integrated Safety Management System
ISO*	International Organization for Standardization K potassium
kBq	kilobecquerels (1,000 Bq)
KeV	kilo (thousand) electron volts
Kg	kilograms
Kr	kryptonite
kwH	kilowatt hours
lbs.	pounds

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
LTRA	Long Term Remedial Action
mA	milli-amperes
M&V	Measurement and Verification
MACT	Maximum Available Control Technology
MAPEP	Mixed Analyte Performance Evaluation Program
MAR	Materials-at-risk
MBAS	methylene blue active substances
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
MDC	minimum detectable concentration
MDL*	minimum detection limit
MEG	Miller Environmental Group
MEI*	maximally exposed individual
MEOSI	maximally exposed off-site individual
MET	Meteorological Services
MeV	million electron volts
MFL	million fibers per liter
MGD	million gallons per day
mg/L	milligrams per liter
MMBtu	million British thermal units
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPF	Major Petroleum Facility
MPN	most probable number
MPO	Modernization Project Office
mrem	milli (thousandth of a) rem
MRC	Medical Research Center
MRDL	maximum residual disinfectant level
MRI	Magnetic Resonance Imaging
MSL*	mean sea level
mSv	millisievert
MTBE	methyl tertiary butyl ether
MW	megawatt
MWh	megawatt hours
NA	not analyzed
NASA	National Aeronautics and Space Administration
NCRP	National Council on Radiation Protection and Measurements
ng/L	nanograms per liter
ND	not detected
NEAR	Neighbors Expecting Accountability
NEPA*	National Environmental Policy Act and Remediation
NELAC	National Environmental LaboratoryAccreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NEPA*	National Environmental Policy Act
NESHAPs*	National Emission Standards for Hazardous Air Pollutants
NetDMR	Network DMR
ng/J	nano (one-billionth) gram per Joule
NHPA*	National Historic Preservation Act
NHTSA	National Highway Traffic Safety Administration
NIST	National Institute for Standards and Technology
nm	nanometer
NNSS	Nevada National Security Site
NO2	nitrogen dioxide
NOV	Notice of Violation
NOX*	nitrogen oxides
NOEC	no observable effect concentration
NPDES	National Pollutant Discharge Elimination System
NR	not required
NRMP	Natural Resource Management Plan
NS	not sampled
NSERC	Northeast Solar Energy Research Center
NSF-ISR	NSF-International Strategic Registrations, Ltd.
NSLS	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source II
NSPS	new source performance standards
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
O3*	ozone
O&M	Operation and Maintenance
ODS	ozone-depleting substances
OEP	Office of Education Programs
OFIs	opportunities for improvement
OHSAS	Occupational Health and Safety Assessment Series
OMC	Occupational Medical Clinic
ORC	oxygen-releasing compound
ORNL	Oak Ridge National Laboratory
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
PEMP	Performance Evaluation Management Plan
PET	positron emission tomography
PFAS	per- and polyfluoroalkyl substances
PFCs	Perfluorocarbons
PFOA	perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PIC	potential impact category
PIMS	Proposal Information Management System
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PPTRS	Pollution Prevention Tracking System
PRAP	Proposed Remedial Action Plan
PUE	Power Utilization Effectiveness
PV	photovoltaic
QA*	quality assurance
QAPP	Quality Assurance Program Plan QC* quality control
QCU	quantum chromodynamics
QM	Quality Management
R2A2	Roles, Responsibilities, Accountabilities, and Authorities
R-11 (etc.)	ozone-depleting refrigerant
RA*	removal action
RACT	Reasonably Available Control Technology
RATA	Relativistic accuracy test
RCA	recycled concrete aggregate
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
RRPL	Radionuclide Research and Production Laboratory
RSB	Research Support Building
RWMB	Radioactive Waste Management Basis
RWP	Radiological Work Permit
S&M	surveillance and maintenance
SARA*	Superfund Amendments and Reauthorization Act
SBMS*	Standards Based Management System
SCDHS	Suffolk County Department of Health Services
SCR	Special Case Resource
SCR	Stakeholder and Community Relations
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
SO2	sulfur dioxide
SOP	standard operating procedure
SPB	Southern Pine Beetle
SPCC	Spill Prevention Control and Countermeasures
SPDES*	State Pollutant Discharge Elimination System
Sr	strontium
SSPP	Strategic Sustainability Performance Plan
STAR	Solenoid Tracker at RHIC
STEM	Scanning Transmission Electron Microscope
STL	Severn Trent Laboratories, Inc.
STP	Sewage Treatment Plant
SU	standard unit
SULI	Science Undergraduate Laboratory Internship
SUNY	State University of New York
SUSC	Science and User Support Center
Sv*	sievert; unit for assessing radiation dose risk
SVE*	soil vapor extraction
SVOC*	semi volatile organic compound t1/2* half-life
TA	Test America
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
TED	Total Effective Dose
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
TTA	Tolytriazole
TVDG	Tandem Van de Graaff
TVOC*	total volatile organic compounds
UESC	Utility Energy Services Contract
µg/L	micrograms per liter
UIC*	underground injection control
UPS	uninterrupted power supplies
UST*	underground storage tank
VFP	Visiting Faculty Program
VOC*	volatile organic compound
VUV*	very ultraviolet
WAC	waste acceptance criteria
WBS	Work Breakdown Structure

WCP	Work Control and Planning
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
WWI	World War I
WWII	World War II
ZEV	zero emission vehicle

Intentionally Left Blank

APPENDIX A
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 Comprehensive Environmental Response, Compensation and Liability Act (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.

AGS (Alternating Gradient Synchrotron) – One of the world's premier particle accelerators, in which the field gradients of the accelerator's 240 magnets are successively alternated inward and outward, permitting particles to be focused in both the horizontal and vertical plane at the same time. Capable of accelerating 70 trillion protons with every pulse, and heavy ions such as gold and iron, the AGS receives protons and other ions and delivers them to the Relativistic Heavy Ion Collider (RHIC) after acceleration.

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 volatile organic compounds (VOCs) from contaminated water byforcing 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 radionuclides). 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.

BLIP (Brookhaven Linac Isotope Producer) – Brookhaven Linac Isotope Producer is a facility that consists of a beam line and target bombardment area for isotope production that uses protons of up to 200 MeV energy and 165-μA intensity from Brookhaven's Linac.

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.

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 abandonedhazardous 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 (NYSDEC) 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 global warming potential (GWP) of each of the six greenhouse gases (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 (EDE) – 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 Site Environmental Report (SER), radiological values are shown with a 95% confidence interval: there is a 95% 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 con- tact 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 450.1A – This order, Environmental Protection Program, is dated 6/04/08. It revises DOE Order 450.1, issued in January 2003, to incorporate and implement the new requirements of Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, issued in January 2007.

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 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 reason- ably 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 **radionuclides.** 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. FWS 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 radionuclides. 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.

LINAC (Linear Accelerator Facility) – The purpose is to provide accelerated protons to the AGS. The basic components of the LINAC include ion sources, a radiofrequency quadrupole, and nine accelerator radiofrequency cavities spanning the length of a 459-foot tunnel. The LINAC is capable of producing a negatively charged hydrogen beam of up to 200 million electron-volts (MeV) energy and 165 microampere average current.

liquid scintillation counter – An analytical instrument used to quantify tritium, carbon-14, and other beta-emitting radionuclides. See also scintillation.

M

matrix, matrices – The natural context (e.g., air, vegetation, soil, water) from which an environmental sample is collected.

MDC (minimum detectable concentration) – The amount of a radionuclide, which if present in a sample, would be detected with an α probability of non-detection while accepting a β probability of erroneously detecting that radionuclide in an appropriate blank sample. For this procedure, the α and β probabilities are both set at 0.05. The MDC is expressed in concentration units relative to the sample weight or volume.

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% 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

NASA (National Aeronautics and Space Administration) – An independent agency of the U.S. federal government responsible for the civil space program, aeronautics research, and space research.

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% of surveyed rivers, lakes, and estuaries are not clean enough to meet basic uses such as fishing or swimming.

NO_x (Nitrogen oxide) – 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.

NSRL (NASA Space Radiation Laboratory) – A joint laboratory on the Brookhaven campus to study the possible effects of exposure to radiation in space. It uses beams of heavy ions extracted from Brookhaven's Booster accelerator to simulate the high-energy cosmic rays found in space. Its beamline is dedicated to radio biology research and space technology studies. Other experiments use industrial materials as samples, studying their suitability for space suits and spacecraft shielding.

nuclide – A species of atom characterized by the number of protons and neu- trons 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 ad- dresses 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, inter-laboratory 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 nuclides, 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.

RRPL (Radionuclide Research and Production Laboratory) – A laboratory facility that has various facilities for handling accelerator-produced radioactivity, where the accelerator-bombarded targets are received for processing into various radionuclides to produce useful isotopes for the medical field.

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 GHG emissions from sources that are owned or controlled by a Federal agency.

Scope 2 emissions – Indirect GHG emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency.

Scope 3 emissions – GHG 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 re- quirements 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 vari- ous 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.

STP (Sewage Treatment Plant) – This plant treats sanitary and certain process wastewater from BNL facilities prior to discharge into groundwater recharge beds, similar to the operations of a municipal STP. The plant has a design capacity of 2.3 million gallons per day. Effluent is monitored and controlled under a permit issued by the New York State Department of Environmental Conservation.

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. *See 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 pri- marily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10% 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 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, gener- ated 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.

APPENDIX B
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 types of radiation 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, definitions and background information, scientific notation and numerical prefixes used when measuring dose and radioactivity, and finally, a discussion of radionuclides that are of environmental interest at Brookhaven National Laboratory (BNL). The definitions of commonly used radiological terms are found in the Technical Topics section of the glossary, Appendix A.

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 repulsive force that tries to push them apart. Radioactivity occurs when the ratio between protons and neutrons in the nucleus becomes too unbalanced (too many or too few neutrons). If this ratio is unbalanced, the nucleus becomes unstable and will spontaneously "decay," emitting excess energy in the form of charged particles or electromagnetic waves. Unstable atoms are called radionuclides, and their emissions are known as radiation. When a radionuclide decays, it transforms into a different atom, which may be stable or continue decaying until stability is reached. This is one reason radioactivity decreases over time. Not all atoms decay at the same rate — some decay faster than others. The time it takes for half of a sample of radioactive atoms to decay is called the half-life. After one half-life, half the original substance remains; after two, one quarter; then one-eighth, and so on. Different radionuclides have different half-lives.

Radiation that has enough energy to remove orbital electrons (a process called ionization) is classified as ionizing radiation. Radiation that does not have enough energy to remove electrons is called non-ionizing radiation. Examples of non-ionizing radiation include most visible light, infrared light, microwaves, and radio waves. All types of radiation, whether ionizing or not, may pose health risks in sufficient quantities. 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 and Numerical Prefixes

Some numbers used for measurement and quantification in the SER are either very large or very small therefore, scientific notation is used to effectively communicate the information. For example, the number two million five hundred thousand (2,500,000) is written in scientific notation as 2.5×10^{6} or 2.5E+06. A small number like 0.0000025 is written in scientific notation as 2.5×10^{-6} or 2.5E-06.

Another method of representing very large or small numbers is to use prefixes. For example, the prefix milli (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 surrounds us from both natural and human-made sources. Referred to as "Background Radiation," it consists of cosmic radiation from outer space, radiation from radioactive elements in soil and rocks, and radiation from radon and its decay products. 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. 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 33 mrem per year (For an explanation of dose, see effective dose equivalent in Appendix A).

Radon Gas – Is produced from the radioactive decay of uranium which is naturally present in soil. Radon gas migrates through the soil and into the air. Long Island has minimum uranium in its soil; therefore, the background dose from radon gas is much lower than the national average.

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 21 mrem per year but may vary considerably depending on the local geology.

Internal – Potassium-40 (K-40) is the most common naturally occurring radionuclide in the body and in animals. Potassium-40 is found in the food, soil, and water we ingest. The average dose received from food in the United States is about 29 mrem per year.

Human-Made Sources of Radioactivity

Medical – Procedures such as chest and dental x-rays, Computed Tomography (CT), mammography, heart stress tests, and tumor irradiation therapies utilize ionizing radiation. The average dose received from medical procedures are: CT at 147 mrem, nuclear medicine at 77 mrem, and radiography/fluoroscopy at 43 mrem.

Anthropogenic – Sources of anthropogenic (human-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 is 13 mrem per year (excluding tobacco contribution).

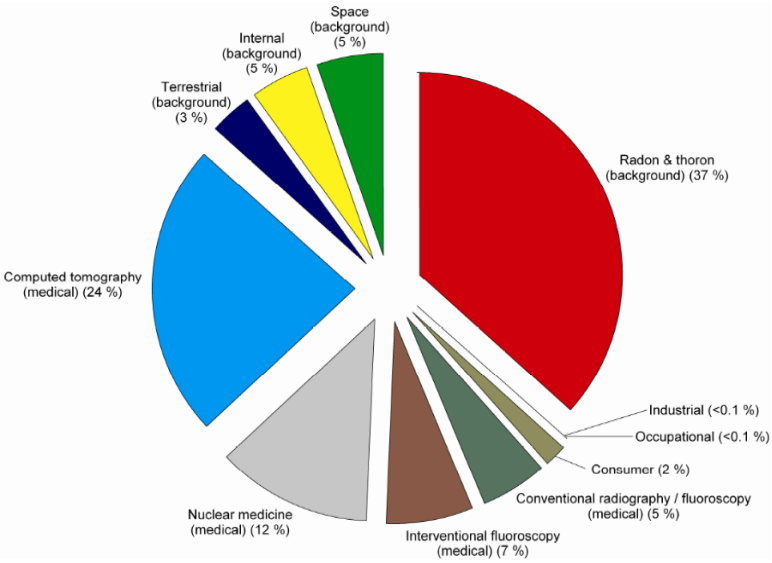


Figure B-1. Typical Annual Radiation Doses from Natural and Man-Made Sources (mrem). Source: NCRP Report No. 160 (NCRP 2009).

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 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 ingested, alpha particles can pose a health risk inside the body.

Beta Radiation – Beta radiation is composed of either electrons or positrons. 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. Beta particles present a hazard to the skin and eyes.

Gamma Radiation – Gamma radiation is a high-energy form of electromagnetic radiation (light). Gamma rays are emitted from a radioactive nucleus along with alpha or beta particles. Gamma radiation is capable of passing through dense material such as concrete. Because gamma rays are so penetrating, only a fraction of the total gamma rays a person is exposed to will interact with the human body — most will pass straight through.

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 – 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 Spectroscopy – This analysis technique identifies specific radionuclides. It measures the 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% "confidence interval" of that result. That means there is a 95% 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. Negative results are reported, even though doing so may seem illogical, but they are essential when conducting statistical evaluations of data.

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. For any value that is greater than or equal to the MDL, there is 95% confidence that it represents the true activity of the sample.

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 2015)*.

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% confidence interval, is determined by multiplying the sample standard deviation of the mean by the t-statistic (0.05).

Radionuclides of Environmental Interest

Several radionuclides are found in the environment at BNL.

Cesium-137 – Cs-137 is a fission produced radionuclide with a half-life of 30 years. It is found worldwide as a result of past above ground nuclear weapons testing and can be observed in surface soils at very low concentrations, usually less than 1 pCi/g (0.004 Bq/g). Cs-137 is found in the environment at BNL mainly as a soil contaminant, from worldwide deposition from nuclear accidents, fallout from weapons testing programs, and from spills or releases from BNL operations. In the past, wastewater containing small amounts of Cs-137 generated from some research operations was routinely discharged to the Sewage Treatment Plant (STP), resulting in low-level contamination of the STP and the Peconic River. In 2002 and 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 was associated with the following areas that have been 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 from fall-out from above-ground 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). Sr-90 was also released from the 1986 Chernobyl accident in the former Soviet Union.

Sr-90 is present at BNL in the soil and groundwater from worldwide nuclear testing and 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.

Tritium – Among the radioactive materials that are used or produced at BNL, tritium has received the most public attention. Tritium has a half-life of 12.3 years and approximately four to five million Ci (1.5E+5 TBq) per year is produced in the atmosphere naturally (NCRP 1979).

Above-ground weapons testing was a major contributor to the increase of tritium in the global atmosphere. Other 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. 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 above-ground 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.

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 H2O 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 (BLIP), where tritium is formed from secondary radiation interaction with cooling water. 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.

References and Bibliography

DOE. 2015. Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance. DOE/ EH-0173T. U.S. Department of Energy, Washington, DC.

NCRP. 2009. Ionizing Radiation Exposure of the Population of the United States. Report No. 160. National Council on Radiation Protection and Measurements. Bethesda, MD.

NCRP. 1979. Tritium in the Environment. NCRP Report No. 62. National Council on Radiation Protection and Measurements. Bethesda, MD.

NCRP. 1985. Handbook of Radioactivity Measurements Procedures, NCRP Report No. 58. National Council on Radiation Protection and Measurements, Bethesda, MD.

NYSDOH. 1996. Radioactive Contamination in the Peconic River. Bureau of Environmental Radiation Protection, New York State Department of Health, Albany, NY.

NYSDOH. 1993. Environmental Radiation in New York State. Bureau of Environmental Radiation Protection, New York State Department of Health, Albany, NY. Radiochemistry Society Online. *www.radiochemistry.org/nomenclature/index/html*, accessed 3-25-04

APPENDIX C
Units of Measure & 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
Na-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	~4.5 billion yrs (4.468E9)

APPENDIX D
Federal, State, and Local Laws and Regulations Pertinent to BNL

DOE Directives, Regulations, and Standards

DOE O 151.1E	Comprehensive Emergency Management System, effective 10/28/2024
DOE O 231.1B	Order: Admin Change 1: Environment, Safety and Health Reporting 11/28/2012
DOE O 413.3B	Program and Project Management for the Acquisition of Capital Assets, effective 6/21/2023
DOE O 414.1E	Quality Assurance 12/18/2024
DOE O 435.1	Order: Change 2: Radioactive Waste Management 01/11/2021
DOE O 456.1A	Safe Handling of Unbound Engineered Nanoparticles
DOE O 458.1	Order: Change 4: Radiation Protection of the Public and the Environment 9/15/2020
DOE O 460.1D, 2B	Hazardous Materials Packaging Safety and Management
DOE-STD-1153-2019	A Graded Approach for Evaluation of Radiation Doses to Aquatic and Terrestrial Biota 2/12/2019
DOE-STD-1196-2011	Derived Concentration Technical Standard 5/05/2011

Federal Laws and Regulations

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
16 USC 461-467	Historic Sites Act of 1935
16 USC 469	Archaeological and Historic Preservation Act
16 USC 470	National Historic Preservation Act
16 USC 470aa-470ll	Archaeological Resources Protection Act of 1979
16 USC 668 A-D	The Bald and Golden Eagle Protection Act
16 USC 703-712	Migratory Bird Treaty Act

29 CFR 1910.119	Process Safety Management of Highly Hazardous Chemicals
29 CFR 1910.120	Emergency Response to Hazardous Substance Releases
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 60, A	Standards of Performance for New Stationary Sources (NSPS)
40 CFR 60, Db	Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units
40 CFR 60, IIII	Standards of Performance for Stationary Compression Ignition Internal Combustion Engine
40 CFR 60, JJJJ	Standards of Performance for Stationary Spark Ignition Internal Combustion Engines
40 CFR 61, A, G, H	National Emission Standards for Hazardous Air Pollutants
40 CFR 63	National Emissions Standards for Hazardous Air Pollutants for Source Categories: General Provisions; and Requirements for Control Technology Determinations for Major Sources in accordance with Clean Air Act Sections 112(g) and 112(j)
40 CFR 68	Chemical Accident Prevention Provisions
40 CFR 82	Protection of Stratospheric Ozone
40 CFR 82 F	Recycling and Emission Reduction
40 CFR 98	Mandatory Greenhouse Gas Reporting
40 CFR 109	Criteria for State, Local and Regional Oil Removal Contingency Plans
40 CFR 110.6	Discharge of Oil
40 CFR 112	Oil Pollution Prevention Act
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 126	Rule for limiting fugitive particulate matter emissions

40 CFR 127	NPDES Electronic Reporting
40 CFR 129	Toxic Pollutant Effluent Standards
40 CFR 130	Water Quality Planning and Management
40 CFR 131	Water Quality Standards
40 CFR 133	Secondary Treatment Regulation
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 145	Underground Injection Control (UIC) Program
40 CFR 146	Underground Injection Control (UIC) Program: Criteria and Standards
49 CFR 147	Underground Injection Control (UIC) Program
40 CFR 148	Hazardous Waste Injection Restrictions
40 CFR 167	Submissions of Pesticide Reports
40 CFR 168	Statements of Enforcement Policies and Interpretations
40 CFR 170	Worker Protection Standard
40 CFR 171	Certification of Pesticide Applicators
40 CFR 194	Waste Characterization Program Documents Applicable to Transuranic Radioactive Waste from Rocky Flats Environmental Technology Site for Disposal at the Waste Isolation Pilot Plant
40 CFR 230	Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material
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 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Program: The Hazardous Waste Permit Program
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 302.6	Notification Requirements under CERCLA and Title III of the Superfund Amendments and Reauthorization Act of 1986
40 CFR 355	Protection of the Environment/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 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 721	Significant New Users of Chemical Substances
40 CFR 745	Lead-Based Paint Poisoning Prevention in Certain Residential Structures
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
40 CFR 1604	Reporting of Accidental Releases
43 CFR 10	Native American Graves Protection and Repatriation Regulations
49 CFR 172	Transportation/Hazardous Materials Regulations/ Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Transportation/Shippers - General Requirements for Shipments and Packaging
50 CFR 17	Endangered and Threatened Wildlife and Plants
50 CFR 21	Migratory Bird Permits 16 USC 703-712 Migratory Bird Treaty Act
50 CFR 22	Eagle Permits 16 USC 668a-d Bald and Golden Eagle Protection Act

New York State Laws, Regulations, and Standards

6 NYCRR 182	Endangered and Threatened Species of Fish and Wildlife, Species of Special Concern
6 NYCRR 193.3	Trees and Plants/Protected Native Plants
6 NYCRR 200	General Provisions
6 NYCRR 201	Subpart 201-1: General Provisions
6 NYCRR 202	Part 202: Emissions Verification
6 NYCRR 205	Architectural and Industrial Maintenance (AIM) Coatings
6 NYCRR 207	Control Measures for an Air Pollution Episode
6 NYCRR 208	Landfill Gas Collection and Control System for Certain Municipal Solid Waste Landfills
6 NYCRR 211	General Prohibitions
6 NYCRR 212	Process Operations
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 226	Solvent Metal Cleaning Processes
6 NYCRR 227	Subpart 227-2: Reasonable Available Control Technology (RACT) for Major Facilities of Oxides of Nitrogen (NOx)
6 NYCRR 228	Subpart 228-1: 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 for New and Modified Facilities
6 NYCRR 234	Graphic Arts
6 NYCRR 241	Asphalt Pavement and Asphalt Based Surface Coating Regulation and Update of VOC Lists. (Effective Date 01-01-2011)
6 NYCRR 320	Pesticides - General
6 NYCRR 325	Application of Pesticides
6 NYCRR 326	Registration and Classification of Pesticides
6 NYCRR 360	Solid Waste Management Facilities General Requirements
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 375	Environmental Remediation Programs
6 NYCRR 376	Land Disposal Restrictions
6 NYCRR 595-599	New York State Department of Environmental Conservation, “Hazardous Substance Bulk Storage Regulations,”
6 NYCRR 608	Article 15, Title 5 – Protection of Waters
6 NYCRR 610	New York State Navigation Law - Article 12 Oil Spill Control and Compensation Act
6 NYCRR 611-613	Handling and Storage of Petroleum
6 NYCRR 662-663	Article 24 - Freshwater Wetlands
6 NYCRR 666	Article 15, Title 27 - Wild, Scenic, Recreational River Systems Act
6 NYCRR 700	Classification and Standards of Quality and Purity
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
8 NYCRR 101	New York State Environmental Quality Review Act
10 NYCRR 5	State Sanitary Code – Part 5
ECL – Article 27	Title 21 – Section 2: NYS Environmental Conservation Law, Mercury-Added Consumer Products
ECL – Article 27	Title 9 – Section 27-0908: NYS Environmental Conservation Law of 1990, Hazardous Waste Reduction Plan
NYSDOH Article 28;	Public Health Law Pertaining to Cooling Tower Legionella Prevention

Suffolk County Rules, Regulations, and Standards

Suffolk County Memorandum of Agreement

SCSC Art. 12	Toxic and Hazardous Material Storage, Handling and Control Substance Bulk Storage Regulations
SCSC Art. 18	Petroleum Bulk Storage Regulations

Intentionally Left Blank

Site Environmental Report
Reader Response Form

The Site Environmental Report (SER) is written to inform regulators, the public, and Brookhaven National Lab (BNL) employees of the Laboratory's environmental performance for the calendar year in review. The report summarizes the Laboratory's on-site environmental data; environmental management performance; compliance with applicable regulations; and environmental, restoration, and surveillance monitoring programs.

BNL welcomes your comments, suggestions for improvements, or any questions you may have. Please fill in the information below, and mail your response form to:

Brookhaven National Laboratory
Environmental Protection Division
Attention: SER Project Coordinator
Building 860
P.O. Box 5000
Upton, NY 11973-5000

Name _____

Address _____

_____

Phone _____

Email _____

Comments, Suggestions, or Questions

_____

_____

_____

_____

_____

Brookhaven
National Laboratory

SER Project Coordinator
Environmental Protection Division
Building 860
Brookhaven National Laboratory
PO Box 5000
Upton, NY 11973-5000

Brookhaven National Laboratory

U.S. DEPARTMENT of ENERGY

Environmental Protection Division
Attention: SER Project Coordinator
Building 860
P.O. Box 5000
Upton, NY 11973-5000

www.bnl.gov