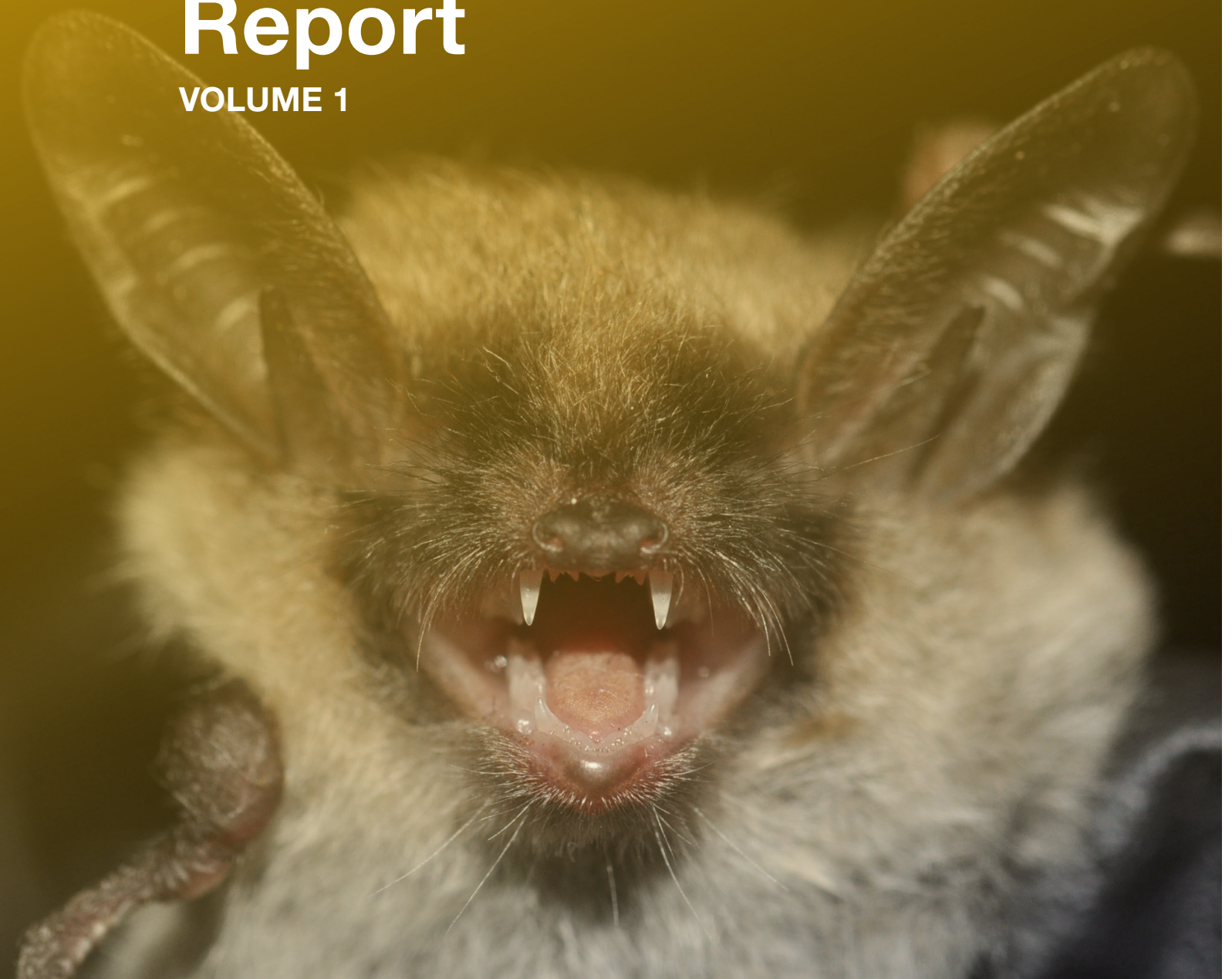




Brookhaven
National Laboratory

2025 Site Environmental Report

VOLUME 1



The front and inside covers for this year's Site Environmental Report (SER) feature images of two species of bats found on the Lab site. A photo of a federally endangered northern long-eared bat (NLEB) (*Myotis septentrionalis*) that was captured on-site during mist netting activities is featured on the front cover and a big brown bat (*Eptesicus fuscus*) is pictured on the inside cover. While some may feel these creatures have faces only a mother could love, these bats offer significant ecological and economic benefits. They act as natural pest control agents eating enormous quantities of moths, beetles, flies, and other insects that can cause damage to crops, gardens, and forests. In fact, bats contribute to an estimated \$23 billion in savings annually for the U.S. agricultural industry by reducing the need for chemical pesticides.

NLEB and big brown bats use echolocation to detect and capture their prey. NLEB are also called "whisper bats" because their echolocation calls are of such a high frequency they cannot be heard by the insects upon which they feed and are able to sneak up on them. In addition to capturing prey on the wing, NLEB can also pick off insects from surfaces, called gleaning.

NLEB are small bats—their bodies ranging from 3.0-3.7 inches in length with a wingspan of 9-11 inches and weigh 5-9 grams (about 1/8-1/4 ounce). They have long ears and a wing shape that differs from most other bats that allows them to agilely navigate dense forests better than other species. From spring through fall, they roost in trees under the bark or in crevices and in winter, they hibernate in caves. Because we don't have caves on Long Island, it is believed that they hibernate in man-made structures like old building foundations, crawl spaces, cellars, and perhaps in tree crevices. Due to their nocturnal behavior and small size, bats are notoriously difficult to study so there is much we have yet to learn about them.

What we do know is that NLEB and other regional bat species have been suffering steep declines in recent years. While habitat loss is a contributing factor, the biggest culprit is the introduction of a fungal infection called white nose syndrome (WNS) (*Pseudogymnoascus destructans*) that thrives in the cold, humid environments found in the caves in which many bats hibernate. The NLEB has been hit particularly hard by this fungus and populations have declined by an estimated 98%, causing them to be listed as an endangered species by the U.S. Fish & Wildlife Service in 2022. Atlantic coastal islands like Long Island have seen slower declines, likely due to the lack of caves and the resulting inability for these bats to hibernate in large numbers, which may reduce transmission rates. Thus, these areas are seen as refugia for this species and conservation efforts are prioritized.

Forest management at the Lab, including prescribed fire and mechanical treatments, may positively impact this species by improving habitat and by creating snags in which NLEB can roost. Continued monitoring of this and other bat species will help to inform future management both at the Lab and throughout the region, and contribute to the limited information we currently have.

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 2025 Site Environmental Report, released October 2026.

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, 2026.

Revision History

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SER 2025, Revision 0	October 1, 2026	First published version

2025

SITE ENVIRONMENTAL REPORT

BROOKHAVEN NATIONAL LABORATORY

Volume I

October 2026

Prepared by
Brookhaven Science Associates, LLC
For the U.S. Department of Energy
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Brookhaven National Laboratory
Brookhaven Science Associates, LLC
P.O. Box 5000
Upton, NY 11973-5000



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Executive Summary

INTRODUCTION

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).

BNL advances **scientific discovery** and innovation through world-leading research facilities, **interdisciplinary collaboration**, efficient initiatives, and **safe, community-focused** operations.

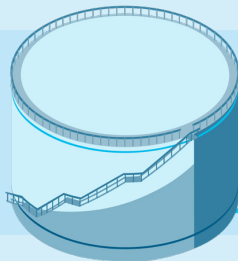


Long Island Rail Road (LIRR) Yaphank-BNL Station opened. Construction of the LIRR station will provide **rail access** from New York City and New Jersey's major airports.

Spent \$61 million in New York State, supporting **local and state businesses**.

ENVIRONMENTAL MANAGEMENT SYSTEM

Brookhaven National Laboratory (BNL) has an **effective Environmental Management System (EMS)** that **improves compliance** and **drives efficiency** by following Integrated Safety Management System (ISMS) Plan-Do-Check-Act principles and applying the concept of continuous improvement.



BNL recycled or reused 1,861 tons of waste material during 2025 resulting in an **83% waste diversion** rate.

The Laboratory engaged stakeholders **through transparent communication** about its **environmental impacts and stewardship** of Long Island's limited resources.



COMPLIANCE STATUS

Brookhaven National Laboratory (BNL) continued to protect Long Island's drinking water through per- and poly fluoroalkyl substances (PFAS) treatment, monitoring, and full compliance with drinking water standards.

Regulatory inspections, audits, and assessments conducted by New York State Department of Environmental Conservation (NYSDEC), the Department of Energy (DOE), and internal programs found no significant violations, demonstrating continued compliance with all environmental requirements.

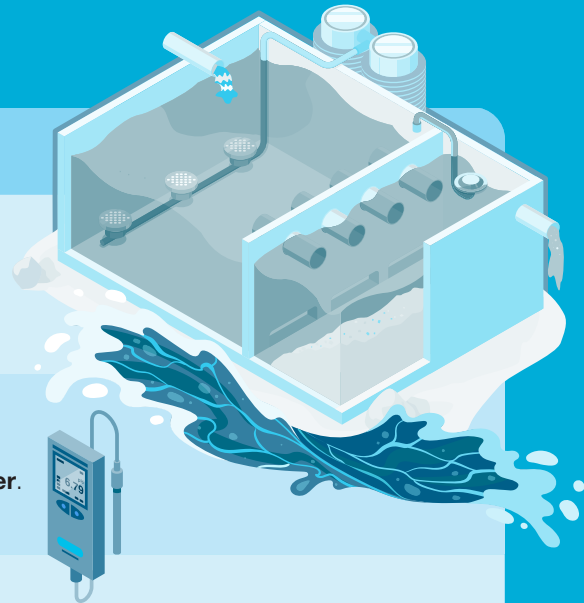
Environmental reviews were completed for 175 projects while ensuring regulatory compliance and environmental stewardship, supporting the Laboratory's mission.



NON-RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMS

In 2025, **no noncompliance events** occurred for any of the **State Pollutant Discharge Elimination System (SPDES)** permitted recharge basin outfalls or effluent limits.

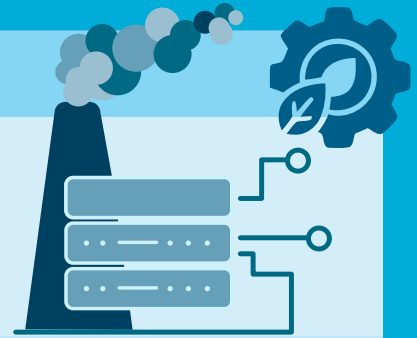
Environmental monitoring showed that the **Laboratory's controls** continue to **protect Long Island's groundwater and surface water**.



Air emissions from the Central Steam Facility (CSF) remained well **below permit limits** for all regulated pollutants.

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM & DOSE ASSESSMENT

The results of monitoring air emissions, ambient air, and direct radiation confirmed **Laboratory operations continue to show no impact on the public or the environment.**



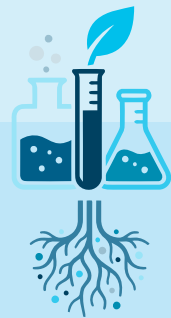
Monitoring of water, soil, vegetation, and wildlife demonstrated the **effectiveness** of the Laboratory's environmental protection programs.

NATURAL AND CULTURAL RESOURCES

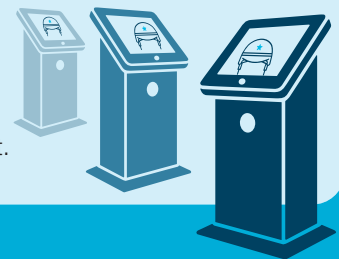
Thirty-two acres of forest were thinned and mechanically treated in preparation for **prescribed fire** and 23 acres were burned.



Deer, vegetation, and soil **sampling results** are **consistent** with previous years' results. The Natural Resource Management Program is described in the Natural Resource Management Plan (NRMP) (BNL 2021).



Historical kiosks were installed to highlight the site's history, including the World War I (WWI) and World War II (WWII) hospital area, roadways through the Camp Upton property, and **medical research** that took place at the Brookhaven Medical Reactor (BMRR) and Medical Department.



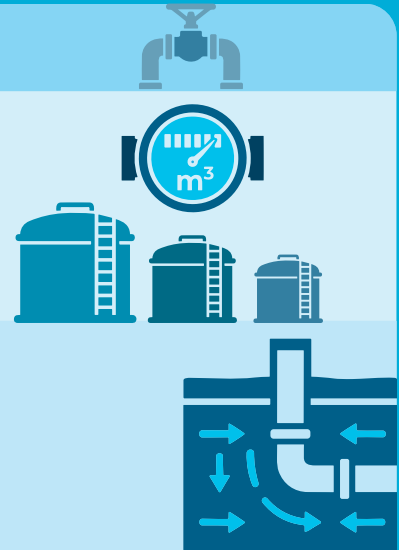
GROUNDWATER PROTECTION

Groundwater protection efforts remained effective, supported by the operation of **10 groundwater treatment systems** and routine monitoring from **687 permanent monitoring wells** and installation of **10 temporary wells**.

Groundwater treatment system operations to date have removed **7,952 pounds of volatile organic compounds (VOCs)** and **35 mCi of Strontium-90 (Sr-90)**, returning **34 billion gallons of treated groundwater** to the aquifer.



PFAS remediation continued, with the operation of two groundwater treatment systems removing **1.9 pounds of PFAS**, to date.



QUALITY ASSURANCE

Supports an environment that facilitates **scientific and operational excellence**.

All analytical data reported for the 2025 Site Environmental Report (SER) is **reliable**.

Analyses performed by contract laboratories are **state certified** and participate in **independent performance testing**.

Analytical data generated for BNL, was evaluated by external **audits, proficiency assessments, data verifications**, and data validations to ensure all results are **reliable and defensible**.



2025 Site Environmental Report

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



The 2025 SER Team

(Back row, left to right) Tim Welty, Doreen Carlson, Jason Remien, Larry Singh, Brian Barth.

(Front row, left to right) Jennifer Higbie, Deborah Bauer, Lindsey Brooks, Amy Engel.

(not pictured: Kasey Corona-Borger, Allison McGovern, Kathy Schwager).



The Environmental Protection Division Field Sampling Team

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

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Lead Chapter Authors

ENVIRONMENTAL PROTECTION DIVISION

EXECUTIVE SUMMARY	Lindsey Brooks	CHAPTER 5.....	Tim Welty/ Peter Hayes
CHAPTER 1	Lindsey Brooks/Amy Engel	CHAPTER 6	Kathy Schwager/ Allison McGovern
CHAPTER 2.....	Deborah Bauer	CHAPTER 7	Brian Barth/Julia Michaels
CHAPTER 3.....	Jason Remien	CHAPTER 8.....	Larry Singh
CHAPTER 4.....	Doreen Carlson/ Peter Hayes		

Co-authors and/or Key Contributors

ENVIRONMENTAL PROTECTION DIVISION

Amanda Chiappone
Jennifer Higbie
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

Valerie Lentz, Stakeholder & Community Relations

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Stakeholder and Community Relations
Environment, Safety & Health Directorate
Environmental Protection Division
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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.

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

Chapter 1

Introduction



CHAPTER HIGHLIGHTS

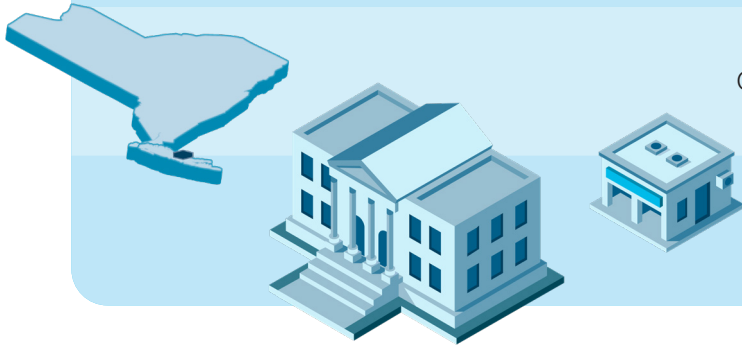
Brookhaven National Laboratory (BNL) is one of **ten National Laboratories** overseen and primarily funded by the U.S. Department of Energy's (DOE's) Office of Science (SC).

BNL advances **scientific discovery** and innovation through world-leading research facilities, **interdisciplinary collaboration**, efficient initiatives, and **safe, community-focused** operations.



Long Island Rail Road (LIRR) Yaphank-BNL Station opened. Construction of the LIRR station will provide **rail access** from New York City and New Jersey's major airports.

Spent \$61 million in New York State, supporting **local and state businesses**.



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 Laboratory 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 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 Laboratory's core expertise; and foster programs that address energy security and essential resource independence.

BNL carries out its mission in an environmentally responsible and safe manner, with the partnership of local, state, national, and international communities. The Laboratory 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.

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 community outreach that drives regional partnerships to address national needs.

Each employee, contractor, and guest is expected to take personal responsibility for adhering to BNL's values toward environmental protection as stated in the Laboratory's Code of Conduct.

1.2

Major Initiatives

BNL has identified scientific initiatives that will help realize its larger vision and mission. 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 Laboratory'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.



BNL Main Gate Sign.

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.

1.3

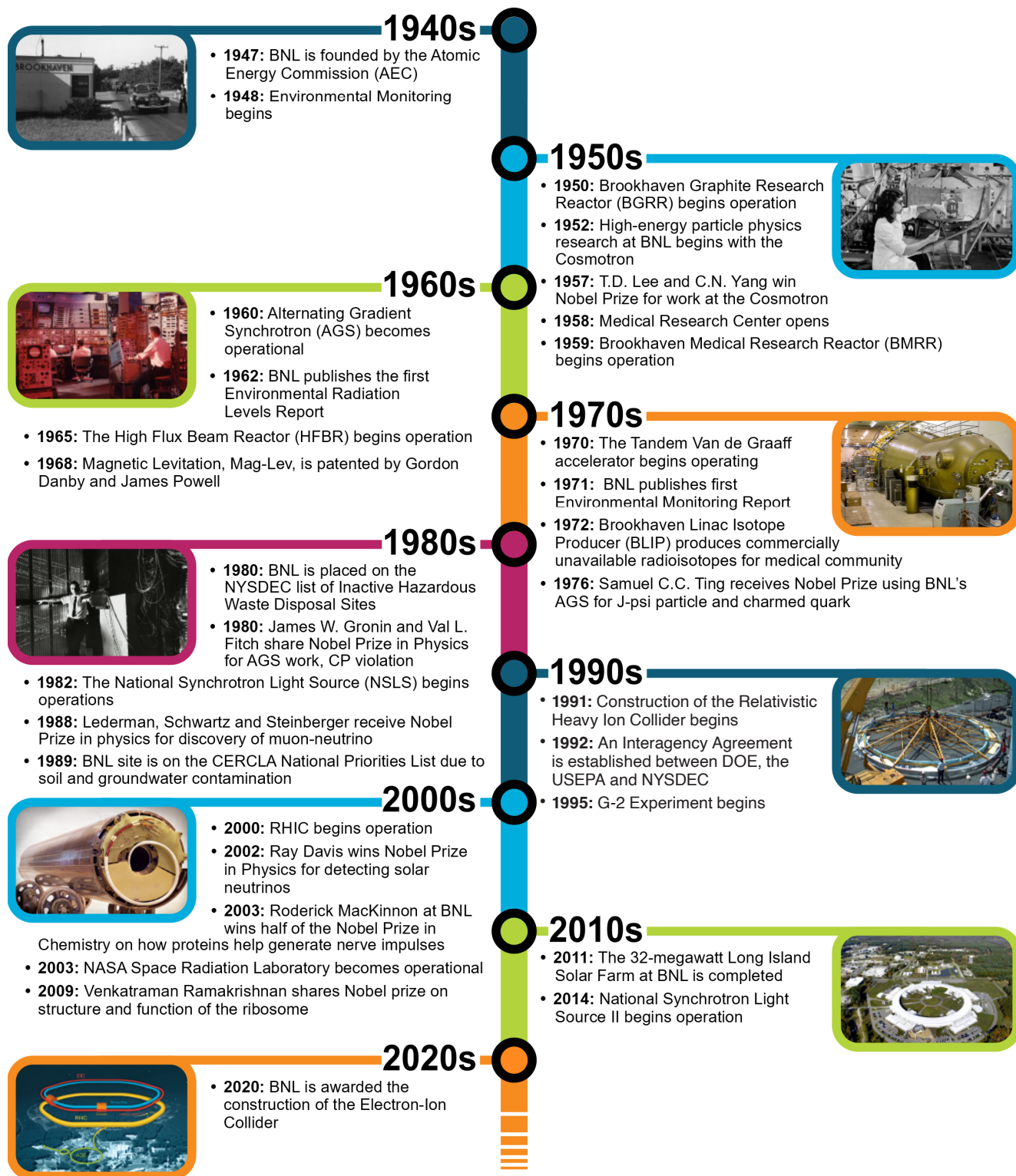
History and Overview of Major Scientific Facilities

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 through the design, construction, and operation of large-scale scientific facilities beyond the capabilities of individual institutions.

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. The High Flux Beam Reactor (HFBR) was in operation from 1965 through 1996, and further expanded neutron research capabilities in materials science, chemistry, biology, and physics. Both reactors have since been permanently shut down and decommissioned, with remaining structures maintained under long-term inspection and surveillance.

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 nation's first reactor designed specifically for medical research, operated from 1959 until 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.

BNL by the Decade



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

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 and led to the Laboratory's first Nobel Prize in 1957. Knowledge gained from the Cosmotron led to design improvements and paved the way for construction of the Alternating Gradient Synchrotron (AGS), a much larger particle accelerator that became operational in 1960 and allowed scientists to accelerate protons to energies that have yielded many discoveries of new particles and phenomena, and resulted in three Nobel Prizes. For the complete list of Nobel Prizes, see BNL Nobel Prize Timeline on page 1-7, or visit <https://www.bnl.gov/bnlweb/history/nobel/>.

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.

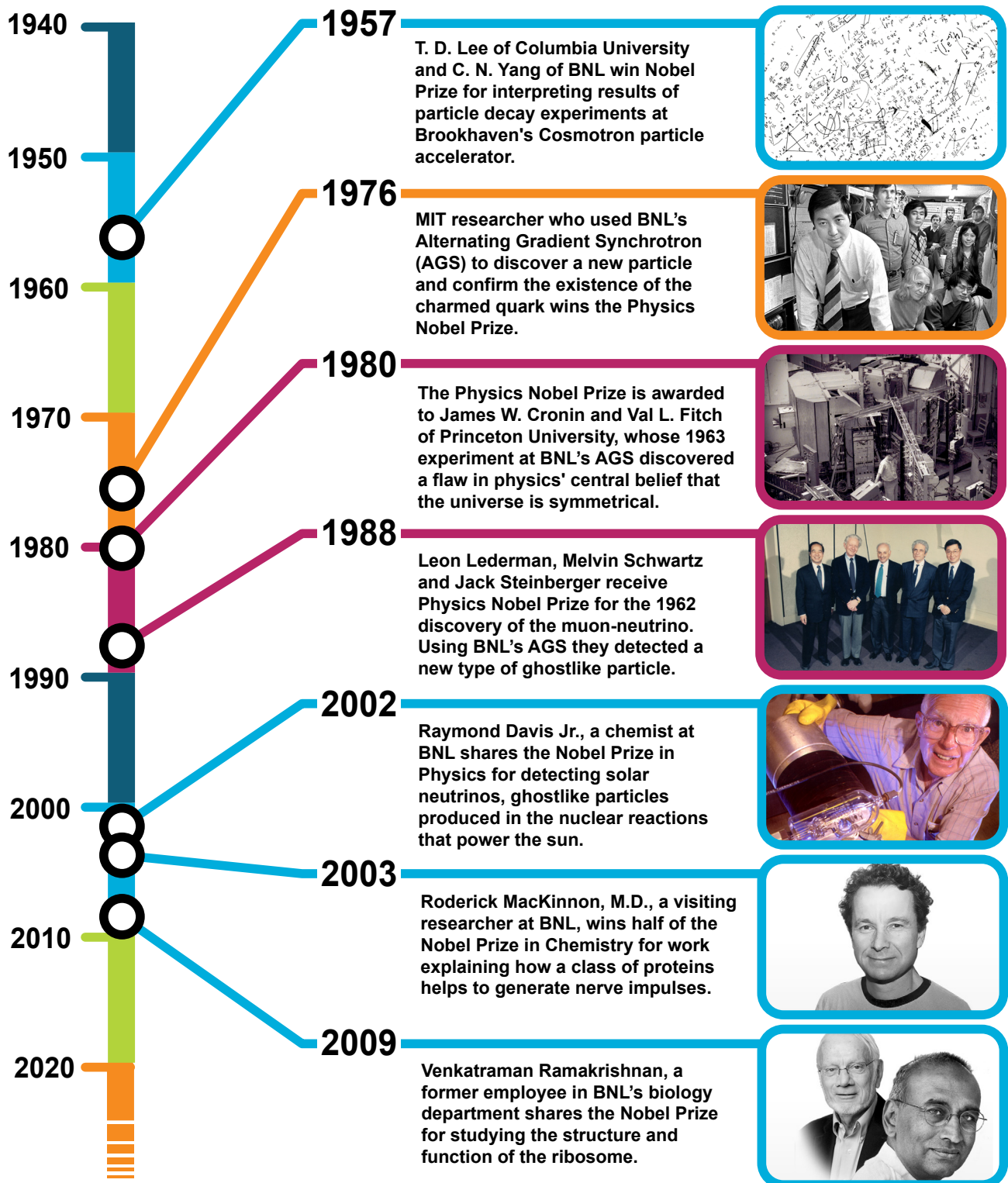
RHIC has been continuously upgraded and its productivity now exceeds its initial design by 100 times. The most recent upgrade is the Low-Energy RHIC Electron Cooling project, which supports a new research program.

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 selected BNL as the site for the EIC, a next-generation accelerator. A collaboration between BNL and Thomas Jefferson National Accelerator Facility, 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.

BNL Nobel Prize Timeline





National Synchrotron Light Source II.

1.3.1 User Facilities

BNL also hosts several major user facilities that support multidisciplinary research. The National Synchrotron Light Source II (NSLS-II), which replaced the original Nobel Prize winning NSLS in 2014, provides ultra-bright x-ray, ultraviolet, and infrared light offering 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 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 was awarded Leadership in Energy and Environmental Design (LEED) Silver certification.

The 32-megawatt Long Island Solar Farm (LISF) was completed in 2011 in collaboration with BP Solar, Long Island Power Authority (LIPA), the State of New York, and other organizations. The LISF generates renewable energy that helps meet peak electricity demands during the summer months from an increase in air conditioning use, powers approximately 4,500 homes, and supports New York State’s clean energy efficiency goals.

In addition to scientific infrastructure, BNL has made significant investments in efficient and modern facilities including the NSLS-II, CFN, and the Interdisciplinary Science Building (ISB). These energy efficient facilities provide labs, offices, and support functions to bring together a broad spectrum of researchers, including industry, universities, and other National Laboratories. The ISB’s scientific mission fosters energy research, focusing on the effective uses of renewable energy through improved conversion, transmission, and storage. The ISB was awarded LEED



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

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 on 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. The 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. The CSI has 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 the CSI's growing high-performance computing capabilities.

Looking ahead, BNL continues to modernize its site through strategic developments like Discovery Park, a transformative vision for the Laboratory's entryway to welcome visitors, provide housing for facility users and guests, and offer new opportunities for private industry to collaborate. It also provides 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, a Technology Park, and the Science User Support Center (SUSC). Discovery Park will help modernize the site while reducing the overall building footprint, which lowers operations and maintenance costs. SUSC opened its doors in 2025 as the first completed facility within Discovery Park and supports BNL's long-term mission support goal to foster innovation, community engagement, and scientific research. The SUSC is the only federally funded building in Discovery Park, and all other planned buildings will be privately funded. For more information about Discovery Park, please visit <https://discoverypark.bnl.gov/>.



Newly built Science and User Support Center (SUSC).

Another exciting development that will benefit both private industry in Discovery Park, as well as the Laboratory itself, is the upgraded LIRR Yaphank-BNL Station. The long anticipated station began operation in 2026 and provides a direct rail connection to New York and New Jersey's three major airports including the Long Island MacArthur Airport. A new easy access route to the Laboratory benefits the more than 7,300 visiting scientists who use its world-class facilities each year. It will also benefit Laboratory employees who live in New York City and western Long Island, enhance BNL's workforce development programs, and support future development in Discovery Park. Both the Laboratory and the Town of Brookhaven have plans to include shuttle service to and from the new station.



Rendering of Long Island Rail Road (LIRR) Yaphank-BNL 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.

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



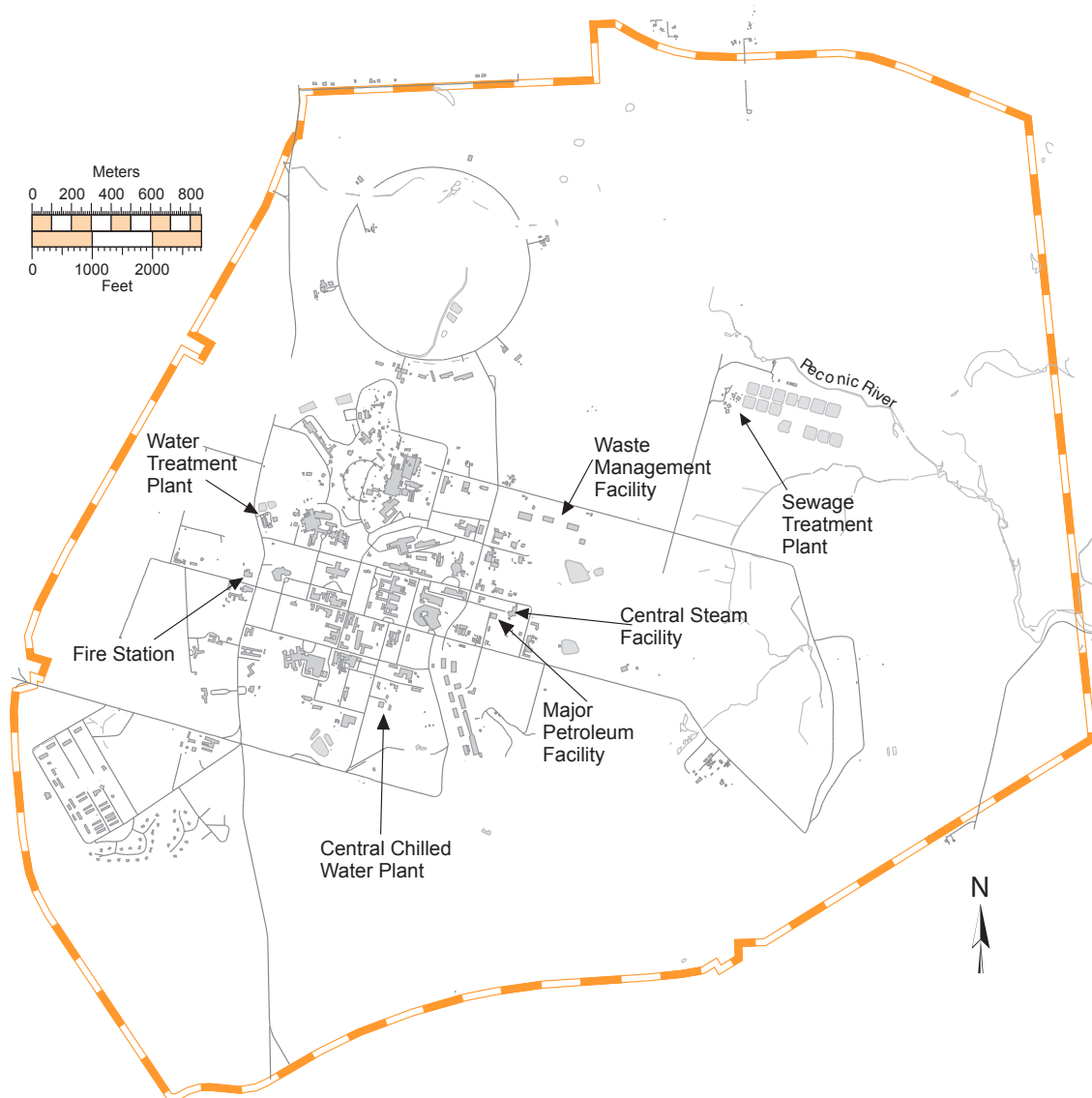


Figure 1-1. Major Scientific Facilities at BNL

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

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.

The Laboratory's 5,265-acre site is located in Brookhaven Town, Suffolk County, New York, approximately 65 miles east of New York City. In 2025, BNL employed 2,796 full-time employees and 76 part-time staff, comprised of scientists, engineers, technicians, and support staff. In addition, the Laboratory annually hosts an estimated 7,300 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 its geographic location and fiscal year 2025 budget of \$930 million, the Laboratory has a significant economic impact on New York State. In 2025, Laboratory employee salaries, wages, and fringe benefits accounted for approximately \$540 million, or 60% of its total budget. Supporting local and state businesses whenever possible, the Laboratory spent \$61 million in New York State with \$45 million of that amount spent in Nassau and Suffolk counties.

1.6

Environmental Setting

BNL is situated within the Central Pine Barrens region of Long Island, a New York State designated area of significant ecological importance that plays a critical role in the protection of Long Island's groundwater resources. The site lies along the western edge of the Peconic watershed, with marshy areas in the northern and eastern section of the rivers' headwaters.

Geologically, the area consists of thick glacial sand and gravel that allows water to penetrate the deposits, resulting in minimal surface runoff unless precipitation is intense. The sandy deposits store large quantities of water in the Upper Glacial aquifer. On average, about half of the annual precipitation is lost through evapotranspiration, while the rest percolates through the soil to recharge the groundwater (Franke & McClymonds, 1972; Aronson & Seaburn, 1974).

The local hydrology is closely tied to the Upper Glacial aquifer. Depending on precipitation conditions, the Peconic River both recharges and receives water from the aquifer. The terrain on-site is gently rolling, with elevations varying between 44 and 120 feet above mean sea level.

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.

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. Thus, the protection of groundwater resources is an important consideration in site planning and operations. For more details on the site's hydrogeology and groundwater system, refer to Chapter 7.

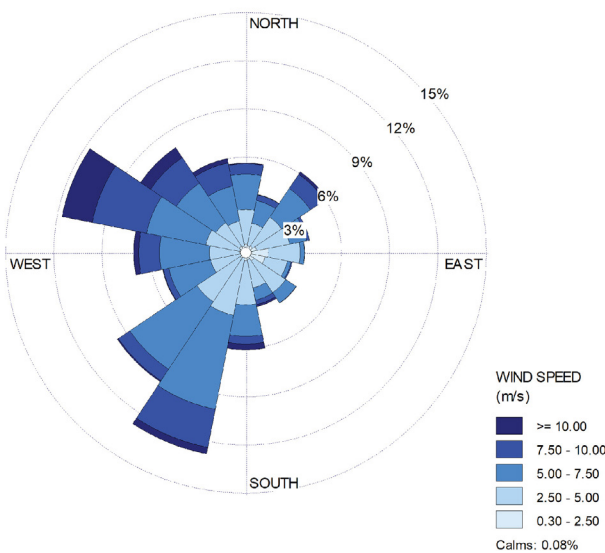
1.6.1 Climate

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.

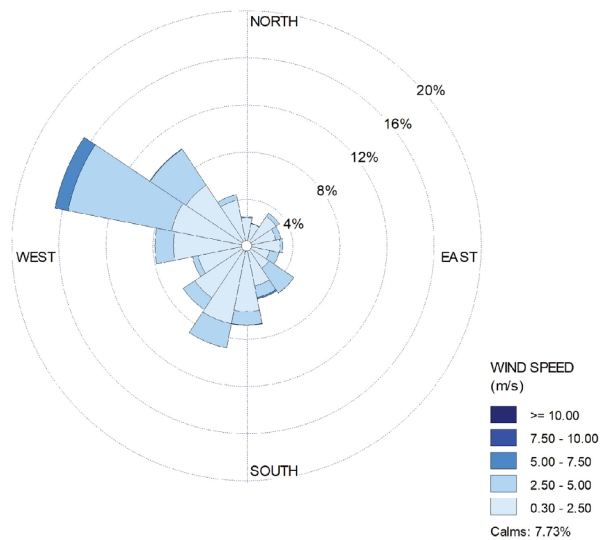
The Laboratory is broadly influenced by continental and maritime weather systems. Locally, the Long Island Sound, Atlantic Ocean, and associated bays influence wind directions and humidity and provide a moderating influence on extreme summer and winter temperatures.

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 1-3 shows the 2025 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 1-3. BNL Wind Rose (2025)



Wind Rose for Jan 1 to Dec 31, 2025
taken at the 85m height.



Wind Rose for Jan 1 to Dec 31, 2025
taken at the 10m height.

In 2025, the average yearly temperature for this area of Long Island was 52.3 °F. The coolest month of the year, January, had a monthly average temperature of 29.8 °F while the warmest month of the year, July, had a monthly average temperature of 72.3 °F. Figures 1-4 and 1-5 show the 2025 monthly mean temperatures and the historical annual mean temperatures, respectively.

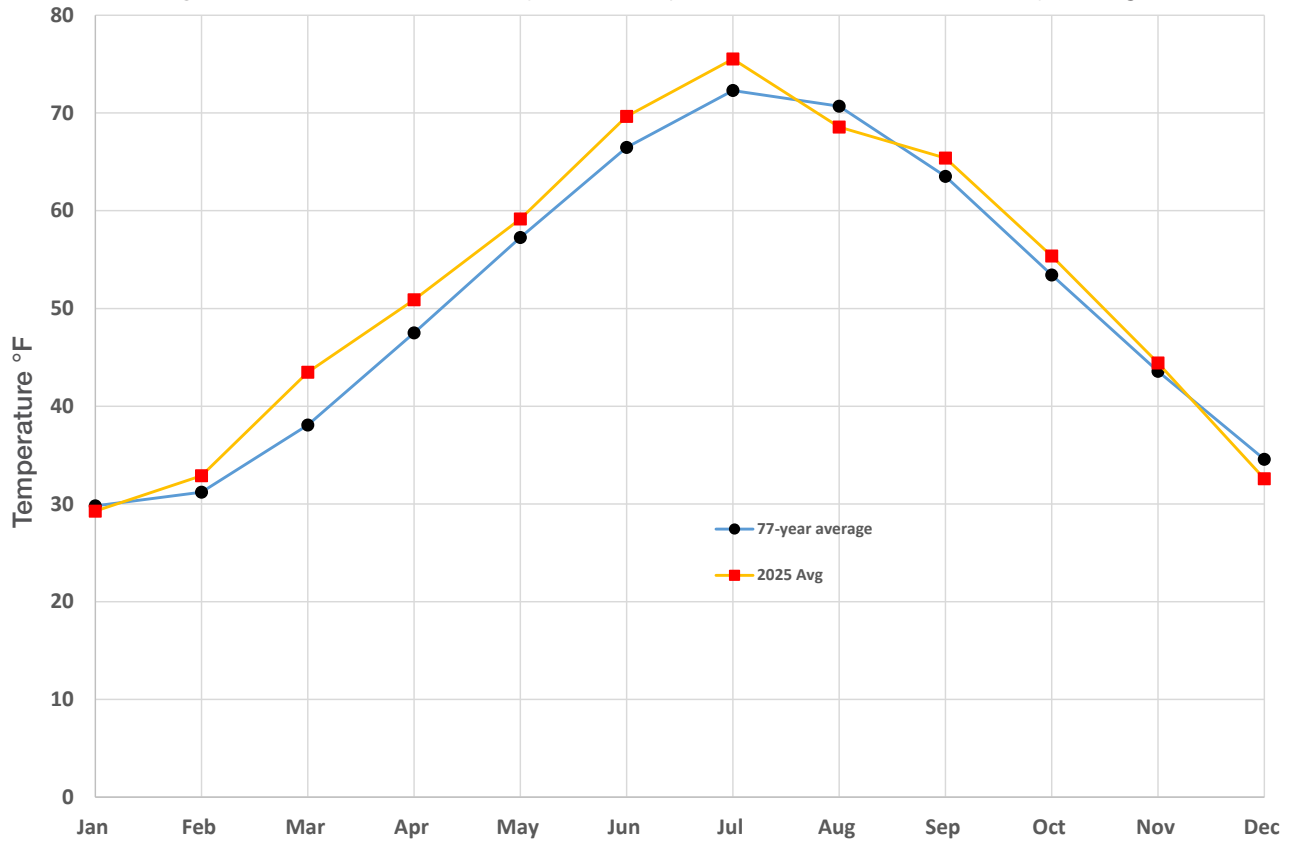
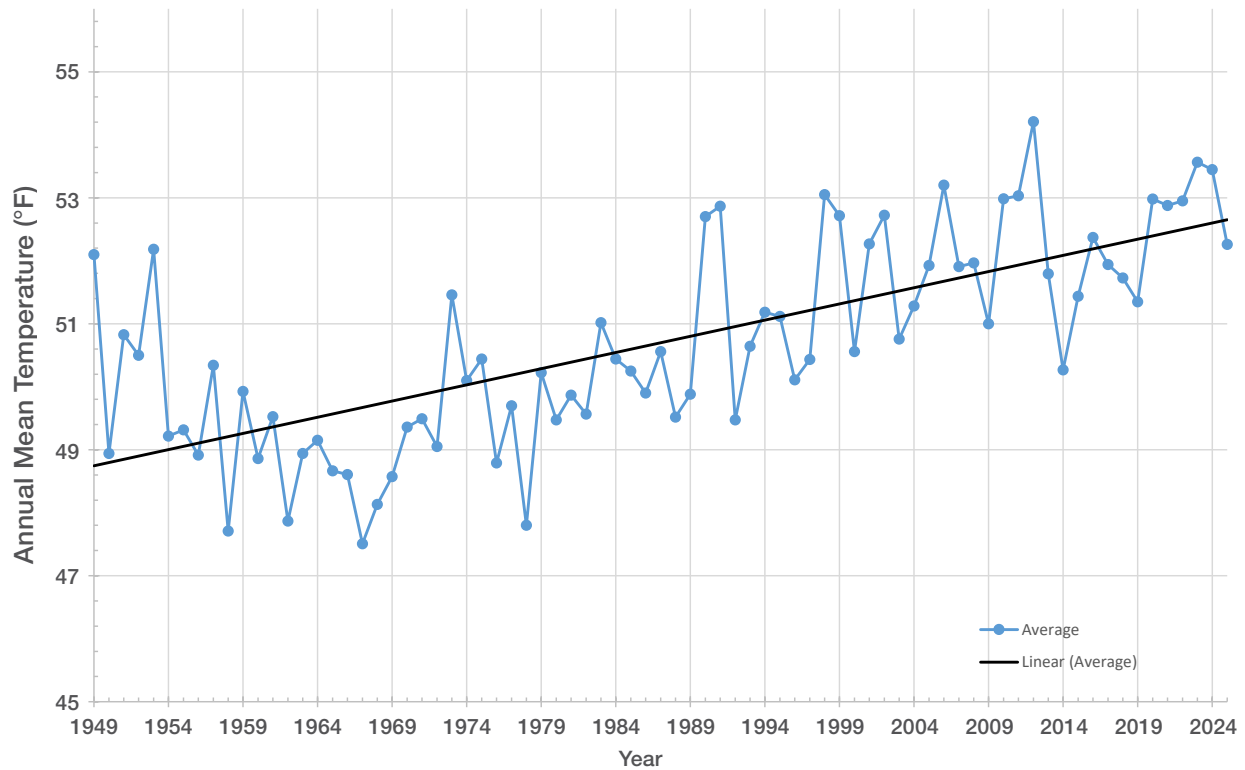
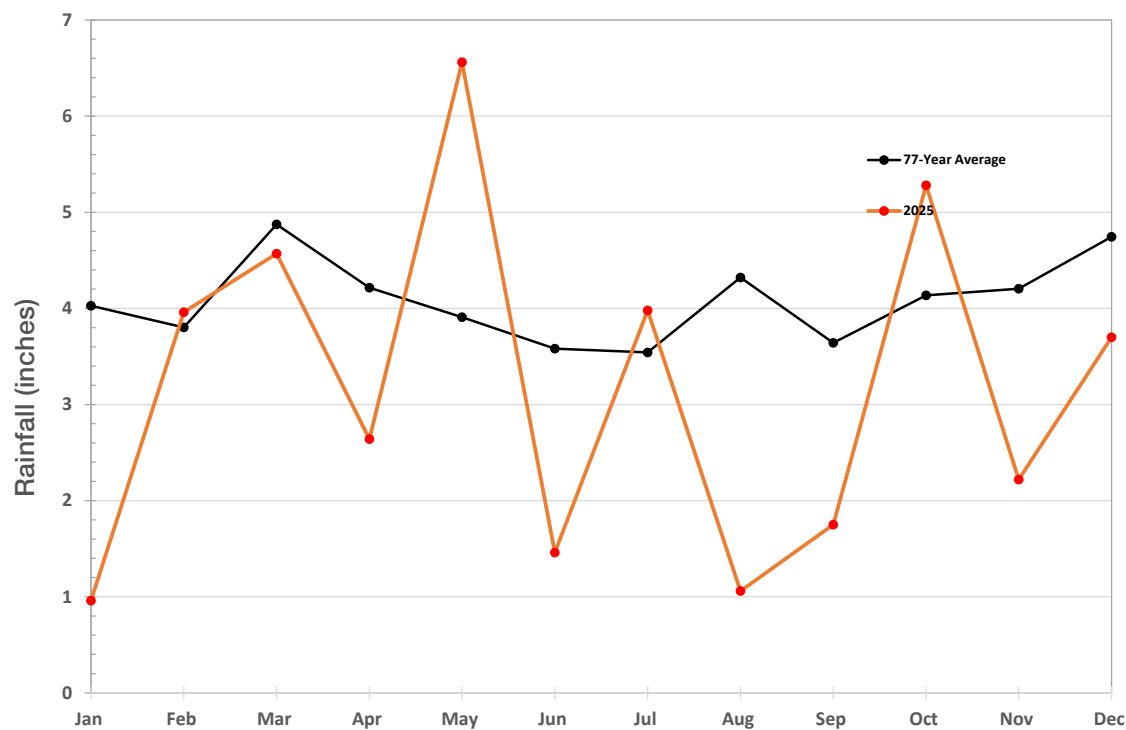
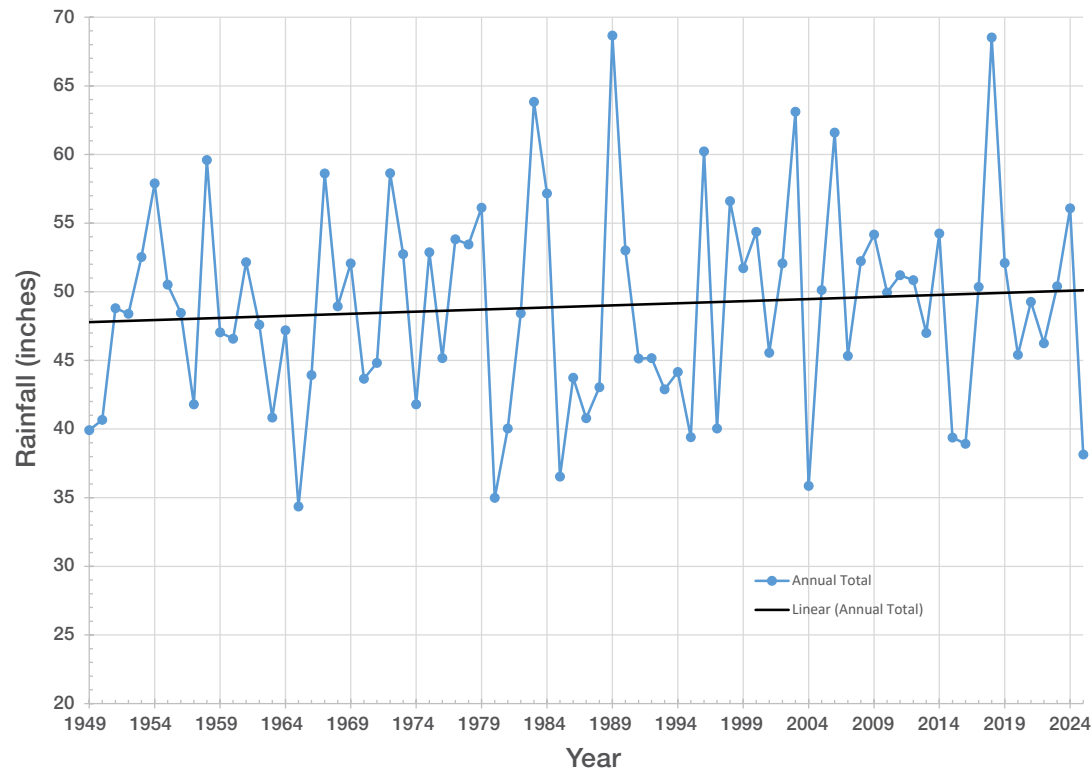
Figure 1-4. BNL 2025 - Monthly Mean Temperature versus 77-Year Monthly Average**Figure 1-5. BNL Annual Mean Temperature Trend (77 Years) 1949 to 2025**

Figure 1-6. BNL 2025 Monthly Precipitation versus 77-Year Monthly Average



The total annual precipitation in 2025 was 38.1 inches. Figures 1-6 and 1-7 show the 2025 monthly and the 77-year annual precipitation data, respectively. The yearly total snowfall for 2025 was 11.6 inches, well below the 25.4 inches average yearly snowfall for this area of Long Island.

Figure 1-7. BNL 2025 Annual Precipitation Trend (77 Years)



References and Bibliography

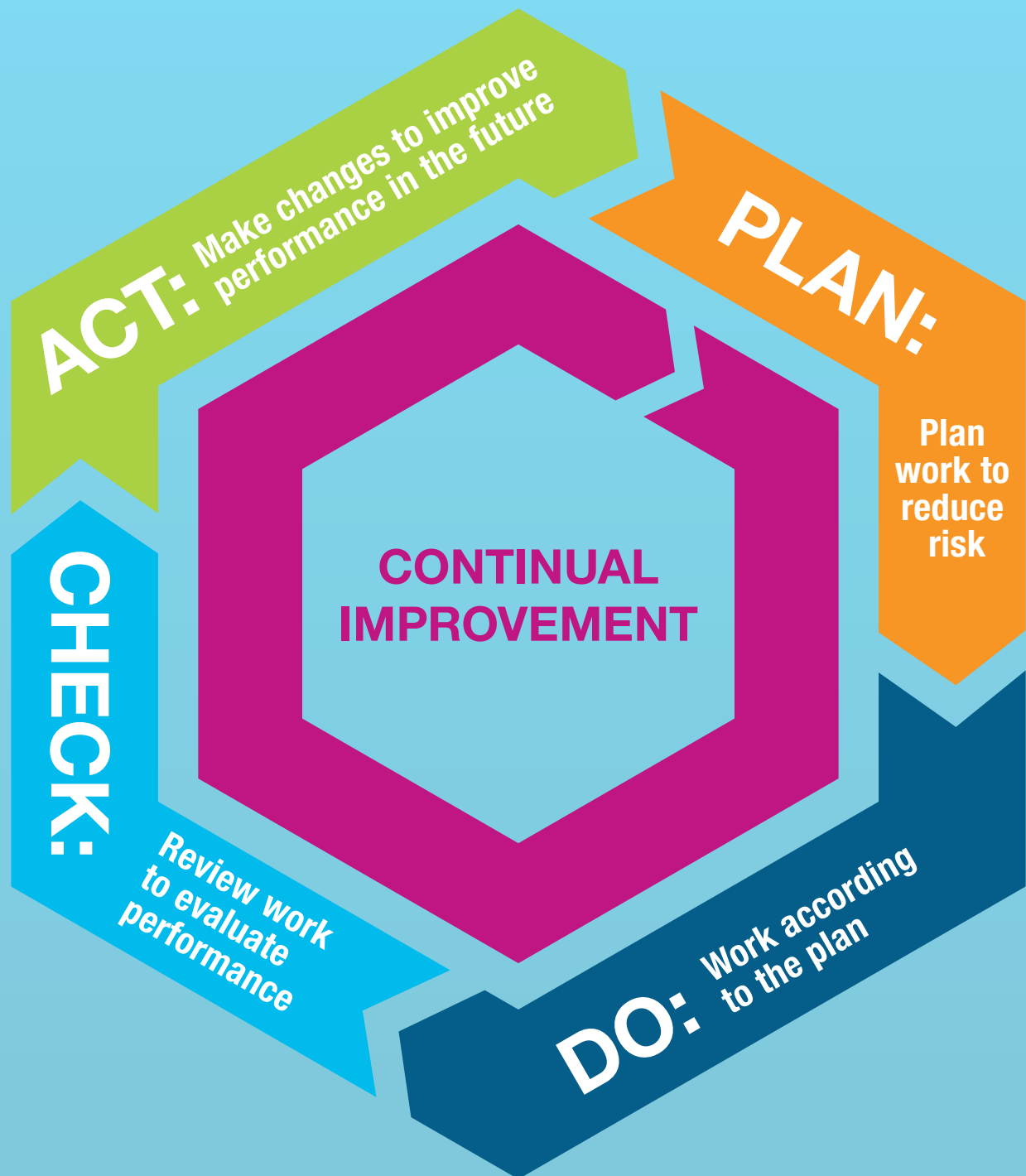
Aronson, D.A. and Seaburn, G.E. 1974. Appraisal of the operating efficiency of recharge basins on Long Island, NY in 1969. USGS Water Supply Paper 2001-D.

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.

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.



The “Plan-Do-Check-Act” improvement cycle.

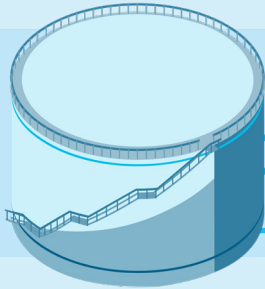
Chapter 2

Environmental Management System



CHAPTER HIGHLIGHTS

Brookhaven National Laboratory (BNL) has an **effective Environmental Management System (EMS)** that **improves compliance** and **drives efficiency** by following Integrated Safety Management System (ISMS) Plan-Do-Check-Act principles and applying the concept of continuous improvement.



BNL recycled or reused 1,861 tons of waste material during 2025 resulting in an **83% waste diversion** rate.

The Laboratory engaged stakeholders **through transparent communication** about its **environmental impacts and stewardship** of Long Island's limited resources.



2.1

Integrated Safety Management and EMS

BNL's ISMS integrates environmental protection, pollution prevention, safety, health, and quality management into all work planning and execution. The purpose of the ISMS is to integrate the Department of Energy's (DOE's) five Core Functions and seven Guiding Principles into all work processes. The five Core Functions, as defined by 48 CFR Subpart 970.5223-1, Integration of Environment, Safety, and Health into Work Planning and Execution for contractors and DOE O 450.2, Chg 1 (MinChg), Integrated Safety Management, (2011) for DOE elements, 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.

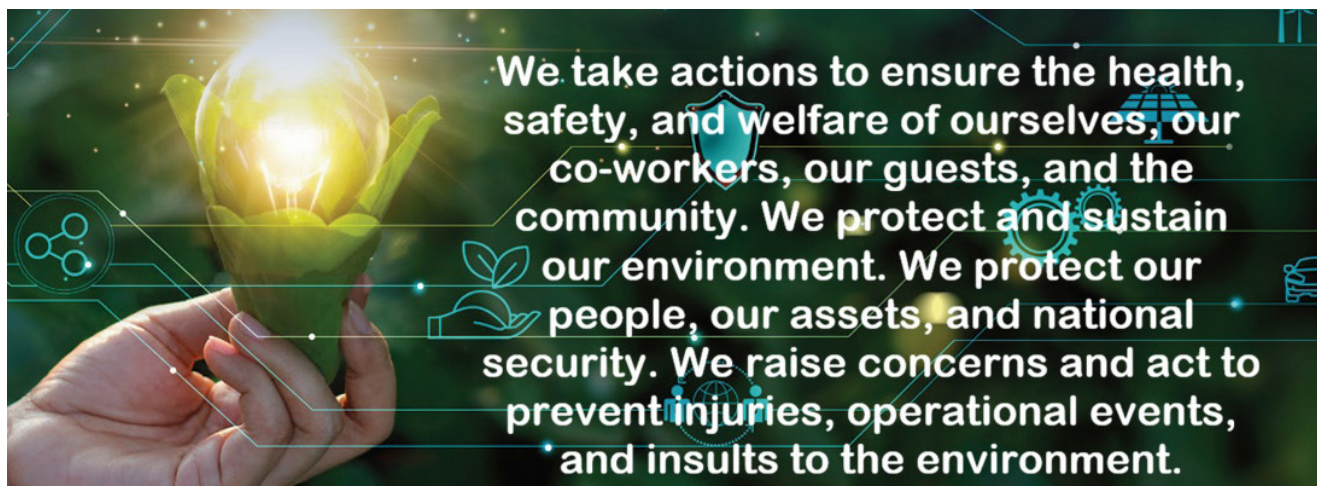
The seven Guiding Principles, also defined by DOE P 450.4A, Chg 1, are:

- **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.

2.1.1 BNL Values

The integrated processes within ISMS contribute to BNL maintaining an effective EMS based on the “Plan-Do-Check-Act” improvement cycle. Built on the ISO 14001 standard framework, the system requires BNL to develop and implement environmental commitments, monitor progress, take corrective actions, and review the system periodically to ensure its continued suitability, adequacy, and effectiveness.

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 the Laboratory’s Vision and Values Statement. The statement communicates the Laboratory’s intentions and principles regarding overall environmental performance, and provides a framework for planning and action, and is included in all employee, guest, and contractor training programs. The values are on the BNL website at <https://intranet.bnl.gov/conduct/>.



2.2

EMS Planning and Performance

2.2.1 Environmental Aspects

BNL 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 the work planning process so they are identified and reviewed for all work. Environmental professionals work closely with Laboratory personnel to ensure that work planning activities thoroughly capture all aspects, requirements, and associated environmental controls. Annual work planning reviews ensure that aspects and impacts are evaluated on a regular basis and continue to reflect stakeholder concerns and changes in regulatory requirements.

2.2.2 Objectives

The Laboratory's 2025 EMS objectives focused on maintaining a strong and compliant EMS, supporting major Laboratory infrastructure projects, advancing long-term groundwater stewardship activities, and strengthening operational sustainability initiatives. Objectives included auditing, conducting programmatic self-assessments and updating key environmental subject areas and procedures. The plan also emphasized long-term stewardship responsibilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), including groundwater treatment system management, per- and poly fluoroalkyl substances (PFAS) and 1,4-dioxane investigations, permit renewals, treatment system engineering design work, and regulator engagement regarding closure and shutdown petitions. Additional priorities included supporting the building demolition projects and related remedial activities and obtaining environmental permits and regulatory approvals for the Electron-Ion Collider (EIC) project. Other efforts included strengthening internal Environment, Safety, and Health (ES&H) support processes, and onboarding new staff.

The Laboratory will continue to focus on advancing operational excellence, major infrastructure initiatives, environmental stewardship, and modernization of environmental compliance and information management programs. Key efforts include support of the EIC project and the Relativistic Heavy Ion Collider (RHIC) Removal and Repurposing Project while coordinating with regulators on wetlands, endangered species, and National Environmental Policy Act (NEPA) requirements. Long-term stewardship activities will include completion of the CERCLA Five-Year Review process, groundwater treatment system evaluations, PFAS characterization activities, and development of engineering designs and cost estimates for potential remediation system enhancements. The Environmental Protection Division (EPD) will also continue environmental liability reduction efforts associated with building construction and demolition while maintaining regulator, community, and stakeholder engagement during the remediation and demolition progress.

Operational modernization and efficiency initiatives will also be advanced during 2026 through development of new programmatic agreements with regulators, notably the New York State Historic Preservation Office (NYSHPO), as well as modernization of the division's website and SharePoint collaboration tools, and increased integration of artificial intelligence (AI) technologies, such as ChatGPT, into environmental reporting, compliance tracking, and data analysis activities.



2.2.3 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. 5, (2025), 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 Environmental Monitoring Program 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 Environmental Monitoring Plan (EMP) (BNL 2025) 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 EMP uses the Environmental Protection Agency (EPA) Data Quality Objective approach for documenting the decisions associated with the monitoring program. In addition to the required triennial update, an annual electronic update is also prepared. 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 2-1, there were 6,040 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 4 and 5. The EMP addresses three components: compliance, restoration, and surveillance monitoring.

Table 2-1. Summary of BNL Sampling Program Sorted by Media, 2025

Environmental Media	No. of Sampling Events (a)	Purpose
Groundwater	1370	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	42	Recharge basins used for wastewater, and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes. See Chapter 4 for further details.
Potable Water	20 C	Potable water supply 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)	135	The STP influent and effluent and both 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	241	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	353 ES/C 52 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 (NYSDOH) as part of their program to assess radiological air concentrations statewide. See Chapter 5 for further details.

(continued on next page)

Table 2-1. (continued) Summary of BNL Sampling Program Sorted by Media, 2025.

Environmental Media	No. of Sampling Events (a)	Purpose
Fauna	18	Fish and deer are monitored to assess impacts on wildlife associated with past or current BNL operations. See Chapter 6 for further details.
Flora	11	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	29	Soil samples are collected as part of the Natural Resource Management Program to assess faunal uptake, during Environmental Restoration investigative work, during the closure of drywells and underground tanks, and as part of preconstruction background sampling.
Miscellaneous	101	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	1025	Samples are collected from groundwater treatment systems operated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program. The Laboratory has ten operating groundwater treatment systems. See discussion in Chapter 7.
State Pollutant Discharge Elimination System (SPDES)	319	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 New York State Department of Environmental Conservation (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	445	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)	791	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	232	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	6040	The total number of sampling events includes all samples identified in the EMP (BNL 2025), 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



2.2.4 Assurance

To periodically verify that the EMS is operating as intended, assessments are conducted as part of the Laboratory's Contractor Assurance System (CAS). Self-assessment is the systematic evaluation of internal processes and performance and includes both systematic assessments and regulatory compliance audits. The CAS is augmented by programmatic external audits conducted by the DOE. Brookhaven Science Associates (BSA) staff and subcontractors also perform periodic independent reviews, and a team consisting of certified assessors from other Battelle Laboratories independently assess and verify BNL's EMS program through a Community of Practice (CoP), further discussed in Section 2.3.1. BNL is subject to extensive oversight by external regulatory agencies (see Chapter 3 for details). In 2025, the assessors came on-site and there were no findings. The Laboratory earned a "Green" rating on the DOE Annual EMS Report, indicating strong performance against its environmental management objectives.

2.3

Environmental Operating Experience

2.3.1 Collaboration and Continuous Improvement

In 2025, BNL hosted a peer review through the Battelle CoP, bringing together environmental professionals from six National Laboratories to exchange best practices, discuss regulatory challenges, and identify opportunities to improve environmental management programs.

During the visit, staff presented on chemical management and legacy waste prevention, natural and cultural resource programs, contractor assurance, navigating a changing regulatory environment, operational improvements, EMS, and strategies for long-term environmental stewardship. The review included tours at the National Synchrotron Light Source II, the Center for Functional Nanomaterials, and the National Aeronautics and Space Administration (NASA) Space Radiation Laboratory in addition to field trips that highlighted the Laboratory's prescribed fire management program, the wildlife of the Long Island Pine Barrens, and Brookhaven's historic buildings, guided by Natural and Cultural Resource managers.

The Laboratory's Office of Institutional Improvement applies human performance improvement principles to streamline work processes, reduce waste, and improve organizational effectiveness. Within EPD, these methods have been used to improve management of empty compressed gas cylinders and streamline processes for managing excess soils generated during site development activities.

BNL's sustainable procurement program was recognized with the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT) Purchaser Award for its commitment to purchasing environmentally preferable electronic products.

During 2025, Brookhaven also opened the new Science User Support Center (SUSC), the first completed facility in Discovery Park. The building was designed in accordance with DOE Guiding Principles for Sustainable Buildings and incorporates numerous sustainable design features, including stormwater management through on-site collection and bioretention, native and drought-tolerant landscaping that minimizes irrigation requirements, extensive use of recycled construction materials such as structural steel, and a building orientation and high-performance glazing that maximize natural daylight while reducing energy demand. Energy-efficient LED lighting with occupancy and daylight controls further reduces electricity consumption while providing a comfortable environment for users.

The Laboratory's Natural and Cultural Resources Program continues to preserve Brookhaven's historical resources through partnerships with local museums and historical organizations. During 2025, these collaborations highlighted Brookhaven's scientific achievements and the history of Camp Upton through exhibits featuring Laboratory artifacts and historical collections. Scientists also worked closely with museum curators to ensure the scientific and historical accuracy of the exhibits.

The Laboratory's Wildfire Management Program is one such example, having become a model for effective wildfire risk reduction in the 13 years since the 2012 Crescent Bow Fire. Through the Natural and Cultural Resources Program, BNL has implemented a proactive forest management strategy that includes mechanical fuel reduction treatments to prepare designated management units for prescribed burns. These activities reduce hazardous fuel loads, decreasing wildfire risk to both the Laboratory and the neighboring Ridge community. BNL works in close partnership with the New York State Department of Environmental Conservation (NYSDEC), the Long Island Central Pine Barrens Commission, and other agencies to safely plan and conduct prescribed burns. The effectiveness of this program has been recognized by the New York Wildfire and Incident Management Academy, which has selected BNL as the site of its annual training academy.

These collaborative efforts demonstrate BNL's commitment to continuous improvement of the EMS by collaborating and advancing environmental stewardship and operational performance.

2.4

Efficient Operations

The Laboratory incorporates efficiency into its operations to prevent incidents and conserve resources through the reuse of materials whenever possible. Waste management is one example, with programs that manage a variety of waste types through segregation and recycling. Ongoing campus modernization and the removal of old facilities generate large amounts of construction and demolition (C&D) debris, including debris from the demolition of legacy contaminated facilities.

2.4.1 Waste Management and Minimization

Due to the world-class research it conducts, BNL generates a wide range of wastes. Laboratory activities generate waste that is characterized as either hazardous, radioactive, mixed, or industrial as per applicable Federal and State requirements notably the Resource Conservation and Recovery Act (RCRA) and related New York State hazardous waste regulations. These materials come from routine Laboratory research and operational activities as well as non-routine construction and demolition activities. Table 2-2 shows waste generation rates and trends. Routine and nonroutine wastes are reported separately because the volume of waste from nonroutine operations typically overwhelms the routine data.

Hazardous waste generation from routine operations, which consists of a wide variety of chemical waste from research activities, remained within expectations in 2025. Nonroutine hazardous waste during 2025 consisted of the usual variety of unused, expired, or contaminated materials generated from maintenance activities and building cleanouts. Industrial waste, which is a non-RCRA hazardous waste requiring special handling under other regulations, is not broken down as routine and nonroutine because the nature of the generating processes can make it difficult to differentiate. In 2025, the industrial waste stream included waste generated from the demolition of Building 197. That waste stream had trace mercury contamination that did not meet the toxicity characteristic defined in RCRA regulations.

There were five tons of mixed waste generated from facility maintenance during 2025 and one ton of nonroutine mixed waste generated from miscellaneous clean-up improvement activities. Routine radioactive waste

generated from BNL's medical isotope research program continued to trend downward. Activities at the facility have been curtailed for several years for programmatic reasons, so minimal waste is expected next year. A minimal quantity of nonroutine radioactive waste from the demolition of Building 197 was disposed of in 2025.

BNL also generates municipal solid waste (MSW) and C&D debris that does not have hazardous or radioactive waste characteristics and is disposed of out of state. Most of this material is diverted from the MSW and C&D waste streams into BNL's Pollution Prevention (P2) Program.

The P2 Program reflects national and DOE pollution prevention policies and represents an ongoing effort to make P2 and waste minimization an integral part of BNL's operating philosophy. Key elements of the P2 Program include:

- Conserving natural resources and energy;
- Evaluating other methods of power generation to determine best technology to fuel future growth;
- Reusing and recycling materials;
- Complying with environmental purchasing requirements,
- Reducing waste management costs; and
- Communicating successes.

Table 2-2. Regulated Waste Generation for 2025

Waste Type - Regulated	Tons	5 Year Trend
Hazardous Waste Routine (tons)	3	↓
Hazardous Waste Nonroutine (tons)	23	↑
Mixed Waste Routine (tons)	5	↑
Mixed Waste Nonroutine (tons)	1	↓
Radioactive Waste Routine (cft)	2169	↓
Radioactive Waste Nonroutine (cft)	442	↓
Industrial Waste (tons)	225	↓

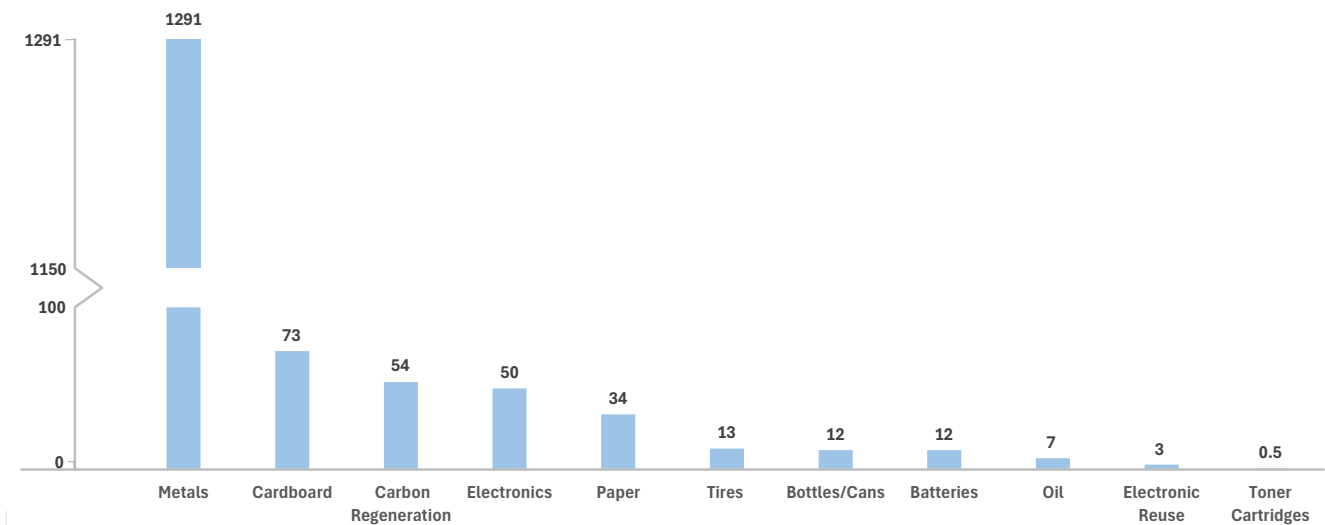
BNL's EMS establishes objectives and targets to drive pollution prevention and waste reduction as part of overall sustainable business practices, including the annual P2 Program that provides funds to purchase equipment or other materials to either reduce an environmental risk or reduce or eliminate a waste stream. Figure 2-1 shows a breakdown of the various materials that BNL recycles and reuses, with the predominant material being metal.

During 2025, the program funded 13 new proposals, investing approximately \$18,600. The proposals involved reducing spill risk, reducing plastic waste in laboratories, promoting the 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 2025, these efforts resulted in nearly \$1.5 million in cost avoidance or savings and approximately 1,503 tons (over 3 million pounds) of materials being reduced, recycled, reused or sent for energy recovery.

In 2025, BNL collected approximately 1,291 tons of scrap metal for recycling which is consistent with 2024 and indicative of the C-AD ongoing Removal and Repurposing Project. Cardboard, office paper, bottles and cans, construction debris, motor oil, lead, automotive and uninterrupted power supply (UPS) batteries, electronic scrap, and tires were also recycled.

The P2 program has achieved long-term reductions in waste generated by routine operations. However, population growth and site improvement activities challenge this trend. Overall waste trends can be seen in Table 2-3 with increases in C&D debris generated due to ongoing site development, including building demolition and removal of accelerator components and associated equipment from Collider-Accelerator Department's (C-AD's) RHIC facility as part of preparing the facility for the EIC upgrade project. These activities will continue for the foreseeable future. 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.

Figure 2-1. Materials Recycled or Reused in Tons for 2025



2.4.2 Water Conservation

The Laboratory’s water conservation program achieved a 63% reduction in water use from the mid-1990’s resulting in savings of a half billion gallons of water every year. Much of that reduction was achieved in the early years prior to 2007. As described in BNL’s 2025 Energy and Water Management Plan (formerly named the Site Sustainability Plan), the site’s potable water usage intensity increased from 80.54 gallons per gross square foot to 82.8 gallons per gross square foot, representing a 2.8% increase. Progress toward potable water intensity reduction goals was negatively affected by the site’s aging infrastructure. A primary contributing factor was the deteriorating steam infrastructure, which caused an 11% increase in boiler make-up water demand, rising from 57,400 gallons per day to 63,800 gallons per day when comparing FY24 to FY25.

Another contributing factor was the aging process infrastructure. For example, in Building 902 a cooling tower gearbox failure in the summer of FY25 prevented proper heat rejection during a critical test. As a temporary measure, the cooling tower was operated in a single-pass cooling configuration until the system could be taken offline for repairs, resulting in additional potable water consumption.

Plans and Projected Performance

In FY26, the RHIC will be taken out of service for upgrades to the EIC. This transition is expected to produce an immediate decrease in potable water usage for process loads over the next four to five years. However, it

Table 2-3. Municipal Solid Waste Recycling and Reuse, 2025

Waste Type - Municipal Solid Waste (MSW)	Tons	5 Year Trend
Landfill/Waste to Energy	310	↑
Recycle	1494	↑
Reuse	57	↓
Total Tons of Waste	1861	
% Recycled or Reused	83%	
Waste Type - Construction & Demolition (C&D)		
C&D Landfill	1089	↑
C&D Waste Recycled	56	↑
Total Tons of Waste	1145	
% Recycled or Reused	5%	



should be noted that potable water consumption is projected to increase significantly in the following decade as additional heat rejection capacity is required to support EIC operations.

2.4.3 Energy Conservation

BNL's overall energy performance remained relatively stable between FY24 and FY25. Total site energy intensity increased slightly, driven primarily by changes in fuel use at the Central Steam Facility (CSF). While electricity consumption remained generally consistent, natural gas use decreased modestly as the facility relied more heavily on fuel oil during periods of cold weather and in response to operational and economic considerations.

Because the CSF is the site's primary source of steam and heating, changes in its fuel mix significantly influence overall energy consumption patterns. Increased use of fuel oils resulted in a modest increase in overall fossil fuel energy intensity compared with the previous year. In addition, aging steam distribution infrastructure contributed to higher make-up water requirements, reducing system efficiency and increasing fuel consumption.



BNL employee recycling gloves.

Plans and Projected Performance

For FY26, energy use is expected to decline due to the final operational run of the RHIC, which will operate for a shorter period than in FY25. Key efforts include plans to continue transitioning away from No. 6 fuel oil as existing reserves are depleted and regulatory requirements drive the use of cleaner alternative fuels. These operational and fuel-transition changes are expected to result in noticeable changes in site-wide energy consumption and fuel-use patterns.

2.5

Community Outreach

2.5.1 Communications 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



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.



CAC members pictured with BNL staff outside of the new Science User Support Center (SUSC).

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 the 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 (WDSE) 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.

2.5.1.1 Communications 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 Community Advisory Council (CAC), established by BNL in 1998, advises Laboratory management primarily on environmental, health, and safety issues related to BNL that are of importance to the community. The CAC is 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, meets six times a year, and 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 Interagency Agreement (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 scientific machines, 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 three Sundays each summer, these open houses enable the public to visit BNL science facilities, experience hands-on activities, and learn about the Laboratory's scientific research. In 2025, more than 5,000 visitors participated in the program.

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, the Maker's Faire, and partnering with Stony Brook University on their "Comms/University Day." Internally, All Hands staff meetings are held throughout the year to keep employees apprised of Laboratory updates and new programs.

The SRO's Media and 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, the Monday Memo, is issued bi-weekly to employees and focuses on topics important to the Laboratory population. The Laboratory maintains an informative website at 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 which keeps 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.



PubSci, a science cafe event sponsored by BNL.

2.5.1.2 Community Involvement in Cleanup Projects

In 2025, 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:

- **Environmental Updates:** In 2025, the CAC received additional environmental updates such as the general status of the groundwater contaminant plumes and remediation systems, emerging contaminants PFAS and 1,4 Dioxane in groundwater, and updates on the mercury remediation project and the Site Environmental Report.
- **Discovery Technology Overview:** Overview of the new directorate was given by the new Associate Lab Director, Gabriella Carini. The new directorate focuses on four areas: 1) Instrumentation, 2) Microelectronics, 3) Quantum Information Science, Technology and Engineering and 4) Accelerator Science and Technology.
- **New Long Island Rail Road (LIRR) Yaphank-BNL Station Opening:** An overview was provided by representatives of Metropolitan Transportation Authority (MTA)/LIRR about construction of a new Yaphank station. The station was moved closer to the Laboratory and provides rail access from New York City and New Jersey's airports.
- **Energy Storage (batteries) Overview:** Amy Marschilok, Manager of the Energy Storage Division and Energy Systems Division, as well as a scientist in BNL's Interdisciplinary Science Department (ISB), provided an update on electrochemical energy storage. She noted that the ISB's research is centered on three main areas: energy efficiency, grid modernization, and energy storage.
- **Update on the Center for Functional Nanomaterials (CFN):** Chuck Black, Director of the CFN, gave an update about the exciting science and research taking place to accelerate nanomaterial discoveries of the 21st century.
- **EIC Tunnel Cooling Water Design Update:** Charlie Folz, Infrastructure Division Director for the EIC, provided an update on the EIC tunnel cooling water design. He explained that systems for magnet and vacuum beam pipe cooling water are needed to cool components for the Electron Storage Ring.
- **Natural and Cultural Resource Updates:** The CAC received updates on BNL's natural resources, such as deer and fire management, as well as a general overview of the Cultural Resource Program, including historical buildings, Camp Upton trenches, and remnants from historical homesteads.

References and Bibliography

DOE Order 450.2, Chg. 1 (MinChg), Integrated Safety Management, U. S. Department of Energy, Washington, January 17, 2017.
 DOE O 458.1 Admin Chg. 5, Radiation Protection of the Public and the Environment, U. S. Department of Energy, Washington, January 30, 2025.
 BNL 2025. Environmental Monitoring Plan for Brookhaven National Laboratory, Brookhaven National Laboratory, Upton, NY.





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

Chapter 3

Compliance Status

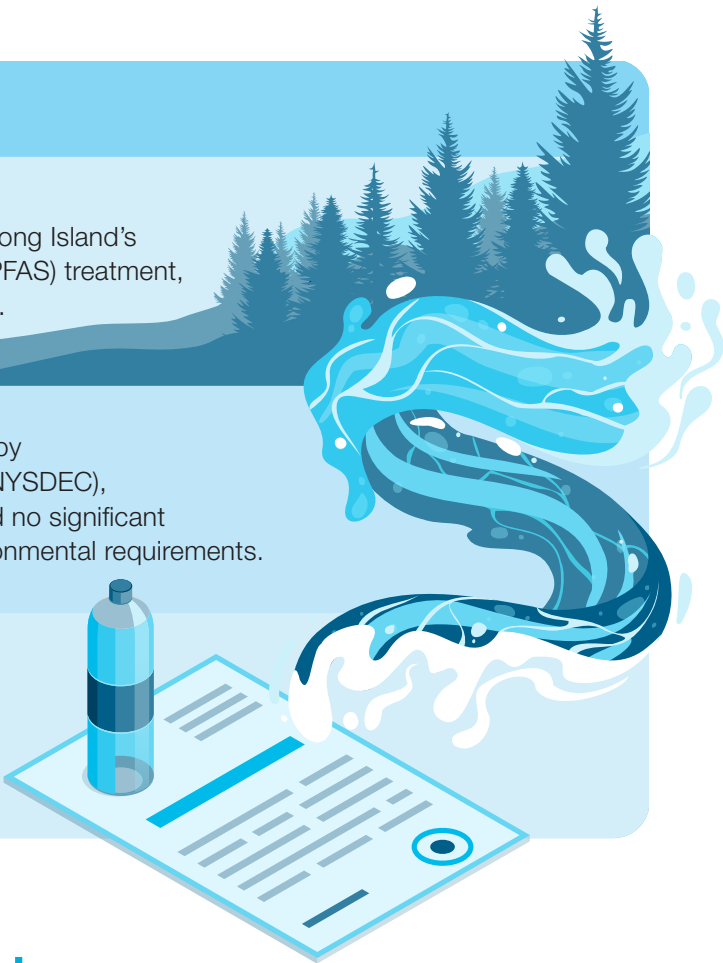


CHAPTER HIGHLIGHTS

Brookhaven National Laboratory (BNL) continued to protect Long Island’s drinking water through per- and poly fluoroalkyl substances (PFAS) treatment, monitoring, and full compliance with drinking water standards.

Regulatory inspections, audits, and assessments conducted by New York State Department of Environmental Conservation (NYSDEC), the Department of Energy (DOE), and internal programs found no significant violations, demonstrating continued compliance with all environmental requirements.

Environmental reviews were completed for 175 projects while ensuring regulatory compliance and environmental stewardship, supporting the Laboratory’s mission.



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 high-level discussion of the Laboratory’s compliance status. The last column of Table 3-1 (Report Sections) provides the section and/or chapter in this report where more details are provided on the compliance status of the various environmental regulatory programs.

Table 3-1. Environmental Compliance Obligations Overview

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
EPA: 40 CFR 300 40 CFR 302 40 CFR 355 40 CFR 370 NYSDEC: 6 NYCRR Part 375	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, Brookhaven National Laboratory (BNL) became subject to a tri-party agreement among EPA, NYSDCE, 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 monitoring of institutional controls. The High Flux Beam Reactor (HFBR) reactor vessel is scheduled for decontamination and decommissioning by 2072. All groundwater treatment systems operated as required in 2025. Management of the characterization and remediation of perfluorooctane sulfonate (PFOS) perfluorooctanoic acid (PFOA) and 1,4-dioxane was formally included under the BNL CERCLA program.	Chapter 7

(continued on next page)

Table 3-1. Environmental Compliance Obligations Overview (*continued*)

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
DOE: 10 CFR 1021 New York: 6 NYCRR 617	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 and issued implementing procedures outside of the New York Codes, Rules, and Regulations (NYCRR).	BNL is in full compliance with NEPA requirements. The Laboratory has established site-wide procedures for implementing NEPA requirements.	3.2
NYSHPO: 36 CFR 60 36 CFR 63 36 CFR 79 36 CFR 800 43 CFR 10	The National Historic Preservation Act (NHPA) establishes procedural protections that include identification, evaluation, and protection of 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).	There are now multiple buildings and features at BNL that have been determined to be National Register Eligible including the 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. 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.	Chapter 6
EPA: 40 CFR 50 40 CFR 60-61 40 CFR 63 40 CFR 68 40 CFR 80 40 CFR 82 40 CFR 98 40 CFR 1604 NYSDEC: 6 NYCRR 200-202, 205, 207, 208, 211, 212, 215, 217, 218, 225, 226, 227-231, 234, 239, 241, 248, 257.	The Clean Air Act (CAA) and the New York 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. BNL also complies with federal refrigerant management requirements for ozone-depleting substances and substitute refrigerants.	Chapters 4 and 5

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Table 3-1. Environmental Compliance Obligations Overview (*continued*)

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
EPA: 40 CFR 109–140 40 CFR 230, 231 40 CFR 401, 403 NYSDEC: 6 NYCRR 700–703 6 NYCRR 750	The Clean Water Act (CWA) and New York 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 2025.	Chapter 4
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 2025. 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.	3.3
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 submitted all required chemical inventory, release reporting, and emergency planning notifications in accordance with EPCRA and SARA requirements in 2025.	3.4.1 3.4.2 3.4.3
EPA: 40 CFR 280 NYSDEC: 6 NYCRR 596–598 6 NYCRR 610 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.	These materials are 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.	3.4.4 3.5
EPA: 40 CFR 260–280 NYSDEC: 6 NYCRR 221, 360, 361, 363–365, 367,371–374, and 376 NYSDEC/SCDHS Article 27 Title 9, 21	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 NYSDEC Part 373-permitted waste management facility.	3.6
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 polychlorinated biphenyls (PCBs) and is in compliance with all requirements.	3.7

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Table 3-1. Environmental Compliance Obligations Overview (*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.	3.8 and Chapter 6
DOE: 10 CFR 1022 NYSDEC: 6 NYCRR 608 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.	Chapter 6
U.S. Fish & Wildlife Service: 50 CFR 17 NYSDEC: 6 NYCRR 182 6 NYCRR 193.3	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 (BNL 2015) outlines activities to protect these vulnerable species and their habitats. Two consultations made with USFWS in 2025 resulted in "not likely to adversely affect" determinations therefore no Biological Opinions were issued.	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 50 CFR 21 50 CFR 22	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 forest management, the control of invasive species, planting of native plants 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.	Chapter 6

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Table 3-1. Environmental Compliance Obligations Overview (*continued*)

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
DOE: Order 414.1F 10 CFR 830, Subpart A Order 450.2 8 NYCRR 101	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 through 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 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 8
DOE: Order 435.1 Chg. 2	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 implementation. 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.	Chapter 2

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Table 3-1. Environmental Compliance Obligations Overview (*concluded*)

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	Report Sections
DOE: Order 458.1, Change 5 DOE-STD-1153-2019 A Graded Approach for Evaluation of Radiation Doses to Aquatic and Terrestrial Biota 2/12/2019 Derived Concentration Technical Standard 5/05/2011	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. 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.	Chapter 5

Notes:

CFR = Code of Federal Regulations

NYCRR = New York Codes, Rules, and Regulations

SCSC = Suffolk County Sanitary Code

3.1.1 Existing Permits

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

- State Pollutant Discharge Elimination System (SPDES) permits, issued by NYSDEC;
- Major Petroleum Facility (MPF) license, issued by NYSDEC;
- Resource Conservation and Recovery Act (RCRA) permit, issued by NYSDEC for BNL's Waste Management Facility (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 three 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]).

3.1.2 New or Modified Permits

3.1.2.1 Title V Permit Renewal Application

Review of the Title V Air Permit renewal application, submitted by the Laboratory in 2024, was initiated by the NYSDEC in 2025 and is ongoing. The existing Title V permit expired in January 2025, however, under the authorization of NYSDEC, the Laboratory continues to operate under the conditions of the existing permit.

3.1.3 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

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

Issuing Agency	Bldg. or Facility	Process/Permit Description	Permit ID No.	Expiration or Completion	Emission Unit ID	Source ID
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-27	NA	NA
NYSDEC - LI Well Permit	BNL	Domestic Potable/Process Wells	1-4722-00032/00151	02-Apr-35	NA	NA
NYSDEC - Air Quality	423/495	Metal Parts Cleaning Tank	1-4722-00032/00115	30-Jan-25 ²	U-METAL	42308
NYSDEC - Air Quality	498	Aqueous Cleaning Facility	1-4722-00032/00115	30-Jan-25 ²	U-METAL	49801
NYSDEC - Air Quality	610	Metal Parts Cleaning Tray	1-4722-00032/00115	30-Jan-25 ²	U-METAL	61008
NYSDEC - Air Quality	423	Gasoline & E85 Storage and Fuel Pumps	1-4722-00032/00115	30-Jan-25 ²	U-FUELS	42309/10
NYSDEC - Air Quality	423	Motor Vehicle A/C Servicing	1-4722-00032/00115	30-Jan-25 ²	U-MVACS	MVAC2
NYSDEC - Air Quality	423	Motor Vehicle A/C Servicing	1-4722-00032/00115	30-Jan-25 ²	U-MVACS	MVAC5
NYSDEC - Air Quality	244	Paint Spray Booth	1-4722-00032/00115	30-Jan-25 ²	U-PAINT	24402
NYSDEC - Air Quality	244	Flammable Liquid Storage Cabinet	1-4722-00032/00115	30-Jan-25 ²	U-PAINT	244AE
NYSDEC - Air Quality	734	Spin Coating Operation	1-4722-00032/00115	30-Jan-25 ²	U-INSIG	734AA
NYSDEC - Air Quality	801	Target Processing Laboratory	1-4722-00032/00115	30-Jan-25 ²	U-INSIG	80101
NYSDEC - Air Quality	Site	Aerosol Can Processing Units	1-4722-00032/00115	30-Jan-25 ²	U-INSIG	AEROS
NYSDEC - Air Quality	922	Silver Electroplating Operation	1-4722-00032/00115	30-Jan-25 ²	U-INSIG	92204
NYSDEC - Air Quality	624	WWTP Lime Mixing Tank	1-4722-00032/00116	30-Jan-25 ²	U-INSIG	624AA
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25 ²	U-61005	6101A
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25 ²	U-61005	61005
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25 ²	U-61006	61006
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	30-Jan-25 ²	U-61007	61007
NYSDEC - Air Quality	902	Epoxy Coating/Curing Exhaust	1-4722-00032/00115	30-Jan-25 ²	U-COILS	90206
NYSDEC - Air Quality	Site	Commercial Refrigeration Equipment	1-4722-00032/00115	30-Jan-25 ²	U-RFRIG	COMRE
NYSDEC - Air Quality	Site	Packaged A/C Units (16)	1-4722-00032/00115	30-Jan-25 ²	U-RFRIG	PKG01-16
NYSDEC - Air Quality	Site	Reciprocating Chillers (44)	1-4722-00032/00115	30-Jan-25 ²	U-RFRIG	REC01-65
NYSDEC - Air Quality	Site	Rotary Screw Chillers (19)	1-4722-00032/00115	30-Jan-25 ²	U-RFRIG	ROT01-20
NYSDEC - Air Quality	Site	Split A/C Units	1-4722-00032/00115	30-Jan-25 ²	U-RFRIG	SPL01-02
NYSDEC - Air Quality	Site	Centrifugal Chillers (17)	1-4722-00032/00115	30-Jan-25 ²	U-RFRIG	CEN06-29

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

Issuing Agency	Bldg. or Facility	Process/Permit Description	Permit ID No.	Expiration or Completion	Emission Unit ID	Source ID
NYSDEC - Air Quality	463	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	46301
NYSDEC - Air Quality	490	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	49006
NYSDEC - Air Quality	515	Diesel Non-Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	51501
NYSDEC - Air Quality	555	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	55503
NYSDEC - Air Quality	635	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	63501
NYSDEC - Air Quality	734	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	73401
NYSDEC - Air Quality	735	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	73501
NYSDEC - Air Quality	740	Diesel Emergency Generators (2)	1-4722-00032/00115	30-Jan-25 ²	U-GENER	74001/02
NYSDEC - Air Quality	801	Diesel Emergency Generator	1-4722-00032/00115	30-Jan-25 ²	U-GENER	80102
NYSDEC - Air Quality	912	Diesel Emergency Generators (3)	1-4722-00032/00115	30-Jan-25 ²	U-GENER	912A1/A2/A3
NYSDEC - Air Quality	30	Combustion Unit	1-4722-00032/00115	30-Jan-25 ²	U-SMBLR	030AB
NYSDEC - Air Quality	422	Combustion Unit	1-4722-00032/00115	30-Jan-25 ²	U-SMBLR	422AF
NYSDEC - Air Quality	423	Combustion Unit	1-4722-00032/00115	30-Jan-25 ²	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:

¹Source Facility Removed and awaiting EPA termination of NESHAPs authorization.

²With NYSDEC authorization, BNL is currently operating under the conditions of the expired Title V air permit. The renewal application is still undergoing NYSDEC review.

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 Collider

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

3.2

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 2025, environmental evaluations were completed for 175 proposed projects at BNL. A total of 171 projects were considered minor actions requiring no additional documentation. Four projects were addressed by submitting a notification form to the DOE, which determined that the projects were covered by existing “Categorical Exclusions” (per 10 CFR 1021).



3.3

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 Suffolk County Department of Health Services (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, 2025) is prepared by the Laboratory to comply with these requirements.

3.3.1 Potable Water

The Laboratory has six water supply wells for on-site distribution of potable water, four of which were active during 2025. 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. 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 2025.

BNL has determined that all six supply wells are highly susceptible to PFAS associated with the Laboratory's past use of firefighting foam. In August 2020, New York State established drinking water standards of 10 ng/L (parts per trillion) for PFAS compounds perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). PFOS and several other PFAS compounds have been detected in supply wells at concentrations above 10 ng/L. To address this contamination, BNL has placed back into service granular activated carbon (GAC) filtration systems at three wells to remove PFAS before the water is released into the distribution system. BNL also ended the operation of two supply wells (Wells 4 and 6) that do not have GAC filters.

All in service potable supply wells and water leaving the Water Treatment Plant are now tested on a quarterly basis for PFAS in accordance with applicable county, state, and federal regulations and are in full compliance.

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/>.

3.3.2 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



2026 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 2025.

BNL's Energy & Utilities (E&U) 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, E&U 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.



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 437 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 (831) 344-8282	Jason Remien Manager Environmental Protection Division (831) 344-3477	Suffolk County Department of Health Services (831) 852-5810
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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 2025, the Laboratory inspected 292 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.

3.3.3 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 2025. BNL's total UIC inventory at the end of 2025 was 133.

3.4

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.

3.4.1 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 2025.

3.4.2 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 3-3 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 40 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.

To satisfy the requirements of the Tier III submittal, the Laboratory submitted its data via the EPA-approved web based Toxic Release Inventory (TRI-ME) submittal program. During 2025, BNL reported releases of lead (about 28,000 pounds), mercury (about 28 pounds), polychlorinated biphenyls (PCBs) (about five pounds), benzo(g,h,i)perylene (less than one pound), polycyclic aromatic compounds (less than one pound), asbestos (friable) (6,960 pounds), and 2,2-Dichloro-1,1,1-trifluoroethane (HCFC-123) (five pounds). Releases of lead, PCBs, asbestos, 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. Fugitive losses of the refrigerant HCFC-123 were from centrifugal chillers on-site. In 2025, there were no releases of extremely hazardous substances reportable under Part 304.

Table 3-3. Applicability of EPCRA to BNL

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

Notes:

EHS = Extremely Hazardous Substance

SDS = Safety Data Sheet

TRI = Toxic Release Inventory

3.4.3 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 3-4. Summary of Chemical and Oil Spill Reports

BNL Spill No. and Date	Material/Quantity	ORPS Report	Source/Cause and Corrective Action
25-01 1/31/25	Hydraulic fluid/ 0.5 gallons	NO	During an inspection of a vendor's (Coastal Environmental Solutions) groundwater well installation drill rig repair operation, it was observed that the rig was leaking hydraulic oil from a hydraulic hose onto the soil. After the leak was observed, the vendor was instructed to place poly sheets onto the ground to prevent further leaks. Members of the Brookhaven National Laboratory (BNL) Police Group and Fire Rescue were notified of the spill. After the rig was repaired, the vendor cleaned up the contaminated soil with BNL staff providing oversight and it was determined that the amount of hydraulic fluid released to the soil was 0.5 gallons. The soil was placed into a 55-gallon metal drum that was labelled with the Spill Number. Coastal arranged for the off-site disposal of the soil and provided a Bill of Lading to BNL to close the spill out with the New York State Department of Environmental Conservation (NYSDEC).
25-03 3/13/25	Hydraulic fluid/ 0.5 gallons	NO	During offloading of a vendor's (ETGI) rolloff container to be used for waste hauling, the piston seal gasket leaked hydraulic fluid onto the ground. Upon observing the leak, the driver immediately ceased the offloading operation and informed on-site BNL Staff involved in waste loading operations. Absorbent pads were placed on the ground where the oil leaked and absorbent pads were used to wipe down the oil that sprayed onto the vehicle's truck body. The truck was moved to a nearby parking lot (impermeable surface) and the stained soil was excavated by BNL Staff. Visibly stained soil was shoveled into two-55 gallon open-head drums. The vehicle was driven off-site and repaired by the vendor's mechanics and driven back to the vendor's location. The two waste drums were immediately taken to the on-site, BNL Waste Management Treatment, Storage, and Disposal Facility (TSDF)/Bldg. 855 for proper storage prior to off-site disposal.
25-08 4/30/25	Hydraulic fluid/ 0.5 gallons	NO	The Production Division's small Bobcat leaked hydraulic fluid onto the lower chassis and rear rubber tire and then onto the ground. Fire Rescue was notified and placed secondary containment trays under the vehicle and used absorbent pads to capture the spilled oil on the soil. The vehicle was transferred to the Motor Pool for repairs. One 55-gallon drum was used to containerize the stained soil and miscellaneous debris. The drum was transferred to the DEC-permitted Part 373 TSDF for storage prior to off-site shipment.
25-12 8/4/25	Fuel Oil/ 0.25 gallons	NO	Stained soil with a petroleum odor was encountered during construction excavation activities occurring outside Bldg. 610 as part of a construction project involving building an addition. Based on the location, the stained soil was believed to be #6 fuel oil. The soil that displayed visual staining was removed and placed inside three 5-gallon pails and were transferred to the Facilities and Operations (F&O) 90-day Hazardous Waste Accumulation Area at Bldg. 630. Additionally, a 1.5-inch diameter steel pipe was observed that was badly corroded, therefore it was severed and removed. This pipe was also taken to the 90-Day Hazardous Waste Accumulation Area in Bldg. 630 for staging prior to off-site disposal through Bldg. 855/Waste Management.
25-13 8/8/25	Compressor oil/ 5 gallons	NO	Approximately five gallons of UCON compressor oil leaked from a transfer pipe onto soil (the oil was being transferred from a storage skid inside B1005H to B1005R). The leak was discovered immediately after the valve was opened. Impacted soil was drummed by F&O Grounds Staff. Speedy-dri absorbent material used for cleaning the concrete/paved surfaces was also drummed. The waste was picked up by Waste Management Techs and transferred to Bldg. 919 for accumulation prior to off-site disposal through Waste Management/Bldg. 855 as Industrial-oily waste.
25-14 10/1/25	Fuel Oil #2/ 5.1 gallons	NO	During a routine, monthly tank inspection performed by the Steam Shop, fuel was detected inside the interstice of a "Lube Cube", double walled tank (DEC Registered Tank No. 339-04). The contents of this tank were transferred into a spare, 1000-gallon double-walled tank and investigation initiated on cause of spill to secondary containment. Unusable fuel was containerized and was transferred to the 90-Day Hazardous Waste Accumulation Area in Bldg. 630. From there, the waste was transferred to the on-site, NYSDEC Part 373-Permitted Storage Facility in Bldg. 855 for eventual, off-site disposal.

(continued on next page)

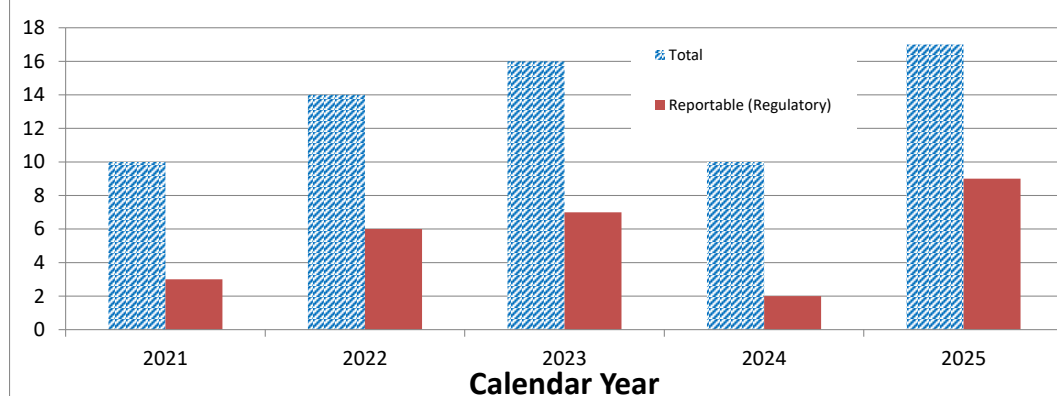
There were 17 spills in 2025 and nine of those spills met regulatory agency reporting criteria. The remaining spills were small-volume releases either to containment areas or to other impermeable surfaces that did not exceed a reportable quantity. Table 3-4 summarizes each of the nine reportable events, including a description of the cause and corrective actions taken.

Table 3-4. Summary of Chemical and Oil Spill Reports (*concluded*)

BNL Spill No. and Date	Material/Quantity	ORPS Report	Source/Cause and Corrective Action
25-15 PSEG Equipment 10/16/25	Transformer Oil/ 3 gallons	NO	On 10/13/25, a broken utility pole (#14) was observed in the woods near Monitoring Well PT-590. A transformer on the pole was facing downward and leaked approximately three gallons of mineral oil onto the ground. PSEG was notified and responded the same day to repair the pole. PSEG returned on 10/15 to remediate the mineral oil spill. Approximately three gallons of oil were spilled, and three 55-gallon drums of stained soil were removed. Clean soil from the installation of the new utility pole was placed in the excavated area. NYSDEC and the Department of Energy (DOE) were both notified by PSEG and BNL, respectively, upon discovery of the spill. PSEG believes the pole broke and the spill occurred on Saturday, 10/11/25. The cause of the spill was heavy winds during a storm event. Three 55-gallon drums of contaminated, non-polychlorinated biphenyl (PCB) soil were removed from the site and were managed by PSEG at their Hicksville Hazardous Waste Storage Facility.
25-16 10/28/25	R-TEMP/ Transformer Oil 0.5 gallons	NO	Electricians working at Well House 7 observed oil stains on the housing of a pad-mounted transformer near Well House 7 (Bldg. 619). Notifications were made and observed stained soil and a stained concrete pad adjacent to the pad-mounted transformer. The BNL Grounds Dept. excavated the stained soil and applied adsorbent to the concrete. Two (2) five-gallon pails of oil-contaminated soil were generated by Grounds personnel, and the pails were transferred to Bldg. 630, the F&O 90-Day Haz Waste Accumulation Area. From there, the waste containers were transferred to the on-site, NYSDEC Part 373-Permitted, Storage Bldg. 855 for storage prior to off-site disposal.
25-17 PSEG Spill 11/14/25	Hydraulic fluid/ 0.25 gallons	NO	PSEG owned forklift leaked hydraulic fluid on the grass at the rear/northeastern grassy area of Bldg. 603. The hydraulic fluid leaked from a PSEG forklift. The forklift was removed from the site and PSEG removed the oil-contaminated soil and disposed of all waste via their work location. PSEG also made all required external, regulatory notifications.

Figure 3-1 is a five-year trend of spills that have occurred at BNL. The increased trend in the number of spills over the last year is primarily due to an overall increase in major exterior construction activities. 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 3-1.
Spills Trend
2021-2025



3.4.4 Major Petroleum Facility (MPF) License

The storage and transfer of 1.9 million gallons of fuel oil (principally No. 4 oil and No. 2 oil) subjects the Laboratory to MPF licensing by NYSDEC. The fuel oil used at the Central Steam Facility (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 2025, 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 2025, no SVOCs or floating products attributable to MPF activities were present above detectable limits. Tetrachloroethene, chloroform, cis-1,2-dichloroethene and trichloroethene were detected in an upgradient well at concentrations at or below their applicable New York State Ambient Water Quality Standard (NYS AWQS) for Class GA groundwater. Tetrachloroethene was also detected in two downgradient wells at concentrations below the NYS AWQS. The VOCs are believed to originate from historical solvent spills that occurred near the CSF and upgradient near former Building 650. No detections of petroleum products associated with the MPF were detected in the groundwater samples. See the Site Environmental Report (SER) Volume II, Groundwater Status Report, for additional information on groundwater monitoring results in areas where bulk petroleum products are being stored.

In February of 2025, there was a NYSDEC, Title 6 Codes, Rules, and Regulations of the State of New York (NYCRR) Part 613, regulatory compliance inspection. The inspection included a review of records and field inspections of the NYSDEC-registered petroleum tanks including sumps, piping, overfill, leak detection, and tank labelling. The NYSDEC inspector sent a final Compliance Evaluation Letter in March indicating that there were no concerns observed.

3.5

Chemical Bulk Storage (CBS)

Title 6 of the Official Compilation of the 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 was a NYSDEC-CBS Facility inspections in February of 2025 and there were no concerns observed.

3.6

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.

During 2025, BNL submitted a request to the NYSDEC for a Minor Modification to its RCRA Permit to reflect the approved closure of four 90-Day Hazardous Waste Storage Areas. These closures were witnessed and certified completed by the NYSDEC in 2024. The request for minor modification was approved and incorporated into the RCRA Permit.

In August 2025, the NYSDEC 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 the August inspection was received from the NYSDEC on September 15, 2025, indicating that the review of information provided by the facility uncovered no concerns or violations.

3.7

Polychlorinated Biphenyls (PCBs)

The storage, handling, and use of PCBs are regulated under the Toxic Substances 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 2025 and disposed of 545 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.

3.8

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 (IPM) approach that was developed over a decade ago and was assessed in 2025 by a third-party (Cornell Cooperative Extension). The final report indicated that BNL's IPM program is strong with several recommended opportunities for improvement identified. These recommendations are being evaluated and addressed as necessary pending available funding.

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, continued in 2025, has resulted in the reduction of the amount of pesticide applied to the rollers on the devices. The amount of overall pesticide usage in 2025 versus previous years has decreased while maintaining effectiveness at an 85% 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, algicide, 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.

3.9

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 2025, 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 2025.

3.10

External Audits and Oversight

The DOE Brookhaven Site Office (BHSO), regulatory agencies, and Brookhaven Science Associates (BSA) routinely conduct inspections, assessments, and surveillances to evaluate environmental compliance, program effectiveness, and opportunities for continual improvement.

BHSO provides independent oversight of Laboratory operations and, in 2025, also participated as an observer during BSA's multi-topic environmental compliance assessment, monitoring the assessment planning, execution, and reporting processes. In addition, the EPD conducts periodic programmatic assessments based on regulatory requirements, previous findings, operational risks, and results of prior inspections and self-assessments.

Collectively, these evaluations confirmed the continued effectiveness of BNL's environmental protection programs, with the majority of inspections identifying no violations or significant findings. Where minor findings or opportunities for improvement were identified, corrective actions were promptly implemented to strengthen program performance and ensure continued compliance. Table 3-5 summarizes the environmental regulatory inspections, DOE oversight activities, and internal assessments conducted during 2025, along with their results and associated corrective actions.

Table 3-5. Assessments and Regulatory Inspection Results

Type	Lead Agency	Date (Month)	Scope	Results or Findings	Corrective Actions
Regulatory Oversight					
Potable Water Inspection (Safe Drinking Water Compliance)	SCDHS	June	Annual Water Supply Sanitary Survey of the BNL potable water system.	Several deficiencies were identified.	Corrective actions for identified deficiencies were established and communicated with SCDHS and are being addressed by the Laboratory's Energy & Utilities Division.
Sewage Treatment Plant SPDES Compliance	SCDHS	February May August November	Quarterly inspection of the STP to evaluate operations and sample the effluent for SPDES compliance.	No performance or operational issues identified.	NA
RCRA Compliance	NYSDEC	August	Inspection of hazardous waste activities.	No violations or concerns.	NA
Petroleum and Chemical Bulk Storage Compliance	NYSDEC	February	Inspection of the Laboratory's regulated aboveground and belowground tanks.	No violations or concerns.	NA
Clean Air Act (Title V Compliance)	NYSDEC	August	Determine compliance with New York State Air Pollution Control Act.	No violations or concerns.	NA
DOE Assessment/Surveillance					
Sustainability	BHSO	November	Review of BSA data entered into the DOE Sustainability Dashboard.	No findings.	NA

(continued on next page)

Table 3-5. Assessments and Regulatory Inspection Results (*concluded*)

Type	Lead Agency	Date (Month)	Scope	Results or Findings	Corrective Actions
DOE Assessment/Surveillance					
Waste Management Surveillance – Waste Tracking and Inventory Management	BHSO	January	Surveillance of Waste Management personnel performing waste tracking and inventory management in accordance with WM-SOP-725 procedure.	One minor finding and other opportunities for improvement identified for more detail and clarification within procedure.	Findings were reviewed and addressed by BSA. The procedure was revised to include universal waste, and added requirements for scanner maintenance, calibration, and software updates.
Groundwater Protection Program Surveillance: Semi-Annual Land Use and Institutional Controls (LUICs) Inspection performed by BSA	BSA/BHSO (Observer)	October November	Annual evaluation on the status of the LUICs, to include deficiencies or inconsistent uses.	No findings.	NA
Internal Assessments					
Independent EMS Assessment	Qualified Auditors from SRNL and LANL DOE Labs	March	Conformance to the ISO 14001 Standard.	Three noteworthy practices, no major or minor non conformances.	NA
Environmental Compliance Assessments	BSA/BHSO (Observer)	June	Assess the effectiveness of BNL's compliance with "Spill Response" Subject Area and line management procedural requirements.	Five administrative opportunities for improvement were identified.	Corrective actions were established and addressed in 2025.
	Performed by Cornell Cooperative Extension of Suffolk County	January	Independent Assessment of BNL's Integrated Pest Management Program	Overall program is strong with several recommended opportunities for improvement identified.	Recommendations for improvement have been evaluated and addressed as necessary and pending available funding.
	BSA	May	Evaluate the data quality and information management of BNL's Environmental Monitoring Program	One Level 2 finding regarding QA Record Reviews not being conducted and one Opportunity for Improvement.	Corrective actions for the one finding and opportunity for improvement were identified and addressed in 2025.

Notes:

BHSO = Brookhaven Site Office

BSA = Brookhaven Science Associates

DOE = Department of Energy

EMS = Environmental Management System

LANL = Los Alamos National Laboratory NA = Not Applicable

NYSDEC = New York State Department of Environmental Conservation

RCRA = Resource Conservation and Recovery Act

SCDHS = Suffolk County Department of Health Services

SPDES= State Pollutant Discharge Elimination System

SRNL = Savannah River National Laboratory

STP = Sewage Treatment Plant



References and Bibliography

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 Laboratory, Upton, NY.

Bruno, C. 2025. Brookhaven National Laboratory 2025 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.





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

Chapter 4

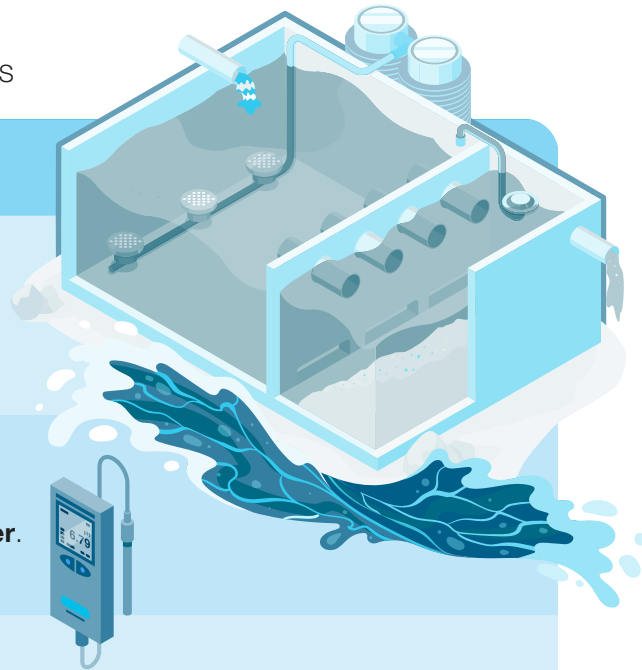
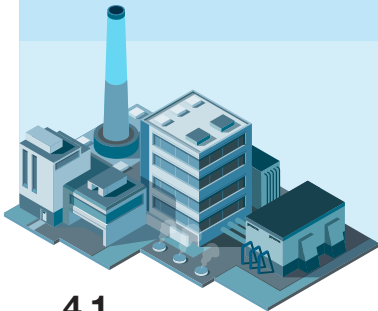
Non- Radiological Environmental Monitoring Programs



CHAPTER HIGHLIGHTS

In 2025, **no noncompliance events** occurred for any of the **State Pollutant Discharge Elimination System (SPDES)** permitted recharge basin outfalls or effluent limits.

Environmental monitoring showed that the **Laboratory's controls** continue to **protect Long Island's groundwater and surface water**.



Air emissions from the Central Steam Facility (CSF) remained well **below permit limits** for all regulated pollutants.

4.1

Programs Summary

Brookhaven National Laboratory (BNL) monitors effluents and emissions to ensure the effectiveness of controls in place, adherence to regulatory requirements, and timely identification and implementation of corrective measures. BNL's Environmental Monitoring Program is a comprehensive, site-wide program that identifies potential pathways for exposure of the public and employees, evaluates the Laboratory's environmental impact, and ensures compliance with environmental permit requirements.

This chapter summarizes the non-radiological compliance and surveillance monitoring results of wastewater/surface water discharges and air emissions.

4.2

Wastewater & Surface Water Monitoring Programs

4.2.1 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 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). Figure 4-1 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, 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 4-1. 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 en route 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 2025, 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.

4.2.1.1 Sanitary System Effluent Monitoring Results

A summary of SPDES compliance monitoring results for the STP discharge at Outfall 001 is provided in Table 4-1, 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 2025.

Table 4-1. 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)	6.7	7.9	Continuous Recorder	Min. 5.8, Max. 8.5	0	100
Solids, Total Dissolved (mg/L)	312	471	Monthly	1000	0	100
Total nitrogen (mg/L)	5.8	9.3	Twice Monthly	10	0	100
Total phosphorus (mg/L)	0.6	1.2	Twice Monthly	NA	0	100
Cyanide (mg/L)	< 0.002	< 0.002	Twice Monthly	0.1	0	100
Copper (mg/L)	0.009	0.02	Twice Monthly	0.15	0	100
Iron (mg/L)	0.1	0.2	Twice Monthly	0.6	0	100
Lead (mg/L)	< 0.0005	0.001	Twice Monthly	0.025	0	100
Mercury (ng/L)	1.4	7	Twice Monthly	200	0	100
Methylene chloride (ug/L)	1.1	4.3	Twice Monthly	5	0	100
Nickel (mg/L)	< 0.002	0.004	Twice Monthly	0.1	0	100
Silver (mg/L)	< 0.0003	0.001	Twice Monthly	0.015	0	100
Toluene (ug/L)	< 1	< 1	Twice Monthly	5	0	100
Zinc (mg/L)	0.02	0.1	Twice Monthly	2	0	100
1,1,1-trichloroethane (ug/L)	< 1	< 1	Twice Monthly	5	0	100
Max. Flow (MGD)	0.23	0.54	Continuous Recorder	2.3	0	100
Avg. Flow (MGD)	0.14	0.28	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 4-2 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

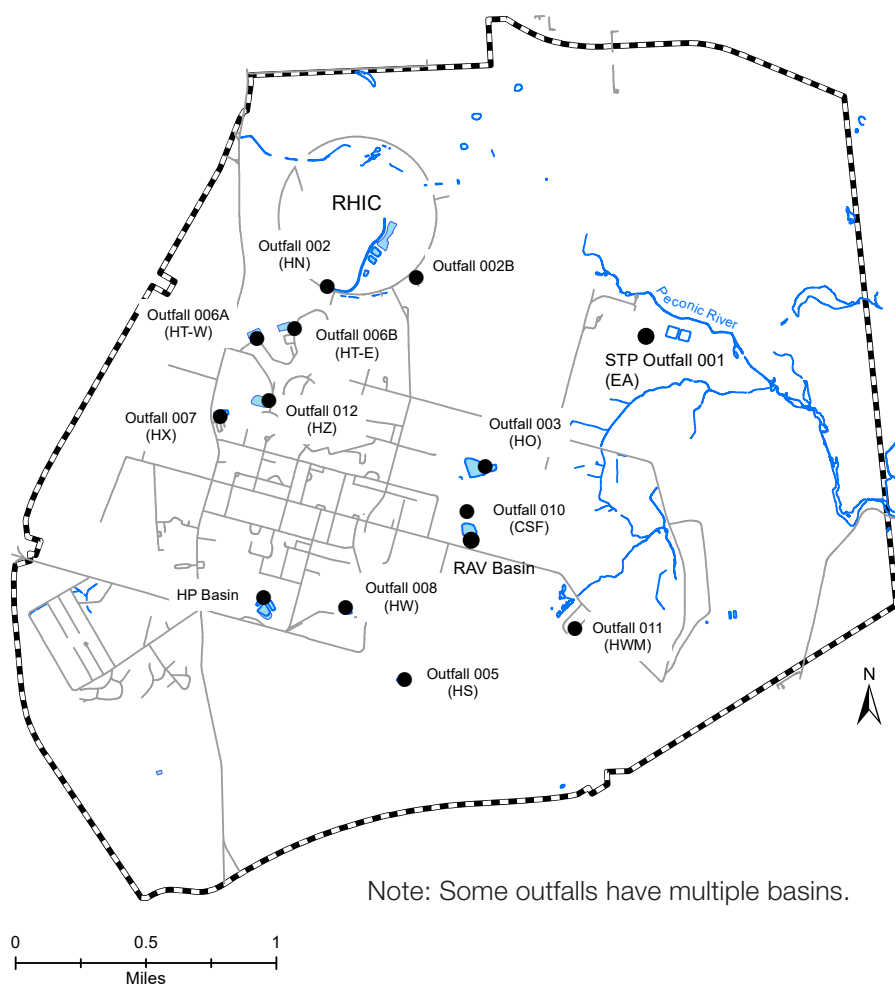


4.2.2 Recharge Basins

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 4-2 shows the locations of the Laboratory’s discharges to recharge basins (also called “outfalls” under BNL’s SPDES permit):

- Basin HZ receives stormwater and cooling water discharges from Building 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 Building 725 (Computational Science Initiative facility).
- 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 Building 750 (the former High Flux Beam Reactor [HFBR]).

Figure 4-2. BNL Recharge Basin/Outfall Locations



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 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. Monitoring requirements for each of these discharges vary, depending on the type of wastewater received and the type of cooling water treatment reagents used. Where required by the permit, the basins are equipped with a flow monitoring station, allowing for weekly recordings of flow rates.

To supplement the compliance monitoring program, samples are also routinely collected and analyzed under BNL's environmental surveillance program for volatile organic compounds (VOCs), metals, and anions. During 2025, water samples were collected semi-annually from all the basins listed above except for recharge Basin HX at the Water Treatment Plant (because previous evaluations documented no impact to groundwater) and a recharge basin at the FHWMF (due to absence of operations at the FHWMF that could lead to the contamination of runoff).

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. Stormwater runoff typically has elevated levels of inorganics (e.g., metals) and a low pH. The inorganics are attributable to high sediment content in stormwater (inorganics occur naturally in native soil).

To further improve the quality of stormwater runoff on-site, formal procedures are in place for managing and maintaining outdoor work and storage areas. The requirements include covering 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 a 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.

4.2.2.1 Recharge Basin Monitoring Results

In 2025, no noncompliance events occurred for any of the SPDES permitted recharge basin outfalls. Additional surveillance 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 results are summarized in Table 4-2. 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.

Low concentrations of disinfection byproducts were periodically detected above the Method Detection Limits (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. A sample collected from Basin HT-E in September 2025 had a resulting bromoform concentration of 80.4 µg/L which is the highest concentration of bromoform observed at this location in the past 10 years. The remaining results were all below the 50 µg/L New York State Ambient Water Quality Standard (NYS AWQS). The relatively high concentration observed at Basin HT-E is likely attributed to a required cleaning of a cooling tower that discharges to this location that was performed earlier in the month of September 2025 utilizing calcium hypochlorite to combat

bacteria growth. A standard part of the cleanout/disinfection protocol also involves increasing the output of bromine biocide for one to two weeks which would have potentially coincided with the date sampling occurred. All other disinfection byproducts were either below the MDL, or below the applicable NYS AWQS standard.

The water quality analytical data presented in Table 4-2 show that, for 2025, 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 2025. With respect to metals, an elevated iron concentration of 1500 µg/L was observed at Basin HZ. Additionally, antimony was detected in a sample from Basin HO at a concentration of 6.5 µg/L. Both concentrations exceeded the NYSDEC Effluent Limits of 600 µg/L for iron and 6 µg/L for antimony; however, these exceedances only occurred in the unfiltered samples. Post-filtration, concentrations for both analytes were reduced to below the limit indicating that suspended sediment was partially responsible for metals in the samples. Additionally, iron is typically found in high concentrations in Long Island soils and groundwater. Antimony also naturally exists in trace amounts in soils. Moreover, the concentration of antimony at 6.5 µg/L was an estimated value and the samples collected from Basin HO from May of 2010 until 2025 all resulted in non-detect concentrations of antimony. All other metals results for samples collected from the recharge basins were below their respective effluent limits and ambient water quality standards.

Table 4-2. Water Quality Data for On-site Recharge Basins (2025)

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)		
No. of Samples		2	2	2	2	2	2	2		
pH (SU)	Min.	7.7	8.1	7.5	7.9	7.9	7.7	8.2	6.5 - 8.5	NA
	Max.	8.0	8.3	8.0	8.0	8.2	7.8	8.5		
Conductivity (µS/cm)	Min.	425	267	213	388	1050	47	120	SNS	NA
	Max.	466	378	350	391	4178	804	1764		
	Avg.	446	323	282	390	2614	426	942		
Temperature (Deg. C)	Min.	12.1	17.9	7.4	9.5	9.8	8.6	8.6	SNS	NA
	Max.	12.4	24.2	11.3	12.3	16.7	15.5	16.3		
	Avg.	12.3	21.0	9.4	10.9	13.3	12.1	12.5		
Dissolved Oxygen (mg/L)	Min.	9.4	8.4	10.4	10.2	7.3	9.9	9.7	SNS	NA
	Max.	10.4	9.2	10.9	10.9	10.1	11.2	11.9		
	Avg.	9.9	8.8	10.7	10.6	8.7	10.6	10.8		
Chlorides (mg/L)	Min.	72	60	32	65	200	4	10	SNS	0.2
	Max.	410	66	70	71	1000	260	570		
	Avg.	241	63	51	68	600	132	290		
Sulfate (mg/L)	Min.	13.0	8.5	6.2	10.1	21.0	2.3	6.5	500	0.5
	Max.	14.2	12.0	11.0	14.0	43.7	4.9	9.1		
	Avg.	13.6	10.2	8.6	12.1	32.4	3.6	7.8		
Nitrate as Nitrogen (mg/L)	Min.	0.4	0.6	0.4	0.7	0.3	0.2	0.2	10	0.1
	Max.	0.7	0.7	0.5	0.7	0.7	0.2	0.2		
	Avg.	0.6	0.6	0.4	0.7	0.5	0.2	0.2		

Notes:

See Figure 4-2 for recharge basin/outfall locations.

S = stormwater

AGS = Alternating Gradient Synchrotron

HFBR = High Flux Beam Reactor

Linac = Linear Accelerator

MDL = method detection limit

NA = not applicable

NYSDEC = New York State Department of Environmental Conservation

RHIC = Relativistic Heavy Ion Collider

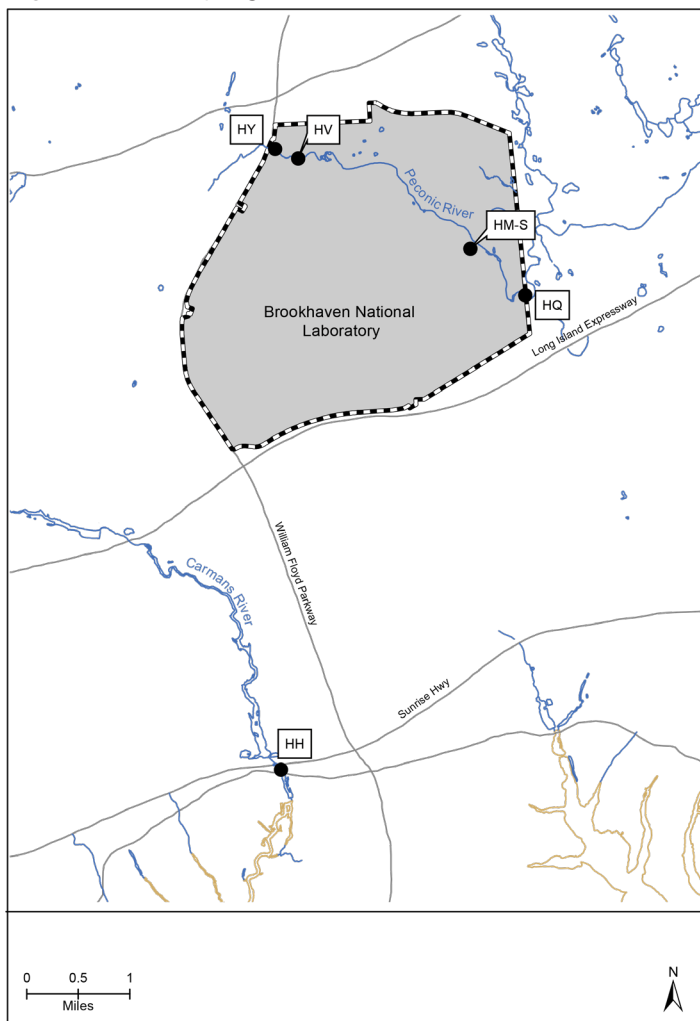
SNS = effluent standard not specified

4.2.3 Peconic River

BNL routinely monitors surface water quality 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 4-3). 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. There was no off-site flow in 2025. 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 section describes BNL's surface water monitoring and surveillance program.

Figure 4-3. Sampling Stations for Surface Water



4.2.3.1 Peconic River Monitoring Results

River water samples collected in 2025 were analyzed for water quality parameters (e.g., pH, temperature, conductivity, and dissolved oxygen), anions (e.g., chlorides, sulfates, and nitrates), metals, and VOCs. Due to a lack of observed flow at locations HM-S and HQ, samples were unable to be collected from those stations. Additionally, station HV is sampled exclusively for select water quality parameters. No VOCs were found in any samples collected from the Peconic and Carmans Rivers in 2025. Water quality parameters measured at the Peconic River location (HY) and the Carmans River control location (HH) show that temperature, conductivity, pH, and dissolved oxygen levels were all within applicable NYS 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 2025, 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, and iron were present in concentrations at Peconic River location HY that exceeded NYS AWQS. Total iron was also detected in Carmans River location HH at a concentration exceeding the NYS AWQS. Filtration of samples reduced concentrations for each of the aforementioned samples and analytes to below the NYS AWQS, suggesting that suspended sediment was partially responsible for metals in those samples. Additionally, iron and aluminum are found in high concentrations in native Long Island soil and, for iron, at high levels in groundwater.

4.3

Airborne Emissions Monitoring Program

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 following subsections describe the more significant sources that require routine monitoring and other sources that do not, and the methods used by BNL to comply with applicable regulatory requirements.

4.3.1 Central Steam Facility (CSF)

BNL is required to maintain a NYSDEC Title V Air Permit since oxides of nitrogen (NO_x) emissions generated from the operation of the CSF exceed “major facility” thresholds. Consequently, the CSF is the only BNL facility that requires monitoring for non-radiological emissions.

Boiler Emissions Requirements

The CSF utilizes large boilers, which combust fuel to supply steam for heating and cooling to major BNL facilities through an underground steam distribution and condensate grid. The four combustion units at the CSF are designated as Boilers 1A, 5, 6, and 7.

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. Typically, due to costs, natural gas is the fuel predominantly burned at the CSF. Since the boilers have the potential to emit more than 25 tons per year of oxides of nitrogen (NO_x), the CSF is considered a *major* facility and, therefore, all four boilers are subject to NYSDEC Reasonably Available Control Technology (RACT) requirements of 6 NYCRR Subpart 227-2 (NYC 2019).

NO_x RACT emission standards are established for boilers with maximum operating heat inputs greater than or equal to 25 million British thermal units (MMBtu)/hr (7.3 MW). 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). From May 1 to September 30 of each year, the peak ozone period, owners and operators of boilers equipped with continuous emissions monitoring system (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.

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 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).



Control monitors located at CSF.

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 CEMS to demonstrate compliance with the NO_x standards of these subparts, and with continuous opacity monitoring systems (COMS) to demonstrate compliance with Subpart Db opacity monitoring requirements. The opacity monitors measure the transmittance of light through the exhaust 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. To measure combustion efficiency, the boilers are also monitored for carbon monoxide (CO).

At the end of each calendar quarter, CEMS and COMS data for the preceding three months is tabulated and summarized and then reported to the Environmental Protection Agency (EPA) and the NYSDEC in the quarterly Site-Wide Air Emissions and Monitoring Systems Performance Report.

Boiler Emissions Monitoring Results

To satisfy the Laboratory's Title V operating permit quality assurance requirements for the CEMS, a relative accuracy test audit (RATA) of the Boilers 6 and 7 continuous emissions monitoring systems for NO_x and CO₂ was conducted in December 2025. The results of the RATA demonstrated that the Boiler 6 and 7 NO_x and CO₂ CEMS met RATA acceptance criteria, which are defined in 40 CFR 60, Appendix B, Specifications 2 and 3.

The most recent stack tests, performed on Boilers 1A and 5 in December 2024 and 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, and 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, it is not considered a concern because the Laboratory does not anticipate burning distillate fuel in Boiler 1A in the foreseeable future.

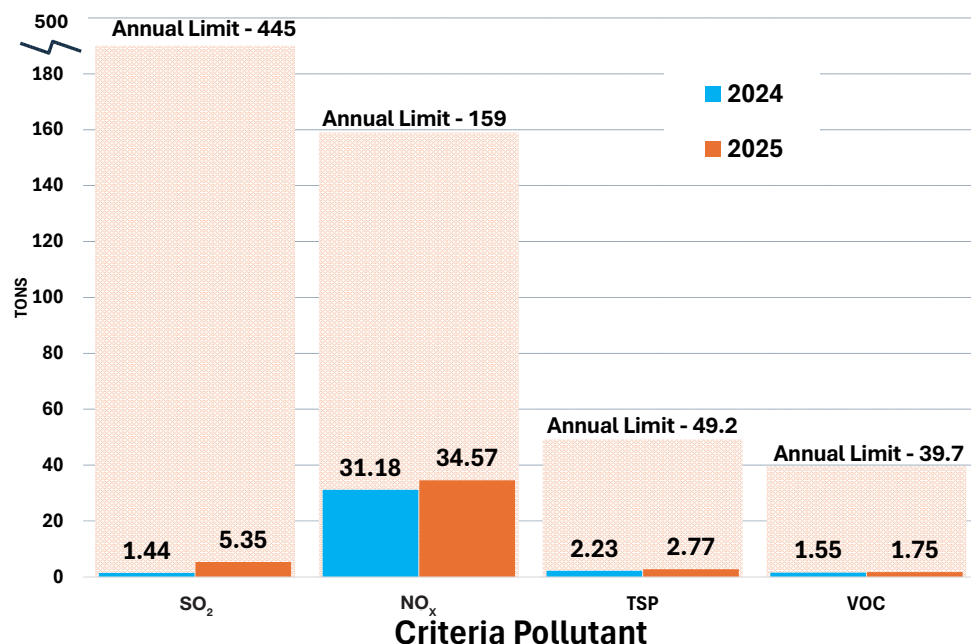
BNL uses an approved system averaging plan to demonstrate NO_x compliance. This plan utilizes a ledger, where NO_x rate credits accumulated during quarterly periods when natural gas is burned at levels below the NO_x RACT limits offset ledger debits that may occur when fuel oil is burned. To demonstrate compliance, 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. Using the system averaging approach, actual weighted average NO_x emission rates for operating boilers for the first through fourth quarters were 0.122, 0.108, 0.089, and 0.107 lbs/MMBtu, respectively, which were below the corresponding quarterly permissible weighted average emissions rates of 0.150, 0.154, 0.150, and 0.151 lbs/MMBtu.

During 2025, there were two (2) CEMS recordings at Boiler 6 that exceeded the 0.15 MMBtu/hr NO_x RACT emission rate limitation. One occurred on April 29 and was due to boiler start-up activities. The second occurred on May 19, the cause of which was unknown.

There were two (2) 6-minute average opacity readings, recorded at Boiler 7, that exceeded 27% on October 16 and December 16, 2025. The October exceedance was due to boiler startup activities, and the December exceedance was due to probe interference with the opacity light path, which occurred during the annual RATA. In both cases, the issue was rectified on the same day. 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.

Title V permit conditions restrict total annual emission releases from the CSF for four criteria pollutants including SO₂ (445 tons), NO_x (159 tons), total suspended solids (TSP) (49.2 tons), and VOCs (39.7 tons). Figure 4-4 displays criteria pollutant limitations as compared to actual emissions for 2024 and 2025. As indicated, actual emissions were well within permitted limitations.

Figure 4-4. Annual Emission Totals



4.3.2 Ozone-Depleting Substances

Refrigerants: The Laboratory's preventative maintenance program requires regular inspections 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 2025, 133 pounds of R-22 and 155 pounds of R-410A (a 50:50 blend of HFC-32 and HFC-125) were recovered and recycled from refrigeration equipment that was serviced while an estimated 166 pounds of R-22 and 293 pounds of R-410A was lost to the atmosphere from equipment leaks normally associated with refrigeration appliances. Refrigeration leaks for each calendar year are reported in the Annual Emissions Statement transmitted to NYSDEC.

Halon: Halon 1211 and 1301 are extremely efficient fire suppressants that have been phased out due to their effect on the earth's ozone layer. In August of 2025, the remaining supply of Halon cylinders was 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, has been replaced with an EPA Significant New Alternative Policy (SNAP) approved alternative.

4.3.3 Hazardous Air Pollutants (HAPs)

In 1970, the Clean Air Act (CAA) established standards to protect the public from HAPs that may lead to death or an increase in irreversible or incapacitating illnesses. The National Emission Standards for Hazardous Air Pollutants (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 188 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.

4.3.3.1 Groundwater Remediation

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 Laboratory's Groundwater Protection Group to document the process used 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 2025, the Laboratory's groundwater treatment systems emitted an estimated total of 25 lbs of HAPs, which is well within acceptable limits.

4.3.3.2 Asbestos Management

Throughout the year, 5,860 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 and disposed of in accordance with EPA requirements. The Laboratory notified the EPA Region II office about the removal of asbestos containing materials (ACM) in 2025.



4.3.4 Hydrofluorocarbons (HFCs)

In continued preparation for anticipated decreases in the availability of certain 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 46,088 lbs 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.

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.





Sewage Treatment Plant operator and staff conducting monitoring activities.

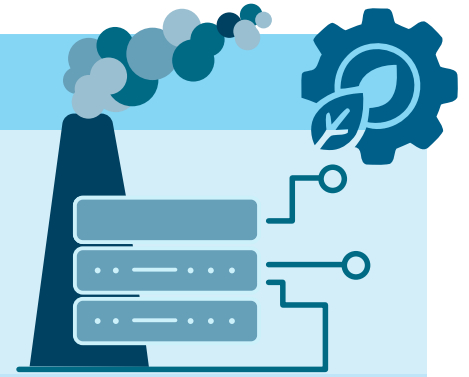
Chapter 5

Environmental Radiological Monitoring Program & Dose Assessment



CHAPTER HIGHLIGHTS

The results of monitoring air emissions, ambient air, and direct radiation confirmed **Laboratory operations continue to show no impact on the public or the environment.**



Monitoring of water, soil, vegetation, and wildlife demonstrated the **effectiveness** of the Laboratory's environmental protection programs.

5.1

Introduction

Brookhaven National Laboratory (BNL) maintains a comprehensive Environmental Radiation Monitoring Program to verify that Laboratory operations present no risk to the public, workers, or the environment, and to comply with applicable U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) regulations. The program measures radionuclides in facility emissions and the environment, including air, water, soil, vegetation, wildlife, and direct radiation. The monitoring data is then used to estimate the radiation dose that could be received by members of the public.

While environmental monitoring measures the concentration of radioactive materials or radiation present in the environment, the dose assessment translates those measurements into potential health impacts. Together, environmental monitoring and dose assessment demonstrate that radiological impacts from Laboratory operations remained well below applicable regulatory limits during 2025.

5.1.1 Radiological Protection Program

The Environmental Radiation Protection Program (ERPP) implements DOE and U.S. EPA requirements for monitoring radiological emissions in the environment. Monitoring data is used to assess potential radiation dose to the public and demonstrate compliance with applicable regulatory standards. The monitoring activities and dose assessment methods used in 2025 are summarized in the following sections.

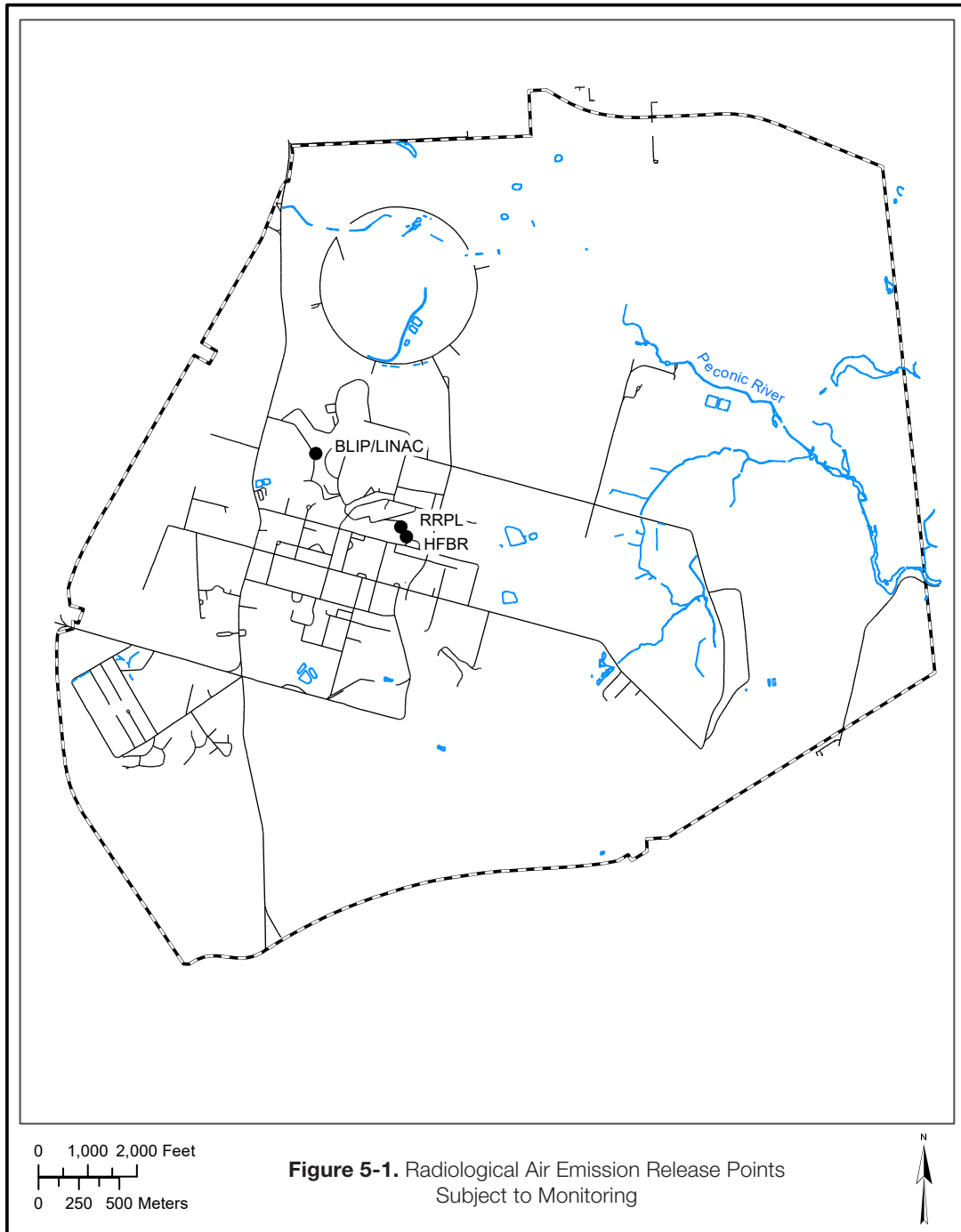
5.2

Radiological Environmental Monitoring Programs

5.2.1 Airborne Radioactive Releases

Federal air quality laws and U.S. 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 U.S. EPA's Clean Air Act, and DOE Order 458.1, Chg. 4 (DOE 2020), Radiation Protection of the Public and the

Environment. Under NESHAPs Subpart H, DOE sites must seek authorization to construct or modify a facility and continuously monitor that facility's emissions if those emissions have the potential to cause an annual radiation dose greater than 0.1 mrem ($1.0 \mu\text{Sv}$) to an off-site member of the public. Facilities capable of delivering radiation doses below that limit require periodic, confirmatory sampling. BNL has two active facilities: the Brookhaven Linac Isotope Producer (BLIP) and the Radionuclide Research and Production 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 5-1 provides the locations of these monitored facilities and Table 5-1 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 5-7.



5.2.2 Facility Air 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 0.0021 and 0.0264 pico-Curies per cubic meter (pCi/m³), respectively. Annual average gross alpha and beta airborne activity concentration levels for samples collected from the RRPL were 0.0028 and 0.0112 pCi/m³, respectively. The 2025 analytical results are summarized in Table 5-2.

Table 5-1. Airborne Radionuclide Releases From Monitored Facilities

Facility	Nuclide	Half-Life	Ci Released
HFBR	Tritium	12.3 years	2.87E-01
	C-11	20.38 minutes	2.50E+03
	O-15	122 seconds	5.01E+03
RRPL	Tritium	12.3 years	3.74E-02
Total			7.51E+03

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 and Production Laboratory
* < 1.5 µCi - No MEOSI Dose Impact (See Section 5.2.2.3)

5.2.2.1 High Flux Beam Reactor (HFBR)

The HFBR was permanently shut down in 1999. Residual tritium in water in the reactor vessel and piping systems continues 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. As part of the HFBR Long-Term Surveillance Program (BNL 2023), air samples are collected from inside 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. In 2025, 0.287 Ci of tritium were released. See Table 5-1.

5.2.2.2 Brookhaven Linac Isotope Producer (BLIP)

Protons from the Linear Accelerator (LINAC) Complex are directed 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 chemical dissolution, separation, and purification, followed by 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 irradiate the targets. In 2025, BLIP operated over a period of 8.32 weeks, during which 2,504 Ci of C-11 and 5,008 Ci of O-15 were released, totaling 7,512 Ci (see Table 5-1). In 2025, BLIP's combined emissions of C-11 and O-15 were lower than 2024 levels of 22,040 Ci. The decrease in released Curies resulted from a decrease in beam current hours. The 2025 release of tritium produced from activation of target cooling water was 0.037 Ci compared to 0.072 Ci of tritium released in 2024.



5.2.2.3 Radionuclide Research and Production Laboratory (RRPL)

As mentioned above, 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 an acid scrubber before flowing through a multi-stage 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 materials present in 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 this chapter.

5.2.2.4 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 entails 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, 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 later in this chapter in Table 5-7.

5.2.2.5 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 release 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. The NESHAPs evaluations of diffuse sources in 2025 are discussed in section 5.5.

Table 5-2. Gross Activity in Facility Air Particulate Filters

Monitored Facility	Gross Alpha		Gross Beta
	----- (pCi/m ³) -----		
BLIP	N	51	51
	Max.	0.0007 $\pm$ 0.0003	0.0054 $\pm$ 0.0011
	Avg.	0.0021 $\pm$ 0.0008	0.0264 $\pm$ 0.0023
	MDL	0.0006	0.0010
RRPL - Bldg. 801	N	52	52
	Max.	0.0008 $\pm$ 0.0004	0.0033 $\pm$ 0.0010
	Avg.	0.0028 $\pm$ 0.0009	0.0112 $\pm$ 0.0015
	MDL	0.007	0.0012

Notes:

See Figure 5-2 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 and Production Laboratory

5.2.3 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 5-2). These are four blockhouse stations equipped for air sampling. At each blockhouse, vacuum pumps draw outdoor air through columns where airborne particulate matter is captured on a glass-fiber filter. Particulate filters are normally collected weekly and analyzed off-site 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 off-site processing by liquid scintillation analysis.

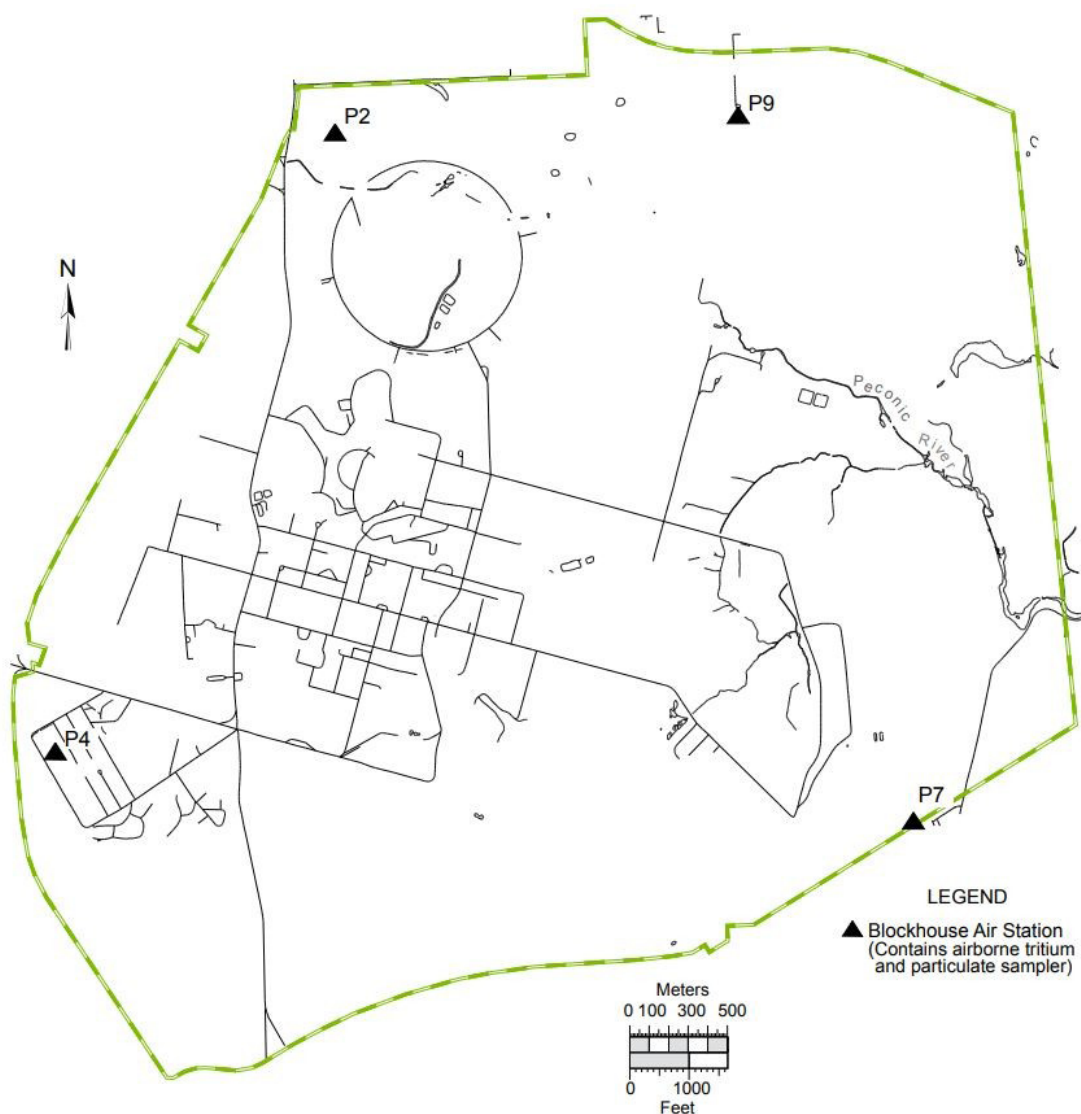


Figure 5-2. BNL On-site Ambient Air Monitoring Stations

5.2.3.1 Gross Alpha and Beta Activity

Particulate filter analytical results for gross alpha and beta airborne activity are reported in Table 5-3. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., sample air volumes were not acceptable).

In 2025, the annual average gross alpha and beta airborne activity levels for the four monitoring stations were 0.007 and 0.049 pCi/m³, respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 5-3.

As part of a state-wide monitoring program, the New York State Department of Health (NYSDOH) also collects air samples in Albany, New York, a control location with no potential to be influenced by BNL radiological facility emissions. 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 NYSDOH 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 0.0012 and 0.0027 pCi/m³, with an average concentration of 0.0124 pCi/m³. BNL results ranged from 0.0009 to 0.0022 pCi/m³, with an average concentration of 0.008 pCi/m³. 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.

Table 5-3. Gross Activity Detected in Ambient Air Monitoring Particulate Filters, 2025

Sample Station		Gross Alpha	Gross Beta
		(pCi/m ³)	
P2	N	52	52
	Max	0.024 ± 0.009	0.163 ± 0.021
	Avg.	1.168 ± 0.447	8.030 ± 1.020
	MDL*	0.0096	0.0098
P4	N	51	51
	Max	0.001 ± 0.001	0.009 ± 0.001
	Avg.	0.003 ± 0.001	0.020 ± 0.002
	MDL*	0.0006	0.0010
P7	N	47	47
	Max	0.001 ± 0.001	0.009 ± 0.002
	Avg.	0.005 ± 0.002	0.036 ± 0.009
	MDL*	0.0007	0.0013
P9	N	49	49
	Max	0.001 ± 0.000	0.007 ± 0.001
	Avg.	0.006 ± 0.003	0.020 ± 0.006
	MDL*	0.0004	0.0008
Grand Average		0.007 ± 0.003	0.049 ± 0.006

Notes:

See Figure 5-2 for sample station locations.

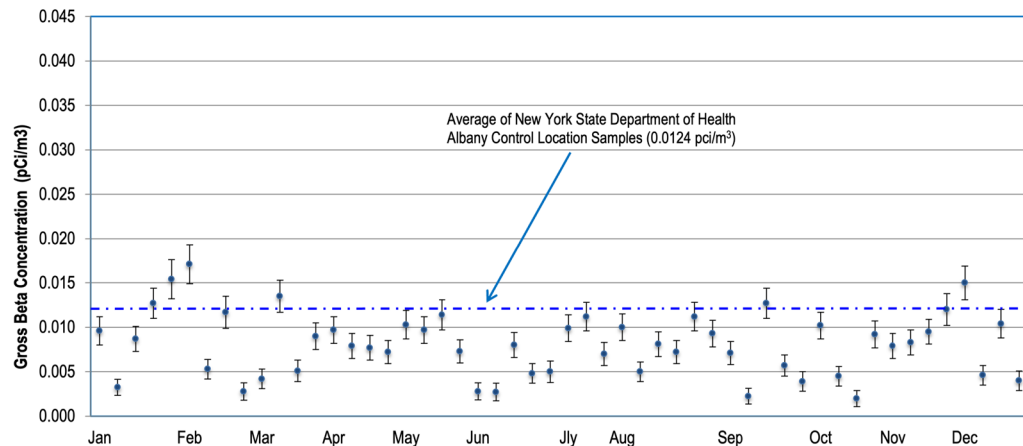
All values shown with a 95% confidence interval.

MDL = Minimum Detection Limit

N = Number of validated samples collected

*Average MDL for all samples taken at this location.

Figure 5-3.
Airborne Gross Beta
Concentration Trend
Recorded at Station
P7 in 2025



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

5.2.3.2 Airborne Tritium

Airborne tritium in the form of tritiated water (HTO) is monitored throughout the site. In 2025, samples were collected from Stations P2, P4, P7, and P9 to assess the potential impacts from the two tritium sources. Table 5-4 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 2025. The average tritium concentrations at the four sampling locations ranged from 1.8 to 6.7 pCi/m³ and were less than the contracted analytical lab's typical minimum detection limits.

Table 5-4. Ambient Airborne Tritium Measurements in 2025

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m ³)	Average
P2	NNW	26	29.8 ± 16.7	6.3 ± 3.5
P4	WSW	24	17.8 ± 10.0	6.4 ± 3.6
P7	ESE	26	17.4 ± 10.8	6.7 ± 3.8
P9	NE	26	6.9 ± 3.8	1.8 ± 0.9
Grand Average				6.2 ± 3.3

Notes:
See Figure 5-2 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/m³.

5.2.4 Surface Water Monitoring

As part of its site Surveillance Program, BNL routinely monitors wastewater at the sewage treatment plant (STP), wastewater that is discharged to on-site groundwater recharge basins, and surface waters for the presence of radionuclides. The following sections provide further details on the radiological monitoring that was performed at these locations in 2025 and the results of the monitoring. For additional background information regarding the sewage treatment plant, recharge basins, and surveillance of surface waters, see Chapters 3 and 4.

5.2.4.1 Sewage Treatment Plant

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 4-1. 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 Strontium-90 (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 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 5-5 shows the monthly gross alpha and beta activity data and H-3 concentrations for the STP influent and effluent during 2025. Annual average gross alpha and beta activity levels in the STP effluent were 0.8 ± 0.7 pCi/L and 5.7 ± 2.5 pCi/L, respectively. Both gross alpha and gross beta average concentrations were well below the SDWA standards of 15 pCi/L and 4 mrem/yr respectively, that are used for comparison purposes. The average annual effluent concentration of H-3 was 97.4 ± 49.3 pCi/L, well below the SDWA standard of 20,000 pCi/L. Conservative estimates of total releases based on H-3, gross-alpha, and gross-beta in millicuries are provided in Table 5-5. In 2025, there were no gamma-emitting nuclides detected in the STP effluent.

Table 5-5. Tritium and Gross Activity in Water at the Sewage Treatment Plant for 2025

		Flow	Tritium (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)	
		(liters)	max.	avg.	max.	avg.	max.	avg.
January	influent	1.74E+07	< 529.2	<MDC	11.4 ± 2.1	<MDC	< 90.4	22.9 ± 23.8
	effluent	1.64E+07	< 540.6	<MDC	4.0 ± 1.9	<MDC	8.9 ± 1.8	5.0 ± 3.2
February	influent	1.74E+07	< 532.1	<MDC	9.0 ± 4.2	4.4 ± 3.3	16.1 ± 2.1	7.0 ± 5.7
	effluent	2.04E+07	< 541.6	<MDC	8.9 ± 2.7	<MDC	< 69.0	16.4 ± 25.8
March	influent	2.24E+07	< 323.5	<MDC	< 5.1	<MDC	8.2 ± 3.6	4.3 ± 2.6
	effluent	3.16E+07	< 585	<MDC	< 2.1	<MDC	10.0 ± 3.2	4.4 ± 2.7
April	influent	1.50E+07	< 508.5	<MDC	< 4.1	<MDC	10.6 ± 3.2	8.7 ± 2.1
	effluent	1.72E+07	< 512.9	<MDC	< 4.4	<MDC	13.6 ± 4.0	7.9 ± 4.1
May	influent	2.15E+07	< 552.6	<MDC	< 4.1	<MDC	7.3 ± 1.8	5.2 ± 1.7
	effluent	2.22E+07	< 536.5	<MDC	3.0 ± 1.8	<MDC	8.8 ± 1.9	6.8 ± 2.1
June	influent	3.28E+07	< 528.3	<MDC	< 13.1	<MDC	< 25.5	8.9 ± 7.5
	effluent	2.98E+07	< 545.4	<MDC	< 6.3	<MDC	< 11.5	1.1 ± 4.2
July	influent	2.78E+07	< 566.3	<MDC	4.0 ± 2.8	<MDC	9.1 ± 3.5	7.0 ± 1.8
	effluent	2.67E+07	< 570.7	<MDC	< 2.8	<MDC	5.5 ± 2.2	5.1 ± 0.6
August	influent	2.92E+07	< 593.6	<MDC	7.7 ± 4.9	4.3 ± 2.6	12.4 ± 3.9	8.3 ± 3.9
	effluent	3.10E+07	< 607.4	<MDC	6.1 ± 2.8	4.7 ± 1.3	11.7 ± 2.6	6.7 ± 3.6

(continued on next page)

Table 5-5. Tritium and Gross Activity in Water at the Sewage Treatment Plant for 2025 (*concluded*)

		Flow	Tritium (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)	
		(liters)	max.	avg.	max.	avg.	max.	avg.
September	<i>influent</i>	3.21E+07	< 512	<MDC	< 12.2	<MDC	26.1 ± 9.9	7.2 ± 9.3
	<i>effluent</i>	3.30E+07	< 606.7	<MDC	0.8 ± 1.8	<MDC	7.5 ± 4.0	3.9 ± 1.7
October	<i>influent</i>	1.83E+07	< 428.1	<MDC	< 4.8	<MDC	6.8 ± 4.5	4.0 ± 2.0
	<i>effluent</i>	2.20E+07	< 434	<MDC	< 4.6	<MDC	< 4.9	3.0 ± 0.9
November	<i>influent</i>	1.98E+07	< 471.6	<MDC	< 3.6	<MDC	6.1 ± 1.7	4.0 ± 1.9
	<i>effluent</i>	2.29E+07	< 469.6	<MDC	< 3.1	<MDC	7.3 ± 1.9	3.4 ± 2.8
December	<i>influent</i>	2.73E+07	< 356.5	<MDC	6.7 ± 2.9	<MDC	8.8 ± 5.4	5.3 ± 2.6
	<i>effluent</i>	2.93E+07	< 342.2	<MDC	< 7.8	<MDC	6.9 ± 2.8	4.3 ± 2.2
Annual Avg.	<i>influent</i>			96.8 ± 47.5		2.1 ± 0.8		8.4 ± 3.4
	<i>effluent</i>			97.4 ± 49.3		0.8 ± 0.7		5.7 ± 2.5
Total Release		3.02E+08		31.5 mCi (a)		0.3 mCi		1.6 mCi
Average MDC (pCi/L)				509.7		4.2		5.7
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.

5.2.4.2 Recharge Basins

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. Gross alpha values were below the minimum detectable concentration (MDC) and gross beta activity ranged from non-detect to 5.28 ± 1.53 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.

5.2.4.3 Peconic River and Carman's River

During 2025, radionuclide analyses were performed on surface water samples collected from two of the Peconic River sampling locations, HY and HV, and the Carmans River control location, HH. Station HY provides information on the background water quality of the Peconic River for comparison to other sampling points that may show impacts from Laboratory operations. Station HV on the Peconic River allows for radiological assessment of potential Relativistic Heavy Ion Collider (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 on-site. In 2025, 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, and only one sample was able to be taken at sampling location HV. No flow was observed at sample locations HM-S and HQ in 2025. Radiological analysis of water samples collected from HY and control location HH had very low concentrations of gross beta activity that were attributed to natural sources. The gross beta value for location HV was below the MDC, and all detected levels were below the applicable New York State Drinking Water Standards (NYSDWS). H-3, gross alpha, and Sr-90 values were below MDCs at all locations on the Peconic and Carmans Rivers.

5.3

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.

5.3.1 Ambient Radiation

To assess the dose impact of direct radiation from BNL operations, Thermoluminescent Dosimeters (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 5-1). 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 2025, a total of 63 environmental TLDs were deployed on-site. Fifty-three TLDs were deployed on-site (see Figure 5-4) to measure on-site background. Ten TLDs were placed in areas known to see dose rates higher than background due to the nature of work conducted in the nearest facility. A total of 16 environmental TLDs were deployed at off-site locations to measure off-site background dose. In 2025, all 16 wind sectors around the Laboratory (see Figure 5-5) had at least one TLD location. 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 2025 was 26 ± 2 mrem (260 ± 20 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 2025 are shown in Figure 5-5.



Photo 5-1. Thermoluminescent dosimeter (TLD) at P-4 Perimeter Station

Figure 5-4. On-site Background TLD Locations

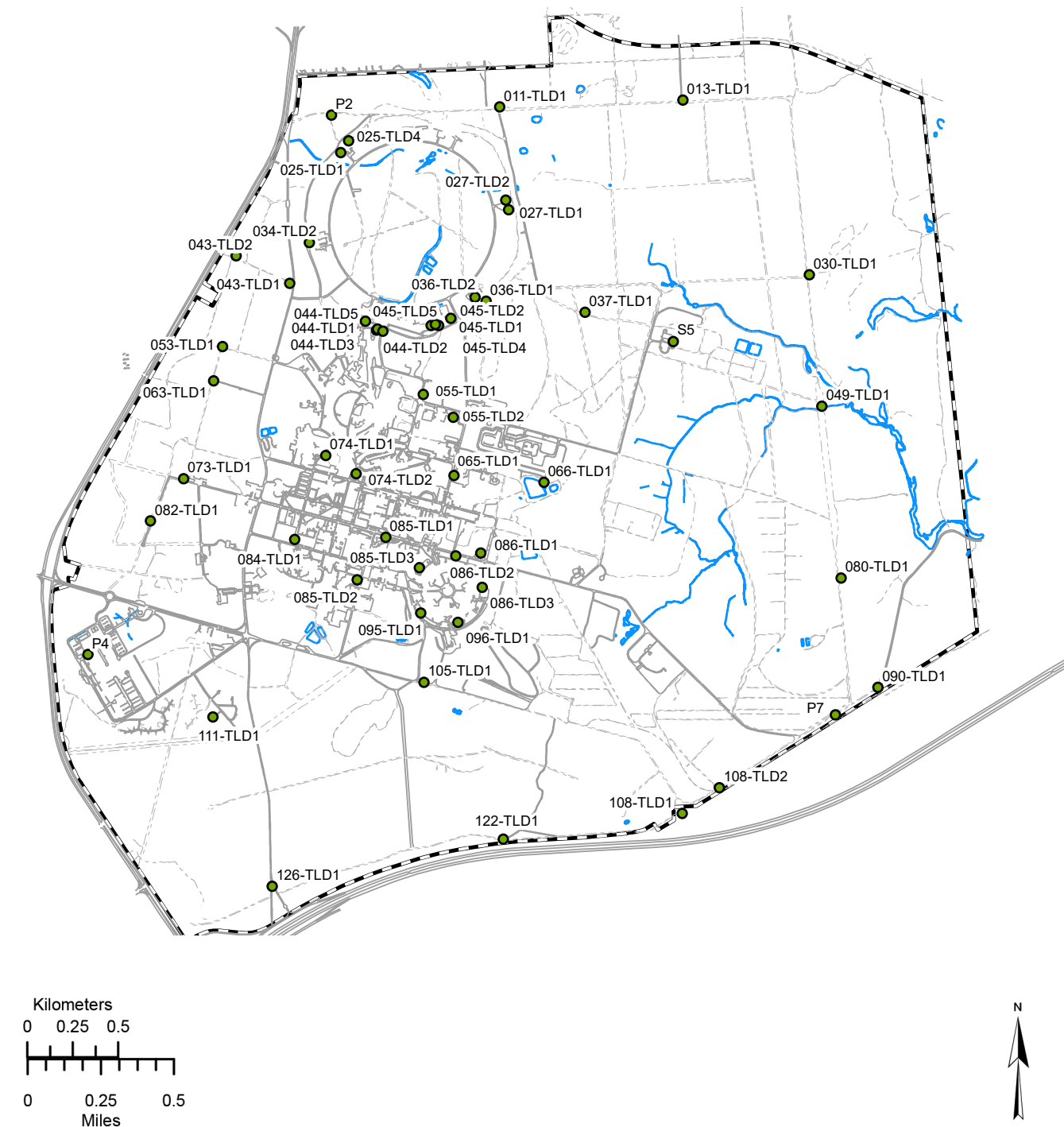
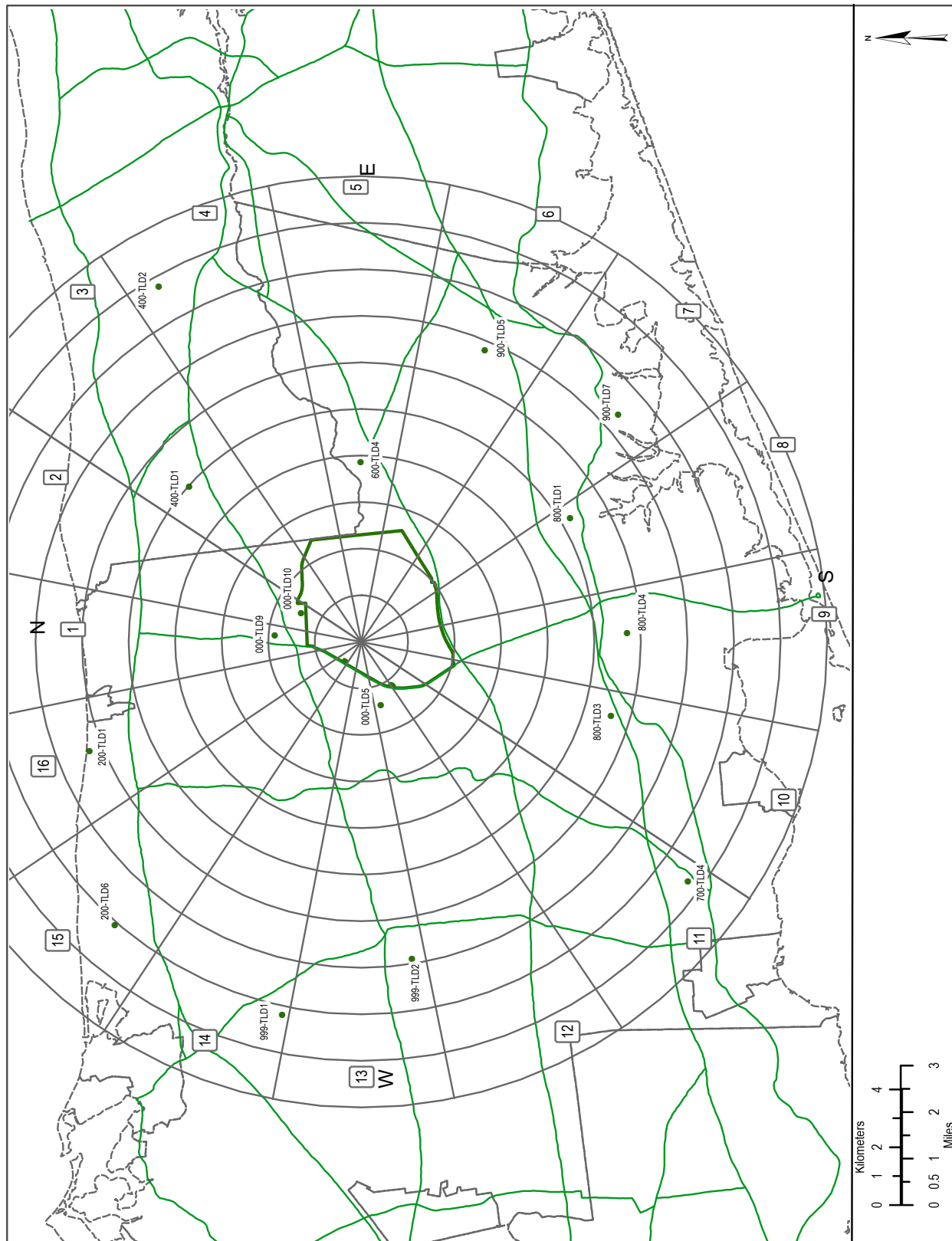
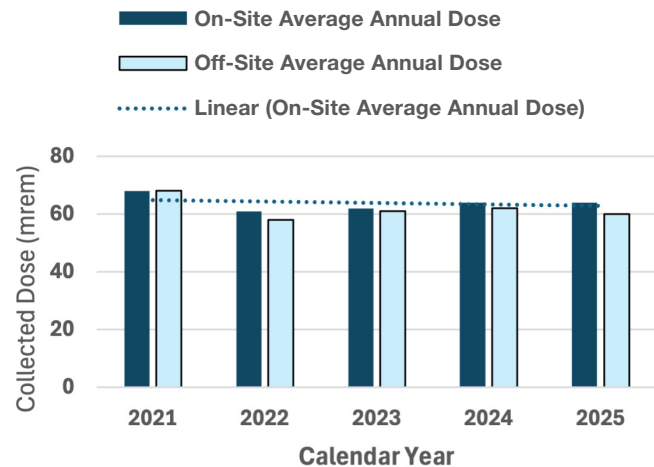


Figure 5-5. Off-site Background TLD Locations



The on- and off-site TLDs were collected and read quarterly to determine the annual total external radiation dose measured. For 2025, the average on-site external dose from all potential environmental sources, including cosmic and terrestrial radiation sources, was 64 ± 11 mrem (640 ± 110 μ Sv). The on-site measurements generally exhibit year-to-year variation within 10% or less of their average. The same can be said about the off-site measured doses. The average off-site total ambient dose in 2025 from all potential environmental sources, including cosmic and terrestrial radiation sources, was 60 ± 11 mrem (600 ± 110 μ Sv). To determine the Laboratory's 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 (60 ± 11 mrem) and on-site dose (64 ± 11 mrem) at the 95% confidence level. From the measured TLD doses, it is safely concluded that there was no measurable external dose contribution to on- or off-site individuals at locations from Laboratory operations in 2025.

Figure 5-6. Comparison of On-Site vs. Off-Site Ambient Dose (2021-2025)



5.3.2 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). 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. 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 78 ± 12 mrem (780 ± 120 μ Sv) and 82 ± 23 mrem (820 ± 230 μ Sv), 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.” 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 Alternating Gradient Synchrotron [AGS] tunnel access) showed slightly elevated ambient external dose levels. The full-year doses at these sites were measured at 73 ± 16 mrem (730 ± 160 μ Sv) for 054-TLD1, 76 ± 10 mrem (760 ± 100 μ Sv) for 054-TLD2, and 66 ± 10 mrem (660 ± 100 μ Sv) for 054-TLD3 (compared to the on-site dose of 64 ± 11 mrem and off-site dose of 60 ± 11 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.

5.3.2.1 Neutron Monitoring

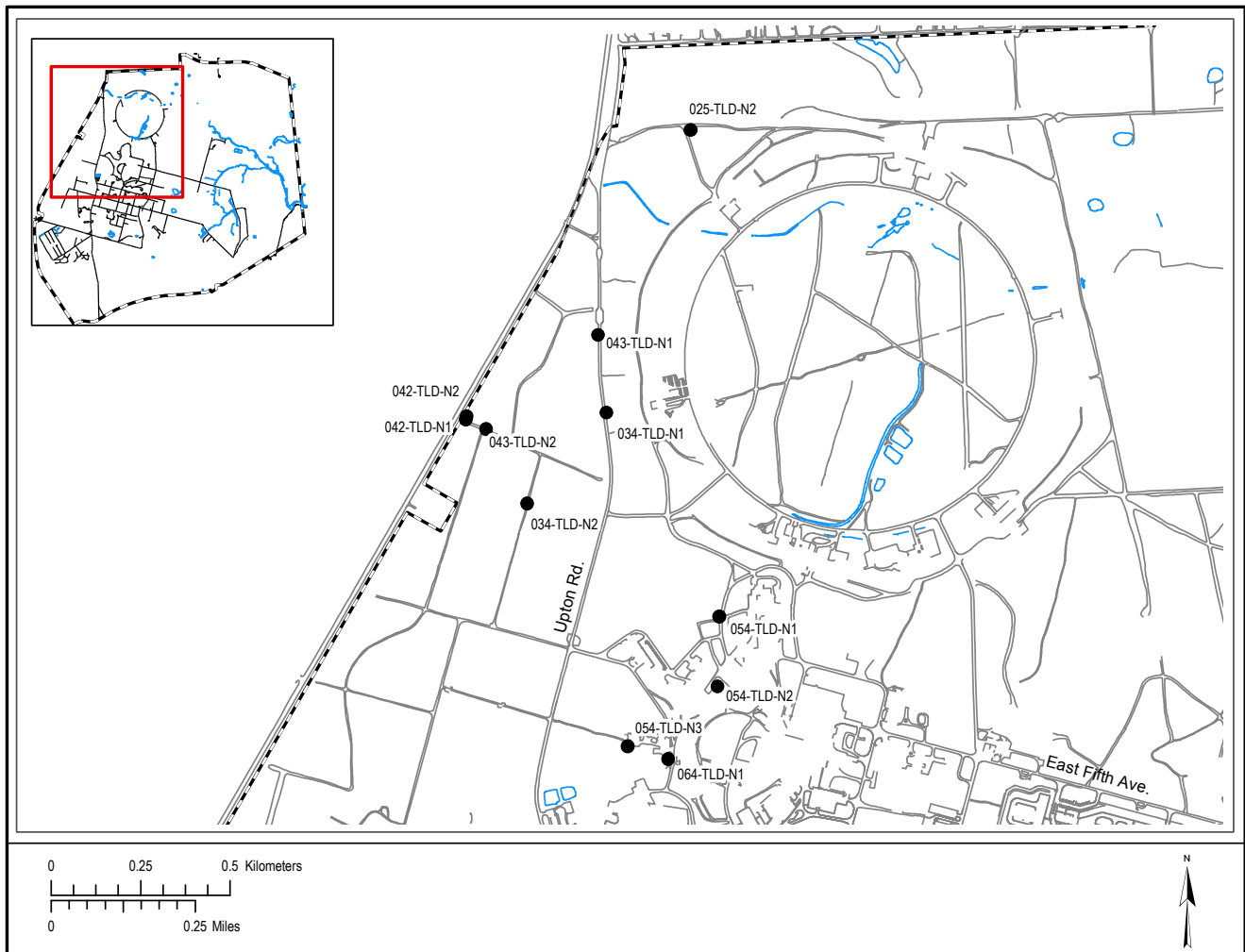
The AGS accelerates protons to energies up to 30 GeV and heavy ions up to 15 GeV/amu. At RHIC, protons and heavy ions received from the AGS are further accelerated up to final energies of 250 GeV for protons and 100 GeV for ions. Under these high-energy conditions, such accelerated particles have the 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 2025, 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 5-7 for locations).

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 5-2).

In 2025, all 11 pairs averaged 1 mrem, while none exceeded four mrem and seven showed no dose. All these low-level neutron doses indicate that engineering controls (i.e., berm shielding) in place at AGS and RHIC are effective.

Photo 5-2. Neutron TLDs in Monitored Area.



Figure 5-7. Neutron TLD Area Monitors

5.4

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 also mandates that no member of the public shall receive a dose greater than 10 mrem (100 μ Sv) in a year from airborne emissions from DOE facilities.

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 NESHAPs report to the EPA that describes the major and minor emission sources, their releases, and their resultant dose to the maximally exposed off-site individual (MEOSI). The dose estimates from various facilities are provided in Table 5-6, and the actual air emissions for 2025 are discussed in detail earlier in this chapter.

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 5.4.1 for details). Because this software 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 5-6. Maximally Exposed Off-Site Individual (MEOSI) Effective Dose Equivalent From Facilities or Routine Processes, 2025

Building No.	Facility or Process	Construction Permit No.	MEOSI Dose (mrem) (a)	Notes
348	Radiological Control Division	None	1.74E-08	(b,f)
356	Instrumentation	None	1.72E-04	(b)
463	Biology	None	5.37E-08	(b)
480	Condensed Matter Physics	None	ND	(e)
490	Radiation Therapy Facility	BNL-489-01	ND	(g)
490C	Nonproliferation & National Security	None	9.02E-12	(b)
490D	Nuclear Science & Security	None	1.28E-09	(b)
491	BMRR	None	ND	(g)
510	Calorimeter Enclosure	BNL-689-01	ND	(g)
510A	Physics	None	2.65E-14	(b)
555	Chemistry Facility	None	5.67E-05	(b)
734	Interdisciplinary Science Building	None	3.66E-14	(b)
735	Center for Functional Nanomaterials	None	ND	(e)
743	Photon Science	None	2.64E-04	(b)
745	NSLS-II	None	6.45E-08	(b)
750	HFBR	None	6.85E-05	(c)
801	RRPL	BNL-2022-01	1.24E-04	(c)
802B	Evaporator Facility	BNL-288-01	ND	(g)
817	Nuclear Science & Technology	None	4.39E-07	(b)
820	Accelerator Test Facility	BNL-589-01	ND	(e)

(continued on next page)

Table 5-6. Maximally Exposed Off-Site Individual (MEOSI) Effective Dose Equivalent From Facilities or Routine Processes, 2025 (concluded)

Building No.	Facility or Process	Construction Permit No.	MEOSI Dose (mrem) (a)	Notes
830	Environmental Science Department	None	ND	(e)
865	Waste Management Facility	None	ND	(e)
902	Superconducting Magnet Division	None	ND	(e)
906	Imaging Lab	None	ND	(e)
911	Collider Accelerator	None	1.67E-09	(b)
925	RF Systems	None	ND	(e)
931	BLIP	BNL-2009-01	6.07E-01	(c)
938	REF/NBTF	BNL-789-01	ND	(g)
942	AGS Booster	BNL-188-01	ND	(d)
---	RHIC	BNL-389-01	ND	(d)
Total Potential Dose from BNL Operations			6.08E-01	
EPA Limit (Air Emissions)			10	

Notes:

- (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 2025.
 (f) Sealed sources were excluded from this inventory - no emission
 (g) demolished and removed and/or permit terminated
 ND = not detected
 BMRR = Brookhaven Medical Research Reactor
 NSLS-II = National Synchrotron Light Source II
 HFBR = High Flux Beam Reactor
 RRPL = Radionuclide Research and Production Laboratory
 BLIP = Brookhaven Linac Isotope Producer
 REF/NBTF = Radiation Effects Facility / Neutron Beam Test Facility
 AGS Booster = Alternating Gradient Synchrotron Booster
 RHIC = Relativistic Heavy Ion Collider



5.4.1 Dose Monitoring 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 dose 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 dose 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 BNL emissions except those from Building 801 are treated as having been released from the BLIP Facility (see Figure 5-1, Section 5.2), 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 using instruments on 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 2025 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 2025's operation. The average volumetric flow rate of the BLIP exhaust system in 2025 was 467 cfm, or 0.2203 m³/sec. With an exit diameter of 0.1 m, the exit velocity was 28.05 m/sec, up very slightly from last year's 28.0 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.

5.4.2 Dose Calculation Methods and Pathways

5.4.2.1 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 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 (near Building 356) was measured at 11 mrem in 2025. The increase in MEI dose in 2025 was due to an increase in research irradiation conducted with a Co-60 source in Building 356 during the year, as discussed in section 5.3.2. The 11-mrem dose to the on-site MEI is less than the dose expected from three round-trip flights from Los Angeles, California to New York, New York, and equal to about 3.5% of the average annual natural background in the U.S. of 310 mrem.

5.4.2.2 Fish Ingestion Pathway

To calculate the dose 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 dose. The dose is calculated as: $\text{dose in (rem/yr)} = \text{intake (kg/yr)} \times \text{activity in flesh (}\mu\text{Ci/kg)} \times \text{dose coefficient (rem/}\mu\text{Ci)}$. For BNL’s case, the committed effective dose coefficient for Cesium-137 (Cs-137) is 5.03E-02 rem/ μCi .

5.4.2.3 Deer Meat Ingestion Pathway

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).

5.5

Diffuse and Fugitive Emission Sources

5.5.1 Remediation Activities

There was no remediation work with the potential for radiological air emissions performed at BNL in 2025.

5.5.2 Other Diffuse and Fugitive Sources

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.

5.6

Dose from Air Emission-Monitored Facilities

Actively Monitored Facilities

5.6.1 Brookhaven LINAC Isotope Producer (BLIP)

Source term descriptions for point sources are discussed earlier in Chapter 5. In 2025, the BLIP facility was the only emission source with enough emissions to contribute dose to members of the public greater than 1% of the EPA limit (0.1 mrem or 1.0 μ Sv). 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 2025, the BLIP facility was active for 8.32 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 ($3.7\text{E-}02$ Ci) of residual tritiated water vapor from activation of the targets' cooling water was released since the exhaust system ran continuously, as well. The dose to the MEOSI from BLIP operations was calculated to be 0.61 mrem (6.1 μ Sv) in a year.

5.6.2 RRPL

There was one 12-uCi release of Thallium-208 emitted from the RRPL that had an insignificant impact on the MEOSI dose for the site. See Table 5-6 for the dose from the RRPL.

5.6.3 High Flux Beam Reactor (HFBR)

The residual tritium emissions from the HFBR facility were measured at 0.29 Ci, and the estimated dose attributed to those emissions was $6.85\text{E-}5$ mrem ($6.85\text{E-}4$ μ Sv) in a year.

5.6.4 Waste Management Facility

There were no detectable levels of emissions from the Waste Management Facility.

5.6.5 Unplanned Releases

There were no unplanned releases at BNL in 2025.

5.7

Dose from Environmental Ingestion Pathways

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 on 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, 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 2025, samples were collected from nine deer, four of which were taken in a managed cull. All were analyzed 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 3.02 ± 0.38 pCi/g (wet weight) in the tissue (i.e., meat) and 2.15 ± 0.31 pCi/g (wet weight) in the liver. The average K-40 concentration in culled deer tissue samples (managed cull) was 2.88 ± 0.40 pCi/g (wet weight). The average K-40 concentration in culled deer liver samples was 1.85 ± 0.29 pCi/g (wet weight). The maximum Cs-137 tissue concentration in all samples (non-culled and culled) was 0.95 ± 0.03 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 1.39 mrem (13.9 μ Sv) in a year. This dose is below the health advisory limit of 10 mrem (100 μ Sv) 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 2025, 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.

5.7.1 Deer Meat Consumption

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).

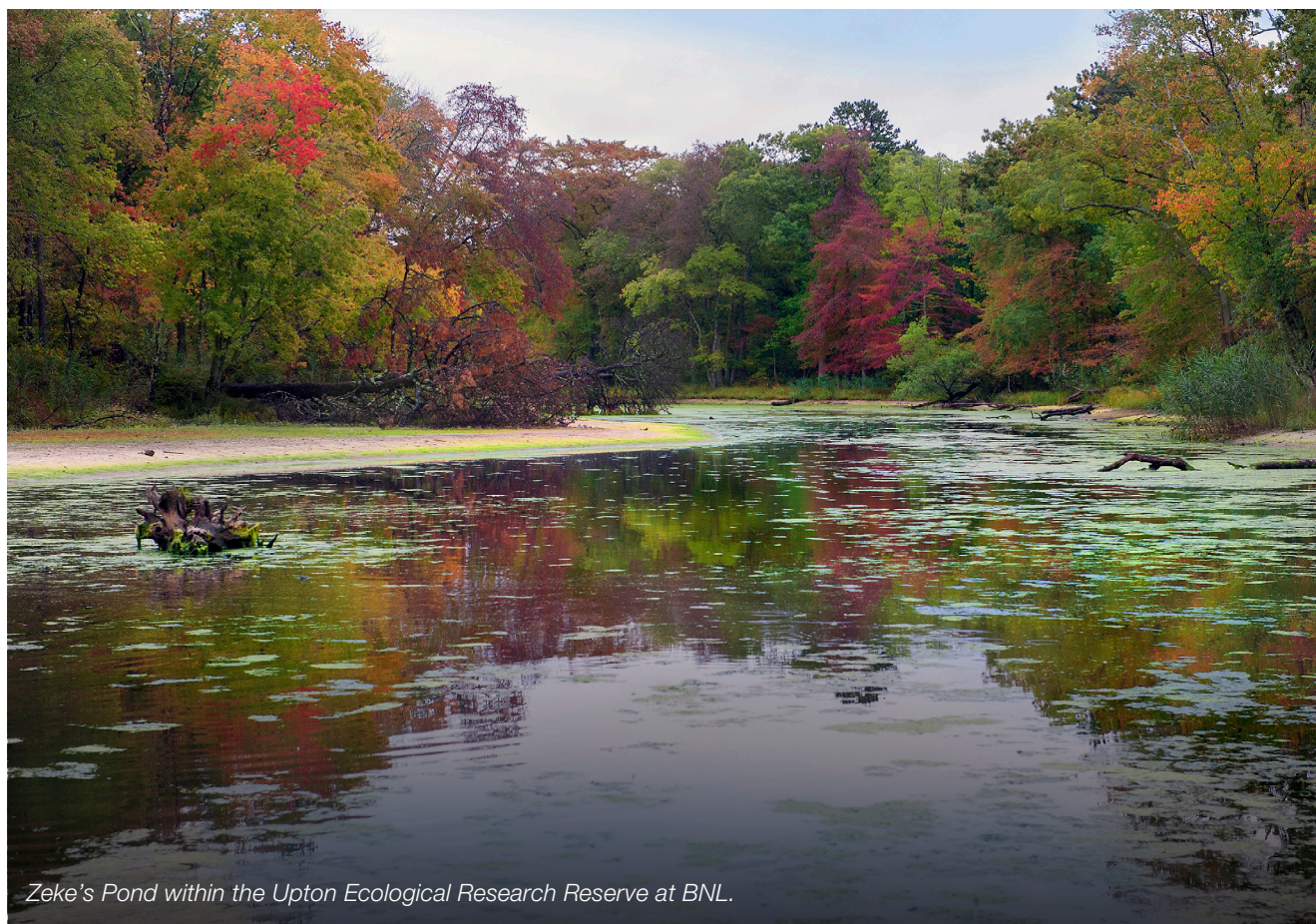
5.8

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 2025, the terrestrial animal and plant doses were evaluated based on 1.11 ± 0.26 pCi/g of Cs-137 (see Table 6-3) found in soil in the Pond Edge North of Forest Path, and a Sr-90 concentration of 0.77 pCi/L in the surface water collected from the HY station West of the RHIC ring. The resultant dose to terrestrial animals was calculated to be 49.3 μ Gy/day, and to plants to be 3.1 μ Gy/day. The dose to terrestrial animals was well below the biota dose limit of 1000 μ Gy/day, and the plant dose was below the limit of 10,000 mGy/day for terrestrial plants.

To calculate the dose to aquatic and riparian animals in 2025, the surface water Sr-90 concentration mentioned above, 0.77 pCi/L, was used. A Cs-137 concentration of 0.14 ± 0.05 pCi/g was detected in vegetation at the Pond Edge North of Forest Path. Using these concentrations, the calculated estimate of dose to aquatic animals was 0.183 μ Gy/day, and the dose to riparian animals was 3.00 μ Gy/day. Therefore, the dose to aquatic animals was well below the limit of 10,000 μ Gy/day, and the dose to riparian animals was also well below the 1,000 μ Gy/day limit specified by the Order.



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

5.9

Total Dose from All Pathways

Table 5-7 summarizes the estimated dose to the MEOSI from the inhalation, immersion, and ingestion pathways for the years 2021 through 2025. The total dose to the MEOSI from the inhalation and ingestion pathways in 2025 was estimated at 2.00 mrem (20.0 μ Sv). In comparison, the DOE limit on dose from all pathways is 100 mrem (1 mSv). The cumulative population dose from airborne emissions was 2.9 person-rem (2.9E-2 person-Sv) in 2025. There is no current regulatory limit on cumulative population dose. However, BNL strives to maintain all doses received as low as reasonably achievable (ALARA).

In conclusion, the effective dose from all pathways due to BNL operations in 2025 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 2.00 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 5-7. Five-Year Site Dose Summary (2021-2025)

Pathway		Annual Maximally Exposed Off-Site Individual Dose, mrem				
		2021	2022	2023	2024	2025
Inhalation	Air	0.71	1.19	2.57	1.67	0.61
Ingestion	Drinking Water	None	None	None	None	None
	Fish	NS	NS	NS	NS	NS
	Deer	2.9	3.82	0.35	0.61	1.39
All Pathways		3.61	5.01	2.92	2.28	2

Notes:

1 - Peconic River remained dried up in 2025, so no fish data were available to represent magnitude since sampling was not possible in 2025.

References and Bibliography

U.S. EPA, 2026. 40 CFR 61, Subpart H. National Emission Standards for Hazardous Air Pollutants. U.S. Environmental Protection Agency, Washington, DC. December 15, 1989.

ANSI/HPS, 2021. Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities. N13.1-2021.

DOE, 2020. A Graded Approach for Evaluation of Radiation Doses to Aquatic and Terrestrial Biota. DOE-STD-1153-2019. U.S. Department of Energy, Washington, DC. June, 2020.

DOE, 2025. Radiation Protection of the Public and the Environment. DOE Order 458.1. U.S. Department of Energy, Washington, DC. Admin Chg.5. January 30, 2025.

DOE, 2022. Derived Concentration Technical Standard, DOE-STD-1196-2022. U.S. Department of Energy, Washington, DC. December 08, 2022.

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

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





Children participating in Take Your Children to Work Day hosted by the Office of Workforce Development and Science Education.

Chapter 6

Natural and Cultural Resources

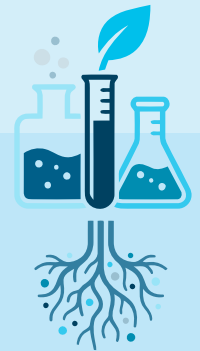


CHAPTER HIGHLIGHTS

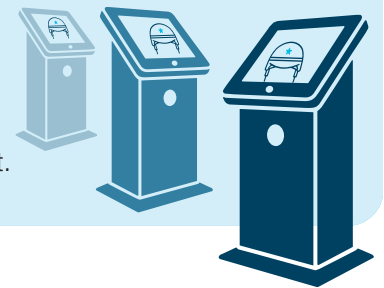
Thirty-two acres of forest were thinned and mechanically treated in preparation for **prescribed fire** and 23 acres were burned.



Deer, vegetation, and soil **sampling results** are **consistent** with previous years' results. The Natural Resource Management Program is described in the Natural Resource Management Plan (NRMP) (BNL 2021).



Historical kiosks were installed to highlight the site's history, including the World War I (WWI) and World War II (WWII) hospital area, roadways through the Camp Upton property, and **medical research** that took place at the Brookhaven Medical Reactor (BMRR) and Medical Department.



6.1

Natural Resource Management Program

The Natural Resource Management Program promotes stewardship of the natural resources found at the Laboratory and integrates natural resource management and protection with BNL's scientific mission on a five-year cycle, with the most recent update in 2021 (BNL 2021). The NRMP also describes the program strategy, elements, and planned activities for managing the various natural resources found on-site.

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 Laboratory 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 the Laboratory during the past 30 years or are expected to be present on-site (see Table 6-1). Federal and New York State endangered animal species confirmed as currently inhabiting Laboratory property include the northern long-eared bat (NLEB; *Myotis septentrionalis*), eastern tiger salamander (*Ambystoma t. tigrinum*), and the peregrine falcon (*Falco peregrinus*).

Table 6-1. Federal and New York State Threatened, Endangered, 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 darter	<i>Anax longipes</i>	SGCN	Confirmed
Frosted elfin	<i>Callophrys iris</i>	T	Likely
New England bluet	<i>Enallagma laterale</i>	SGCN	Likely
Little bluet	<i>Enallagma minusculum</i>	T	Likely
Scarlet bluet	<i>Enallagma pictum</i>	T	Likely
Pine Barrens bluet	<i>Enallagma recurvatum</i>	T	Confirmed
Mottled duskywing	<i>Erynnis martialis</i>	SC	Likely
Persius duskywing	<i>Erynnis persius persius</i>	E	Likely
Pine barrens zanclognatha	<i>Zanclognatha martha</i>	SGCN	Confirmed
Black-bordered lemon moth	<i>Marimatha nigrofimbria</i>	SGCN	Confirmed
Fish			
Banded sunfish	<i>Enneacanthus obesus</i>	T	Confirmed
Swamp darter	<i>Etheostoma fusiforme</i>	T	Confirmed
Amphibians			
Marbled salamander	<i>Ambystoma opacum</i>	SC	Confirmed
Eastern tiger salamander	<i>Ambystoma tigrinum tigrinum</i>	E	Confirmed
Fowler's toad	<i>Bufo fowleri</i>	SGCN	Confirmed
Four-toed salamander	<i>Hemidactylium scutatum</i>	SGCN	Confirmed
Eastern spadefoot toad	<i>Scaphiopus holbrookii</i>	SC	Confirmed
Reptiles			
Worm snake	<i>Carphophis amoenus</i>	SC	Confirmed
Snapping turtle	<i>Chelydra serpentina</i>	SGCN	Confirmed
Spotted turtle	<i>Clemmys guttata</i>	SC	Confirmed
Northern black racer	<i>Coluber constrictor</i>	SGCN	Confirmed
Eastern hognose snake	<i>Heterodon platyrhinos</i>	SC	Confirmed
Stinkpot turtle	<i>Sternotherus odoratus</i>	SGCN	Confirmed
Eastern box turtle	<i>Terrapene carolina</i>	SC	Confirmed
Eastern ribbon snake	<i>Thamnophis sauritus</i>	SGCN	Confirmed
Birds (nesting, transient, or potentially present)			
Cooper's hawk	<i>Accipiter cooperii</i>	SC	Confirmed
Sharp-shinned hawk	<i>Accipiter striatus</i>	SC	Confirmed
Great egret	<i>Ardea alba</i>	SGCN	Confirmed
Whip-poor-will	<i>Caprimulgus vociferus</i>	SC	Confirmed
Northern harrier	<i>Circus cyaneus</i>	T	Confirmed
Black-billed cuckoo	<i>Coccyzus erythrophthalmus</i>	SGCN	Confirmed
Northern bobwhite	<i>Colinus virginianus</i>	SGCN	Confirmed
Prairie warbler	<i>Setophaga discolor</i>	SGCN	Confirmed
Perigrine Falcon	<i>Falco peregrinus</i>	E	Confirmed
Bald Eagle	<i>Haliaeetus leucocephalus</i>	T	Confirmed
Wood thrush	<i>Hylocichla mustelina</i>	SGCN	Confirmed
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	SC	Confirmed
Osprey	<i>Pandion haliaetus</i>	SC	Confirmed
Scarlet tanager	<i>Piranga olivacea</i>	SGCN	Confirmed
Glossy ibis	<i>Plegadis falcinellus</i>	SGCN	Confirmed
Brown thrasher	<i>Toxostoma rufum</i>	SGCN	Confirmed
Blue-winged warbler	<i>Vermivora pinus</i>	SGCN	Confirmed

(continued on next page)

Endangered plants that have been confirmed on-site include Engelman spikerush (*Eleocharis engelmannii*), lpecac 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 (stiff-leaved goldenrod [*Oligoneuron rigida*], stargrass [*Aletris farinose*], 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 minusculum*) 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 or of special concern by New York State either currently inhabit the site, visit during migration, or have been identified historically. BNL has one federally endangered species, the NLEB, that has

Table 6-1. Federal and New York State Threatened, Endangered, 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*	<i>Myotis septentrionalis</i>	FE	Confirmed
Tricolored bat	<i>Perimyotis subflavus</i>	SGCN	Confirmed
Plants			
Small-flowered false foxglove	<i>Agalinis paupercula</i>	R	Confirmed
Stargrass	<i>Aletris farinosa</i>	T	Confirmed
Butterfly weed	<i>Asclepias tuberosa</i> ssp. <i>interior</i>	V	Confirmed
Spotted wintergreen	<i>Chimaphila maculata</i>	V	Confirmed
Flowering dogwood	<i>Cornus florida</i>	V	Confirmed
Pink lady's slipper	<i>Cypripedium acaule</i>	V	Confirmed
Ground pine	<i>Dendrolycopodium obscurum</i>	V	Confirmed
Round-leaved sundew	<i>Drosera rotundifolia</i> var. <i>rotundifolia</i>	V	Confirmed
Marginal wood fern	<i>Dryopteris marginalis</i>	V	Confirmed
Engelman spikerush	<i>Eleocharis engelmannii</i>	E	Confirmed
Ipecac spurge	<i>Euphorbia ipecacuanhae</i>	E	Confirmed
Eastern showy aster	<i>Eurybia spectabilis</i>	T	Confirmed
Dwarf huckleberry	<i>Gaylussacia bigeloviana</i>	E	Confirmed
Winterberry	<i>Ilex verticillata</i>	V	Confirmed
Sheep laurel	<i>Kalmia angustifolia</i>	V	Confirmed
Narrow-leaved bush clover	<i>Lespedeza angustifolia</i>	R	Confirmed
Wild lupine	<i>Lupinus perennis</i>	R	Confirmed
Whorled loosestrife	<i>Lysimachia quadrifolia</i>	E	Confirmed
Bayberry	<i>Myrica pensylvanica</i>	V	Confirmed
Stiff-leaved goldenrod	<i>Oligoneuron rigida</i>	T	Confirmed
Cinnamon fern	<i>Osmunda cinnamomea</i>	V	Confirmed
Clayton's fern	<i>Osmunda claytoniana</i>	V	Confirmed
Royal fern	<i>Osmunda regalis</i>	V	Confirmed
Crested fringed orchid	<i>Platanthera cristata</i>	E	Likely
Green fringed orchid	<i>Platanthera lacera</i>	V	Confirmed
Prostrate knotweed	<i>Polygonum aviculare</i> ssp. <i>buxiforme</i>	E	Possible
Bracken fern	<i>Pteridium aquilinum</i> var. <i>pseudocaudatum</i>	E	Possible
Swamp azalea	<i>Rhododendron viscosum</i>	V	Confirmed
Long-beaked bald-rush	<i>Rhynchospora scirpoides</i>	R	Confirmed
New York fern	<i>Thelypteris novaboracensis</i>	V	Confirmed
Marsh fern	<i>Thelypteris palustris</i> var. <i>pubescens</i>	V	Confirmed
Possum haw	<i>Viburnum nudum</i> var. <i>nudum</i>	E	Possible
Virginia chain-fern	<i>Woodwardia virginica</i>	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

historically been found within the forests of the Laboratory.

6.1.1 Habitat Protection and Restoration

Administrative processes are 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.

Ecological restoration has become a priority in recent years. BNL is in the heart of the Central Pine Barrens Region of Long Island and represents one of only three known Atlantic coastal pine barrens ecosystems in the world. They consist primarily of communities of pitch pine (*Pinus rigida*) and oak species (*Quercus coccinea*, *Q. rubra*, *Q. alba*, *Q. velutina*) with an understory of scrub oak (*Q. ilicifolia*) and a variety of ericaceous (heath) shrubs like black huckleberry (*Gaylussacia baccata*), and blueberry species (*Vaccinium* spp.) (USFWS 1997). These systems have evolved over thousands of years in the presence of frequent fires. As a result, plant and animal species of the pine barrens have become adapted to conditions created by periodic fires. Throughout the pine barrens, fire has been aggressively suppressed for nearly a century and this has resulted in the degradation of our forests making them more susceptible to pests and pathogens, such as southern pine beetle (*Dendroctonus frontalis*), which has killed hundreds of thousands of trees on-site. This is also causing a shift in species



composition towards less fire-adapted species. In essence, Long Island is losing its native pine barrens to a more hardwood-dominated ecosystem.

Efforts are being made to restore on-site pine barrens through the use of prescribed fire and mechanical treatments. A total of 91 acres have been mechanically treated in preparation for prescribed fire and 63 acres burned in the northern portion of the Laboratory through 2025. 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 23-acre prescribed burn was conducted in 2025.

6.1.1.1 Pollinators

Pollinator populations are declining throughout the world due to habitat loss, pesticide use, pests and pathogens, and the introduction of invasive species. They play a vital role in maintaining ecosystem health by pollinating more than 90% of all flowering plants (Ollerton et al., 2011). Many of these plants are also critical to our food supply.

Best Management Practices were adopted by the Department of Energy (DOE) and have been implemented by the Laboratory to create or enhance the pollinator habitat which include limiting pesticide use, habitat management in the form of prescribed fire and/or mowing, managing lawns for pollinators, and proper use of mulch in landscaping.

Per the Laboratory's Integrated Pest Management (IPM) program, the use of pesticides has been minimized to prevent harm to non-target species. For example, herbicide application is limited to specific areas to prevent application to nectar-producing plants. Insecticides/acaricides are seldom utilized for broadcast spraying, tick management areas have targeted application of pesticides through use of tools like the 4-Poster™ tick management devices, and careful consideration is given to requests for broadcast application of broad-spectrum pesticides. In addition, pesticides and fertilizers are not applied to lawns to allow species that are attractive to pollinators, such as clovers, to grow.

Prescribed fire has been shown to be beneficial to many native pollinator species, and a prescribed/reduced mowing regime is being implemented on some areas of the Laboratory which includes seeding with native grasses and wildflowers known to promote pollinators. Thus far, 24 acres have been seeded with wildflowers, with 10 of those acres having been planted in 2025.

6.1.1.2 Salamander Protection Efforts

Many safeguards are in place to protect eastern tiger salamander breeding areas. 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 4. 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.

Drought conditions during autumn in 2024 resulted in many ponds failing to hold enough water to trigger salamander movements through the winter. Egg mass surveys for winter 2024-2025 were conducted in

February, however only six ponds were accessible, and a total of seven egg masses were documented in those ponds. One pond which usually contains more egg masses than all other ponds combined had extremely low water levels in early 2025 and may not have been suitable for tiger salamanders.

6.1.1.3 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 on-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 2025.

6.1.1.4 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 2025, monthly surveys were conducted starting at the end of April and extending through the end of August. These surveys identified 80 bird species which was a slight increase over the 74 species identified in 2024. A total of 139 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.

A new transect was established in 2025 that aims to survey bird species occurring in the areas where forest management is being implemented in the northern portion of the site. This transect was tied with the Z-Path transect that goes through the eastern forested portion of the Laboratory as having the greatest species diversity. The Biology Fields and Solar Farm transects are nearly as diverse (See Figure 6-1). 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*).

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 (USFWS). In 2025, 23 nests were managed either through egg-oiling or destroying of the nests due to safety issues from aggressive adults protecting nests. The population was estimated at approximately 40 birds in spring 2025 going into nesting season, however an additional 20-30 geese began using the site during the summer, particularly around the new Science and User Support Center (SUSC) building. With the addition of this new flock, the number of geese on-site in late summer was nearing 80 individuals. In the fall of 2025, BNL contracted with a company that uses specially trained dogs as goose deterrents to help decrease numbers providing an effective, though temporary, solution.

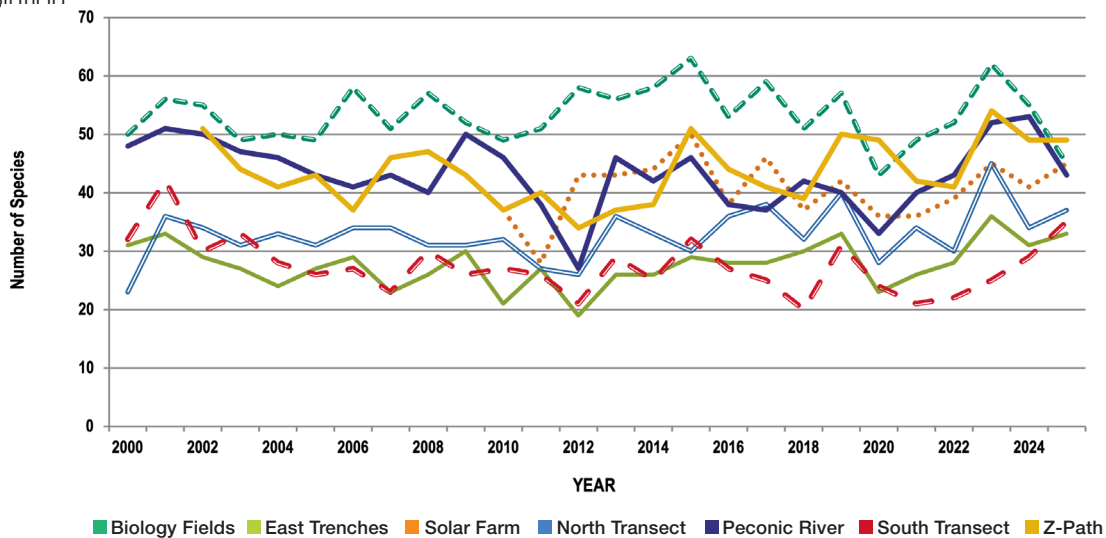


Figure 6-1. Trends in species counts by transect from 2000-2025

6.1.1.5 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 2025, 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-site will increase as well. In early 2025, three deceased juvenile bald eagles were found in different areas of the site. Natural resources staff worked with the NYSDEC to collect the carcasses to have them necropsied. It was found that they likely died due to avian influenza. This information was also shared with the USFWS as bald eagles are a federally protected species.

6.1.1.6 Northern Long-eared Bat

As discussed in Section 6.1.1, the NLEB was federally listed as endangered in 2023. The activities most likely to impact this bat 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 2025, one building was demolished, and no bats were found prior to demolition. The only project requiring formal consultation with the USFWS was for the first phase of construction of the Electron-Ion Collider (EIC) because it involves significant tree removal during the bats' active period and resulted in the issuance of a Biological Opinion and Statement of Incidental Take.

No mist netting was conducted in 2025, however. Acoustic surveys were conducted around the Laboratory site during the late summer and early fall, focusing on the forested areas inside the Relativistic Heavy Ion Collider (RHIC) ring and within the forest management units. They did not yield any NLEB detections. The need to continue bat monitoring will likely increase in the future as the tri-colored bat (*Perimyotis subflavus*) has also been petitioned for listing.

6.1.2 Population Management

6.1.2.1 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 property under optimal circumstances. This was the approximate density in 1966, when BNL reported an estimate of 267 deer on-site (Dwyer 1966), and has been conducting routine population surveys of white-tailed deer since 2000.

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 began to see a slight increase towards the end of the year, likely due to the fact that a full-scale culling operation was not conducted in 2025 resulting in more deer utilizing the central campus area. 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 2025, the herd was estimated at approximately 350 individuals at the beginning of the year, and a cull was planned for three separate weekends in February and March. It was only possible to implement one weekend of culling during which a total of 43 animals were taken, which did not allow us to meet our reduction goals of less than 250 deer. Deer surveys conducted in December 2025 resulted in a population estimate of around 550 individuals.



4-Poster™ tick management system.

6.2

Upton Ecological and Research Reserve

In November 2000, DOE established the 530-acre Upton Ecological and Research Reserve (Upton Reserve) at BNL. Located on the eastern portion of the site within the Core Preservation Area of the Long Island Central Pine Barrens, the reserve comprises approximately 10% of the property and includes forests and wetlands that

support diverse plant and animal communities. Based on a 1994-1995 biological survey, the reserve is home to more than 200 plant species and at least 162 species of mammals, birds, fish, reptiles, and amphibians (LMS 1995).

Initial funding through a DOE Inter-Agency Agreement with the USFWS (2000–2004) supported conservation, enhancement, and habitat restoration efforts. The reserve is managed under BNL's NRMP and serves both as a protected habitat and as a site for ecological research. BNL coordinates research activities within the reserve and the broader Pine Barrens, including forest health monitoring conducted in partnership with SUNY's College of Environmental Science and Forestry (SUNY-ESF). A Memorandum of Understanding with SUNY-ESF has expanded research opportunities, including a 2023–2025 PhD study examining the effects of fire on tick populations.



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 2025, a total of nine deer were taken both on- and off-site. Figure 6-2 shows the location of all deer samples taken within a five-mile radius of the Laboratory between 2021 and 2025. 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

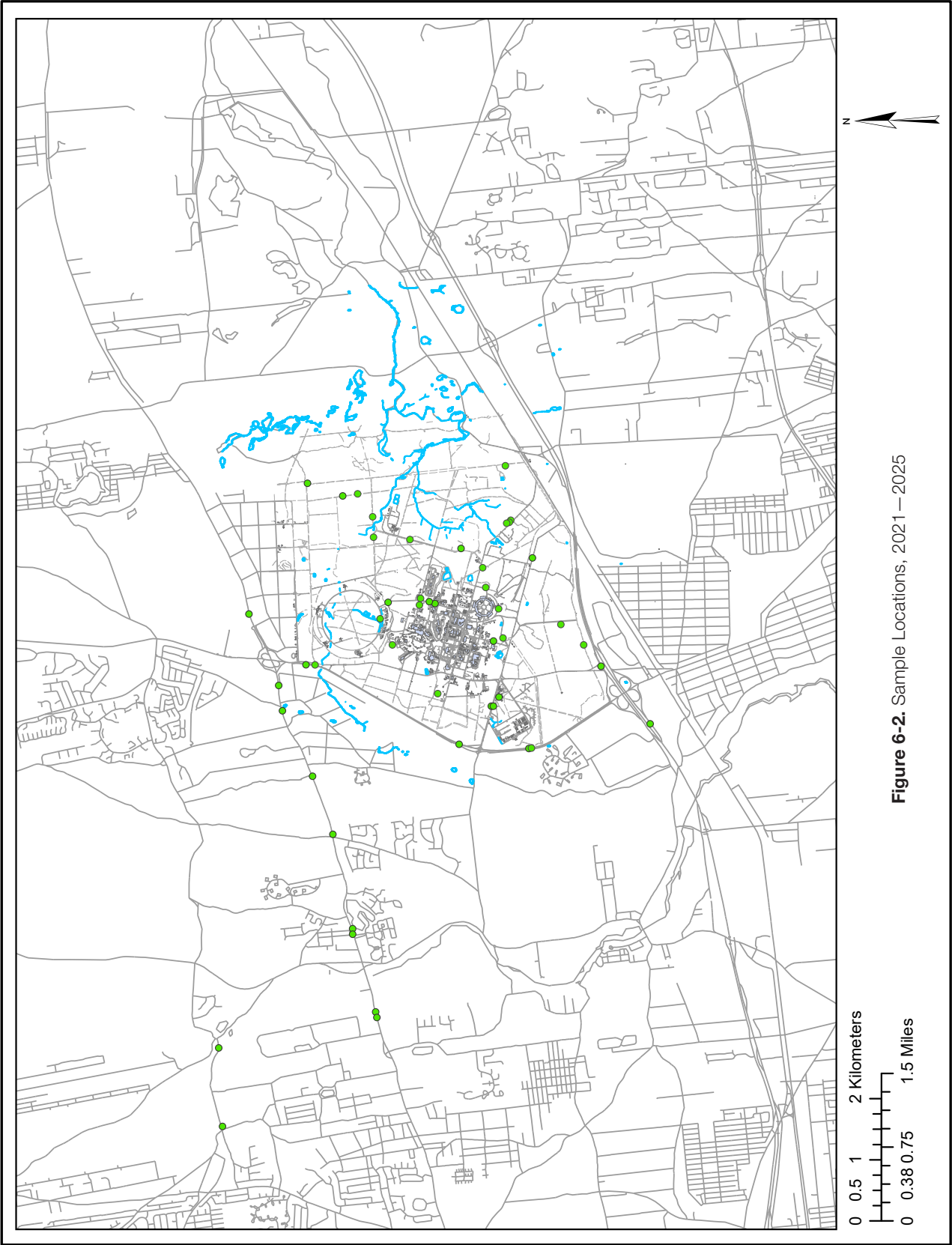


Figure 6-2. Sample Locations, 2021—2025



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.

In 2025, seven deer were obtained on-site, four of which were sampled as part of deer management efforts; two deer were taken less than a mile from BNL, and there were no deer taken from off-site greater than a mile from BNL. The two off-site deer and three of the on-site deer were the result of 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 2025, Cs-137 concentrations in deer meat samples were obtained from seven deer on-site with values ranging from non-detectable to 0.28 pCi/g, wet weight, and an arithmetic average of 0.16 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 2025 (0.28 pCi/g, wet weight) was two-thirds that of the highest on-site sample reported in 2024 (0.42 pCi/g, wet weight) and 42 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 (two samples in 2025) and samples taken farther away shown in Table 6-2, however no samples were collected greater than one mile from the Laboratory in 2025. Deer taken less than one mile from the Laboratory had Cs-137 values ranging from 0.15 pCi/g, to 0.95 pCi/g, wet weight.



Deer visiting a 4-Poster™ device.

Table 6-2. Radiological Analysis of Deer Tissue (2025)

Location	Date	Distance Miles	Organ	K-40 pCi/g (wet)±95% C.I.	Cs-137 pCi/g (wet)±95% C.I.
BNL					
South of Building 740	1/7/25	0	tissue	3.00±0.27	0.28±0.01
			liver	2.02±0.18	0.05±0.01
BNL Cull Sample 1 - Field north of Building 348	2/1/25	0	tissue	2.72±0.49	0.28±0.04
			liver	2.09±0.35	0.06±0.01
BNL Cull Sample 2 - Thomson Rd.	2/1/25	0	tissue	2.79±0.40	0.13±0.03
			liver	2.17±0.31	0.05±0.02
BNL Cull Sample 3 - Upton Rd., West of LISF	2/3/25	0	tissue	2.68±0.32	0.12±0.02
			liver	1.20±0.25	0.03±0.01
BNL Cull Sample 4 - Near softball field	2/3/25	0	tissue	3.31±0.38	0.12±0.02
			liver	1.95±0.24	0.03±0.01
East of NSLS-II	9/11/25	0	tissue	3.93±0.63	ND
			liver	3.22±0.54	ND
Renaissance Rd., Building 933	11/4/25	0	tissue	3.02±0.20	0.18±0.01
			liver	2.71±0.19	0.07±0.01
< 1 Mile from BNL					
William Floyd Pkwy, 1/2 mi south of gate	4/16/25	< 1 mile	tissue	2.71±0.34	0.15±0.02
			liver	2.24±0.36	0.06±0.02
William Floyd Pkwy, near north entrance	10/13/25	< 1 mile	tissue	3.02±0.24	0.95±0.03
			liver	1.78±0.23	0.68±0.03
> 1 Mile from BNL					
No samples taken				NA	NA
Tissue Averages					
All Samples (9)				3.02±0.38	0.25±0.03
BNL Average (7)				3.06±0.41	0.16±0.03
< 1 Mile Average (2)				2.87±0.29	0.55±0.03
> 1 Mile Average (0)				NA	NA
Cull Average (4)				2.88±0.40	0.16±0.03
Liver Averages					
All Samples (9)				2.15±0.31	0.12±0.02
BNL Average (7)				2.19±0.32	0.04±0.01
< 1 Mile Average (2)				2.01±0.30	0.37±0.02
> 1 Mile Average (0)				NA	NA
Cull Average (4)				1.85±0.29	0.04±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%) propagated error.

ND=non-detect

Figure 6-3 compares the average values of Cs-137 concentrations in meat samples collected in 2025 from on-site, within one mile, combined on-site and within one mile, greater than one mile, and deer taken from culling. Figure 6-4 presents the ten-year trend of on-site and near off-site Cs-137 averages in deer meat. The 2025 average (0.25 pCi/g) is slightly higher than the 2024 value of 0.22 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 2016 to 2025, 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 ten-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 2025, Cs-137 concentrations ranged from non-detectable to 0.07 pCi/g, wet weight, with an average of 0.04 pCi/g, wet weight. Cs-137 concentrations in liver samples taken from deer less than one mile from the site ranged from 0.06 pCi/g to 0.68 pCi/g, wet weight. The potential radiological dose resulting from deer meat consumption is discussed in Chapter 5.

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 43 deer were taken during population reductions in 2025. Meat samples were obtained from every tenth deer. Samples were sent for analysis and are included in Table 6-2. The results ranged from 0.12 to 0.28 pCi/g, wet weight, with the arithmetic average being 0.16 pCi/g, wet weight. Since all samples were well below the 1.0 pCi/g, wet weight administrative limit, all 1,015 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 μ Ci. 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 6-3. 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.

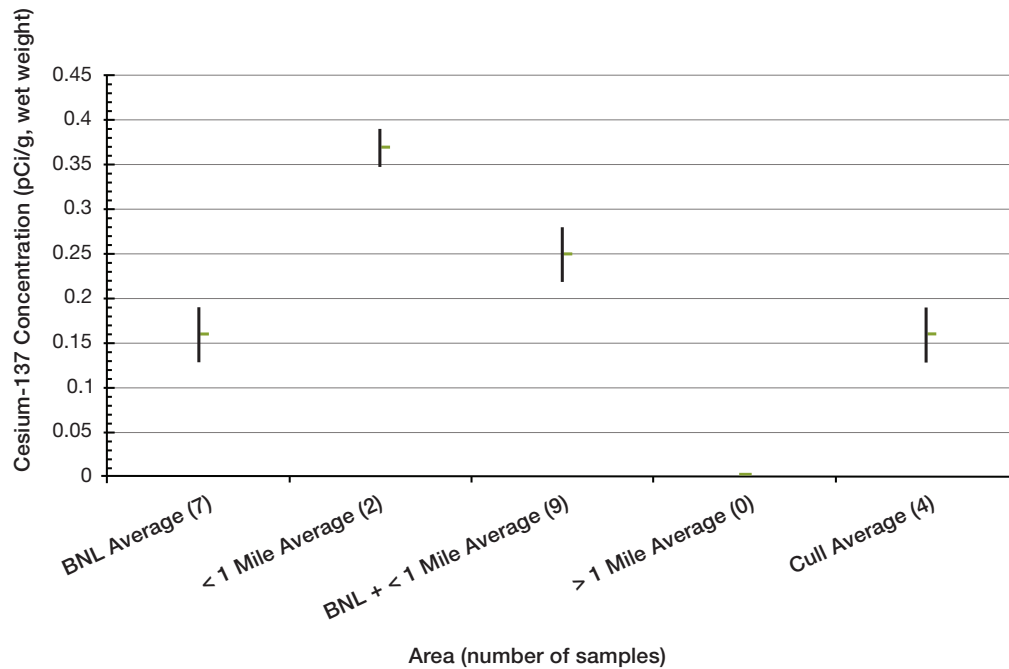
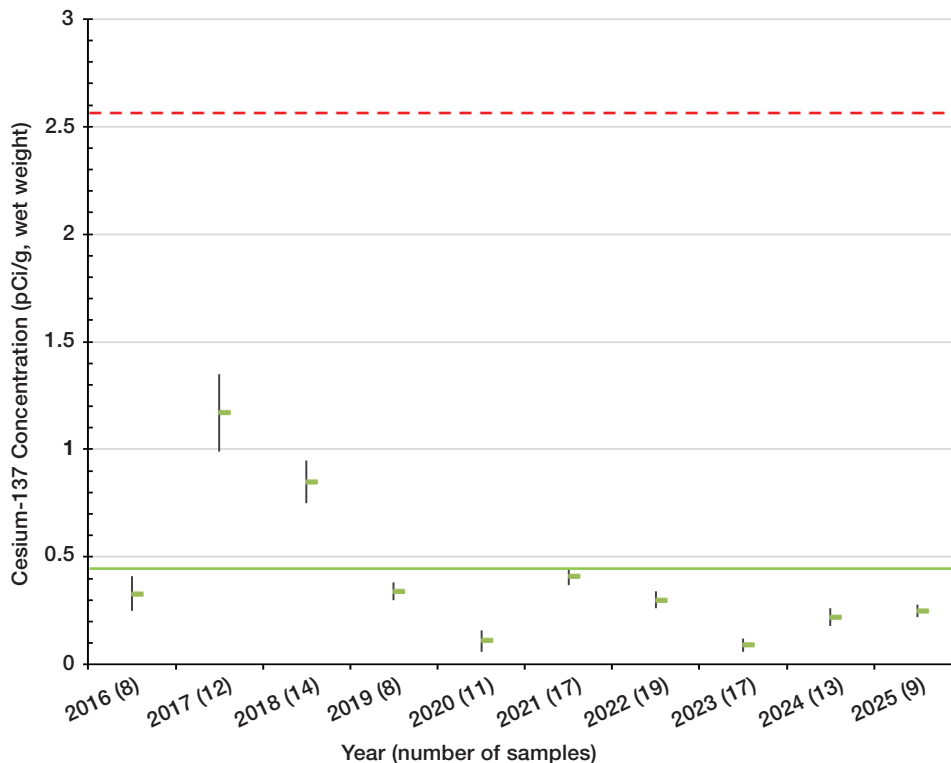


Figure 6-4. Ten-year trend in Cs-137 in deer flesh for samples taken at BNL and within 1 mile of the Laboratory. Average before clean-up (dashed line) 2.57 pCi/g wet weight. Ten-year average (solid line) 0.41 pCi/g wet weight.



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 2025, the water levels did not support fish 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 2025. 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 2025, insufficient water levels did not allow for a population assessment to be conducted.

6.3.3 Vegetation Sampling

6.3.3.1 Grassy Plants and Soil

During 2025, grassy vegetation samples were collected from ten locations around the Laboratory (Figure 6-5) 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). Seven vegetation samples were undetected or indistinguishable from background for

Table 6-3. Radiological Analysis of Grassy Vegetation and Associated Soils (2025)

Location/ Matrix	K-40 pCi/g±95% C.I.	Cs-137 pCi/g±95% C.I.
Yaphand Rd. Firebreak		
Vegetation	3.45±1.02	ND
Soil*	5.16±0.73	0.16±0.05
NWS Balloon Launch Area		
Vegetation	3.53±1.36	ND
Soil*	4.51±0.72	0.07±0.03
Pond Edge North of Forest Path		
Vegetation*	4.86±0.65	0.14±0.05
Soil	3.07±2.49	1.11±0.26
Ecology Field		
Vegetation*	5.16±1.00	0.07±0.06
Soil	7.14±0.95	0.15±0.05
BNL Weather Station		
Vegetation	3.87±0.53	ND
Soil	9.01±1.13	0.31±0.08
OU3 Basin		
Vegetation	4.34±0.57	ND
Soil	3.53±0.56	ND
RHIC 1010 Beamstop		
Vegetation	1.81±0.33	ND
Soil	6.73±0.81	0.22±0.06
RHIC Ring North of Canal		
Vegetation	3.56±0.38	ND
Soil	2.17±0.67	ND
Meadow Marsh		
Vegetation*	2.93±0.63	0.06±0.03
Soil*	3.85±0.87	0.14±0.06
No-Mow Area next to B750		
Vegetation	4.0±0.60	ND
Soil*	7.33±1.23	0.05±0.04
NYSDEC Check Station (Control)		
Vegetation	8.1±0.95	ND
Soil	6.48±0.89	0.23±0.07

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

* = estimated value for Cs-137 based on laboratory qualifiers.

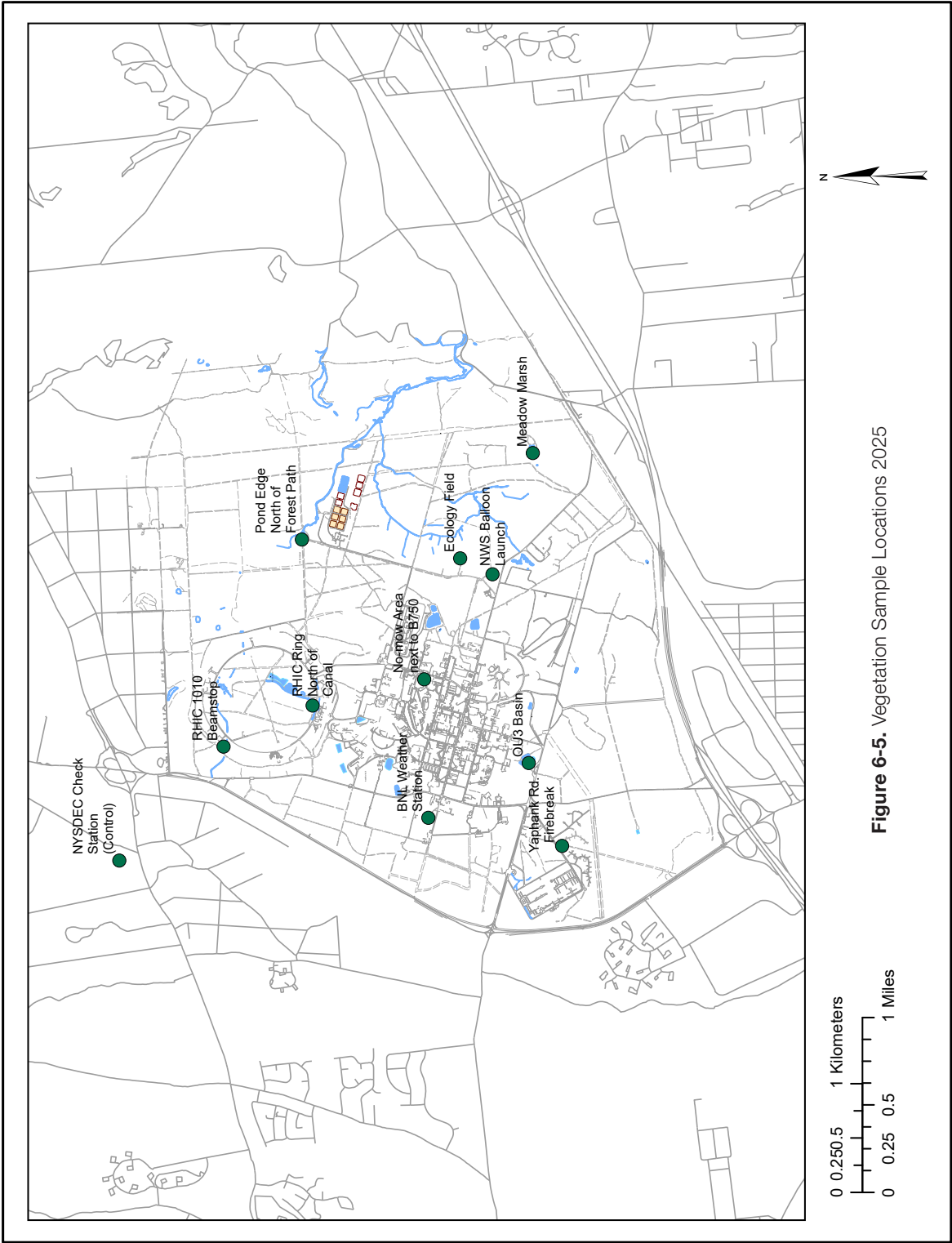


Figure 6-5. Vegetation Sample Locations 2025



Cs-137, and the remaining samples had Cs-137 levels ranging from 0.06 to 0.14 pCi/g, dry weight. Two soil samples were undetected or had levels of Cs-137 indistinguishable from background. The remaining eight samples had Cs-137 levels ranging from 0.05 to 1.11 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 5.

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 4-2 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.

6.5

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 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 FY25, nine undergraduate interns and one graduate intern completed projects during the summer and fall. Ecology-focused projects included an analysis of impacts of forest management on avian communities, fire effects on soils, factors influencing fine-scale spatial distribution of ticks, wildlife camera trapping, and the impacts of fire and forest microclimates on tick populations.

BNL participates in, coordinates, or hosts activities that support ecological education on Long Island. In 2025, the following programs were completed, or involved participation:

- Brookhaven Science Scholars Symposium (170 students, 58 posters)
- New York Wildfire & Incident Management Academy
- Northeast - Midwest Prescribed Fire Science and Management Workshop

The Day in the Life of a River program ran from September 26 to November 7, 2025. 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 1,800 students and 100 teachers across 7 elementary, and 25 middle and high schools, including SUNY Old Westbury, 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 and historic preservation requirements. The BNL Cultural Resource Management Plan (CRMP) outlines those regulations, identifies BNL's cultural and historic resources, and provides guidance for the protection and management of those resources (BNL 2023). BNL's cultural resources include WWI earthwork features, WWII barracks, Civilian Conservation Corps features, and historic scientific buildings and features, structures, programs, and discoveries associated with high-energy physics, research reactors, and other science conducted at BNL. The Cultural Resources program also maintains the Camp Upton Historical Collection, historic 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.



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

6.6.1 Compliance

The Laboratory is subject to several cultural resource laws, most notably the National Historic Preservation Act (NHPA), and the Archeological Resource Protection Act. These laws require agencies to consider the effects of proposed federal actions on historic structures, objects, and documents.

The NHPA requires federal agencies to establish programs for the identification and protection of cultural resources, including buildings, sites, artifacts, and documents.

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 WWII barracks portion of Building 120, the 1940s era Water Tower, the 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 2025, 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."

Several kiosks were developed for compliance with Memoranda of Agreement (MOA) for the 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 were installed in FY25 around the SUSC (Building 101)



Kiosk of Camp Upton during World War II at Building 101.

and outside of Building 490. All stipulations for the BMRR and Discovery Park MOAs have been met and the agreements have been closed. In addition, a Phase I archaeological survey was conducted in approximately 44 acres that comprises a potential location of a new injector for the EIC. The archaeological survey was completed by an off-site contractor in May of 2025 to identify the presence or absence of historic and archaeological material in the area of proposed effect (APE). No archaeological sites, features, or significant artifacts were identified during the archaeological survey.

6.6.2 Cultural Resource Outreach and Education

Community outreach in 2025 included an update on cultural resources to the Community Advisory Council (CAC) in May, and a short presentation entitled “Remembering Camp Upton” at BNL’s Open House event in June. A lecture on the history of WWII Camp Upton titled “Boots to Breakthroughs: The Legacy of Camp Upton” was also presented at the Southampton History Museum to complement their exhibit on WWII at the Southampton Veterans Memorial Hall in September.

Several educational visits were made to local elementary and middle schools in the William Floyd, Eastport-South Manor, and Shoreham-Wading River school districts to support Science, Technology, Engineering, and Math (STEM) clubs who were participating in a global robotics competition that focused on the theme “Unearthed.” These visits provided the students with access to a professional in archaeology who could answer their questions about the work archaeologists do and the potential problems that they face in the field to meet the requirements of their project designs. Presentations on archaeology were also given to the Long Island History class and the entire ninth grade Global Studies student body at the Eastport-South Manor Junior Senior High School in November.

The Cultural Resource Management Program also hosted two interns participating in the Science Undergraduate Laboratory Internship program in the summer of 2025. One intern conducted an analysis of WWI uniforms and how they can give us insights into the experiences of the soldiers who wore them. Another intern examined 19th Century lifeways in the Pine Barrens through an archaeological lens; this research was presented at the Council for Northeast Historical Archaeological Annual Conference in November.



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.
- Dwyer, Norval. 1966. Brookhaven National Laboratory. Long Island Forum (reprint), West Islip, NY.
- Fish & Wildlife Service. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. Southern New England – New York Bight Coastal Ecosystems Program, Charlestown, RI. November 1997.
- 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.
- Ollerton, J., Winfree, R., and Tarrant, S. 2011. "How many flowering plants are pollinated by animals?" *Oikos* 120:321–326.
- 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.



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

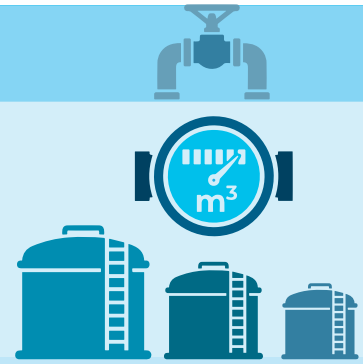
Chapter 7

Groundwater Protection

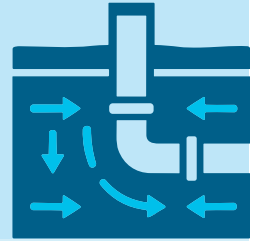


CHAPTER HIGHLIGHTS

Groundwater protection efforts remained effective, supported by the operation of **10 groundwater treatment systems** and routine monitoring from **687 permanent monitoring wells** and installation of **10 temporary wells**.



Groundwater treatment system operations to date have removed **7,952 pounds of volatile organic compounds (VOCs)** and **35 mCi of Strontium-90 (Sr-90)**, returning **34 billion gallons of treated groundwater** to the aquifer.



Per- and polyfluoroalkyl substances (PFAS) remediation continued, with the operation of two groundwater treatment systems removing **1.9 pounds of PFAS**, to date.

7.1

The BNL Groundwater Protection Management Program

The primary goal of Brookhaven National Laboratory's (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 and Department of Energy (DOE) Orders. 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 integrated 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 below. Detailed information on the site's geology and hydrogeology, environmental monitoring, and remediation is presented in the Site Environmental Report (SER) Volume II, Groundwater Status Report.

7.1.1 Geology and Hydrology

BNL is located on the western rim of the shallow Peconic River watershed, with the marshes in the northern and eastern portions of the site forming the river's headwaters. 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. During drought periods, the river water recharges to the aquifer; with normal to above-normal precipitation, groundwater discharges to the river.

The Laboratory's terrain is gently rolling, with elevations varying between 44 and 120 feet above mean sea level. Groundwater depths vary 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).

The highly permeable glacial sands readily absorb precipitation, allowing recharge of the Upper Glacial aquifer with minimal surface runoff. 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 (see reference page).

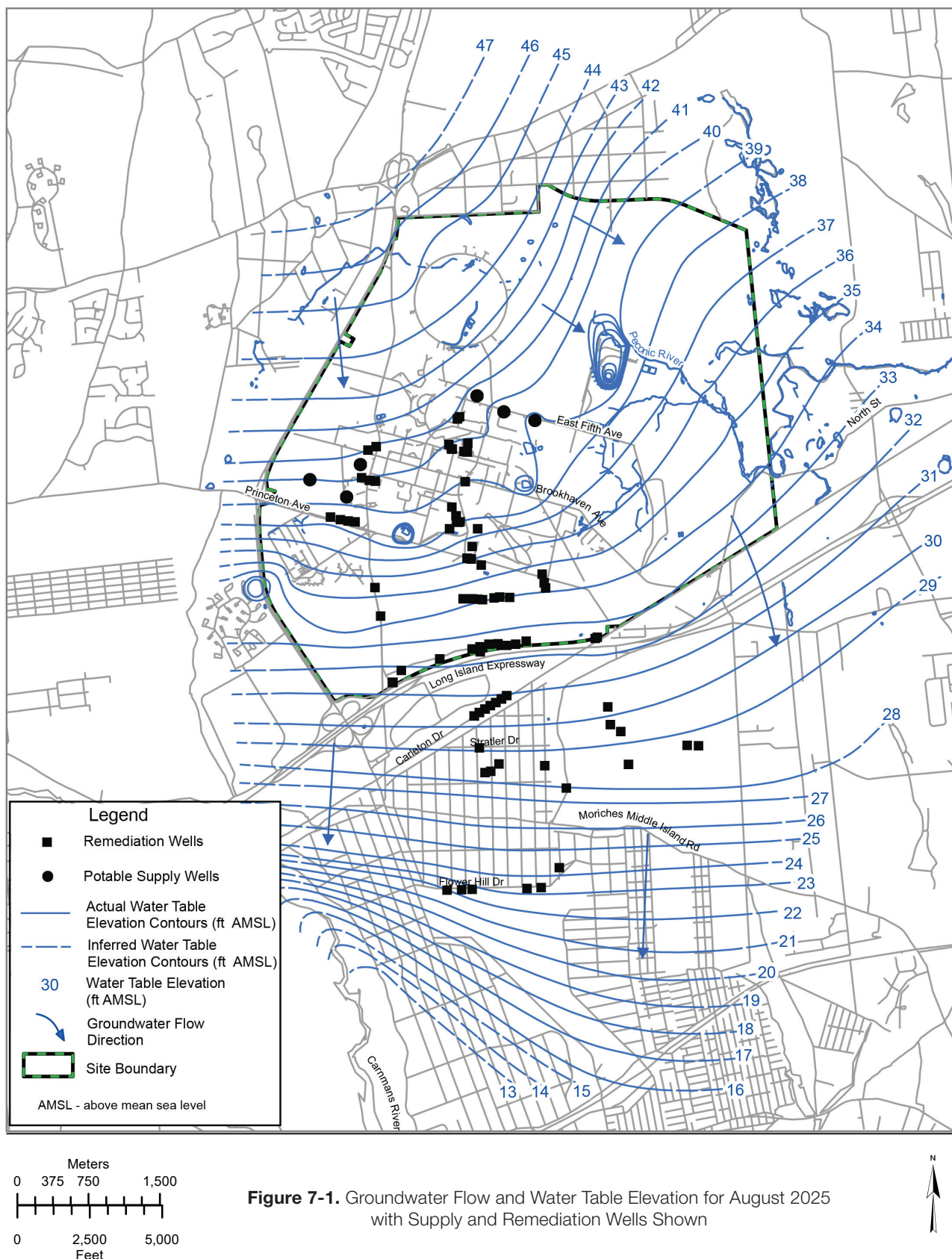
The Long Island Regional Planning Board and Suffolk County have identified the Laboratory site as overlying a deep-flow recharge zone for Long Island groundwater (Koppelman, 1978). Precipitation and surface water that recharge within this area have the potential to replenish the Magothy and Lloyd aquifer 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 aquifer 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 (U.S. EPA).

The Laboratory's four in-service drinking water wells withdraw approximately 1.2 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 site are influenced by natural drainage systems as shown in Figure 7-1.

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).

Groundwater beneath most of the site moves at an average rate of approximately 0.75 to 1.2 feet per day (Geraghty & Miller, 1996), requiring roughly 20 to 22 years to travel from the central, developed portion of the Laboratory to its southern boundary.



7.1.2 Protection

As part of BNL's Environmental Management System, the Laboratory has implemented several pollution prevention activities that are designed to protect groundwater resources. A work control program was established 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.

Actions have been taken to achieve or maintain compliance with regulatory requirements and to implement best management practices designed to protect groundwater (see Chapter 3, Section 3.3). Examples include upgrading underground storage tanks, 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 effective.

7.1.3 Monitoring

The groundwater monitoring network is designed to evaluate the impacts of groundwater contamination from former and current operations and to track cleanup progress.

Each year, groundwater samples are collected 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) (U.S. EPA 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.

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 2025, BNL continued the surveillance and maintenance of the Brookhaven Graphite Research Reactor (BGRR) and the High Flux Beam Reactor (HFBR). Table 7-1 provides a description of each Operable Unit (OU) and a summary of environmental restoration actions taken. See the SER Volume II, Groundwater Status Report for further details.

7.1.4 Remediation

As part of CERCLA, the U.S. EPA established the National Priorities List, which identifies sites where clean-up of past contamination is required. BNL was placed on the list in 1989 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, U.S. EPA, and New York State Department of Environmental Conservation (NYSDEC), under an Interagency Agreement (IAG) (U.S. EPA 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.

To help manage the restoration effort, 34 separate Areas of Concern are grouped into 11 OUs. Remedial and/or removal actions have been implemented for each OU. Contaminant sources for volatile organic compounds (VOCs) and radionuclides (e.g., contaminated soil and underground storage tanks) have been removed or remediated to

Table 7-1. Summary of BNL 2025 Environmental Restoration Activities

Project	Description	Environmental Restoration Actions
Soil Projects	Operable Unit (OU) I/II/III/IV/V/VII/X	Performed inspections, monitoring, and maintenance of institutional controls for cleanup areas.
Groundwater Projects	OU I/III/VI	- Continued operation of seven groundwater treatment systems that remove volatile organic compounds (VOCs) and one system that removes strontium-90 (Sr-90). - Removed 38 pounds of VOCs and 0.08 mCi of Sr-90 during the treatment of approximately 750 million gallons of groundwater. Since the first groundwater treatment system started operating in December 1996, approximately 7,952 pounds of VOCs and 35 mCi of Sr-90 have been removed, while treating approximately 34 billion gallons of groundwater. - The CERCLA groundwater monitoring program monitored 608 permanent wells during 1,316 individual groundwater sampling events. - 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 standards for these analytes. - Groundwater modeling simulations were performed for the Middle Road and South Boundary treatment systems to evaluate whether modifications to the system are appropriate to address VOC concentrations that are not declining at a rate that will definitively meet the ROD cleanup goal of meeting MCLs by 2030.
	OU X (PFOS/PFOA/1,4-Dioxane)	- As part of the Time-Critical Removal Action (TCRA) under CERCLA, continued the operation of two PFAS groundwater treatment systems, the Current Firehouse/Building 170 system and the Former Firehouse system. - In 2025, approximately 0.3 pounds of PFAS were removed from the aquifer and approximately 320 million gallons of treated groundwater were returned to the aquifer. 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 1.9 pounds of PFAS have been removed and approximately 1.04 million gallons of groundwater have been treated. - Installation of seven permanent monitoring wells downgradient of recharge basins that have received treatment system discharge with detectable concentrations of PFAS and/or 1,4-dioxane. This work was completed in accordance with the Groundwater Discharge Compliance Plan. - Based on temporary well data from 2024, six monitoring wells were installed in 2025 to monitor PFAS and 1,4-dioxane downgradient of the Current Firehouse/Building 170 at the site boundary. - A subset of monitoring wells from the Current Firehouse/Building 170 plume and the Former Firehouse plume were also monitored for 1,4-dioxane.
Peconic River	OU V	Due to inadequate water levels observed in the on-site portion of the Peconic River in 2025, a population survey of fish could not be performed. Annual population surveys in the on-site portion of the Peconic River are performed under BNL's Environmental Surveillance Program.

(continued on next page)

Table 7-1. Summary of BNL 2025 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.
Former Building 197	Former Engineering Laboratory for Nuclear Engineering Department	- In 2025, demolition of the High Bay portion of the building was conducted, exposing mercury contaminated soils. Soils were remediated to remove elemental mercury and mercury-contaminated soil until the remediation work needed to be paused due to project funds being nearly exhausted. The work area was stabilized with institutional and engineering controls in accordance with a regulatory approved plan. The engineering and institutional controls will be maintained until funds are identified to complete the remediation effort. - Installation of one permanent monitoring well immediately downgradient of the former High Bay section to monitor for mercury in groundwater.

prevent further contamination of groundwater. However, the Laboratory 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. EPA, NYSDEC, and DOE (U.S. EPA 1992).

7.1.5 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 34 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 while monitoring and communicating program performance. During 2025, monitoring conducted at BNL's active research and support facilities did not identify any new impacts to groundwater quality.

7.3

Groundwater Monitoring Programs

BNL maintains an extensive network of groundwater monitoring wells that are located on-site and off-site. During 2025, the Laboratory collected groundwater samples from 687 permanent monitoring wells to analyze for various contaminants that may be in the groundwater. Water levels were measured in approximately 231 of the permanent monitoring 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 U.S. EPA 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 (AWQS) 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



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

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

PFAS and 1,4-dioxane are emerging contaminants of concern. PFAS have been widely used in a variety of common household and commercial products, and in aqueous film forming foam (AFFF) used for fighting Class B fires. 1,4-Dioxane has been broadly used in numerous commercial products, including as a chemical stabilizer for the chlorinated solvent 1,1,1-trichloroethane (TCA). PFAS chemicals have impacted groundwater quality at numerous sites across the nation, especially in areas where firefighting foam was used for training, fire suppression systems, and emergency response. In 2017, several PFAS were detected in water samples collected from three BNL water supply wells. Since that time, BNL identified 12 areas where PFAS containing AFFF had been used for firefighter training or fire suppression system maintenance from 1966 through 2008. In each area, the PFAS chemicals perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) concentrations were found in groundwater to exceed their Federal DWS of 4 nanograms per liter (ng/L) and the New York State DWS of 10 ng/L that were adopted for these chemicals in August 2020. The New York State Ambient Water Quality Guidance Values for PFOS (2.7 ng/L) and PFOA (6.7 ng/L) are also applied as enforceable industrial effluent discharge values that apply to the operation of groundwater treatment systems.

The highest PFAS concentrations observed 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.

As part of a Time Critical Removal Action, BNL installed two groundwater treatment systems to remediate the high concentration portion of the PFAS plumes associated with the former firefighter training areas. The Current Firehouse/Building 170 PFAS Treatment System went into operation in December 2022 and the Former Firehouse PFAS Treatment System went into operation in January 2023. The monitoring well network at the Current Firehouse/Building 170 plume consists of 86 wells, and the monitoring well network at the Former Firehouse plume consists of 73 wells.

Since 2017, BNL has also been characterizing the extent of 1,4-dioxane contamination in groundwater. 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 micrograms per liter (µg/L) in a Western South Boundary area monitoring well. In August 2020, New York State adopted a DWS for 1,4-dioxane of 1.0 µg/L. New York State also has an Ambient Water Quality Guidance Value of 0.35 µg/L that is applied as an enforceable effluent discharge limit.

7.4

Groundwater Monitoring Results

During 2025, the Facility Monitoring program monitored 79 permanent wells during 108 individual sampling events. The CERCLA groundwater monitoring program monitored 608 permanent wells during 1,316 individual groundwater sampling events. Ten temporary wells were also installed as part of the CERCLA program, for the continued characterization of several PFAS plumes. Detailed descriptions and maps related to the groundwater monitoring programs can be found in SER Volume II, Groundwater Status Report. Maps showing changes over time of the VOC plumes, radionuclide plumes, and PFOS plumes are provided as Figures 7-2 through 7-5, respectively.

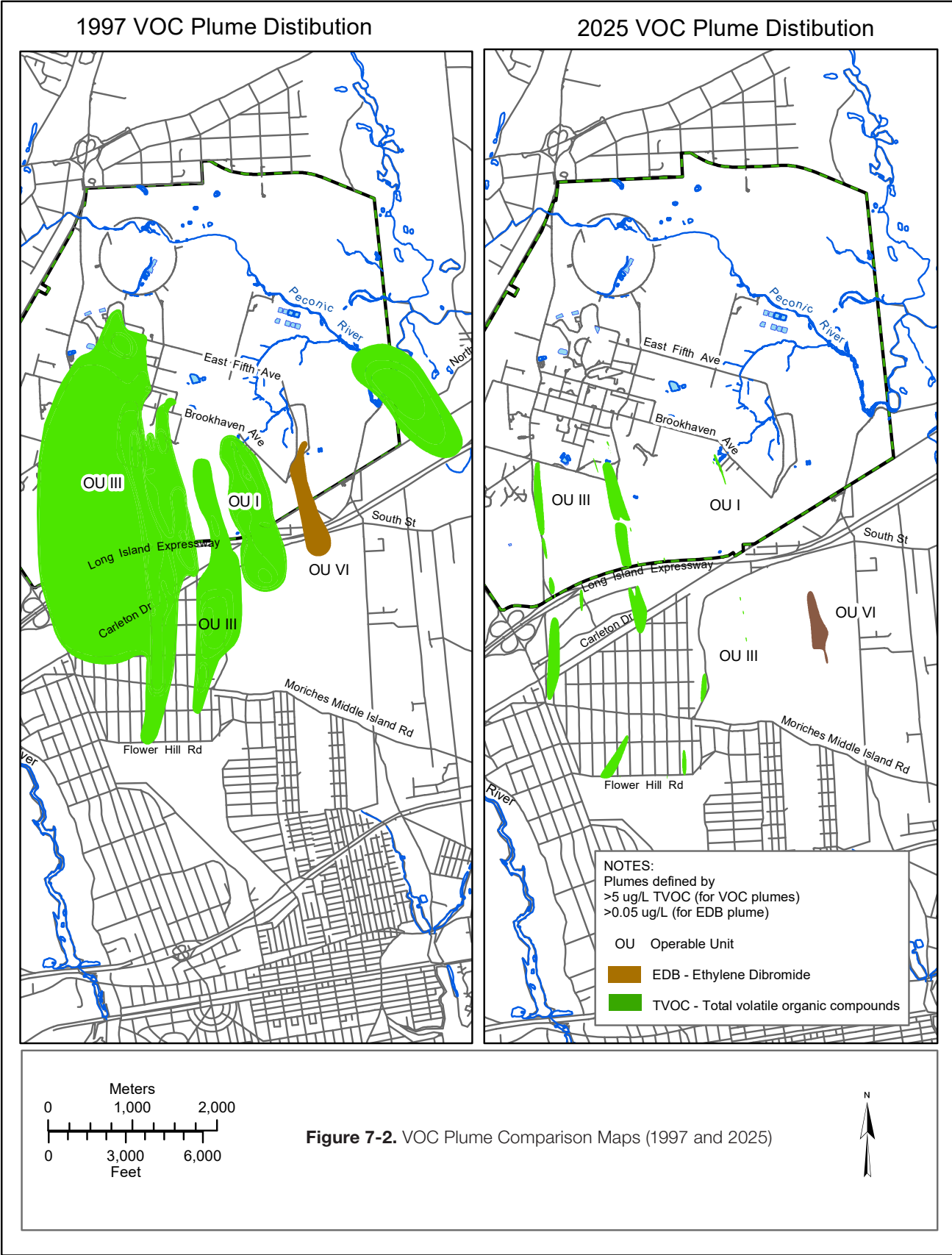
Highlights of the groundwater monitoring programs for 2025 include the following:

- 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), in 2024 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. Post-injection monitoring results have indicated that the treatment was successful in 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 performed groundwater model simulations to evaluate whether modifications to the system are appropriate. The modeling results indicated that three additional extraction wells may reduce the overall cleanup timeframe. The addition of extraction wells is contingent on additional technical assessment and evaluation needed to help quantify the extent to which the cleanup timeframe can be reduced. BNL is putting together engineering design plans to prepare for the construction of additional extraction wells if it is determined that increased pumping is required and when funding is available.
- 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 2025, total VOC (TVOC) concentrations in plume core monitoring wells were below the treatment system capture goal of 20 µg/L. 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 five years of groundwater remediation. During 2025, EDB concentrations in plume core wells continued to be below the 0.05 µg/L MCL. In January 2026, the system was approved for shutdown by the regulators as it had met its shutdown criteria and the extraction wells are currently in standby mode (BNL 2026).
- 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



through 2025. With the addition of the two extraction wells, the cleanup timeframe will need to be reevaluated with the groundwater model utilizing updated information from the pump test and recent monitoring well data.

- TVOC concentrations in plume core wells associated with the off-site Industrial Park treatment system has remained below the 50 µg/L capture goal for this system. A petition for closure for the Industrial Park treatment system (BNL 2025) was approved by the regulators in November 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 in 2025, PFOS and PFOA were detected at concentrations up to 3,000 ng/L and 514 ng/L, respectively. In the Current Firehouse area in 2025, PFOS and PFOA were detected at concentrations up to 1,700 ng/L and 360 ng/L, respectively. Whereas at the Building 170 source area, PFOS and PFOA were detected at concentrations up to 7,550 ng/L and 113 ng/L, respectively. Effluent monitoring results for the two PFAS treatment systems showed that the granular activated carbon (GAC) filters were effectively 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 to the site boundary. The monitoring results confirmed that the PFAS contamination has migrated to the BNL southwestern boundary. In 2025, six permanent monitoring wells were installed based on the temporary well data, and the wells were sampled for the first time in 2026 (Figure 7-4). Furthermore, analytical results from existing OU III monitoring wells confirmed that the Former Firehouse PFAS plume extends off-site into the Industrial Park area (Figure 7-5) to the south.
- 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 2025, PFOS and PFOA were detected in several permanent and temporary monitoring wells at concentrations up to 21 ng/L and 10 ng/L, respectively. Based on these results, two permanent monitoring wells were installed in 2026, and the monitoring network was expanded to include three additional existing monitoring wells, to evaluate the presence of PFAS and 1,4-dioxane in the area.
- The Recharge Basin Monitoring Program was established in 2025 to routinely monitor PFAS and 1,4-dioxane in groundwater downgradient of recharge basins that have received treatment system effluent discharge with concentrations of PFOA, PFOS, and/or 1,4-dioxane exceeding the AWQGVs. These recharge basins include the OU III, HP, RA V, and HS. Seven permanent monitoring wells were installed: five downgradient of OU III and HP basin; and two downgradient of HS basin. Routine program monitoring will begin in 2026.



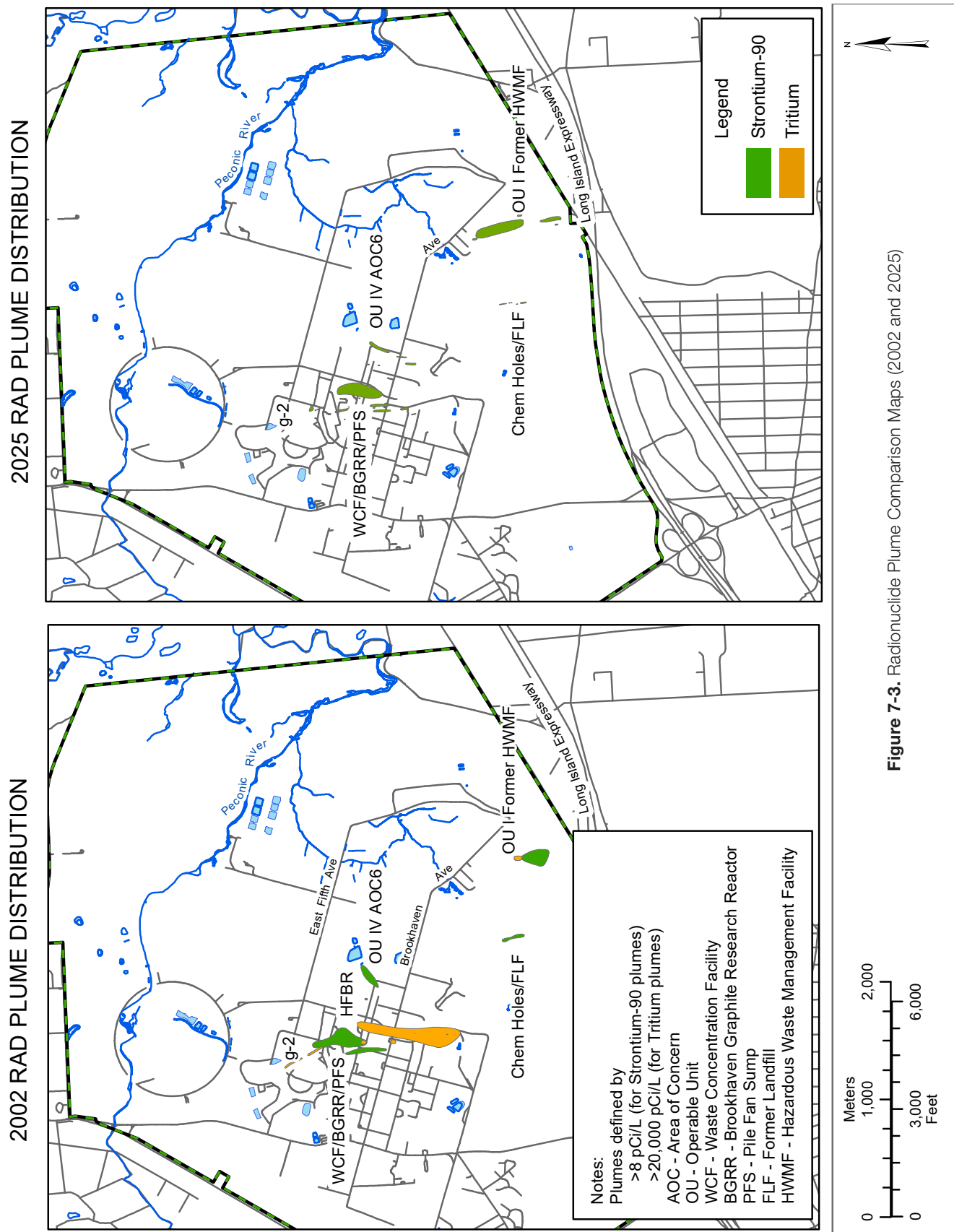
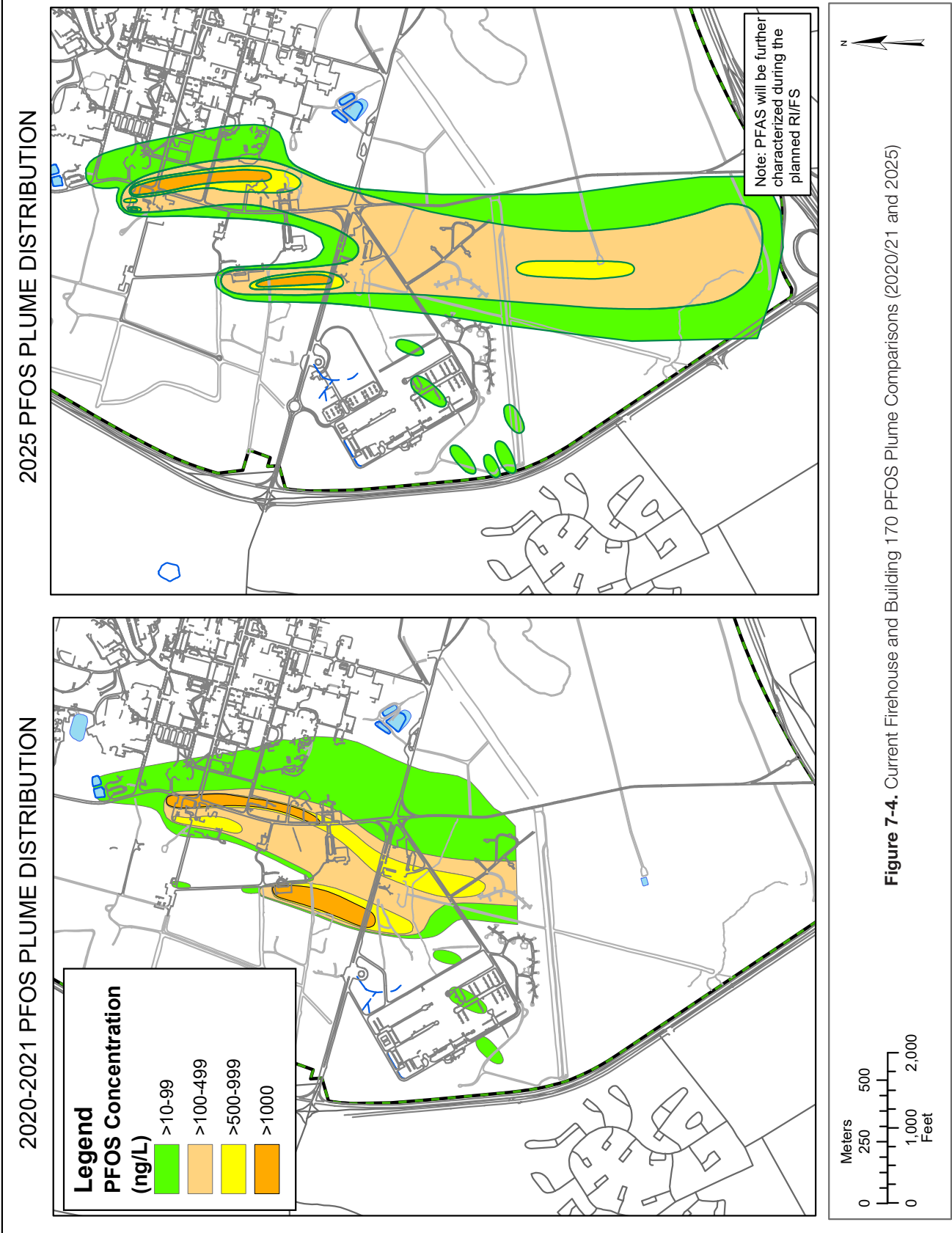
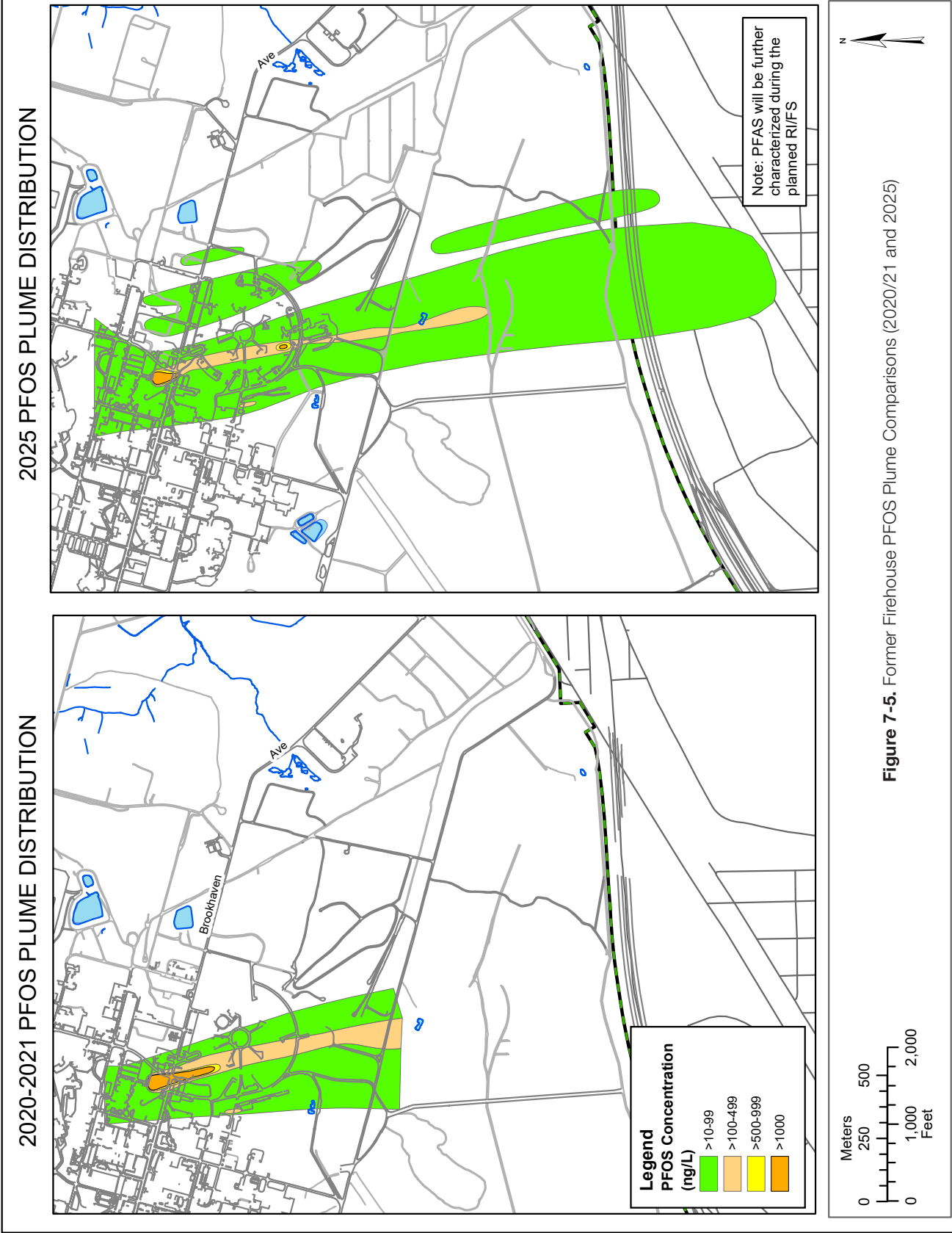


Figure 7-3. Radionuclide Plume Comparison Maps (2002 and 2025)





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 treatment 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 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 2025, 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 that were operational in 2025. Table 7-2 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 2025, approximately 38 pounds of VOCs, 0.3 pounds of total PFAS, and 0.08 mCi of Sr-90 were removed from groundwater and nearly 1.1 billion gallons of treated groundwater were returned to the aquifer. Detailed information on the groundwater contaminant plumes and treatment systems can be found in SER Volume II, Groundwater Status Report.

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 guidance values. NYSDEC 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 GAC filtration, the focus was on the treatment of 1,4-dioxane. The selected treatment technology was advanced oxidation process. 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.



Measuring depth to groundwater in a monitoring well.

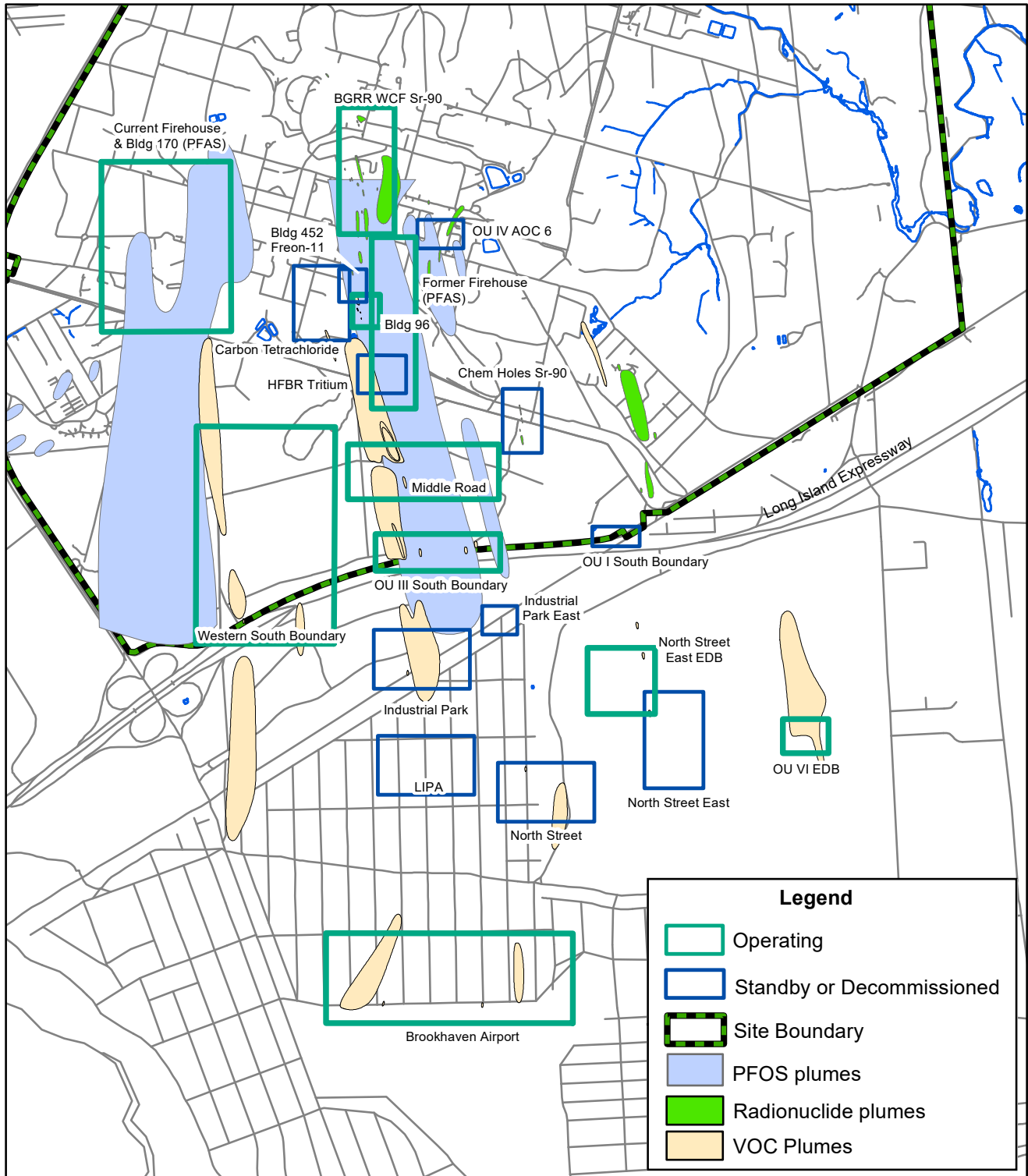


Figure 7-6. Locations of BNL Groundwater Remediation Systems

Table 7-2. BNL Groundwater Treatment System Treatment Summary for 1997 through 2025.

VOC Remediation (start date)	1997-2024		2025	
	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)	627,209,800	147	13,257,000	0.3
OU III Building 452 Freon-11 (March 2012) (a)	124,997,000	106	(Closed)	0
OU III Middle Road (Oct. 2001)	4,458,547,000	1,399	170,650,000	18.3
OU III South Boundary (June 1997)	5,645,151,000	3,090	72,000,000	6.9
OU III W. South Boundary (Sept. 2002)	2,776,555,000	219	93,786,000	7.3
OU III Industrial Park (Sept. 1999) (i)	2,577,662,000	1,076	(Closed)	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)	1,406,110,000	51	51,162,000	0.8
OU III LIPA/Airport (June 2004) (h)	4,586,990,240	511	194,910,000	4.6
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)	3,093,257,000	0.53 (d)	150,090,000	0.09 (d)
Totals	32,427,419,040	7,914	746,443,000	38
Sr-90 Remediation (start date)	2003-2024		2025	
	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)	231,203,000	30.04	4,613,000	0.07
Totals	296,866,000	34.98	4,613,000	0.08
PFAS Remediation (start date)	2022-2024		2025	
	Water Treated (gallons)	PFAS Removed (lbs)	Water Treated (gallons)	PFAS Removed (lbs)
OU X Current Firehouse (Oct. 2022)	453,144,000	1.16	221,247,000	0.21
OU X Former Firehouse (Jan. 2023)	213,518,000	0.42	117,619,000	0.08
Totals	666,662,000	1.58	338,866,000	0.29

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.

(i) Industrial Park system approved for closure in December 2025.

NA – Not applicable



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 2021. 2021 CERCLA Five-Year Review for Brookhaven National Laboratory Superfund Site (NY7890008975), Town of Brookhaven, Hamlet 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.
- BNL 2025. Petition for Closure Industrial Park Treatment System, Upton, New York. 2025.
- BNL 2026. Petition for Shutdown OU III North Street East EDB Groundwater Treatment System, Upton, New York. 2026.
- 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.
- 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.
- 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.
- U.S. EPA 1992. 1992 Interagency Agreement, Administrative Docket Number: II-CERCLA-FFA-00201. U.S. Environmental Protection Agency.
- 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.

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

Chapter 8

Quality Assurance



CHAPTER HIGHLIGHTS

Supports an environment that facilitates **scientific and operational excellence**.

All analytical data reported for the 2025 Site Environmental Report (SER) is **reliable**.

Analyses performed by contract laboratories are **state certified** and participate in **independent performance testing**.

Analytical data generated for BNL, was evaluated by external **audits, proficiency assessments, data verifications**, and data validations to ensure all results are **reliable and defensible**.



8.1

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 414.1E, 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.

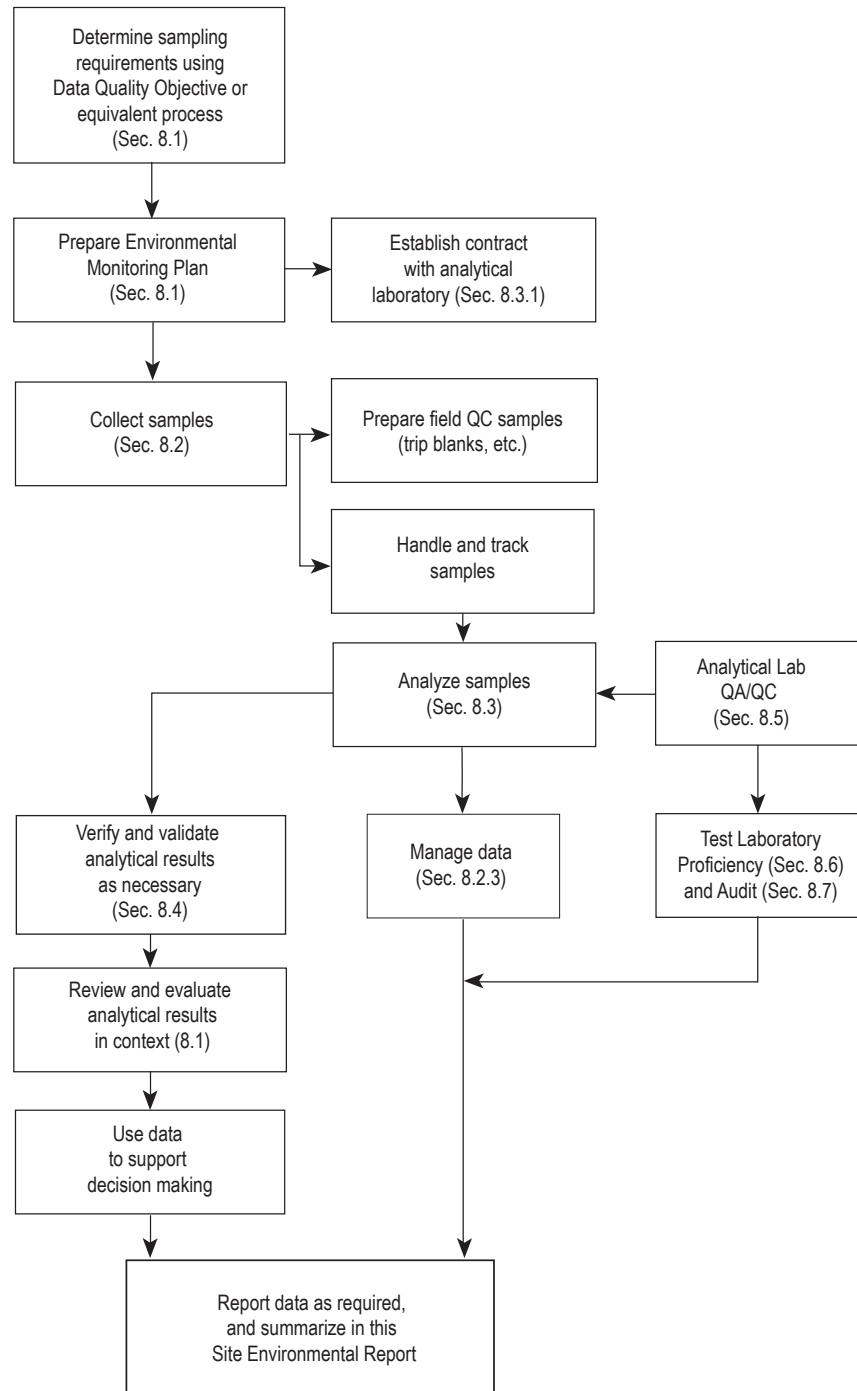
For environmental monitoring, QA is deployed as an integrated system of management activities. These activities involve planning, implementation, control, reporting, assessment, and continual improvement. QC activities measure each process or service against the QA standards. QA/QC practices and procedures 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 8-1 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 (U.S. EPA 2006a), or its equivalent.

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.

Figure 8-1.
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.

8.2

Sample Collection and Handling

In 2025, environmental monitoring samples were collected as specified in the Environmental Monitoring Plan Update (BNL 2025) 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 waste generated during sampling. QC checks of sampling processes include the collection of field duplicates, matrix spike samples, field blanks, trip blanks, and equipment blanks.

8.2.1 Field Sample Handling

To ensure the integrity of samples, chain of custody (COC) was maintained and documented for all samples collected in 2025. 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.
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 2025).

8.2.1.1 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 2024), 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.

8.2.1.2 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.

8.2.2 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 2025.

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 2025.

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 2025, the most common contaminant detected above reporting limit (RL) in the trip, field, and equipment blanks was methylene chloride (Table 8-1). This commonly observed VOC is likely due to minor cross contamination of the samples at the analytical laboratory and its 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 8.4). The results from blank samples collected during 2025 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 (U.S. EPA 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 2025, a total of 148 duplicate samples were collected for non-radiological analyses, and 99 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 7,446 non-radiologic parameters analyzed, no parameters (0%) were above 50% Relative Percent Difference (RPD). For the radiologic parameters, 5 of the 148 parameters (3%) 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 2025, a total of 242 MS/MSD samples were collected for non-radiological analyses, and 194 MS/MSD samples were collected for radiological analyses. Not all parameters were analyzed for every MS/MSD pair. Of the 14,536 non-radiological parameters analyzed, 610 parameters (4%) were outside of the QA criteria. For the radiological parameters, 345 of the 472 (73%) 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 8-1. 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	237	26	0.51	4.52	0.5	µg/L
Methyl bromide	237	6	0.27	2.8	0.5	µg/L
Naphthalene	193	5	0.22	0.73	0.5	µg/L
1,2,3-Trichlorobenzene	194	4	0.16	0.38	0.5	µg/L
1,2,4-Trichlorobenzene	194	2	0.17	0.21	0.5	µg/L
Carbon tetrachloride	237	1	0.97	0.97	0.5	µg/L
Chloroform	237	1	0.61	0.61	0.5	µg/L
o-Xylene	194	1	0.34	0.34	0.5	µg/L
Trichloroethylene	237	1	0.19	0.19	0.5	µg/L
Field Blank Results						
Organic Compounds						
Methylene chloride	61	11	0.75	2.44	0.5	µg/L
Styrene	61	3	0.18	0.96	0.5	µg/L
1,4-Dioxane	26	3	0.616	0.19	0.2	µg/L
Bromoform	61	2	0.17	0.28	0.5	µg/L
o-Xylene	61	3	0.18	0.96	0.5	µg/L
Methyl chloride	61	3	0.17	0.32	0.5	µg/L
Perfluorooctanoic acid (PFOA)	14	6	0.41	0.61	1.6	µg/L
Fluorotelomer sulfonate 6:2 (6:2 FTS)	13	1	1.7	1.7	3.1	µg/L
Metals						
Mercury	38	5	0.2	0.26	0.2	µg/L
Manganese	11	4	3.6	4.11	2	µg/L
Calcium	11	2	80.4	140	50	µg/L
Sodium	11	2	138	238	100	µg/L
Potassium	11	1	59.3	59.3	50	µg/L
Zinc	11	1	13	13	3.3	µg/L
General Chemistry Parameters						
Ammonia (as N)	3	1	0.021	0.021	0.017	µg/L
Chloride	6	1	0.122	0.122	0.067	µg/L
Total Kjeldahl Nitrogen	3	1	0.057	0.057	0.033	µg/L
TSS	1	1	2.4	2.4	0.814	µg/L
Cyanide	3	1	1.96	1.96	1.67	µg/L
Equipment Blank Results						
Organic Compounds						
Perfluorooctanoic acid (PFOA)	18	3	0.41	0.58	1.6	ng/L
1,4-Dioxane	9	1	0.15	0.15	0.25	ng/L
Metals						
Manganese	4	4	4.18	5.41	2	ng/L
Calcium	4	3	51.4	73.8	50	µg/L
Mercury	30	3	0.197	0.42	0.2	µg/L
Chromium	4	1	1	1	1	µg/L
Iron	4	1	75.8	75.8	30	µg/L
Zinc	4	1	3.88	3.88	3.3	µg/L
General Chemistry Parameters						
Chloride	2	1	0.142	0.142	0.067	µg/L

Note: µg/L Micrograms per liter.
ng/L Nanograms per liter.



8.2.3 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.

8.3

Sample Analysis

In 2025, environmental samples were analyzed by five contract analytical laboratories, whose selection is discussed in Section 8.3.1. 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.

8.3.1 Qualifications

BNL used the following five contract analytical laboratories for analysis of environmental samples in 2025:

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; Radiological samples from BNL were subcontracted out to TA-St. Louis for radiological analysis.
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 analysis to be performed, as applicable.
- Their record on performance evaluation (PE) tests.
- Their contract with the DOE Integrated Contract Procurement Team.
- Pre-selection bidding.
- 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 8.5, 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 2025 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 were also subject to PE testing and DOE-sponsored audits (see Section 8.7).

8.4

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 2025 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 8-1. 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.

8.4.1 Checking Results

Non-radiological data analyzed in 2025 were verified and/or validated when required by project DQOs, BNL EM-SOPs, and/or EPA contract laboratory program guidelines (U.S. EPA 2000). Radiological packages were verified and/or validated using BNL and DOE guidance documents (BNL 2022b). During 2025, 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.

8.5

Contract Analytical Laboratory QA/QC

In 2025, 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.

8.6

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 2025. 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 8.6.1.1 and 8.6.1.2.

8.6.1 Summary of Test Results

As shown by Figures 8-2 and 8-3, 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 8-2 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 2025 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 8.7.

Table 8-2. Summary Results of 2025 DOECAP Audits

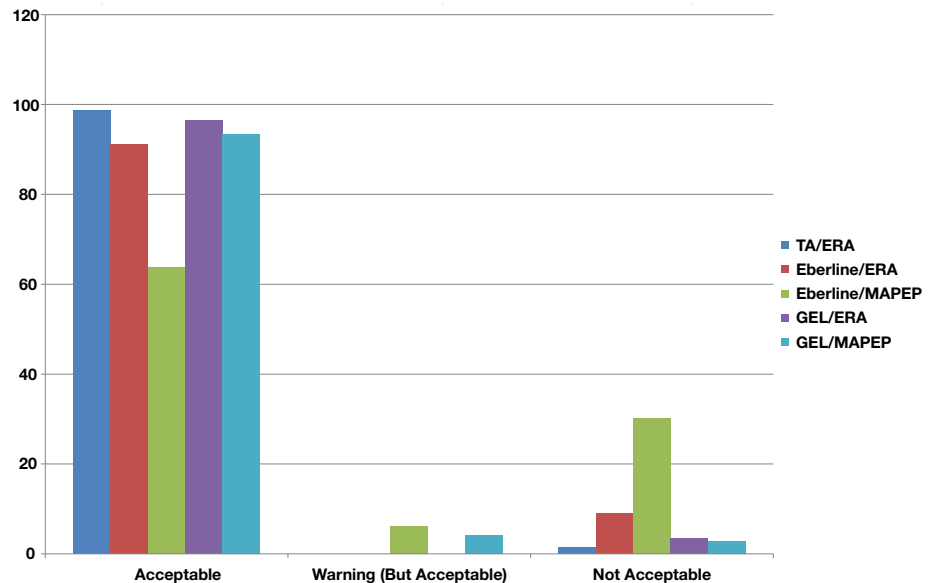
Laboratory	Finding Priority	Area of Concentration	Number of Findings
Eurofins/Test America, St. Louis, Missouri December 2-5, 2025	II	Radiochemistry	3
	II	Quality Assurance	1
	NA	Organic Analyses	0
	NA	Inorganic Analyses and Wet Chemistry	0
	NA	Laboratory Information Management Systems	0
	NA	Materials Management	0
Eberline Analytical Corp., Oak Ridge, Tennessee June 30-July 2, 2025	NA	Radiochemistry	0
	NA	Quality Assurance	0
	NA	Organic Analyses	0
	NA	Inorganic Analyses and Wet Chemistry	0
	NA	Laboratory Information Management Systems	0
	NA	Materials Management	0

NA Not applicable.

8.6.1.1 Radiological Assessments

Figure 8-2 summarizes radiological performance scores in the ERA and MAPEP programs for 2025. Eberline, GEL and TA participated in the ERA radiological PE studies with Eberline having an average overall score of 91%. GEL had an average overall score of 96%. TA also had an overall score of 99%. GEL scored 93% in the MAPEP program, while Eberline had 64%. The low MAPEP PT score for Eberline has resulted in three Corrective Action Reports (CAR). These corrections have led to additional technician training, improvements in data review and sample processing review. TA no longer participates in the MAPEP tests. Chemtex and PACE did not analyze radiological samples for BNL.

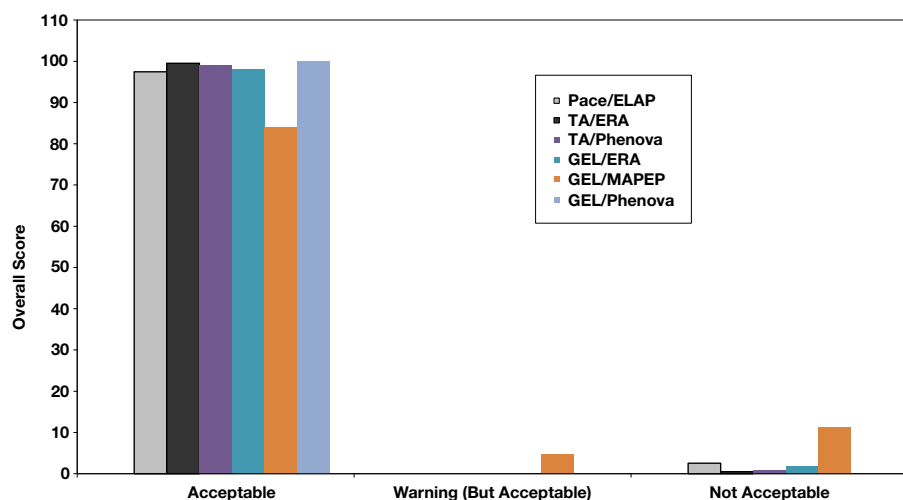
Figure 8-2.
Summary of Scores
in the Radiological
Proficiency Evaluation
Programs



8.6.1.2 Non-radiological Assessments

Figure 8-3 summarizes the non-radiological performance results of three participating laboratories (GEL, Pace, and TA) in the ERA, MAPEP, Phenova, and ELAP tests. During 2025, PACE participated in the NYSDOH ELAP evaluations of performance tests of non-potable water, potable water, and solid wastes. NYSDOH found 97% 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 98%. GEL also scored 84% 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 8-3.
Summary of Scores in
the Non-radiological
Proficiency Evaluation
Programs



8.7

Audits

As part of DOECAP, Eberline was audited in June/July 2025 (PJLA 2025) by Perry Johnson Laboratory Accreditation, Inc. (PJLA). During the audit, there were no findings and no observations.

TA-St. Louis was audited December 2025 (ANAB 2025) by ANSI-ASQ National Accreditation Board (ANAB). During this audit, four non-conformities were found. One for QA/QC and three for radiochemistry. These findings did not affect the quality of BNL data. GEL, TA-Denver, Chemtex, and PACE were not assessed for DOECAP during the 2025 calendar year.

Based on the audit, assessments, and corrective action response, the analytical laboratories met the criteria of the audit programs for Acceptable Status.

8.8

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

- U.S. EPA. 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.
- U.S. EPA 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 2025. 2025 DOECAP Accreditation Program Assessment Report for Eurofins Test America Laboratories, Inc.-St. Louis, Missouri, December 2025.
- PJLA 2025. 2025 DOECAP Accreditation Program Assessment Report for Eberline Analytical Corporation. Oak Ridge, Tennessee, August 2025.
- BNL 2025. 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 2025. Brookhaven National Laboratory Environmental Monitoring Plan Update. Brookhaven National Laboratory, Upton, NY. January 2025.
- BNL 2024. EM-SOP-201 Documentation of Field Activities. Brookhaven National Laboratory, Upton, NY.
- DOE Order 414.1E. Quality Assurance. U.S. Department of Energy. Washington, DC. December 18, 2024.



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.

AA	atomic absorption	CCR	Consumer Confidence Report
AEC	Atomic Energy Commission	CCWF	Central Chilled Water Facility
AFV	Alternative Fuel Vehicles	CEDR	Consolidated Energy Data Report
AGS	Alternating Gradient Synchrotron	CEMS	continuous emission monitoring systems
ALARA*	"As Low As Reasonably Achievable"	CERCLA*	Comprehensive Environmental Response, Compensation and Liability Act
AMSL	above mean sea level	Cf-252	californium-252
AMU	atomic mass unit	CFC-11	chlorofluorocarbon an ozone- depleting refrigerant
AOC*	area of concern	<i>cfm, cfs</i>	cubic feet per minute, per second
APG	Analytical Products Group	CFN	Center for Functional Nanomaterials
ARARs	Applicable, Relevant, and Appropriate Requirements	CFR	U.S. Code of Federal Regulations
ARPA*	Archeological Resource Protection Act	CHP	combined heat and power
ARRA	American Recovery and Reinvestment Act	Ci*	curie
AS/SVE*	air sparging/soil vapor extraction	CLCP	Climate Leadership and Community Protection Act
AST	aboveground storage tank	CO COC*	certificate to operate chain-of-custody
ATF	Accelerator Test Facility	CRM	Cultural Resource Management
AWQS	Ambient Water Quality Standards	CRMP	Cultural Resource Management Plan
BAF	Booster Applications Facility	Cs	cesium
BER	Brookhaven Executive Roundtable	CSF	Central Steam Facility
BGD	belowground duct	CSI	Computational Science Initiative
BGEPA	Bald and Golden Eagle Protection Act	CTN	Center for Transitional Neuroimaging
BGRR	Brookhaven Graphite Research Reactor	CVO	Contractor Vendor Orientation
BHSO	DOE Brookhaven Site Office	CWA*	Clean Water Act
BLIP	Brookhaven Linac Isotope Producer	CXs	categorical exclusions
BMRR	Brookhaven Medical Research Reactor	CY	calendar year
BNL	Brookhaven National Laboratory	D ₂ O*	heavy water
BOD*	biochemical oxygen demand	DAC	Derived Air Concentration
Bq*	becquerel	DCA	1,1-dichloroethane
Bq/g	becquerel per gram	DCE	1,1-dichloroethylene
Bq/L	becquerel per liter	DCG*	derived concentration guide
BRAHMS	Broad Range Hadron Magnetic Spectrometer	D&D	decontamination and decommissioning
BSA	Brookhaven Science Associates	DDD	dichlorodiphenyldichloroethane
Btu	British thermal units	DDE	dichlorodiphenyldichloroethylene
CAA*	Clean Air Act	DDT	dichlorodiphenyltrichloroethane
CAAA*	CAA Amendments (1990)	DMR	Discharge Monitoring Report
CAC	Community Advisory Council	DOE*	U.S. Department of Energy
CAFE	Corporate Average Fuel Economy	DOE CH	DOE Chicago Operations Office
CAP	Clean Air Act Assessment Package	DQO	Data Quality Objective
CBS	chemical bulk storage		

APPENDIX A: GLOSSARY

DSA	Documented Safety Analysis	FIFRA*	Federal Insecticide, Fungicide, and Rodenticide Act
DSB	Duct Service Building	FM	Facility Monitoring
DUV – FEL	Deep UltraViolet – Free Electron Laser DWS	FPM	Facility Project Manager
DWS	Drinking Water Standards	FRP	Facility Response Plan
E	Endangered	FWS*	U.S. Fish & Wildlife Service
EA*	Environmental Assessment	FY	Fiscal Year
EBIS	Electron Beam Ion Source	GAC	Granular Activated Carbon
ECM	Energy Conservation Measures	GBq	giga (billion or E+09) becquerel
ECR	Environmental Compliance Representative	GAB	gross alpha and beta
EDB*	ethylene dibromide	GC/ECD	Gas chromatography/electron capture detector
EDE*	Effective Dose Equivalent	GC/MS	gas chromatography/mass spectrometry
EDTA	ethylenediaminetetraacetic acid	GDS	Groundwater Discharge Standard
EE/CA	Engineering Evaluation/Cost Analysis	GEL	General Engineering Laboratory, LLC
EE-OICPA	Energy Employees Occupational Illness Compensation Program Act	GeV	giga (billion) electron volts
EIC	Electron Ion Collider	gge	gas gallon equivalent
EIMS*	Environmental Information Management System	GHG	Greenhouse Gas
EISA	Energy Independence and Security Act	GIS	Geographical Information System
ELAP	Environmental Laboratory Approval Program	GPG	Groundwater Protection Group
EML	Environmental Measurements Laboratory	GSA	US General Services Administration
EMP	Environmental Monitoring Plan	GSF	gross square feet
EMS*	Environmental Management System	GWh	gigawatt hour
EO	Executive Order	GWP	Global warming potential
EPA*	U.S. Environmental Protection Agency	HAA5	five haloacetic acids
EPCRA*	Emergency Planning and Community Right-to-Know Act	HAP	Hazardous Air Pollutant
EPeAT	Electronic Product Environmental Assessment Tool	HEPA	high efficiency particulate air
EPD	Environmental Protection Division	HFBR	High Flux Beam Reactor
EPP	Environmentally Preferable Purchasing	HFCs	Hydrofluorocarbons
ERP	Environmental Restoration Projects	HITL	Heavy Ion Transfer Line
ERPP	Environmental Radiation Protection Program	HPRS	Health Physics Reporting System
ERA	Environmental Resource Associates	HPSB	High Performance and Sustainable Buildings
ERD	Environmental Restoration Division	HSS	Health, Safety and Security
ES*	environmental surveillance	HTO	tritiated water (liquid or vapor)
ESF	SUNY School of Environmental Science and Forestry	HVAC	heating/ventilation/air conditioning
ESPC	Energy Savings Performance Contract	HWMF	Hazardous Waste Management Facility
ESR	Experimental Safety Review	IAEA	International Atomic Energy Agency
ES&H	Environment, Safety, and Health	IA	Interagency Agreement
ESA*	Endangered Species Act	IC	ion chromatography
ESH&Q	Environment, Safety, Health, and Quality Directorate	ICP/MS	inductively coupled plasma/mass spectrometry
ESPC	Energy Savings Performance Contract	IGA	Investment Grade Audit
ESSH	Environmental Safety, Security and Health	ILA	industrial, landscaping, and agricultural
FaST	Facility and Student Teams Program	IOPS	Integrated Operational Performance System
FAMS	Facility area monitors	IPM	Integrated Pest Management
FCA	Facility Condition Assessment	ISB	Interdisciplinary Science Building
FCM	Facility Complex Manager	ISMS	Integrated Safety Management System
FEMP	Federal Emergency Management Program	ISO*	International Organization for Standardization K potassium
FERN	Foundation for Ecological Research in the Northeast	kBq	kilobecquerels (1,000 Bq)
FFCA*	Federal Facilities Compliance Act	KeV	kilo (thousand) electron volts
FFA	Federal Facilities Agreement	Kg	kilograms
FHWMF	Former Hazardous Waste Management Facility	Kr	kryptonite
		kWh	kilowatt hours



lbs.	pounds	NELAC	National Environmental Laboratory Accreditation Conference
LDR	Land Disposal Restriction	NELAP	National Environmental Laboratory Accreditation Program
LED	light emitting diode	NEPA*	National Environmental Policy Act
LEED	Leadership in Energy and Environmental Design	NESHAPs*	National Emission Standards for Hazardous Air Pollutants
LIE	Long Island Expressway	NetDMR	Network DMR
LIMS	Laboratory Information Management System	ng/J	nano (one-billionth) gram per Joule
Linac	Linear Accelerator	NHPA*	National Historic Preservation Act
LIPA	Long Island Power Authority	NHTSA	National Highway Traffic Safety Administration
LISF	Long Island Solar Farm	NIST	National Institute for Standards and Technology
LTRA	Long Term Remedial Action	nm	nanometer
mA	milli-amperes	NNSS	Nevada National Security Site
M&V	Measurement and Verification	NO ₂	nitrogen dioxide
MACT	Maximum Available Control Technology	NOV	Notice of Violation
MAPEP	Mixed Analyte Performance Evaluation Program	NO _x *	nitrogen oxides
MAR	Materials-at-risk	NOEC	no observable effect concentration
MBAS	methylene blue active substances	NPDES	National Pollutant Discharge Elimination System
MBTA	Migratory Bird Treaty Act	NR	not required
MCL	maximum contaminant level	NRMP	Natural Resource Management Plan
MDC	minimum detectable concentration	NS	not sampled
MDL*	minimum detection limit	NSERC	Northeast Solar Energy Research Center
MEG	Miller Environmental Group	NSF-ISR	NSF-International Strategic Registrations, Ltd.
MEI*	maximally exposed individual	NSLS	National Synchrotron Light Source
MEOSI	maximally exposed off-site individual	NSLS-II	National Synchrotron Light Source II
MET	Meteorological Services	NSPS	new source performance standards
MeV	million electron volts	NSRC	Nanoscale Science Research Centers
MFL	million fibers per liter	NSRL	NASA Space Radiation Laboratory
MGD	million gallons per day	NT	not tested
mg/L	milligrams per liter	NTS	Nevada Test Site
MMBtu	million British thermal units	NYCRR*	New York Codes, Rules, and Regulations
MOA	Memorandum of Agreement	NYISO	New York Independent System Operator
MOU	Memorandum of Understanding	NYPA	New York Power Authority
MPF	Major Petroleum Facility	NYS	New York State
MPN	most probable number	NYSDEC	NYS Department of Environmental Conservation
MPO	Modernization Project Office	NYSDOH	NYS Department of Health
mrem	milli (thousandth of a) rem	NYSHPO	NYS Historic Preservation Office
MRC	Medical Research Center	O ₃ *	ozone
MRDL	maximum residual disinfectant level	O&M	Operation and Maintenance
MRI	Magnetic Resonance Imaging	ODS	ozone-depleting substances
MSL*	mean sea level	OEP	Office of Education Programs
mSv	millisievert	OFIs	opportunities for improvement
MTBE	methyl tertiary butyl ether	OHSAS	Occupational Health and Safety Assessment Series
MW	megawatt	OMC	Occupational Medical Clinic
MWh	megawatt hours	ORC	oxygen-releasing compound
NA	not analyzed	ORNL	Oak Ridge National Laboratory
NASA	National Aeronautics and Space Administration	ORPS*	Occurrence Reporting and Processing System
NCRP	National Council on Radiation Protection and Measurements	OSHA	Occupational Health and Safety Administration
ng/L	nanograms per liter	OSSP	Open Space Stewardship Program
ND	not detected	OU*	operable unit
NEAR	Neighbors Expecting Accountability	P2*	pollution prevention
NEPA*	National Environmental Policy Act and Remediation	PAAA*	Price-Anderson Act Amendment

APPENDIX A: GLOSSARY

PAF	Process Assessment Form	SCSC	Suffolk County Sanitary Code
Pb	lead	SDL	Source Development Laboratory
BPT	persistent, bioaccumulative, and toxic	SDWA*	Safe Drinking Water Act
PCBs*	polychlorinated biphenyls	SER	Site Environmental Report
PCE	tetrachloroethylene (or perchloroethylene)	SI	International System (measurement units)
pCi/g	picocuries per gram	SNS	standard not specified
PE	performance evaluation	SO ₂	sulfur dioxide
PEMP	Performance Evaluation Management Plan	SOP	standard operating procedure
PET	positron emission tomography	SPB	Southern Pine Beetle
PFAS	per- and polyfluoroalkyl substances	SPCC	Spill Prevention Control and Countermeasures
FPCs	Perfluorocarbons	SPDES*	State Pollutant Discharge Elimination System
PFOA	perfluorooctanoic acid	Sr	strontium
PFOS	Perfluorooctanesulfonic acid	SSPP	Strategic Sustainability Performance Plan
PIC	potential impact category	STAR	Solenoid Tracker at RHIC
PIMS	Proposal Information Management System	STEM	Scanning Transmission Electron Microscope
ppb	parts per billion	STL	Severn Trent Laboratories, Inc.
ppm	parts per million	STP	Sewage Treatment Plant
ppt	parts per trillion	SU	standard unit
PPTRS	Pollution Prevention Tracking System	SULI	Science Undergraduate Laboratory Internship
PRAP	Proposed Remedial Action Plan	SUNY	State University of New York
PUE	Power Utilization Effectiveness	SUSC	Science and User Support Center
PV	photovoltaic	Sv*	sievert; unit for assessing radiation dose risk
QA*	quality assurance	SVE*	soil vapor extraction
QAPP	Quality Assurance Program Plan	SVOC*	semi volatile organic compound
QC*	quality control	t _{1/2} *	half-life
QCU	quantum chromodynamics	TA	Test America
QM	Quality Management	TBq	tera (trillion, or E+12) becquerel
R2A2	Roles, Responsibilities, Accountabilities, and Authorities	TCA	1,1,1-trichloroethane
R-11 (etc.)	ozone-depleting refrigerant	TCAP	Transportation Safety and Operations
RA*	removal action	CAP	Compliance Assurance Process
RACT	Reasonably Available Control Technology	TCE*	trichloroethylene
RATA	Relativistic accuracy test	TCLP	toxicity characteristic leaching procedure
RCA	recycled concrete aggregate	TEAM	Transformational Energy Action Management
RCRA*	Resource Conservation and Recovery Act RD/	TED	Total Effective Dose
RA	Remedial Design/Remedial Action	TEDE	Total Effective Dose Equivalent TKN Total Kjeldahl nitrogen
REC	Renewable Energy Credit	TLD*	thermoluminescent dosimeter
RF	resuspension factor	TPL	Target Processing Laboratory
RHIC	Relativistic Heavy Ion Collider	TRE	Toxic Reduction Evaluation
ROD*	Record of Decision	TRI	Toxic Release Inventory
RPD	relative percent difference	TSCA*	Toxic Substances Control Act
RRPL	Radionuclide Research and Production Laboratory	TTA	Tolytriazole
RSB	Research Support Building	TVDG	Tandem Van de Graaff
RWMB	Radioactive Waste Management Basis	TVOC*	total volatile organic compounds
RWP	Radiological Work Permit	UESC	Utility Energy Services Contract
S&M	surveillance and maintenance	µg/L	micrograms per liter
SARA*	Superfund Amendments and Reauthorization Act	UIC*	underground injection control
SBMS*	Standards Based Management System	UPS	uninterrupted power supplies
SCDHS	Suffolk County Department of Health Services	UST*	underground storage tank
SCR	Special Case Resource	VFP	Visiting Faculty Program
SCR	Stakeholder and Community Relations	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

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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 by forcing a stream of air through the water in a vessel. The contaminants evaporate into the air stream. The air may be further treated before it is released into the atmosphere.

ambient air – The surrounding atmosphere, usually the outside air, as it exists around people, animals, plants, and structures. It does not include the air immediately adjacent to emission sources.

analyte – A constituent that is being analyzed.

anneal – To heat a material and then cool it. In the case of thermoluminescent dosimeters (TLDs), this is done to reveal the amount of radiation the material 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.

bremssstrahlung – 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, CCl₄.

CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) – Pronounced “sir-klah” and commonly known as Superfund, this law was enacted by Congress on December 11, 1980. It created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of

hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified. The law authorizes two kinds of response actions: short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response, and long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on EPA's National Priorities List (NPL). CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) on October 17, 1986, accessed 03-7-05).

CFR (Code of Federal Regulations) – A codification of all regulations developed and finalized by federal agencies in the Federal Register. The CFR is arranged by “title,” with Title 10 covering energy- and radiation-related issues, and Title 40 covering protection of the environment. Subparts within the titles are included in citations, as in “40 CFR Subpart H.”

characterization – Facility or site sampling, monitoring, and analysis activities to determine the extent and nature of contamination. Characterization provides the basis of necessary technical information to select an appropriate cleanup alternative.

Ci (curie) – A quantitative measure of radioactivity. One Ci of activity is equal to 3.7E+10 decays per second. One curie has the approximate activity of 1 gram of radium. It is named after Marie and Pierre Curie, who discovered radium in 1898.

Class GA groundwater – New York State Department of Environmental Conservation (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.

CO₂ equivalent (CO₂e) – 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 CO₂. It is used to evaluate the release (or the avoided release) of different GHG emissions against a common basis and is commonly expressed as metric tons carbon dioxide equivalent (MtCO₂e), 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 contact with process raw materials or final products.

cover boards – Sheets of plywood placed on the ground near ponds to serve as attractive habitat for salamanders, as part of a population study.

curie – See Ci.

CWA (Clean Water Act) – Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. It established the basic structure for regulating discharges of pollutants into the waters of the United States, giving EPA the authority to implement pollution control programs such as setting waste-water 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

D₂O – 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 reasonably be anticipated to be a carcinogen, it is still used to treat felled logs for bark beetles; to control wax moths in beehives; as a chemical

intermediary for dyes, resins, waxes, and gums; to spot-treat milling machinery; and to control Japanese beetles in ornamental plants.

EDE (Effective Dose Equivalent) – A value used to express the health risk from radiation exposure to tissue in terms of an equivalent whole-body exposure. It is a “normalized” value that allows the risk from radiation exposure received by a specific organ or part of the body to be compared with the risk due to whole-body exposure. The EDE equals the sum of the doses to different organs of the body multiplied by their respective weighting factors. It includes the sum of the EDE due to radiation from sources external to the body and the committed effective dose equivalent due to the internal deposition of 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 (CO₂), nitrous oxide (N₂O), methane (CH₄), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

global warming potential (GWP) – A factor describing the radiative forcing impact of one unit of a given GHG relative to one unit of CO₂.

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 (D₂O) – 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 neutrons in the nucleus.

NYCRR (New York Codes, Rules, and Regulations) – The NYCRR primarily contains state agency rules and regulations adopted under the State Administrative Procedure Act. There are 22 Titles: one for each state department, one for miscellaneous agencies and one for the Judiciary. Title 6 addresses environmental conservation, so many references in the SER are to “6 NYCRR.”



O

O₃ – 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 (O₃) – A very reactive type of oxygen formed naturally in the upper atmosphere which provides a shield for the earth from the sun's ultraviolet rays. At ground level or in the lower atmosphere, it is pollution that forms when oxides of nitrogen and hydrocarbons react with oxygen in the presence of strong sunlight. Ozone at ground level can lead to health effects and cause damage to trees and crops.

P

P2 (pollution prevention) – Preventing or reducing the generation of pollutants, contaminants, hazardous substances, or wastes at the source, or reducing the amount for treatment, storage, and disposal through recycling. Pollution prevention can be achieved through reduction of waste at the source, segregation, recycle/reuse, and the efficient use of resources and material substitution. The potential benefits of pollution prevention include the reduction of adverse environmental impacts, improved efficiency, and reduced costs.

PAAA (Price-Anderson Act Amendments) – The Price-Anderson Act (PAA) was passed in 1957 to provide for prompt compensation in the case of a nuclear accident. The PAA provided broad financial coverage for damage, injury, and costs, and required DOE to indemnify contractors. The amended act of 1988 (PAAA) extended indemnification for 15 years and required DOE to establish and enforce nuclear safety rules. The PAAA Reauthorization, passed in December of 2002, extended current indemnification levels through 2004. 10 CFR 820 and its Appendix A provide DOE enforcement procedure and policy.

Parshall flume – An engineered channel used to measure the flow rate of water. It was named after the inventor, who worked for the U.S. government as an irrigation research engineer.

PCBs (polychlorinated biphenyls) – A family of organic compounds used from 1926 to 1979 (when they were banned by EPA) in electrical transformers, lubricants, carbonless copy paper, adhesives, and caulking compounds. PCBs are extremely persistent in the environment because they do not break down into different and less harmful chemicals. PCBs are stored in the fatty tissues of humans and animals through the bioaccumulation process.

percent recovery – For analytical results, the ratio of the measured amount, divided by the known (spiked) amount, multiplied by 100.

perfluorocarbons (PFCs) – One of the six primary GHGs consisting of a class of gases containing carbon and fluorine typically emitted as by-products of industrial and manufacturing processes and possessing GWPs ranging from 5,700 to 11,900.

permit – An authorization issued by a federal, state, or local regulatory agency. Permits are issued under a number of environmental regulatory programs, including CAA, CWA, RCRA, and TSCA. Permits grant permission to operate, to discharge, to construct, and so on. Permit provisions may include emission/effluent limits and other requirements such as the use of pollution control devices, monitoring, record keeping and reporting. Also called a "license" or "certificate" under some regulatory programs.

pH – A measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, neutral solutions have a pH of 7, and basic solutions have a pH greater than 7 and up to 14.

plume – A body of contaminated groundwater or polluted air flowing from a specific source. The movement of a groundwater plume is influenced by such factors as local groundwater flow patterns, the character of the aquifer in which groundwater is contained, and the density of contaminants. The movement of an air contaminant plume is influenced by the ambient air motion, the temperatures of the ambient air and of the plume, and the density of the contaminants.

point source – Any confined and discrete conveyance (e.g., pipe, ditch, well, or stack) of a discharge.

pollutant – Any hazardous or radioactive material naturally occurring or added to an environmental medium, such as air, soil, water, or vegetation.

potable water – Water of sufficient quality for use as drinking water without endangering the health of people, plants, or animals.

precision – A statistical term describing the dispersion of data around a central value, usually represented as a variance, standard deviation, standard error, or confidence interval.

putrescible waste – Garbage that contains food and other organic biodegradable materials. There are special management requirements for this waste in 6 NYCRR Part 360.

Q

QA (quality assurance) – In environmental monitoring, any action to ensure the reliability of monitoring and measurement data. Aspects of QA include procedures, interlaboratory comparison studies, evaluations, and documentation.

QC (quality control) – In environmental monitoring, the routine application of procedures to obtain the required standards of performance in monitoring and measurement processes. QC procedures include calibration of instruments, control charts, and analysis of replicate and duplicate samples.

qualifier – A letter or series of letter codes in a graph or chart indicating that the associated value did not meet analytical requirements or was estimated.

quenching – Anything that interferes with the conversion of decay energy to electronic signal in the photomultiplier tubes of detection equipment, usually resulting in a reduction in counting efficiency.

R

R (roentgen) – A unit of exposure to ionizing radiation. It is the amount of gamma or x-rays required to produce ions carrying one electrostatic unit of electrical charge in one cubic centimeter of dry air under standard conditions. It is named after the German scientist Wilhelm Roentgen, who discovered x-rays.

RA (removal actions, “removals”) – Interim actions that are undertaken to prevent, minimize, or mitigate damage to the public health or environment that may otherwise result from a release or threatened release of hazardous substances, pollutants, or contaminants pursuant to CERCLA, and that are not inconsistent with the final remedial action. Under CERCLA, EPA may respond to releases or threats of releases of hazardous substances by starting an RA to stabilize or clean up an incident or site that immediately threatens public health or welfare. Removal actions are less comprehensive than remedial actions. However, removal actions must contribute to the efficiency of future remedial actions.

radiation – Some atoms possess excess energy, causing them to be physically unstable. Such atoms become stable when the excess energy is released in the form of charged particles or electromagnetic waves, known as radiation.

radiation event – A single detection of a charged particle or electromagnetic wave.

radioactive series – A succession of 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: $RPD = [(A-B)/(A+B)] \times 200$, 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 ground or underground sources. The SDWA authorized EPA to establish safe standards of purity and required all owners or operators of public water systems to comply with health-related standards. State governments assume regulatory power from EPA.

sediment – The layer of soil and minerals at the bottom of surface waters, such as streams, lakes, and rivers.

sensitivity – The minimum amount of an analyte that can be repeatedly detected by an instrument.

sievert – See Sv.

skyshine – Radiation emitted upward from an open-topped, shielded enclosure and reflected downward, resulting in the possibility that flora and fauna (including humans) outside the shielded enclosure can be exposed to radiation.

sludge – Semisolid residue from industrial or water treatment processes.

sole source aquifer – An area defined by EPA as being the primary source of drinking water for a particular region. Includes the surface area above the sole source aquifer and its recharge area.

SPDES (State Pollutant Discharge Elimination System) – This permit program is delegated to the states, but the effluent limitations and other requirements are set by the federal government. 6 NYCRR Section 750-1.11(a) concerns the provisions of SPDES permits and lists the citations for the various effluent limitations from the Federal Register and the CFR.

stable – Nonradioactive.

stakeholder – People or organizations with vested interests in BNL and its environment and operations. Stakeholders include federal, state, and local regulators; the public; DOE; and BNL staff.

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 (SF6) – 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

t½ (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 in 1976, TSCA empowers EPA to track the 75,000 industrial chemicals produced or imported into the United States. EPA repeatedly screens these chemicals and can require reporting or testing of any that may pose an environmental or human health hazard. EPA can ban the manufacture or import of chemicals that pose an unreasonable risk.

TVOC (total volatile organic compounds) – A sum of all individual VOC concentrations detected in a given sample.

U

UIC (underground injection control) – A hole with vertical dimensions greater than its largest horizontal dimensions; used for disposal of wastewater.

UST (underground storage tank) – A stationary device, constructed primarily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10% 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, generated when high-energy electrons strike matter or when lower-energy beta radiation is absorbed in matter. Gamma radiation and x-rays are identical, except for the source.

Z

zeolite – A naturally occurring group of more than 100 minerals, formed of silicates and aluminum, with unique and diverse crystal properties. Zeolites can perform ion exchange, filtering, odor removal, and chemical sieve and gas absorption tasks. Synthetic zeolites are now used for most applications.

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 – 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).

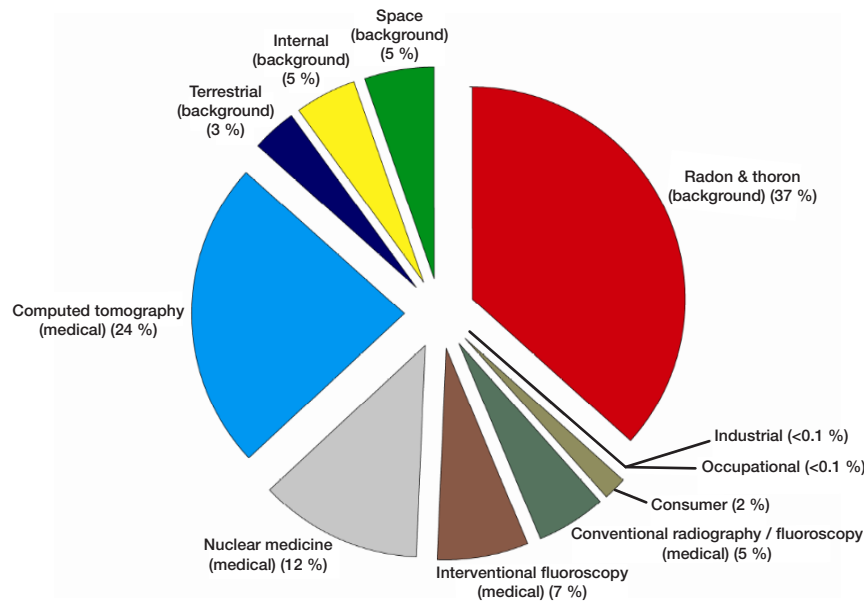


Figure B-1. Typical Annual Radiation Doses from Natural and Man-Made Sources (mrem). Source: NCRP Report No. 160 (NCRP 2009)

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 $x \pm y$ format, where “x” is the analysis result and “ $\pm y$ ” 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. 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).

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 ($1.5\text{E}+5$ 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 = 3.7×10^{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
1×10^{12}	1,000,000,000,000	E+12	Tera-	T
1×10^9	1,000,000,000	E+9	giga-	G
1×10^3	1,000	E+03	kilo-	k
1×10^{-2}	0.01	E-02	centi-	c
1×10^{-3}	0.001	E-03	milli-	m
1×10^{-6}	0.000001	E-06	micro-	μ
1×10^{-9}	0.000000001	E-09	nano-	n
1×10^{-12}	0.000000000001	E-12	pico-	p

Concentration Conversions

1 ppm = 1,000 ppb
1 ppb = 0.001 ppm = 1 µg/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)



FY 2025 Site Sustainability Plan



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I. Executive Summary and Executive Summary Table

Brookhaven Science Associates (BSA) is pleased to submit this annual Site Sustainability Plan (SSP) for Brookhaven National Laboratory (BNL). Effectively managing such a large, diverse portfolio of programs takes many committed individuals working towards a common goal. This document is the work of a large cross-functional team of BSA employees both within the science directorates as well as the support or operations directorates.

BNL is operated and managed for the Department of Energy Office of Science (DOE-SC) by BSA, a partnership formed by Stony Brook University (SBU) and Battelle Memorial Institute. BNL is staffed by over 3,000 research and support employees and hosts an even greater number of facility users, guest researchers, and scientists annually. The Laboratory operates from an extensive campus located in Upton, New York, on 5,320 acres with approximately 4.9 million gross square feet (GSF) of space in over 300 buildings.

BNL conceptualizes, designs, builds, and operates major scientific facilities and makes them available to university, industry, and government researchers in support of the SC mission. The sustainability vision for BNL leverages this unique combination of access to diverse research talent, stewardship for a significant national research infrastructure, and a location in the energy intensive northeastern United States.

As a result, BNL is well established as a northeastern regional resource for sustainability expertise and is effectively utilizing its physical infrastructure to demonstrate sustainability technology. This approach to development and deployment of technology, combining the unique resources of both research and operations, is the vision of the BNL SSP to help ensure a successful future for our nation.

The Laboratory's efforts in sustainability have been consistent over the last several years and they focus on four broad principles:

1. Striving to be climate neutral through reducing energy use and effective energy management;
2. Lowering the environmental impact of the campus through sustainable infrastructure;
3. Leveraging research in conjunction with our operations and in support of the northeastern region; and
4. Fostering a culture of sustainability with our employees and our community.

The Laboratory remains strongly committed to supporting and achieving the targets in the DOE Strategic Sustainability Performance Plan (SSPP). Leadership in sustainability is demonstrated through the Laboratory's management practices, stewardship of the BNL campus, as well as our research and education programs. The efforts in sustainability are communicated widely across the Laboratory, and the Senior Leadership team remains actively engaged.

BNL's Energy Management program continues to be the centerpiece of our Sustainability program. In FY24, BSA matured the Energy Management Planning Team with representatives from both science and support directorates. The team continued to maintain solid relationships with the New York Power Authority (NYPA) and local utility providers ensuring cost effective power rates for operating the energy intensive user facilities and general infrastructure. In addition, the team had several meetings with NYPA to discuss collaborating on both BNL and regional renewable energy projects. These relationships are

critical to achieve our sustainability goals and to address the increased energy demand and consumption in the next decade due to the Electron Ion Collider (EIC).

BNL's Energy Management program remains dedicated to securing affordable and reliable power for the laboratory. In FY24, the team worked closely with the Brookhaven Site Office (BHSO), the NYPA, and the Long Island Power Authority (LIPA) to re-execute the sale-for-resale agreement for the 15 MW allocation of low-cost NYPA hydropower. At the time of writing, the agreement had received approvals from the Governor, DOE Headquarters, and LIPA, with final signatures pending.

BNL continues to host the Long Island Solar Farm (LISF), a solar photovoltaic (PV) power plant, developed through a collaboration that included BP Solar, the LIPA, and DOE. The LISF, located on the BNL site, began delivering power to the LIPA grid in November 2011. The LISF is made up of 164,312 PV panels and can produce up to 32 MW of electricity.

Additionally, the Laboratory has developed the Northeast Solar Energy Research Center (NSERC) on its campus that serves as a solar energy research and test facility for the solar industry. The mission of the NSERC is to support the expansion of solar power by providing high-quality data, field-testing, analyses, and solar energy expertise to address technical, economic, environmental, and policy issues facing solar power deployment in northeastern climates. The NSERC will be a proving ground for BNL and our industrial partners to test new solar technologies, including electrical inverters, storage devices, and solar modules, which effectively adds solar energy research to the user facility portfolio of BNL. BNL has discussed upgrading the NSERC in partnership with NYPA and will continue to explore options in FY25.

These projects demonstrate how BNL is continuing to collaborate with many organizations both internally and externally to enhance research at the Laboratory with the sustainability goals in mind. Staff members from the BNL Environment, Biology, Nuclear Science, and Nonproliferation (EBNN) Directorate, Facilities and Operations (F&O) Directorate, Information Technology Division (ITD), and the DOE BHSO have been instrumental in preparing our research agenda and developing a plan to bring it to fruition. In addition, BSA and BHSO have started cultivating relationships with local providers on a potential Grid Facility that will bring the Laboratory's sustainability efforts to the entire nation.

There are areas where BNL has been extremely successful, and these include metering under energy management, sustainable buildings, potable water intensity, municipal solid waste, sustainable acquisition, electronics stewardship, and electronics recycling. We continue to see reduced rates of air travel and commuting; however, these are increasing. It is expected that these areas will remain at lowered rates due to remote and telework agreements, continued collaboration via virtual meeting platforms, and enforcement of travel guidelines.

The Laboratory continues to work on creative solutions to overcome challenges. This coming year we will focus on maintaining established progress, building upon the relationship with NYPA, making the most of opportunities that arise, and concentrating on making improvements where we are not on track towards meeting requirements. Activities include but are not limited to increasing bio-fuel usage, planning a Net Zero building, replacing a centrifugal chiller with a low global warming potential (GWP) chiller, ensuring power management on new computers, leasing electric vehicles when they are made available, generating ideas for reduction of single-use laboratory plastics, and expanding our current programs addressing workforce and community investments.

BNL's Environmental Management System (EMS) uses the Laboratory's requirements management process to direct sustainability requirements to the appropriate organizational managers for implementation. The EMS includes this SSP and its objectives, but also uses a business planning process as a way to establish additional sustainability objectives where appropriate elsewhere in the Laboratory. The EMS relies on the Laboratory's contractor assurance process to provide oversight over implementation and the business planning process as a mechanism for reporting on performance to senior Laboratory management and the DOE. The process also provides a mechanism for senior management to provide feedback back to the EMS for future improvements.

The Lab's strategy for mission readiness will provide a revitalized physical plant to improve scientific productivity, promote the attraction and retention of the scientific workforce, including the significant BNL user population, and assure the safe, reliable functioning of BNL's major scientific facilities. The resulting strategy consists of five major elements:

1. Focus limited DOE investment in critical core buildings and infrastructure to enable the scientific agenda. As part of the Core Facility Revitalization (CFR) Science Laboratories Infrastructure (SLI) line-item project the newest data center was completed. While power utilization effectiveness (PUE) is reduced, submetering is being added to ensure targets are achieved.
2. Make research safe and cost effective by downsizing the campus and demolishing old buildings. This is evidenced by BNL's consolidation planning and right-sizing of its campus footprint.
3. Ensure scientific reliability through targeted investments in buildings and utility infrastructure. The Critical Utility Rehabilitation Project (CURP) commenced in FY21 and the project has achieved Critical Decision (CD) 2/3 and is in construction and on schedule. Funding has been allocated for replacement of several central chilled water facility chillers with chillers that meet the Federal Energy Management Program efficiency requirements.
4. Support the growing population of scientific users through an innovative concept called "Discovery Park." Construction is nearly complete on the Science and User Support Center (SUSC), and this will allow for the demolition of inefficient facilities across the campus.
5. Ensure renewed critical infrastructure and buildings are resilient against severe climate and weather. Climate resiliency is being factored into all projects.

Sustainability remains an important focus for BNL. BSA and BHSO work collaboratively on these efforts. We continue with our quarterly meetings to ensure that we are on track to meet the goals as well as to discuss challenges in meeting these goals. This is a marathon, not a sprint and requires a strong team effort to ensure that we continue to press forward in doing our part to protect the environment. We are on a very good path.

A copy of the Executive Summary Table is provided below, highlighting plans for anticipated performance towards DOE targets as a guide.

DOE Goal	Current Performance Status	Planned Actions & Contributions	Overall Risk of Non-Attainment
Energy Management			
Reduce energy intensity (Btu per gross square foot) in goal-subject buildings by 50% by the end of FY 2030.	Limited progress due to aging district steam.	Where funding is allocated, implement ECMs to reduce energy intensity in goal-subject buildings.	High
Achieve a net-zero emissions building portfolio by 2045 through building electrification and other efforts.	No progress to date. Seeking solutions to Scope 1 emissions, and a path to 100% Carbon Free Electricity (CFE) to eliminate Scope 2 emissions.	Investigate electrification of Steam Boiler 1A to reduce heating emissions in a 100% CFE scenario.	High
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	Compliant.	Continue compliance cycle, improve steam metering to increase evaluation accuracy.	Low
Meter individual buildings for electricity, natural gas, steam, and water to adhere to Federal metering guidance.	In progress.	Continue to expand steam metering infrastructure until complete, then begin water metering.	High
Water Management			
Reduce potable water use intensity (Gal per gross square foot).	FY24 water use intensity was 80.54 G/GSF vs. FY07 benchmark of 101.16 G/GSF.	Over the next decade, potable water use will increase significantly due to increased heat reject for High Emission Mission Specific Facilities.	High
Reduce non-potable freshwater consumption (Gal) for industrial, landscaping, and agricultural.	BNL Water Management Plan does not allow for irrigation outside of establishment period for native species.	No changes.	Low
Waste Management			
Reduce non-hazardous solid waste sent to treatment and disposal facilities.	BNL's overall recycling rate for FY24 is 84%. The overall landfill diversion rate (recycling + waste-to-energy) is 94%.	As described in the acquisition section, BNL will pilot recycling options for nitrile gloves and laboratory plastics with a company that has developed a direct closed-loop program for	Low

DOE Goal	Current Performance Status	Planned Actions & Contributions	Overall Risk of Non-Attainment
	Only 6% (100 tons) of BNL's nonhazardous waste was sent to a landfill.	these waste streams.	
Reduce construction and demolition (C&D) materials and debris sent to treatment and disposal facilities.	A total of 190 tons of concrete and asphalt from building demolition were collected for crushing and reuse and 60 tons of metal collected for recycling out of a total of 992 tons of landfilled C&D waste. The resulting recycling rate is 18%.	There will be numerous buildings demolished during FY25. Communication regarding recycling improvements will be communicated and encouraged directly to the project managers for these projects.	Low
Fleet Management			
Reduce petroleum consumption.		Provide ChargePoint station access to guests and employees. BNL installed 14 Level 2 Charging stations on-site to support the increase in government EV fleet bringing the total to 18 Level 2 charging stations and 5 Level 1 stations. Funding has been provided to install more charging stations in FY25.	Low
Increase alternative fuel consumption.		Flex Fuel vehicles will only be assigned E-85.	Medium
Acquire alternative fuel and electric vehicles (EVs).		A total of 23 EVs ordered and received 14 EVs for FY24. BNL will continue to receive more EVs as they become available through the General Services Administration (GSA).	High
Clean & Renewable Energy			
Achieve 100 percent carbon pollution-free electricity on a net annual	Study complete. Unfunded, high risk non-attainment.	Given current load growth projections, BNL currently has no viable path to 100% CFE. The	High

DOE Goal	Current Performance Status	Planned Actions & Contributions	Overall Risk of Non-Attainment
basis by 2030, including 50 percent 24/7 carbon pollution-free electricity.		site has performed feasibility studies for wind and solar. An aggressive FY24 solar feasibility study resulted in achieving only 7.2% of the annual electric consumption forecasted for 2030 at an unfunded cost of \$81M. The Lab would also have to invest \$12-14M/yr in environmental attribute certificate (EAC) procurements beginning in FY30. While there are plans to revisit wind and execute a new feasibility study in FY25, achieving these goals are further exacerbated due to the sheer amount of additional electrical energy that will be consumed by the new EIC.	
Increase consumption of clean and renewable non-electric thermal energy.	No performance regarding non-electric thermal energy to date.	No planned activities.	High
Sustainable Buildings			
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	The BNL SUSC currently under construction is scheduled for substantial completion by January 2025.	The EIC Project is in progress at BNL. The facility will require approximately 12 new support facilities, all of which are planned to be compliant with the Guiding Principles for Sustainable Buildings. Conventional facility design is in the preliminary stage. The project design is not baselined.	Low
Acquisition & Procurement			
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all sustainability clauses are included as appropriate.	Sustainable clauses are included in contract terms and conditions. The SFTool Product Database had been made available to staff for help in	BNL will apply for the Green Buy Award. BNL will evaluate labware made of bio-based plastics or recycled plastics. Several scientists are	Low

DOE Goal	Current Performance Status	Planned Actions & Contributions	Overall Risk of Non-Attainment
	identifying sustainable products. BNL received its eighth Green Buy Gold award for 12 priority products in 8 categories. BNL also received its fourth Green Buy Superior Award recognizing BNL for receiving eight Green Buy Gold awards.	currently testing these items in their labs. BNL is asking machine shop staff to evaluate a bio-based product replacement for polytetrafluoroethylene (PTFE) Mold Release Spray. Building 703 West Lab upgrade will incorporate Environmentally Preferable Purchasing (EPP) materials.	
Efficiency & Conservation Measure Investments			
Implement life-cycle cost effective efficiency and conservation measures with appropriated funds and/or performance contracts.	Site continues to install occupancy-controlled thermostats. Site continues to operate site-chilled water storage tank to reduce emissions Site Demand response activated multiple times in FY24 to conserve energy. Steam trap surveys were executed for four facilities in FY24. In FY24, Chiller #8 was overhauled, greatly improving chiller efficiency. There are no active performance contracts.	Site heating retro-commissioning is planned for all heating controls in FY25. Site cooling retro-commissioning is planned for all cooling controls in FY25. Site will complete steam trap repairs from FY24 surveys and execute steam trap surveys in seven more facilities. Site plans to overhaul four chillers in FY25 to improve central cooling efficiencies. Site plans to install all cooling tower retrofit kits purchased in FY24 to improve cooling efficiencies across the site. UESCs are being evaluated.	Medium
Electronic Stewardship			
Electronics stewardship from acquisition, operations, to end of life.	BNL received an EPEAT Award from the Green Electronics Council for its purchases of	BNL will continue to provide the highest rated EPEAT products to BNL staff for purchase via an on-line service portal.	Low

DOE Goal	Current Performance Status	Planned Actions & Contributions	Overall Risk of Non-Attainment
	environmentally sustainable electronics.	BNL will apply for the EPEAT Award.	
Increase energy and water efficiency in high-performance computing and data centers.	Data center is currently meeting Platinum requirements.	Sustain Platinum performance.	Low
Adaptation & Resilience			
Implement climate adaptation and resilience measures.	Progress was made on all Resilience Solution projects being tracked in FY24 and BNL's Office of Emergency Management (OEM) continued to integrate climate resilience into its day-to-day risk management processes. Details are provided in the narrative section.	Continue making progress on executing the resilience solutions being tracked in the Dashboard module and evaluate if there are other projects that can be implemented to improve resiliency against identified climate change hazards.	Low
Multiple Categories			
Reduce Scope 1 & 2 greenhouse gas emissions.	BNL's current projections dramatically increase Scope 2 emissions through 2030 and beyond if not offset by the progress in the grid becoming cleaner. BNL continues to make repairs to Steam distribution system to increase condensate returns thereby reducing Scope 1 emissions.	Studies to electrify steam are in planning via the most recent AFFECT Grant Application.	High
Reduce Scope 3 greenhouse gas emissions.	With increasing numbers of employees returning to on-site work, increased travel, and increased use of rental vehicles during travel, along with the need to operate sPHENIX in purge mode during the FY24 Relativistic Heavy Ion Collider (RHIC) run, Scope 3 greenhouse emissions	Reintroduction of ridesharing to staff through message on BNL intranet, updates to the ridesharing page, and efforts to coordinate rides for those in need. Continue to engage with NY State, the Metropolitan Transportation Authority (MTA), Long Island Railroad	Medium

DOE Goal	Current Performance Status	Planned Actions & Contributions	Overall Risk of Non-Attainment
	increased in FY24 compared to FY23.	(LIRR), and Suffolk County/Town of Brookhaven officials regarding plans for the relocation of the Yaphank rail station closer to BNL.	

II. Performance Review and Plan Narrative

Energy Management

This category focuses on efforts to reduce energy intensity, non-fleet fuel use, and increase electrified buildings. This category also discusses site metering and benchmarking efforts, building a Net-Zero Energy Building portfolio and conducting energy evaluations, and implementing an energy management system.

Current Performance

High-Energy Mission-Specific Facilities (HEMSF)

HEMSF have a significant impact on sustainability metrics.

Collider-Accelerator Department (C-AD)

In past decades, the schedule for C-AD has been focused on running more powerful equipment during the winter months and shoulder seasons, when power is less expensive, local congestion is lower, and Scope 2 electric emissions are lower due to regional loads being able to be maintained without the use of peaking power plants. In FY23 and F24, there was a shift to summer operations to accommodate completing as much of the Relativistic Heavy Ion Collider (RHIC) mission as possible before transition to the EIC. The shift has increased site-wide power costs by increasing the unforced capacity (UCAP) of BNL from approximately 35 to 57 MW; UCAP is similar to a ratchet peak demand charge in other electric markets. The shift also resulted in higher Scope 2 emissions intensity, as the demand peaks occur during summer months when the carbon intensity of the grid is higher due to the requirement of the grid to run its high emission peaking plants to ensure grid stability. In FY25, the RHIC run will follow a schedule similar to the previous two years. Fortunately, this schedule is temporary and when the new EIC is commissioned, run times will go back to shoulder season and winter months.

All HEMSFs

With many areas dependent on district steam for heating, it is a challenge to de-carbonize the site. The result is that sustainability metrics, particularly those related to site emissions, are negatively impacted by HEMSf.

Initiatives, Projects, and Actions to Improve Efficiency

Critical Utilities Rehabilitation Project (CURP)

The site is currently undergoing a CURP. This initiative is addressing some of the largest steam distribution system leaks. The goal of the several projects in CURP is to increase the amount of hot condensate returning to Central Steam Facility (CSF) from the site, thus reducing the amount of fuel required to create steam. Currently, condensate returns in peak winter months hover around 60%, meaning the distribution network is 37% inefficient with regards to recovering heat from the site back to the plant.

Demand Response

The site had the successful implementation of a demand response protocol in FY23 that was expanded in FY24. The protocol for demand response was set up in the Automated Logic Controls (ALC) Energy Management Controls System (EMCS) and is written to shed electric load in three tiers. All three tiers progressively increase the cooling setpoint in site-wide office areas by an additional 1° F site-wide, with the click of a button. Each protocol is activated when any of three benchmark conditions is exceeded: site chilled water loads increase above a benchmark capacity, outdoor air temperature rise above a specific value, or when Day Ahead Market (DAM) electricity costs exceed a certain value. The program has proven the successful load shedding of up to 3 MW site-wide.

Thermal Energy Storage

The Central Chilled Water Facility (CCWF) is equipped with a 3.2-million gallon thermal energy chilled water storage tank. The capacity of the tank allows the site to shed a maximum of two chillers for as many as eight hours at any given moment. Since December of 2022, the site has been tracking energy costs on the DAM and using the tank to shed chillers during the daily energy cost peaks. The storage tank is then recharged at night when energy costs decrease. During FY24, \$1.32M in energy costs were avoided using the storage tank, and a significant load is able to be shed during the peak summer periods.

Enhanced Controls Projects

In FY24, BNL continued to phase out and upgrade the original Barber-Coleman control systems from the late 20th century. These control systems in most cases were operating without feedback to properly control the spaces resulting in increased duty cycle of equipment and wasted energy. The controls team completed the design and upgrade of the Heating, Ventilation, and Air Conditioning (HVAC) controls in Building 729, integrating them into the campus-wide ALC system. In addition, the ALC system was expanded into Building 1004b, and the EIC design now includes ALC controls to better integrate C-AD into the campus-wide network of building automation.

The BNL Controls Team began piloting occupancy-controlled thermostats for Variable Air Volume (VAV) systems in FY23. The successful pilot resulted in the broader implementation of occupancy-controlled thermostats to more accurate control setpoints and schedules in hybrid and regular workspaces. In FY24, occupancy-controlled thermostats were added to Buildings 488, 1005s, 703, and 030.

In FY24, the site was less successful implementing the retro-commissioning program for the site's ALC system, compared to FY23. However, repairs from FY23 continued to allow systems to operate efficiently. The efficient operations of building-specific cooling equipment resulted in a drop in chilled water flow at peak load conditions, from 16,000 gpm to below 15,000 gpm in FY23, an over 6% improvement in peak site performance that continued in FY24. Shoulder season performance was even better with shoulder season chilled water flow to the site dropping from an average condition of 8,000 gpm in FY22 to an average condition of 7,000 gpm in FY23, with levels reaching similar results in FY24; the continuation of a roughly 12% efficiency improvement.

The site shifted resources to continue to add to the success of the retro-commissioning program by retro-commissioning the heating equipment controlled by ALC in advance of the FY25 heating season and committing to a full retro-commissioning of ALC controlled cooling equipment in FY25.

The fault detection and diagnostic (FDD) system continues to be rolled out in facilities controlled by the ALC EMCS. The FDD algorithms are used to detect HVAC system inefficiencies before they become large issues, improving operational efficiency of building HVAC equipment throughout BNL with plans to be expanded. When issues are detected, they are logged in reports which get sent out to the Facility Project Managers, the Production Division, and BNL’s Controls Service Contractor for corrective action. The system is comparable to retro-commissioning but uses advance algorithms as a means of identifying root-cause issues. In FY24, the FDD system was expanded to include Building 490, Building 488, and Building 515 NET Wing. In addition to expanding the system, the new Air Conditioning (AC) shop leads were trained on using the FDD system to identify root cause issues and to advance preventative predictive maintenance activities on-site.

Net Zero Emission Buildings (NZE)

There are currently no Net Zero Emission Buildings at BNL.

Current Projections Given Available Funding for NZEB

The current projection for net-zero emissions is that BNL will not achieve the net-zero goal, as shown in the following chart.

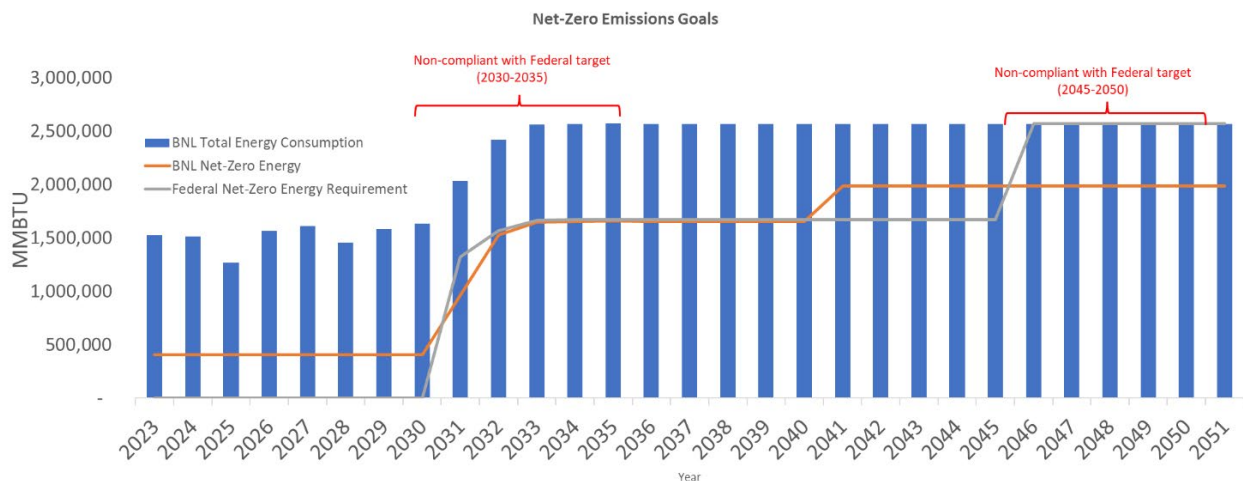


Figure 1: Net-Zero Emission Goals

The largest barrier to net-zero is the site’s dependence on the CSF for heating. This facility utilizes fossil fuel boilers to produce high pressure steam to satisfy most campus heating, hot water, humidification, and process heating loads. Steam is distributed through a distribution network that is decades beyond the expected life. As the system deteriorates further, site maintenance staff are unable to maintain the leaks as most of the leak maintenance repairs have been classified as Davis Bacon-covered work. The emissions of this plant, the deteriorating distribution system, and the availability of insufficient construction funding to make repairs are the largest of many barriers to achieving net-zero emissions on-site.

Electrification Retrofit Projects

There are currently no electrification projects planned until FY30. There are currently no electrification retrofit projects planned that involve converting building systems that directly use fossil fuels to systems that use electricity.

Deep Energy Retrofits

There are currently no Deep Energy Retrofit projects planned from now until FY30.

Plans and Projected Performance

High-Energy Mission-Specific Facilities (HEMSF)

One highlight will be the EIC, with all new buildings being designed to be all-electric, with much of the internal heating being carried by waste heat of process loads. The HEMSF will increase the site's electric load by roughly 60 MW. As the New York grid transitions to carbon-pollution free electricity (CFE), this load will become the Lab's first net-zero HEMSF.

On the current path, the costs tied to the increase in electricity consumption will be significant, higher costs required to meet programmatic needs will likely impede the ability for other areas of the Lab to decarbonize. Furthermore, because the demand for electric energy will be so high, BNL cannot achieve 100% CFE without leaning on the local electric grid to first decarbonize. New York State is not currently on track to meet the Climate Leadership Community Protection Act's (CLCPA) goal of a 70% CFE grid by 2030, or 100% CFE grid by 2035. Moreover, qualifying renewable energy certificates (RECs) and environmental attribute certificates (EACs) that include all of the federally defined prerequisites to qualify as CFE do not yet exist; this is discussed more broadly in a later section of the SSP. As a result, HEMSF will have a negative impact on Scope 2 emissions through to 2030 100% CFE date.

Initiatives, Projects, and Actions to Improve Efficiency

To improve efficiency to achieve goals such as a 50% reduction in site Energy Utilization Index (EUI), significant investment in existing infrastructure must be made either through grant funding, Utility Energy Service Contracts (UESCs), and SLI projects. The current programs are very effective but will not go far enough to making these goals achievable.

Currently there are no UESCs or other initiatives, projects, and actions in the works to make such goals possible.

Net Zero Emission Buildings

Table 1: Planned Net-Zero Emission Buildings

Anticipated Building Name or Descriptor	Estimated Building Gross Square Footage	Actual/Anticipated Construction Completion Year
1001A PS	11,194	2028
1003A PS	11,194	2028

APPENDIX D: SITE SUSTAINABILITY PLAN

1004G Cooling/Kicker	4,080	2028
1005T PS	16,527	2028
1006G PS	5,979	2028
1007A PS	11,194	2028
1009A PS	24,184	2028
1010C RF PA	54,961	2029
1010D DI Pumphouse	8.262	2029
1010E Cryo	5,979	2028
1011A PS	11,194	2028
1012C Kicker PS	5,915	2028
1012E 400 MeV Linac	3,682	2028

Water Management

This category focuses on initiatives to reduce potable and non-potable water consumption, comply with stormwater management requirements, and improve water efficiency. In addition, the category summarizes any obstacles related to the implementation of conservation strategies or the collection of water consumption data.

Current Performance

Alternative Water

Currently, no plans exist to add alternative water uses to the site. BNL projects to continue to capture stormwater in recharge basins and continue to be a net recharger of the local aquifer. The site water balance, which accounts for all pumped water (aquifer discharge) and outfall water flows (aquifer recharge), is shown in the following figure.

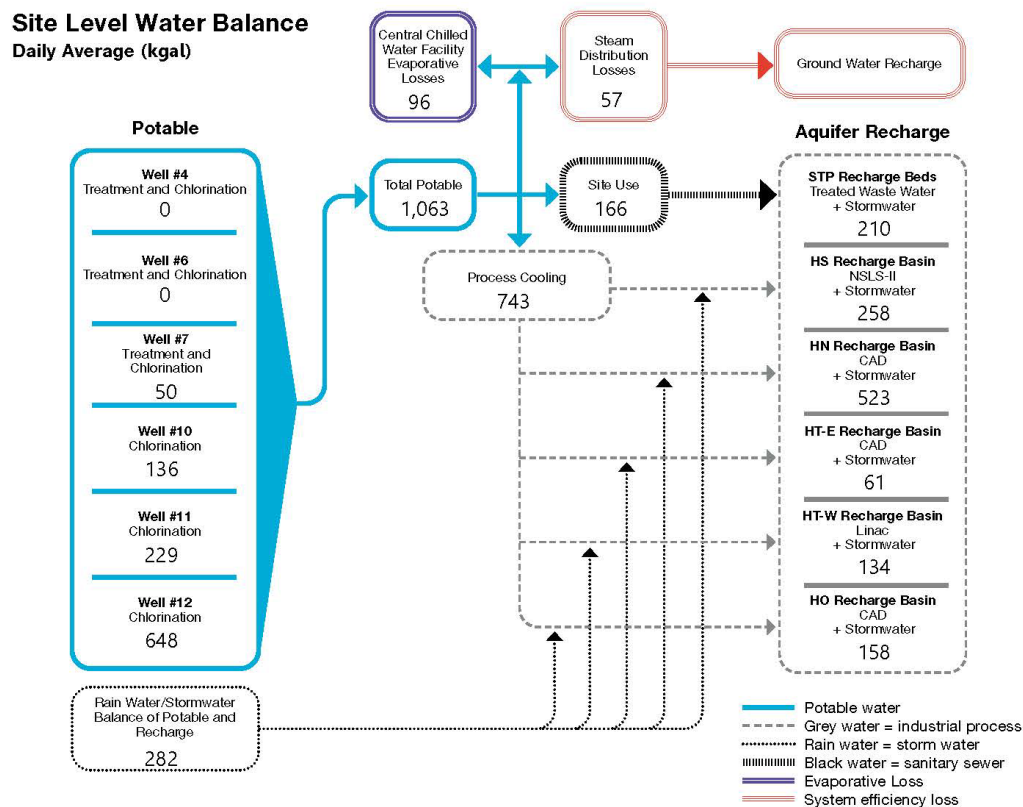


Figure 2: BNL Site Level Water Balance

Evaluations and Best Management Practices

As its own water utility, BNL's potable water cost is much lower than the local utilities' cost. The variable cost of water production is currently about \$3.79 per thousand gallons. Site water usage has improved continuously since the 1999 and 2007 benchmark years. The following table shows the facility usage data since the benchmark years.

Table 2: Annual Change Gal/GSF Water Use (FY99-FY23)

FY	kGal	GSF	G/GSF
FY99	931,452	4,363,224	213.48
FY00	732,408	4,281,455	171.07
FY01	710,583	4,286,993	165.75
FY02	698,340	4,241,450	164.65
FY03	666,916	4,191,562	159.11
FY04	530,414	4,148,593	127.85
FY05	542,568	4,128,355	131.42
FY06	493,641	4,105,635	120.23
FY07	412,935	4,081,900	101.16
FY08	427,400	4,237,100	100.87
FY09	504,500	4,252,200	118.64
FY10	505,075	4,203,457	120.16
FY11	520,308	4,249,150	122.45
FY12	418,153	4,586,455	91.17
FY13	419,372	4,906,797	85.47
FY14	433,718	4,865,753	89.14
FY15	416,904	4,843,649	86.07
FY16	417,364	4,854,679	85.97
FY17	406,876	4,905,386	82.94
FY18	393,096	4,845,380	81.13
FY19	368,520	4,815,914	76.52
FY20	389,437	4,812,662	80.92
FY21	304,042	4,807,484	63.24
FY22	368,800	4,805,758	76.74
FY23	346,402	4,790,451	72.31
FY24	387,868	4,815,914	80.54

In FY24, BNL updated its Water Management Plan and completed a thorough internal site water assessment spanning from October 2023 to March 2024. The purpose of the Water Management Plan is to provide information about current water uses, chart a course for water efficiency improvements, conservation activities, and water-reduction goals using industry best management practices (BMP) and those identified by the Federal Energy Management Program (FEMP). This site water assessment served to reaffirm the efficacy of existing best practice policies while also shedding light on areas for possible improvements.

Some highlights of the assessment include BNL's stormwater and wastewater management processes to recharge the subterranean aquifer allowing BNL to be a net recharger to the aquifer, a policy promoting native plant species and prohibiting irrigation, cooling tower management practices optimizing cycles of concentration, and the communication protocols allowing for the quick identification and repair of leaks.

Several opportunities for improvement identified in the assessment include high make-up water rates at the Lab's CSF caused by a deteriorating steam distribution infrastructure beyond its useful life, single pass cooling towers still in use, and a lack of building level metering infrastructure that would allow for a more detailed study of individual building water use.

The current status of these opportunities for improvement and some other BMPs identified in the Water Management Plan are summarized below:

BMP #1 – Water Management Planning

As mentioned above, BNL completed a comprehensive evaluation to understand the site's current water use and costs. This part of the evaluation included the collection of utility data and conducting facility surveys to gather critical information on water uses. This information was compiled into a "water balance," which is a comparison of the water consumption of major end-uses to the total water supply. The water balance provided important information on major water uses that helped target efficiency opportunities and provided insight on potential system losses.

BMP #3 – Distribution System Audits, Leak Detection, and Repair

BNL invested approximately \$100,000 in metering infrastructure for potable water and condensate/steam systems in FY24.

BMP #4 – Water Efficient Landscaping

BNL's policy is to use only native species as part of its landscaping. The use of native species provides the site with water efficient landscaping that can survive in the local climate with no permanent irrigation necessary beyond a plant's establishment period.

BMP # 5 – Water-Efficient Irrigation

BNL's policy is to have no permanent irrigation systems on-site.

BMP #8 – Boiler/Steam Systems

BNL has a district steam system and CSF. Certain losses are unavoidable (e.g., humidification). The network of steam and condensate distribution piping in many areas is in excess of 60 years old, with an expected life of only 25 years according to industry experts. As a result, the network of steam distribution and condensate return is riddled with leaks. BNL is constantly working to identify leaks, and where funding allows, replace entire sections of piping to address these areas of both water and energy inefficiency. Major new buildings have either been Leadership in Energy & Environmental Design (LEED) Certified or are built as per the Guiding Principles "Silver" certified and have included water conserving fixtures. It should be noted that only about 10% of BNL's water use is for human consumption and sanitation.

In FY23, a CURP was funded to invest in major infrastructure repairs of the distribution system. In FY24 designs were completed with construction between MH-1 and MH-6 (10" steam, 4" condensate) beginning in late FY24 and continuing into FY25.

Table 3: Steam and Condensate Infrastructure Requiring Replacement

Description	Piping Size
Partial line West of MH-55 from B488	2" C
Partial line South of MH-10 to MH-22	4" C
Entire line between MH-35 to B830	2" C
Entire line between MH-52 and MH-23/MH-23A	4" C
Entire line between MH-36 and B832	1-½" C
Entire line between MH-33 and MH-34	4" C
Entire line between B498 and B479	3" C
Future Leak to be Identified by BNL's E&U Dept.	4"
Replace steam and condensate pipe between MH17 and B801	3"
Replace steam and condensate piping between MH-1 and MH-6	10" steam, 4" condensate

BNL will continue to actively work to identify opportunities for improvement of this distribution network.

BMP #9 – Single-pass Cooling Equipment

BNL's policy is to not allow single pass cooling equipment in any construction or renovation projects. The vast majority of single pass cooling equipment have been decommissioned and replaced with air-cooled equipment or evaporative cooling equipment.

BNL has identified several single pass cooling systems that could be retrofitted during the site water assessment performed in FY24. The single pass cooling systems exist as follows:

Table 4: Single Pass Cooling Systems

Location	Application
Bldg. 463	Biology -80C Freezers
Bldg. 515	CRAC units
Bldg. 902 West	Magnet Div. specialized power supplies
Bldg. 911/912	H10 house cooling system
Bldg. 911	Multi pole system
Bldg. 911	Power room pumps for Westinghouse
Bldg. 911/951	Fast Pulse Quad
Bldg. 912	Room 1-18 CES (800 sq. ft.)
Bldg. 930	Tenth station LINAC
Bldg. 930/946	Beam Stop cooling station

The following retrofit options will be further studied and applied as applicable and as funding allows to help maintain water efficiency across facilities:

- To maximize water savings, eliminate single pass cooling by modifying equipment to operate on a closed loop that recirculates water, a minimum of five cycles of concentration, instead of discharging it to the Sewage Treatment Plant (STP).
- If modification of equipment to a closed-loop system is not feasible, add an automatic control to shut off the entire system during unoccupied night or weekend hours. This option will be considered only when shutdown has no adverse impact on indoor air quality.

BMP #10 – Cooling Tower Management

BNL has invested in multiple cooling tower rehabilitation projects which focus about replacing fill, and hot deck metering orifices, as well as making other ancillary repairs in order to bring older towers back to good working standards. Towers involved in rehabilitation projects include the CCWF south towers, satellite chilled water facility cooling Towers, Tower 901A, Tower 902W, Tower 928, Tower 930, and Berkner Hall's cooling tower. Note that cooling towers are named for the buildings they serve.

Plans and Projected Performance

BNL's water conservation program has achieved dramatic reductions in water use since the mid-1990's. The Lab will continue to evaluate water conservation measures and, as funding allows, address the priority opportunities for improvement identified in the March 2024 Site Water Assessment including:

- Steam Distribution Leak Repairs;
- Retrofitting Single Pass Cooling; and
- Advanced Metering.

It should be noted that over the next decade, potable water use will increase significantly due to increased heat reject for HEMSFs (i.e., EIC). This will significantly increase the risk of non-attainment for this goal.

Fleet Management

This category focuses on the site's approach and vision for addressing transitioning to one hundred percent acquisition of light duty vehicles to Zero Energy Vehicles by 2027, fleet optimization, and strategies used to reduce petroleum use and increase alternative fuel use.

Current Performance

In accordance with Executive Order (EO) 14057, 14 more Level 2 charging stations were installed in FY24 with plans to install more stations in FY25. One of the Level 2 stations is Americans with Disabilities Act (ADA) accessible. Charging station membership increased from 76 users to 120 since September 2023. The additional participation in personal Electric Vehicles (EVs) and government EVs, demonstrated a decrease of on-site greenhouse gas emissions from ~30,000 kg to ~80,000 kg. In FY24, the government fleet had a 4,842 kg greenhouse gas emission savings which saved 800 gallons of gas.

BNL uses ChargePoint for our EV charging program. ChargePoint provides BNL the servicing of the stations and BNL manages the user's account and pricing to create a seamless experience. BNL uses the connection code feature and various pricing policies to ensure proper pricing for government fleet and personal vehicles while managing who has access to the stations. Campus installation sites will be based on the electrical grid, infrastructure, and EV distribution.

BNL received 13 zero emission vehicles (ZEVs) in FY24 out of the 21 ordered. BNL will continue to monitor the specific vehicles which have the capability to be replaced with full electric models to meet the EO requirements.

The BNL Fleet Supervisor received the Secretary of Energy Achievement Award in collaboration with other DOE Labs for our strategy in meeting the EO 14057 by ordering ZEVs.

BNL is continuing to use Geotab Global Positioning System (GPS) units in every government vehicle to facilitate meeting sustainability requirements. The GPS units measure usage, driving behavior, and idling times. Geotab also offers an analysis of what vehicles in the fleet can be converted to electric vehicles. This data can be used to assist in making the best selection for each vehicle based on its driving history. Other initiatives that BNL implemented to increase sustainability are spot checks, on-site car washing, and preventative maintenance compliance. During the spot checks performed at BNL, the government vehicles are checked to ensure there is no idling while unoccupied, as well as to look for tire wear, damage, WEX card, and accident report storage.

Plans and Projected Performance

Due to the General Services Administration (GSA) converting over to a new system (GSAFleet.gov), BNL has observed a delay in the replacement ordering and the projection of next year's replacements. BNL will continue to order any ZEVs that meet mission requirements. DOE requires each new acquisition to be ZEV only and justifications will be required for any non-ZEV acquisition. Options will be limited in FY25 due to supply chain issues and availability. The Fleet Supervisor will continue to work with GSA and DOE on recommendations for ZEV replacement options each year.

BNL's on-site shuttle service will continue business with an online reservation system for Long Island Railroad (LIRR) transfers to decrease unnecessary trips to the train station. In FY24, we increased the transportation of passengers by approximately 2,000 employees for each on-site shuttling and the train reservations. The Fleet Supervisor continued to utilize the route system during the FY24 summer season to decrease duplicate requests and in addition added one more shuttle van to increase efficiency. This strategy enables the transport of more people at designated times while reducing the number of trips and gas emissions in comparison to previous years. With attendance increasing each year and the opening of the new building, the SUSC, BNL was approved by DOE for an increase in fleet to lease an accessible ADA 32 passenger bus. BNL will order the bus when GSA's vehicle ordering is open for requests in FY25. The bus will help transport larger groups of people on-site and to the train, reducing the number of trips.

Fleet Management Program Subsection

BNL's Fleet Supervisor reports directly to the DOE Consolidated Service Center (CSC) Fleet Manager, Tom Back, for fleet maintenance, utilization, procurement, and mission support needs. EO 14057 requires BNL's fleet acquisitions to be 100% ZEV by 2035. The goal is to acquire a ZEV, when available, in the same class as the previous vehicle being replaced.

BNL currently has nine Plugin Hybrid Electric vehicles, two Hybrid vehicles, and twenty-one Electric vehicles. The Fleet Supervisor will continue to consider which vehicles are capable of transitioning to ZEV to meet the current EO requirements in FY25 when ordering vehicles.

The BNL Fleet Supervisor created in-person training for Electric Vehicles. The training covers everything from proper safety procedures to operations of an electric vehicle. This will be in addition to the virtual training for all government vehicle drivers. The Fleet Supervisor has been collaborating with other Labs to learn their best practices in ZEV training and lessons learned for BNL's future acquisitions.

The Vehicle Allocation Methodology (VAM) survey is now being performed at a local level by the SC-CSC Fleet Manager to right size fleet. It will no longer be performed by an outside contractor. BNL will continue to identify drivers' needs and right-size fleet to increase usage and performance.

BNL currently has five Level 1 charging stations and eighteen Level 2 charging stations. More charging stations are planned to be installed in FY25. BNL is promoting more personal electric vehicle purchases by offering on-site employees the opportunity to charge their personal electric vehicles while at work at minimal cost. Currently, there are 120 on-site employees registered for this personal vehicle incentive and utilization is expected to grow. A challenge in supporting the EV program is the capability of the electrical grid supporting station installations in locations they are most needed. Supply chain issues are also of concern to attain future EV acquisitions.

BNL is continuing to use a new Fleet Management System, Fleetio. The past system was not curated for fleet management, which had presented several obstacles in reporting. This system integrates with the Geotab GPS system in addition to other fuel systems. The Fleetio reports are assisting with Federal Automotive Statistical Tool (FAST) reporting needs, including maintenance, accident, and fuel costs. Additionally, the Fleetio reports are fully customizable to adapt to BNL's needs. Fleetio can create sustainability goals from data collected by the system.

Clean & Renewable Energy

This category focuses on-site efforts towards utilizing renewable and clean energy resources.

Current Performance

The site currently has more than 50% of its clean power procurements from CFE sources. However, the power is not bundled with its associated EACs, and the purchase of the EACs are unavailable to BNL in the current market. Even if the EACs were available, the hydro procurement is from sources built before October of 2021, therefore only 7.5% of this power would be allowed to count towards the FY30 CFE goal, given the current language surrounding the goal. Because the EACs are not available BNL purchases renewable energy certificates amounting to 7.5% of its total energy consumption annually. Again, by the letter of the law, even these RECs would not count toward the FY30 goal because they are not purchased within the New York State balancing authority. BNL does not currently have access to RECs for CFE in New York State for projects commissioned after October 2021, because there aren't any in existence.

BNL is actively exploring options to increase its use of CFE through grid purchases and energy attribute acquisitions. However, challenges have emerged, particularly the fact that within the balancing authority of New York there does not currently exist an offering to purchase RECs or power available at the scale required from projects that began service on or after October 21, 2021. As a result, it is not possible to meet these specific requirements. Significant changes within the site's local balancing authority will be necessary for BNL to comply with its ambitious sustainability goals.

Furthermore, funding for the future CFE from offshore wind energy is being supplemented by the New York State Energy Research and Development Authority (NYSERDA). In exchange for supplemental funding, NYSERDA retains exclusive rights to the EACs generated by these projects; as such all power will be de-bundled from the environmental attribute. Moreover, the EACs are planned to be marketed as "Tier 1 RECs." In FY24, NYSERDA announced the sale of Tier 1 RECs at a cost of \$25.07 per REC; currently, only legacy hydroelectric power is included in the Tier 1 REC offering. In 2030, legacy hydroelectric procurement may count for not more than 7.5% of the CFE requirement. All electricity procured by BNL is de-bundled from the EAC. Therefore, by FY30, 100% of electrons flowing to the site must have an additional EAC purchased to count the power as CFE. The only reprieve to this requirement will be new on-site CFE generation.

Regarding on-site generation, a recent solar feasibility study identified BNL's capacity to host 30.35 MW DC (24.7 MW AC) of solar arrays, which may generate approximately 40,000 MWh annually at an estimated installation cost of \$81 million. If fully operational by FY30, this output would cover 7.6% of the forecasted 523,500 MWh demand.

Future projects may also include a revitalization of the LISF, a 32 MW solar facility on-site. However, any revitalization would occur after the FY30 goal, as the land lease agreement does not expire until 2031, so it currently cannot be counted towards the FY30 goal. Even if BNL retained the EACs from this field, the construction ended in FY11 and therefore would not qualify according to federal law.

In an optimistic scenario, BNL could meet its FY30 goal by doing the following:

- \$81 million investment (in FY24 dollars) in on-site solar, which would allow 7.6% of the total goal to be met through on-site production.
- The remaining CFE would be covered by EAC purchases. If available, BNL would need to procure 482,943 Tier 1 RECs from NYSEDA at a cost of \$25.07 per EAC, totaling approximately \$12.1 million.
- As the EIC transitions to full operation, and assuming no additional load growth, 548,500 EACs would be required annually, with a recurring cost of \$13.75 million in perpetuity.

BNL will measure and track its CFE consumption by installing utility grade meters on the load side of all new solar arrays. The EACs will be tracked via spreadsheet to account for all remaining electrical energy consumed.

Table 5: Projected CFE With Current Funding

Metric		FY24	FY25	FY26	FY27	FY28	FY29	FY30
1	Total annual CFE (a+b+c+d)	23,310	22,374	17,822	19,704	21,992	28,344	523,500
<i>a</i>	<i>Grid-supplied CFE¹</i>	0	0	0	0	0	0	0
<i>b</i>	<i>On-site CFE</i>	510	557	557	557	557	557	40,557 ³
<i>c</i>	<i>Purchased CFE</i>	0	0	0	0	0	0	443,681 ²
<i>d</i>	<i>Legacy CFE from EPA Act 7.5% cap</i>	21,800	21,817	17,265	19,147	21,435	27,787	39,262 ²
2	Total annual electricity usage	291,040	290,900	230,200	255,300	285,800	370,500	523,500

¹New York State goal is to have 70% CFE grid by 2030, recent reporting indicates state is behind on goal. Grid power will be de-bundled with New York State Energy Research Authority owning the EACs from all new CFE projects (mainly offshore wind).

²Requires procurement of Tier 1 RECs from NYSEDA.

³Requires \$81M in investment in all sites identified by solar feasibility study.

Plans and Projected Performance

Given current load growth projections, BNL currently has no viable path to 100% CFE. The site has performed feasibility studies for wind and solar. A decade's old wind feasibility study ascertained that wind was not feasible due to Federal Aviation Administration (FAA) regulations restricting turbine height in areas where sufficient wind flux may be available to generate power. Since changes in technology have greatly advanced since the study, BNL plans to revisit wind and execute a new feasibility study in FY25. An aggressive solar feasibility study identified all BNL open spaces and parking lots capable of hosting solar arrays will total 24.7 MW of nameplate capacity and 40,000 MWh of output energy capacity, representing 7.2% of the annual electric consumption forecasted for 2030. Meeting this 7.2% requires \$81M in unfunded investment. BNL cannot meet this goal with all viable areas being covered with solar panels. Achieving the goals are further exacerbated due to the sheer amount of additional electrical energy that will be consumed by the new EIC, the high cost of integrating decentralized solar on-site, and the current state of unavailable new CFE projects.

Table 6: Predicted Scenario with Funding

On-site CFE system type (solar, wind, etc.)	Nameplate Capacity (MW)	Funding source(s) (appropriations, performance contract, AFFECT, etc.)	Estimated Year of Completion
Solar	30.35 MW DC (24.7 MW AC)	Not Funded	2030

Acquisition & Procurement

This category focuses on all relevant sustainable acquisition clauses, recent sustainable purchases.

Current Performance

BNL includes all sustainable acquisition requirements from DOE's Priority Products List and the Federal Acquisition Regulation into all contract terms and conditions. BNL provides training on these requirements to procurement staff.

BNL was recognized for its performance in sustainable purchasing by the receipt of its eighth Green Buy Gold award for 12 priority products in 8 categories. BNL also received its fourth Green Buy Superior Award recognizing BNL for receiving eight Green Buy Gold awards. BNL also received the 2024 EPEAT Award for electronics purchases, given by the Green Electronics Council. BNL won the 2023 Green Space Bronze award, the first in the DOE complex to win both GreenBuy and Greenspace simultaneously.



Figure 3: BNL GreenBuy Awards

Plans and Projected Performance

The following activities are planned for FY25:

- BNL will apply for the Green Buy Award based on 2024 purchases.
- Pilot plastic labware made of bio-based plastics with interested scientists in order to evaluate the products.
- Hold a webinar with a vendor who specializes in closed-loop laboratory supplies providing bioplastics and labware made from recycled plastic as well as a path for recycling and reuse.
- A vendor fair for similar sustainable laboratory plastics is planned for the 2025 BNL Earth Day Celebration.
- Machine shop staff are being asked to evaluate a bio-based product replacement for polytetrafluoroethylene (PTFE) Mold Release Spray.
- The Building 703 West laboratory upgrades will include sustainable design choices in furniture and flooring.

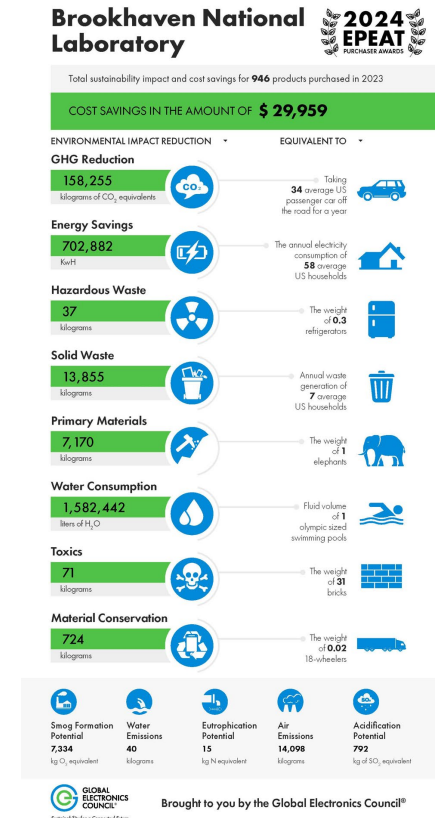


Figure 4: BNL EPEAT Award Summary

The inclusion of the SFTool product search feature for use by staff will make identification of conforming items easier, but issues will remain regarding our ability to get performance information back out of the system.

Investments: Improvement Measures, Workforce, & Community

This category focuses on efforts to implement identified Efficiency & Conservation Measures (ECMs) through appropriations, performance contracts, or other funding mechanisms. Additionally, this category discusses investment efforts to enhance workforce capabilities and support environmental and energy justice efforts in the site's community.

Current Performance

Improvement Measures

There are currently no active UESCs that would support investment in implementing energy conservation measures.

In FY23, the site identified a critical low-cost/no-cost energy efficiency measure implemented to reduce emissions and energy costs. This measure was to monitor pricing and carbon intensity of the electric grid and shed load via the CCWF's 3.2M gallon chilled water storage tank. In FY24 the site continued this practice, shifting load daily and saving the site \$1.32M in power costs.

The site has also continued to implement demand response, a three-tiered load shedding program, managed by the ALC EMCS. The utilization of load shedding takes place during heat waves to alleviate load in the CCWF, and during emission intensive grid operations to reduce emissions and cost. In FY24, the site was able to shed 3MW of load during such intervals reducing operating costs by approximately \$18k.

Workforce and Community

BNL is committed to increasing environmental justice efforts and creating avenues for participation for disadvantaged and marginalized communities in environmental decision making. Brookhaven uses community involvement, science education, and workforce development programming to address Justice 40 Initiatives. To facilitate stakeholder input, Stakeholder Relations Office (SRO), in coordination with the Environmental Protection Division (EPD), participates in or conducts on- and off-site meetings through its Speaker's Bureau. Stakeholder Relations 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 Lab also opens its doors to the public for free every year through its Explore Brookhaven open house program. The program is a unique opportunity for the public to come meet scientists, participate in hands-on science activities, visit world-class research facilities, enjoy science shows and more. In 2024 the open house program welcomed over 5,200 people to the Lab.

In 2024 the Lab continued the Science in the Community initiative to bring its programs into the field and make them more accessible, especially to disadvantaged communities. For example, the Lab's partnership with the Jones Beach Energy and Nature Center is free and features hands-on activities for students. The Lab offers programming on Earth Day and features a special emphasis on the importance of renewable energy, climate solutions, and preserving the environment. The Lab added to its renewable energy community programming by developing an interactive, miniature model renewable energy home featuring a wind turbine, solar panels, wood-burning stove and geothermal system. The various

interactive features are children-friendly and encourage hands-on learning, while highlighting the importance of renewable energy use. The model home is portable and has been used in Science in the Community programs as well as by the Office of Educational Programs (OEP).

Brookhaven Lab also has a robust workforce development program which includes many programs specifically designed to give opportunities to students from traditionally underrepresented and underserved communities. These programs include the following: Science, Technology, Engineering and Math (STEM)-Prep Summer Institute, Alliances for Graduate Education, and the Professoriate Predominantly Undergraduate Institutions (AGEP-PUI), Community College Internship (CCI), Student Partnership for Advanced Research and Knowledge (SPARK), Day in the Life of a River, and even a Science at Home program with activities and lessons that students and their parents can do almost anywhere.

Plans and Projected Performance

Improvement Measures

Utility Energy Service Contracts (UESCs)

There are currently no plans to pursue UESCs to support investment in implementing energy conservation measures.

Grants and Studies

In FY24, BNL and FEMP had a kick-off meeting for the Assisting Federal Facilities with Energy Conservation Technologies (AFFECT) award to study heat recovery on campus. The study is anticipated to focus on adding heat recovery to the new EIC, and other areas of campus. Pending the phase of the EIC design process when funding is made available, the focus of heat recovery may shift from the EIC to other loads including the data center.

In the early weeks of FY25, the DOE notified BNL that it had received another AFFECT grant to study decarbonizing the site's CSF. BNL is particularly interested in studying the CSF because the findings will help direct the site's path toward net-zero goals. These findings will provide valuable insights as the site incorporates net-zero strategies into its Utility Master Plan.

Central Steam Distribution

The central steam distribution network is undergoing substantial repairs targeting the aging distribution network and plant, all of which are contributing to resiliency, energy efficiency, cost savings and Scope 1 emissions reductions.

BNL's efforts to execute site-wide steam traps surveys, repairs, and replacements have many benefits to the site. Most importantly, properly functioning steam traps contribute to energy efficiency because steam traps remove condensate from the steam system without letting steam escape. A properly maintained steam trap system reduces the amount of fuel needed for heating, thus lowering emissions and helping to meet environmental regulations and sustainability goals. A properly maintained steam trap also enhances efficiency by removing condensate minimizing the risk of water hammer, which can be dangerous for personnel and equipment. Also, steam leaks are reduced, decreasing the risk of burns and other heat-related injuries.

In FY24, steam trap surveys took place in four buildings: 490, 464, 515, and 535. The findings indicate poor building performance relating to steam distribution, impacting heating loads and condensate returns to the plant. The procurement of replacement traps is complete, with project execution expected in FY25. The risk of this measure not being attained is high due to high utilization of steam ship personnel absent of these repairs.

In FY25, the site will continue to execute steam trap surveys with surveys in Buildings 400, 463, 488, 703, 725, 902, and 912.

In FY24, the CURP project began work rebuilding manhole one and replacing distribution piping at the CSF north export and main condensate return pipe. Construction has also begun in areas of significant condensate losses and will continue in FY25. Key projects are identified in the following table:

Table 7: Critical Distribution Repairs

Description	Piping Size	Trench Feet
Partial line West of MH-55 from B488	2"	100'
Partial line South of MH-10 to MH-22	4"	250'
Entire line between MH-35 to B830	2"	270'
Entire line between MH-52 and MH-23/MH-23A	4"	500'
Entire line between MH-36 and B832	1-½ "	420'
Entire line between MH-33 and MH-34	4"	300'
Entire line between B498 and B479	3"	140'
Entire line between MH-17 and B801	3"	130'

The FY24 efforts on the CURP demonstrate a proactive approach to addressing the resiliency and efficiency of the steam distribution infrastructure associated with the CSF. By targeting areas with significant condensate losses, this project aims to reduce both water and energy waste by improving condensate return, which minimizes the need for makeup water and reduces the energy required to reheat this water into steam.

Each segment of piping scheduled for replacement, as shown in Table 7, reflects a clear prioritization of sections with significant inefficiencies, based on size and length. Addressing these segments—from smaller sections like the 130' line between MH-17 and B801 to the 500' line between MH-52 and MH-23/MH-23A—should notably decrease condensate losses across the system.

Critical distribution repairs such as these will not only improve overall efficiency but will also support long-term sustainability goals by lowering the carbon footprint associated with heating and water treatment at BNL. The reductions in makeup water and softener use, along with the decreased reliance on fossil fuels, directly align with BNL's goals of carbon-free and net-zero operations. These upgrades will likely have a significant cumulative impact on operational efficiency and environmental footprint.

In addition to the steam distribution repair work, in FY25, the site is undergoing an aggressive retro-commissioning on all heating system controls under the management of the EMCS. For each building operation of the following points will be verified: fresh air damper controls, critical sensors, preheat valves, reheat valves, variable air volume boxes, hand heat exchanger valves and control points. Where

minor control-related repairs and calibrations are feasible, the contractor will make the necessary corrections.

Retro-commissioning has many benefits. The primary benefit is energy efficiency because over time heating systems may drift from optimal settings resulting in inefficiencies. The process ensures heating controls are calibrated and properly actuating thereby optimizing energy consumption. Occupants also serve to benefit from enhanced comfort as properly functioning controls allow setpoints to be maintained at optimal levels. Finally, by optimizing the efficiency of the sites heating systems, retro-commissioning may reduce the carbon footprint of heating, aligning with sustainability goals by using less energy and reducing Scope 1 emissions.

Site Cooling

In FY24, the site began undertaking an aggressive effort to improve cooling efficiencies by executing critical rehabilitations and heat rejection at building and central cooling systems throughout site.

First, the site invested in overhauling Chiller 8 in the CCWF. This overhaul included a major bearing replacement and resulted in an improved refrigerant approach internal to the chiller, greatly improving the chiller's thermal efficiency. In FY25 this work will continue with the overhauls of Chillers 5 and 6 in the CCWF. The site has also executed a contract to overhaul both chillers in the satellite chilled water facility.

In the area of heat rejection, the site has begun investing in cooling tower infrastructure. Most cooling towers have a service life of 10-15, many of the towers on-site have a life expectancy on the lower end due to high operating hours year over year, and operating conditions inherent to the site. The project began by identifying seven buildings with cooling towers operating beyond their usable life. In FY24 the procurement of parts for the execution of rehabilitations were complete for the following towers:

Table 8: Cooling Towers in Queue for Rebuild

Tower Name	Building Name	Cooling Capacity (Nominal Tonnage)	Circulation rate (GPM)
B488 Cooling Tower	Berkner Hall	275	826
B555 Tower 1	Satellite Chilled Water Facility (SCFW)	400	2,000
B555 Tower 2	Satellite Chilled Water Facility (SCFW)	400	2,000
B600 Couth Cell #5	Central Chilled Water Facility (CCWF)	1700	3,610
B600 Couth Cell #6	Central Chilled Water Facility (CCWF)	1700	3,610
B600 Couth Cell #7	Central Chilled Water Facility (CCWF)	1700	3,610
B600 Couth Cell #8	Central Chilled Water Facility (CCWF)	1700	3,610
B600 Couth Cell #9	Central Chilled Water Facility (CCWF)	1700	3,610
Tower 901A	Van de Greff	320	960
Tower 902W	Magnet Division	1,250	1,500

Tower 928 (RFMG)	Siemens Magnet Power Supply	3,200	4,800
Tower 930 (LINAC)	200 MEV LINAC	2,500	3,000

In FY25, the site is working towards completing a task order agreement contract with the intent of completing the rehabilitations of the above lists of cooling towers and cooling tower cells. The essential maintenance services will have many positive impacts including extended service life of critical infrastructure, energy efficiency improvements by as much as 15%, operation cost and maintenance savings, and enhanced system resiliency and reliability.

In FY25, the site will also continue with its third year of cooling controls retro-commissioning. The cooling controls retro-commissioning focuses on ensuring controls are optimized and properly working to maintain the most efficient cooling. During retro-commissioning, the following are checked: economizer controls, cooling coil valve controls, and dehumidification controls. Properly functioning economizers allow the system to increase outside air during intervals when outside air may be used to meet cooling needs, in place of running compressors and cooling mechanically. Properly functioning cooling coil controls prevent over cooling or uncontrolled cooling in service areas. Finally, dehumidification controls ensure conditions are proper so that process loads can run efficiently.

Workforce and Community

To improve education outreach to staff whose expertise is less aligned with climate literacy our goal is to build a climate campaign to raise climate literacy and awareness of the current state of climate science. The goal will be reached via the following action items:

- Capitalize on Earth Day 2025 activities to educate staff on the impact climate change may have on the planet and the many small ways we can mitigate the impacts of climate change.
- Utilize existing campus communications and newsletters to raise climate literacy and awareness.
- Feature articles about the Lab's climate research into aerosols and clouds and their impact on climate.
- Organize opportunities to showcase the Lab's mobile Center for Multiscale Applied Sensing which focuses on collecting data in urban and coastal locations and renewable energy locations.
- Highlight the Lab's participation in the Climate Resilience and Adaptation Initiative (Climate READi) and its work with the Climate Lighthouse project, led by City College of New York City, in which BNL partners to help residents better cope with extreme heat. The focus will be on using climate data to improve NYC residents' resilience and to build actionable knowledge among the public.

An environmental justice website is being developed to highlight the Lab's outreach in local communities, with federally identified tribal communities, as well as other disadvantaged communities.

BNL also plans to continue building upon its already successful community outreach initiatives including those listed under current performance.

Fugitives & Refrigerants

This category focuses on efforts to reduce GHG from fugitive emissions or refrigerants.

Current Performance

A variety of activities and operations at BNL use greenhouse gases (GHGs) for different purposes. The largest user of GHGs at BNL is the Tandem Van de Graaff Facility. The two Tandem accelerator vessels with a combined storage volume of 16,050 ft³ are filled with an insulating gas mixture consisting of 46%v SF₆, 44%v N₂, 6%v CO₂, and 4%v O₂. Annually, there are some emissions of SF₆ and CO₂ due to insulating gas leaks and the transfer of insulating gases during periodic maintenance of the Tandem accelerators.

The table below provides a summary of the sources of BNL fugitive GHG emissions in FY24.

Table 9: Fugitive Greenhouse Gas (GHG) Emissions

Source	Activity	Gas	GHG Emissions (MtCO ₂ e)
Tandem Van de Graff	Insulating gas leaks	SF ₆	2,068.38
	Accelerator gas transfers	SF ₆	40.33
		CO ₂	0.00
STAR Experiment	Detector gas purging	CH ₄	0.09
		CO ₂	0.07
		HFC-134a	922.43
		SF ₆	359.9
sPHENIX Experiment	Detector gas purging	CF ₄	26970.55
Fleet Vehicle Repair	Fleet Motor Vehicle A/C Leaks	HFC-134a	10.89
		HFO1245yf	0.00
Refrigeration/AC Equipment	Gas Leaks	R-410A	0.00
LEReC Accelerator DC Gun	SF ₆ service cart compressor leak	SF ₆	0.00
Current Landfill	Methane generation	CH ₄	26.42
Wastewater Treatment Plant	Effluent discharges	N ₂ O	0.75

The majority of fugitive GHG emissions were from detector purging of carrier gases during the Solenoidal Tracker at RHIC (STAR) experiment and the sPHENIX experimental runs. As in the past, to reduce carrier gas emissions of hydrofluorocarbon (HFC)-134a during the operational interval from April 6 to September 30 when the gas flow rates were highest, the STAR experimental time of flight (TOF) detector system was operated in recirculation mode wherein 86.5 percent of carrier gases were continuously recirculated. Had the TOF been operating in purge mode during this period where all system gases would have been continuously purged to the atmosphere, HFC-134a emissions would have been 301.1 pounds higher (i.e., 195.35 MtCO₂e).

Although it was designed to recirculate 95 percent of the 60%v argon and 40%v carbon tetrafluoride (CF₄) gas mixture used in the sPHENIX time projection chamber (TPC) detector subsystem, detector gas contamination problems encountered during the TPC commissioning phase in FY23 forced sPHENIX staff to alter gas flow rates and continuously purge gas during the entire experimental run. Staff expected to be able to run in recirculation mode for the FY24 experimental run, however, in FY24 staff were having operational difficulties with the detector. Given that the detector is one of the critical detectors for the physics program, staff needed to prioritize stable conditions during experimental runs and the highest priority went to working on the detector during shutdown periods with operating gas.

Comfort cooling and process refrigeration equipment also utilize GHGs. To ensure that comfort cooling and process refrigeration equipment are operating efficiently prior to the start of the cooling season, preventative maintenance inspections of all refrigeration equipment and air conditioning appliances with refrigerant charges of 50 or more pounds are performed. To document preventative maintenance inspections of refrigeration and air conditioning equipment and repairs to address refrigerant leaks or operational deficiencies, the F&O Center Preventative Maintenance (PM) group utilizes the Refrigerant Compliance Manager software.

As the Modernization Project Office (MPO) implements facility improvements and equipment replacements, applicable guidelines and regulations are adhered to, including those pertaining to the HFC phase down and refrigerants with lower GWPs.

During January 2024, BNL's Clean Air Act Subject Matter Expert (SME) met with HVAC staff during a plan of the day meeting to reeducate them on the importance of properly documenting repairs to leaking refrigeration and air conditioning equipment on the Refrigerant Usage Forms in conformance with F&O's Refrigerant Management Plan.

Plans and Projected Performance

In September 2024, F&O had Sphera staff, the developer of Refrigerant Compliance Manager software, provide HVAC staff training on recent updates to federal regulatory requirements covering the handling, service, and repair of refrigeration and air conditioning equipment that utilize class I and class II ozone depleting refrigerants and high global warming potential Environmental Protection Agency (EPA) Significant New Alternative Policy (SNAP) program approved HFCs.

Replacement of HFCs include A2L and A3 refrigerants. These refrigerants have lower GWPs but have higher flammability than HFCs being phased out. In September 2024, Refrigeration Service Engineers Society (RSES) provided BNL personnel (including HVAC staff, emergency services, operation support and planning division, and environmental protection division staff) training on A2L and A3 refrigerants. Due to the higher flammability of the A2L and A3 refrigerants, special considerations, training, and operational improvements must be implemented for the safe handling and proper storage of the refrigerants.

During FY24, EPD Environmental Compliance Group staff continued to follow EPA's draft rulemaking that appeared in the Federal Register pertaining to draft regulations requiring facilities to conduct leak detection, equipment repair, and material reclamation on air conditioning, refrigeration, and fire suppression equipment containing HFCs. The EPA finalized the rule on October 11, 2024. As such, EPD will work with F&O to incorporate the revisions into its Refrigerant Management Plan and to help HVAC staff to understand the revisions during FY25.

Adaptation & Resilience

This category focuses on-site efforts to increase site adaptation and resilience to address the impacts of climate change. Resilience is the ability to adapt to changing conditions and withstand or recover from disruption. Adaptation refers to actions taken to reduce risks from changed climate conditions (e.g., even current conditions) and to prepare for impacts from additional changes expected in the future. Resilience and adaptation efforts help sites manage risks to DOE assets, infrastructure, operations, and personnel.

Current Performance

BNL has experienced extreme weather events over the years and, as a result, has prepared and executed a procedure titled, “Storm Preparation.” This procedure provides guidance on the actions required by the F&O Directorate prior to, during, and after a large storm. The last section of the procedure, Post Storm Event – Recovery, includes responsibility of the General Supervisors and Facility Project Managers to:

- Survey site to determine damage and operational problems;
- Establish a written list of required actions and submit to Facility Complex Manager;
- Contact F&O responsible management for reporting requirements and determinations;
- Contact/callout supervisory and craft personnel to report to site and begin essential repairs; and
- Return facilities to normal operation, where possible.

The table below summarizes the high priority rank resilience solutions whose implementation status is currently being tracked within the DOE Sustainability Dashboard. These projects were all determined to be feasible, and funding mechanisms were available for implementation.

Table 10: Brookhaven National Laboratory Resilience Portfolio Summary Table

Solution	Priority Rank (High, Medium, Low)	Timing	Funding Mechanism	Implementation Status
Critical Response Facilities – Emergency Power	High	Planned start in FY23	Overhead	Identified
Replacement of Chillers at the Central Chilled Water Plant	High	Planned start in FY23 (Design)	Direct - SLI	Funded
New 13.8kV feeder	High	Planned start in FY23 (Design)	Direct - SLI	Funded
Additional Utility Metering	High	Ongoing Program	Overhead (M&R)	Planned
Wildfire Management Program	High	Ongoing Program	Overhead (M&R, IGPP)	Planned
Water System Connection	High	Planned start in FY24	Direct - SLI	Funded

Five of the projects were successfully implemented in FY23 and continued in FY24. The Water System Connection project was added in FY24 and will continue in FY25. Below is a summary of each project, current status, anticipated effectiveness, and cost information.

Critical Response Facilities – Emergency Power

Summary of Project – In FY23, a team evaluated the existing emergency generators or feasibility of installing temporary or permanent generators at Critical Response Facilities at BNL. This evaluation resulted in some proposed projects being submitted through BNL’s Project, Planning, Programming and Budgeting Process (3PBP) for funding consideration by the Lab’s Policy Council. At the end of FY23, the final Consolidated Unfunded Requirements List (CURL) was approved and included the installation of an emergency generator at the Lab’s main gate security station (Building 680) in FY24, which will add resiliency to an important facility in the event of a loss of power to ensure security and allow for proper site response.

Current Status – Construction for the Building 680 emergency generator and transfer switch started in September 2024 and will be completed during the first quarter of FY25.

Anticipated Effectiveness – In the long run the continued evaluation and installation of emergency power will add resiliency to facilities in the event of a loss of power to allow proper site response and continued mission critical operations.

Cost – Will depend on 3PBP approved projects. \$480K in FY24 for the installation of Building 680 emergency generator.

Replacement of Chillers at the Central Chilled Water Plant

Summary of Project – Most mission critical facilities use central chilled water as the source for comfort cooling and to support the growing demand of process loads and enable periodic maintenance and resiliency, added back-up chiller capacity was identified as a priority. This project was awarded in FY23 under the CURP and includes the replacement of two aged chillers.

Current Status – The design is complete, and the two new chillers are scheduled to arrive mid-winter 2025.

Anticipated Effectiveness – Considering that the Lab’s existing chillers are beyond their useful life, replacement is an effective solution that will reduce the likelihood of failure potentially impacting site operations, especially when running chillers extensively during heat waves resulting from climate change.

Cost – Total project cost is estimated at \$8.1M.

Installation of New 13.8kV Feeder

Summary of Project – This project was also awarded in FY23 under the CURP and will provide a new 15 kV feeder, consisting of two (2) sets of paralleled cable, from Substation 603 (B603) to the CCWF (B600).

Current Status – The design has been completed and concrete duct bank has been installed in FY24. Currently waiting on the delivery of the cable and the associated switchgear that will be installed in FY25.

Anticipated Effectiveness – Completion of this project will add redundancy and resiliency at the CCWF and the National Synchrotron Light Source II (NSLS-II), one of the newest, most advanced synchrotron facilities in the world.

Cost – Total project cost is estimated at \$11.6M.

Additional Utility Metering

Summary of Project – This project includes the design and installation of additional metering on the electric, chilled water, potable water, and steam system at BNL.

Current Status – In FY24 the site began revamping of its condensate/steam metering plan. During the fiscal year, metering was purchased for the following facilities: B452, B463, B490, B535, B555, B510, B725, B734, and B832.

In addition, a calibration of all site-level chilled water meters occurred in the spring of FY24. Although site chilled water is 100% metered the calibration identified six meters that require replacement. The replacement meters were purchased and are pending installation.

Anticipated Effectiveness – The installation of additional meters allows for more effective management of key utilities and will add redundancy and resiliency to the overall BNL utility distribution system.

Cost – Approximately \$100K was spent in FY24 purchasing and installing new and maintaining existing meters at BNL.

Wildfire Management Program

Summary of Project – This project includes continued fuels management and prescribed fire management to support site ecology, land preservation, and reduce risks to sitewide critical assets.

Current Status – Fire management activities continued in FY24. In collaboration with the Central Pine Barrens Commission and the New York State Department of Environmental Conservation (NYSDEC), a landscape level prescribed burn plan that includes 530 acres of the Lab site was finalized. Using CURL funds, 23 acres in the northern portion of the Lab were mechanically treated to reduce hazards. A single prescribed fire was initiated but was quickly halted when test fire indicated that fire behavior would not meet prescriptions.

Anticipated Effectiveness – This program is continuously developing and if fully implemented, could ensure a high level of ecosystem resilience and protection of critical assets.

Cost – Cost for mechanical treatments is approximately \$100K/year. Cost for staff and equipment to implement prescribed fires is shared between BNL, NYSDEC, and Central Pine Barrens Commission.

Water System Connection

Summary of Project – Install emergency water system connection to the local utility provider.

Anticipated Effectiveness – This project will add redundancy and resiliency to the entire BNL potable water system if an emergency arises.

Current Status – Service line from Suffolk County Water Authority has been installed on-site and currently capped near the new SUSC. Design for cross-connection building and hookup to BNL supply currently under review. Anticipate construction in FY25.

Cost – Total cost is anticipated to be approximately \$1.2M.

In FY24, BNL’s Office of Emergency Management (OEM) continued to integrate climate resilience into its day-to-day risk management processes. Some examples include:

- OEM monitors the National Weather Service (NWS) and National Hurricane Center for all severe weather activities that have the potential to impact the BNL site. OEM provides BNL leadership with timely weather-related data updates used to evaluate the Lab’s posture to remain open or to close the BNL site.
- OEM analyzes the potential for the Peconic River to flood using the Federal Emergency Management Agency (FEMA) National Flood Hazard Layer, a geospatial database that contains current effective flood hazard data. Both the 100- and 500-year analyses are included in the Site Emergency Plan and the recently updated 2023 All Hazards Survey.
- OEM included Continuity of Operations planning as part of integrating climate resilience per the DOE 150.1B, Continuity of Operations Order.
- OEM maintains the Threat and Hazard Identification and Risk Assessment (THIRA), which takes climate change and severe weather into account. This document is reviewed annually and updated as needed. It also maintains and updates the All-Hazards Survey annually, which addresses the potential for severe weather and weather-related hazards on-site.

Resilience Research

BNL continues to advance climate resiliency through its research and partnerships. For example, in August 2024 the DOE announced \$10 million in funding to support the development of Climate Resilience Centers across the nation. DOE then selected ten university-led research teams to leverage modeling, data and research from the DOE Laboratories to focus on climate prediction of weather hazard risks to better prepare communities. For the New York metropolitan region, the Climate Lighthouse project, led by City College of New York City, will partner with BNL to help residents better cope with extreme heat. The focus will be on using climate data to improve NYC residents’ resilience and to build actionable knowledge among the public.

In addition, BNL co-hosted the Climate READi Northeast Regional Workshop with the Electric Power Research Institute (EPRI) at the end of August 2024. The workshop was the final of four hosted around the country as part of the Climate READi program. The workshop specifically focused on the future of the power system in a world affected by climate change, and planning for impacts of floods and clouds on the power system. BNL’s research in atmospheric and climate science is critical to understanding the climate system and helping utilities in predicting and optimizing restoration after outages from storms.

The programs, processes, research and resilience solutions described above are continuing to support improved resiliency against climate change hazards and will continue to be implemented going forward.

Plans and Projected Performance

The plan for FY25 is to continue making progress on executing the resilience solutions being tracked in the Dashboard module and evaluate if there are other projects that can be implemented to improve resiliency against identified climate change hazards. Available funding to implement additional solutions remains the biggest challenge faced by BNL.

Below is a summary of FY25 plans for the identified resilience solutions:

- Critical Response Facilities (Emergency Power) – Complete the design and installation of the emergency backup generator at the Lab’s main gate security station in FY25 (estimated at \$480K). Also, continue to evaluate other emergency power needs to increase resiliency and prepare necessary Project Data Sheets, which are then included in the CURL for funding consideration by the Lab’s Policy Council.
- Replacement of Chillers at the CCWF – Begin the initiation of construction activities.
- New 13.8kV Feeder – Continue with the construction after the arrival of the long-lead items such as the 15kV cable and switchgear.
- Additional Utility Metering – In FY25 \$75K in funding has been allocated to bolster the site’s metering infrastructure. There is a plan to install the above listed condensate and steam metering infrastructure and tie the data into the site’s EMCS. Additionally, 13 of the new meters are being installed at the cubicle level of substation 631. The cubicle level metering will also be tied into the EMCS system enhancing visibility into distributed electricity usage.
- Fire Management Program – Planning for additional prescribed fires will continue, including thinning/mechanical treatments with approved FY25 CURL funds (\$100K).
- Water System Connection – This project is included in the CURP that was awarded in FY23. This project will install emergency water system connection to the local utility provider and will add redundancy and resiliency to the entire BNL potable water system if an emergency arises. The final design is in progress and a Utility Procurement Plan needs to be developed to purchase the water.

BNL’s resilience planning and projected performance will continue to be conducted as part of the established SSP development, evaluation, execution, and reporting process. It is during this process that any new guidance or information received, funding, available technologies, or new climate policies will be reviewed and assessed for future planning.

Appendix A: List of Acronyms & Abbreviations

3PBP	Project, Planning, Programming and Budgeting Process
AC	Air Conditioning
ADA	Americans with Disabilities Act
AFFECT	Assisting Federal Facilities with Energy Conservation Technologies
AFV	Alternative Fuel Vehicles
AGEP-PUI	Alliances for Graduate Education and the Professoriate Predominantly Undergraduate Institutions
AGS	Alternating Gradient Synchrotron
ALC	Automated Logic Controls
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ATF	Accelerator Test Facility
BAS	Building Automation System
BC	Barbara Coleman Controls
BHSO	Brookhaven Site Office
BLCC	Building Life-Cycle Cost
BNL	Brookhaven National Laboratory
BMP	Best Management Practice
BORE	Beneficial Occupancy Readiness Evaluation
BSA	Brookhaven Science Associates
Btu	British thermal unit
C&D	Construction & Demolition
C-AD	Collider-Accelerator Department
CAFE	Corporate Average Fuel Economy
CCNY	City College of New York
CCWF	Central Chilled Water Facility
CD	Critical Decision
CEM	Certified Energy Manager
CERG	Continuity of Emergency Response Group
CERN	European Organization for Nuclear Research
CFE	Carbon-Pollution Free Electricity
CFE	Carbon-Pollution Free Energy
CFL	Computers for Learning
CFM	Certified Facility Manager
CFN	Center for Functional Nanomaterials
CFR	Code of Federal Regulations
CFR	Core Facility Revitalization
CHP	Combined Heat and Power
CCI	Community College Internship
CLCPA	Climate Leadership and Community Protection Act
CMS	Chemical Management System
COOP	Continuity of Operations Plan
CSF	Central Steam Facility
CSI	Computational Science Initiative

APPENDIX D: SITE SUSTAINABILITY PLAN

CURL	Consolidated Unfunded Requirements List
CURP	Critical Utility Rehabilitation Project
DAM	Day Ahead Market
DBT	Design Based Threat
DCOI	Data Center Optimization Initiative
DOAS	Dedicated Outdoor Air System
DOE	Department of Energy
EAC	Environmental Attribute Certificate
EBNN	Environment, Biology, Nuclear Science, and Nonproliferation
ECM	Efficiency & Conservation Measures
EIC	Electron-ion collider
EHSS	Office of Environment, Health, Safety & Security
EISA	Energy Independence and Security Act
EMCS	Energy Management Control System
EMI SIG	Emergency Management Issues Special Interest Groups
EMS	Environmental Management System
EO	Executive Order
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
EPD	Environmental Protection Division
EPEAT	Electronic Product Environmental Assessment Tool
EPHA	Emergency Preparedness Hazard Assessment
EPP	Environmentally Preferable Purchasing
EPRI	Electric Power Research Institute
ERO	Emergency Response Organization
ESCO	Energy Service Company
ESF	Emergency Support Functions
ESPC	Energy Savings Performance Contract
ESSH	Environmental, Security, Safety & Health
EU	Energy & Utilities
EUI	Energy Utilization Index
EV	electric vehicle
FDD	Fault Diagnostic Detection
F&O	Facilities and Operations
FAA	Federal Aviation Administration
FAST	Federal Automotive Statistical Tool
FCA	Facility Condition Assessment
FCE	Facility Complex Engineer
FCM	Facility Complex Manager
FEMA	Federal Emergency Management Agency
FEMP	Federal Energy Management Program
FIMS	Federal Information Management System
FPDS	Federal Procurement Data System
FY	fiscal year
gal	gallons
GHG	Greenhouse Gas
GOCO	Government-Owned, Contractor-Operated
GP	Guiding Principle

gpf	gallons per flush
GPM	Gallons Per Minute
GPS	Global Positioning System
GSA	U.S. General Services Administration
Gsf	gross square feet
GWP	global warming potential
HASP	Health and Safety Plan
HBCU	Historically Black Colleges and Universities
HEMSF	High-Energy Mission-Specific Facility
HFC	hydrofluorocarbon
HPC	High-Performance Computing
HPSB	High Performance Sustainable Buildings
HQ	Headquarters
HR	Human Resources
HVAC	heating, ventilation, and air-conditioning systems
IESNA	Illuminating Engineering Society of North America
IFM	Integrated Facility Management
IFMA	International Facilities Management Association
IGA	Investment Grade Audit
IGPP	Institutional General Plant Projects
IPLV	Integrated Part-Load Value
ISOMF	Integrated Site Operations and Maintenance Facility
ILA	industrial, landscaping, and agricultural
ISB-I	Interdisciplinary Science Building I
ITD	Information Technology Division
JFK	John F. Kennedy International Airport
kV	kilovolt
kW	kilowatt
kWh/yr	kilowatt hour per year
LBNL	Lawrence Berkley National Laboratory
LCC	Life-Cycle Cost
LDT	light-duty truck
LEED	Leadership in Energy & Environmental Design
LI	Long Island
LINAC	linear accelerator
LIPA	Long Island Power Authority
LIRR	Long Island Railroad
LISF	Long Island Solar Farm
LOB	Laboratory Office Building
M&V	measurement and verification
mmBtu	one million Btu
MPO	Modernization Project Office
MSI	Minority Serving Institution
MSW	Municipal Solid Waste
MTA	Metropolitan Transportation Authority
MtCO ₂ e	metric tons of carbon dioxide equivalent
MW	megawatts
MWh	megawatt hours

APPENDIX D: SITE SUSTAINABILITY PLAN

NEPA	National Environmental Policy Act
NPCC	Northeast Power Coordinating Council, Inc.
NREL	National Renewable Energy Laboratory
NSERC	Northeast Solar Energy Research Center
NSLS-I	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source-II
NWS	National Weather Service
NYC	New York City
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research and Development Authority
NYPA	New York Power Authority
NZEB	<u>Net Zero Emission Buildings</u>
O&M	Operation and Maintenance
ODS	ozone depleting substance
OEM	Office of Emergency Management
OH&P	Overhead and Profit
OMB	Office of Management and Budget
OMC	Occupational Medicine Clinic
ORNL	Oak Ridge National Laboratory
PA	Preliminary Assessment
PAP	Performance Assurance Plan
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances
PFC	perfluorocarbon
PHENIX	Pioneering High Energy Nuclear Interaction Experiment
PHEV	plug-in hybrid electric vehicles
PM	preventative maintenance
PNNL	Pacific Northwest National Laboratory
PPA	Power Purchase Agreement
PPPL	Princeton Plasma Physics Laboratory
PPM	Procurement and Property Management
PRV	pressure relief valve
PSC	Public Service Commission
PTFE	polytetrafluoroethylene
PUE	power utilization effectiveness
PV	photovoltaic
RACF	RHIC ATLAS Computing Facility
RCA	recycled concrete aggregate
RE	Renewable Energy
REC	Renewable Energy Credit
RFP	Request for Proposals
RHIC	Relativistic Heavy Ion Collider
RSES	Refrigeration Service Engineers Society
SC	Office of Science
SCR	Stakeholder and Community Relations
SF ₆	Sulfur Hexafluoride

SLAC	Stanford Linear Accelerator
SLI	Science Laboratories Infrastructure
SLI	Science Line Item
SME	Subject Matter Expert
SNAP	Significant New Alternative Policy
SPARK	Student Partnership for Advanced Research and Knowledge
SPO	Sustainability Performance Office
SSP	Site Sustainability Plan
SSPP	Strategic Sustainability Performance Plan
STAR	Solenoidal Tracker at RHIC
STEM	Science, Technology, Engineering, and Math
STP	Sewage Treatment Plant
SUF	Service Usage Forms
SUSC	Science User Support Center
SUV	Sports Utility Vehicle
SWP	Safe Work Plan
T&D	Transmission & Distribution
TEC	total estimated cost
THIRA	Threat and Hazard Identification and Risk Assessment
TJNAF	Thomas Jefferson National Accelerator Laboratory
TOF	time of flight
TPC	time projection chamber
UESC	Utility Energy Service Contract
USDA	U.S. Department of Agriculture
VAM	Vehicle Allocation Methodology
VARP	Vulnerability Assessment and Resilience Plan
WWII	World War II
WWTP	Wastewater Treatment Plant
YOY	Year-over-year
ZEV	zero emission vehicle

Appendix B: Comprehensive Scorecard



Scope 1 & 2 Greenhouse Gas Emissions

Goal: Reduce direct GHG emissions by 50 percent by FY 2025 relative to FY 2008 baseline.
Interim Target (FY 2024): -46.0%

Baseline: 205,628.2 MtCO₂e

Current Performance: -32.6%
(138,605.9 MtCO₂e)



Scope 3 Greenhouse Gas Emissions

Goal: Reduce indirect GHG emissions by 25 percent by FY 2025 relative to FY 2008 baseline.
Interim Target (FY 2024): -23.0%

Baseline: 19,713.6 MtCO₂e

Current Performance: -37.0%
(12,415.9 MtCO₂e)



Energy Intensity

Goal: Reduce facility energy in goal subject facilities by 30 percent relative to FY 2015 baseline.
Interim Target (FY 2024): -30.0%

Baseline: 242,880.5 Btu/GSF

Current Performance: -7.7%
(224,263.5 Btu/GSF)



Renewable Energy

Goal: Use 30 percent renewable energy as a percentage of overall facility electricity use by FY 2025.
Interim Target (FY 2024): 27.5%

Baseline: 291,655.0 MWh

Current Performance: 7.4%
(21,628.9 MWh)



Potable Water Intensity

Goal: Reduce potable water intensity by 36 percent by FY 2025 relative to FY 2007 baseline.
Interim Target (FY 2024): -31.0%

Baseline: 22.3 gal/GSF

Current Performance: -196.4%
(-21.5 gal/GSF)



Fleet Petroleum

Goal: Reduce fleet petroleum use by 20 percent by FY 2015 and thereafter relative to FY 2005 baseline.
Interim Target (FY 2024): -20.0%

Baseline: 115,684.0 GGEs

Current Performance: -100.0%
(0.0 GGEs)



High Performance Sustainable Buildings

Goal: Ensure 15 percent (18 percent by GSF) of buildings meet the Guiding Principles for sustainable buildings by FY 2025.

Interim Target (FY 2024): 16.8%

Baseline: 40.0 Buildings

Current Performance: 27.5%
(11.0 Buildings)



Fleet Greenhouse Gas Emissions/Mile

Goal: Reduce per-mile greenhouse gas emissions by 30 percent by FY 2025 relative to FY 2014 baseline.

Interim Target (FY 2024): -28.0%

Baseline: 0.0 GHG/Mile

Current Performance: 0.0%
(0.0 GHG/Mile)

Environmental Protection Division

Attention: SER Project Coordinator

Building 860

P.O. Box 5000

Upton, NY 11973-5000

www.bnl.gov