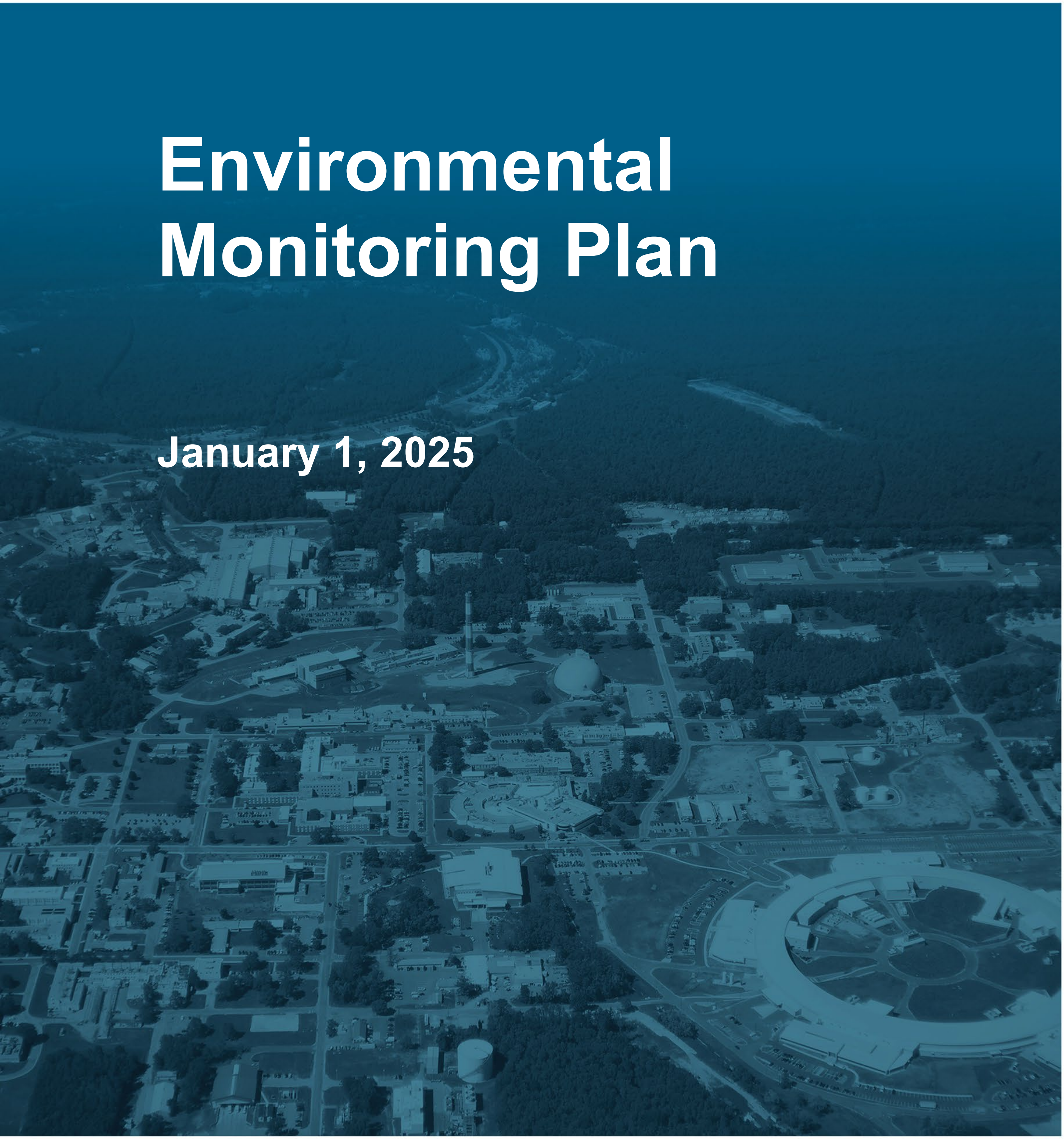
Brookhaven National Laboratory

Environmental Monitoring Plan

January 1, 2025



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

U.S. DEPARTMENT OF ENERGY

EXECUTIVE SUMMARY

Brookhaven National Laboratory (BNL) is a multi-program national laboratory operated by Brookhaven Science Associates, LLC for the U.S. Department of Energy (DOE) and is located on a 5,265-acre site in Suffolk County, Long Island, New York. DOE Order 436.1A (2023), *Departmental Sustainability*, requires DOE sites to maintain an Environmental Management System (EMS). An EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, of site operations. DOE Order 458.1 Admin Chg. 4 (2020), *Radiation Protection of the Public and Environment*, requires DOE sites to maintain surveillance monitoring for determining radiological impacts to the public and environment.

BNL has a comprehensive EMS in place, which meets the requirements of the International Organization for Standardization 14001 Standard. The Laboratory's extensive environmental monitoring program is one component of the EMS, and the BNL Environmental Monitoring Plan (EMP) describes this program in detail. The data derived from systematically monitoring the various environmental media enables the Laboratory to make informed decisions concerning the protection of human health and the environment and to be responsive to stakeholder concerns.

The Laboratory's Environmental Protection Program ensures that operations fully comply with applicable federal, state, and local environmental laws and regulations; executive orders; and DOE policies. The Laboratory monitors radiological and non-radiological aspects of ambient air quality, emissions from point sources, wastewater discharges, surface water quality, groundwater quality, precipitation, soil, flora, and fauna. Sampling is performed under one or more types of environmental monitoring: compliance, restoration, or surveillance monitoring. Compliance monitoring ensures adherence to regulatory and permit limits. Restoration monitoring measures the impact of past operations and assesses the effectiveness of remedial measures. Surveillance monitoring evaluates the impacts, if any, of current or historical operations on the various environmental media.

Air surveillance monitoring at the Laboratory involves the analysis of particulate matter collected on filters, as well as vapor chemically trapped in a collection medium. Monitoring is conducted for various airborne radionuclides (including particulates and tritiated water vapor) at both on- and off-site locations. Continuous radiological monitoring is conducted for operations that have the potential to result in a radiological dose at the closest offsite residence or occupied building in excess of 0.1 millirem per year. For facilities with emissions below that value, periodic confirmatory monitoring is conducted. Specific diffuse or nonpoint sources, arising as a result of environmental restoration activities, are monitored to protect worker and public health. BNL also measures environmental background radiation through a network of on- and off-site thermoluminescent dosimeter (TLD) badges.

Samples of wastewater effluent from Laboratory operations are collected at the point of discharge. Monitoring is conducted in accordance with permit requirements and includes water quality parameters—such as pH, dissolved oxygen, and temperature—as well as radiological, organic, and inorganic parameters.

The Peconic River is sampled at several on-site locations from the point where the Peconic River enters the BNL site to the point where the river leaves the BNL site. The Carmans River, located to the west of the BNL site, is used as a control location to determine background or ambient conditions. Collected samples are analyzed for radiological and non-radiological parameters.

The Laboratory site is included on the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) National Priorities List. The U.S. Environmental Protection Agency

(EPA) and the New York State Department of Environmental Conservation (NYSDEC) have integrated DOE's response obligations into a comprehensive Federal Facilities Agreement. In compliance with this agreement, BNL's comprehensive groundwater protection program evaluates groundwater contamination from historical operations and determines whether measures taken to protect or restore groundwater quality are effective. To comply with NYS operating permits and DOE Orders, groundwater quality is also monitored at research and support facilities where there is a potential for environmental impact to determine whether operational and engineered controls designed to protect groundwater are working effectively.

The Laboratory maintains four operable groundwater production wells to supply potable water. The supply wells and distribution system are monitored for chemical and radiological parameters to ensure that concentrations of regulated contaminants present in the domestic water system are less than the maximum contaminant levels specified by regulation.

Data from the sampling and analysis of vegetation and fauna are used to estimate bioaccumulation and potential dose via the ingestion pathway. Precipitation, soil, and sediment are analyzed for contaminants released to the atmosphere and surface water.

All environmental monitoring data must meet appropriate quality assurance requirements. BNL maintains contracts with five contract analytical laboratories, all of which are certified by New York State for specific parameters and are subject to audits by the New York State Department of Health (NYSDOH), BNL, and/or DOE through their Laboratory Approval Program.

BNL uses the Data Quality Objective (DQO) process developed by EPA to describe the environmental monitoring matrices, sampling methods, locations, frequencies, and measured parameters, as well as the methods and procedures for data collection, analysis, maintenance, reporting, and archiving.

The EMP summarizes the drivers (i.e., compliance, support compliance, surveillance, and restoration), DQOs, potential sources and contaminants, extent and frequency of monitoring, analytical procedures, and quality assurance processes. The plan is reviewed and revised annually to reflect any changes made to the monitoring program from the previous year.

SUMMARY of PROPOSED CHANGES EMP CALENDAR YEAR 2025

Highlights of proposed changes for the calendar year (CY) 2025 monitoring program are described below. Full descriptions of the changes are detailed in each DQO.

AIR EMISSIONS SOURCE (CH. 5):

- **AIR MONITORING AT THE BROOKHAVEN LINAC ISOTOPE PRODUCER**

  The Data Quality Objective was updated to capture two changes that will be made in calendar year (CY) 2025 at the Brookhaven National Laboratory (BNL) Linear Accelerator (LINAC) Isotope Producer (BLIP) facility. An uninterruptible power supply will be placed in service for the continuous emissions monitoring system in CY2025 after being delayed in CY2024. Also, plans are being developed for the installation of a cascading delay tank gaseous emissions mitigation system for the BLIP. This system is intended to mitigate or eliminate the emission of C-11 and O-15 gases from the stack, which is the largest contributor to offsite dose to the maximally exposed off-site individual (MEOSI).

RADIOLOGICAL AIR MONITORING AT THE BNL SITE (CH. 6)

In calendar year (CY) 2024, new active air monitoring instruments in each of the four perimeter air monitoring stations were installed and became operational. Three more monitoring instrument sets are expected to be deployed in CY 2025. No additional changes in radiological air monitoring are expected.

DIRECT RADIATION: THERMOLUMINESCENT DOSIMETERS (CH. 7)

One off-site thermoluminescent dosimeter (TLD) was taken out of service in calendar year (CY) 2024 due to Retirement. One off-site location will be sought in early 2025 to maintain full, 16-sector TLD coverage off site around BNL.

LIQUID EFFLUENTS (CH. 9)

- **SEWAGE TREATMENT PLANT**

  Updated to clarify procedure used to minimize the impact of analytical errors associated with Sewage Treatment Plant State Pollutant Discharge Elimination System (SPDES) permit compliance sampling.

SURFACE WATER (CH.10)

Updated to clarify analysis and frequency of surface water monitoring surveillance sampling conducted at Peconic River outfall HV.

GROUNDWATER MONITORING (CH. 12):

- **OU I SOUTH BOUNDARY (RA V REMOVAL ACTION)**

  The proposed changes for the Operable Unit (OU) I South Boundary (RA V Removal Action)

  Treatment System groundwater monitoring program for CY 2024 are as follows:

- Maintain the VOC post-closure groundwater monitoring program of annual sample collection from post-closure wells: 107-40, 107-41, 115-13, 115-16, and 115-51. Maintain quarterly sampling of Current Landfill sentinel well 098-99.

- Install temporary wells as needed to fill monitoring data gaps and characterize extent of the Sr-90 plume. Install a temporary well to the west of OU I -Sr-90-GP-74 to verify the western extent of this higher concentration plume segment.

- **OPERABLE UNIT (OU) III MIDDLE ROAD PUMP AND TREAT SYSTEM**

  The proposed change to the OU III Middle Road Pump and Treat System groundwater monitoring program for CY 2025 is to remove monitoring well 106-56 from OU III Middle Road monitoring program. This well has not had VOC concentrations above maximum contamination levels (MCL)s in over ten years. Two additional monitoring wells for VOCs were added during 2024, wells 105-80 and 105-81.

- **OU III SOUTH BOUNDARY PUMP AND TREAT SYSTEM**

  The proposed change for the OU III South Boundary Treatment System groundwater monitoring program for calendar year 2025 is to discontinue sampling monitoring wells 114-06, 121-18, 121-21, 122-09, 122-10 and 122-31 from OU III South Boundary monitoring program. These wells have not had VOC concentrations above MCLs in over ten years. Monitoring well 121-57 for VOCs was added during 2024.

- **OU III INDUSTRIAL PARK**

  There are no changes for calendar year 2025 for the Industrial Park In-Well Air Stripping System groundwater monitoring program. Based upon the concentration trends in both the monitoring and extraction wells it is anticipated that this system will have achieved its cleanup goals by the end of 2024 and a Petition for Shutdown will be submitted in 2025.

- **OU III NORTH STREET**

  Due to the system having met its cleanup goals, a Petition for Closure for the North Street Pump and Treat System and groundwater monitoring program was submitted and approved in CY 2019. Seven of the core monitoring wells will be sampled annually for volatile organic compounds (VOCs) until results for individual VOCs are consistently below MCLs. Sampling of the other monitoring wells will be discontinued but the wells will be retained until the completion of the per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane characterization as per regulatory guidance.

- **OU III NORTH STREET EAST**

  Maintain quarterly sampling frequency for the 12ethylene dibromide (EDB) monitoring wells using Method 504, except for upgradient perimeter well 115-42 which is sampled semi-annually. Maintain annual VOC sampling using Method 8260 Low Level for all wells except for 115-42 and 000-138. Prepare a petition for system shutdown if EDB concentrations remain below the DWS through the third quarter of 2024.

- **OU III LONG ISLAND POWER AUTHORITY (LIPA)**

  The proposed change for the OU III Long Island Power Authority (LIPA) treatment system groundwater monitoring program for calendar year 2025 is to maintain the current monitoring schedule for the LIPA monitoring wells pending approval of the LIPA system is received from the regulators. Upon approval, begin the proposed post closure monitoring schedule of wells 000-130, 000-131, 000-425, 000-448, and 000-449 on an annual basis.

- **OU III SOUTH BOUNDARY RADIONUCLIDE**

  Due to the lack of radionuclide detections above the Drinking Water Standard (DWS) for the last 20 years, a recommendation to discontinue further sampling for the OU III South Boundary and Western South Boundary Pump and Treat Systems was submitted to regulators and approved. The 48 monitoring wells that formerly comprised this program are listed in Table 12.13.2 and shown on Figure 12.13.1.

- **OU III BROOKHAVEN GRAPHITE RESEARCH REACTOR WASTE CONCENTRATION FACILITY STRONTIUM-90**

  The proposed change for the Brookhaven Graphite Research Reactor (BGRR) Waste Concentration Facility (WCF) Groundwater Treatment System groundwater monitoring program in CY 2025 are as follows:

  Discontinue sampling of existing monitoring wells 075-809, 075-810, 075-811, 075-415, 075-417, 075-419, 085-171, 085-285, 085-286, 085-287, 085-01, 085-406, 085-407, and 085-290 for Sr-90 analysis. This data was utilized to evaluate the presence of Sr-90 in the vicinity of extraction well FF-RW-A and is no longer needed.

- **CURRENT LANDFILL POST-CLOSURE**

  The changes to the Current Landfill monitoring program for calendar year 2025 are to add PFAS EPA Method 1633 and 1,4-dioxane EPA Method 8270D SIM to the analytical list of parameters for all 12 monitoring wells on an annual basis with collection during the fourth quarter sampling round.

- **GROUNDWATER MONITORING AT THE WASTE MANAGEMENT FACILITY**

  With observed changes in groundwater flow directions in the Waste Management Facility (WMF) area due to increased use of nearby water supply Wells 11 and 12 starting in 2020 and 2022, respectively, four monitoring wells (056-21, 056-22, 056-23, and 066-84) were re-incorporated into the routine (semi-annual) groundwater monitoring program starting in calendar year (CY) 2023. These wells will continue to be sampled during CY 2025.

- **GROUNDWATER MONITORING AT THE BROOKHAVEN MEDICAL RESEARCH REACTOR**

  The Brookhaven Medical Research Reactor (BMRR) groundwater monitoring wells were sampled every two years, with the last sampling of the wells occurring in 2022. Because tritium was not detected during the past three sample periods (2018, 2020, and 2022), the monitoring program is being discontinued starting in 2024. The monitoring wells will continue to be maintained for potential post-decommissioning/demolition surveillance.

- **GROUNDWATER MONITORING AT THE NATIONAL SYNCHROTRON LIGHT SOURCE II (NSLS-II)**

  For calendar year 2025, continue annual sampling of the wells that monitor the National Synchrotron Light Source II (NSLS-II) beam loss areas. However, discontinue sampling upgradient wells 076-18 and 076-19 located at the Major Petroleum Facility because sufficient data have been collected from these wells to verify that tritium is not present in the shallow groundwater upgradient of the NSLS-II facility.

- **OU X FORMER FIREHOUSE GROUNDWATER TREATMENT SYSTEM**

  Routine groundwater sampling activities related to the Former Firehouse PFAS treatment system began in January 2023. The monitoring program uses 42 wells to evaluate the effectiveness of the groundwater treatment system to remediate PFAS that were released to soil during firefighter training activities from 1966 through 1985. In addition to testing for PFAS, samples from select wells are also analyzed for 1,4-dioxane, which originated from the releases of the solvent 1,1,1-trichloroethane (TCA) in areas upgradient of the Former Firehouse (e.g., the Alternating Gradient Synchrotron) and downgradient (e.g., the former Building 208 vapor degreaser facility).

- **OU X CURRENT FIREHOUSE GROUNDWATER TREATMENT SYSTEM**

  Routine sampling activities related to the Current Firehouse PFAS treatment system began in October 2022. The treatment system is designed to remediate PFAS plumes originating from firefighter training areas located at the Current Firehouse and west of Building 170. The monitoring program uses 77 wells to evaluate the effectiveness of the treatment system. In addition to testing for PFAS, samples from select wells are also analyzed for 1,4-dioxane, which originated from the releases of 1,1,1- trichloroethane (TCA) in areas upgradient of the Current Firehouse (e.g., Alternating Gradient Synchrotron) and the downgradient Paint Shop areas.

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1 INTRODUCTION

1.1 PURPOSE OF THE ENVIRONMENTAL MONITORING PLAN

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 impact Laboratory activities have on the environment, and ensures compliance with environmental permit requirements.

U.S. Department of Energy (DOE) Order 436.1a (2023), *Departmental Sustainability*, requires DOE sites to maintain an Environmental Management System (EMS). An EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, from site operations. DOE Order 458.1 Admin Chg 4, (2020), *Radiation Protection of the Public and Environment*, requires DOE sites to maintain surveillance monitoring for determining radiological impacts, if any, to BNL workers, the public, and environment from site operations. An extensive environmental monitoring program is one component of the Laboratory's EMS, and the BNL's Environmental Monitoring Plan (EMP) describes this program in detail. The plan uses the U.S. Environmental Protection Agency (EPA) Data Quality Objective (DQO) approach for documenting the decisions associated with the monitoring program.

A full review of the Laboratory's EMP is performed triennially. In addition, an annual review is performed to ensure that any changes in permit requirements, facility-specific monitoring activities, trends in analytical data, or responses to stakeholder concerns are addressed. The plan is structured to provide people familiar with environmental requirements and monitoring at DOE facilities with an understanding of how BNL fulfills its monitoring requirements.

BNL's EMP describes the Laboratory's environmental monitoring matrices, sampling methods, locations, frequencies, and measured parameters, as well as methods and procedures for data collection, analysis, maintenance, reporting, and archiving. It also addresses quality assurance and quality control of monitoring data.

The Laboratory's EMP is supplemented with standard operating procedures, as well as other technical documents, that provide detailed monitoring instructions. Monitoring results are summarized annually in the BNL Site Environmental Report.

1.2 ORGANIZATION OF THE ENVIRONMENTAL MONITORING PLAN

The EMP is organized into two parts, and supplementary information is provided in Appendices A and B.

Part I (Chapters 1 through 4)

- Chapter 1 describes the purpose and organization of the EMP.
- Chapter 2 describes the Laboratory's physical setting and the surrounding environment.

- Chapter 3 describes the major facility sources, characterizes their principal effluents and/or emissions, and describes the possible pathways for exposure to radiological and nonradiological contaminants.
- Chapter 4 describes BNL's Quality Assurance/Quality Control Program (QA/QC) Program.

Part II (Chapters 5 through 13)

- Chapters 5 through 13 include the DQOs for the various environmental media (e.g., air, surface water, potable water, groundwater, precipitation, flora, fauna, and soil/sediment) and direct radiation measurements. Each DQO summarizes the proposed changes for the calendar year, provides a description and technical basis, the drivers for the program, and completes the seven steps of the DQO process.
- Appendix A provides a glossary of terms and acronyms used throughout the plan.
- Appendix B provides a table that combines a list of measured parameters by media.

1.3 ENVIRONMENTAL MONITORING AT BNL

BNL monitors radiological and nonradiological aspects of ambient air quality, emissions from point sources, wastewater discharges, surface water quality, groundwater quality, precipitation, soil, flora, and fauna.

Radiological monitoring includes the following:

- Assessment of airborne emission impacts through National Emission Standards for Hazardous Air Pollutants (NESHAPs) reviews of facilities that are known to utilize radioactive materials while performing experimental research;
- Continuous monitoring of facilities, such as medical isotope production areas and accelerators that use large quantities of or generate radioactive materials;
- Liquid effluent monitoring for radiological materials discharged from facilities before release to the environment for compliance with DOE Orders;
- Environmental surveillance of soil, vegetation, and fauna (including aquatic biota);
- Monitoring of potable water for compliance with the U.S. Safe Drinking Water Act (SDWA);
- Determination of external exposure component of dose using thermoluminescent dosimeters (TLDs);
- Groundwater monitoring for radiological constituents to evaluate the impact of BNL operations on its EPA-designated sole source aquifer.

Nonradiological monitoring includes the following:

- Monitoring of effluents for parameters listed in BNL's State Pollutant Discharge Elimination System (SPDES) permit;
- Monitoring of fuel oils used by the Laboratory's Central Steam Facility (CSF) for potential polychlorinated biphenyl (PCB) contamination, as needed;
- Monitoring of air emissions from the BNL CSF;
- Monitoring of potable water for parameters regulated by the SDWA and the New York State Department of Health (NYSDOH);
- Environmental surveillance of soil, surface water, and groundwater for nonradiological parameters to assess the impact of BNL operations on the environment.

BNL environmental monitoring programs consist of:

- Compliance monitoring to ensure adherence to regulatory and permit limits;
- Restoration monitoring to measure the impact of past operations and assess the effectiveness of remedial measures;
- Surveillance monitoring to evaluate what impact, if any, current operations have on environmental and public health.

1.3.1 Compliance Monitoring

Compliance monitoring is conducted to ensure that wastewater effluents, air emissions, and groundwater monitoring data comply with regulatory and permit limits issued under the federal Clean Air Act (CAA), Clean Water Act (CWA), Oil Pollution Act, SDWA, and the New York State equivalents. Compliance monitoring includes air emissions monitoring, wastewater monitoring, and groundwater monitoring.

1.3.1.1 Air Emissions Monitoring

To protect BNL workers, members of the public, and the environment, radiological and nonradiological air emissions monitoring is conducted in compliance with the CAA. Facilities that have the potential to exceed the annual NESHAPs dose limit of 0.1 mrem (1.0 µSv) to a member of the public must be continuously monitored for emissions. Facilities capable of delivering radiation doses below that limit require periodic, confirmatory monitoring. The Laboratory has two facilities, the Brookhaven Linac Isotope Producer (BLIP) and the Target Processing Laboratory (TPL), that are continuously monitored with inline detection systems, and one facility, the High Flux Beam Reactor (HFBR), where periodic monitoring is conducted.

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The CSF is the only BNL facility that requires monitoring for nonradiological emissions and is monitored with real-time, continuous monitoring equipment. The CSF supplies steam for heating and cooling to major Laboratory facilities through an underground steam distribution and condensate grid. The Laboratory has several other emission sources subject to state and federal regulatory requirements that do not require emission monitoring.

1.3.1.2 Wastewater Monitoring

Wastewater discharges are regulated under the CWA, as implemented by the New York State Department of Environmental Conservation (NYSDEC) and under DOE Order 458.1. Monitoring is performed at the point of the discharge and is conducted to ensure that the effluent complies with release limits in BNL’s SPDES permits.

Twenty-four point-source discharges are permitted at the Laboratory—12 under BNL’s SPDES Permit and 12 under equivalency permits issued to the Environmental Restoration Program for groundwater treatment systems. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly and monitored for organic, inorganic, and radiological parameters. Monthly Discharge Monitoring Reports provide analytical results and an assessment of compliance for that reporting period and are filed with NYSDEC.

1.3.1.3 Groundwater Monitoring

Some groundwater monitoring is performed in accordance with permit requirements. Specifically, monitoring of groundwater is required under BNL's Major Petroleum Facility (MPF) License for the CSF, the Resource Conservation and Recovery Act (RCRA) permit for the Laboratory's Waste Management Facility (WMF), and the SPDES permit for the Sewage Treatment Plant (STP). Extensive groundwater monitoring is also conducted under the CERCLA Program BNL's Groundwater Protection Group, as required under a Record of Decision (ROD) for Operable Units (OUs) or Areas of Concern (AOC). To ensure that the Laboratory maintains a viable potable water supply, potable water supply wells and the distribution system are monitored, as required by SCDHS.

1.3.2 Restoration Monitoring

Monitoring is conducted to determine the overall impact of past operations, to delineate the real extent of contamination, and to ensure that removal actions are effective and remedial systems are performing as designed under the CERCLA and RCRA. This program involves collecting soil and groundwater samples to determine the lateral and vertical extent of a contaminated area. Samples are analyzed for organic, inorganic, and radiological contaminants, and the analytical results are compared with guidance, standards, cleanup goals, or background concentrations. Areas where impacts have been confirmed are fully characterized and, if necessary, remediated to mitigate continuing impacts. Follow-up monitoring of groundwater is conducted in accordance with a ROD with regulatory agencies.

1.3.3 Surveillance Monitoring

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

1.4 ENVIRONMENTAL DATA REVIEW

The EMP provides the scope, rationale, and justification for the collection and analysis of environmental samples. Samples are collected by trained BNL staff according to approved sample collection procedures and submitted under strict Chain-of-Custody (COC) procedures to a contract analytical laboratory for the analyses specified under this plan. Within the contract analytical laboratory, a laboratory-assigned sample identification number tracks the samples until analyses are completed and reported.

Analytical results are reviewed to ensure the data are of high quality. Various personnel assess BNL’s compliance with regulatory requirements and compare the data with permit limits and background levels to evaluate the Laboratory’s impact on the environment. BNL has established a Standard Operating Procedure (SOP) and a Standards-Based Management System (SBMS) subject area for addressing data that exceed permit limits, diverge from “typical” levels, or exceed regulatory standards. The Laboratory's Groundwater Contingency Plan Procedure and the *Event/Issues Management* Subject Area provide a framework for responding to an environmental event to facilitate protection of environmental quality, compliance with applicable requirements and regulations, and to ensure timely notification to BNL stakeholders. The primary goal is to assure that appropriate, timely, and coordinated actions are taken and communicated.

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2 LABORATORY SETTING

2.1 INTRODUCTION

To help evaluate past and present impacts from Brookhaven National Laboratory (BNL) operations on the environment and to better identify potential pathways for possible exposures to the public and employees, local site characteristics are taken into consideration. These characteristics include human population, geology, hydrology, meteorology data, and natural and cultural resources.

2.2 SITE LOCATION AND LOCAL POPULATION

BNL is located near the geographical center of Suffolk County, Long Island, New York. The Laboratory's 5,265-acre site located in Brookhaven Township, the largest township in both area and population, and is approximately 60 miles east of New York City. BNL is one of the five largest high-technology employers on Long Island, with about 2,800 employees who include scientists, engineers, technicians, and administrative personnel. In addition, the Laboratory annually hosts almost 5,000 visiting scientists and students from universities, industries, and government agencies, who often reside in apartments and dormitories on site or in nearby communities.

2.3 FACILITIES AND OPERATIONS

Most of BNL's principal facilities are located near the center of the site. The developed area is approximately 1,820 acres and consists 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, research agricultural fields, housing facilities, and fire breaks;
- 400 acres of roads, parking lots, and connecting areas;
- 200 acres occupied by the Long Island Solar Farm.

The balance of the site, approximately 3,445 acres, is mostly wooded and represents the native Long Island Pine Barrens ecosystem.

2.4 GEOLOGY AND HYDROGEOLOGY

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

The terrain of the BNL site is gently rolling, with elevations varying between 44 and 120 feet above mean sea level. Depth to groundwater from the land surface ranges from five feet near the Peconic River to approximately 80 feet in the higher elevations of the central and western portions of the site. Studies of Long Island hydrology and geology near the Laboratory indicate that the upper most Pleistocene deposits, composed of highly permeable glacial sands and gravel, are between 120 and 250 feet thick (Warren et al., 1968; Scorca et al., 1999). Water penetrates these deposits readily and there is little direct runoff into surface streams unless precipitation is intense. The sandy deposits store large quantities of water in the Upper Glacial aquifer. On average, approximately half of the annual precipitation is lost to the atmosphere through evapotranspiration, and the other half percolates through the soil to recharge the groundwater (Franke and McClymonds, 1972; Aronson and Seaburn, 1974).

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

The Laboratory's four in-service drinking water wells withdraw almost 1 million gallons of water per day from the aquifer to supply drinking water, process cooling water, or fire protection. Drinking water is treated prior to entering the distribution system. In 2023, approximately 335 million gallons of water were pumped for use on site.

Groundwater flow directions across the BNL site are influenced by natural drainage systems: eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River (as shown in Figure 2-1). 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* (Scorca et al., 1999).

In most areas at BNL, the horizontal velocity of groundwater is approximately 0.75 to 1.2 feet per day (Geraghty & Miller 1996). In general, this means that groundwater travels for approximately 20 to 22 years as it moves from the central, developed area of the site to the Laboratory’s southern boundary.

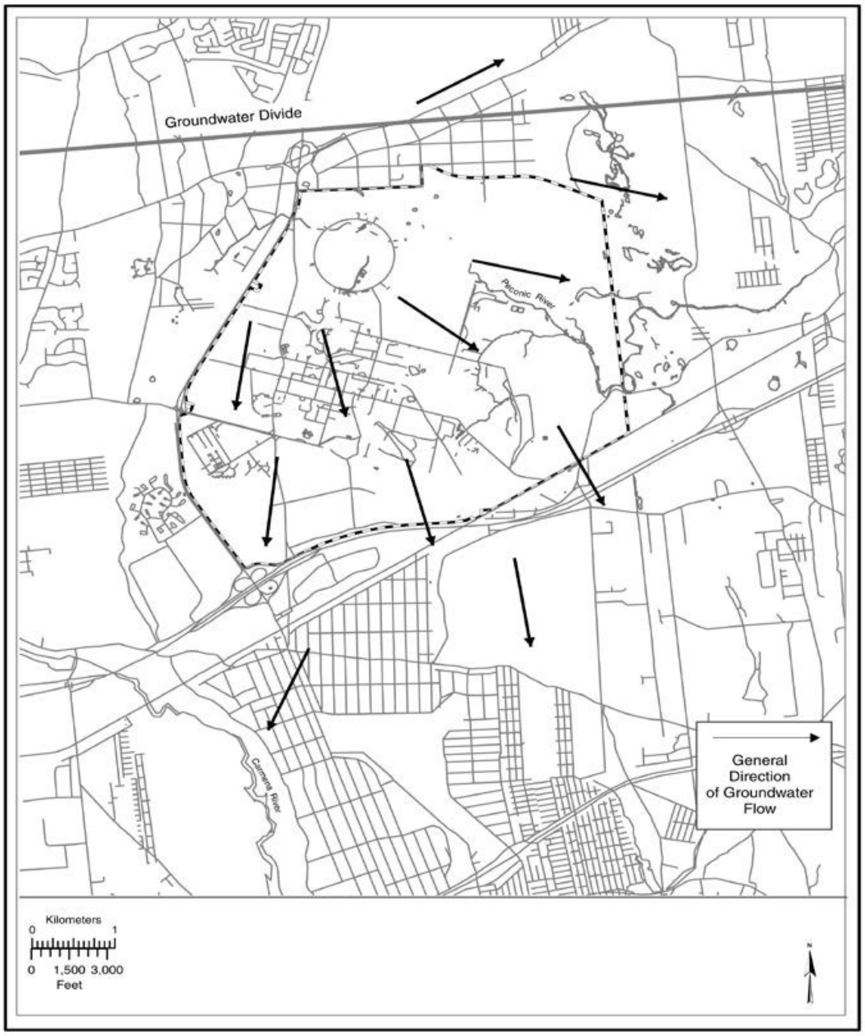


Figure 2.1. BNL Groundwater Flow Map

2.5 Meteorological Data

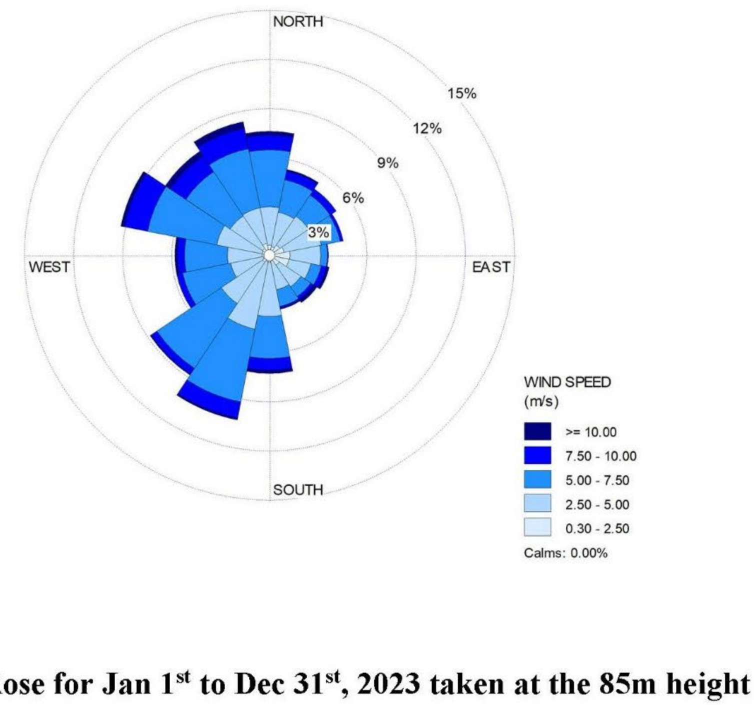
Meteorological Services (MET Services) at BNL has been recording on-site weather data since August 1948. MET Services is responsible for the maintenance, calibration, data collection, and data archiving for the weather instrumentation network at BNL. Measurements include wind speed, wind direction, temperature, rainfall, barometric pressure, and relative humidity. Figures shown in this chapter reflect the latest data available.

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 2-2 shows the 2023 annual wind rose for BNL which depicts the annual frequency distribution of wind speed and direction, measured at an on-site meteorological tower at heights of 33 feet (10 meters) and 300 feet (85 meters) above land surface. The readings were plotted on the charts to indicate how often wind came from each direction. The concentric circles represent multi-percentage increases in frequency. For example, at 10 meters above the ground, the wind was from due south seven percent of the time. The predominant wind direction in 2023 was from the northwest at the 10-m level and from the southwest at the 85-m level.

In 2023, the average yearly temperature for this area of Long Island was 53.6°F. The coolest month of the year, January, had a monthly average temperature of 36.9°F while the warmest month of the year, July, had a monthly average temperature of 74.8°F. Figures 2-3 and 2-4 show the 2023 monthly mean temperatures and the historical annual mean temperatures, respectively.

Figures 2-5 and 2-6 show the 2023 monthly and the 75-year annual precipitation data, respectively. The yearly total snowfall for 2023 was 12.7 inches, well below the 33.0 inches average yearly snowfall for this area of Long Island. The total annual precipitation in 2023 was 50.40 inches.



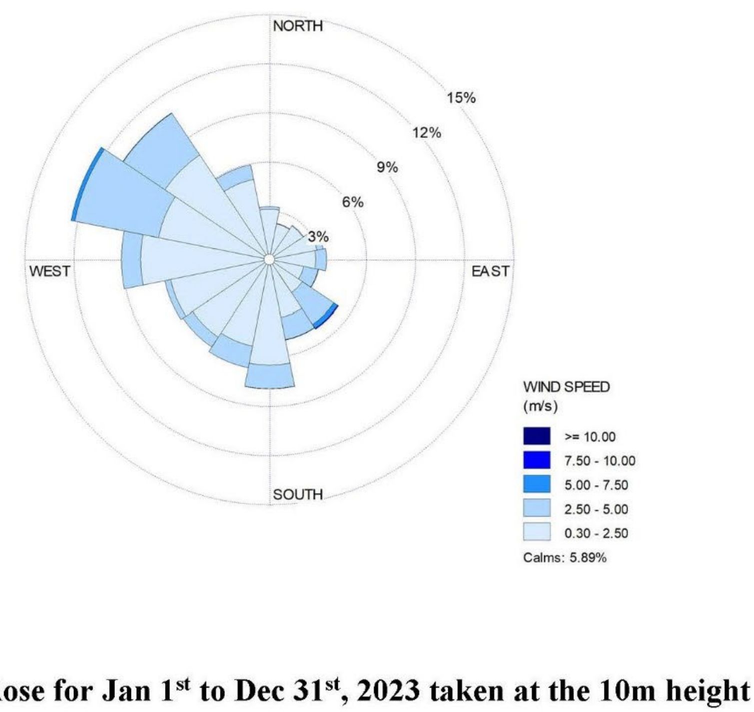


Figure 2.2. BNL Wind Rose (2023).

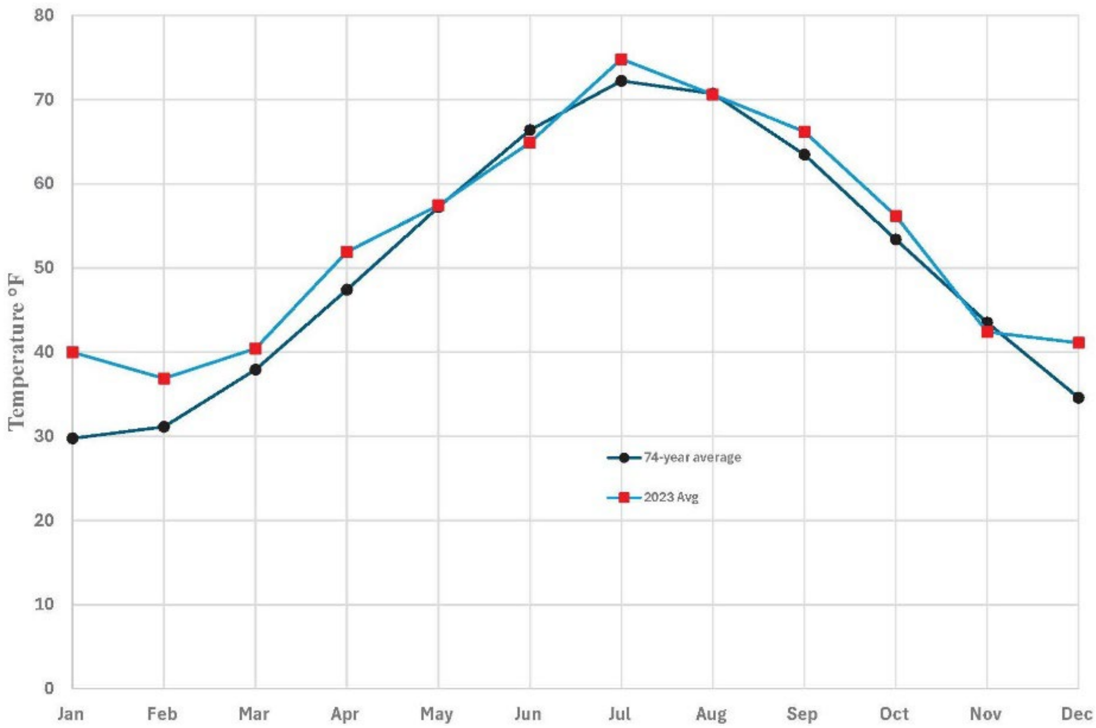


Figure 2.3. BNL 2023 Monthly Mean Temperature Versus 75-Year Monthly Average.

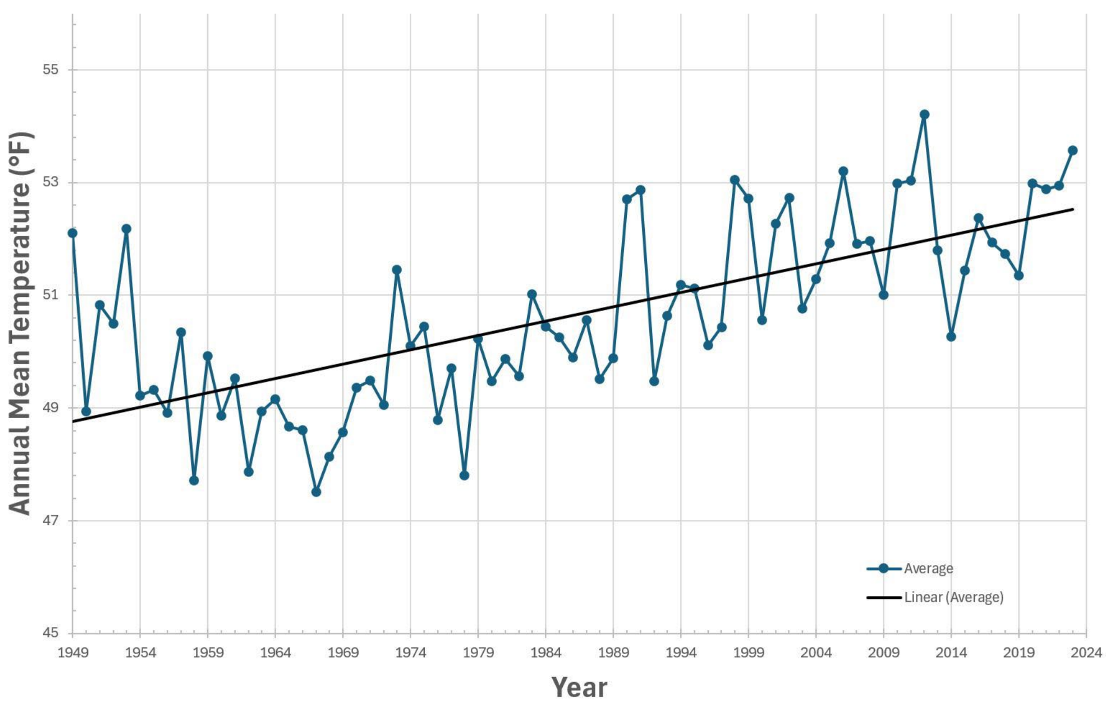


Figure 2.4. BNL 2023 Annual Mean Temperature Trend (75-Years).

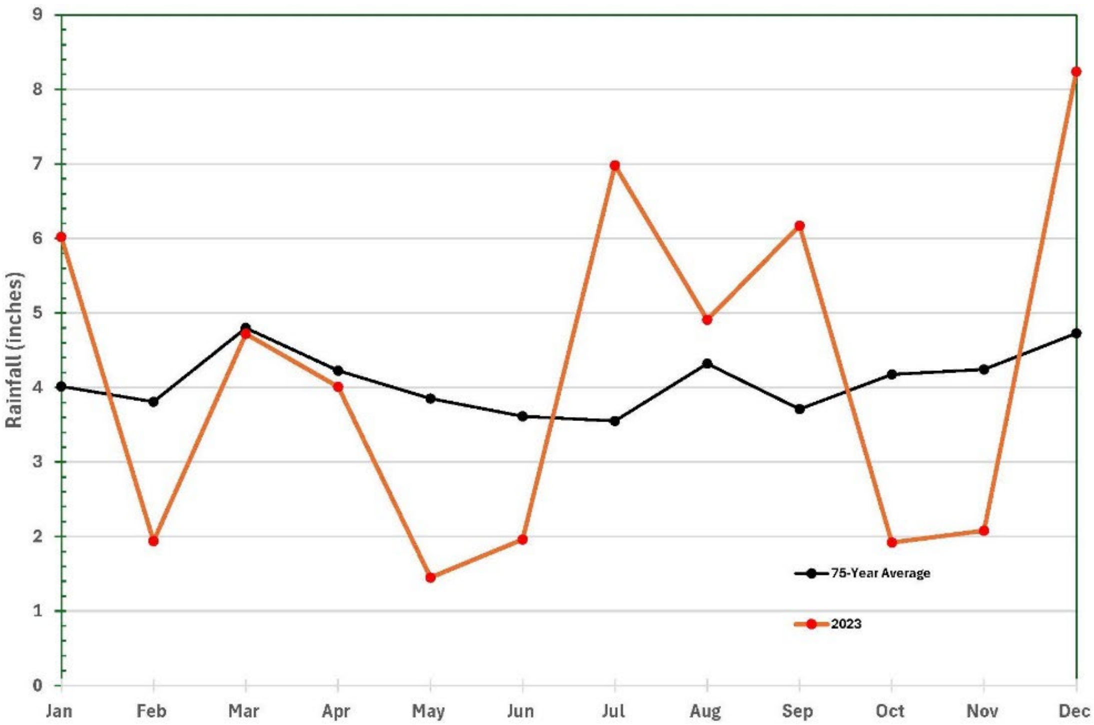


Figure 2.5. BNL 2023 Monthly Precipitation Versus 75-Year Monthly Average.

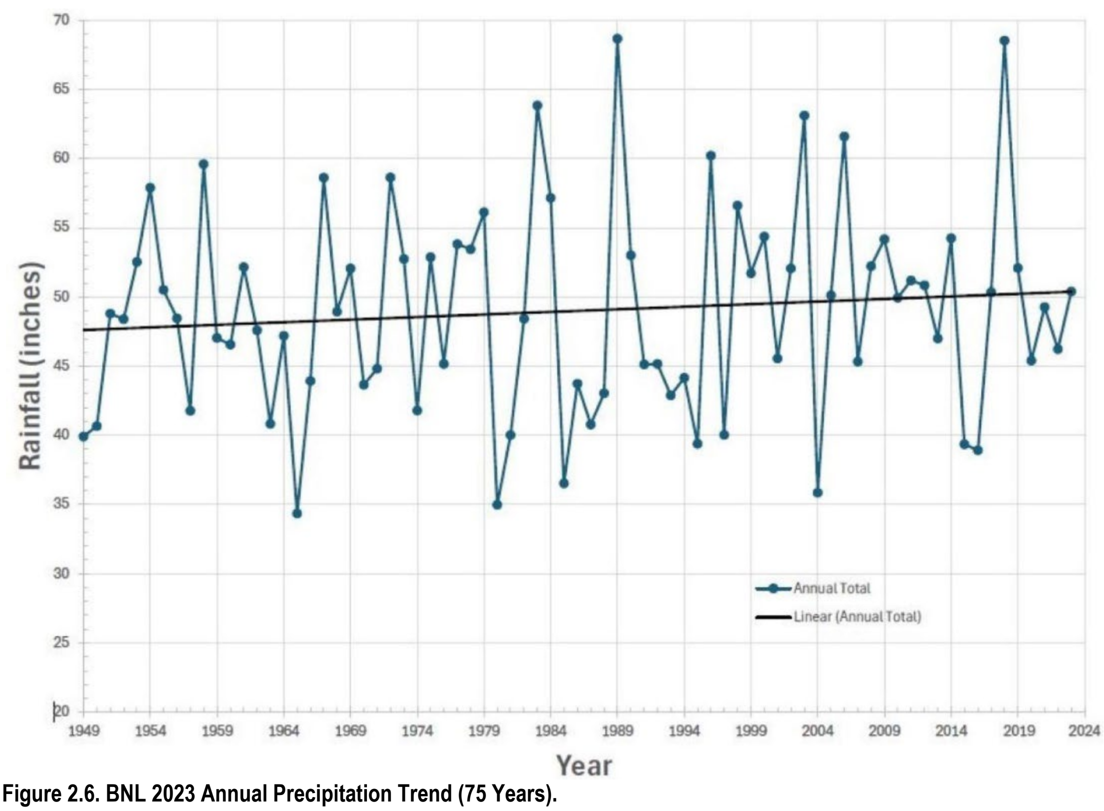


Figure 2.6. BNL 2023 Annual Precipitation Trend (75 Years).

2.6 NATURAL RESOURCES

The Laboratory is located in the oak/chestnut forest region of the Coastal Plain and constitutes about five percent of the 105,000-acre New York State–designated region on Long Island known as the Central Pine Barrens. The section of the Peconic River running through BNL is designated as "scenic" under the New York State Wild, Scenic, and Recreational River System Act of 1972. Due to the general topography and porous soil, the land is very well drained and there is little surface runoff or open standing water. However, depressions form numerous small, pocket wetlands with standing water on a seasonal basis (vernal pools), and there are six regulated wetlands on site. Thus, a mosaic of wet and dry areas correlates with variations in topography and depth to the water table.

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

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

In November 2000, the U.S. Department of Energy (DOE) established the Upton Ecological and Research Reserve at BNL. The 530-acre Upton Reserve (ten percent of the Laboratory's property) is on the eastern portion of the site, in the Core Preservation Area of the Central Pine Barrens. The Upton Reserve creates a unique ecosystem of forests and wetlands that provides habitats for plants, mammals, birds, reptiles, and amphibians.

From 2000 to 2004, funding provided by DOE under an Inter-Agency Agreement between DOE and the U.S. Fish & Wildlife Services was used to conduct resource management programs for the conservation, enhancement, and restoration of wildlife and habitat in the reserve. Since 2005, management of the Upton Reserve falls within the scope of BNL's Natural Resource Management Plan, and the area will continue to be managed for its key ecological values and as an area for ecological research (BNL 2021).

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3 EMISSION/EFFLUENT SOURCES AND PATHWAYS

3.1 INTRODUCTION

Brookhaven National Laboratory (BNL) estimates potential exposures from radioactive and chemical substances that could be received by humans, terrestrial and aquatic plants, and flora and fauna through various pathways. To calculate the exposures, the characteristics of the pollutants emitted (e.g., identity, amount, rate of release, chemical form, etc.) and how the pollutants are subsequently absorbed, retained, and passed along by the various possible exposure pathways, must be researched. Sources of radioactive and chemical emissions and effluents from laboratory facilities are described below. A general description of the primary exposure pathways to members of the public and environment is also provided.

3.2 PATHWAYS

Chemicals and radionuclides released into the environment can move through the biosphere by several routes, which can eventually lead to exposure of humans, animals, and vegetation to those types of substances. These routes can be direct, by the inhalation of contaminated air or ingestion of contaminated drinking water, or indirect, by involving many complex levels of the food chain and different transport mechanisms. Exposure is defined as the interaction of an organism with a physical or chemical agent of interest. An exposure pathway is identified based on the following factors:

- An examination of the type, location, and source (contaminated soil, raw effluent, etc.) of contaminants;
- Principal release mechanisms;
- Probable environmental fate and transport (including persistence, partitioning, and intermediate transfer) of contaminants of interest; and,
- Location and activities of potentially exposed populations.

Mechanisms that influence the transport and destination of chemical and radiological contaminants through the environment and influence the amount of exposure a person might receive at various receptor locations are listed below. While atmospheric processes that transport contaminants tend to dilute those contaminants, many transport processes that move contaminants through the food chain to humans can cause bioaccumulation.

Once a radionuclide or chemical is released into the environment, it may be:

- *Transported* (e.g., migrate downstream in solution or on suspended sediment, travel through the atmosphere, or be carried off-site in contaminated wildlife),
- *Physically or chemically transformed* (e.g., deposition, precipitation, volatilization, photolysis, oxidation, reduction, hydrolysis, or radioactive decay),
- *Biologically transformed* (e.g., biodegradation), or
- *Accumulated in the receiving media* (e.g., strongly absorbed in the soil column, stored in organism tissues).

The atmosphere and surface water are the primary pathways for movement of radioactive materials and chemicals from the Laboratory site to the public. Figure 3-1 illustrates the potential routes and exposure pathways to humans. The significance of each pathway is determined by comparing measurements and calculations that estimate the amount of radioactive material or chemical substances transported along each pathway with the concentrations or potential doses to environmental and public health protection standard. Pathways are also evaluated based on prior studies and observations of radionuclide and chemical movement through the environment and food chains. Calculations based on effluent and emission data show the expected concentrations beyond the BNL site to be low for all Laboratory-produced radionuclides and most chemicals. Frequently, concentrations are below the level that can be accurately detected by monitoring technology. To ensure that radiological and chemical analyses of samples are sufficiently sensitive, minimum detection limits of key radionuclides and chemicals have been established at levels well below applicable health standards.

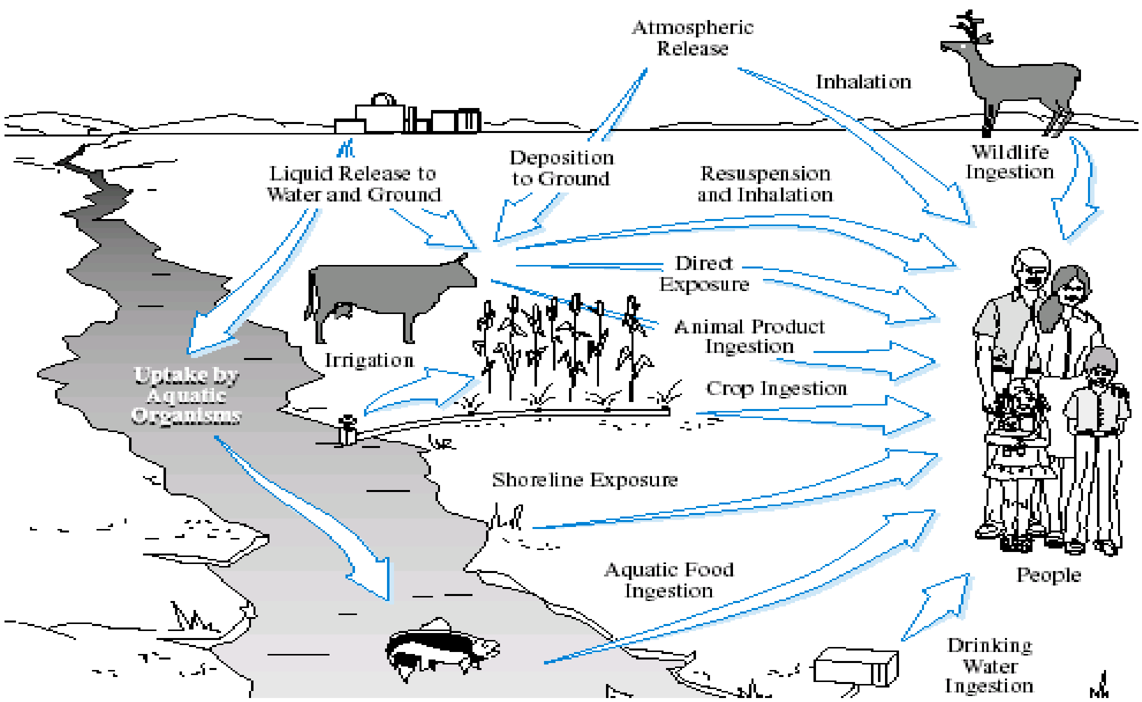

Figure 3.1. Primary Exposure Pathways to Humans

3.3 Sources

3.3.1 Airborne Emissions – Radioactive

Federal air quality laws and Department of Energy (DOE) regulations that govern the release of airborne radioactive material include 40 CFR 61 Subpart H: National Emission Standards for Hazardous Air Pollutants—part of the Clean Air Act, and DOE Order 458.1 Admin Chg. 4 (2020), *Radiation Protection of the Public and Environment*. Facilities with emissions that have the potential to deliver a radiation dose equal to or greater than 0.1 millirem per year to a member of the public require a U.S. Environmental Protection Agency (EPA) permit and must continuously monitor emissions. Facilities capable of delivering radiation doses below that limit require periodic, confirmatory monitoring. BNL has two active facilities: Brookhaven LINAC Isotope Producer (BLIP) and the Radionuclide Research and Production Laboratory (RRPL), whose emissions are continuously monitored with in-line detection systems, and one inactive facility, the High Flux Beam Reactor (HFBR), where continuous emissions monitoring is conducted. Figure 3-2 indicates the location of each of these monitored facilities.

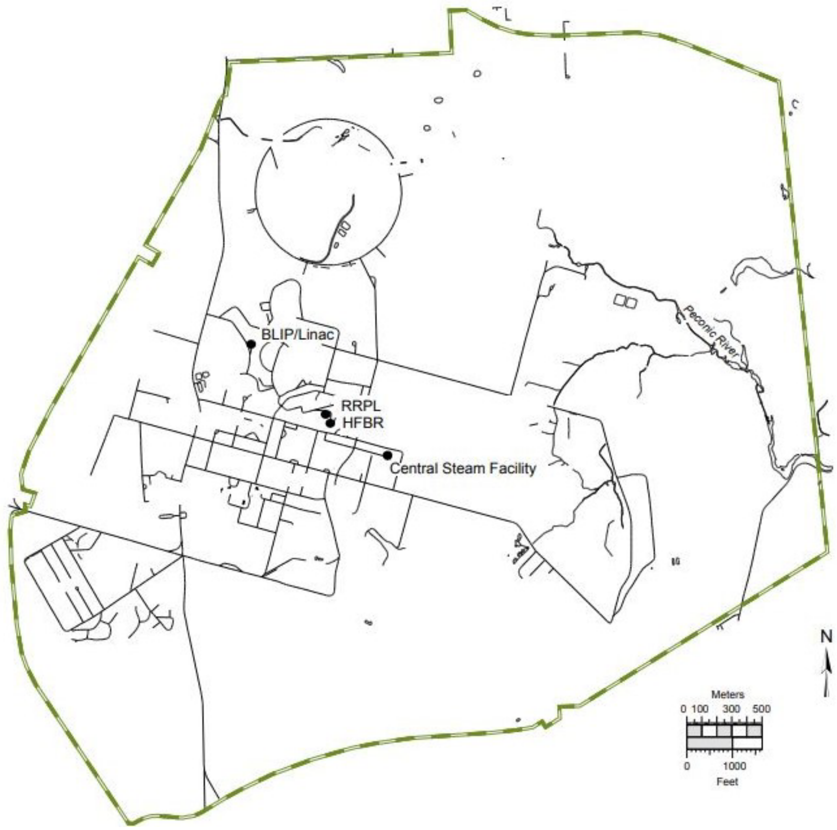

Figure 3.2. Potential Air Emission Release Points Subject to Monitoring.

The most significant sources of radionuclide emissions are the BLIP and the RRPL. The BLIP typically contributes the largest fraction (99 percent or more) of the total annual effective dose equivalent to the maximally exposed individual residing outside the BNL site boundary. The primary radionuclide releases from Laboratory operations are Carbon-11 (C-11), Oxygen-15 (O-15), and tritium (H-3).

Metal targets irradiated at the BLIP are transported to the RRPL in Building 801, where isotopes are chemically extracted for radiopharmaceutical production. Annual radionuclide quantities released from Building 801 are very small, typically in the micro- to millicurie (μCi to mCi) range. Historical analytical results of RRPL particulate filters show gross alpha/beta levels to be minimal. As a result, there are no reported radionuclide emissions from the RRPL, as shown in Table 3-1. Beginning in calendar year (CY) 2023, gross alpha analysis, gross beta analysis, alpha spectroscopy, and gamma spectroscopy are used to detect, identify, and quantify potentially emitted nuclides.

Facility	Nuclide	Half-Life	Ci Released
HFBR	Tritium	12.3 years	3.53E-01
BLIP	C-11	20.38 minutes	9.94E+03
	O-15	122 seconds	1.99E+04
	Tritium	12.3 years	5.91E-02
Total			2.98E+04

Notes:
1 Ci = 3.7E+10 Bq
BLIP = Brookhaven Linac Isotope Producer
HFBR = High Flux Beam Reactor (operations were terminated in November 1999)

Table 3-1. Airborne Radionuclide Releases from Monitored Facilities (2023).

Other facilities that have the potential for radiological emissions are associated with accelerator operations, such as the Alternating Gradient Synchrotron (AGS) Booster, the 200-MeV Linear Accelerator (LINAC), and associated experimental facilities. Emissions from these facilities are extremely low and are insignificant contributors to off-site dose. The other potential source of low-level airborne radionuclide emissions is laboratory fume hoods, where work with dispersible radionuclides is sometimes performed. Small quantities of radioactive materials are typically used in these hoods, usually on the order of µCi to mCi quantities. Compliance with National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations for these sources is demonstrated annually using an inventory system, as allowed under Appendix D of the NESHAPs regulations. Environmental surveillance air monitoring conducted at the site boundaries also provides verification that off-normal emissions from these sources have not occurred.

New facilities or planned activities that could potentially generate environmental releases of airborne radionuclides are reviewed for NESHAPs compliance. The review documents the details of the operation generating the release, the source term involved, proposed effluent control equipment, and the calculated dose impact from the potential release. The evaluation is also used to assess the need for possible modifications to the environmental monitoring program.

The following sections briefly describe the primary sources of radioactive air emissions from BNL operations.

3.3.1.1 High Flux Beam Reactor

In 1997, a plume of tritiated groundwater was traced back to a leak in the HFBR spent fuel storage pool. Consequently, the HFBR was put in standby mode until November 1999, when DOE declared that it was to be permanently shut down. Residual tritium in water in the reactor vessel and piping systems 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.

In 2010, the HFBR was disconnected from the 100-meter stack and a new HFBR exhaust system was installed in 2011. Consistent with the HFBR Long-Term Surveillance Program, air samples are collected from outside the HFBR confinement using an ANSI-compliant emissions monitoring system consisting of a silica gel cartridge, pump, and totalizer. The exhaust air sampling occurs for three to four weeks a month and the collected sample is analyzed offsite for tritium to ensure that air quality within the building is acceptable to permit staff entry.

3.3.1.2 Brookhaven LINAC Isotope Producer

Protons from the Linear Accelerator (LINAC) are sent via a beamline in an underground beam tunnel to the BLIP, where they strike various metal targets to produce new radionuclides for medical diagnostics and therapy. As described in Section 3.3.1, the activated metal targets are transferred to the RRPL in Building 801 for separation and shipment to various radiopharmaceutical research laboratories. During irradiation at BLIP, 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). Both isotopes are released as gaseous, airborne emissions through the facility's 33-foot stack. Generation of these radionuclides is dependent on the current and energy of the proton beam used to produce the radioisotopes and are monitored and quantified using a sodium iodide detector and counting system.

3.3.1.3 RRPL Target Processing Laboratory

Metal targets irradiated at the BLIP are transported to the RRPL in Building 801, where isotopes are chemically extracted for radiopharmaceutical production. Effluents generated during the extraction process are drawn through an acid scrubber, followed by multistage HEPA and charcoal filters. The filtered air is then exhausted to the atmosphere. The types of radionuclides that are released depend on the isotopes chemically extracted from the irradiated metal targets, which may vary from year to year.

Annual radionuclide quantities released from this facility are very small, typically in the µCi to mCi range. Gamma analysis of monthly composite samples was discontinued in 2013 but resumed when processing for Ac225 began. This decision was based on historical analytical results of TPL particulate filters that showed gross alpha/beta levels to be very low and consistent with background concentrations. Beginning in CY 2023, gross alpha and beta analyses of RRPL emissions continued, and monthly alpha and gamma spectroscopy began with the start of processing for Ac225.

3.3.1.4 Additional Minor Sources

Several research departments at BNL use designated fume hoods for work that involves small quantities of radioactive materials (in the µCi to mCi range). The work typically involves labeling chemical compounds and transferring material between containers using pipettes. Due to the use of HEPA filters and activated charcoal filters, the nature of the work conducted, and the small quantities involved, these operations have a very low potential for atmospheric releases of any significant quantities of radioactive materials.

Compliance with NESHAPs Subpart H is demonstrated using an inventory system that allows an upper estimate of potential releases to be calculated. Facilities that demonstrate compliance in this way include Buildings 348, 463, 480, 490, 490A, 801, 865, 815, and 901, and other buildings where research is conducted in the fields of nuclear safety, biology, high energy physics, medicine, medical therapy, photon science, advanced technology, environmental chemistry, and synthetic biology.

3.3.2 Airborne Emissions-Nonradioactive

Various state and federal regulations governing nonradioactive airborne releases require facilities to conduct periodic or continuous emissions monitoring to demonstrate compliance with emission limits.

BNL's Central Steam Facility (CSF) is the only facility that requires monitoring for non-radiological emissions. The Laboratory has several other emission sources subject to state and/or federal regulatory requirements that do not require emission monitoring. The CSF supplies steam for heating and cooling to several major facilities on site through an underground steam distribution and condensate grid. The combustion units at the CSF emit oxides of nitrogen, sulfur dioxide, oxides of carbon, and particulate matter. Continuous emissions monitors are used on two boilers to measure NO_x, and particulates (i.e., opacity). Data are reported quarterly to EPA and the New York State Department of Environmental Conservation (NYSDEC).

3.3.3 Liquid Effluents

BNL's State Pollutant Discharge Elimination System (SPDES) permit provides the basis for regulating wastewater effluents at the Laboratory. The SPDES permit establishes release concentration limits and dictates monitoring requirements. BNL's SPDES permit was renewed on January 28, 2021, with an expiration date of December 31, 2030.

3.3.3.1 BNL Sewage Treatment Plant (Outfall 001)

Sanitary and process wastewaters generated by Laboratory operations are conveyed to the BNL STP for subsequent treatment prior to discharge. The STP effluent (Outfall 001) is a discharge point authorized under BNL's SPDES permit. 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 prior to discharge to groundwater via one of four recharge beds. Tertiary treatment for nitrogen removal is also provided by controlling the oxygen levels in the aeration tanks. During the aeration process, the oxygen levels are allowed to drop to the point where microorganisms use nitrate-bound oxygen for respiration; this liberates nitrogen gas and consequently reduces the concentration of nitrogen in the STP discharge.

3.3.3.2 BNL Recharge Basins and Stormwater (Outfalls 002,003,005-008, 010-012)

Recharge basins are used for the discharge of "clean" wastewater streams, including once-through cooling water, stormwater runoff, and cooling tower blowdown. Figure 3-3, on the following page, depicts the locations of BNL's recharge basins and stormwater outfalls. Each recharge basin is a permitted point-source discharge under the Laboratory's SPDES permit:

- Basins HN, HT-W, and HT-E receive once-through cooling water discharges generated at the AGS and Relativistic Heavy Ion Collider, as well as cooling tower blowdown and stormwater runoff.
- Basin HS receives predominantly stormwater runoff and minimal cooling tower blowdown and once-through cooling water from the National Synchrotron Light Source-(NSLS) II and the Chemistry Department. This basin also receives treated groundwater from the Building 96 Treatment Systems, which are managed by the Groundwater Protection Group, and reporting is performed in accordance with a SPDES equivalency permit.
- Basin HX receives Water Treatment Plant filter backwash water.
- Basin HO receives cooling water discharges from the AGS and stormwater runoff from the area surrounding the HFBR.
- Several other recharge areas are used exclusively for discharging stormwater runoff. These areas include Basin HW near the NSLS-II site, Basin CSF at the CSF, Basin HW-M at the former Hazardous Waste Management Facility, and Basin HZ near Building 902.
- Recharge basins HP and RAV are used for discharge of treated water from the groundwater remediation systems and are monitored under BNL's CERCLA equivalency permits.

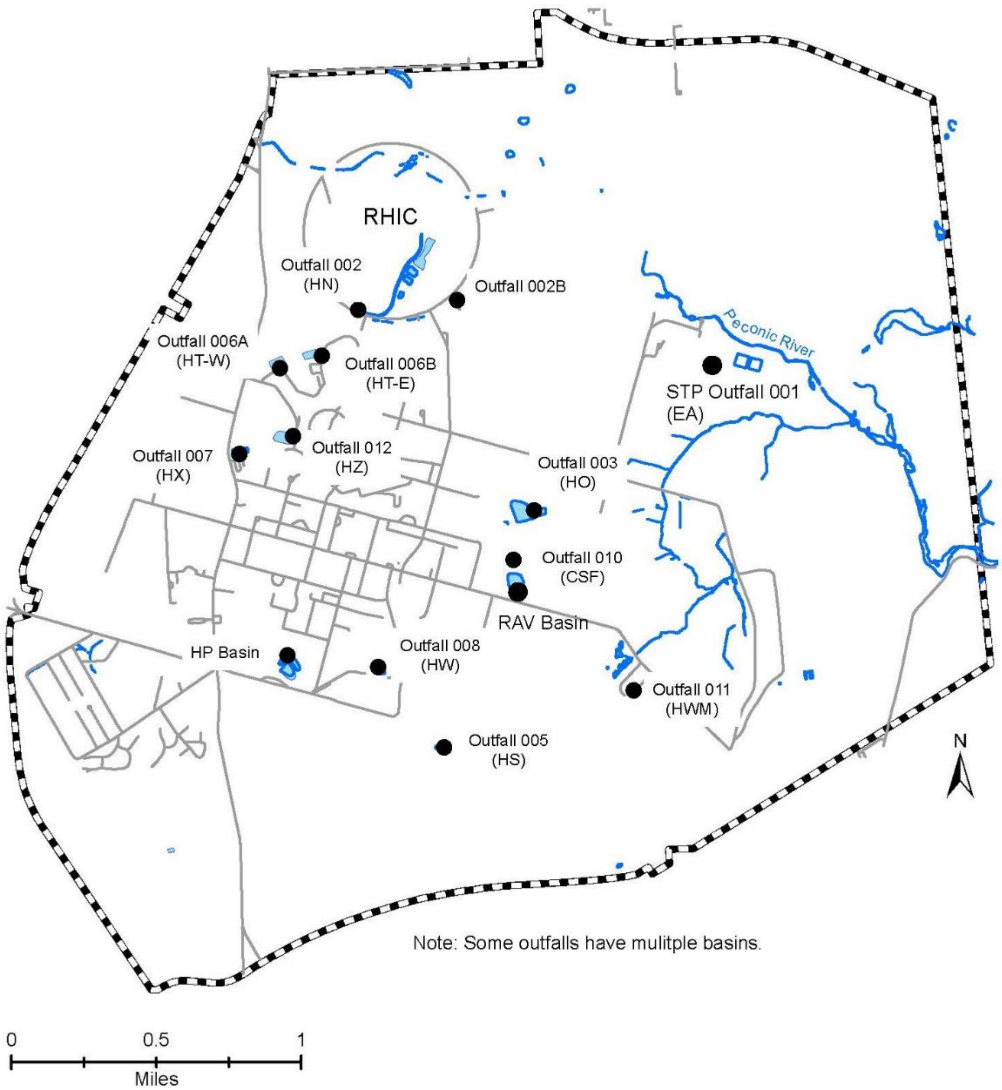

Figure 3.3. BNL Recharge Basins/Outfalls

3.3.3.3 Assessments of Process-Specific Wastewater

Wastewater that may contain constituents above SPDES permit limits or groundwater discharge standards is held and characterized to determine the appropriate means of disposal. The analytical results are compared with the appropriate limit and the wastewater is released only if the discharge would not jeopardize the quality of the effluent.

Examples of process-specific wastewater requiring routine characterization are discharges from metal-cleaning operations in Building 498 (Central Cleaning Facility) and cooling tower discharges from Building 902 (Superconducting Magnet Division). These operations are potential sources of contaminants, such as inorganic elements (i.e., metals and cyanide) and volatile and semi-volatile organic compounds. The metal cleaning operation in Building 498 is currently out of service and there are no discharges to sanitary process wastewaters that are not routinely monitored under the SPDES permit, and are held for characterization before release to the sewer system. Wastewaters that are routinely evaluated are releases from primary, closed-loop cooling water systems and water collected in berms that provide secondary containment for tanks and other industrial wastewaters. To determine the appropriate disposal method, samples are analyzed for contaminants specific to the process.

In all instances, any waste that contains hazardous levels of contaminants or elevated radiological contamination is sent to the waste management program for disposal.

3.4 ENVIRONMENTAL RESTORATION MONITORING

BNL's Groundwater Protection Group operates and maintains groundwater treatment systems to remediate contaminant plumes both on and off site. The Laboratory maintains an extensive network of groundwater monitoring wells to verify the effectiveness of remediation efforts. Modifications to groundwater remediation systems are implemented, as necessary, based upon a continuous evaluation of monitoring data and system performance. Additionally, fish sampling, when fish are available, is conducted to verify the effectiveness of the Peconic River cleanup efforts. Peconic River monitoring is conducted under the Surveillance Monitoring Program.

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4 QUALITY ASSURANCE

4.1 INTRODUCTION

As required by Department of Energy (DOE) Order 458.1, *Radiation Protection of the Public and Environment*, and DOE Order 436.1A (2023), *Departmental Sustainability*, Brookhaven National Laboratory (BNL) has established a Quality Assurance (QA)/Quality Control (QC) Program to ensure that the accuracy, precision, and reliability of environmental monitoring data are consistent with the requirements of Title 10 of the Code of Federal Regulations, Part 830 10 CFR 830, Subpart A, *Quality Assurance Requirements* (2022), and DOE Order 414.1D (Chg. 2: Ltd. Chg 2020), *Quality Assurance*. The responsibility for quality at BNL starts with the Laboratory Director, who approves the policies and standards of performance governing work and extends throughout the entire organization. The purpose of the BNL QA Program is to implement QA methodology throughout the various Laboratory management systems and associated processes to do the following:

- Plan and perform BNL operations in a reliable and effective manner to minimize any impact on the health and safety of the public, employees, and the environment;
- Standardize processes and support continual improvement in all aspects of BNL operations;
- Enable the delivery of products and services that meet customers' requirements and expectations, and
- 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. Quality Control activities measure each process or service against the QA standards. Quality Assurance/Quality Control 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.

4.2 ENVIRONMENTAL SAMPLE ANALYSIS AND QUALIFICATIONS

The Laboratory's environmental QA practices and procedures are documented in manuals and SOPs that govern sample collection, radiation measurements, chain-of-custody (COC) requirements, and analytical chemistry standards. Environmental samples are analyzed through contracts with five off-site analytical laboratories: General Engineering Lab (GEL) and Eurofins/Test America (TA) perform radiological and non-radiological analyses; Pace and Chemtex Lab perform non-radiological analyses; and Eberline Analytical perform radiological analyses.

Four of the five laboratories are certified by the New York State Department of Health (NYSDOH) for the relevant analytes, where such certification exists, and are periodically audited to ensure that quality standards are maintained. NYSDOH does not currently certify for the specific analytes tested by Chemtex Lab, which has Louisiana National Environmental Laboratory Accreditation Program (NELAP) accreditation.

The labs are required to incorporate QA guidelines into their operations when performing work and participate in several national and/or state performance evaluation (PE) testing programs. Results of the PE tests provide information on the quality of a laboratory's results and allow comparisons to be made between labs. In addition, BNL has established a program of internal and external audits to verify the effectiveness of the environmental sampling, analysis, and database activities. Contractor laboratories may also be subject to DOE Consolidated Audit Program (DOECAP)-

sponsored audits and/or state (NELAP) audits.

4.3 DATA QUALITY OBJECTIVES

The Data Quality Objectives (DQOs) included in this plan follow the DQO process, a seven-step planning approach to develop sampling designs for data collection activities that support decision making. This process uses systematic planning and statistical hypothesis testing to differentiate between two or more clearly defined alternatives. The DQO process provides the following benefits:

- Promotes understanding of the real purpose of collecting data (i.e., why the data are needed and what questions the data may help answer);
- Provides a convenient way to document activities and decisions;
- Facilitates rapid review and approval by regulators and stakeholders;
- Fosters communication between interested parties;
- Promotes efficient use of limited resources, and
- Outlines methods of assessing performance and states the consequences of decision errors.

4.4 SAMPLE COLLECTION

Trained technicians follow procedures outlined in EM-SOPs. Technicians use bound logbooks, electronic tablets, and media-specific log sheets to document sample collection. COC procedures are followed to ensure that each sample is properly handled and controlled from time of collection through analysis.

4.5 DATA MANAGEMENT

Each environmental sample collected is identified with a unique number and accompanied by a COC. The sampling data are reported in two electronic formats (PDF and EDD). All electronic data are maintained in the BNL Environmental Information Management System (EIMS). The EIMS consists of an environmental data management system platform that is linked with a geographic information system (GIS). Analytical data in the EIMS can be retrieved and evaluated using custom applications. In September 2022, *EPD-SOP-004, Electronic Data Archiving* (BNL 2022a), was reviewed and updated. This procedure provides a standardized method to electronically archive environmental sampling laboratory data packages. Environmental samples include drinking water, groundwater, surface water, soil, sediment, flora, fauna, air, and waste matrices. Samples are sent to contractor laboratories for the analysis of radiological and non-radiological parameters. Once the data are reviewed, tabulated, and disseminated, the electronic data packages are archived. Depending on the use and regulatory requirement the data was collected for, the packages remain in electronic archive between 30 and 75 years.

Sample location identifications are addressed using EM-SOP-202. This procedure establishes a common Laboratory-wide system for uniquely identifying the locations where environmental samples are collected. The procedure for identifying sampling locations stored in the BNL EIMS is also described within EM-SOP-202. Identification includes location name (Site ID) and geographic location, as designated by geographic coordinates.

4.6 ELECTRONIC DATA QUALITY ASSURANCE

Data quality assurance steps are detailed in the EIMS Data Management Description and in applicable SOPs. When data are entered into the EIMS, completeness checks are automatically performed to ensure that analyses are provided for all samples, required data fields are not empty, and that certain fields contain only predefined legal values or formats. If any data quality issues are found, the data are checked by using the data verification process outlined in EM-SOP-203 and EM-SOP-204. If any quality control checks are not satisfied, the analytical data are qualified, and a Data Verification Form is created and stored. The form is then forwarded to the project manager. All analytical results entered into the EIMS are automatically checked for outlier values. Project managers using the Data Flagging Query Tool are notified of any outlier values to expedite evaluation of the data.

4.7 VERIFICATION, VALIDATION AND USABILITY OF ANALYTICAL RESULTS

Environmental monitoring data are subject to data verification, usability and, in certain cases, data validation when the DQOs of the project require this step.

Data Verification process involves checking for common errors associated with analytical data such as: holding times missed, incorrect test method, poor recovery, incorrect method detection limits, invalid COC, instrument failure, preservation requirements not met, contamination of samples, and matrix interference (BNL 2022 b, d).

Data Validation involves a more extensive process than data verification. Validation includes all the verification checks, as well as checks for less common errors, including instrument calibration that was not conducted as required, internal standard errors, transcription errors, and calculation errors (BNL 2023 a, 2022 c, h).

Data Usability is the process by which laboratory results are determined to be consistent with project-specific DQOs. This procedure may be applied to data that has been identified by the project manager as outside the range of normal expectations and may include examination of the verification or validation reports, process knowledge, inspection of raw data, and/or checks of general analytical correctness of data (BNL 2022 e, f).

All analytical results received from contract laboratories are reviewed in accordance with Environmental Protection Division (EPD) data review procedures to ensure the data are of acceptable quality. Based on the large amount of monitoring data collected over the past years, BNL has determined that full validation of the analytical results as described in EM-SOP-209, *Radiochemical Data Validation,* and EM-SOP-212, *Chemical Data Validation,* is not necessary. All data for the EMP programs are verified as per EM-SOP-203, *Chemical Data Verification,* and EM-SOP-204, *Radiochemical Data Verification*. Project manager(s) also review results to identify any contaminant concentrations that differ significantly from historical data for the sample point(s). If any questionable data are identified, a further review of the data is conducted as per EM-SOP-210, *Radiochemical Data Usability,* and EM-SOP-211, *Chemical Data Usability*.

4.8 DATA QUALITY PROCESS

The goal of the data quality process is to ensure that analytical results are representative and defensible, and that the data are of the type and quality needed to verify that BNL operations and controls are protective of the public, employees, and the environment. The quality system diagram on the following page details the three-stage data quality process: planning, implementation, and assessment. The planning stage can be divided into the DQO process and the QA plans associated with the program. The implementation stage entails the actual collection of samples and analysis in accordance with the SOPs and quality control guidelines. The final stage is data quality assessment which may include data verification and/or data validation, as well as data usability which includes review of the decision-making process to ensure that effluents, emissions, and receptor data are adequate to assess impacts to the health of the BNL environment. The outcomes of the quality process are defensible products and decisions.

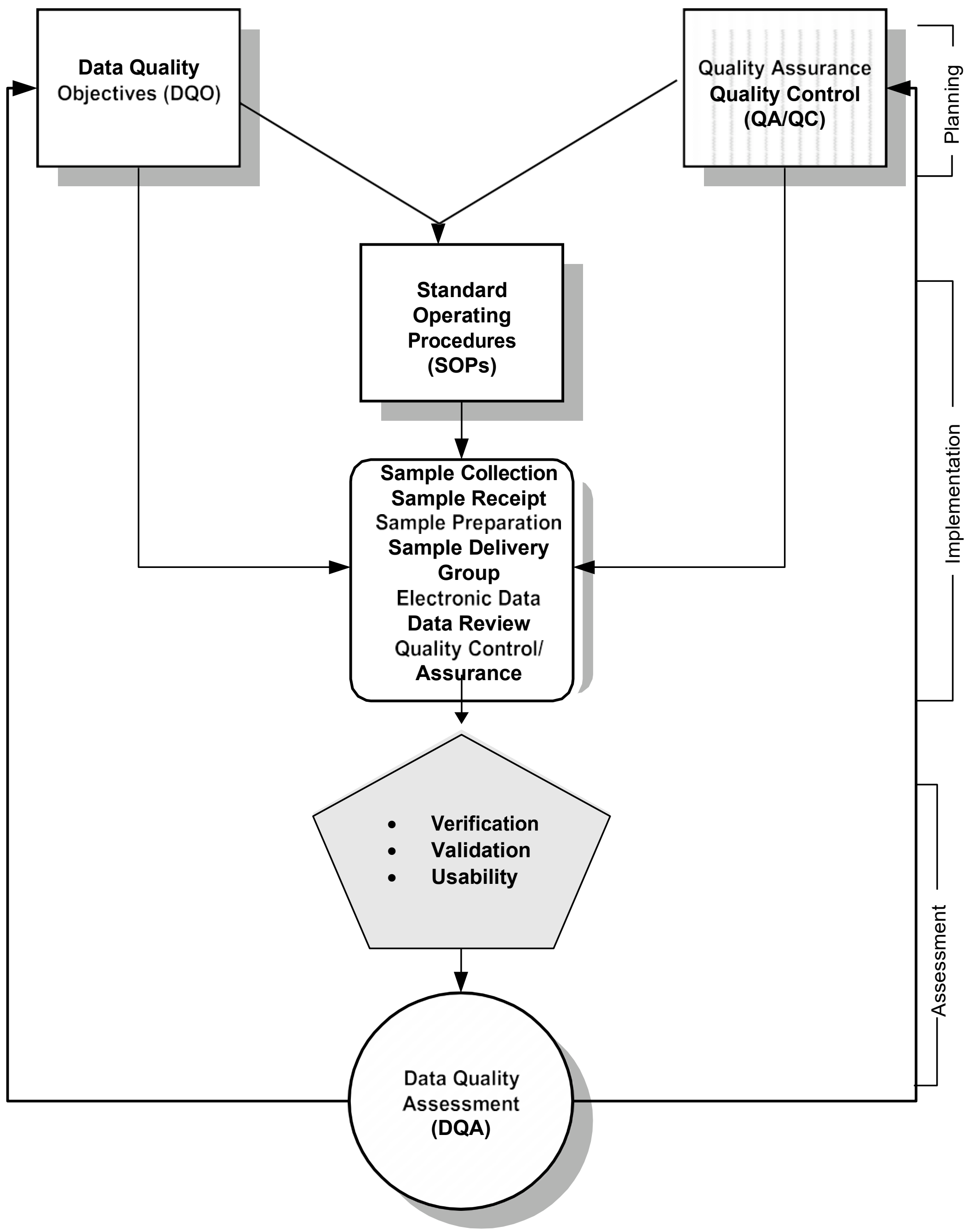

Figure 4.1. Data Quality Flowchart

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5 AIR EMISSIONS SOURCE

CHAPTER CONTENTS

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5.1 AMBIENT AIR QUALITY

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT TBD

SUMMARY OF PROPOSED CHANGES

There were a couple of minor grammatical changes for Ambient Air Quality for calendar year 2024.

DESCRIPTION AND TECHNICAL BASIS

Airborne emissions are routinely generated as a result of Brookhaven National Laboratory (BNL) operations and research activities. These emissions are released to the atmosphere through dedicated exhaust systems designed to protect workers and building occupants from inhalation exposure to irritants or potentially toxic compounds or via a building's general ventilation system when emissions from an operation do not present potential health impacts to workers. Airborne emissions may be released as particles, fumes, or gases.

The Environmental Protection Agency (EPA) has previously delegated authority to NYSDEC to issue permits in accordance with Part 201 of Title VI of the New York State Code of Rules and Regulations (NYCRR) for the construction or modification of any stationary source subject to the federal requirements of prevention of significant deterioration (PSD) and for many sources subject to New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAPs). These permits are issued only after NYSDEC is assured from information provided with permit applications that the operation or activity will be operated in compliance with all applicable regulatory requirements and emissions from new or modified sources and will not adversely impact the ambient air quality or place members of the public at undue risk of inhalation exposure from pollutants of varying levels of toxicity.

A condition of the Title V Facility Permit issued to BNL in January 2002 and renewed in January 2020 states:

> "No person shall cause or allow emissions of air contaminants to the outdoor atmosphere of such quantity, characteristic, or duration which are injurious to human, plant, or animal life or to property, or which unreasonably interfere with the comfortable enjoyment of life or property. Notwithstanding, the existence of specific air quality standards or emissions limits, this prohibition applies, but is not limited to, any particulate, fume, gas, mist, odor, smoke, vapor, pollen, toxic, or deleterious emission, either alone or in combination with others."

This condition and regulatory requirement (6 NYCRR 211.1) is a facility-wide condition that applies not only to operations and activities that release emissions to the atmosphere and are authorized under the Title V Facility permit issued by NYSDEC, but also to operations and activities that are exempt from New York State permitting requirements.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

X Compliance
___ Support compliance
___ Surveillance
___ Restoration

The Clean Air Act (CAA) and CAA Amendments of 1990 establish a national permitting program for facilities that are considered to be major sources of criteria and/or hazardous air pollutants, specify emissions standards and monitoring requirements applicable to various industrial source categories that are significant contributors of criteria pollutants, establish emissions standards applicable to industrial categories which are significant contributors of 189 identified hazardous air pollutants, and seek to maintain and improve air quality throughout the nation. Many of the statutory requirements of the CAA and the 1990 Amendments aimed at maintaining or improving air quality were promulgated into regulations administered by NYSDEC under Parts 200–257 of the NYCRR.

In their evaluations of new applications for permits to operate emissions sources, NYSDEC uses a guidance document called the DAR-1, Guidelines for the Evaluation and Control of Ambient Air Contaminants Under 6NYCRR Part 212*,* to evaluate the potential impact to the public of pollutants released into the atmosphere from a process and to determine whether existing or proposed pollution control devices and administrative controls for the process are sufficient to protect the public from adverse impacts from the source's emissions.

Using these guidelines, emissions source-specific information (such as exhaust system stack height and diameter, stack exit velocity, and building height) and source-specific potential and actual emissions information are plugged into EPA's conservative dispersion screening model AERSCREEN. The model calculates average ambient annual and average short-term concentrations of a compound that would be expected at receptors downwind of the emissions source for the meteorological conditions built into the model.

These concentrations are then compared to Annual Guideline Concentrations (AGCs) and short-term guideline concentrations (SGCs) that have been established by the New York State Department of Health (NYSDOH) based on available toxicology data on the health risks to humans for that compound. To demonstrate compliance with the Title V Facility permit condition, the potential impacts for all proposed emissions sources at BNL that have the potential to release toxic compounds are evaluated using the DAR-1 model.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Laboratory operations that release emissions have the potential to impact ambient air quality, the environment, and members of the public if the emissions are not properly controlled at the point where they are generated. Facility-wide procedures are in place requiring owners or operators of new emissions sources to assemble qualitative and quantitative information about potential emissions from the source, along with information about the exhaust system and emissions control devices. This information must be reviewed to determine whether adequate engineering and administrative controls are in place to ensure that the environment and members of the public are not adversely impacted by potential emissions from the source.

Step 2: Identify the Decision

The desired decisions for the review of BNL operations with potential emissions of toxic compounds are:

- Have all potential sources of toxic compound emissions been identified, and their potential impacts evaluated?
- Do the DAR-1-assessed impacts of a source's potential emissions show maximum potential concentrations of toxic compounds at downwind receptor locations to be less than corresponding AGCs?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- Completed Emissions Source Inventory or Emissions Source Modification forms with supporting information on compounds released (i.e., estimated quantities, safety data sheets, etc.)
- Exhaust system parameters including stack height, building height, exit velocity, and stack exit temperature
- Pollutant emissions rates
- EPA AP-42 emissions factors
- Meteorological data
- Pollution control device efficiencies
- AGC and SGC limits/emissions limits
- NYSDEC DAR-1, Guidelines for Evaluation and Control of Toxic Ambient AirContaminants Under 6NYCRR Part 212
- Chemical Management System queries and reports on chemical use

Step 4: Define the Study Boundaries

To calculate worst-case impacts to compare with AGC and SGC limits, the DAR-1 model requires estimates of maximum hourly emissions rates (lbs./hr.) and maximum annual emissions rates (lbs./yr.) for all source pollutants. These estimates are based on information from completed Emissions Source Inventory forms or Emissions Source Modification Forms provided by BNL personnel. The estimates can be based on material balance calculations, published emissions factors, emissions test results, emissions tests from geometrically similar emissions sources, equipment manufacturer guarantees, and best engineering judgment. Due to atmospheric dispersion of the pollutants, the model may show that maximum impacts may occur beyond the Laboratory boundaries.

Step 5: Develop the Decision Rules

Decision 1

Have all potential sources of toxic compound emissions been identified, and potential impacts of emissions evaluated?

BNL's Standards-Based Management System (SBMS) *Non-Radioactive Airborne Emissions* Subject Area requires line personnel who are responsible for operations that generate nonradioactive emissions to complete and submit forms for new emissions sources or existing sources that are being modified to the Environmental Protection Division (EPD). These forms are reviewed to determine if new or modified sources are subject to New York State permit or other regulatory requirements. All new or modified emissions sources that emit toxic air contaminants are assessed using DAR-1, Guidelines for the Evaluation and Control of Toxic Ambient Air Contaminants Under 6NYCRR Part 212*,* to ensure that the sources are equipped with the appropriate emissions control equipment and will not have an adverse impact on potential on- or off-site receptors. The Environmental Protection Division Procedure for Completing a Process

Assessment Evaluation and Form (i.e., Procedure No. RC-SOP-402) also provides an opportunity for identifying potential sources of toxic emissions.

If there are potential sources of toxic compound emissions that have not been identified and evaluated for their potential impacts to the public and the environment, **then** periodic assessments of conformance to the *Non-Radioactive Airborne Emissions* Subject Area can be a means to identify additional sources for evaluation. Decisions should then be made as to whether the identified sources are subject to permitting requirements and if DAR-1 assessments of the potential impacts of the sources' emissions to members of the public and the environment need to beconducted.

Decision 2

Do the DAR-1 assessed impacts of a source's potential emissions show maximum potential concentrations of toxic compounds at downwind receptor locations to be less than corresponding AGCs?

If the calculated downwind receptor concentrations of the compounds emitted from a source are less than the respective AGCs and SGCs, **then** no additional control devices are suggested and the impacts from potential impacts of the source emissions are considered acceptable.

If administrative controls are implemented or pollution control devices are added to reduce emissions, **then** the potential impacts will be re-evaluated using the EPA AERSCREEN conservative computer model, based on reduced emissions rates.

If the AERSCREEN model shows calculated downwind receptor concentrations of one or more compounds to be above corresponding AGCs or SGCs, **then** the more sophisticated model EPA AERMOD should be used unless administrative controls, such as the substitution of an environmentally benign product or the addition of pollution control devices, have been implemented by the operator of the emissions source.

If the assessed impacts from an existing source's emissions are greater than one half the respective AGC or SGC for any highly toxic or moderately toxic compound based on the EPA AERSCREEN method and estimated emissions rates are in doubt, **then** EPD may request that representative stack samples be collected to verify emissions rates.

Step 6: Specify Acceptable Error Tolerances

To estimate worst-case toxic emissions rates from the source, instructions with the Emissions Source Inventory and the Emissions Source Modification forms direct users to provide information on the maximum number of hours per day and days per year the emissions source will be used. Similarly, the AERSCREEN dispersion screening model analyses building wake effects to calculate worst-case impacts under building downwash conditions. As a result, the screening method calculates conservative impacts under all conditions and will likely overestimate both the short-term and annual impacts.

The NYSDEC Division of Air Resources tries to base every ambient guideline concentration on its own chemical-specific evaluations. However, due to the number of chemicals manufactured and used in the State of New York, NYSDEC does not have sufficient funds to conduct an evaluation for each chemical. In the absence of self-conducted evaluations, NYSDEC uses other qualitative and quantitative information sources to derive AGCs and SGCs, based on the following hierarchy:

1) Toxicological assessments conducted by NYSDEC
2) Toxicological assessments conducted by NYSDOH
3) Information from the EPA-Integrated Risk Information System
4) Information from EPA Health Assessment Documents
5) Information from the National Toxicology Program
6) Data from the American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLV) and National Institute for Occupational Safety and Health recommended exposure limits (REL) (whichever is more restrictive)

Interim AGCs can be calculated by applying uncertainty factors (as noted in the equations below) to the most restrictive recognized occupational exposure limits (time-weighted average [TWA] threshold limit value, TWA-TLV, or the TWA-recommended exposure limit, TWA-REL). Interim AGCs are not calculated for high toxicity contaminants such as known or potential human carcinogens.

HIGH & MODERATE TOXICITY CONTAMINANTS

$$\text{Interim AGC} = \frac{\text{Occupational Exposure Limit}}{420}$$

LOW TOXICITY CONTAMINANTS

$$\text{Interim AGC} = \frac{\text{Occupational Exposure Limit}}{42}$$

Step 7: Optimize the Design

With respect to existing laboratory hoods at BNL, a prior evaluation of the potential emissions from this large group of sources revealed an information gap. Estimates provided in Annual Emissions Statements for CY 1997, 1999, and 2001 suggested that the predicted impacts of chloroform emissions would have exceeded one-half the AGC in each of these years and the predicted impact of estimated carbon tetrachloride emissions in 2002 would have exceeded one-half its AGC. A follow-up evaluation of the potential impacts of lab hood emissions using the DAR-1 computer-based model showed predicted impacts of chloroform and carbon tetrachloride emissions for the years in question were less than one-half their respective AGCs.

Subsequent evaluations of lab hood emission impacts for CY 2004 through CY 2022, based on an examination of Chemical Management System hazardous air pollutant consumption records, showed that estimated impacts of carbon tetrachloride and all other hazardous air pollutant compounds in use, with the exception of chloroform, were less than one-half of their respective AGCs. A follow-up evaluation of the potential impacts of lab hood emissions using the DAR-1 computer-based model showed predicted impacts of chloroform for CY 2023 are less than one-half its AGC.

See Appendix B for the monitoring program for this Data Quality Objective.

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5.2 CENTRAL STEAM FACILITY EMISSIONS

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT TBD

SUMMARY OF PROPOSED CHANGES

Proposed changes for Central Steam Facility Emissions for calendar year 2024 include:

1) Description and Technical Basis (paragraphs 7 and 8, respectively) were realigned to be in chronological order.
2) Description and Technical Basis (paragraph 8) was revised to accurately reflect 6 NYCRR 227-2 NOx emission standards and to accurately reflect where compliance was and was not demonstrated by 2018 stack tests.
3) Text in "Drivers for Monitoring Being Conducted Under This Program" was amended to reflect revisions to the 6 NYCRR 227-1 total suspended particulates emission limit.
4) Paragraph 4 was added in "Drivers for Monitoring Being Conducted Under This Program" subsection to describe Title V permit modifications affecting intermittent particulate emissions testing requirements for Boilers 1A, 5, and 6.

DESCRIPTION AND TECHNICAL BASIS

Airborne emissions are routinely generated as a result of Brookhaven National Laboratory (BNL) operations and research activities. These emissions are released to the atmosphere through a dedicated exhaust system designed to protect workers and building occupants from inhalation exposure to irritants or potentially toxic compounds or via a building's general ventilation system when emissions from an operation do not present potential health impacts to workers. Airborne emissions may be released as particles, fumes, or gases.

Emissions released to the atmosphere from many operations and activities at the Laboratory were authorized via individual permits issued by the New York State Department of Environmental Conservation (NYSDEC). These permits were issued only after NYSDEC was assured from information provided in permit applications submitted by BNL that the operation or activity would be operated in compliance with all applicable regulatory requirements and that emissions from new sources would not adversely impact the ambient air quality or place members of the public at undue risk of inhalation exposure from pollutants of varying levels of toxicity.

Various state and federal regulations governing non-radiological releases require facilities to conduct periodic or continuous emissions monitoring to demonstrate compliance with emissions limits. The Laboratory has several sources subject to state and/or federal regulatory requirements that do not require emissions monitoring. These emissions sources are included in the Title V Facility permit issued by NYSDEC to BNL on January 11, 2002, and subsequently renewed effective January 31, 2020. Conditions within the permit or the applicable requirements themselves require BNL to demonstrate compliance with federal and state requirements by means other than emissions monitoring. The Central Steam Facility (CSF) is the only BNL Title V permitted source that is required to monitor non-radiological emissions.

The CSF supplies steam for heating and cooling to BNL major facilities through an underground steam distribution system. The combustion units at the CSF are designated as Boiler Nos. 1A, 5, 6, and 7. Boiler 1A, which was installed in 1962, has a heat input of 56.7 MMBtu/hr. Boiler 5 was installed in 1965 and has a heat input of 225 MMBtu/hr. The newest units, Boilers No. 6 and 7, were installed in 1984 and 1996, respectively. Each of these boilers has a heat input of 147 MMBtu/hr.

Because of their design, heat inputs, and dates of installation, Boiler Nos. 6 and 7 are subject to Title 6 NYCRR Part 227-2 and the federal New Source Performance Standard, 40 CFR 60 Subpart Db. As such, these boilers are equipped with continuous emissions monitors for NO_x. Boiler No. 7 is also subject to the 40 CFR 60 Subpart Db emissions standard for total suspended particulates. Initial compliance with the total suspended particulate standard was demonstrated during a boiler performance test completed in December 1997. Flue gases released from the Boiler 7 stack are also continuously monitored for opacity. To measure combustion efficiency, both boilers are also monitored for carbon dioxide (CO2). To enhance the Laboratory's ability to monitor particulate emissions from Boiler No. 6, a continuous opacity monitor was brought online in 2004. Continuous emissions monitoring results from the two boilers are reported on a quarterly basis to the Environmental Protection Agency (EPA) and NYSDEC.

Due to their age, Boilers 1A and 5 are only subject to Title 6 of NYCRR Part 227-2. Initial compliance with the 0.30 lbs./MMBtu NO_x emissions standard of Part 227-2 was demonstrated during stack tests conducted in January 1995 while the boiler burned No. 6 oil with a fuel nitrogen content of less than 0.3 percent and a fuel sulfur content of less than 0.3 percent. Continued compliance with the emissions standard is presumed if laboratory analysis of composite residual fuel samples confirms the fuel nitrogen content does not exceed 0.3 percent by weight.

On July 1, 2014, the new lower reasonably available control technology (RACT) limits for NO_x in 6 NYCRR 227-2 became effective. As a result, NO_x limits for CSF Boilers 5, 6, and 7 dropped from 0.30 lbs./MMBtu and 0.20 lbs. per/MMBtu when oil and natural gas are respectively combusted to 0.15 lbs./MMBtu for both fuels. Similarly, the NO_x limit for the CSF's one mid-size boiler, Boiler 1A, dropped from 0.30 lbs./MMBtu to 0.20 lbs./MMBtu.

Per condition 40 of BNL's Title V Facility permit that was renewed effective January 31, 2020, stack tests must be conducted once during the five-year term of the permit. The tests are done to confirm that Boilers 1A and 5 are meeting their respective 6 NYCRR 227-2 NO_x emissions standards while Boiler 1A fires residual fuel and while Boiler 5 fires residual fuel and natural gas. Stack testing of Boilers 1A and 5, conducted respectively on December 7, 2018, and on December 4 and 5, 2018, demonstrated that Boiler 1A was compliant with the NO_x standard of 0.20 lbs./MMBtu firing residual oil and that Boiler 5 was compliant with the 0.15 lbs./MMBtu NO_x emissions standard while burning natural gas but was above the 0.15 lbs./MMBtu NO_x emissions standard when Boiler 5 burned residual oil.

Recognizing that, based on past performance testing, none of the four boilers could meet the new RACT limits when residual oil was burned, BNL took advantage of flexibility provisions within 6 NYCRR 227-2 to craft a system averaging plan that was submitted to NYSDEC in January 2012 to comply with the new lower limits. Under the plan, BNL uses a NO_x ledger to account for NOx credits accumulated during periods when natural gas is burned at levels below the NO_x RACT limits to offset debits on the ledger that occur when any of the four boilers burn residual oil. Copies of the NO_x ledger are included in quarterly Site-Wide Air Emissions/Monitoring System Performance Reports submitted to NYSDEC.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

__X__ Compliance
Support compliance
Surveillance
Restoration

The Clean Air Act (CAA) and CAA Amendments of 1990 establish a national permitting program for facilities that are significant contributors of the 189 identified hazardous air pollutants. The permitting program seeks to maintain and improve air quality throughout the nation by specifying emissions standards and the monitoring requirements that apply to various industrial sources. Many of the statutory requirements of the CAA and the 1990 Amendments for maintaining or improving air quality were promulgated into regulations administered by NYSDEC under Parts 200–257 of the New York State Code of Rules and Regulations.

Federal and state regulations 40 CFR 60 Subpart Db and 6 NYCRR 227-2 establish emissions standards for NO_x for all four CSF boilers and continuous emissions monitoring requirements for NO_x covering Boilers 6 and 7. Conditions of the Title V Facility permit require quarterly reports to demonstrate ongoing compliance with the emissions standards. Conditions of the renewal permit specific to Boilers 1A and 5 require that stack tests be conducted once during the five-year term of the permit to confirm that the NO_x emissions standard is being met while Boiler 1A burns residual fuel and Boiler 5 burns residual fuel and natural gas in separate tests.

Another permit condition requires BNL to conduct a stack test of Boiler 7 once during the five-year term of the permit to confirm that the total suspended particulate emissions standard is being met while burning residual fuel. In June 2018, BNL's permit was revised with the addition of Condition 63 requiring the Laboratory to conduct stack tests of Boilers 1A, 5, and 6 once during the five-year term of the permit to confirm that total suspended particulate emissions do not exceed applicable emission limit of 0.2 lbs./MMBtu when burning residual fuel. Effective February 25, 2021, NYSDEC lowered the total suspended particulates emission limit of 6 NYCRR 227-1 for boilers with a maximum heat input capacities exceeding 50 MMBtu/hr to 0.1 lbs./MMBtu. In addition, DOE Order 436.1A (2023), *Departmental Sustainability*, requires that DOE sites comply with federal and state statutes and regulations.

In March 2023, the Laboratory received notice that minor Title V permit modifications submitted to NYSDEC in December 2022 had been approved. Included among the permit modifications was a request to remove the intermittent particulate emissions testing requirements of Condition 63. The Laboratory contended that Condition 63 should be removed based on NYSDEC's September 1, 2019 admission in the NYS Register that EPA AP-42 particulates emission factor for boilers burning residual oil with a sulfur content less than 0.50% wt. will be less than 0.1 lbs./MMBtu.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

CSF boilers subject to regulatory emissions and opacity standards rely on continuous emissions monitoring systems, intermittent emissions tests, periodic opacity observations, or sampling and analysis of materials used by the operation. Procedures have been established for operating and maintaining the boilers' continuous emissions monitoring systems (CEMS) and to make and log daily observations of stack opacity from Boilers 1A and 5. These procedures are designed to ensure:

- Compliance with regulatory permit monitoring and reporting requirements
- Collection and analysis of samples are performed according to EPA, state, and regulatory agency standards or guidelines.
- Compliance with NYSDEC Quality Assurance (QA) and Quality Control (QC) requirements for continuous emissions monitoring systems

Step 2: Identify the Decision

The desired decisions for the CSF boilers compliance and monitoring program can be cast as the following questions:

- Have we collected sufficient monitoring data during periods of boiler operation to meet minimum regulatory and permit data acquisition requirements?
- Are we in compliance with emissions and opacity standards and Title V Facility permit conditions?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- CEMS CO_2 and NO_x data for Boilers 6 and 7
- Opacity data for Boilers 6 and 7
- Analytical results of residual fuel analysis
- CSF Control Room log
- CEMS log
- Smoke Monitoring log sheets
- Daily CEMS calibration reports
- Contractor quarterly CEMS cylinder gas audit and opacity calibration error test results

Step 4: Define the Study Boundaries

The study boundaries incorporate the stacks for each of the four CSF boilers and continuous or periodic emissions monitoring equipment used to capture, analyze, and record representative samples for compliance monitoring purposes. NO_x data is recorded at 15-minute intervals and the data are reduced to one-hour block arithmetic averages. At least three data points are needed for a valid one-hour block average NO_x reading. Pursuant to 6 NYCRR Part 227-2.6, CEMS data for NO_x must demonstrate compliance with the NO_x emissions limits of the Title V permit on a 24-hour heat-weighted arithmetic average basis during the period from May 1 to September 30, and on a 30-day rolling average basis from October 1 to April 30.

The Boiler 6 and 7 opacity monitors record light transmittance across the stack diameters at ten-second intervals and automatically convert the data to percent opacity. Collected opacity data is reduced to six-minute averages that are compared to the opacity standards. Excess opacity is any six-minute average reading greater than 27 percent opacity or two or more six-minute average opacity readings in one hour greater than 20 percent opacity.

Periodic testing of Boilers 1A and 5 for conformance with the Title V Permit NO_x emissions limit must be conducted once during the five-year term of the permit (January 31, 2020, to January 30, 2025). Periodic tests of Boilers 1A, 5, 6, and 7 to confirm that flue gas emissions meet the Title V permit particulate emissions standard must also be conducted once during the five-year term of the permit. The periodic test of Boiler 1A will consist of three one-hour test runs while the boiler is burning residual fuel oil with a nitrogen content not to exceed 0.30 percent by weight. Separate stack tests of Boiler 5 will be conducted while the boiler is burning natural gas and residual fuel with a nitrogen content not to exceed 0.30 percent by weight, and with each test consisting of three one-hour test runs. The particulate emissions tests of Boilers 1A, 5, 6, and 7 will consist of three one-hour test runs, while residual fuel oil is fired.

Step 5: Develop the Decision Rules

Decision 1

Have we collected sufficient monitoring data during periods of boiler operation to meet minimum regulatory and permit data acquisition requirements?

Calibration drift tests are conducted daily on the Boiler 6 and 7 NO_x and CO_2 CEMS. Whenever the measured drift exceeds twice the allowable drift test limits, the CEMS data logger flags this as a warning and the calibration is adjusted.

If the daily drift reading is greater than twice the drift limit five or more consecutive days or the drift reading is more than four times the drift limit, **then** the data logger flags the hourly NO_x as OC (Out of Control) periods.

All successive hourly periods are flagged as OC until corrective actions have been taken and the calibration drift measurements are less than the allowable limits (i.e., either less than two times or four times the allowable limit). OC periods are not counted as valid data. Periods of CEM maintenance, CEM calibration, and periods where erroneous data or system errors occur are all flagged by the CEMS data loggers and are counted as invalid data. Under conditions of the Title V Facility permit and requirements of 40 CFR Subpart Db and 6 NYCRR 227-2, sufficient monitoring data have been collected if there is valid CEMS data for 75 percent of the hours per day for 75 percent of the days of the month and 90 percent of the boiler operating hours in the quarter.

If at the end of the quarter it is determined that sufficient valid monitoring data has not been collected, **then** the data substitution method of 6 NYCRR 227-2.6(b) (3) (vii) will be used. Using this method, the 90th percentile value of all CEMS NO_x data collected over the last 180 boiler operating days will be substituted for the invalid or missing periods.

If NO_x monitoring data is not available during the quarter, **then** the data loggers flag the invalid data (e.g., OC – Out of Control, MD – CEM down for maintenance, ED – erroneous data/system error.).

OC periods and ED periods are the most likely source of insufficient data being captured during a quarter. Stationary engineers manning the CSF must record the apparent causes for invalid data and actions taken to restore proper CEMS operations. The CEMS Calibration Reports, the CSF Control Room log, and the CEMS log, are reviewed quarterly to ensure that the causes of the invalid periods are identified, and corrective and preventive actions are taken to prevent reoccurrences.

Decision 2

Are we in compliance with emissions and opacity standards and Title V Facility permit conditions?

If monitoring data, sample results, and opacity observations demonstrate compliance with emissions limits, opacity standards, and permit conditions, **then** compliance status is communicated to regulators through quarterly Air Emissions and Monitoring System Performance Reports and the Semi-Annual Monitoring Report.

If opacity observations show an exceedance of an emission or opacity standard and the cause is found to be due to quarterly calibration error testing of the opacity monitor or to boiler start-ups or shutdowns, **then** no further notifications beyond those made in quarterly Air Emissions and Monitoring System Performance Reports are required. If NO_x monitoring data shows an exceedance of an emission standard, the cause of the exceedance and the corrective actions taken to bring emissions under the standard are described in the quarterly report. Exceedances of emissions limits or opacity standards are described both quantitatively in Section 1 of the reports and qualitatively (determined causes of exceedances and the corrective or preventative action taken) in Section 5 of the reports.

If, however, emissions in excess of emissions standards or deviations from permit conditions are found to be due to unavoidable malfunctions of equipment during its operation or maintenance, **then** notification to regulatory agencies shall be made as soon as possible, but no later than 48 hours after the occurrence and an evaluation of the equipment malfunction will be conducted under the Standards Based Management System (SBMS) *Event/Issues Management* Subject Area.

Step 6: Specify Acceptable Error Tolerances

CEMS for NO_x have been used on Boilers 6 and 7 to demonstrate compliance with applicable NO_x emissions standards since these boilers became operational in November 1990 and May 1996, respectively. Initial performance tests of the CEMS for each boiler were conducted using EPA-approved methods to verify their accuracy and ensure that NO_x emissions standards were being met. For Boiler 7, initial testing included an emissions test to confirm that total suspended particulates were below the 40 CFR Subpart Db limit. To ensure that flue gas opacity limits are not exceeded, a continuous opacity monitor is required on Boiler 7. This monitor also serves as a surrogate monitoring device to ensure ongoing compliance with the total suspended particulates emissions limit. A separate continuous opacity monitor is voluntarily used on Boiler 6.

Because the CEMS are used to continuously demonstrate compliance with NO_x emissions standards and opacity limits, quality assurance is essential to ensure that the CEMS are functioning properly. To satisfy the quality assurance requirements of 40 CFR 60 Appendices B and F that are applicable to CEMS, a quality assurance plan for the CEMS for Boilers 7 was prepared and submitted to NYSDEC in 1994 along with an operating permit application. The quality assurance plan was subsequently amended in the summer of 1999 when a new dedicated CEMS was installed for Boiler 6.

Before the installation of the new system, emissions from Boiler No. 6 were monitored by a time-share system that electronically switched between stacks to continuously monitor flue gas concentrations of CO_2 and NO_x in Boilers 6 and 7. After installation of an opacity monitor for Boiler 6 was completed, a separate quality assurance plan for Boiler 6 CO_2, NO_x, and opacity CEMS was submitted to NYSDEC in June 2004. CEMS quality assurance plans for both boilers were revised in 2016, following the replacement of NOx analyzers for both boilers in July 2015, and again following the replacement of the continuous opacity monitors for both boilers in May 2018. The revised plans discuss quality assurance practices that are followed to satisfy the requirements set forth in 40 CFR 60 Appendix B and F.

The CEMS for NO_x and opacity undergo quality assurance checks on a daily and quarterly basis. Daily calibrations to measure the relative accuracy of the CEMS are called calibration drift (CD) tests. The ESC Data Acquisition System initiates the CD tests each day at 7:00 a.m. and 8:00 a.m., respectively, for the Boiler 6 and 7 CEMS. For the CO_2 and NO_x monitors, samples from calibration gas cylinders are extracted and analyzed by the CEMS. The CD is the difference between the measured CEMS concentration of the cylinder gas sample and the certified concentration of the gas. For the transmissometer (opacity monitor), a calibrated filter screen is automatically placed in the transmissometer path. A spectrophotometer in the transmissometer measures the amount of light trapped by the filter screen and converts the value to an equivalent opacity. The CD is the difference between the measured opacity of the filter screen and the calibration value certified by the filter screen manufacturer. The allowable calibration drift test limits for each type of monitor are noted in the table below.

Table 5.3.1. Daily Drift Limits

CEM Pollutant	Allowable Limit	Maintenance Limit	Out of Control Limit
Opacity	± 1%	± 2 %	± 4 %
NOx	± 12.5 ppm	± 25 ppm	± 50 ppm
CO2	± 0.5 %	± 1 %	± 2 %

Whenever the measured drift exceeds the maintenance limits for NO_x and CO_2, the CEMS data logger flags this as a warning and the CSF personnel manually adjust the calibrations. If the daily drift reading is greater than the maintenance limit five or more consecutive days or the drift reading is more than the OC limit, the data logger flags the hourly NO_x as OC periods. All successive hourly periods are flagged as OC until corrective actions have been taken and the calibration drift measurements are less than the allowable limits.

For NO_x and CO_2 monitors, quarterly cylinder gas audits must be performed during three calendar quarters, and a relative accuracy test audit (RATA) of the CEMS must be done during one calendar quarter of the year. The cylinder gas audits are usually completed during the first, second, and third quarters of the year, while the RATA is normally completed during the fourth quarter. Quarterly calibration error tests must be performed each quarter for the opacity monitors.

Step 7: Optimize the Design

The current monitoring fulfills regulatory and Title V permit requirements for Boilers 1A, 5, 6, and 7. As previously noted, conditions within BNL's Title V permit require the Laboratory to conduct stack tests of Boilers 1A, 5, 6, and 7 once during the five-year term of the permit. Stack tests of Boilers 1A and 5 performed the week of December 3, 2018, and stack tests of Boilers 6 and 7 performed on January 23, 2019, confirmed that the total suspended particulate emissions standard were met while burning residual fuel. Test results for Boiler 1A confirmed that it met the NOx emission standard of 6 NYCRR 227-2.4(c)(1)(ii). Meanwhile, test results for Boiler 5 confirmed that it complied with the NOx emission standard when natural gas was combusted and exceeded the NOx emission standard of 0.15 lbs./MMBtu when residual fuel was burned.

During periods of operation, the opacity limitations of 6 NYCRR Part 227-1.3 are applicable to CSF Boilers 1A, 5, 6, and 7. This regulatory requirement restricts opacity from a boiler to not more than 20 percent (i.e., a six-minute average) except for one six-minute period per hour of not more than 27 percent opacity. Boiler 7 demonstrates compliance with this requirement via the continuous opacity monitor that was installed pursuant to the opacity monitoring requirements of 40 CFR 60 Subpart Db. To demonstrate that Boilers 1A, 5, and 6 comply with the opacity limitations of 6 NYCRR Part 227-1.3 during periods of operation, BNL made a commitment to use the flue gas oxygen monitors on each boiler as a surrogate indicator of opacity levels in its initial Title V permit application. Since the flue gas monitor data acquisition systems were programmed to record measured concentrations at two-minute, five-minute, ten-minute, hourly, or daily intervals, significant data acquisition system reprogramming would have been needed to report flue gas oxygen concentrations as six-minute averages, the reporting interval that NYSDEC had preferred.

BNL staff discussed the matter with NYSDEC during an annual inspection of Title V permitted processes conducted on March 11, 2002. During these discussions, NYSDEC suggested an option that would allow BNL to certify compliance with the opacity limitations by making and recording daily observations of stack opacity using a method other than EPA Reference Method 9. The Laboratory subsequently developed and began using a new opacity monitoring procedure (BNL Energy & Utilities Procedure No. EU-CSF-018), whereby CSF operators objectively observe and record opacity daily using a 0–10 scale with a reading of 2 being “Economy Haze,” a universally recognized term used by boiler operators that suggests an unacceptable level of opacity.

Because the individual opacity observations under this procedure are but snapshots of visible particulate emissions from each boiler and represent a small fraction of the boiler operating day, periods where excess particulate emissions might exceed 20 percent opacity are likely to go unnoticed. Recognizing the deficiencies in the procedure and the fact that violation of the opacity limits could result in the assessment of civil penalties up to $32,500 per violation per day, BNL requested and received funds to purchase and install continuous opacity monitors for each of the boilers. Installation of the Boiler 6 opacity monitor was completed in 2004. Calibration drift tests of the unit were successful and data acquisition system integration was finalized. Upon completion of performance testing conducted in accordance with the NYSDEC approved test protocol, the opacity monitor was brought online on October 1, 2004. BNL subsequently reconsidered its plans to purchase and install continuous opacity monitors for Boilers 1A and 5 and opted instead to continue to use the opacity observation procedure to demonstrate compliance with 6 NYCRR Part 227-1.4 opacity limits.

See Appendix B for the monitoring program for this DQO.

5.3 AIR MONITORING AT THE BROOKHAVEN LINAC ISOTOPE PRODUCER

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Tim Welty (631) 344-4212

SUMMARY OF PROPOSED CHANGES

The Data Quality Objective was updated to capture two changes that will be made in calendar year (CY) 2025 at the Brookhaven National Laboratory (BNL) Linear Accelerator (LINAC) Isotope Producer (BLIP) facility. An uninterruptible power supply will be placed in service for the continuous emissions monitoring system in CY2025 after being delayed in CY2024. Also, plans are being developed for the installation of a cascading delay tank gaseous emissions mitigation system for the BLIP. This system is intended to mitigate or eliminate the emission of C-11 and O-15 gases from the stack, which is the largest contributor to offsite dose to the MEOSI.

DESCRIPTION AND TECHNICAL BASIS

The BNL LINAC accelerates protons into the booster of the Alternating Gradient Synchrotron (AGS). The BLIP facility uses a beam of excess protons from the LINAC to irradiate targets for the production of short-lived radioisotopes used for medical diagnostic procedures and scientific research. The energy of the proton beam from the LINAC degrades through up to eight different BLIP targets placed in series. During the highest energy runs, the first target in the series is irradiated with protons up to 200 MeV and the last target is irradiated with protons up to 20 MeV. The proton beam current can reach 173 microAmperes, but the average range has been 80-166 microAmperes. During the irradiation process, the targets are cooled continuously by recirculating water in an 18-inch-diameter shaft, which is enclosed in a 30-foot underground tank. After irradiation, the targets are moved to the Radionuclide Research and Production Laboratory (RRPL), Building 801, for processing.

The principle gaseous radionuclides produced during target irradiation are oxygen-15 (half-life: 122.2 seconds) and carbon-11 (half-life: 20.38 minutes), due to the activation of cooling water and air. The BLIP facility exhaust effluent is monitored on a weekly basis for Gross Alpha, Gross Beta, and tritium emissions with particulate filters and silica gel cartridges at the location identified as 064-60. The sample collection and analyses are performed in accordance with Environmental Monitoring Standard Operating Procedure (EM-SOP-506), *Air Sampling at Radiological Emissions Facilities*, and 40 CFR 61 Appendix B, Method 114, prescribed by the US Environmental Protection Agency (EPA). Due to current BLIP operations, the estimated annual dose to the maximally exposed individual exceeds 0.1 mrem, the level at which EPA requires continuous emissions monitoring.

The latest authorization to construct and modify the BLIP facility stack was approved by EPA in August 2009, and the stack and sampling systems were last upgraded and modified to the ANSI N13.1-1999 standard before the start of the 2010 run season.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

__X Compliance
__X Support compliance
__X Surveillance
_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

For the BLIP facility to be in compliance with the NESHAPs regulations, radiological air emissions are measured on a continuous basis and characterized properly. The technical problem is the sampling of the exhaust effluent for the activation radionuclides created by interaction of the proton beam with the cooling water, which include tritium, Beryllium-7, Carbon-11, Nitrogen-13, Oxygen-15, and Sodium-22. The potential hazards associated with BLIP are tritium in water vapor form and Carbon-11, Nitrogen- 13, and Oxygen- 15 in gaseous form, as well as hazards from rare events such as target can failures. Sampling for tritium is conducted with silica gel, and sampling for particulates of alpha- and beta- emitting nuclides is conducted using two-inch-diameter particulate filters. The most significant gaseous effluents include Oxygen-15, with a 122.2-second half-life, and Carbon-11 (in CO_2), with a 20.38-minute half-life. These gaseous effluents decay via positron emissions and electron capture and contribute the most to the immersion dose in contaminated air, and therefore should be characterized to comply with regulations.

The radioactive gaseous emissions in the effluent cannot be captured by conventional methods, but their radioactivity is directly measured using a low-resolution gamma spectrometer with an in-line sampling system connected to the hot cell exhaust system. In addition, Carbon-11, Nitrogen-13, and Oxygen-15 spectra must be stripped to evaluate the potential for dose contribution from any of these radionuclides to be greater than ten percent of the total dose.

To be able to accurately quantify emissions during the entire year or for the period of an unusual event, the effluent flow rate must be measured and recorded on a periodic basis, and the accuracy of the flow rate measurement system must be verified on a periodic basis. The emissions monitoring system must also remain in continuous operation at all times since the exhaust system at BLIP operates continuously.

Step 2: Identify the Decision

The decisions for the BLIP monitoring program can be formulated as the following questions:

- Does the potential radiological dose to members of the public exceed one percent of the federal dose limit of 10 mrem per year?
- Is BNL in compliance with ambient air quality regulatory requirements?
- Have risk and dose to the members of the public exceeded any threshold values?
- Are facility emissions control and monitoring systems effective and robust?
- Are all actual and potential released radionuclides detected and identified?
- Which radionuclides, if any, contribute to dose in excess of the "10 percent of the dose" limit?

Step 3: Identify Inputs to the Decision

Conduct sampling and analysis in accordance with 40 CFR 61, Appendix B, Method 114. The following items need to be characterized before any dose estimates can be made. The inputs necessary for the decision include:

- Beam current, beam energy, water gaps between objects in the beam, and planned operations at BLIP
- Stack effluent flow rates—measured, characterized, and confirmed
- Short-lived gases emission rate—sampled, analyzed, and quantified
- Meteorological data
- Stack height, stack diameter, precipitation, and other variables
- Modeling of dose to maximally exposed off-site individual (MEOSI) using the current version of CAP-88 PC
- 40 CFR 61, Subpart H NESHAPs regulations
- Regulatory requirements (DOE Order 458.1)
- Analytical methods and detection limits (as described in this document)
- Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities: ANSI N13.1 - 2011
- Tritium – EPA Method 906
- Gross Alpha/Gross Beta – EPA method 900.0
- Results of alpha and gamma spectroscopy of the particulate filter
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality

Step 4: Define the Study Boundaries

The purpose of the study is to characterize the radioactivity of BLIP stack emissions based on prescribed NESHAPs regulations and ANSI N13.1-2011 standards by collecting representative samples from an acceptable sampling point in the BLIP stack. The bounding conditions for sampling the effluents include:

- Expected temperature range at potential sampling points in the stack
- Air effluent flow rates, composition, and particle size representative of stack flow
- Proper air effluent mixing and stable extraction point

Step 5: Develop the Decision Rules

If any radionuclide is identified that is not naturally occurring in the environment, **then** evaluate the raw data to confirm the presence of the radionuclide and compare the concentration with the derived concentration guide to assure regulatory compliance. Calculate the effective dose and base the decision on the following:

- **If** the effective dose to the MEOSI is less than one percent of the NESHAPs standard of 10 mrem, **then** no action is required.
- **If** the dose is greater than one percent of the NESHAPs standard of 10 mrem and the facility is not continuously monitored, **then** the facility is non-compliant, and an evaluation will be conducted in accordance with the BNL *Event/Issues Management* Subject Area.
- **If** trending of emissions data from continuously monitored facilities at BNL, compared to historic operational releases, indicates potential dose below 15 percent of the NESHAPs standard of 10 mrem, **then** no action is required.
- **If** trending of emissions data from continuously monitored facilities at BNL, compared to historic operational releases, indicates potential dose to the MEOSI may be greater than 15 percent of the NESHAPs standard of 10 mrem, **then** use actual sample analysis data to continually track the estimate of expected resultant dose using the current version of the CAP88-PC modeling program **and** inform management of the program producing the subject emissions as well as the management of EPD to determine if mitigation measures need to be taken.
- **If** the effective dose to the MEOSI approaches 50 percent of the NESHAPs standard dose of 10 mrem**,** **then** a request for authorization from the Brookhaven Site Office to exceed the administrative control limit (ACL) of five mrem will be required.
- If the effective dose to a MEOSI exceeds 50 percent of the NESHAPs standard of 10 mrem, then the facility is approaching non-compliance, and without emissions mitigation will be approaching

violation of EPA regulations. This may result in the need to apply mitigation measures to the BLIP facility to avoid exceeding the standard.

Step 6: Specify Acceptable Error Tolerances

The acceptable error tolerances for record sampling and control monitoring are listed below.

Factor or Consideration	Record Sampling	Control Monitoring
Frequency of Sampling	Continuous	Continuous
Frequency of Measurement	Weekly	Real-time
Overall Accuracy	± 30%	± 40%
Overall Precision	± 30%	± 40%
Sampling Accuracy	± 20%	± 20%
Sampling Precision	± 20%	± 20%
Measurement Accuracy	± 20%	± 35%
Measurement Precision	± 20%	± 35%
System Availability	> 95%	> 95%

Step 7: Optimize the Design

The air-monitoring program shall be optimized based on the surveillance data collected, audits, air surveillance assessments, the anticipated source term, and level of system robustness every calendar year. After collection of air emissions data for a year and proper characterization of the short-lived gases Carbon-11 and Oxygen-15, BNL will undertake a design review of the emissions system. The design basis shall assess the cost–benefit impact and consider the necessity of measures to decrease the amount of radioactive emissions.

For CY 2025, no changes shall be made to the monitoring system.

See Appendix B for the monitoring program for this DQO.

5.4 AIR MONITORING AT THE RADIONUCLIDE RESEARCH AND PRODUCTION LABORATORY (RRPL) (BLDG. 801)

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Tim Welty (631) 344-4212

SUMMARY OF PROPOSED CHANGES

For calendar year (CY) 2025, no changes are anticipated in the continuous emissions monitoring system at the RRPL.

DESCRIPTION AND TECHNICAL BASIS

The RRPL in Building 801 includes five semi-hot cells, three chemical processing hot cells, and three high-level hot cells for the handling and processing of radioactive materials. Three new hot cells were commissioned in CY 2023 to process targets for production of Actinium-225 (Ac-225). Metal targets irradiated at the Brookhaven LINAC Isotope Producer (BLIP) facility, and in the near future at the Cyclotron facility, are transported to the RRPL and radiopharmaceuticals are chemically extracted for medical use. Radioactive airborne emissions are generated as a result of procedures involving the processing of irradiated targets for the recovery of radioisotopes.

Each hot cell is provided with individual exhaust air filters, as well as a backup filter preceding discharge to a common duct leading to the Building 801 Main Exhaust stacks. Exhaust potentially containing airborne radionuclides released during the extraction process is drawn through an acid scrubber before going through multi-stage HEPA and High Efficiency Gas Adsorption (HEGA) filters and then to the Building 801 stacks. The RRPL emissions are monitored by sampling them with particulate filters, which are then tested for gross alpha/beta activity. The particulate filters also undergo alpha and gamma spectroscopy for alpha- and gamma-emitting particulates, and gaseous emissions are sampled with charcoal canisters for gaseous gamma emitters as well, with the advent of Thorium-232 targets. Radionuclides released to the atmosphere from RRPL operations have not been significant contributors to the site perimeter dose from the airborne pathway (less than one percent). This is not expected to change, but the potential exists for an increase in such emissions as processing production ramps up.

Department of Energy (DOE) facilities with airborne emissions that have the potential to deliver a radiation dose to a member of the public of greater than 0.1 mrem/yr. must be continuously monitored in accordance with National Emission Standards for Hazardous Air Pollutants (NESHAPs) requirements (40 CFR 61, Subpart H). The facilities with such emissions that fall below NESHAP levels require only periodic, confirmatory monitoring. The sample collection and analyses will continue to be done in accordance with Environmental Monitoring Standard Operating Procedure (EM-SOP-506), *Air Sampling at Radiological Emissions Facilities*, and 40 CFR 61 Appendix B, Method 114, prescribed by the U.S. Environmental Protection Agency (EPA).

In 2009, a decision was reached to decommission and demolish the 98-meter High-Flux Beam Reactor (HFBR) stack, which released the Building 801 emissions. Therefore, three new stacks were built on the roof of Building 801, with the modifications completed in August 2010. Historically, the emissions from Building 801 have been very low; therefore, authorization from the EPA was not required for the stack modification. Nonetheless, the three new stacks were constructed and modified to comply with ANSI N13.1-1999 for radioactive emissions sampling. Each stack has a 12,400-cfm exhaust fan and, at any given time, two fans are operational with a capacity of ~23,390 cfm.

The existing multi-stage HEPA and HEGA filters for the exhaust system were kept intact. An additional multi-stage HEPA and HEGA filter train for the new hot cells, named All-inclusive Production Hot Cells (AP Hot Cells), was added. Although the emissions from Building 801 are very small, the facility is continuously monitored as described above. In addition, the exhaust emissions from Ac-225 processing will require continuous spectroscopic monitoring as well.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ X Compliance
___ X Support
___ compliance X
____ Surveillance Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

- Laboratory operations that have the potential to impact the environment through discharge of radioactive airborne emissions must be monitored in accordance with NESHAPs.
- The source term of operations includes new alpha-emitting and gamma-emitting nuclides.
- Exhaust potentially containing radioactive airborne emissions from the facility must be measured and recorded for annual reporting.
- Exhaust emissions must comply with 40CFR61, Subpart H.
- Unplanned releases of radioactive airborne materials or gases must be detected and quantified.

Step 2: Identify the Decision

- Is BNL in compliance with ambient air quality regulatory requirements?
- Do dose and risk to members of the public exceed any threshold values?
- Are facility emissions control systems effective and robust?
- Which radionuclides, if any, contribute to offsite dose in excess of the "10 percent of the dose" limit?

Step 3: Identify Inputs to the Decision

Complete sampling and analysis in accordance with 40 CFR 61, Appendix B, Method 114. The following items shall be characterized before any dose estimates can be made. The inputs necessary for the decision include:

- Stack effluent flow rates
- Quantified emission rates
- Meteorological data, including wind data
- Agricultural data
- Radionuclide emissions data
- Stack height, stack diameter, and other variables
- Model the dose to the maximally exposed off-site individual (MEOSI), using the current version of CAP88-PC, according to 40 CFR 61, Subpart H NESHAPs regulations
- Regulatory requirements (DOE Order 458.1 [2020], *Radiation Protection of the Public and the Environment*; DOE Order 436.1A [2023], *Departmental Sustainability*)

- Analytical methods and detection limitsSampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities: ANSI N13.1 (2011)
- Gross Alpha/Gross Beta Particulate Filter Analysis – EPA Method 900.0
- Gamma composite sampling and analysis – DOE HASL300
- Charcoal cartridge sampling and analysis for noble gases – DOE HASL300
- Real-time gamma detection counting and count channel analysis
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality

Step 4: Define the Study Boundaries

Based on prescribed NESHAPs regulations and the ANSI N13.1-2011 standards, representative effluent and analysis samples are collected from an acceptable sampling point in the Building 801 main exhaust duct. The following parameters shall form the basis for the design of the system for sampling the effluents:

- Expected temperature range at potential sampling points in the stack
- Air effluent flow rates, composition, and particle size
- Proper air effluent mixing and stable-flow extraction point

Step 5: Develop the Decision Rules

If any gross alpha-, gross beta-, or gamma-emitting activity above the normal range is identified that is not naturally found in the environment, **then** use alpha and gamma spectroscopy results to identify the isotopes generating the activity. Make a comparison with the derived concentration guide to assure regulatory compliance. Calculate effective dose and base the decision on the following statement:

If the calculated dose from this facility, compared to historic operational releases, indicates a resultant dose to the MEOSI, then continually track the estimate of expected resultant dose using the current version of the CAP88-PC modeling program and inform the management of the program producing the subject emissions as well as the management of EPD to determine if mitigation measures need to be taken.

Step 6: Specify Acceptable Error Tolerances

The acceptable error tolerances for record sampling and control monitoring are listed below.

Factor or Consideration	Record Sampling	Control Monitoring
Frequency of Sampling	Continuous	Continuous
Frequency of Measurement	Weekly	Real-time
Overall Accuracy	± 30%	± 40%
Overall Precision	± 30%	± 40%
Sampling Accuracy	± 20%	± 20%
Sampling Precision	± 20%	± 20%
Measurement Accuracy	± 20%	± 35%
Measurement Precision	± 20%	± 35%
System Availability	> 95%	> 95%

The baseline condition (i.e., the null hypothesis [H_o]) was established for the emissions rate.

Step 7: Optimize the Design

The emissions monitoring program shall be optimized based on the surveillance data collected, audits, and air surveillance assessments every calendar year.

In CY 2025, the design of the CEMS is anticipated to remain stable and without significant changes.

See Appendix B for the monitoring program for this DQO.

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6 AIR SURVEILLANCE

CHAPTER CONTENTS

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6.1 Radiological Air Monitoring at the BNL Site

DQO Start Date January 1, 2003

Implementation Date January 1, 2025

Point of Contact Tim Welty (631) 344-4212

Summary of Proposed Changes

In calendar year (CY) 2024, new active air monitoring instruments in each of the four perimeter air monitoring stations were installed and became operational. Three more monitoring instrument sets are expected to be deployed in CY 2025. No additional changes in radiological air monitoring are expected.

Description and Technical Basis

Airborne emissions can be generated from various facilities at Brookhaven National Laboratory (BNL) during operations, research, and scientific activities. The Laboratory's environmental protection program implements engineering and administrative controls to detect, reduce, prevent, and/or eliminate air pollutants from emission to the environment. Pollution prevention and control technologies, such as high-efficiency particulate air (HEPA) filters or charcoal high-efficiency gas (HEGA) air filters, are applied when potentially toxic or radioactive pollutants are possible. BNL conducts both air surveillance and facility emissions monitoring to assess the adequacy of these controls to protect human health and determine any impact from air pollutants on the environment.

Environmental surveillance at BNL involves the analysis of particulate matter collected on filters, water vapors chemically trapped in a collection medium, real-time counting of effluent sample air flowing through a steady-state volume of flowing air, and real-time monitoring of ambient air around the Lab site. Specific diffuse sources, where particulates or gases could become airborne due to environmental restoration activities, are also monitored, as needed. Dose impacts that have the potential to exceed National Emission Standards for Hazardous Air Pollutants (NESHAPs) limits are calculated to show compliance with Department of Energy (DOE) requirements, federal and state laws and regulations, and industry standards.

Drivers for Air Monitoring at the BNL Site

__X_ Compliance
__X_ Support compliance
__X_ Surveillance
____ Restoration

- DOE Order 436.1A (2023), *Departmental Sustainability*, and DOE Order 458.1 (2020), *Radiation Protection of the Public and the Environment*, define standards for controlling exposures to the public from operational DOE facilities.
- Regulation 40 CFR 61, Subpart H, administered by the US Environmental Protection Agency (EPA), requires DOE facilities to monitor for radiological discharges and to estimate the radiological dose to the public.
- Guidance on emissions sampling is provided in the Environmental Radiological Effluent Monitoring and Environmental Surveillance (DOE-HDBK-1216-2015),

- "Standards of Performance for New Stationary Sources" (40 CFR 60), and the NESHAPs-cited American National Standards Institute standards (ANSI N13.1-2011).
- DOE Order 458.1 establishes a primary radiation protection standard for members of the public at 100 mrem/yr effective dose equivalent (EDE) for prolonged exposure from all sources, including air emissions. For air, derived concentration guides (DCGs) listed in DOE Standard 1196 specify the concentrations of radionuclides that can be inhaled without exceeding the DOE primary radiation protection standard for the public. The order also states that facilities should have the capability, consistent with the types of operations conducted, to monitor routine and unplanned releases and to assess dose impact to members of the public.
- BNL's air monitoring is governed by the Clean Air Act (CAA). The fundamental objective of the CAA is to protect human health and the environment from air pollutants. The CAA enables EPA to define and establish standards and criteria for air pollutants that are of major concern. These pollutants and the National Primary and Secondary Ambient Air Quality Standards (NAAQS) are defined in 40 CFR 50. In 1990, Section 112 of the CAA, NESHAPs 40 CFR 61, was amended by Title

  III. Title III lists 189 hazardous air pollutants (HAPs), which include radionuclides, calls for the reduction of toxic substance emissions to the air, and imposes new standards on both new and existing sources. While standards have not yet been set for many hazardous air pollutants, a dose limit has been established for radionuclide emissions.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

BNL's research operations and scientific activities could potentially impact human health and the environment. Therefore, an emissions surveillance program to quantify radiological emissions is a regulatory requirement. DOE–HDBK–1216-2015 states that all DOE or DOE contractors conducting radiological activities must develop and implement a documented Environmental Radiological Protection Program. This program must describe the methods used to achieve compliance with DOE 458.1 and should: (1) demonstrate compliance with applicable requirements, (2) confirm adherence to DOE environmental and radiation protection policies and directives, and (3) support environmental management decisions. It should also provide for properly and accurately measuring radionuclides in their effluents and in the ambient environmental media with provisions for the detection and quantification of unplanned releases of radionuclides to the environment.

This guidance document also specifies that the surveillance program shall characterize the radiological conditions at off-site environment locations, estimate public doses, confirm predictions of public dose based on effluent monitoring data and modeling, and provide compliance data for all applicable environmental regulations. The guidance document further states that surveillance may be necessary for legal reasons, public concerns, and/or state and local commitments.

The historical tritium air surveillance data collected at the Laboratory has shown that tritium concentrations have been well below the minimum detection level (MDL) at most sampling locations following the shutdown of the reactors. Therefore, by streamlining the sampling program while retaining the capability to detect unplanned releases, the Laboratory has eliminated the redundant locations for air sampling for tritium. While air surveillance is necessary and is required to show compliance with the different regulations, sampling for airborne tritium at the blockhouses is believed to be sufficient to monitor the few sources of tritium left on site and to document compliance with EPA and DOE requirements. A reduction in sample collection must support budget constraints on the environmental protection program. In addition, because less-detailed analysis of samples, such as gross alpha/gross beta analysis rather than gamma composite analysis, might provide sufficient protection, gross alpha/gross beta sampling is implemented to achieve savings in monitoring costs as well.

Finally, blind duplicate quality assurance sampling is conducted to test the precision of sampling and analyses. At present, the duplicate station is permanently stationed at P7, which does not allow testing the sampling precision at other environmental sampling stations, although P7 is located downwind of the most significant emission points and in the predominant wind direction. The rotation of the duplicate sampling station would enhance the capability to compare and test the precision and accuracy of all the sampling locations rather than only the P7 location, as is currently done.

Step 2. Identify the Decisions

The desired decisions for the air surveillance and monitoring program are:

- Will the number of air samples collected and their frequency of collection be adequate to detect any potential impact from research operations?
- Will the regulatory compliance requirements for ambient air quality be met if air monitoring is reduced?
- Will the capability to confirm the effectiveness of current emission control systems continue to be adequate using reduced monitoring?
- Will the risk and dose to the members of the public exceed any threshold values, and will the data collected continue to be defensible?

Step 3: Identify Inputs to the Decisions

Environmental air surveillance samples shall be collected in accordance with Environmental Monitoring Standard Operating Procedures (EM-SOPs):

- BNL EM-SOP-500, Air Sampling at Permanent Monitoring Stations
- BNL EM-SOP-501, Tritium Air Sampling at Portable Stations
- Data from active monitors at P-stations and various other site locations

The particulate matter sampling media consists of a 5-cm (diameter) glass fiber air filter with a backing to hold the filter in place. While air sampling pumps generally run continuously, samples are collected weekly and counted for gross alpha and gross beta radiation using an anti-coincidence proportional counter. Environmental air sample criteria are based on the premise that representative samples of the ambient air are taken continuously. The preferred sampling height is 1.5 meters above the ground and away from traffic, large buildings, or similar obstructions. Analyses for gamma-emitting nuclides on monthly composites are not performed, since review of historical data has shown no detection of such radionuclides attributed to BNL operations.

At the P-stations, the ambient air is sampled for tritiated water vapor by continuously drawing streams of air through silica gel cartridges. After collection, any entrapped liquid is extracted from the desiccant and analyzed for tritium using liquid scintillation techniques. In all cases, flow rates, media volumes, and exposure periods are such that the media are not likely to be saturated during the sampling period; high collection efficiencies are achieved in accordance with the manufacturer's recommendations.

Specific inputs include:

- The highest concentrations of the pertinent radionuclide expected above the MDL near operations and their dispersion due to meteorological conditions;
- Representative radionuclide concentrations in areas where public health is a concern; occupancy factors and doses to the public via the air pathway from operations must remain as low as reasonably achievable relative to standards;
- The existence of areas known to have potential for contamination; an increase in contamination by resuspension of particulates in those areas would require air monitoring;
- Frequency of review of actual emissions from facilities and in areas with surface and soil contamination;
- Pre-operational baseline data and any environmental surveillance data for areas near waste units that are scheduled for treatment or restoration, to assess the integrated effects of individual site influence over time;
- Measurements at the site perimeter and in nearby communities;
- Continuous operation of the remaining on-site air monitors, including new real-time air monitors;
- Use of thermo-luminescent dosimeters (TLDs) to assess the environmental doses from unusual releases, if any;
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality;
- Trends of background concentration levels with historically collected data in each wind sector to assess the impact of site operations, if any.

Step 4: Define the Study Boundaries

Since 1972, the perimeter blockhouse ambient air monitoring stations have collected weapons test fallout data and natural background data. These stations are located in all the predominant wind directions and, where warranted, by site-specific meteorological conditions. Four of the six air particulate sample collection stations are situated within dedicated blockhouses. These sample collection stations (P2, P4, P7, and P9) are located at the boundary perimeter. The population surrounding the Laboratory is beyond the sampling stations, which allows for the opportunity to detect and mitigate any unplanned releases.

Step 5: Develop the Decision Rules

If the tritium concentrations are greater than twice the 12-month trailing average, **then** request re-analysis of the sample, investigate the source of elevated tritium at that location, and implement corrective actions. The project manager will review all detections above the limits for comparison with historical values and significance. **If** the gross alpha concentration in the filters is greater than twice the minimum detection limit (MDC), **then** request re-analysis of the sample and collect more samples in the vicinity. The project manager will review all detections above the limits for comparison with historical values and significance. **If** the gross beta concentration in the filters is greater than twice the 12-month trailing average, **then** request a re-analysis of the sample and collect more samples in the vicinity. If one or more active monitoring stations senses a count rate of 200 counts per minute above the established background, then the display of the count rate will register an alert signal on the display. The project manager will review all detections above the limits for comparison with historical values and significance. All values greater than the above-stated gross alpha/beta concentration and/or gamma background shall trigger an investigation of potential sources in that wind sector.

Step 6: Specify Acceptable Limits on Decision Areas

Air surveillance data are analyzed with the intent of satisfying the following goals:

- Estimate concentrations at each sampling point.
- Compare current concentrations to previous concentrations to identify changes or inconsistencies.
- Compare concentrations to established DCGs or permit limits.
- Compare concentrations at a single location, or a group of locations, to control or background locations and evaluate the reliability of the comparisons.

Step 7: Optimize the Design

The duplicate mobile station at P7 shall be moved from one blockhouse to another and kept at each blockhouse for a period of two months to test the precision of all the environmental sampling and analyses. Facility process data is reviewed and the effectiveness of emission controls in the relevant facilities and other remediation projects for potential source of emissions, if any, is assessed.

The air monitoring program shall be optimized based on the surveillance data, audits, and air surveillance assessments during the calendar year.

See Appendix B for the monitoring program for this Data Quality Objective.

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7 DIRECT RADIATION: TLD PROGRAM

CHAPTER CONTENTS

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7.1 THERMOLUMINESCENT DOSIMETERS (TLDS)

DQO START DATE January 1, 2004

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Tim Welty (631) 344-4212

SUMMARY OF PROPOSED CHANGES

One off-site thermoluminescent dosimeter (TLD) was taken out of service in calendar year (CY) 2024 due to retirement One off-site location will be sought in early 2025 to maintain full, 16-sector TLD coverage off site around BNL.

DESCRIPTION AND TECHNICAL BASIS

The regulatory dose limit set by the Department of Energy (DOE) for members of the public is an effective dose equivalent (EDE) of 100 mrem (1mSv) in a year from all DOE activities via all environmental pathways. The Environmental Protection Agency (EPA) dose limit for airborne emissions under the Clean Air Act (CAA) for members of the public is 10 mrem (0.1 mSv) in a year via the inhalation and immersion pathways. The EDE includes the deep dose equivalent from yearly exposures to radiation sources external to the body (measured with TLDs), plus the committed effective dose equivalent from radionuclides taken into the body (e.g., inhalation, ingestion, and skin absorption).

Brookhaven National Laboratory (BNL) measures environmental background radiation through a network of on- and off-site TLDs suspended approximately one meter above the ground. These devices measure direct, penetrating beta/gamma radiation originating from cosmic and terrestrial sources, as well as any contribution from Laboratory operations. The off-site exposures are assumed to be true natural background doses with no contribution from Laboratory operations. On-site and off-site external doses are compared with each other statistically to estimate the contribution, if any, from BNL operations above the natural background level of radiation.

The scientific principle on which TLDs function is that when certain crystals contained in the TLD holder are exposed to penetrating gamma or neutron radiation, the impurities in the crystals' low-temperature trapping sites for electrons are excited to higher energy states proportional to the dose received. These electrons remain in a high-energy state at normal ambient temperatures. The crystals are then heated in a controlled manner to release, measure, and record the stored energy, which is called "processing".

The processing of TLDs by the BNL Personnel Monitoring Group consists of three phases. First, the TLD card is heated, causing the electrons to be released from the trapping sites and dropped to a lower energy state, which results in the emission of photons in the form of visible light; the intensity of emitted light is proportional to the original absorbed dose of radiation. Next, the light photons are measured with a photomultiplier tube and the light intensity measurement is recorded. Finally, after the TLD is read, the TLD is heated and read a second time for any residual dose to ascertain that all the gamma radiation-induced stored energy has been released, referred to as "annealing." This verifies that the TLD is ready for re-use in the field.

The environmental TLDs used at BNL are composed of calcium fluoride (CaF_2: Dy) doped with Dysprosium or lithium fluoride (LiF: Mg, Ti) doped with magnesium titanium. The accuracy of the TLD is verified using sources of known radiation exposure rates. For quality control, the Laboratory also participates in inter-comparison programs with other sites. The Personnel Monitoring Group in the Radiological Control Division processes environmental TLDs at BNL. The DOE Laboratory Accreditation Program accredits that laboratory operation.

The TLD used for neutron measurements at BNL is the Harshaw badge model 8814, which contains the neutron chip for measurement. Personnel Monitoring supplies and reads the TLDs after exposure, and subsequently reports the results to the Radioactive Airborne Emissions Subject Matter Expert on a quarterly basis.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
_X_ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

This document was developed based on the EPA's Data Quality Objective (DQO) process. The DQO process is used to clarify objectives, define the type of data, and specify levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decision-making.

Step 1: State the Problem

Radioactive materials and/or airborne emissions sources can contribute to ambient radiation levels. These sources include routine facility emissions and effluents, equipment and machines that generate radiation, environmental restoration activities, and on-site vehicle transport of sources or radioactive wastes. The environmental air and surface water pathways may also transport radionuclides from emission or effluent sources (point or diffuse) to locations near the public and/or terrestrial and aquatic biota. Many of these released radionuclides produce penetrating particles and photons (i.e., beta and gamma radiation) during decay processes in media that are external to an organism. This external radiation must be monitored to minimize exposure and demonstrate compliance with regulatory limits.

Step 2: Identify the Decision

The primary decision to be made using data from direct radiation monitoring is whether the dose, if any, to members of the public originates from BNL sources and, if so, whether the dose is below the regulatory dose limits set by DOE and EPA. The following questions are considered in support of the decision-making:

- Are the external exposure measurements that were taken at locations with public or non-involved worker access higher than historical measurements and survey results?
- Is the dose below the regulatory compliance limits set by EPA and DOE?
- Are the site perimeter external doses reasonable and in the range of natural background?
- Is the potential dose to members of the public from the external dose pathway as low as reasonably achievable?
- Is the radiation exposure near specific facilities or waste sites contributing to the cumulative dose?
- Are all emission/source terms taken into consideration during placement of TLDs?

- Does the placement of background TLDs accurately portray background levels of radiation?
- What is the dose contribution from thermal neutrons?

Step 3: Identify Inputs to the Decision

Currently, 63 environmental TLDs are deployed on the BNL site and 16 TLD's are deployed off site. An additional 30 control TLDs are stored in a lead-shielded container in Building 490. The average dose of the control TLDs is reported annually in the annual BNL Site Environmental Report as a reference dose measure labeled "075-TLD4."

The primary purpose of monitoring direct radiation is to measure the dose, if any, to members of the public from gamma radiation sources at BNL. The main objectives are to:

- Obtain ambient external dose measurements from potential sources at the BNL site;
- Obtain ambient external background dose measurements from full-occupancy, off-site locations inhabited by members of the public and uninvolved workers;
- Verify that the potential dose to members of the public from external pathways remains as low as reasonably achievable (the ALARA principle);
- Obtain radiation exposure data near facilities with radiation-generating machines or equipment and near radioactive waste sites to assess the integrated effect of the operations on overall exposures;
- Obtain dose measurements at the site perimeter and adjacent communities to ensure that external exposure from BNL operations is known at various distances and to confirm that exposure is in the range of background levels;
- Measure on- and off-site external radiation exposures to assess the environmental dose from unplanned releases, if any, and for comparison/assessment purposes;
- Document and maintain a record of exposure to show compliance with DOE and EPA dose limits.

At present, on- and off-site areas are divided into grids and the TLD numbers are assigned based on these grids. For more detailed information, refer to Environmental Monitoring Standard Operating Procedure (EM-SOP-202), *Sample Location Identification*.

As part of a voluntary program implemented by BNL employees, 16 TLDs are placed off site, nominally with one in each of all 16 wind sectors to monitor background dose levels. The placement of TLDs in these 16 off-site locations provides dose measurement which surrounds the Lab site.

Some facilities on the BNL site have the potential to generate high energy neutrons ranging from 0.025eV to >100 MeV. The Lab's Alternating Gradient Synchrotron (AGS) accelerates protons to energies up to 30GeV and heavy ion beams to 15 GeV/amu. The Relativistic Heavy Ion Collider (RHIC) has two beams circulating in opposite directions and can accept either protons or heavy ions up to gold. Protons are accelerated up to a final energy of 250 GeV and gold ions to 100 GeV per nucleon. Passive monitoring devices for neutrons provide retrospective indication of any change in radiological conditions to protect the environment and residents within the BNL vicinity. Therefore, to confirm and ascertain that there is no neutron dose contribution to the public, 11 pairs of neutron TLDs are placed near the Laboratory boundary on the west side.

Important factors that have influenced the decision to keep the TLD locations largely the same (in alignment with the previous regime) were the capability to look at the long-term trend analysis from previously collected historical data, the comparability of the recent TLD data with the enormous quantity of baseline data, the population distribution around the site, the site-specific meteorological conditions, and the recreational activities of the community adjacent to the site.

The types of radiation causing most of the external exposures are gamma photons and beta particles. Because the site is large and there are no longer any large-scale potential sources such as reactors, the maximum predicted exposure or concentration would typically be to on-site receptors rather than off-site receptors. Historical data support the approach of designing the measurement methods mainly for photon sources, but pure beta emitters can exist in the environment unaccompanied by gamma emitters (e.g., strontium-90). The following inputs are required to support decision-making based on TLD data:

- Analytical results are reviewed by project managers in accordance with EPD data review procedures to ensure data is of acceptable quality;
- TLD doses measured at BNL monitoring locations are compared to both recent and historical background measurements to determine the contribution, if any, from BNL operations;
- TLD doses measured at off-site monitoring locations are compared to both recent and historical background measurements to spot long-term trends in the data;
- Dose contributions from neutron TLDs are evaluated;
- TLDs are read, annealed, and reported by the Personnel Monitoring Group within BNL's Radiological Control Division;
- TLDs undergo a Cs-137 relative response test annually with sources traceable to the National Institute for Standards and Technology;
- Environmental TLDs are exchanged quarterly and read using Harshaw TLD readers and associated EM-SOPs and quality control;
- The dose units are reported in rem/day or rem/quarter with the number of exposure days documented in the report prepared by the Personnel Monitoring Group;
- The Personnel Monitoring Group corrects the TLD measurements for any residual dose found during the annealing process;
- Processing (annealing, calibration, reading, and testing) of the environmental dosimeters is done in accordance with the American National Standards Institute (ANSI) N13.29 standard.

Step 4: Define the Study Boundaries

The frequency for exchanging TLDs deployed in the field is determined on the basis of the potential for detecting external radiation levels above natural background radiation and the characteristics of the crystal used in the TLDs. For the environmental TLDs in use on site, a quarterly exchange frequency is considered optimal (so "fading" is minimal). This interval was determined to be the approximate exposure time needed to generate statistically distinguishable results.

External radiation is measured with consideration for the types and levels of exposure expected from the various pathways, transport media, and other direct radiation sources. Examples of critical environmental media or sources that present the potential for external radiation exposure are airborne cloud passage and exposure to contaminated surface water, vegetation, sediment, or soil. Regulatory dose limits have not changed and the burden to show regulatory compliance with ALARA limits continues to be required of BNL's environmental surveillance program. At present, the major facilities at the Laboratory that can contribute to ambient external exposure are the Brookhaven LINAC Isotope Producer (BLIP), the AGS, the Tandem Van de Graaff, the Booster Storage Ring, RHIC, the Former Waste Management Facility (FWMF), the Radionuclide Research and Production Laboratory, and the National Synchrotron Light Source II (NSLS-II). NSLS-II increased beam current from 400 mA to 500 mA several times in CY 2024. There may be more operation time at 500 mA in CY2025 than CY2024.

In an accelerator environment (e.g., AGS, RHIC), when a high-energy charged particle leaves the vacuum confines of the accelerator, nuclear fragments may be produced along the path of the energy particle or when it collides with other matter. TLD locations are selected near the accelerators to fulfill the surveillance objectives. Also, the radioactive source information is used to determine the potential locations for placement of TLDs and the timely detection of exposures, if any. One facility known to releases airborne gaseous products, and therefore is significant from an environmental monitoring point of view, is the BLIP facility.

Meteorological factors also play a part in the selection of TLD locations. At BNL, the ground-level winds are from the southwest during the summer, from the northwest in the winter, and with equal frequency from these two directions during the spring and fall. There is an ongoing need for dosimeters that provide background monitoring for public assurance, as well as dosimeters that would only be used in emergencies, to confirm emission controls or for dose modeling. Fulfilling these needs requires TLD placement in off-site locations that are generally upwind (for the background locations) and in population centers located downwind from the laboratory in the prevailing wind directions.

Of the 63 TLDs on site, 36 were posted at natural background locations within the BNL site boundary for comparison with the off-site TLDs (Table 7.1-1 below).

Table 7.1.1. Ambient Background TLD Locations at BNL

TLD Number	Location	Rationale for Placement
011-TLD1	North Firebreak	Measure natural background dose
013-TLD1	North Firebreak	Measure natural background dose
030-TLD1	NE Firebreak	Measure natural background dose
037-TLD1	S-13	Measure natural background dose
043-TLD1	North Access Road	Measure natural background dose
043-TLD2	North of Meteorology Tower	Measure natural background dose
049-TLD1	East Firebreak	Measure natural background dose
053-TLD1	West Firebreak	Measure natural background dose
055-TLD1	Fence - Thomson & Fifth	Measure natural background dose
055-TLD2	Bldg. 935 Notice Shelter	Measure natural background dose
063-TLD1	West Firebreak	Measure natural background dose
065-TLD1	Fence – Bldg. 820	Measure natural background dose
066-TLD1	Waste Management Facility	Measure natural background dose
073-TLD1	Meteorology Tower	Measure natural background dose
080-TLD1	East Firebreak	Measure natural background dose
082-TLD1	West Firebreak	Measure natural background dose
084-TLD1	Tennis Court	Measure natural background dose
085-TLD1	Building 735	Measure natural background dose
085-TLD2	Upton Gas Station	Measure natural background dose
085-TLD3	NSLS-II LOB 745	Measure natural background dose
086-TLD1	Baseball Fields	Measure natural background dose
086-TLD2	NSLS-II LOB 741	Measure natural background dose
086-TLD3	NSLS-II LOB 742	Measure natural background dose
090-TLD1	North St. Gate	Measure natural background dose
095-TLD1	NSLS-II LOB 744	Measure natural background dose
096-TLD1	NSLS-II LOB 743	Measure natural background dose
105-TLD1	South Firebreak	Measure natural background dose
108-TLD1	Water Tower	Measure natural background dose
108-TLD2	Tritium Pole	Measure natural background dose
111-TLD1	Trailer Park	Measure natural background dose
122-TLD1	South Firebreak	Measure natural background dose
126-TLD1	South Gate	Measure natural background dose
P-2, P-4, P-7, and S-5	Perimeter Blockhouses	Measure natural background dose and compare with historical data

The remaining on-site TLDs are posted at various facility monitoring locations and are categorized as Facility Area Monitors (FAM). The FAM dosimeters are deployed in locations where there are known sources of potentially higher external radiation dose, such as the sky shine phenomenon, possible beam loss, loss of shielding, or near beam stops. These dosimeters do not represent the true environment background dose but could have elevated dose contributions from operations, any of the above-stated causes, or from an emergency scenario. If data from the FAM dosimeters were used to calculate the annual on-site average dose, the value would be inflated and incorrect. The primary purpose of the FAM TLDs is to measure and monitor dose due to known sources or to unplanned releases.

Five TLDs are in the vicinity of the AGS to monitor the ambient external dose rates in that area (Table 7.1.2).

Table 7.1.2. AGS TLD Locations

TLD Number	Location	Rationale for Placement
074-TLD1	Bldg. 560	Occupied area/background
074-TLD2	Bldg. 907	Occupied area/background
054-TLD1	Bldg. 914	Beam stop/Sky shine
054-TLD2	Northeast of Bldg. 913B	Beam stop/Sky shine
054-TLD3	Northwest of Bldg. 913B	Beam stop/Sky shine

Radiation external to the RHIC tunnel is generated by facility operations. The radiation field consists mainly of neutrons, muons, and gamma radiation. The beam stops are expected to account for 85 percent of the total beam loss energy. Fifteen TLDs are deployed near the RHIC Ring, beam stops, and occupied buildings (Table 7.1-3).

Table 7.1.3. RHIC TLD Locations

TLD Number	Location	Rationale for Placement
025-TLD1	Bldg. 1010 Beam Stop 1	Beam Stop/shielding
025-TLD4	Bldg. 1010 Beam Stop 4	Beam Stop/Shielding
027-TLD1	South of Bldg. 1002A	Occupied areas/study
027-TLD2	East of Bldg. 1002D	Occupied areas/study
034-TLD2	Bldg. 1008 Collimator 4	Beam Collimator
036-TLD1	East side of Bldg. 1004B	Occupied area/study
036-TLD2	East corner of 1004	Occupied area
044-TLD1	Bldg. 1006	Occupied area
044-TLD2	South of Bldg.100E	Occupied area
044-TLD3	South of Bldg.1000P	Occupied area
044-TLD5	North of Bldg. 1000P	Occupied area
045-TLD1	Bldg. 1005S	Occupied area
045-TLD2	East of Bldg. 1005S	Occupied area
045-TLD4	SW of Bldg. 1005S	Occupied area
045-TLD5	WSW of Bldg. 1005S	Occupied area

Data from the S-6 location near the FWMF, together with previously collected TLD external dose data, suggests that there are radiation sources near the S-6 blockhouse location. The potential sources in this area could be contaminated materials stored within the fenced area, materials being repackaged for disposal at an off-site licensed location, or contaminated media (e.g., soils). To investigate the extent of contamination as well as the external dose rate at this location, four additional TLDs (088-TLD1 through 088-TLD4) are posted at the S-6 ambient air sampling location, equidistant from each other, on the enclosure fence of the FWMF.

Building 356 houses one Cobalt-60 source, one Am-Be source, and five small Californium-252 sources. This building is being monitored because previous TLD readings were higher than the natural background dose. The original TLD (075-TLD3) has been supplemented with an additional TLD, 075- TLD5, which is located at the corner of Building 356 to record the dose rate.

Twelve TLD pairs that contain the neutron chip were posted in 2010 to evaluate neutron dose from the AGS and RHIC facilities (Table 7.1-4). As mentioned earlier, one pair was converted to a pair of environmental TLDs and moved to the NSLS-II in the third quarter of 2017; eleven TLD pairs remain.

Table 7.1.4. Neutron TLD Locations

TLD#	Location	Rational for Placement
025-TLD-N2	Bldg. 1010 Beam Stop	Beam Stop/shielding
034-TLD-N1	Bldg. 1008 Collimator	Beam Collimator
034-TLD-N2	Bldg. 1008 Collimator	Beam Collimator
043-TLD-N1	Upton Road/North Gate	Occupied Area
043-TLD-N2	White Pine Path/Canopy Road	Proximity to Site Boundary
042-TLD-N1	RHIC W-line Beam Stop	Beam Stop/Shielding
042-TLD-N2	West 5th/Canopy Road	Proximity to Site Boundary
054-TLD-N1	J-10 beam Stop	Beam Stop/Shielding
054-TLD-N2	LINAC to Booster transition (EBIS)	Beam Stop/Shielding
054-TLD-N3	BLIP Area	Soil Activation
064-TLD-N1	Booster Stop	Beam Stop/Shielding

Step 5: Develop the Decision Rules

The annual BNL Site Environmental Report shall be used as the reporting method and as a record of dose for members of the public. **If** the annual average dose for an off-site TLD is statistically outside the range of 60 to 76 mrem at the 2σ confidence interval, **then** an investigation into the cause of higher/lower dose at the off-site location would be performed. **If** the annual dose for on-site TLDs is statistically outside the range of 66 to 85 mrem at the 2σ confidence interval, **then** an investigation into the cause of higher/lower dose at the on-site location would be performed and corrective action taken to reduce the dose to normal background levels.

Perform a statistical test to determine whether the variability in the on-site, off-site, and natural background exposures is statistically different. **If** the variability is higher than normal (based on historical data), **then** notify the facility manager of the need to implement corrective actions. **If** the TLD readings continue to remain above normal background, **then** access to radiological areas may be restricted, radiological postings may be necessary, or other corrective actions will be taken. The Radiological Control Division Manager and the Environmental Protection Division Manager shall be informed about the above-background exposure rate at the facility or area. **If** a TLD is missing, **then** the annual dose is calculated as four times the average quarterly dose, determined from available data. **If** TLDs are wet, damaged, or found on the ground, **then** they are not accepted for use in reporting monitoring data. **If** an unplanned release occurs, **then** the TLDs in the upwind and downwind directions shall be immediately retrieved and processed to estimate the dose to members of the public. **If** intermittent or sporadic operations have a significant potential for elevating environmental exposures, **then** survey frequencies shall be increased. **If** the quality control program does meet the ANSI standard, **then** the dose data shall be evaluated for usability and reportability.

Step 6: Specify Acceptable Error Tolerances

The TLD readings' arithmetical average, normalized to 365 days, would be acceptable at 72 ± 8 mrem/year at 2σ. Sampling frequencies for on-site TLDs may require adjustments to reflect changes, such as the potential for elevated exposure rates due to modifications in operations or the transportation of radiation sources.

Step 7: Optimize the Design

The TLD data are evaluated on a quarterly basis to upgrade the monitoring program until dose rates are at normal background levels or until a radiological boundary sign is posted. BNL's personnel dosimetry program undergoes the DOE Laboratory Accreditation Program evaluation every two years and must meet specified inter-laboratory comparison performance goals. The accreditation program is specifically for dosimeters worn by personnel to monitor the dose they receive. Although no comparable DOE accreditation program exists for environmental monitoring, the Laboratory has participated in the field testing of a proposed comparable program and has incorporated the key features of that program into the

BNL environmental dosimetry program.

The quality control features in this program are:

- Calibration, maintenance, and audits of the TLD reading/recording system
- Anomalous data evaluation
- Personnel training
- Procedures and records maintenance

The quality control program within the Personnel Monitoring group maintains routine quality control of the TLD process cycle. The quality control program provides a measure of the quality of the complete TLD processing cycle. Inter-comparison studies are conducted to determine and document TLD processing performance.

Anomalous TLD results are evaluated promptly to confirm or dismiss them. Investigation into an anomalous result includes, as necessary, verification of the quality of the result (sampling and analytical aspects), questioning staff at facilities near the location with anomalous results about unusual situations, reviewing nearby air sampling results, and following up with immediate portable instrument measurements and/or gamma spectroscopy.

The TLDs are handled carefully during transport to keep them away from significant external radiation fields that would generate false positive data. Comments describing any unusual handling of TLDs or any findings that may affect TLD results are recorded in the BNL Field Sampling Team's field notebook. Sample collection and handling procedures are documented in EM-SOP 502, *Placement and Collection of Thermoluminescent Dosimeters*.

See Appendix B for the monitoring program for this DQO.

8 FLORA, FAUNA, PRECIPITATION, SOILS, AND PECONIC RIVER

CHAPTER CONTENTS

Section Page

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8.1 PECONIC RIVER FISH SURVEILLANCE MONITORING

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Kathy Schwager (631) 344-8471

SUMMARY OF PROPOSED CHANGES

No changes are proposed for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Laboratory (BNL) has historically carried out surveillance monitoring of fish, aquatic vegetation, sediment, and water within the Peconic River and control locations. The purpose of the surveillance monitoring has been used to evaluate impacts from reactor operations, Sewage Treatment Plant (STP) operations, environmental management programs (Comprehensive Environmental Response, Compensation and Liability Act [CERCLA]), and the Peconic Estuary Program. Historic data typically indicates the presence of cesium-137 (Cs-137), various heavy metals, polychlorinated biphenyl (PCB), and certain pesticides within the various aquatic media at locations on site, with declining concentrations downstream of the Laboratory. PCBs and pesticides have also been detected in control locations not impacted by BNL operations. Historic data from the Peconic River consistently indicates that there is no effect from BNL operations far downstream of the site boundary and the current level of surveillance monitoring is sufficient to document known contaminants onsite at BNL.

Changes to the BNL State Pollutant Discharge Elimination System (SPDES) permit for the STP resulted in moving the discharge from the Peconic River to groundwater recharge basins to the southeast of the STP in September 2014. This resulted in a significant change in the extent of wet streambed and open water in the on-site portions of the Peconic River, which, in turn, affects the potential availability of fish sampling on site. This data quality objective (DQO) establishes the decision criteria to decrease or increase fish surveillance monitoring, as necessary. This balanced approach will provide flexibility to the monitoring program.

Fish have been sampled since the early 1990s to support reactor operations, as well as discharge, monitoring, and environmental restoration activities. Fish sampling has historically occurred at several locations along the Peconic River, including on-site and off-site reaches, Swan Pond, Donahue's Pond, Forge Pond, and at Lower Lake on the Carmans River (a control location). Annual sampling on site between 1990 and 1999 had resulted in a depletion of the number and size of fish available for sampling. As a result, sampling was suspended to allow the fish population to recover. Drought and cleanup operations had prevented the re-establishment of sufficient fish populations for sampling, and the suspension of on-site sampling continued until the populations recovered. In 2007, sufficient numbers and sizes of fish were present on site to allow sampling.

Until 2015, continued presence of water throughout the year within the Peconic River allowed for fish sampling. With discharges from the STP no longer going to the river, conditions now depend on the river receiving water from groundwater sources when the water table is high and/or from significant precipitation events. Drought conditions may result in the complete drying of on-site portions of the river, resulting in the near complete absence of fish. Results of sampling at other areas along the Peconic River have shown a decline in the levels of Cs-137 found in fish, both over time and distance from the Laboratory. Fish sampling along the Peconic River has also consistently shown the presence of PCBs, pesticides, and some heavy metals, including mercury in fish tissues that are attributable to historical BNL practices and atmospheric deposition.

Due to long-term data sets showing little or no influence from the Laboratory, sampling at Swan Pond and Forge Pond was discontinued in 2013. Based on the five-year review of the Peconic River cleanup program, fish sampling between post-cleanup monitoring and surveillance monitoring alternated yearly. With the completion of a supplemental cleanup action of a small area on site in 2017, the need for continued fish monitoring associated with cleanup actions is no longer needed. This leaves the surveillance monitoring program as the primary program for the Peconic River. Because of the removal of discharges to the river, aquatic vegetation and sediment monitoring have been eliminated and the decision for continued and modified monitoring of fish is addressed in this DQO.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

____ Compliance
____ Support compliance
__X Surveillance
____ Restoration

- DOE Order 436.1A (2023), *Departmental Sustainability*, requires sites to maintain an Environmental Management System (EMS). BNL's EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, of site operations. DOE Order 458.1, Admin Chg. 4, (2020) *Radiation Protection of the Public and Environment*, requires DOE sites to maintain surveillance monitoring for determining radiological impacts to the public and environment.
- Surveillance monitoring to determine impacts from past discharges from the STP can also be considered a best management practice to track the continued decay of anthropogenic radionuclides present in the onsite portions of the river.
- Request by the New York State Department of Environmental Conservation under the CERCLA Five-Year Review to monitor small whole fish from onsite portions of the Peconic River for mercury and PCBs.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Past practices at BNL have resulted in contaminants being released to the Peconic River System. These contaminants were released from the STP and entered the river at the permitted discharge point, with eventual migration downstream. Upgrades to the STP include treatment to a tertiary level and the redirection of effluent to groundwater recharge basins and have eliminated the potential of future releases of contaminants (conventional and radiological). Challenges for the monitoring program include documentation of the continued decline in existing contaminants.

Step 2: Identify the Decision

The desired decisions for the fish surveillance monitoring programs can be represented through the following questions:

- Are contaminants attributable to Laboratory operations present in fish within the Peconic River System?
- Are water levels within the Peconic River System sufficient to support fish populations?
- Are fish populations and fish sizes on site large enough to support surveillance monitoring?
- Are the levels of known BNL-contributed contaminants declining in fish within the Peconic River System?
- Are levels of known BNL-contributed contaminants available for movement up the food chain?
- Has historic monitoring provided sufficient information to make a decision for continuation, modification, or termination of monitoring?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- DOE-established dose guideline of 10 mrem/year for the general public
- Historic STP discharge monitoring data
- New York State Department of Environmental Conservation (NYSDEC) consumption guidelines: 15 lbs/year/person of fish for radiological dose assessment
- U.S. Environmental Protection Agency (EPA) water quality criteria for methyl mercury (0.3 mg/kg)
- Need for suitable data to determine Dose to Biota
- Field Sampling Team field logs and records maintained by field sampling personnel
- Environmental Monitoring Standard Operating Procedures (SOPs)
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality
- Documented remediation of contaminated river sediment
- Records of Decision (RODs) for the STP and Peconic River remediation in Operable Unit (OU) V
- Closeout reports for the STP and Peconic River Cleanup Projects
- Peconic River Annual Monitoring Report and Five-Year Reviews
- Historic aquatic vegetation sampling results
- Historic sediment sampling results
- Historic Peconic River surface water sampling results
- Historic fish results
- Elimination of discharges to the Peconic River
- Presence of water sufficient to support fish
- Presence of fish populations of sufficient number and size for sampling

Step 4: Define the Study Boundaries

The boundaries of this study include the Peconic River system from the former STP outfall on site, extending downstream to the BNL boundary (HQ). The control location for comparison data is Lower Lake on the Carmans River for fish. Sampling is carried out during the spring and summer months when oxygen levels support the presence of fish in the shallow waters of the Peconic River. Onsite sampling can only occur when sufficient water and abundant fish are present. Off-site sampling at the Carman's River control location (Lower Lake) will only occur if on-site sampling for larger fish is accomplished to collect edible filets.

Step 5: Develop the Decision Rule

Decision 1

Are there potential impacts from historic discharges to the Peconic River from contaminants attributable to BNL operations present in fish within the Peconic River System?

If discharges to the Peconic River are terminated, **then** periodic surveillance monitoring will be conducted to document changes in contaminant levels compared to historic data and control locations.

Note: With discharges having been eliminated, BNL will periodically monitor fish to track changes in Cs-137, mercury, and PCBs in on-site fish and compare those values to fish from the Lower Lake Carmans River control location for fish of sufficient size to obtain edible portions (filets). For potential food chain impacts from mercury and PCBs, smaller fish may be obtained, however, data from Lower Lake may not be available. *The decision rules below will be followed to determine if sampling can take place.*

Decision 2

Are water levels within the onsite portion of the Peconic River System sufficient to support fish populations?

As noted in Decision 1, since surveillance monitoring will be continued, **then** the following decision must be made for on-site monitoring. **If** water levels within the on-site portions of the Peconic River are sufficient to support fish populations, **then** monitoring may continue. **If** water levels within the on-site portions are not sufficient to support fish populations, **then** monitoring will not occur.

Decision 3

Are fish populations and fish sizes on site large enough to support surveillance monitoring?

If water levels are sufficient to support fish, then the following decisions must be made prior to sampling fish. **If** fish population and size surveys indicate that sufficient numbers of fish exist at sizes large enough for sampling, **then** surveillance monitoring of fish may occur on site. **If** fish population and size surveys indicate insufficient numbers of fish and/or fish are not of significant size for sampling, **then** surveillance monitoring will be suspended, and population and size surveys will continue to facilitate documentation of population recovery.

Note: For human health considerations in the above decision rules, "sufficient" body and population size mean that enough fish exist to (1) support the preparation of a 1-kg-sample (e.g., edible fillets) of each species desired (composite samples are permitted) and (2) be taken without disrupting the population. This requires that enough fish of reproductive age remain in the river for the population of each species to survive and reproduce so that surveillance samples can be obtained the following year. **For ecological food chain considerations** in the above decision rules, any fish greater than 50 mm (2 in.) in total length may be composited to obtain 50-gram whole body samples for mercury and PCB analysis. Whenever possible, composite samples should be composed from a single species (e.g., all pumpkinseed, bluegill, etc.). The species, number of individuals, and size range included in a sample will be recorded.

Decision 4

Are the levels of known BNL-contributed contaminants declining in fish within the Peconic River System?

Historic sampling of river flora and fauna has typically indicated that radionuclide concentrations are declining, while other contaminants have no consistent pattern of increase or decline. **If** trending continues to show declining levels of radionuclide contaminants in fish, **then** re-evaluation of the monitoring program will occur when values reach background or are below health criteria. **If** mercury contaminant concentrations in fish are found to be above the 0.3 mg/kg water quality criterion, **then** the data will be reviewed to determine any changes in the environmental monitoring requirements. The data will be shared with EPA, NYSDEC/New York State Department of Health (NYSDOH), and Suffolk County Department of Health Services to document current conditions.

Step 5: Specify Acceptable Error Tolerances

The upper reaches of the Peconic River have historically been fed by discharges from the BNL STP. Historic discharges have resulted in various contaminants accumulating in river sediment. Since the discharges from the STP to the river have been eliminated, the amount of area within the river sustaining fish populations has declined. Sampling for fish may not take place due to low or non-existent water for long periods of time. Radiological monitoring data will be of sufficient quality to measure constituents to the same level of detection used for drinking water. False positives and negatives will be minimized, and data will not have excessive qualifiers attached if the values are above minimum detection limits. Duplicate sampling will be submitted, when possible, at a rate of ten percent of the sample collection to check and verify lab quality. Data will be reviewed upon being received.

Step 6: Optimize the Design

To document recovery of fish populations and size classes in the on-site portion of the Peconic River, an evaluation of the size and number of fish will occur prior to taking samples. The survey may utilize electro-shocking and other appropriate sampling techniques to collect the highest number of fish possible, with reasonable effort. (Note: Fish are released once population and size measures are completed.) This monitoring can be conducted concurrently with efforts to obtain samples in years where fish samples are taken if the number of samples ensures sufficient numbers of fish of reproductive age remain in the river, allowing sample collection the following year. All fish collected will be identified as to species and, at a minimum, will have total body length measured. Total numbers sampled will be recorded.

Fish sampling for surveillance monitoring will include at least five samples of each species of fish, as is practical or available, and no more than ten samples of each species. Species to be sampled include brown bullhead, chain pickerel or largemouth bass, or yellow perch, or bluegill. Fish from different feeding guilds (e.g., bottom feeders, predatory fish, etc.) are sampled to document potential pathways of contaminants through the food chain and up to the level of potential human consumption (e.g., game fish). Samples will be taken from locations including but not limited to BNL on-site (Area A or C, and/or D) when population sizes permit and Lower Lake on the Carmans River (control location). Filets of larger species of fish will be utilized as being representative of edible portions suitable for human consumption.

Radionuclide (gamma) and metals analysis may require composite sampling of two or more fish to ensure sufficient sample volume for analysis. To maximize the analytical process, sample analysis will be conducted in priority order of mercury, PCBs (on-site samples only), and gamma-emitting radionuclides. It may be necessary to take separate samples or composite samples to gather radionuclide data supporting dose to biota calculations. See Table 8.1.1, Aquatic Surveillance

Monitoring Program.

Table 8.1.1. Aquatic Surveillance Monitoring Program

Matrix	Location	Number of Samples	Analysis	Frequency	Sample Type
Fish	BNL	10 + 1QA	PCBs, Mercury, Gamma	Annually (as possible)	Grab
	Lower Lake, Carmans River	10 + 1QA	Gamma, Mercury	Annual	Grab
Fish	BNL (as needed)	Population Survey	Length and Weight (if possible)	As river water levels permit	Grab
Water	Meadow Marsh	1	Metals, Nutrients, Water Quality Parameters	Annual	Grab

See Appendix B for the monitoring program for this DQO.

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8.2 PRECIPITATION MONITORING

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Kathy Schwager (631) 344-8471

SUMMARY OF PROPOSED CHANGES

No proposed changes for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Lab (BNL) currently samples precipitation on a quarterly basis at two locations on site: Station P4 at the apartment area on site and S5 at the Sewage Treatment Plant (STP).

Historically, precipitation monitoring was used to determine impacts from reactor operations. BNL's three reactors have all been permanently shut down. The Brookhaven Graphite Reactor (BGRR) ceased operation in 1968 with decontamination and decommissioning completed in 2012. The High Flux Beam Reactor (HFBR) was permanently shut down in 1999 and has been placed in a safe and secure configuration and the HFBR stack was demolished in 2021. The Brookhaven Medical Research Reactor (BMRR) was permanently shut down in December 2000 and is in a secure configuration; the BMRR stack was demolished in 2022.

Historical precipitation data has been reported as providing little, if any, indication of BNL-related radionuclides in precipitation. Modifications to precipitation monitoring are based on the need to track atmospheric inputs of mercury to natural systems.

The cleanup of the Peconic River, which was primarily driven by mercury in sediments, has raised questions about the importance of atmospheric deposition of mercury. To answer this question, low-level mercury analysis has been added to the precipitation monitoringprogram.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

_ Compliance
_ Support compliance
X Surveillance
_ Restoration

- Historic data from Peconic River cleanup and subsequent monitoring for mercury and methyl mercury to document that the river remains in a clean state warrant investigating, whether atmospheric deposition of mercury is significant or not.
- Mercury from atmospheric deposition has been found to potentially affect wildlife, therefore monitoring mercury in precipitation may provide data for future research and track changes over time.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Precipitation monitoring may be able to determine the extent of mercury being deposited from the atmosphere in precipitation, which may then impact the Peconic River and wildlife.

Step 2: Identify the Decision

The desired decision for precipitation monitoring is:

Does precipitation contain mercury that is being deposited from the atmosphere?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- Historical precipitation data
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality
- Field Sampling Team field logs and records

Step 4: Define the Study Boundaries

This data quality objective (DQO) affects only the current precipitation sampling at BNL stations P4 and S5. Sampling occurs on a quarterly basis at both locations. P4 is located near the apartment complex on site and S5 is located at the STP. No off-site precipitation is collected for analysis.

Step 5: Develop the Decision Rule

Decision 1

Does precipitation contain mercury being deposited from the atmosphere?

If quarterly precipitation data show evidence of mercury from atmospheric deposition, **then** report data in the BNL Site Environmental Report and continue monitoring quarterly.

If data covering a period of five years since initiation of mercury testing indicate no measurable levels of mercury from atmospheric deposition, **then** precipitation monitoring may be discontinued.

Step 6: Specify Acceptable Error Tolerances

Mercury analysis should be conducted under the U.S. Environmental Protection Agency (EPA) method 1631 and meet the quality assurance guidelines of this method. Data are reviewed when received.

Step 7: Optimize the Design

Quarterly precipitation data should be acquired from on-site precipitation-monitoring locations and analyzed for low-level mercury. Results should be reported to the subject matter expert and reviewed quarterly, and any abnormalities in the data investigated accordingly. See Table 8.2.1.

Table 8.2.1. Precipitation Surveillance Monitoring

Matrix	No. of Samples	Analysis	Frequency	Type
Precipitation	8	Low Level Hg	Annual (2/quarter)	Grab

See Appendix B for the monitoring program for this DQO.

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8.3 TERRESTRIAL VEGETATION AND SOIL MONITORING

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Kathy Schwager (631) 344-8471

SUMMARY OF PROPOSED CHANGES

No changes are proposed for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

Historical operations at Brookhaven National Laboratory (BNL) have resulted in the distribution of cesium-137 (Cs-137) in landscape soils. Most of this contamination has been remediated. However, low levels of Cs-137 remain in specific landscape areas at or below cleanup goals. In addition, soils at or below cleanup goals in these areas have been covered with clean fill material, from six to 12 inches in depth. Other areas containing higher levels of Cs-137 contamination (e.g., 650 Sump Outfall and the Hazardous Waste Management Facility (HWMF) have been cleaned.

Detectable levels of Cs-137 are still present at the former HWMF but have been covered with clean fill material to allow natural attenuation. The continued presence of soil contamination and the potential for uptake by plants, which can then be passed along to animals, should be monitored. This pathway can be done through surveillance monitoring of deer. Soil and vegetation monitoring within the former HWMF is necessary to periodically document whether uptake is occurring. The periodic assessment of soil and vegetation within remediated landscaped soils should be conducted to determine uptake and/or redistribution of contaminants. Additionally, to support the calculation of dose to biota from Lab operations, annual sampling should be conducted as a best management practice. The remainder of the soil and vegetation monitoring at BNL will follow a graded approach, as outlined below.

The terrestrial vegetation and soil-monitoring program at BNL is designed to supplement and support other monitoring efforts in a graded approach. Because current BNL operations only produce short-lived radionuclides that are not transported significant distances, the need for continuous or routine soil and vegetation monitoring is greatly reduced. Areas of beam stops associated with the various accelerators may result in soil activation which in turn may result in uptake of activation products by biota.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

___ Compliance
_X_ Support compliance
_X_ Surveillance
_X_ Restoration

- DOE Order 436.1A (2023), *Department Sustainability*, requires sites to maintain an Environmental Management System (EMS). BNL's EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, of site operations. DOE Order 458.1, Admin Chg 4, (2020), *Radiation Protection of the Public and the Environment*, requires DOE sites to maintain surveillance monitoring for determining radiological impacts to the public and environment.
- DOE-STD-1153-2002, *A Graded Approach for Evaluation of Radiation Doses to Aquatic and Terrestrial Biota*, recommends sampling design to assess radiological impacts to the biotic community.
- Surveillance monitoring to determine impacts from BNL operations can also be considered a best management practice to ensure the early detection of long-term accumulation of potential contamination to better protect the public and environment.
- Periodic monitoring to determine effectiveness of cleanup operations is necessary to document compliance with requirements of the Record of Decision (ROD) for Operable Unit (OU) I for the former HWMF.
- Periodic monitoring is necessary to determine effectiveness of cleanup operations of land-scape soils to calculate a dose to biota.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

BNL has been in operation since 1947. Its long history of operations has included various large-scale experiments, as well as large user facilities such as reactors and accelerators. The primary source of potential contamination was the operation of reactors. Since all reactors have been permanently shut down, the need for continued soil and vegetation monitoring is no longer necessary to determine impacts from reactors. Current operations produce no long-lived radionuclides that can be deposited in soils or vegetation. The cleanup of the former HWMF has been completed. Under the requirements of the Long-Term Maintenance and Monitoring Plan for OU I and V, vegetation and soil sampling should occur in the first year and every five years after completion of cleanup to document the success of the cleanup operation. Current accelerator operations may result in soil activation products that may be taken up by plants.

Step 2: Identify the Decision

The desired decisions for this monitoring program can be stated as follows.

- Are radionuclides being taken up by vegetation at the former HWMF, and are they also found in surface soils within this facility?
- Are radionuclides being taken up by vegetation in the cleaned-up landscape soils and 650 sump areas?
- Are accelerator operations resulting in soil activation and uptake by plants?
- Are radionuclides found in soils and vegetation resulting in potential dose to biota?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- DOE-established dose to biota guidelines of 1 mrad/day for flora and fauna
- Field Sampling Team field logs and records
- Environmental Monitoring Standard Operating Procedures (SOPs)

- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality
- Closure reports for Landscape Soils Remediation
- Project work plans for Operable Units I, IV, and VI
- Historic soil and vegetation data
- Historic and current air monitoring data
- Close-out report for the former HWMF

Step 4: Define the Study Boundaries

The boundaries of this study include the BNL site, as well as control locations west and northwest of the Laboratory. Deposition of airborne particulates is likely to occur at any location on site, but detection is most likely in the downwind sectors. For this reason, soil and vegetation samples will be taken primarily in areas around accelerator beam stops and historically contaminated areas that have been cleaned up. The close-out report for the former HWMF specifically identified the former HWMF and its associated wetlands as a defined study area.

Step 5: Develop the Decision Rule

Decision 1

Are radionuclides being taken up by vegetation at the former HWMF and are they also found in surface soils within this facility.

If soil and vegetation sampling results after cleanup do not indicate radionuclides being taken up by plant at the former HWMF, **then** sampling will take place every five years after cleanup to reconfirm presence/absence of radionuclides in vegetation and surface soils. **If** soil and vegetation sampling results indicate radionuclides being taken up by plants and in surface soils at concentrations above cleanup goals, **then** an evaluation will be completed to determine a path forward.

Decision 2

Are radionuclides being taken up by vegetation in the cleaned-up landscape soils and 650 sump areas?

If soil and vegetation sampling results from within historically cleaned up landscape soils do not indicate radionuclides being taken up by plants or in the surface soils, **then** sampling will take place every five years to reconfirm the presence/absence of radionuclides in vegetation and surface soils. **If** soil and vegetation sampling results indicate radionuclides being taken up by plants and in surface soils, **then** an evaluation will be completed to determine a path forward.

Decision 3

Are radionuclides being produced due to soil activation and are they taken up by vegetation in beam stop areas?

If soil and vegetation sampling from the area around accelerator beam stops show presence of soil activation products and plant uptake, **then** monitoring will transition to annual routine monitoring of the beam stop to verify occurrence.

Step 6: Specify Acceptable Error Tolerances

Terrestrial vegetation and soil sampling will be conducted based on a graded approach that relies on the detection of contaminants in deer. Therefore, it is acceptable to act on reasonable data.

Analytical data for vegetation and soil sampling within the former HWMF, 650 Sump area, and from landscaped soils cleanup areas showing radionuclides above background should be reported with errors less than 20 percent. Values with errors greater than 20 percent will be reviewed and may warrant additional sampling for verification. Data will be reviewed when received.

Step 7: Optimize the Design

When soil and vegetation sampling occur, at least one off-site soil and vegetation sample must be obtained from established background locations.

Soil and vegetation sampling will necessitate obtaining at least five samples of each media in the upland area and two samples of sediment and emergent vegetation from the eastern portions of the former HWMF wetlands. Additionally, ten to 12 samples of each media should be obtained from the cleaned-up landscape soils area and two samples of each media from the 650 Sump area.

The last round of sampling at the former HWMF was in 2022; the next round of sampling should occur in 2027. Random sampling from a variety of locations around the BNL site should be taken to document potential sources of Cs-137 for dose to biota. See Table 8.3.1.

Table 8.3.1. Terrestrial Soil and Vegetation Surveillance Monitoring

Matrix	Number of Samples	Analysis	Frequency	Type
Vegetation	10-15 + 2QA	Gamma	Annual	Grab
Soil	10-15 + 2QA	Gamma	Annual	Grab

See Appendix B for the monitoring program for this Data Quality Objective.

8.4 DEER SAMPLING

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Kathy Schwager (631) 344-8471

SUMMARY OF PROPOSED CHANGES

No changes proposed for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Laboratory (BNL) has documented the presence of the radionuclide cesium-137 (Cs-137) within landscape soils and other operational areas on site. Faunal monitoring of various wildlife species in 1992 identified the presence of Cs-137 in the tissue of deer and other small mammals. Of all the mammals inhabiting the Laboratory, deer are the only species that are in the direct consumption pathway of humans. Deer are known to acquire Cs-137 through the ingestion of vegetation that has Cs-137 uptake, as well as by direct ingestion of contaminated soils.

In 1996, BNL began a program of sampling deer on and off site for gamma analysis of meat and liver. Sr-90 analysis in bone was added to the program in 2000 to investigate levels present in this matrix and discontinued in 2013. Statistical analysis on the sampling requirements of deer taken through 1998 suggested that 25 samples on site and 40 samples off site were necessary to have sufficient confidence in detecting the average presence of Cs-137 within the deer population.

Fewer samples were required on site since Cs-137 is known to be higher in on-site deer. The higher number of off-site samples was needed to verify the lower concentrations seen off site. It should be noted that in most years, the required number of samples has not been acquired due to the method of acquisition (e.g., road-killed deer or hunter donations).

Landscape soils containing Cs-137 were remediated in 2000, with the remaining contamination at or below assigned cleanup standards. Other areas known to contain Cs-137, including the 650 Sump Outfall, Sewage Treatment Plant (STP) sand filter beds, and the former Hazardous Waste Management Facility (HWMF), were completed in September 2005.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

_ Compliance
_ Support compliance
X Surveillance
_ Restoration

- DOE Order 436.1A (2023), *Departmental Sustainability*, requires sites to maintain an Environmental Management System (EMS). BNL's EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, of site operations. DOE Order 458.1, Admin Chg 4, (2020), *Radiation Protection of the Public and the Environment*, requires DOE sites to determine radiological impacts to the public and environment.

- Surveillance monitoring to determine impacts from past practices can be considered a best management practice to ensure the early detection of potential radiological contamination to better protect the public and environment.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Past practices at BNL have resulted in soil contaminated with Cs-137. Regardless of when clean-up was completed, low levels of radiological contamination will persist in the environment and may be available to wildlife through the consumption of plants via uptake from the soil or through the direct consumption of contaminated soils. To determine the impact of Cs-137 on wildlife and the potential for transfer to the human food pathway, the Laboratory should monitor the deer population to track and trend Cs-137 levels in tissues that are normally consumed by humans.

Step 2: Identify the Decision

The desired decisions for the deer surveillance monitoring programs are:

- Are Cs-137 levels in deer meat above levels considered protective of human health?
- Are the Cs-137 levels in deer continuing to decline after remediation of contaminated soils?
- Are levels of Cs-137 in deer from areas within one mile of BNL identical to on-site levels?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- DOE-established dose guideline of 10 mrem/year for the general public
- New York State Department of Health (NYSDOH) guideline consumption rate, 64 lb/year/person of deer meat > 6.9 pCi/g of Cs-137 (wet weight)
- Field Sampling Team field logs and records
- Environmental Monitoring Standard Operating Procedures (SOPs)
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality
- Documented remediation of radiological-contaminated soils
- Records of Decision (RODs) for OU I, IV, and VI
- Historic vegetation sampling results
- Historic soil sampling results
- Special vegetation sampling results
- Historic deer sampling results

Step 4: Define the Study Boundaries

The boundaries of the study include a comparison of deer taken on site and those taken within one mile of BNL's boundary, as well as deer taken more than one mile from BNL (generally considered background or control deer). Deer taken during routine population reduction activities may also be included provided sampling is from individual deer. Sampling is conducted annually (with trends developed for a rolling ten-year period) and is conducted as evenly across months as can be achieved through opportunistic sampling of deer killed in vehicle accidents.

Step 5: Develop the Decision Rules

Decision 1

Are Cs-137 levels in deer meat above levels considered protective of human health?

If the monitoring data show the data to be consistently below 6.9 pCi/g wet weight, **then** the monitoring will be maintained to document trends. **If** deer meat samples suggest an average annual value of Cs-137 higher than 6.9 pCi/g wet weight, or if a single value in a deer sample is higher than 11.64 pCi/g wet weight (highest value to date), **then** an evaluation will be conducted to determine the path forward.

Decision 2

Are the Cs-137 levels in deer continuing to decline after remediation of contaminated soils?

If Cs-137 levels in on-site deer decline to background levels, **then** a review of the program and data will determine whether the program should continue. **If** Cs-137 values in on-site deer meat samples begin to increase after remediation of contaminated soils, **then** an evaluation will be conducted to determine the path forward.

Decision 3

Are levels of Cs-137 in deer from areas within one mile of BNL identical to on-site levels?

If Cs-137 concentrations in deer meat samples taken within 1 mile of BNL are statistically the same as values on site and are less than or equivalent to background, **then** monitoring may be discontinued. **If** Cs-137 concentrations in deer meat samples taken within one mile of BNL indicate an increasing trend or steady trend compared to on-site values, **then** monitoring will continue.

Step 6: Specify Acceptable Error Tolerances

The presence of Cs-137 in some deer samples indicates that Cs-137 in the environment is available to humans through the ingestion pathway. Hunters take approximately 3,000 deer each year in Suffolk County, some of which are obtained within one mile of BNL. In the past, high values of Cs-137 in deer have been examined, considered to be accurate, and reported to the general public, and then subsequently determined to be in error (false positive). The values were, in fact, much lower than initially reported. This false positive caused substantial concern to the community at large. False positives should be minimized. All values greater than historic high values will be investigated and verified through multiple retesting. Cs-137 is the single highest contributing factor for potential exposures to the general public from Laboratory operations. Therefore, BNL must have, and transmit, an accurate understanding of Cs-137 distribution in deer. Data is reviewed when received to identify errors and determine usability. Potassium-40 is a naturally occurring radionuclide that builds in biological tissues and typically is found in the range of approximately 2-5 pCi/g wet weight in deer. Values significantly outside of this range should trigger a re-analysis of a sample.

Step 7: Optimize the Design

To get sufficient data for comparison and to be statistically sound, samples must be taken both on and off site (see Table 8.4.1). Past efforts indicate that 25 on-site and 40 off-site samples should be obtained annually to produce a statistically accurate average concentration for Cs-137 in deer tissues. The lower number of on-site samples is due to the higher concentration of Cs-137 in on-site deer, which results in better detection. The higher number of samples off site is necessary due to the high incidence of non-detections and very low detectable levels in off-site deer. All deer sampled will be tested for gamma-emitting radionuclides in the flesh (meat) and liver (when available).

BNL has historically relied on opportunistic sampling through hunter donations and notification of road-killed deer on site. BNL has established deer management on site that results in the periodic reduction of significant numbers of deer through culling. When this occurs, it provides an opportunity to acquire large numbers of samples meeting the goal of 25 onsite samples/year. Off-site sampling of up to 40 deer will continue through collection of road-killed deer, acceptance of hunter donations, and deer obtained through donation by other agencies, such as the New York State Department of Environmental Conservation.

Table 8.4.1. Deer Sampling Program

Deer	No. of Samples	Analysis	Frequency	Sample Type
Flesh (meat)	25 onsite 40 offsite + 6 QA	Gamma	Annually	Grab
Liver (as available)	25 onsite 40 offsite +6 QA	Gamma	Annually	Grab

See Appendix B for the monitoring program for this Data Quality Objective.

9 LIQUID EFFLUENTS

CHAPTER CONTENTS

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9.1 GROUNDWATER RECHARGE BASINS

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Joy Haskins (631) 344-7898

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2025.

DESCRIPTION AND TECHNICAL BASIS

Wastewater effluents are routinely generated as a result of Brookhaven National Lab (BNL) operations and research activities. A portion of the wastewater, mainly stormwater runoff and process wastewater, is directly discharged to groundwater via several recharge basins on site. These wastewater discharges have the potential to impact groundwater quality, aquatic and terrestrial organisms, and eventually public health via either direct ingestion of groundwater or ingestion of aquatic or terrestrial organisms. In addition, any contaminants present in the discharge may be trapped and accumulate in the sediments within each recharge basin.

Past sediment sampling has detected contaminants attributable to historic BNL operations and road-way runoff. Wastewater discharges to the on-site recharge basins and stormwater outfalls may contain volatile organic compounds (VOCs), oil and grease, inorganic compounds, metals, and radionuclides originating from process discharges, outdoor storage areas, and stormwater runoff from paved areas on site. To ensure that these discharges comply with regulatory requirements and pose minimal environmental impact, they are monitored on a periodic basis. Permanent monitoring stations have been established for each of these major point-source discharges. Discharges are monitored at the point of release to the environment to support documented compliance with the Laboratory's State Pollutant Discharge Elimination System (SPDES) permit requirements and compliance with Department of Energy (DOE) Orders.

The Laboratory discharges to the following recharge basins and stormwater outfalls:

- Outfall 002 (Recharge Basin HN) receives noncontact cooling water discharges, cooling tower blowdown, drainage from secondary containment and floor drains, and stormwater runoff from the Collider Accelerator Department (CAD) complex.
- Outfall 002B receives cooling tower blowdown from Buildings 1002 and 1004 within the CAD complex (Relativistic Heavy Ion Collider [RHIC]).
- Outfall 003 (Recharge Basin HO) receives once-through cooling water discharges, cooling tower blowdown, and stormwater runoff from the CAD complex, stormwater runoff from areas north and east of the High Flux Beam Reactor (HFBR), and once-through cooling from the Energy, Environment and National Security building (Building 830). There are no SPDES monitoring requirements for this outfall.

- Outfall 004 (Recharge Basin HP) receives treated groundwater discharges from Comprehensive Environmental Response, Compensation, and Liability Act remediation activities. Monitoring and reporting are performed in accordance with SPDES equivalency permits, which are managed by BNL's Groundwater Protection Group (GPG).
- Outfall 005 (Recharge Basin HS) receives predominately stormwater runoff and minimal cooling tower blowdown and once-through cooling water from the National Synchrotron Light Source-II (NSLS-II) and the Chemistry Department. This basin also receives treated groundwater from the Building 96 Treatment System, which is managed by the GPG and reporting performed in accordance with a SPDES equivalency permit.
- Outfall 006A (Recharge Basin HT-W) receives noncontact cooling water discharges, cooling tower blowdown, floor drain discharges (minor), and stormwater runoff from the Alternating Gradient Synchrotron (AGS) complex.
- Outfall 006B (Recharge Basin HT-E) receives noncontact cooling water discharges, cooling tower blowdown, floor drain discharges (minor), and stormwater runoff from the AGS complex.
- Outfall 007 (Recharge Basin HX) receives filter backwash water from the Water Treatment Facility.
- Outfall 008 (Recharge Basin HW) receives stormwater runoff from the NSLS-II area.
- Outfall 009 consists of numerous subsurface wastewater disposal systems that receive predominantly sanitary waste and steam and air compressor discharges. The Laboratory's SPDES permit does not require effluent monitoring at Outfall 009.
- Outfall 010 (Central Steam Facility [CSF] recharge basin) receives stormwater runoff from the CSF area.
- Outfall 011 (former Hazardous Waste Management Facility [HWMF]) formerly received stormwater runoff from the paved areas of the HWMF. The area has since been remediated, and all buildings and most roads have been demolished. This discharge currently redirects accumulated rainwater from one area to another. The Laboratory's SPDES permit does not require effluent monitoring at Outfall 011.
- Outfall 012 (Recharge Basin HZ) receives stormwater discharges from Building 902, 905, and 941 in the CAD complex. There are no SPDES monitoring requirements for this outfall.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

__X__ Compliance
__X__ Support compliance
__X__ Surveillance
_____ Restoration

The Federal Water Pollution Control Act (also known as Clean Water Act [CWA]) establishes a national permitting program that sets effluent standards for direct discharges to waters of the United States and pretreatment standards for indirect discharges of industrial wastes. Under the CWA, the Environmental Protection Agency (EPA) also develops quality-based water criteria. Wastewater discharges from Laboratory operations are subject to the CWA and are regulated through BNL's SPDES permit issued by NYSDEC, who is authorized to implement CWA provisions under Part 750 of Title 6 of the New York Codes, Rules, and Regulations (NYCRR). The SPDES permit authorizes releases to the environment through 12 designated outfalls and specifies monitoring requirements for each, including frequency of monitoring and specification of analytical requirements. Effluent limitations specified for each analytical parameter are based upon the groundwater effluent water quality standards and are codified under 6 NYCRR Part 703.6. A map depicting the locations of each of the monitoring stations is provided in Chapter 3, Figure 3-3. As processes change, they are either added or removed from the Laboratory's SPDES permit through a permit modification and the environmental monitoring program is revised as necessary.

BNL's SPDES permit also requires the preparation, implementation, and revision (as necessary) of a Best Management Plan (BMP) that describes the best management practices (BMPs) used by the Laboratory to prevent, or minimize the potential for, the release of toxic or hazardous pollutants to surface water and groundwater, including releases caused by facility site runoff, spills and leaks, sludge or waste disposal, and drainage from raw material storage. The Laboratory's BMP has been prepared in accordance with the Special Conditions set forth in BNL's SPDES Permit No. 0005835, issued on January 28, 2021, by NYSDEC.

In addition to the federal and state water quality regulations, DOE Order 436.1A (2023), *Departmental Sustainability*, requires sites to maintain an Environmental Management System (EMS). BNL's EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, of site operations on the environment. Because NYSDEC does not regulate radioactive effluents, DOE Order 458.1 Admin Chg 4 (2020), *Radiation Protection of the Public and Environment*, is used as justification for radiological monitoring of recharge basins.

Suffolk County Sanitary Code, Article 12, Toxic and Hazardous Materials Storage and Handling Controls, requires the owner or operator of industrial facilities to cease discharges of toxic or hazardous materials (unless otherwise authorized, such as through a SPDES permit) and to reclaim, recover, dispose of, and restore the environment to the condition that existed prior to discharge. The Suffolk County Sanitary Code Standard Operating Procedure (SOP) No**.** 9**-**95, Pump out and Soil Cleanup Criteria (January 2011), used in administering Article 12 of the Sanitary Code, provides guidance when remediating the environment. When a contaminant or a class of contaminants exceeds the "Action Level" found in the SOP, a cleanup or other action is required. As stated in the Sanitary Code, the goal of any remedial action required by SCDHS is to return the site to pre-discharge conditions. If this is not possible, at a minimum, the cleanup must ensure reasonable protection for public health and the drinking water supply. Therefore, under most conditions, the contaminant concentration in the soil after a cleanup should not exceed the values indicated in the SOP for "Cleanup Objectives." These guidelines are used when evaluating the results of sediment sampling completed for BNL's on-site recharge basins. NYSDEC's 6 NYCRR Part 375 (Environmental Remediation Programs, December 14, 2006) is also referenced and used, as appropriate, when evaluating on-site recharge basin sediment sampling results.

BNL's Natural Resource Management Plan was updated in 2021 (BNL 2021) and continues to promote stewardship of the natural resources found at the Laboratory, as well as to integrate natural resource protection with BNL's mission. The plan incorporates input from EPA and NYSDEC Wildlife Branch. The environmental management strategy includes identification and mapping of natural resources, habitat protection or enhancement, environmental monitoring, population management, compliance assurance and potential impact assessment, education and public outreach, and research. The plan places special emphasis on the New York State endangered tiger salamander and the banded sunfish, a New York State threatened species, by instituting focused programs that monitor, protect, and enhance their habitat to sustain and promote population growth. As part of the Natural Resource Management Plan, the Laboratory agreed to conduct water quality monitoring of the breeding areas on site that include many of the recharge basins.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The Laboratory is permitted to discharge liquid effluents under its SPDES permit; therefore, data are required to verify compliance with the permit limits. In addition, BNL conducts surveillance monitoring to detect unplanned releases of contaminants and to assure that New York State groundwater effluent standards are met for discharge constituents not covered by the permit. In addition, accumulation of contaminants in the recharge basin sediments may occur; therefore, periodic monitoring of contaminant levels in the sediments is required after establishing baseline levels.

Step 2: Identify the Decision

- Are all discharges in compliance with permit limits and/or New York State groundwater effluent standards?
- Have the characteristics of the effluents changed to justify changing the SPDES permit requirements?
- Have contaminants been found in the sediments at the recharge basins at or above Suffolk County Article 12 and/or 6 NYCRR Part 375 Action Levels?
- Is the quality of discharges adequate to support tiger salamander habitats?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- SPDES permit limits or other New York State groundwater effluent standards and relevant changes
- Suffolk County Article 12 and/or 6 NYCRR Part 375 Action Levels for soil cleanup, as applicable
- BNL Natural Resource Management Plan
- Identification of process effluents and their variability contributing to discharges and process knowledge
- Identification of areas contributing to stormwater discharges
- Historical analyses of process discharges and direct discharges to groundwater through the recharge basins
- Appropriate analytical parameters for the processes generating the waste
- Collection and analysis of samples performed according to EPA, state, or other regulatory agency standards or guidelines
- Collection of samples performed as per the frequency and other requirements of BNL's SPDES permit
- Collection of samples representative of routine discharges at appropriate monitoring locations
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality
- Field Sampling Team instrumentation calibration and maintenance records
- Field Sampling Team field logs and records
- Environmental Monitoring SOPs
- Documentation of the sampling and analysis program
- Historic sediment sampling analytical results

Step 4: Define the Study Boundaries

The study boundaries incorporate all watersheds that drain into the recharge basins. BNL's SPDES permit contains specific monitoring requirements, including analytical methods, effluent limitations, and sampling frequencies. Two monitoring programs have been established to collect the necessary water quality data needed to assess the impact of direct discharges to groundwater at the recharge basins and stormwater outfalls on site. Monitoring in support of the BNL's SPDES permit relies on the collection and analysis of flow-proportional composite and grab samples and is conducted either monthly or quarterly, depending on the parameter as set out in the permit. The surveillance monitoring program relies on both real-time analysis of wastewater streams and collection and analysis of flow-proportional composite and grab-samples. Due to the quality of stormwater and process discharges observed over the past several years, surveillance monitoring will be conducted semi-annually based on professional judgment. Historically, surveillance monitoring has been conducted during dry weather conditions. This does not, however, capture discharges of contaminants introduced through stormwater runoff. Therefore, sampling is also conducted during wet weather.

As outlined in BNL’s Natural Resource Management Plan, the Laboratory monitors water quality at the recharge basins on site to support tiger salamander viability. Currently, the quality of water discharged to the basins provides a healthy environment for the tiger salamander and promotes breeding. Degradation in the water quality on site may lead to health problems with the tiger salamander population. In addition, inadvertent spills of oil or other hazardous materials during certain periods of the year may have a greater impact to the salamander population, either due to direct health effects or effects on breeding success.

Discharges of contaminants in wastewater may eventually result in accumulation in the recharge basin sediments. The accumulation of contaminants is, however, slow and the sampling frequency is therefore longer than for wastewater. Historically, sediment sampling was performed periodically rather than on a routine basis. Beginning in 2003, a five-year cycle sediment sampling program was instituted to assess accumulation of any contaminants in the discharged wastewater to the recharge basins. Results to date have shown that there is little impact on sediment quality.

In some cases, the concentrations of contaminants are above the Suffolk County Article 12 Cleanup Objectives, but below the Action Levels; consequently, no remediation has been required. The most recent sampling event occurred in CY 2022. Review of analytical results from the recharge basins shows that all parameters are less than Suffolk County Action Levels or NYSDEC Part 375 Cleanup Objectives. The next routine round of sampling is in CY 2027.

Step 5: Develop the Decision Rule

Decision 1

Are all discharges in compliance with permit limits and/or groundwater effluent standards?

Analytical data generated from the recharge basin monitoring programs are continuously compared to SPDES permit limits or New York State groundwater effluent standards.

If the comparison shows the data to be consistently below regulatory limits or standards, **then** the monitoring will be maintained at its approved frequency.

If the comparison yields an exceedance of either a permit limit or water quality standard, **then** an evaluation will be conducted in accordance with BNL's *Events/Issues Management* Subject Area, as appropriate, to determine the source of contamination and additional samples will be collected to define the extent (i.e., duration and magnitude) of the exceedance and help determine whether corrective actions are required. For SPDES permit excursions that are reported through a Discharge Monitoring Report (DMR), standard reporting methods (i.e., letter and preparation of non-conformance report) will be completed and submitted along with the DMR.

Decision 2

Have the characteristics of the effluents changed to justify changing the SPDES requirements?

Analytical data collected from the recharge basins are evaluated and compared with historical levels to ensure the wastewater is sufficiently characterized and of consistent quality.

If the analytical data are typical of historical levels, **then** the monitoring program will be maintained as defined. **If** the evaluation reveals that a contaminant is present at levels approaching or above New York State groundwater effluent standards, **then** the monitoring frequency will be increased and an investigation conducted to determine the source of the contaminant**.**

If the contaminant source is determined to be associated with a routine source, **then** the contaminant will either be added to the routine compliance monitoring program and the SPDES permit amended and/or corrective actions will be pursued to decrease or eliminate the levels of the containment in the discharge.

Decision 3

Have contaminants been found in recharge basin sediments, at or above Suffolk County Article 12 and/or 6 NYCRR Part 375 Action Levels, and therefore are in need of remediation?

Analytical data from the sediment sampling conducted at the recharge basins are compared with historical levels and with the Action Levels contained in SOP No. 9-95 in administration of Article 12 of the Suffolk County Sanitary Code and/or 6 NYCRR Part 375, as appropriate.

If the contaminant is detected at concentrations below the Action Levels, **then** the surveillance monitoring will be continued every five years.

If this evaluation reveals that a contaminant is present at concentrations above the Action Levels, **then** an evaluation will be conducted in accordance with the *Event/Issues Management* Subject Area, as appropriate, to determine the extent of contamination and the necessary corrective actions.

Decision 4

Is the water quality of discharges adequate to support tiger salamander habitats?

Analytical data collected from recharge basin surveillance monitoring will be compared against action levels developed by BNL's Natural Resources Manager to determine adequate water quality for tiger salamander habitat.

If the comparison reveals that the action levels have not been exceeded, **then** monitoring will continue at its approved frequency.

If the comparison reveals that the action levels have been exceeded, **then** an evaluation will be conducted in accordance with the *Events/Issues Management* Subject Area, as appropriate, to determine the source of the water quality degradation and the necessary corrective actions.

Step 6: Specify Acceptable Error Tolerances

The Laboratory retains a large amount of historical data generated from the recharge basin compliance and surveillance monitoring programs. Metals are the most commonly detected analyte with concentrations that are usually below regulatory limits and groundwater effluent standards. There have been periodic detections of water treatment chemical/byproducts and oil and grease at or above regulatory limits. BNL's SPDES permit limits and the associated New York State groundwater effluent standards incorporate a margin of safety. (The limits are below the concentration of contaminants that would produce deleterious effects to human health and the environment.) Therefore, the risk to human health and the environment is relatively low for the contaminants detected in the effluents.

The sampling frequency outlined in Step 7 is sufficient to detect possible problems with contaminant discharge levels. The sampling and analytical methods employed in the compliance and surveillance programs are those required by regulation or BNL's SPDES permit or accepted as industry standard. The methods have been developed to include an acceptable level of error in the resultant analytical data.

Permit excursions and contaminated sediments due to historic operations could result in loss of public and regulatory confidence in Laboratory operations. Past permit excursions have been attributable to sampling errors, analytical laboratory errors, and contributions from road runoff, which are difficult to control/predict. These sampling and analytical errors have been addressed through SOPs and prompt spill response helps control road runoff. It is difficult to predict the frequency of such occurrences and their effect on public and regulatory confidence.

Step 7: Optimize the Design

BNL is required by its SPDES permit to conduct monthly or quarterly monitoring of the effluents it discharges to the groundwater recharge basins (outfalls) on site. Monitoring results are used to verify compliance with the discharge limits of the permit, which are set to ensure human health and safety and to prevent detrimental environmental impacts. To supplement the SPDES program, and to comply with DOE Order 436.1A (2023), the Laboratory has established a surveillance monitoring program at each of the recharge basins. Starting in CY 2013, this program changed from quarterly surveillance monitoring to semi-annual based on historical data. New contaminants identified through the surveillance monitoring program are either added to the SPDES permit through permit modification or corrective actions are taken to reduce the levels of the contaminant in discharges to the environment.

There have been no changes to BNL's SPDES permit monitoring requirements for groundwater recharge basins since the last revision. The SPDES monitoring requirements for each outfall are summarized below:

Outfall 002 (Recharge Basin HN)

Effluent Parameter	Discharge Limitations, Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor MGD	Monthly	Recorded
pH (range)	NA	Monitor – 9.0 SU	Monthly	Grab
Oil and Grease	NA	15 mg/L	Monthly	Grab
1,1,1-Trichloroethane	NA	5 µg/L	Quarterly	Grab
Chloroform	NA	7 µg/L	Quarterly	Grab
Bromodichloromethane	NA	50 µg/L	Quarterly	Grab
HEDP	NA	0.5 mg/L	Quarterly	Grab
Tolyltriazole	NA	0.2 mg/L	Quarterly	Grab
Aluminum, Total	NA	2.0 mg/L	Quarterly	Grab

Outfall 002B

Effluent Parameter	Discharge Limitations, Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor MGD	Monthly	Recorded
pH (range)	NA	Monitor – 9.0 SU	Monthly	Grab
Oil and Grease	NA	15 mg/L	Monthly	Grab

Outfall 003: With the demolition of the HFBR cooling towers and the change of the AGS main magnet secondary-cooling source water (from AGS wells to domestic water), all monitoring requirements for Outfall 003 have been deleted from the SPDES permit. Since the outfall still receives stormwater runoff and noncontact cooling water discharges, monitoring will be continued under the environmental surveillance program.

Outfall 004: With the permanent shutdown of the BMRR, all cooling water discharges to Outfall 004 ceased as of June 2001. Therefore, all monitoring requirements have been deleted from the permit.

Outfall 005 (Recharge Basin HS)

Effluent Parameter	Discharge Limitations, Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor MGD	Monthly	Recorded
pH (range)	NA	Monitor – 8.5 SU	Monthly	Grab
Oil and Grease	NA	15 mg/L	Monthly	Grab
HEDP	NA	0.5 mg/L	Quarterly	Grab
Tolyltriazole	NA	0.2 mg/L	Quarterly	Grab
Total Copper	NA	1.0 mg/L	Quarterly	Grab

Outfall 006A (Recharge Basin HT-W)

Effluent Parameter	Discharge Limitations, Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor MGD	Monthly	Recorded
pH (range)	NA	Monitor – 9.0 SU	Monthly	Grab
Oil and Grease	NA	15 mg/L	Monthly	Grab
HEDP	NA	0.5 mg/L	Quarterly	Grab
Tolyltriazole	NA	0.2 mg/L	Quarterly	Grab

Outfall 006B (Recharge Basin HT-E)

Effluent Parameter	Discharge Limitations, Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor MGD	Monthly	Recorded
pH (range)	NA	Monitor – 9.0 SU	Monthly	Grab
Oil and Grease	NA	15 mg/L	Monthly	Grab
HEDP	NA	0.5 mg/L	Quarterly	Grab
Tolyltriazole	NA	0.2 mg/L	Quarterly	Grab

Outfall 007 (Recharge Basin HX)

Effluent Parameter	Discharge Limitations, Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor GPD	Monthly	Instantaneous
pH (range)	NA	Monitor – 9.0 SU	Monthly	Grab

Outfall 008 (Recharge Basin HW)

Effluent Parameter	Discharge Limitations Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor GPD	Monthly	Instantaneous
pH (range)	NA	Monitor – 8.5 SU	Monthly	Grab
Oil and Grease	NA	15 mg/L	Monthly	Grab
1,1,1-Trichloroethane	NA	5 µg/L	Monthly	Grab
1,1-Dichloroethane	NA	5 µg/L	Monthly	Grab
Aluminum, Dissolved	NA	2.0 mg/L	Quarterly	Grab

Outfall 009: Outfall 009 consists of numerous subsurface wastewater disposal systems that receive predominantly sanitary waste, and steam and air compressor discharges. BNL's SPDES permit does not require effluent monitoring at Outfall 009.

Outfall 010 (Recharge Basin CSF)

Effluent Parameter	Discharge Limitations, Daily Avg.	Discharge Limitations, Daily Max	Measurement Frequency	Sample Type
Flow	NA	Monitor GPD	Monthly	Instantaneous
pH (range)	NA	Monitor – 8.5 SU	Monthly	Grab
Oil and Grease	NA	15 mg/L	Monthly	Grab
Aluminum, Dissolved	NA	2.0 mg/L	Quarterly	Grab
Copper, Dissolved	NA	1.0 mg/L	Quarterly	Grab
Vanadium, Dissolved	NA	Monitor	Quarterly	Grab
Lead, Dissolved	NA	0.05 mg/L	Quarterly	Grab

Outfall 011: Outfall 011 formerly received stormwater runoff from the paved areas of the HWMF. The area has since been remediated, and all buildings and most roads have been demolished. This

discharge currently redirects accumulated rainwater from one area to another. The Laboratory's SPDES permit does not require effluent monitoring for this outfall.

Outfall 012 (HZ): Outfall 012 receives noncontact cooling water discharges from Building 902 in the CAD complex, as well as stormwater discharges from the surrounding area. Although monitoring is not required under BNL's SPDES permit, this outfall is sampled under the Laboratory's environmental surveillance program.

A general discussion of historical surveillance monitoring results for VOCs, anions, metals, radiological parameters, and associated sampling frequency is provided below.

Surveillance monitoring results show that VOCs are usually not present in the BNL's discharges above the minimum detection limit (MDL). Due to the discharge of chlorinated tap water, trihalomethanes are detected occasionally. Acetone and methylene chloride are also sporadically detected in samples, but at very low levels. Due to the ubiquitous nature of these two contaminants in the contract analytical laboratory, detections are usually attributed to laboratory cross-contamination. Although the detection of other VOCs is infrequent and quarterly sampling is performed under the compliance program for those stations with a potential source, sampling for these analytes will continue under the surveillance monitoring program on a semi-annual basis. Monitoring also supports BNL's Natural Resource Management Program efforts to protect tiger salamander breeding areas.

An analysis of the recharge basin discharges shows that chlorides, sulfates, and nitrates have been detected, but usually only slightly above the respective MDL. Chloride concentrations during winter months may be high due to runoff of salt used in road maintenance. Due to the potential impact of these contaminants on wildlife and groundwater, semi-annual water quality sampling and analysis will continue.

Metals analyses have shown a wide variability depending on the metal species in question, the recharge basin from which the samples were taken, and whether the sample was filtered (dissolved concentration) or unfiltered (total concentration). High concentrations of iron, aluminum, and lead are typically found in unfiltered samples, while almost all concentrations are well within effluent standards in filtered samples. Particulates (native soils) entrained in the runoff are the most likely contributors of these contaminants.

Radiological analyses of the discharge to on-site recharge basins includes gross alpha, gross beta, tritium, and gamma analyses. While gross alpha and beta analyses show detectable levels of radioactivity, gamma analysis shows all nuclides to be naturally occurring; potassium-40 is typically the only radionuclide identified. No radionuclides attributable to BNL operations are detected in any of the recharge basins. Tritium concentrations at the recharge basins over the past several years are typically below laboratory method detection limits. However, if detected, the source is most likely from the interaction of high-energy protons and secondary radiation (due to beam/target interactions) with the cooling water within the CAD beam complex.

The collection of radiological samples will continue at the recharge basins on a semi-annual basis due to the possibility of releases in cooling water discharges.

See Appendix B for the monitoring program for this DQO.

9.2 SEWAGE TREATMENT PLANT

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Joy Haskins (631) 344-7898

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2025.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Laboratory's (BNL) Sewage Treatment Plant (STP) receives the majority of the wastewater generated by site operations and treats these wastes prior to discharging them to groundwater via recharge basins. Approximately 200,000 gallons of wastewater per day are processed by the STP. The treatment process includes separation of heavy inert matter (e.g., sand, grit, and other inorganic matter); removal of floatables (e.g., oils); aerobic treatment of the wastewater using a suspended-growth, activated-sludge process; and partial nitrogen removal via oxygen minimization during aeration. The treated waste is then settled, filtered through a disc-filtration system, and discharged to one of four recharge beds.

Wastewater streams received at the STP include sanitary wastes (e.g., kitchen and bathroom wastes); process wastes (e.g., industrial cleaning operations, cooling tower blowdown, air conditioning, and air compressor condensate); glassware cleaning wastewater (e.g., plating and metal cleaning rinse water; boiler blowdown, floor drain discharges, etc.); and non-contact cooling water used in experimental and mechanical systems. Radionuclides and chemical constituents are present in these wastewaters as a result of research facility operations, nonregulated releases associated with medical patients, and routine maintenance operations.

In addition to the contaminants released from routine operations, contaminants are also present in deposited sludge from former BNL operations that still reside in the building piping systems and the main sewage collection piping. These contaminants slowly leach into the main wastewater stream and become a component of the STP discharge. Past analysis of this sludge has shown it to contain mercury and other inorganics, cesium-137 (Cs-137), and other manmade and natural radionuclides; however, continued pollution prevention initiatives, engineering controls and cleanup activities have allowed BNL to continue shipping new sludge directly to the County-operated Bergen Point facility. Representative samples of the sludge will continue to be collected prior to shipment to Bergen Point to ensure waste acceptance criteria continue to be met. Since 2008, all waste characterization samples of sludge have been acceptable and subsequently released to the county sewage works for disposal.

Potential contaminants entering the STP include all chemicals used in a laboratory setting. The list of contaminants is exhaustive and includes acids and bases, inorganics (metals and salts thereof), volatile and semi-volatile organic compounds, conventional pollutants such as nitrogen bearing compounds (organic and inorganic nitrogen compounds, nitrates, nitrites, etc.), phosphates, radio-isotopes, oils, as well as others. While administrative procedures are in place to limit the release of chemicals to the STP, accidental releases are possible and routine releases of residual chemicals during glassware cleaning is probable.

In addition to monitoring liquid effluents at the point of release to the environment, some processes that generate and routinely discharge wastewater to the STP are monitored at the source to ensure that the discharge does not compromise the quality of the STP effluent (e.g., metal-cleaning facility). The sewage collection system is also monitored in real-time using a gross beta and gamma detection system to ensure that no unplanned releases enter the STP influent/effluent.

Discharges are monitored to support documented compliance with the BNL's State Pollutant Discharge Elimination System (SPDES) permit requirements and compliance with DOE Orders. Two monitoring programs have been established to meet these requirements. Compliance monitoring specifically addresses SPDES compliance, whereas surveillance monitoring is conducted to meet DOE requirements for radiological releases, improves knowledge of influent and effluent variability, and determines the overall effectiveness of pollution prevention initiatives and engineered controls.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

__X__ Compliance
__X__ Support compliance
__X__ Surveillance
____ Restoration

The Federal Water Pollution Control Act (also known as the Clean Water Act [CWA]) establishes a national permitting program, specifies minimum treatment levels for sewage treatment plants, establishes pretreatment standards for indirect discharges of industrial wastes, and develops quality-based water criteria. Wastewater discharges from BNL operations are subject to regulation under the CWA.

The Laboratory maintains a SPDES permit issued by NYSDEC, which has been authorized to implement the CWA provisions under Part 750 of Title 6 of the New York Codes, Rules, and Regulations (NYCRR) (6 NYCRR Part 750). BNL's SPDES permit authorizes releases to the environment through 12 designated outfalls and specifies the frequency of monitoring and specification of analytical requirements. Effluent limitations specified for each analytical parameter will be based on discharges to a source of drinking water (Class GA) and the corresponding water quality standards. Water quality standards are codified under 6 NYCRR Parts 700-705. A map showing the locations of each of the monitoring stations is provided in Chapter 3, Figure 3-3.

In addition to the federal and state water quality regulations, DOE Order 436.1A (2023), *Departmental Sustainability*, requires DOE sites to maintain an Environmental Management System (EMS). BNL's EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, of site operations on the environment. Because NYSDEC does not regulate radioactive effluents, DOE Order 458.1 Admin Chg. 4 (2020), *Radiation Protection of the Public and Environment*, is used as justification for monitoring the STP effluent for radioactivity. With the shutdown of the Laboratory's two research reactors, releases of radioactive components have declined drastically. BNL has implemented procedures and guidelines to maintain releases of radioactivity to Outfall 001 (STP) to a maximum of 25 percent of the drinking water standard.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Laboratory operations have the potential to impact the environment either through direct or indirect discharge of wastewater to the environment. Impacts include contamination of drinking water and freshwater ecosystems, including associated aquatic and terrestrial flora and fauna that rely on these water systems for survival. To ensure that wastewater effluents discharged to the environment pose minimal impact to surface waters and groundwater, a sampling and analysis program has been developed that evaluates concentrations of natural and BNL-contributed contaminants and compares them to background levels and established water quality standards. This program has been designed to ensure that:

- BNL complies with regulatory permit monitoring requirements;
- Collection and analysis of samples are performed according to EPA, state, or other regulatory agency standards or guidelines;
- Samples are representative of routine discharges and monitoring locations are appropriate;
- Analytical parameters are appropriate to the processes generating the waste;
- Analytical results are reviewed by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data is of good quality and is representative of discharges to the environment;
- Treatment systems remain efficient and effective;
- The sampling and analysis program is well documented.

The effluent monitoring program relies on both real-time analysis of wastewater streams and collection and analysis of grab and flow-proportional composite samples.

Step 2: Identify the Decisions

The desired decisions for this STP monitoring program can be formulated as questions:

- Are all discharges in compliance with permit limits or ambient water quality standards (or both)? In other words, is no action required?
- Are treatment systems effective at removing or immobilizing contaminants to prevent their release to the environment (i.e., operating as designed)?
- Are radiological releases remaining “As Low as Reasonably Achievable” (ALARA) and continuing to decline as institutional controls are implemented and enforced?
- Are pollution prevention initiatives effective, and is the quality of the effluent continually improving?

Step 3: Identify Inputs to the Decisions

- Identification of process effluents and their variability contributing to discharges and process knowledge
- Historical and current analyses of process discharges and the STP influent and effluent
- Collection and analysis of samples performed according to EPA, state, or other regulatory agency standards or guidelines
- Collection of samples performed as per the frequency and other requirements of the SPDES permit limits
- Collection of samples representative of routine discharges at appropriate monitoring locations
- Review of analytical results by project manager in accordance with EPD data review procedures to ensure data is of acceptable quality

- STP Operators' logs and records
- STP Operators' instrumentation calibration and maintenance records
- Field Sampling Team instrumentation calibration and maintenance records
- Field Sampling personnel field logs and records
- Environmental Monitoring Standard Operating Procedures (SOPs)
- Documentation of the sampling and analysis program
- SPDES permit limits or other New York State ambient water quality standards
- Real-time radiological monitoring system data

Step 4: Define the Study Boundaries

This study incorporates all BNL operations that contribute wastewater to the STP, including from the point of generation (e.g., sink) and contributions from the collection system. These operations include facility operations (mechanical systems operations and maintenance), process discharges (metal-cleaning operations), and research activities (including bench-top and pilot scale).

Data Quality Objectives (DQOs) for the liquid effluent monitoring program are derived largely by permit condition or regulatory guidance. The SPDES permit contains specific monitoring requirements, including references to analytical methods, effluent limitations, and sampling frequencies. Identification of analytical parameters is based on known BNL operations and processes, chemical inventories, and historical analyses of wastewater effluents. Effluent limitations directly influence the methodology detection limits and are directly related to established water quality standards. Similarly, the effluent limits and ambient water quality standards are also the basis for the monitoring implemented under the environmental surveillance program. In the case of radiological parameters, the drinking water standard has been utilized as the comparative standard regardless of the potential pathway analysis of the effluent.

Effluent samples will continue to be collected twice monthly in accordance with SPDES permit requirements to ensure effluent limits are being met. Review of the past five years of analytical data shows the quality of the STP effluent to be very consistent, with most volatile and semi-volatile organic compounds (VOCs/SVOCs) being non-detectable. In accordance with permit conditions, VOCs are analyzed twice monthly. Annual analysis for SVOCs is adequate to verify characterization. Metallic elements are the only routinely detected contaminants, some of which have been found to occasionally exceed established effluent limits.

Influent analyses similarly show that only inorganics are routinely detected at concentrations that could potentially exceed SPDES permit limits if they were to pass through the treatment process. Therefore, monitoring of influent water for inorganics and other parameters is conducted in conjunction with effluent monitoring so that plant performance can be evaluated.

Based on reviews of analytical data, collection of samples for metals, anions, and VOCs analysis will continue to not be performed as part of the surveillance monitoring program. The STP influent and effluent are sampled and analyzed for these parameters at least twice per month as part of the compliance program. Except for an occasional low-level detection of tritium, radionuclides at the STP have not been detected for several years. Therefore, sample collection frequency for gross alpha/beta, tritium, gamma, and strontium-90 will continue to be weekly composite samples.

Step 5: Develop the Decision Rules

Decision 1

Are all discharges in compliance with permit limits or ambient water quality standards (or both)? In other words, is no action required?

Analytical data collected from the STP effluent are continuously compared to SPDES permit limits or New York State ambient water quality standards.

If this comparison yields a violation of either a permit limit or water quality standard, **then** an evaluation is conducted in accordance with BNL's *Event/Issues Management* Subject Area, as appropriate, to determine the source of the contaminant and additional samples are collected to better define the extent (i.e., duration and magnitude) of the violation. For SPDES permit excursions that are reported through a Discharge Monitoring Report (DMR), standard reporting methods (i.e., letter and preparation of non-conformance report) will be completed and submitted along with the DMR.

If the comparison shows the data to be consistently below regulatory limits or standards, **then** the monitoring will continue as required by the SPDES permit and, for the surveillance monitoring program, frequency may be reduced.

Decision 2

Are treatment systems effective at removing or immobilizing contaminants to prevent their release to the environment?

Influent and effluent samples are collected routinely from the STP and compared to historical values. The STP is effective at reducing the concentration of conventional pollutants (e.g., Biological Oxygen Demand [BOD], nitrates, or nitrites) and inorganics.

If the concentration of either the influent or effluent exceeds typical ranges, **then** an investigation will be conducted to identify sources and additional samples will be collected to determine the magnitude of the excursion. STP operations will be evaluated as part of this investigation including clarifier efficiencies, dissolved oxygen levels, mixed liquor suspended solids, pH, etc.

Decision 3

Are radiological releases remaining ALARA and continuing to decline as institutional controls are implemented and enforced?

Radiological monitoring is conducted in real time and samples are collected continuously under the environmental surveillance program to ensure the STP effluent is adequately characterized and effluents remain ALARA.

If either real-time monitoring or analytical data show levels of radiological constituents approaching administrative limits (i.e., 25 percent of the drinking water standard), **then** the plant may be placed into a bypass mode and the wastewater collected for full evaluation conducted in accordance with BNL's *Event/Issues Management* Subject Area, as appropriate.

Decision 4

Are pollution prevention initiatives effective, and is the quality of the STP effluent continually improving as a result of reduced pollutant loads?

The Laboratory is continuously evaluating and implementing pollution prevention projects with the goal of reducing the volume of wastewater treated at the STP and reducing releases of chemical and radiological constituents to the STP. Routine monitoring data are compared with historical and permit levels to ensure concentrations decline or, at a minimum, remain below permit limits.

If comparison of data shows levels are increasing, **then** an evaluation is conducted to determine the source of the contaminant, effectiveness of pollution prevention initiatives, and measures to mitigate the increase.

Step 6: Specify Acceptable Error Tolerances

There are several potential errors associated with monitoring of the STP. These include failure to collect a representative sample, failure of a sample collection device, and analytical errors. Because there are several samples collected from the STP monthly, loss of a single sample would not have a detrimental impact on BNL's ability to adequately characterize the effluent from the STP. Sample collection devices are monitored daily to ensure they are operating properly. After collection, the sample is inspected to determine whether its volume is appropriate for the collection period and whether the sample looks representative (e.g., color, settleable solids, etc.). Deviations are noted on the Field Sampling Team sample logs. If a sample device fails during a sample collection period, or if the sample volume seems inappropriate, samples are either collected on a subsequent day or a grab sample is taken. The field log is appropriately annotated to document the failure of the sample collection device.

Once wastewater enters the plant, it commingles with approximately 200,000 gallons of water contained in the clarifiers. Consequently, if a slug of chemical contaminant were to enter the plant, it would take several days for it to completely discharge. A delay of a day would therefore not preclude detection. Because radiological samples are collected continuously, no impact is expected from a single day's failure of a sample collection device. Real-time monitoring of the influent and effluent also provides added protection against an unmonitored radiological or inorganic discharge.

Analytical errors could have a greater impact on monitoring. Because most of the sample volume is consumed in analysis, if an error is made during the analysis, complete loss of a sample is possible. If the error is not discovered soon enough, the loss could be unrecoverable. To minimize the impact of such an occurrence, samples are collected at the start of the month. This allows time for additional sampling, if necessary, to still meet permit requirements. In addition, increased surveillance of the laboratories performing analyses, increased quality assurance, and modified methods have been implemented, as necessary, to prevent analytical errors from occurring.

If any of the aforementioned errors or malfunctions were to occur, contingency measures would mitigate loss of samples and potential violations of permit conditions. Failure to implement these mitigative measures could result in SPDES permit violations, which could lead to loss in public and regulatory confidence in BNL operations.

Step 7: Optimize the Design

The compliance monitoring program is dictated by the SPDES permit. A full list of parameters and the frequency of sample collection appear in Appendix B of this report.

Monitoring the STP includes routine sampling of both the influent and effluent. Sampling frequency ranges from daily to monthly, depending on the contaminant in question. Samples are tested for radioactivity (daily), conventional pollutants such as nitrogen and total dissolved solids (twice monthly), VOCs and inorganics (twice monthly), water treatment chemicals (monthly) such as TTA and 1-hydroxyethylidene diphosphonic acid (HEDP), and SVOCs (yearly).

Data collected over the past several years show that inorganics are the contaminants most frequently detected at or above permit limits. Organics (both volatile and semi-volatile compounds) are rarely detected above the MDL. Although radioactive elements are detected, they are seldom detected at concentrations approaching limits established by EPA for drinking water, which is the comparative standard adopted by the Laboratory.

Radiological monitoring is not a condition of the SPDES permit. However, samples are collected from the STP influent and effluent continuously and are analyzed weekly under the surveillance program. The radiological monitoring frequency was reduced in 2013 from three times weekly to weekly. This reduction was justified after a review of radiological data collected over the previous five years showed only an occasional low-level detection of tritium and no detection of any other BNL-generated nuclides in both the STP influent and effluent.

In addition, the sewage collection system is monitored in real-time using beta and gamma detection systems to detect unplanned releases, which could jeopardize the quality of the STP effluent. Surveillance monitoring of the STP for VOCs, inorganics, and anions will no longer be performed. These parameters are monitored as part of the Compliance Program. Field data including pH, dissolved oxygen, and conductivity are also recorded. The surveillance monitoring program may be further reduced if the trend of radiological detection continues to decline and if reviews of analytical results show uniform consistency in STP influent and effluent quality.

See Appendix B for the monitoring program for this DQO.

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10 SURFACE WATER

CHAPTER CONTENTS

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10.1 PECONIC RIVER WATER QUALITY SURVEILLANCE

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT **Joy Haskins** (631) 344-7898

SUMMARY OF PROPOSED CHANGES

No changes are proposed for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

The headwaters of the Peconic River, a New York State-designated Scenic River that discharges to the Peconic Estuary, begin west of the Laboratory site. The Peconic River enters the site at the northwest corner, traverses through the Relativistic Heavy Ion Collider (RHIC) area, then flows in an east-southeasterly direction and exits the site along the southeast boundary. With the exception of the RHIC and Sewage Treatment Plant (STP), there has been nominal development along the Peconic River corridor on site.

At Brookhaven National Lab (BNL), 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). During very wet periods, continuous flow can occur across the entire BNL site. Several areas of low topography and areas with near surface silts and clays accumulate water during the dryer seasons. The redirection of treated effluent from the Peconic River to groundwater recharge has no impact on continuous stream flow during wet periods.

Until 2014, treated effluent from the STP was discharged to the Peconic River. In October 2014, treated effluent from the STP was diverted from the Peconic River to nearby groundwater re- charge basins. With the removal of contributions from the STP, surface runoff and groundwater comprise the only other contributed sources of water to the Peconic River. Potential contaminants that could enter the river include sediment, oil, and grease from surface runoff.

Investigation of the Peconic River conducted under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) program indicates that historical releases of radiological materials, PCBs, pesticides, and inorganics have resulted in their accumulation within the Peconic River sediments (ITC, 1998). Re-suspension of sediments due to scouring can result in the migration of these contaminants off site. Most of the contaminants were removed under the CERCLA program in 2004-2005, again in 2011, and a final removal in 2017. Sediments were removed from select areas stretching from the former STP Outfall to the County Parklands east of BNL. Monitoring to measure the effect of these removal actions on fish and sediments were conducted under the Flora/Fauna sampling program through 2015.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

Compliance
Support compliance
X Surveillance
Restoration

Although surface water quality monitoring is not required by BNL's State Pollutant Discharge Elimination System (SPDES) permit, monitoring is performed in accordance with DOE Order 436.1A (2023), *Departmental Sustainability*, which requires that DOE sites maintain an Environmental Management System (EMS), and DOE Order 458.1, Admin Chg. 4 (2020), *Radiation Protection of the Public and Environment*, which requires that DOE sites maintain surveillance monitoring for determining radiological impacts to the public and environment. An extensive environmental monitoring program is one component of the Laboratory's EMS, and it specifies requirements for conducting general surveillance monitoring to:

- Verify compliance with federal, state, and local regulations;
- Determine compliance with commitments made in Environmental Impact Statements, Environmental Assessments, or other official documents;
- Identify potential environmental problems; and
- Detect, characterize, and report unplanned releases.

Additionally, BNL's EMS requires that monitoring be conducted to measure the effects, if any, of DOE activities on and off site, establish baselines of environmental quality, and characterize and define trends in the physical, chemical, and biological conditions of environmental media. The New York State Department of Environmental Conservation (NYSDEC) has established ambient water quality standards for the Peconic River and other local water bodies. These standards have been codified under Parts 700-706 of Title 6 of the NYCRR (6 NYCRR Parts 700-706).

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

While greatly reduced, Laboratory operations have the potential to impact the Peconic River and its environment through nonpoint-source spills and potential operational upsets at RHIC. Impacts include contamination of surface water and associated freshwater ecosystems, including associated aquatic and terrestrial flora and fauna that rely on these water systems for survival and river sediments.

Step 2: Identify the Decision

The desired decisions for the surface water monitoring program are:

- Are BNL operations causing the Peconic River segments on site and immediately downstream of the Laboratory to exceed ambient water quality standards?
- Are BNL's efforts to continually improve its environmental management program improving the water quality of the Peconic River?
- Are BNL operations contributing to any river use restrictions?
- Are engineered and operational controls effective in preventing the activation of the Peconic River water that flows via culverts beneath the RHIC ring?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- Analytical data (and trends) for the Peconic River both upstream and downstream of the former STP discharge
- Analytical data (and trends) for control locations (e.g., Carmans River)
- Historical analyses of process discharges and the STP effluent
- Sampling team field logs and records
- Sampling team instrumentation calibration and maintenance records
- Environmental Monitoring Standard Operating Procedures (SOPs)
- Review of analytical results by project managers in accordance with Environmental Protection Division (EPD) data review procedures to ensure data are of acceptable quality
- Documentation of the sampling and analysis program
- Collection and analysis of samples performed according to regulatory agency standards or guidelines
- New York State ambient water quality standards
- River flow data

Step 4: Define the Study Boundaries

The study area incorporates all BNL operations that contribute surface water runoff to the Peconic River or indirect discharge (via base flow). With discharges from the STP no longer occurring, the Peconic River will be sampled at four locations on site: stations HY, HV, HM-S, and HQ (see Figure 10-1 on Page 10.1-7). Two of the on-site stations are located upstream of the former STP discharge point, and the remaining two stations are downstream. This distribution of sampling will allow for detection of impacts from off-site events (Station HY), potential impacts from RHIC (Station HV), impacts from the east-central portion of BNL (Station HM-S), and final monitoring at the site boundary (Station HQ). Obtaining samples from any or all these locations will be dependent on available flow. The Carmans River, located southwest of the site, is sampled at station HH to determine background or ambient conditions. Samples are collected and analyzed for radiological parameters (gross alpha, gross beta, and tritium activity, as well as strontium-90 [Sr-90] and other gamma-emitting radionuclides), nonradiological parameters (e.g., metals, volatile organic compounds [VOCs], and water quality parameters).

Water samples have historically been collected on a quarterly basis for most locations with samples collected several times weekly at points directly downstream from the STP discharge. Review of past analytical data shows the quality of the Peconic River to be very consistent with most VOCs and semi-volatile organic compounds (SVOCs), and radionuclides being nondetectable. Inorganics are detected throughout the Peconic and Carmans River. To assess the physical state of inorganic contaminants, filtered and unfiltered samples are collected, and the analytical data compared. Evaluation of the data shows that many of the inorganic detections are due to suspension of sediments. Radiological analyses have shown significant decreases in concentration and nuclide detection. For example, tritium is detected typically just above detection limits once or twice yearly, while gamma activity has not been detected for several years.

Historical data show no significant variations in water quality throughout the Peconic River system. Drastic changes in concentrations are unexpected, especially since the STP is no longer discharging to the Peconic River. The focus of the surface water-monitoring program is continuing to assess the long-term, cumulative impact of BNL discharges on surface waters. Because cumulative effects are the focus of this monitoring/decision process, quarterly to annual decisions are appropriate and will be dependent on flow conditions.

Step 5: Develop the Decision Rule

Decision 1

Are BNL operations causing the Peconic River segments on the BNL Site and immediately downstream of the Laboratory to exceed ambient water quality standards and historical levels?

Analytical data collected from the Peconic River are compared to New York State ambient water quality standards and historical and control points analyses.

If this comparison yields an excursion of an ambient water quality standard or a significant deviation from historical data that may be attributable to BNL, **then** implement the *Event/Issues Management* Subject Area, as appropriate, to determine the source of the contaminant and collect additional samples to better define the extent (i.e., duration and magnitude) of the discharge. **If** the comparison shows the data to be consistently below regulatory limits or standards or within historical levels, **then** routine monitoring and reporting is continued.

Decision 2

Are BNL's efforts to continually improve its environmental management program improving the water quality of the Peconic River?

Analytical data collected from the Peconic River are evaluated and compared with historical trends and with data collected from the off-site control location to determine the impact of BNL discharges on the environment.

If contaminant trends for stations HM-S and HQ show improving or stable trends in Peconic River quality and can be correlated with Laboratory actions, **then** BNL will claim credit under the Laboratory's EMS**. If** the evaluation shows declining water quality that may be attributable to BNL, **then** implement the *Event/Issues Management* Subject Area, as appropriate, to determine the cause of the decline.

Decision 3

Are BNL operations contributing to any river use restrictions?

There are no fish advisories issued that are specific to the Peconic River. A general advisory has been issued statewide to protect against eating fish that have not been tested or that may contain unidentified contaminants. The Laboratory will keep apprised of specific health advisories and will maintain data for water and fish, dependent on flow and availability of fish, to determine if BNL is contributing to any future issued advisory. All data is shared routinely with NYSDEC and the New York State Department of Health (NYSDOH), and the Laboratory continually strives to reduce the impact of its discharges by implementing waste minimization and pollution prevention practices and by imposing strict effluent limitations on pollutant sources.

If NYSDOH issues a health advisory for the Peconic River, **then** implement the *Event/Issues Management* Subject Area, as appropriate, and work with the issuing authority to determine if the Laboratory is contributing to the advisory and what steps could be taken to reduce the impact.

Decision 4

Are engineered and operational controls effective in preventing the activation of the Peconic River water that flows via a culvert and/or groundwater beneath the RHIC ring?

Concentrations of radionuclides (e.g., tritium) collected at stations HY and HV are compared to determine if activation is resulting from RHIC operations.

If tritium concentrations at station HV are significantly greater than those measured at HY, **then** implement the *Event/Issues Management* Subject Area, as appropriate, to investigate whether this is an impact from RHIC and determine the cause. Also, see the Data Quality Objective (DQO) for groundwater monitoring at RHIC in Chapter 7.

Step 6: Specify Acceptable Error Tolerances

The Laboratory has monitored the surface waters of the Peconic River and Carmans River routinely for many years and documents the results in BNL's annual Site Environmental Report (SER). The risks of not detecting an impact are erosion in stakeholder confidence and possible cleanup costs. Although BNL has a history of impacting the river, recent improvements in wastewater management, remediation of Peconic River sediments, and removal of the STP discharge from the Peconic River have significantly reduced the potential for future impact.

The most obvious potential error associated with decisions regarding the quality of the Peconic River is in the monitoring program, sample design, and implementation. Potential errors include failure to collect a representative sample, failure of a sample collection device, and impacts to sampling collection schedules due to flow conditions of the river. Monitoring of the Peconic River is limited to semi-annual analysis for most locations; consequently, loss of a single sample could have a detrimental impact on the ability to characterize the Peconic (especially with intermittent flow conditions) and Carmans River. However, diligence on the part of BNL's Sampling Team reduces the potential loss of samples.

Seasonal flow of the Peconic River also impacts the ability to collect samples and characterize water quality (e.g., during extended drought, flows may be absent for one or more quarterly sampling periods and may result in lack of sampling in any given year). Awareness of river flow conditions enables the Sampling Team to maximize the collection of samples when possible. Sample collection devices are checked prior to use to ensure they are operating properly. Upon sample collection, the sample is inspected to determine if the volume is appropriate for the period of sample collection and that the sample looks representative (e.g., color, settleable solids, etc.).

Deviations are noted in a field log and notebooks. Should a sample device fail during a sample collection period or if the sample volume is inappropriate for the collection period, samples are either collected on a subsequent day or a grab sample is taken. The field log is appropriately annotated to document the failure of the sample collection device and describe the action taken.

Analytical errors could have a greater impact on monitoring. Because the sample is consumed in analysis, if an error is made during the analysis, complete loss of a sample is possible. If the error is not discovered soon enough, the loss could be unrecoverable. To prevent such an occurrence, additional sample volume is collected to allow for repeat analyses. Deviations in analytical methods are not expected to impact the results. Data are reviewed upon receipt to determine usability.

Step 7: Optimize the Design

The surface water monitoring program, as required by DOE orders and the Laboratory's EMS, focuses on determining impacts of BNL operations on the environment. With discharges from the STP no longer occurring, the Peconic River will be sampled at four locations on site (stations HY, HV, HM-S, and HQ). Sampling for metals, anions, and VOCs analyses at monitoring station HQ will continue on a quarterly basis (filtered/unfiltered) and is dependent on flow. Samples will be collected at HY, HV, and HM-S semi-annually depending on available flow (filtered/unfiltered).

Except for an occasional low-level detection of tritium, radionuclides in the Peconic River have not been detected for several years. Therefore, sample collection frequency for gross alpha/beta, tritium, gamma, and strontium-90 will continue to be quarterly at monitoring station HQ and semi-annual for the remaining Peconic River stations. Continued review of radiological data shows no impacts from Laboratory operations; consequently, the sampling locations and frequency are justified.

Table 10.1 Surface Water Monitoring Program

Sampling Location	Sample Type	Analysis/Frequency
HQ	24-hr composite	Anions, gross alpha, gross beta, tritium, and metals (filtered/unfiltered); sampled and analyzed quarterly.
HQ	24-hr composite	Gamma and Sr-90 analysis; samples are from individual 24-hour composites and analyzed quarterly.
HQ	Grab sample	VOCs (EPA 624); sampled and analyzed quarterly.
HM-S, HY, HH	Grab sample	Anions, VOCs (EPA 624), metals (filtered/unfiltered), gross alpha, gross beta, tritium, gamma, and Sr-90 analysis; sampled and analyzed semi-annually.
HV	Grab sample	Gross alpha, gross beta, tritium, and gamma analysis; sampled and analyzed semi-annually.
HM-N and HM-S	Grab sample	Flow chart exchanged and pH measurement taken weekly.
HQ	Grab sample	Gross alpha, gross beta, and tritium; quarterly for NYSDOH analysis (used for comparison in the SER).

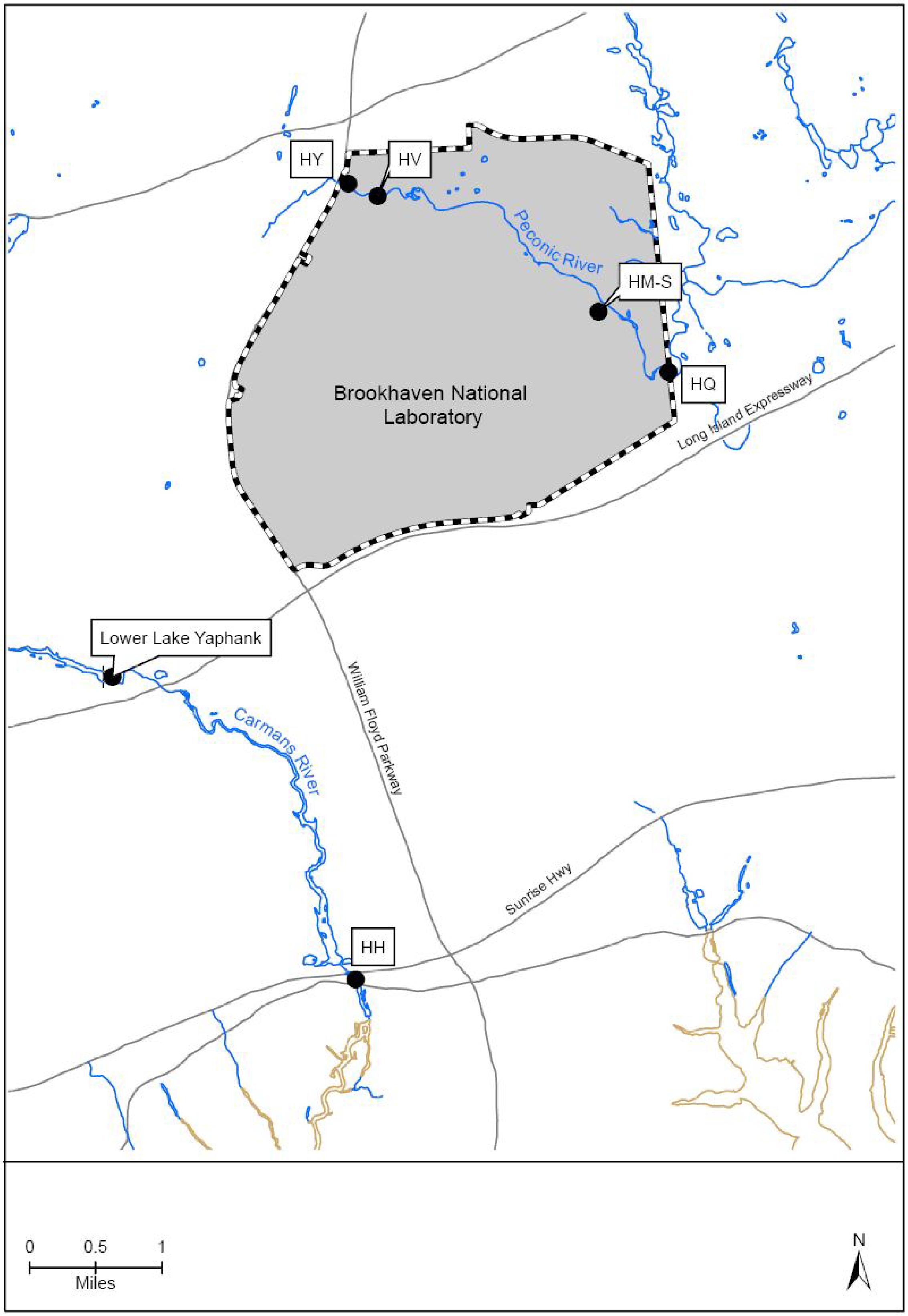

Figure 10.1. Sampling Stations for Surface Water and Fish

See Appendix B for the monitoring program for this DQO.

REFERENCES

IT Corporation, 1998. *Operable Unit V Remedial Investigation Report Volume I or V*. International Technology Corporation, May 27, 1998.

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11 POTABLE WATER

CHAPTER CONTENTS

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11.1 POTABLE WATER MONITORING

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Jennifer Higbie (631) 344-5919

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year 2025 for the Potable Water Monitoring Program.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Lab (BNL) maintains four active potable water wells, a water treatment facility, and a distribution system to supply drinking water and water for heating and cooling purposes. In doing so, the Laboratory is considered a public water supplier and must meet the requirements of the Safe Drinking Water Act (SDWA).

BNL's four active potable wells are screened in the mid Upper Glacial aquifer. This Environmental Protection Agency (EPA)-designated sole source aquifer is susceptible to contamination. The quality of the water supply is protected through (1) a comprehensive program of engineered and operational controls of existing aquifer contamination and potential sources of new contamination, (2) groundwater monitoring, and (3) potable water treatment and monitoring. The Laboratory has enacted a monitoring program to demonstrate compliance with SDWA regulations under the guidance of the SCDHS.

The objective of the potable water compliance monitoring efforts is to ensure that the concentrations of regulated contaminants present in the domestic water system are less than the maximum contaminant levels specified by regulation. Monitoring is conducted at the supply wellheads, the water treatment plant, and within the distribution system.

BNL's Source Water Assessment concluded that the Upper Glacial aquifer on site is susceptible to contamination. Several potential sources of groundwater contamination are within two years of travel to supply wells. In addition, some supply wells are located on the margins of existing contamination. To provide early warning of impacts to potable water supply wells, the Laboratory also conducts surveillance monitoring to discern trends in declining water quality.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS PROGRAM

_X_ Compliance
_X_ Support compliance
_X_ Surveillance
_ Restoration

The SDWA establishes minimum national standards for levels of contaminants in drinking water. These standards assure that water quality is healthy and wholesome for public consumption and include primary standards (health-based) and secondary standards (aesthetics-based). The contaminants that are regulated under the primary standards include microorganisms, inorganic chemicals, synthetic organic chemicals, volatile organic compounds (VOCs), radionuclides, and disinfection byproducts. It also establishes a program for the protection of sole source aquifers and implements an underground injection control program that regulates and restricts the subsurface emplacement of fluids. Potable water system monitoring requirements are contained in Title 40 of the Code of Federal Regulations (40 CFR 141-149) and in the New York State Sanitary Code (10 NYCRR Part 5).

Because BNL distributes domestic water to more than 25 users, the Laboratory's water supply is considered a public water system and must meet the performance and monitoring requirements specified by the SDWA, as well as follow corresponding state regulations. These requirements include specific chemical and radiological monitoring and the enforcement of a strict cross connection control program. The SDWA requirements are implemented at the state level by the New York State Department of Health (NYSDOH) under Part 5 of the New York State Sanitary Code and locally by SCDHS, which specifies yearly the locations and frequency of sample collection, as well as the required methods used in sample analysis.

In addition to federal and state water quality regulations, DOE Order 436.1A (2023), *Departmental Sustainability*, requires sites to maintain an Environmental Management System (EMS). BNL's EMS specifies requirements for conducting general surveillance monitoring to evaluate the effects, if any, of site operations. DOE Order 458.1, *Radiation Protection of the Public and the Environment Chg 4* (2020), requires DOE sites to maintain surveillance monitoring for determining radiological impacts to the public and environment.

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

To assure the quality of groundwater, the quality of drinking water during treatment and distribution, and to confirm compliance with federal and state drinking water regulations, the Laboratory performs monitoring of the BNL potable water supply.

Step 2: Identify the Decision

Does the Laboratory's potable water supply comply with the federal and state drinking water standards?

Is the groundwater quality at the wellhead declining such that the Environmental Protection Division (EPD) should implement the Environmental Monitoring Standard Operating Procedure (EM-SOP), EM-SOP-309, *Groundwater Protection Contingency Plan-Response to Unexpected Monitoring Results*?

Step 3: Identify Inputs to the Decision

Inputs necessary to support the decisions in Step 2 include:

- Federal and State potable water system monitoring requirements in 40 CFR 141-149 and 10 NYCRR Part 5
- New York State Department of Environmental Conservation Long Island Well Permit 1-4722-00032/00113

- BNL Annual Potable Water Sampling Plan
- SCDHS Annual Minimum Monitoring Requirements for BNL
- BNL Source Water Assessment for Drinking Water Supply Wells
- BNL Monthly Water Treatment Facility Reports
- BNL Annual Water Quality Consumer Confidence Report
- Collection and analysis of samples performed according to EPA, state, or other regulatory agency standards or guidelines
- EPD EM-SOP-304, Water Sample Collection Procedure for Potable Supply Wells
- Analytical results for the supply wells and distribution system
- Review of analytical results by project managers in accordance with EPD data review procedures to ensure data is of acceptable quality

Step 4: Define the Study Boundaries

The study boundary includes the BNL supply wells, treatment systems, water treatment facility, and the distribution system. In accordance with SDWA requirements, potable water samples are collected at the wellhead, post treatment, and from the distribution system. The specific location for collecting each sample is contingent upon the type of analysis, method of water treatment, and the purpose of the sample (i.e., to assess groundwater quality or impacts of distribution system piping). Yearly requirements are developed under the guidance of SCDHS and usually exceed the sampling requirements under the SDWA.

To assess source water quality, water samples are typically collected at the wellhead. Analytes assessed at the wellhead include VOCs, pesticides, synthetic organic chemicals, inorganics, perfluoroalkyl substances, and bacteriology. To assess the efficiency of water treatment systems, samples are collected immediately post-treatment. BNL determined that its supply wells are susceptible to Per- and Polyfluoroalkyl Substances (PFAS). In August 2020, NYS established drinking water standards of 10 ng/L (parts per trillion) for PFAS compounds perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). PFOS has been detected in three wells at concentrations above 10 ng/L. To address this contamination, between 2020 and 2023, BNL placed back into service GAC filtration systems at three wells to remove PFAS before the water is released into the distribution system. Post treatment samples are collected for PFAS analyses to ensure treatment is effective. To ensure that the potable water is not corrosive to the BNL distribution system, the piping system material is sound, and to ensure proper disinfection, analyses for asbestos, trihalomethanes, haloacetic acids, and inorganic analyses are conducted on water samples collected at the point of consumption.

Step 5: Develop the Decision Rule

Decision 1

Does the Laboratory's potable water supply comply with the federal and state drinking water standards?

The analytical data generated from the potable water monitoring programs are compared with the drinking water standards.

If the comparison shows the data to be below regulatory limits, **then** the water supply operations and monitoring will continue.

If this comparison yields a violation of a regulatory standard, **then** stakeholders are notified and long- and short-term corrective actions are taken in accordance with the SCDHS and the EPD EM-SOP-309, *Groundwater Protection Contingency Plan-Response to Unexpected Monitoring Results*. Additional samples will be collected, as required, by the drinking water regulations and an evaluation will be conducted under EM-SOP-309, *Groundwater Protection Contingency Plan-Response to Unexpected Monitoring Results,* to determine the cause of contamination.

Decision 2

Is the groundwater quality at the wellhead declining such that the BNL Groundwater Protection Contingency Plan should be implemented?

Analytical data generated from the potable water monitoring program will be evaluated and compared with historical levels to ensure that existing engineered and operational controls of known aquifer contamination are working correctly and to ensure potential sources of new contamination are located. Based on the amount of monitoring data collected for this project since its inception, full verification of the analytical results is not necessary. All new monitoring results undergo routine review by the project manager. If anomalous results are reported, a further quality assurance review of the data will be conducted.

If this evaluation reveals that a contaminant is present at levels approaching drinking water standards, **then** an evaluation will be conducted under the EPD EM-SOP-309, *Groundwater Protection Contingency Plan-Response to Unexpected Monitoring Results*, to determine the source of the contaminant and to identify any operational controls needed to manage the groundwater contaminant.

Step 6: Specify Acceptable Error Tolerances

National Primary Drinking Water Regulations (NPDWRs, or "primary standards") are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. EPA has issued drinking water standards, or Maximum Contaminant Levels (MCLs), for more than 80 contaminants. MCLs are set based on known or anticipated adverse human health effects, the ability of various technologies to remove the contaminant, the effectiveness of the technologies, and the cost of treatment. In addition, EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for 15 contaminants. EPA does not enforce these secondary maximum contaminant levels (SMCLs), but New York State (NYS) does regulate some of the contaminants. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the SMCL.

The Laboratory's compliance monitoring program exceeds the requirements issued by SCDHS in their oversight of the implementation of the SDWA. BNL performs more analyses on a greater frequency and collects additional samples under the surveillance program to ensure the highest quality drinking water. The Laboratory will maintain this heightened sampling program because the standards are health-based. A violation of the standards could produce adverse health effects for the BNL population and visitors on site, regulatory violations and fines, as well as a loss of employee, public, and regulatory confidence.

Historically, the Laboratory's drinking water has been in full compliance with the requirements of the SDWA, with the exception of an iron-sampling violation, and has not violated any maximum contaminant level standard. Some wells were shut down in the early to mid-1980s due to 1,1,1-trichloroethane (TCA) groundwater contamination. Operational controls were installed (GAC filtration) to remove the contamination before distribution. Current monitoring of these systems has shown the levels of VOCs to be much less than the drinking water standard and had been removed. Recently, however, the carbon filtration systems were reinstalled to remove PFAS that has been detected above the 10 ppt NYS limit.

Water removed from the western well field (well #7) has exceeded the secondary contaminant levels (aesthetic, not health-based) for color and iron, because there are naturally high levels of this element in the groundwater on Long Island. However, this water is treated at the BNL Water Treatment Facility to remove the iron. After treatment, the water meets all primary and secondary standards.

Step 7: Optimize the Design

The following table summarizes the potable water monitoring programs. As discussed in Step 6, the Laboratory's compliance monitoring program exceeds the requirements issued by SCDHS in their oversight of the implementation of the SDWA. Furthermore, BNL's compliance monitoring program is supplemented by the surveillance program.

Table 11.1 2025 Sampling and Analysis for Potable Water Monitoring Program

Analysis	Sampling Location	Frequency
Bacteriological	Distribution System	5 times per month
	Supply wells (pre and post GAC)	1 per quarter
Inorganic Compounds	Distribution System	2 per year
	Supply Wells	1 per year
Iron	Supply Wells	1 per quarter
Nitrate/Nitrite	Distribution System	2 per year
	Supply Wells	1 per year
Asbestos	Distribution System	1 per year
Water Quality	Distribution System	1 per quarter
	Supply Wells	2 per year
Principal Organic Compounds, Vinyl Chloride, and MTBE	Supply Wells (pre and post GAC)	1 per year
Synthetic Organic Compounds and Pesticides	Supply Wells	1 per year
Trihalomethanes and Haloacetic Acids	Distribution System	2 per year
Lead and Copper	Distribution System	20 samples once per year
Perfluoroalkyl substances (PFAS)	Supply Wells	1 per quarter
Radiological (gross alpha and beta, Cs-137 Sr-90, and gamma analysis)	Supply Wells	1 per quarter
Tritium	Supply Wells	1 per quarter
Hexavalent Chromium	Supply Wells	1 per year
1,4 Dioxane	Supply Wells	1 per quarter
Tolytriazole (TTA)	Supply Wells	1 per year

See Appendix B for the monitoring program for this DQO.

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12.1 INTRODUCTION AND MONITORING SCHEDULE

DQO START DATE January 1, 2012

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242

GROUNDWATER RESOURCE MANAGEMENT

Groundwater monitoring is driven by regulatory requirements, U.S. Department of Energy (DOE) Orders, best management practices, and Brookhaven National Laboratory's (BNL) commitment to environmental stewardship. The Laboratory monitors its groundwater resources for the following reasons:

- To support initiatives in protecting, managing, and remediating groundwater by refining the conceptual hydrogeologic model of the site and maintaining a current assessment of the dynamic patterns of groundwater flow and water-table fluctuations.
- To determine the natural background concentrations for comparative purposes. The site's background wells provide information on the chemical composition of groundwater that has not been affected by BNL's activities. These data are a valuable reference for comparison with the groundwater quality data from affected areas. The network of wells can also warn of any contaminants originating from potential sources that may be located upgradient of the BNL site.
- To ensure that potable water supplies meet all regulatory requirements.

GROUNDWATER FACILITY MONITORING

- To verify that operational and engineered controls effectively prevent groundwater contamination.
- To trigger early action and communication, should the unexpected happen (e.g., control failure).
- To determine the efficacy of the operational and engineered control measures designed to protect the groundwater.
- To demonstrate compliance with applicable requirements for protecting and remediating groundwater.

GROUNDWATER-COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) MONITORING

- To track a dynamic groundwater cleanup problem when designing, constructing, and operating treatment systems.

- To measure the performance of the groundwater remediation efforts in achieving cleanup goals.
- To protect public health and the environment during the cleanup period.
- To define the extent and degree of groundwater contamination.
- To provide early warning of the arrival of a leading edge of a plume which could trigger contingency remedies to protect public health and the environment.

BNL's CERCLA groundwater monitoring has been streamlined into five general phases**:**

Start-up Monitoring

A quarterly sampling frequency is implemented on all wells for a period of two years. This increased sampling frequency provides sufficient data while the system operation is in its early stages.

Operations and Maintenance (O&M) Monitoring

This is a period of reduced monitoring during the time when the system is in a routine operational state. The timeframe for each system varies. This phase is also utilized for several plume monitoring programs not requiring active remediation.

Shutdown Monitoring

This is a two-year period of monitoring implemented just prior to petitioning for system shut down. The increased sampling frequency provides the necessary data to support the shutdown petition.

Standby Monitoring

This is a period of reduced monitoring up to a five-year duration to identify any potential re-bounding of contaminant concentrations. If concentrations remain below maximum concentration levels (MCLs), the petition for closure and decommissioning of the system is recommended.

Post-Closure Monitoring

This is a monitoring period of varying length for approximately 20 percent of the key wells in a given project following system closure. Monitoring continues until the Record of Decision (ROD) goal of meeting MCLs in the Upper Glacial aquifer is reached. This is expected to occur by 2030. This phase is considerably longer for the Magothy and strontium-90 (Sr-90) cleanups due to greater length of the time to reach MCLs required for those projects.

The groundwater monitoring well networks for each program are organized into background, core, perimeter, bypass, and sentinel wells. The wells are designated as follows:

- <u>Background</u> – Water quality results will be used to determine upgradient water quality.
- <u>Plume Core</u> – Utilized to monitor the high concentration or core area of the plume.
- <u>Perimeter</u> – Used to define the outer edge of the plume both horizontally and vertically.
- <u>Bypass</u> – Used to determine whether plume capture performance is being met.

- Sentinel – An early warning well to detect the leading edge of a plume.

See Table 12.1.1. below for the well sampling frequency of the CERCLA Groundwater Monitoring Program.

Table 12.1.1. CERCLA Groundwater Monitoring Program – Well Sampling Frequency

Project Activity Phase	Well Type	Phase Duration (yrs.)	Sampling Freq. (events/yr.) ****
Start-up Monitoring	Plume Core	2	4x
	Plume Perimeter	2	4x
	Sentinel/Bypass	2	4x
Operations & Maintenance (O&M) Monitoring	Plume Core	End Start-up to Shutdown*	2x
	Plume Perimeter	End Start-up to Shutdown*	2x
	Sentinel/Bypass	End Start-up to Shutdown*	4x
Shutdown Monitoring	Plume Core	2	4x
	Plume Perimeter	2	4x
	Sentinel/Bypass	2	4x
Standby Monitoring	Key Plume Core	5	2x
	Plume Perimeter	5	1x
	Sentinel/Bypass	5	2x
Post Closure Monitoring***	20% of key wells	Up To 2030**	1x

Notes:

*- Duration varies by project.

** - Chemical Holes Sr-90: 2040; Magothy: 2065; BGRR Sr-90: 2070

*** - Verification monitoring for achieving maximum contaminant levels (MCLs).

****- Strontium-90 (Sr-90) monitoring projects use approximately half the defined sampling frequency for a given phase.

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12.2 OU I SOUTH BOUNDARY (RA V REMOVAL ACTION)

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436
James Milligan (631) 344-4458

SUMMARY OF CHANGES

The proposed changes for the OU I South Boundary (RA V Remedial Action) Treatment System groundwater monitoring program for calendar year 2025 are as follows:

- Maintain the VOC post-closure groundwater monitoring program of annual sample collection from post-closure wells: 107-40, 107-41, 115-13, 115-16, and 115-51. Maintain quarterly sampling of Current Landfill sentinel well 098-99.

- Install temporary wells as needed to fill monitoring data gaps and characterize extent of the Sr-90 plume. Install a temporary well to the west of OU I -Sr-90-GP-74 to verify the western extent of this higher concentration plume segment.

The OU I South Boundary project monitors the downgradient extent of commingled contaminant plumes from several sources, including the Current Landfill and the Hazardous Waste Management Facility (HWMF). The groundwater contaminant plume, consisting of VOCs, at one time extended approximately 3,000 feet south of the Brookhaven National Laboratory (BNL) property boundary. In December 1996, a remediation system comprised of two extraction wells screened within the deep Upper Glacial aquifer began operation at the southern property boundary to prevent groundwater with total VOCs exceeding 50 micrograms per liter (µg/L) from migrating off site.

The system was shut down in 2013, as it had met the cleanup goals for treating VOCs. The extracted groundwater was treated via air stripping and recharged northwest of the source areas. In addition, radiological parameters, including tritium and Sr-90, have been detected in several wells near the source areas. A Sr-90 plume originating in the former HWMF is monitored with 38 of the OU I South Boundary wells and supplemented with temporary vertical profile wells as necessary.

The monitoring well network for the OU I South Boundary project consists of 30 wells. Well locations are shown in Figure 12.2.1. The wells are sampled annually to quarterly for analysis of VOCs and Sr-90.

The contaminants of concern in this area are VOCs and Sr-90. The leading edge of the Sr-90 contamination is approximately 400 feet north of the site boundary.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
____Support
____Surveillance
__X_Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A plume of groundwater contaminated by VOCs has been identified within the Upper Glacial aquifer in the southern portion of the BNL site and off site. In response, groundwater remediation was implemented at the southern site boundary in December 1996. A plume of contaminated groundwater off site to the south is addressed by the North Street East remediation system which began operation in June 2004.

Data are needed to demonstrate that:

- The existing groundwater remediation system is intercepting the on-site groundwater plume.
- Influent concentrations to the existing treatment system will not exceed the design criteria.
- Groundwater quality is improving according to plan.

Problem Statement: A VOC plume that could represent a potential risk to human health has been defined on the BNL site. Remediation of the on-site plume has been conducted since December 1996. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decision

The decisions for the project include:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) by 2030 been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into four decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are listed below:

- Background (upgradient) wells (Decisions 1 and 2)
- Plume Core wells (Decisions 1, 2, 3, 4, and 5)
- Plume Perimeter wells, used to define the extent of the plume (Decisions 1, 2, and 5)
- Bypass Detection wells (Decisions 2 and 3)

The wells included in each subunit are shown in Table 12.2.1. The inputs necessary for the decisions include the following:

- Direction and velocity of groundwater flow
- Analytical results for VOCs and radionuclides in groundwater

- Locations of existing wells relative to flow patterns (Figure 12.2.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- North side of the current landfill to the north
- Wells 115-41 and 115-42 to the south
- West side of the current landfill and well 087-21 to the west
- Wells 098-61, 107-10, and 108-08 to the east
- Saturated thickness of the Upper Glacial aquifer

Separate decisions will be made in the subunits described in Step 3. However, some of the decisions, such as system performance, are based on the entire study system. The temporal boundaries of the study area vary, based on the decision. Some decisions are based on the most recent sampling event, while others are based on historic trends (two to three years). Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells. **If** conditions indicate that the BNL Groundwater Contingency Plan needs to be implemented, **then** the Contingency Plan will be implemented.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 50 µg/L (if currently less than 50 µg/L) or a significant increase in total VOC concentration (if currently above 50 µg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 50 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal within 30 years, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goals, **then** a petition for shutdown will be issued to the regulatory agencies.

4a. Are TVOC/Sr-90 concentrations in plume core wells above or below 50 µg/L or 8 pCi/L, respectively?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L **then** proceed with pulsed operation of the system. **If not**, and treatment has occurred for less than seven to ten years, **then** continue treatment. **If not**, and treatment has occurred for at least seven to ten years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, and system has operated for less than seven to ten years, **then** continue operation. **If yes**, and system has operated for more than seven to ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d to help with this decision). **If** no significant rebound is observed within one year, **then** petition for system shutdown and continue with monitored natural attenuation (MNA).

Decision 5

Has the groundwater cleanup goal of meeting MCLs by 2030 been achieved?

If the concentration of total VOCs in groundwater from all plume core wells over the previous two years is less than 50 µg/L and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation. Note: This assumes that system operation is already considered "optimal."

Step 6: Specify Acceptable Error Tolerances

Table 12.2.1 summarizes the decision and possible decision errors for this project.

Table 12.2.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan activated?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily.	(1) Unnecessary administrative process, project delays.
		(2) Fail to trigger Contingency Plan when it should have been triggered.	(2) Lost time in addressing problem, loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not.	(1) Premature petition for system shutoff, project delays.
		(2) Determine plume is not controlled when it is.	(2) Continue remediation longer than necessary, wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue.	(1) Plume growth continues, ultimate project delays.
		(2) Determine to continue operating system when shut down is warranted.	(2) Wasted resources, project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not.	(1) Premature petition for system shutoff, potential to have to restart system.
		(2) Determine system isn't operating as planned when it is.	(2) Continue remediation that is no longer effective

Step 7: Optimize the Design

Number and Locations of Wells

The well network consists of 30 wells located both on and off site.

Parameters and Frequency

The wells are sampled quarterly to annually for the analysis of VOCs and Sr-90. A summary of the proposed 2025 sampling program for this project is shown in Table 12.2.2.

Table 12.2.2. Proposed 2025 Sampling Frequency for the OU I South Boundary Monitoring Wells

Well ID	Sampling Frequency	Parameters
088-26	Annual-Semi-annual (Sr-90)	EPA 905 Sr-90
098-21	Annual-Semi-annual (Sr-90)	EPA 905 Sr-90
098-30	Annual-Semi-annual (Sr-90)	EPA 905 Sr-90
099-04	Annual-Semi-annual (Sr-90)	EPA 905 Sr-90
108-08	Annual	EPA 905 Sr-90
108-12	Annual	EPA 905 Sr-90
108-13	Annual	EPA 905 Sr-90
108-14	Annual	EPA 905 Sr-90
108-17	Annual	EPA 905 Sr-90
108-18	Annual	EPA 905 Sr-90

115-13	Annual	8260 Low Level
115-16	Annual	8260 Low Level
107-35	Semi-annual	EPA 905 Sr-90
108-43	Semi-annually	EPA 905 Sr-90
108-44	Semi-annually	EPA 905 Sr-90
107-34	Semi-annually	EPA 905 Sr-90
107-40	Annual	8260 Low Level
107-41	Annual	8260 Low Level
115-51	Annual	EPA 905 Sr-90 8260 Low Level
107-42	Semi-annually	EPA 905 Sr-90
108-45	Semi-annually	EPA 905 Sr-90
108-55	Semi-annually	EPA 905 Sr-90
108-56	Semi-annually	EPA 905 Sr-90
098-99	Quarterly	8260 Low Level
098-100	Semi-annually	EPA 905 Sr-90
098-103	Semi-annually	EPA 905 Sr-90
098-104	Semi-annually	EPA 905 Sr-90
108-57	Semi-annually	EPA 905 Sr-90
108-58	Semi-annually	EPA 905 Sr-90
108-59	Semi-annually	EPA 905 Sr-90

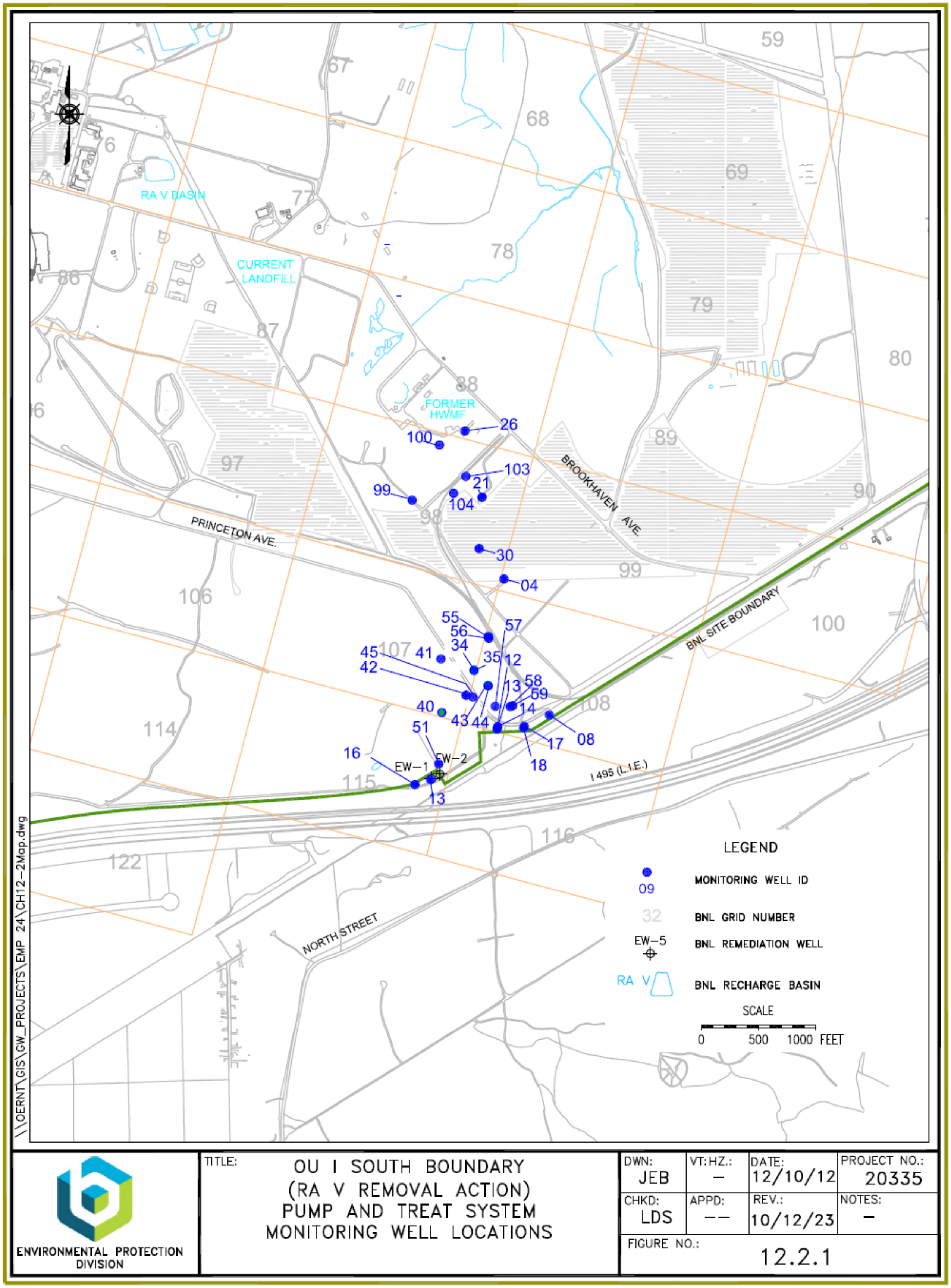


Figure 12-2.1 OU I South Boundary (RA V Removal Action) Pump and Treat System Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.3 OU III Building 96 Area

DQO Start Date January 1, 2003

Implementation Date January 1, 2025

Point of Contact Brian Barth (631) 344-2242

Summary of Changes

There are no proposed changes to the OU III Building 96 Area Groundwater Remediation System monitoring program for calendar year (CY) 2025.

Description and Technical Basis

Solvents were historically used at a former vehicle maintenance and drum storage area located immediately west of the Supply and Material area. While no spills were documented in this area, soil and groundwater samples collected during the Operable Unit (OU) III Remedial Investigation contained high concentrations of tetrachloroethylene (PCE) and 1,1,1-trichloroethane (TCA), especially in shallow groundwater. These results indicated that spillage had historically occurred in this area and a narrow plume (approximately 200 feet wide) was defined migrating south from the area of Building 96.

The identified groundwater contamination was addressed by construction of a treatment system consisting of four recirculation wells (RTW-1, -2, -3, and -4). The highest concentrations of VOCs were detected just north of extraction well RTW-1. The remaining three wells (RTW-2, -3, and -4) are further south (downgradient) in an east–west line to intercept the plume migrating south of RTW-1. Well locations are shown on Figure 12.3.1.

Impacted groundwater is extracted through the well's lower screen, treated via air stripping, and recharged through the well's upper screen. Operation of the system began during CY 2001. On July 13, 2004, wells RTW-2, -3, and -4 were placed in standby mode due to reduced VOC concentrations in the plume. The system continued to operate utilizing well RTW-1 only. Influent samples from wells RTW-2, -3, and -4 continued to be collected quarterly. Due to the high concentrations remaining upgradient of extraction well RTW-1, an engineering evaluation of additional treatment technologies was performed as part of the recommendation to place the three downgradient wells in standby. The proposed remedy resulting from the screening process was chemical oxidation by *in situ* permanganate injection.

As of June 2005, all recovery wells were placed in standby mode. However, due to increasing VOC concentrations in a well immediately upgradient, recovery well RTW-1 was turned back on in October 2005. As noted above, RTW-1 was placed in standby mode in June 2006. Due to increasing VOC concentrations, well RTW-2 was restarted in October 2007.

As noted in the 2006 Groundwater Status Report, the continued operation of RTW-1 as a recirculation well may have been causing adverse impacts on the plume. On December 12, 2007, RTW-1 effluent resample results from two different labs indicated hexavalent chromium, or Cr(VI), at 124 µg/L and 131 µg/L. Subsequent data suggest that the most likely cause of the elevated Cr(VI) levels was the treatment of soils with $KMnO_4$. One of the byproducts of the reaction is manganese oxide, which oxidizes trivalent chromium to Cr(VI). It is expected that over time, the Cr(VI) will revert to trivalent chromium (the less toxic form). In May 2008, Well RTW-1 was modified from a recirculation well to a pumping well with hexavalent chromium ion-exchange treatment and discharge to the nearby surface drainage culvert which ultimately discharges to the recharge basin HS south of the Building 96 area. The ion-exchange treatment was approved by the regulators for decommissioning in January 2018 following the decline of hexavalent chromium to levels below the New York State Ambient Water Quality Standard.

The remediation wells were located to intercept the area of greatest contaminant concentrations. Groundwater flow maps indicate that existing contamination currently downgradient of the Building 96 remediation system will be intercepted by OU III Middle Road treatment system extraction wells, which are approximately 1,500 feet downgradient of the Building 96 area. As a result, the Building 96 contamination is not expected to migrate off site.

The monitoring well network for the OU III Building 96 program consists of 35 wells, all of which are screened in the shallow Upper Glacial aquifer. One of the wells (085-378) is upgradient of the former Building 96 source area. The remaining wells are within the plume core and serve to define the lateral extent of the contamination downgradient of the former source area. Well locations are shown in Figure 12.3.1. The monitoring wells are currently sampled quarterly, semi-annually, and annually for analysis of VOCs to monitor the plume configuration and the effectiveness of the remediation system. A monitoring schedule is provided in Table 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The remediation system for the Building 96 VOC plume consists of four recovery wells. Data are needed to verify that this system is reducing the identified contamination according to plan. In 2007, it was determined that the three applications of the oxidizer potassium permanganate performed in 2005 and 2006 were ineffective in addressing the continuing source of VOCs. In 2008, the source of the VOCs was determined to be a localized area of soil contamination above the water table. PCE-contaminated soils were removed from the source area in 2010.

Step 2: Identify the Decisions

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into three decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 4, and 5)
- Plume perimeter wells (Decisions 1, 2, and 5)
- Bypass detection wells (Decisions 2 and 5)

The decision units for each of the wells in the current monitoring network are shown in Table 12.3.1. The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns (Figure 12.3.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Variability of data

Step 4: Define the Study Boundaries

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in. The decision unit limits for this project are the area being remediated near Building 96, as defined by a perimeter extending approximately 100 feet beyond the groundwater remediation wells. The Building 96 plume becomes commingled with other plumes immediately downgradient of the system.

The potential risk to downgradient receptors from the Building 96 VOC plume was determined to be low based on the following factors:

- Public water hookups have been provided off site.
- This contamination is not within the capture zone of Brookhaven National Laboratory (BNL) supply wells.
- Travel time is approximately 20 years to the BNL site boundary.
- Once the source is addressed, contamination that is not captured by the Building 96 treatment system will be intercepted by the Middle Road treatment systems before reaching the BNL site boundary.

The rate of source removal from the aquifer was expected to be relatively quick, as the treatment system was originally projected to operate for less than three years. The rate of groundwater migration is less than one foot per day. However, there is a continuing source of VOC contamination.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and sentinel wells. **If** the system is performing as planned, **then** actual VOC concentrations in plume perimeter and sentinel wells will compare well to predicted values, based on model runs. A significant difference between actual and predicted concentrations indicates the need for an evaluation for the reason for the difference.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goal by 2030, **then** a petition for shutdown will be issued to the regulatory agencies.

4a. Are TVOC concentrations in plume core wells above or below 50 µg/L?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not, then** continue treatment.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, **then** continue operation. **If yes**, and system has operated for more than ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If** no significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with monitored natural attenuation.

Decision 5

Has the groundwater cleanup goal of meeting Maximum Contaminant Level (MCL) been achieved?

If the concentration of VOCs in groundwater is less than MCLs, **then** petition for the end of monitoring. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.3.1 summarizes the decision and possible decision errors for this project.

Table 12.3.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Was the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily (2) Fail to trigger Contingency Plan when it should have been triggered	(1) Unnecessary administrative process, project delays (2) Lost time in addressing problem, loss of stakeholder confidence
Have the source control objectives been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not (2) Fail to determine cleanup goals are met when they are	(1) Delay in making operational adjustments, avoidable growth of plume (2) Wasted resources considering/ implementing operational adjustments

There are no potential receptors immediately downgradient of the Building 96 area and groundwater travel time to the site boundary is approximately 20 years. In addition, groundwater remediation was implemented in this area during 2001, and other remediation systems (OU III Middle Road) are in place downgradient of the Building 96 area.

Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust and BNL credibility, and potentially wasted resources.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program consisting of 34 monitoring wells is sufficient to monitor the OU III Building 96 area.

PARAMETERS AND FREQUENCY

The monitoring wells are sampled monthly, semi-annually, and quarterly for VOCs. Influent and effluent sampling is conducted monthly when the system is in operation. A summary of the 2025 sampling program for this project is provided in Table 12.3.2.

Table 12.3.2. Proposed 2025 Sampling Frequency for the Building 96 Treatment System Monitoring Wells

Well	Sampling Frequency	Parameters
085-293	Annually	8260 Low Level
095-84	Quarterly	8260 Low Level
095-85	Annually	8260 Low Level
095-159	Quarterly	8260 Low Level
095-162	Quarterly	8260 Low Level
095-163	Quarterly	8260 Low Level
095-165	Annually	8260 Low Level
095-166	Annually	8260 Low Level
095-168	Annually	8260 Low Level
095-169	Annually	8260 Low Level
095-170	Annually	8260 Low Level
095-172	Quarterly	8260 Low Level
095-294	Semi-annually	8260 Low Level
095-305	Quarterly	8260 Low Level
095-306	Quarterly	8260 Low Level
095-307	Semi-annually	8260 Low Level
095-308	Semi-annually	8260 Low Level
085-347	Semi-annually	8260 Low Level
085-348	Quarterly	8260 Low Level
085-349	Semi-annually	8260 Low Level
085-350	Semi-annually	8260 Low Level
085-351	Semi-annually	8260 Low Level
085-352	Semi-annually	8260 Low Level
085-354	Semi-annually	8260 Low Level
095-312	Quarterly	8260 Low Level
095-313	Semi-annually	8260 Low Level
095-318	Annually	8260 Low Level
085-378	Quarterly	8260 Low Level
085-379	Quarterly	8260 Low Level
95-325	Quarterly	8260 Low Level
85-386	Semi-annually	8260 Low Level
85-335	Semi-annually	8260 Low Level
85-383	Semi-annually	8260 Low Level
85-382	Semi-annually	8260 Low Level

085-416	Quarterly	8260 Low Level

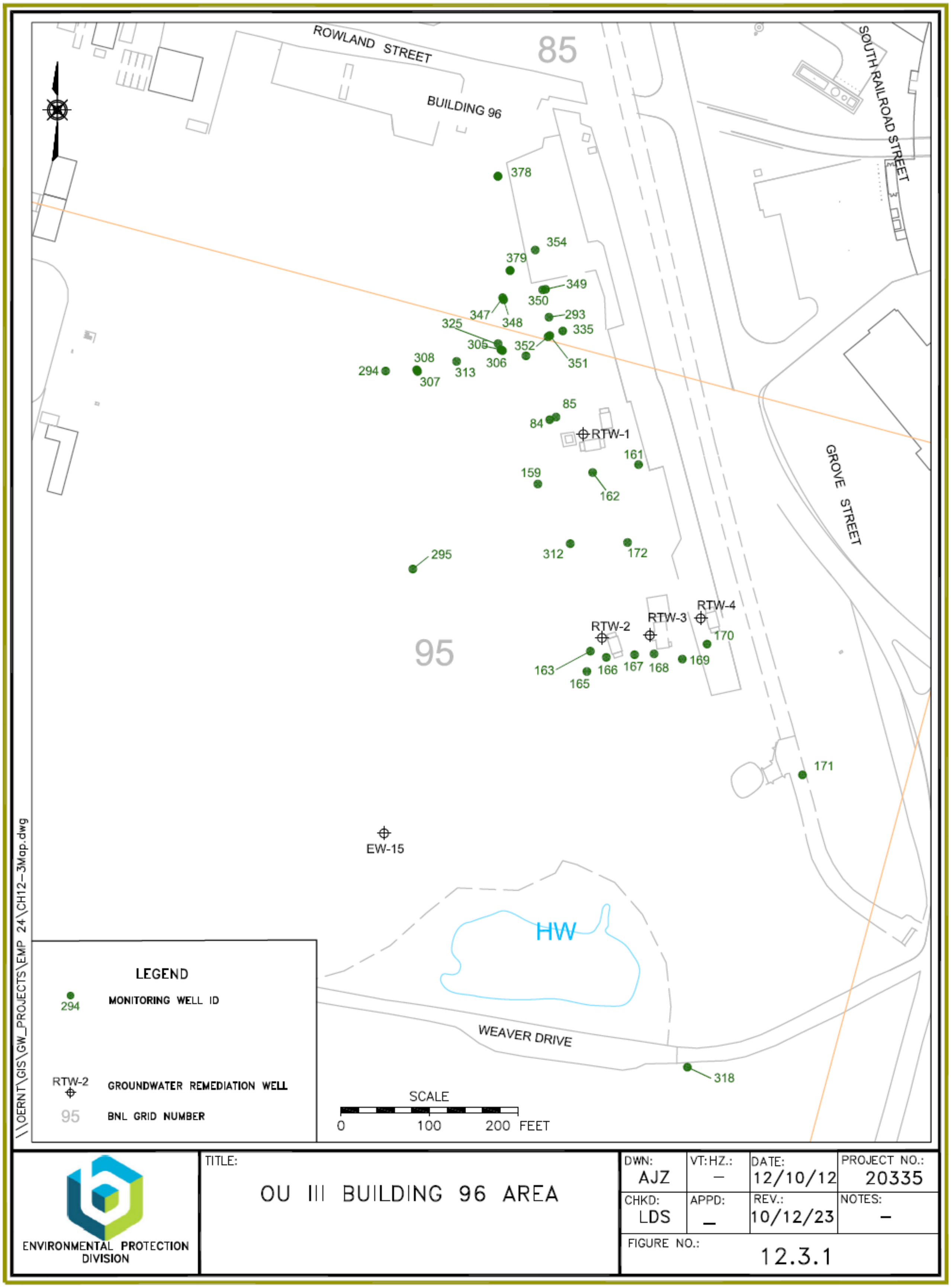


Figure 12-3.1 OU III Building 96 Area

See Appendix B for the monitoring program for this Data Quality Objective.

12.4 OU III MIDDLE ROAD PUMP AND TREAT SYSTEM

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT James Milligan (631) 344-4458

SUMMARY OF CHANGES

The proposed change to the OU III Middle Road Pump and Treat System groundwater monitoring program for calendar year 2025:

Remove monitoring well 106-56 from OU III Middle Road monitoring program. This well has not had VOC concentrations above maximum contamination levels (MCL)s in over ten years.
Two additional monitoring wells for VOCs were added during 2024, wells 105-80 and 105-81.

DESCRIPTION AND TECHNICAL BASIS

The OU III Middle Road Pump and Treat system was designed to capture contamination consisting of VOCs in the Upper Glacial aquifer upgradient of the Brookhaven National Laboratory (BNL) south property boundary. It includes seven extraction wells. The newest extraction well (RW-7) was installed and began operations in November 2013 to capture deeper contamination migrating along the western side of the plume. Extracted groundwater is treated via air stripping and recharged upgradient of the plume. The system has been in operation since the fall of 2001. Shallow groundwater flow in this area is toward the south.

As described in the Operation and Maintenance Manual for the Operable Unit (OU) III Middle Road project, the monitoring network includes 34 wells. Well locations are shown in Figure 12.4.1 at the end of this chapter.

A routine operation and maintenance monitoring frequency was implemented in August 2003. Plume core and perimeter wells will be monitored on a semi-annual frequency. Bypass wells will continue to be sampled at a quarterly frequency. Samples will be analyzed for VOCs.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
__X Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health has been defined on the BNL site. In response, capture and remediation of the plume was implemented in the fall of 2001. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decision

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into three decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, and 3)
- Perimeter wells, used to define the extent of the plume (Decisions 2 and 4)
- Bypass detection wells (Decisions 2 and 4)

The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are:

- Princeton Avenue to the north
- Approximately 500 feet south of Middle Road (wells 113-16, -17, -18, -19, and -20)
- Well 122-33 to the east
- Well 113-08 to the west
- Upper Glacial and upper Magothy aquifers

Separate decisions will be made in the three subunits described in Step 3. However, some of the decisions, such as system performance, are based on the entire study system. As described below, the temporal boundaries of the study area are currently the same for each decision subunit. However, as more data are collected, the timeframe for decisions in a subunit may be modified. Therefore, the subunits have been described separately.

- *Plume Core:* Plume core wells will be used to provide data for measuring the performance of the system. Because the system is in its third year of operation and is in the Operations and Maintenance (O&M) phase, data are needed on a less frequent basis. Therefore, the timeframe for decisions for this subunit is 180 days.

- *Perimeter:* The wells included in this subunit define the plume horizontally and vertically, which is used to determine whether the plume is being captured. Because the system is in its third year of operation and in the O&M phase, data are needed on a less frequent basis. Therefore, the timeframe for decisions for this subunit is 180 days.

- *Bypass Detection Area:* Because the wells in this area indicate whether the plume capture performance objective is being met, the decision timeframe for this area is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedures [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in perimeter or bypass detection wells to above 50 μg/L (if currently less than 50 μg/L) or a significant increase in total VOC concentration (if currently above 50 μg/L).

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goal within 30 years, **then** a petition for shutdown will be issued to the regulatory agencies.

3a. Are TVOC concentrations in plume core wells above or below 50 ug/L?

This decision also applies to the plume core wells. If this occurs, then it is reasonable to expect (based on model projections) that monitored natural attenuation (MNA) of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to MCLs within 30 years. **If** the TVOC concentration remains above 50 µg/L, **then** consider operational adjustments and/or engineering evaluation.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, **then** continue operation. **If yes,** and system has operated for more than ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d to help with this decision). **If** no significant rebound is observed within one year, **then** petition for system shutdown and continue with MNA.

Decision 4

Has the groundwater cleanup goal of meeting MCLs been achieved?

Analytical results from plume core wells will be utilized for this decision. To meet cleanup goals in the required timeframe (by 2030), groundwater extraction should be continued until plume core wells show total VOC concentrations below 50 µg/L. At that time, the project could be reclassified as MNA.

If the mean concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than the established cleanup goal for that parameter and the computed mean is consistent with professional judgment, **then** the cleanup goals for this remedial action have been achieved. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.4.1 summarizes the decision and possible decision errors for this project.

Table 12.4.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays (2) Lost time in addressing problem, loss of stakeholder confidence.
Have cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program consists of 34 monitoring wells located near the Middle Road.

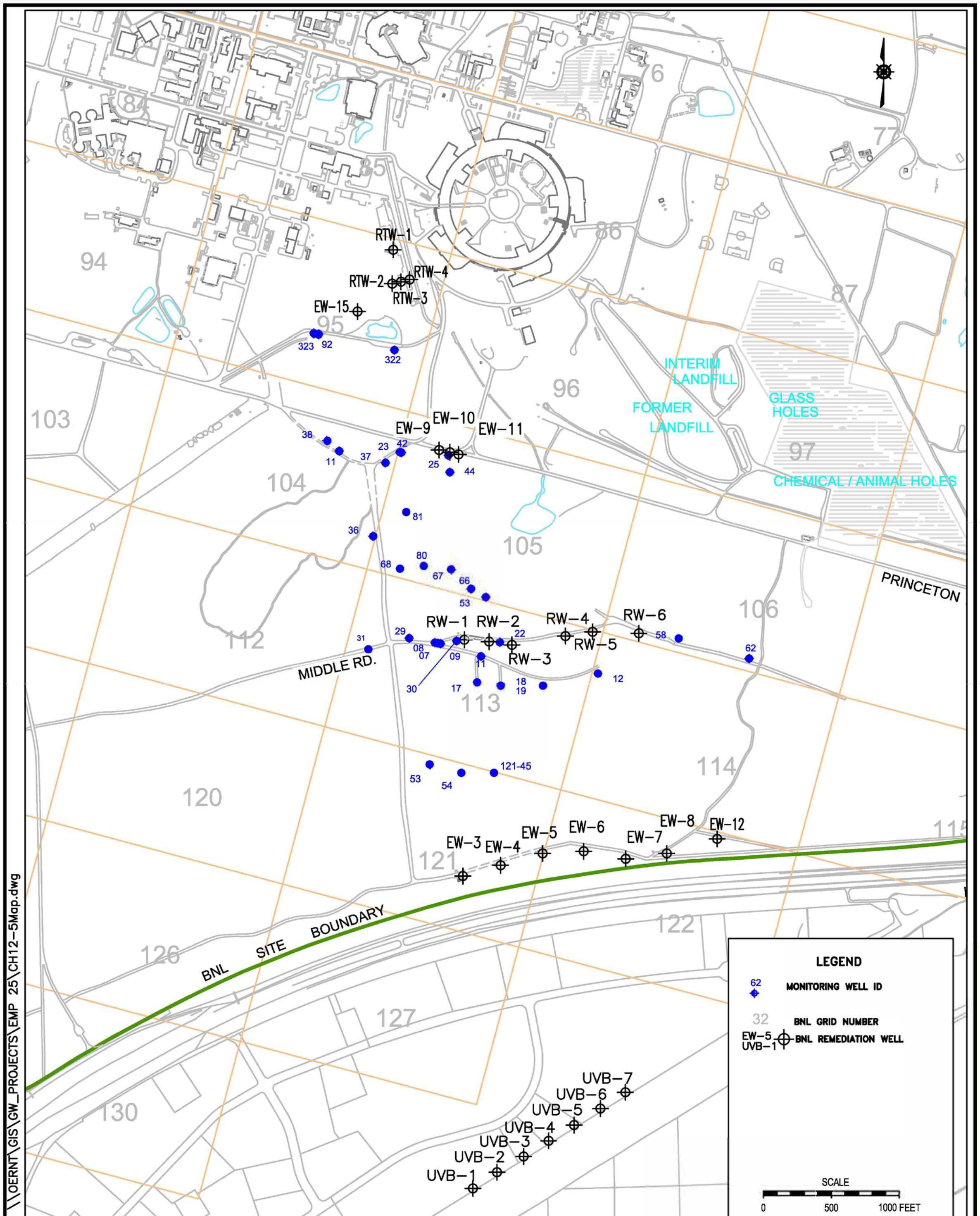
Parameters and Frequency

A routine operation and maintenance monitoring frequency was implemented in August 2003. Plume core and perimeter wells are monitored on a semiannual frequency. Bypass wells will continue to be sampled at a quarterly frequency.

A summary of the 2025 sampling program is shown in Table 12.4.2.

Table 12.4.2. Proposed 2025 Sampling Frequency for the Middle Road Project Monitoring Wells

Well ID	Sampling Frequency	Parameters
095-92	Semi-annually	8260 Low Level
104-11	Semi-annually	8260 Low Level
104-36	Semi-annually	8260 Low Level
104-37	Quarterly	8260 Low Level
104-38	Semi-annually	8260 Low Level
105-53	Semi-annually	8260 Low Level
105-66	Quarterly	8260 Low Level
113-17	Quarterly	8260 Low Level
113-18	Annually	8260 Low Level
113-19	Quarterly	8260 Low Level
113-22	Semi-annually	8260 Low Level
114-12	Quarterly	8260 Low Level
105-23	Quarterly	8260 Low Level
105-25	Semi-annually	8260 Low Level
105-42	Semi-annually	8260 Low Level
105-44	Semi-annually	8260 Low Level
113-07	Annually	8260 Low Level
113-08	Semi-annually	8260 Low Level
113-09	Semi-annually	8260 Low Level
113-11	Semi-annually	8260 Low Level
106-58	Semi-annually	8260 Low Level
106-62	Semi-annually	8260 Low Level
121-45	Semi-annually	8260 Low Level
113-29	Quarterly	8260 Low Level
113-30	Quarterly	8260 Low Level
105-67	Quarterly	8260 Low Level
113-31	Quarterly	8260 Low Level
105-68	Quarterly	8260 Low Level
121-54	Quarterly	8260 Low Level
095-322	Quarterly	8260 Low Level
095-323	Quarterly	8260 Low Level
121-53	Quarterly	8260 Low Level
105-80	Quarterly	8260 Low Level
105-81	Quarterly	8260 Low Level



ENVIRONMENTAL PROTECTION DIVISION

TITLE: OU III MIDDLE ROAD PUMP AND TREAT SYSTEM MONITORING WELL LOCATIONS

DWN: JEB	VT: HZ.: –	DATE: 12/10/12	PROJECT NO.: 20335
CHKD: LDS	APPD: --	REV.: 10/29/24	NOTES: –
FIGURE NO.: 12.4.1			

Figure 12.4.1 OU III Middle Road Pump and Treat System Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.5 OU III South Boundary Pump and Treat System

DQO Start Date January 1, 2003

Implementation Date January 1, 2025

Point of Contact Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

Summary of Changes

The proposed change for the Operable Unit (OU) III South Boundary Treatment System groundwater monitoring program for calendar year 2025 is to:

Discontinue sampling monitoring wells 114-06, 121-18, 121-21, 122-09, 122-10 and 122-31 from OU III South Boundary monitoring program. These wells have not had VOC concentrations above MCLs in over ten years.
Monitoring well 121-57 for VOCs was added during 2024.

Description and Technical Basis

The OU III South Boundary Pump and Treat System was designed to capture contamination consisting of VOCs in the Upper Glacial aquifer. These systems, working together, are designed to remediate the OU III VOC plume. Some VOC contamination present in the upper portion of the Magothy aquifer has been addressed by the Long Island Power Authority (LIPA) and Industrial Park East off-site systems.

The OU III South Boundary groundwater extraction and treatment system includes eight extraction wells. Extraction well EW-17 was installed during 2013. Extracted groundwater is treated via air stripping and recharged upgradient of the plume. The system has been in operation since 1997. The monitoring network for the OU III South Boundary system includes 28 wells. Well locations are shown in Figure 12.5.1. Currently, the wells are sampled quarterly, semi-annual, and annual for analysis of VOCs, as shown in Table 12.5.2

Drivers for Monitoring Being Conducted Under This Change

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health has been defined on the Brookhaven National Laboratory (BNL) site. In response, capture and remediation of the plume was implemented in the fall of 1997. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decisions

The decisions for the project are:

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are total VOC concentrations in plume core wells above or below 50 µg/L?
- Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into three decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3, 4, 5, and 6)
- Perimeter wells, used to define the extent of the plume (Decisions 1, 2, and 6)
- Bypass detection wells (Decisions 2 and 6)

The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns
- Evaluation of capture zone for extraction wells
- Action levels
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Middle Road to the north
- Long Island Expressway to the south
- Well 122-33 to the east
- Wells 121-06, 121-07, and 121-08 to the west

- Upper Glacial and Magothy aquifers

Separate decisions will be made in the three subunits described in Step 3. However, Section 12.1 details the general sampling frequency based on the phase of the monitoring program.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in TVOC concentration in plume fringe or bypass detection wells to above 50 µg/L (if currently less than 50 µg/L) or a significant increase in TVOC concentration (if currently above 50 µg/L).

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goals, **then** a petition for shutdown will be issued to the regulatory agencies.

Decision 4

Are TVOC concentrations in plume core wells above or below 50 µg/L?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not, then** continue treatment.

Decision 5

Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision applies to the plume core wells:

If, for each plume core well, the slope of mean concentrations for all contaminants of concern are not different from the previous three years and if subject matter experts on BNL hydrogeology and hydrochemistry concur with the results of the statistical analysis, **then** petition for system closure.

Decision 6

Has the groundwater cleanup goal of meeting MCLs been achieved?

Analytical results from plume core wells will be utilized for this decision. It has been determined that in order to meet cleanup goals in the required timeframe (30 years), groundwater extraction should be continued until plume core wells show TVOC concentrations below 50 µg/L. At that time, the project could be reclassified as Monitored Natural Attenuation.

If the mean concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than the established cleanup goal for that parameter and the computed mean is consistent with professional judgment, **then** the cleanup goals for this remedial action have been achieved. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.5.1 summarizes the decision and possible decision errors for this project.

Table 12.5.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Have cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjust-ments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program consists of 28 monitoring wells located along the south boundary of the site.

Parameters and Frequency

Plume wells will be monitored on a quarterly, semi-annual, and annual frequency for VOCs. Select wells are analyzed either annually or quarterly for VOCs. These frequencies are based on historic data and proximity to the recovery wells. Monitoring schedule details for 2025 are provided in Table 12.5.2.

Table 12.5.2. Proposed 2025 Sampling Frequency for the South Boundary Monitoring Wells

Well	Sampling Frequency	Parameters
114-07	Annual	8260 Low Level
121-06	Annual	8260 Low Level
121-08	2nd, 3rd, 4th Quarter	8260 Low Level
121-10	Semiannual	8260 Low Level
121-11	Semiannual	8260 Low Level
121-12	Annual	8260 Low Level
121-14	Semiannual	8260 Low Level
121-20	Annual	8260 Low Level
121-23	Annual	8260 Low Level
121-43	Semiannual	8260 Low Level
121-45	Quarterly	8260 Low Level
122-04	Annual	8260 Low Level
122-05	Semiannual	8260 Low Level
122-17	Semiannual	8260 Low Level
122-19	Annual	8260 Low Level
122-20	Annual	8260 Low Level
122-21	Annual	8260 Low Level
122-22	Annual	8260 Low Level
122-32	Annual	8260 Low Level
122-33	Annual	8260 Low Level
122-34	Annual	8260 Low Level
122-35	Annual	8260 Low Level
121-47	Semiannual	8260 Low Level
121-48	Semiannual	8260 Low Level
121-49	Quarterly	8260 Low Level
121-53	Quarterly	8260 Low Level
121-54	Quarterly	8260 Low Level
121-57	Quarterly	8260 Low Level

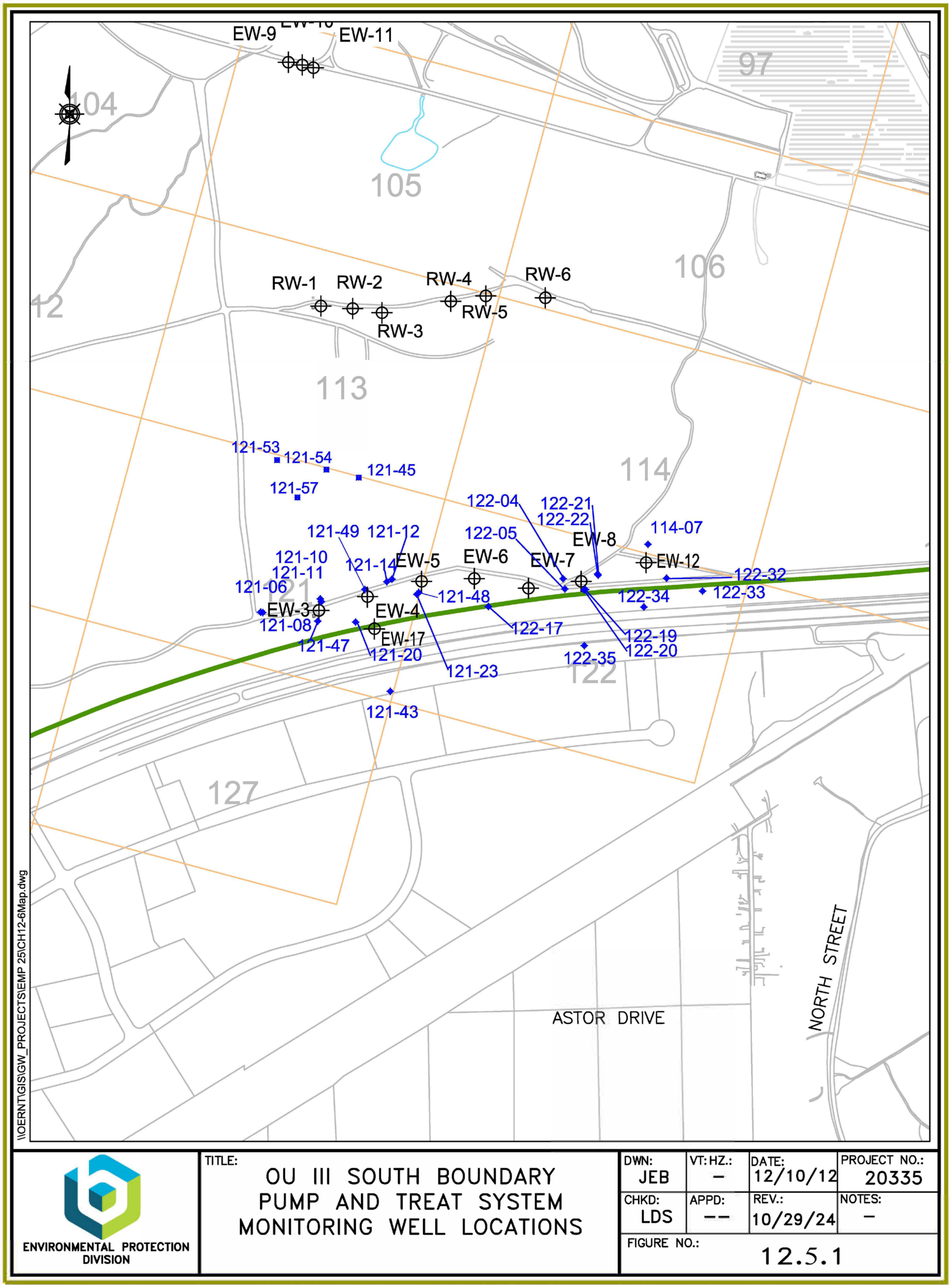


Figure 12.5.1 OU III South Boundary Pump and Treat System Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.6 OU III WESTERN SOUTH BOUNDARY PUMP AND TREAT SYSTEM

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436
James Milligan (631) 344-4458

SUMMARY OF CHANGES

There are no proposed changes to the monitoring program for the Operational Unit (OU) III Western South Boundary Treatment System groundwater monitoring program for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

The OU III Western South Boundary Pump and Treat System was designed to capture the higher concentrations of volatile organic compounds (VOCs) in the Upper Glacial aquifer along the western portion of the Brookhaven National Laboratory (BNL) south property boundary. This system captures and remediates a portion of the OU III VOC plume to reduce future off-site migration of the contamination and potential discharge of the VOC plume to the Carmans River.

The OU III Western South Boundary groundwater extraction and treatment system has been operational since May 2002. The system includes two extraction wells along the BNL south property boundary. Extracted groundwater is treated via air stripping and is piped and treated with the MR/SB systems effluent and discharged to the OUIII basins. Groundwater flow in this area is toward the south.

Four new extraction wells were installed in 2019. The four new wells, along with the existing two extraction wells, were connected to the Middle Road/South Boundary treatment system. The existing Western South boundary air stripper was no longer needed and scheduled for decommissioning.

The monitoring network for the OU III Western South Boundary program includes 35 wells. Well locations are shown on Figure 12.6.1. Groundwater samples are collected and analyzed for VOCs on a semi-annual or quarterly basis, as shown in Table 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
__X__ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment (e.g., an off-site sensitive receptor such as the Carmans River) has been defined on the BNL site. In response, capture and remediation of the higher concentrations of VOCs are being implemented along the western site boundary. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decision

The decisions for the project include:

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into four decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3, and 4)
- Perimeter wells, used to define the extent of the plume (Decision 1 and 2)
- Bypass detection wells (Decisions 1 and 2)
- Perimeter (recharge basin) wells (Decisions 1 and 2)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Princeton Avenue to the north
- Carleton Drive in North Shirley and wells 000-558, 000-559, and 000-560 to the south
- Unpaved north-south access road and wells 121-042, 127-04, 127-06, and 127-07 to the east

- Western south boundary recharge basin and wells 119-03, 125-01, and 125-02 to the west
- Upper Glacial and upper Magothy aquifers

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all four subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 20 µg/L (if currently less than 20 µg/L) or a significant increase in total VOC concentration (if currently above 20 µg/L).

If the trend in each plume fringe and bypass detection well has a negative slope based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 20 µg/L, **then** continue to operate the system. If not, then consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goal within 30 years, **then** a petition for shutdown will be issued to the regulatory agencies.

3a. Are TVOC concentrations in plume core wells above or below 20 ug/L?
This decision also applies to the plume core wells. It is anticipated that approximately seven to ten years of active groundwater treatment will reduce the mean total volatile organic compound (TVOC) concentrations in the plume core to less than 20 µg/L.

If this occurs, **then** it is reasonable to expect (based on model projections) that monitored natural attenuation (MNA) of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to MCLs within 30 years. **If** the TVOC concentration remains above 20 µg/L, **then** consider operational adjustments and/or engineering evaluation.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, **then** continue operation. **If yes**, and system has operated for more than ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If** no significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with MNA.

Decision 4

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 50 µg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than 20 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation. Note: This assumes that system operation is already considered “optimal.”

Step 6: Specify Acceptable Error Tolerances

Table 12.6.1 summarizes the decision and possible decision errors for this project.

Table 12.6.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays (2) Lost time in addressing problem, loss of stakeholder confidence.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The groundwater monitoring program for the Western South Boundary Pump and Treat System contains 35 monitoring wells.

Parameters and Frequency

A summary of the proposed 2025 sampling program for this project is shown in Table 12.6.2.

Table 12.6.2. Proposed 2025 Sampling Frequency for the Western South Boundary Monitoring Wells

Well ID	Sampling Frequency	Parameters
119-06	Quarterly	8260 Low Level
103-15	Quarterly	8260 Low Level
121-42	Semi-annual	8260 Low Level
126-01	Annual	8260 Low Level
130-02	Semi-annual	8260 Low Level
130-03	Semi-annual	8260 Low Level
130-04	Annual	8260 Low Level
126-11	Semi-annual	8260 Low Level
126-15	Semi-annual	8260 Low Level
127-04	Semi-annual	8260 Low Level
126-13	Semi-annual	8260 Low Level
126-14	Quarterly	8260 Low Level
127-06	Semi-annual	8260 Low Level
127-07	Quarterly	8260 Low Level
126-16	Quarterly	8260 Low Level
130-08	Quarterly	8260 Low Level
126-17	Quarterly	8260 Low Level
119-10	Quarterly	8260 Low Level
119-11	Quarterly	8260 Low Level
111-15	Quarterly	8260 Low Level
126-18	Quarterly	8260 Low Level
126-19	Quarterly	8260 Low Level
103-18	Quarterly	8260 Low Level
103-19	Quarterly	8260 Low Level
126-20	Quarterly	8260 Low Level
000-558	Quarterly	8260 Low Level
000-559	Quarterly	8260 Low Level
000-560	Quarterly	8260 Low Level
111-16	Quarterly	8260 Low Level
119-12	Quarterly	8260 Low Level
126-21	Quarterly	8260 Low Level
130-14	Quarterly	8260 Low Level
130-09	Quarterly	8260 Low Level
130-10	Quarterly	8260 Low Level
130-11	Quarterly	8260 Low Level

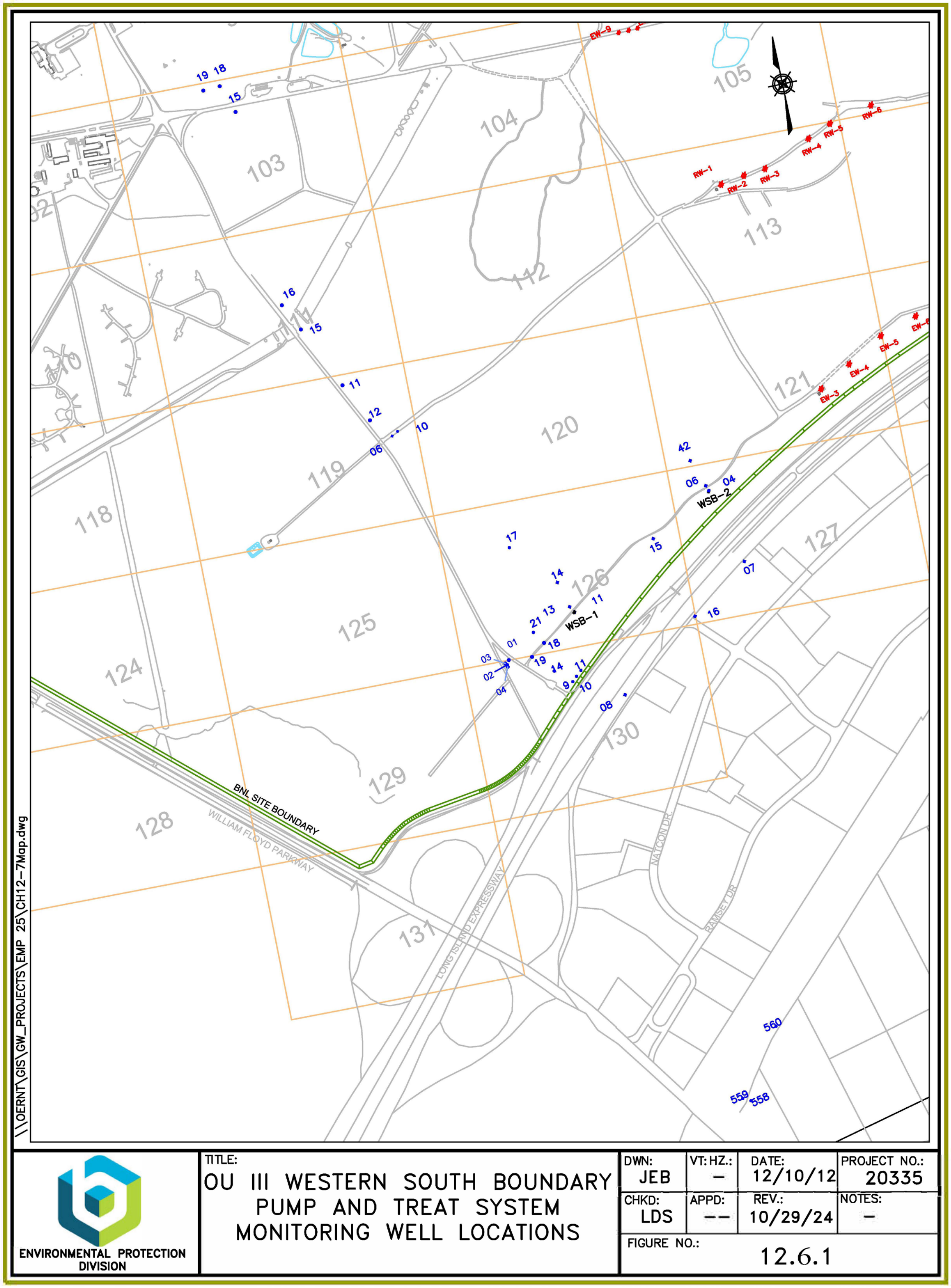


Figure 12.6.1 OU III Western South Boundary Pump and Treat Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.7 OU III INDUSTRIAL PARK

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF PROPOSED CHANGES

There are no changes for calendar year 2025 for the Industrial Park In-Well Air Stripping System groundwater monitoring program. Based upon the concentration trends in both the monitoring and extraction wells it is anticipated that this system will have achieved its cleanup goals by the end of 2024 and a Petition for Shutdown will be submitted in 2025.

DESCRIPTION AND TECHNICAL BASIS

The sources for the volatile organic compounds (VOC) plumes addressed by the Operational Unit (OU) III Industrial Park program are located within the developed central areas of the Brookhaven National Laboratory (BNL) site. Due to the proximity of the plume source areas and variability in groundwater flow direction near the source areas, the plumes are commingled south of the BNL site boundary.

A portion of the commingled VOC plume migrated beyond the BNL site boundary prior to construction and operation of the OU III South Boundary groundwater extraction and treatment system. In response, the seven in-well air stripping treatment wells that comprise the OU III Industrial Park System were constructed within the Industrial Park, located south of the west-central portion of the BNL southern site boundary. This system was constructed to provide hydraulic control to prevent further downgradient migration of the VOC plume and to remediate the portion of the plume with a concentration of total VOCs (TVOC) above 50 µg/L in the deep Upper Glacial aquifer. The system has been operating since December 1999. During 2014, two new groundwater extraction wells were installed in the Industrial Park. These wells became operational in January 2015. The wells are screened deeper than the adjacent wells to capture deeper VOC contamination identified just upgradient of this area. Currently, all extraction wells are in stand-by mode based on TVOC concentrations remaining below the capture goals in the area.

The monitoring well network for the OU III Industrial Park project consists of 40 wells. These wells monitor the VOC plume near the Industrial Park, as well as the effectiveness of the seven in-well groundwater treatment systems. The contaminants of concern associated with the OU III Industrial Park are VOCs.

Well locations are shown in Figure 12.7.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance

____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment has been defined south of the BNL site. In response, remediation of the plume has been ongoing since September 1999. Data are needed to verify the effectiveness of the remediation.

Step 2: Identify the Decision

The decisions for the project are:

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are TVOC concentrations in plume core wells above or below 50 ug/L?
- Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project is divided into four decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3, 4, 5, and 6)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1, 2, and 6)
- Bypass detection wells (Decisions 1, 2, and 6)
- Magothy (Decision 1, 2, and 6)

The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Location of existing wells relative to flow patterns (Figure 12.7.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by the following:

- Long Island Expressway to the north
- Carleton Drive to the south
- Boxwood Drive (well 000-272) to the east
- Lockwood Drive (well 000-245) to the west
- Upper Glacial aquifer
- Upper section of the Magothy aquifer

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits are utilized for this decision. Sample results are evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume fringe and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in TVOC concentration in plume fringe or bypass detection wells to above 50 µg/L (if currently less than 50 µg/L) or a significant increase in TVOC concentration (if currently above 50 µg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 50 µg/L, **then** continue to operate the system. If not, then consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Are TVOC concentrations in plume core wells above or below 50 ug/L?

If the TVOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not**, **then** continue treatment. **If not** and treatment has occurred for at least seven to ten years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether Maximum Contaminant Levels (MCL) will be met by 2030.

Decision 4

Can individual recirculation/extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 50 µg/L TVOC for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Decision 5

Is there a significant concentration rebound in core wells and/or extraction wells following shut-down?

If there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode, **then** continue operation. **If yes**, and system has operated for more than seven to ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d. to help with this decision). **If no**, significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with Monitored Natural Attenuation (MNA).

Decision 6

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of VOCs in groundwater is less than MCLs, **then** petition for sampling to be discontinued. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.7.1 summarizes the decision and possible decision errors for this project.

Table 12.7.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Have cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary, wasted resources.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The groundwater monitoring program for the III Industrial Park In-Well Air Stripping System contains 40 monitoring wells. Well locations are provided in Figure 12.7-1.

Parameters and Frequency

A summary of the proposed 2025 sampling program for this project is provided in Table 12.7.2.

Table 12.7.2. Proposed 2025 Sampling Frequency for the Industrial Park Project Monitoring Wells

Well	Sampling Frequency	Parameters
000-112	Semi-annually	8260 Low Level
000-114	Annually	8260 Low Level
000-245	Annually	8260 Low Level
000-248	Annually	8260 Low Level
000-249	Semi-annually	8260 Low Level
000-250	Annually	8260 Low Level
000-252	Annually	8260 Low Level
000-253	Semi-annually	8260 Low Level
000-255	Annually	8260 Low Level
000-256	Semi-annually	8260 Low Level
000-259	Semi-annually	8260 Low Level
000-261	Annually	8260 Low Level
000-262	Semi-annually	8260 Low Level
000-265	Semi-annually	8260 Low Level
000-267	Annually	8260 Low Level

000-268	Semi-annually	8260 Low Level
000-271	Semi-annually	8260 Low Level
000-272	Annually	8260 Low Level
000-273	Semi-annually	8260 Low Level
000-274	Semi-annually	8260 Low Level
000-275	Semi-annually	8260 Low Level
000-276	Semi-annually	8260 Low Level
000-277	Semi-annually	8260 Low Level
000-278	Semi-annually	8260 Low Level
000-279	Semi-annually	8260 Low Level
000-431	Semi-annually	8260 Low Level
000-432	Semi-annually	8260 Low Level
000-530	Quarterly	8260 Low Level
000-531	Quarterly	8260 Low Level
000-529	Quarterly	8260 Low Level
000-528	Semi-annually	8260 Low Level
000-537	Quarterly	8260 Low Level
000-538	Quarterly	8260 Low Level
127-08	Quarterly	8260 Low Level
127-09	Semi-annually	8260 Low Level
000-541	Quarterly	8260 Low Level
000-542	Semi-annually	8260 Low Level
000-543	Semi-annually	8260 Low Level
000-544	Semi-annually	8260 Low Level
000-548	Quarterly	8260 Low Level

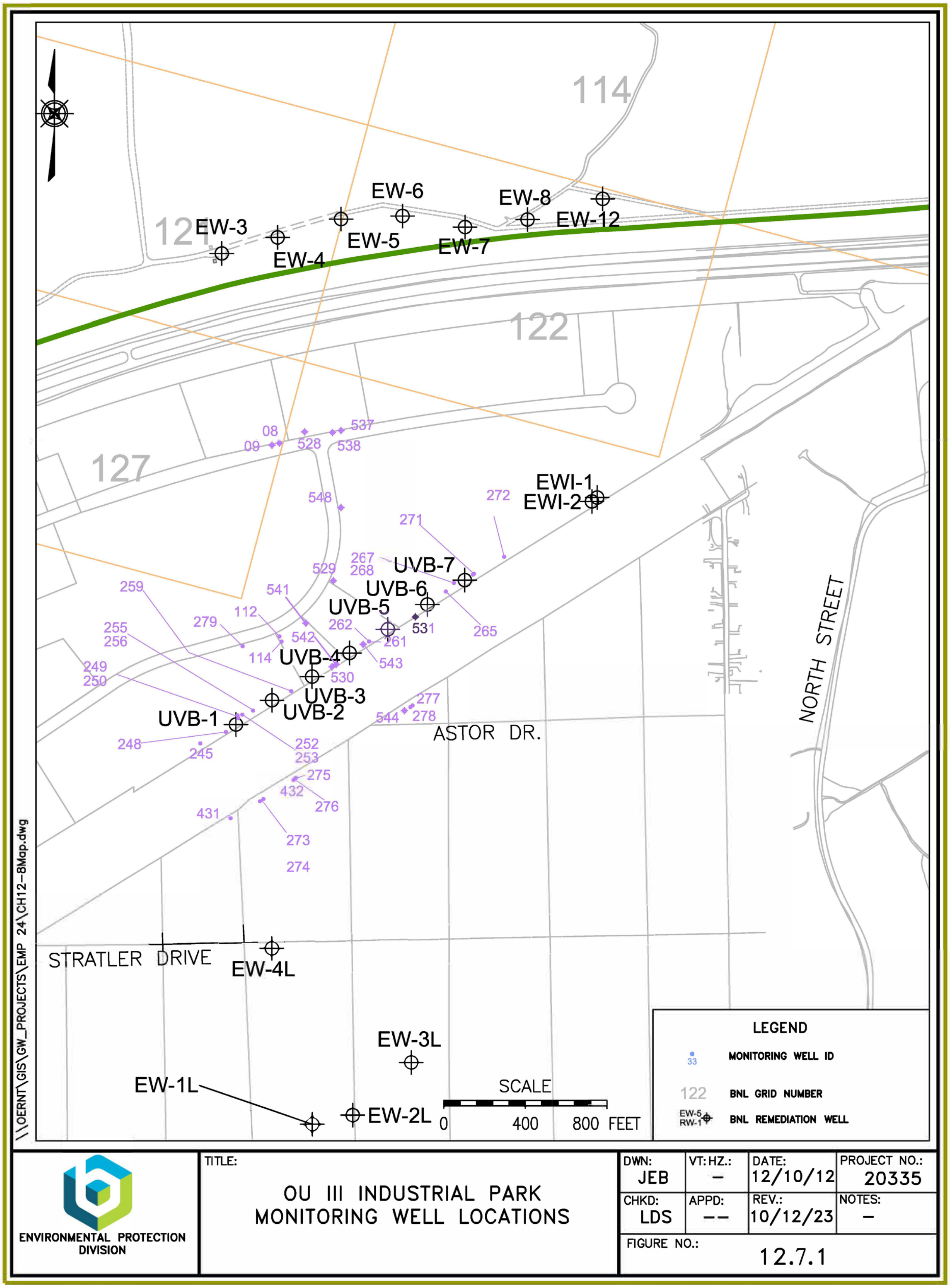


Figure 12.7.1 OU III Industrial Park Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.8 OU III NORTH STREET

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no new changes proposed for the Operational Unit (OU) III North Street Post-Closure groundwater monitoring program for calendar year (CY) 2025.

Due to the system having met its cleanup goals, a Petition for Closure for the North Street Pump and Treat System and groundwater monitoring program was submitted and approved in CY 2019. Seven of the core monitoring wells will be sampled annually for volatile organic compounds (VOCs) until results for individual VOCs are consistently below Maximum Contaminant Levels (MCL). Sampling of the other monitoring wells will be discontinued but the wells will be retained until the completion of the per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane characterization as per regulatory guidance.

DESCRIPTION AND TECHNICAL BASIS

The OU III North Street project monitors the downgradient extent of commingled contaminant plumes from several sources, including the Former Landfill, Chemical/Animal Holes, and the OU IV fuel oil/solvent spill. A groundwater remediation system began full operation in 2004. Groundwater treatment consists of two extraction wells operating at a combined pumping rate of 450 gallons per minute. This pumping captured the higher concentration portion of the VOC plume (i.e., total VOC concentrations greater than 50 micrograms/liter [µg/L]) in the Upper Glacial aquifer and minimized the potential for VOC migration into the Magothy aquifer.

The monitoring well network for the North Street project presently consists of seven wells. Well locations are shown on Figure 12.8.1. The wells are sampled annually for analysis of VOCs. A monitoring schedule is provided in Table 12.1.1.

The primary VOCs associated with this plume are carbon tetrachloride, tetrachloroethylene, and trichloroethane. Total VOC (TVOC) concentrations greater than 1,000 µg/L were observed in 1997 and 1998 but have steadily declined since then.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater in the south-central portion of the Brookhaven National Laboratory (BNL) site and off site has been impacted by VOCs at concentrations exceeding New York State groundwater standards. Monitoring data are needed to verify the effectiveness of the treatment system and attenuation of the VOC contaminants.

Step 2: Identify the Decision

The decisions for the project are:

- Are unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Have the groundwater cleanup goals been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- VOC and radionuclide analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits

Step 4: Define the Study Boundaries

The project decision unit limits are:

- Background water quality is defined by the three monitored wells upgradient of the plume core wells (086-05, 086-43, and 086-70).

- The VOC plume core is defined as the area impacted by TVOCs above 50 μg/L, including wells 000-108, 000-153, 000-154, 000-212, 000-463, 000-464, 000-465, 000-467, 000-470, 000-472, and 115-32.

- The VOC plume fringe is the area surrounding the plume core (horizontally and vertically) where TVOC concentrations are less than 50 μg/L.

Section 12.1 details the general sampling frequency based on the phase of the monitoring pro- gram. Because the VOC contaminant plume has already passed the southern BNL site boundary and therefore has the potential to impact off-site receptors, tracking the plume configuration over time is of critical importance. Since the analytical results from the plume core and plume fringe wells are used to monitor the VOC plume configuration, the timeframe for decisions using these results is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

For each future sampling event, sample results will be evaluated in context with historic data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells. **If** conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in TVOC concentration in plume perimeter or bypass detection wells to above 50 µg/L (if currently less than 50 µg/l) or a significant increase in TVOC concentration (if currently above 50 µg/L).

If the TVOC concentration trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this is consistent with professional judgment, and the TVOC concentration is less than 50 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 50 µg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

3a. Are TVOC concentrations in plume core wells above or below 50 ug/L?

If the TVOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not**, **then** continue full time treatment. **If not**, and treatment has occurred for at least ten years, **then** consider performing an evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode. **If yes**, **then** continue operation. **If yes**, and system has operated for more than ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d. to help with this decision). **If no**, and significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with Monitored Natural Attenuation (MNA).

Decision 4

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of VOCs in groundwater are less than MCLs, **then** petition for the end of monitoring. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.8.1 summarizes the decision and possible decision errors for this project.

Table 12.8.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Does the existing contaminant plume represent a potential risk to downgradient receptors?	See Step 3 for inputs.	(1) Data indicate the plume represents a risk when it does not. (2) Data indicate the plume does not represent a risk when it does.	(1) Wasted resources conducting technical evaluations and possible system modifications. (2) Potential risk to downgradient receptors.
Is the remediation system adequate to intercept and treat the existing contamination to prevent impacts to potential downgradient receptors?	See Step 3 for inputs.	(1) Data indicate the system is not adequate when it will be. (2) Data indicate the system is adequate when it will not be.	(1) Wasted resources conducting technical evaluations and possible system modifications. (2) Potential bypass of contaminants.
Are there off-site radionuclides that would trigger additional actions?	See Step 3 for inputs.	(1) Data indicate evidence for a plume when one does not exist. (2) Data indicate no evidence for a plume when one exists.	(1) Wasted resources evaluating and implementing additional actions. (2) Potential risk to downgradient receptors.

Step 7: Optimize the Design

Number and Locations of Wells

The well network consists of seven wells located both on and off site. The location of the wells is shown in Figure 12.8-1.

Parameters and Frequency

A summary of the 2025 sampling program is provided in Table 12.8.2.

Table 12.8.2. Proposed 2025 Sampling Schedule for the OU III North Street Monitoring Wells

Well	Sampling Frequency	Parameters
000-108	Annual	8260 Low Level
000-154	Annual	8260 Low Level
000-212	Annual	8260 Low Level
000-343	Annual	8260 Low Level
000-465	Annual	8260 Low Level
000-472	Annual	8260 Low Level
000-474	Annual	8260 Low Level

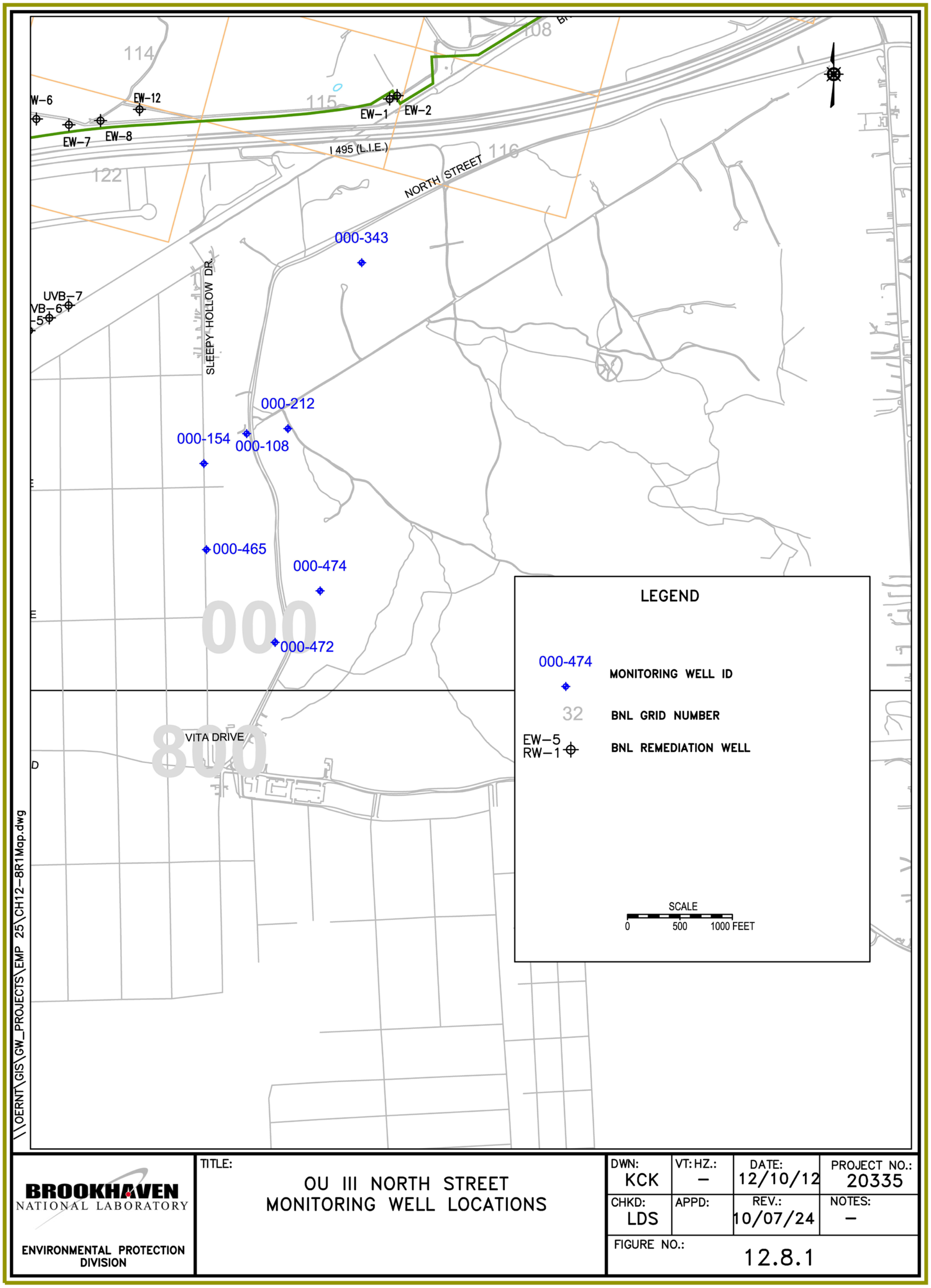


Figure 12.8.1 OU II North Street Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

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12.9 OU III NORTH STREET EAST

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no proposed changes to the Operable Unit (OU) III North Street East groundwater remediation system groundwater monitoring program for calendar year 2025.

Maintain quarterly sampling frequency for the 12ethylene dibromide (EDB) monitoring wells using Method 504, except for upgradient perimeter well 115-42 which is sampled semi-annually. Maintain annual volatile organic compound (VOC) sampling using Method 8260 Low Level for all wells except for 115-42 and 000-138.

Prepare a petition for system shutdown if EDB concentrations remain below the DWS through the third quarter of 2024.

DESCRIPTION AND TECHNICAL BASIS

The OU III North Street East remediation system consists of two groundwater extraction wells and four diffusion wells (to be shared with the OU III North Street system) located east of North Street, south of the Long Island Expressway (LIE), and north of Moriches-Middle Island Road, in East Yaphank, New York. The extraction wells are designed to remediate VOC contamination in the middle portion of the Upper Glacial aquifer.

The contamination in this area had migrated off-site prior to the start-up of the OU I (RA V) South Boundary treatment system in December 1996 and consists primarily of 1,1,1-trichloroethane (1,1,1-TCA), 1,1-Dichloroethylene (1,1-DCE), and trichloroethylene (TCE). The contamination consists of commingled plumes from several sources, including the Current Landfill and the former Hazardous Waste Management Facility (HWMF). The plume is migrating in a southerly direction with groundwater flow. In September 2019, this system was modified to incorporate two new extraction wells to pump and treat EDB contamination that was first observed in this area in 2015.

This system is designed to achieve the OU III Record of Decision (ROD) objectives of minimizing plume growth and meeting Maximum Contaminant Levels (MCLs) in the Upper Glacial Aquifer in 30 years or less. The system will address the highest VOC concentration portion of the plume (above 50 micrograms per liter [µg/l]).

The monitoring well network for the OU III North Street East project consists of 12 wells, all of which are located off site and south of the LIE. Well locations are shown on Figure 12.9.1. The wells will be sampled quarterly for EDB and annually for VOCs. The monitoring schedule is provided in Table 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_x_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment has been defined south of the BNL site. In response, a groundwater remediation system has been constructed to treat this plume. Data are needed to verify that the remediation is occurring according to plan. Based on groundwater modeling, the extraction wells are scheduled to operate for up to ten years.

The detection of EDB in perimeter well 000-394 above the Drinking Water Standard (DWS) in August 2015 has resulted in a modification of the treatment system for remediation of EDB contamination.

Step 2: Identify the Decision

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Have the groundwater cleanup goals been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into five decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 3, and 4)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1 and 2)
- Bypass detection wells (Decisions 1 and 2)

The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Location of existing wells relative to flow patterns (Figure 12.9.1)
- Evaluation of capture zone for extraction wells
- Action levels

- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- LIE to the north
- East of North Street
- North of Moriches–Middle Island Road
- Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (EM-SOP-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells. If the cleanup goals have not been met, then it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 50 μg/L (if currently less than 50 μg/L) or a significant increase in total VOC concentration (if currently above 50 μg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 50 μg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 50 μg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

3a. Are TVOC concentrations in plume core wells above or below 50 ug/L and are EDB concentrations above or below 0.05 ug/L?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L in less than seven to ten years of active remediation, **then** proceed with pulsed operation of the system. **If not**, and treatment has occurred for less than seven to ten years, **then** continue treatment. **If not**, and treatment has occurred for at least seven to ten years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode. **If yes**, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d. to help with this decision). **If no**, significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with Monitored Natural Attenuation (MNA).

Decision 4

Have the groundwater cleanup goals been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 50 µg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than 50 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.9.1 summarizes the decision and possible decision errors for this project.

Table 12.9.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues; ultimate project delays. (2) Wasted resources; project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff; potential to have to restart system. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the OU III North Street East project consists of 12 wells, all of which are located off site south of BNL.

Parameters and Frequency

A summary of the proposed 2025 sampling program for this project is provided in Table 12.9.2.

Table 12.9.2. Proposed 2025 Sampling Schedule for the North Street East Monitoring Wells

Well ID	Sampling Frequency	Parameters
000-394	Annually Quarterly	8260 Low Level EPA 504 EBD
000-138	Quarterly	EPA 504 EBD
115-42	Semi-annual	EPA 504 EBD
000-551	Annually Quarterly	8260 Low Level EPA 504 EBD
000-552	Annually Quarterly	8260 Low Level EPA 504 EBD
000-553	Annually Quarterly	8260 Low Level EPA 504 EBD
000-554	Annually Quarterly	8260 Low Level EPA 504 EBD
000-555	Annually Quarterly	8260 Low Level EPA 504 EBD
000-563	Annually Quarterly	8260 Low Level EPA 504 EBD
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000-566	Annually Quarterly	8260 Low Level EPA 504 EBD

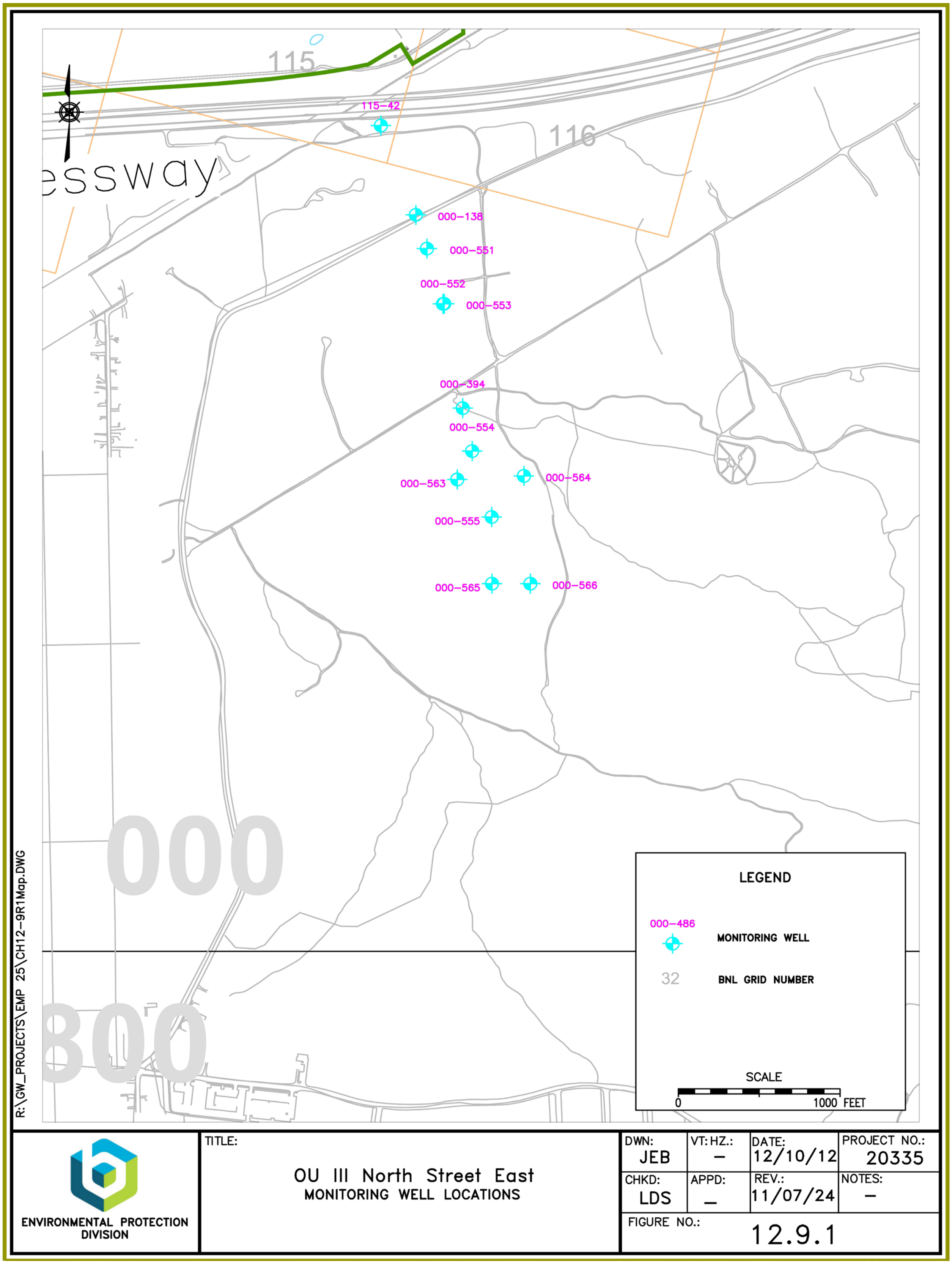

Figure 12.9.1 OU III North Street East Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.10 OU III LONG ISLAND POWER AUTHORITY (LIPA)

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

The proposed change for the Operable Unit (OU) III Long Island Power Authority (LIPA) treatment system groundwater monitoring program for calendar year 2025 is to:

Maintain the current monitoring schedule for the LIPA monitoring wells pending approval of the LIPA system is received from the regulators. Upon approval, begin the proposed post closure monitoring schedule of wells 000-130, 000-131, 000-425, 000-448, and 000-449 on an annual basis.

DESCRIPTION AND TECHNICAL BASIS

The OU III LIPA remediation system consists of three groundwater extraction wells that are located south of the Brookhaven National Laboratory (BNL) boundary and Long Island Express- way (LIE) along the LIPA right of way between Rowlinson Drive and Starlight Drive; this system addresses volatile organic compound (VOC) contamination in the Upper Glacial aquifer and an extraction well located along Starlight Drive in the vicinity of Rowlinson Drive in North Shirley that treats VOCs in the Magothy aquifer. One of the extraction wells is designed to remediate carbon tetrachloride contamination entering the upper portion of the Magothy aquifer. During system design, a determination was made to combine the Airport and LIPA projects into a single groundwater treatment system. The water from the three LIPA and the one Magothy pumping well is piped approximately 6,000 feet to a combined groundwater treatment system at Brookhaven Airport. These areas of contamination had already migrated south of the site boundary prior to the startup of the OU III South Boundary Pump and Treat System in 1997.

This treatment system is designed to achieve the OU III Record of Decision (ROD) objectives of minimizing plume growth and meeting MCL in the Upper Glacial aquifer in 30 years or less. The southernmost portions of this plume will be addressed by the Brookhaven Airport remediation system as it continues to travel south with the regional groundwater flow. The Magothy extraction well captures and treats the highest total volatile organic compound (TVOC) concentrations (>7,000 µg/L) identified in the upper-most portion of the Magothy aquifer.

The Upper Glacial monitoring well network for the OU III LIPA project consists of 17 wells. Seven of these wells are also part of the Magothy monitoring program. These wells monitor the Upper Glacial VOC plume south of the LIE to Waldorf Drive in the North Shirley residential area, and Upper Magothy VOC plume from the Industrial Park area south to Waldorf Drive, as well as the effectiveness of the groundwater treatment systems. The contaminants of concern associated with the OU III LIPA Upper Glacial and Magothy aquifer contamination project include, 1,1-Dichloroethylene (1,1-DCE), carbon tetrachloride, trichloreylene (1,1,1-TCE), and tetrachloeoethylene.

Well locations are shown on Figure 12.10.1. The monitoring schedule for 2025 is provided in Table 12.1.1.

Drivers for Monitoring Being Conducted under This Change

___ Compliance
___ Support Compliance
___ Surveillance
_x_ Restoration

Data Quality Objective Analysis

Step 1: State the Problem

VOC plumes that could represent a potential risk to human health or the environment have been defined south of the BNL site. In response, a groundwater remediation system has been constructed to treat these plumes in both the Upper Glacial and Magothy aquifers. Data are needed to verify that the remediation is occurring according to plan. Based on groundwater modeling, both the Upper Glacial and Magothy extraction wells are scheduled to operate for up to ten years.

Step 2: Identify the Decision

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are TVOC concentrations in plume core wells above or below 50 ug/L?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into eight decision subunits (four each for the Upper Glacial and Magothy systems) to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are as follows:

Upper Glacial System:

- Plume core wells (Decisions 1, 2, 3, 4, and 5)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1 and 5)
- Bypass detection wells (Decision 2)

Magothy System:

- Plume core wells (Decisions 1, 2, 4, and 5)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1 and 3)
- Bypass detection wells (Decisions 1, 3, and 4)

The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Location of existing wells relative to flow patterns (Figure 12.10.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits described in the BNL Quality Assurance Program Plan
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- LIE to the north
- Waldorf Drive to the south
- Starlight Drive to the east
- Rowlinson Drive to the west
- Upper Glacial aquifer (Upper Glacial System)
- Upper Magothy aquifer (Magothy System)

Separate decisions will be made in the eight subunits described in Step 3. However, some of the decisions, such as system performance, are based on the entire system (Upper Glacial or Magothy). The temporal boundaries of the study area vary, based on the decision.

- *Plume Core:* Due to the need for frequent data collection during the system startup period, the timeframe for decisions for this subunit is 90 days.

- *Plume Perimeter:* Because the wells in this subunit define the plume horizontally, which is used to determine whether the plume is being captured, the timeframe for decisions is 90 days. The wells are screened outside the known extent of the plume at the depth of contamination in the plume core. Although the plume is not expected to shift laterally due to changing flow conditions, the decision timeframe for this area will be 90 days during the two-year system startup phase.

- *Bypass Detection Area:* Because the wells in this area indicate whether the plume capture performance objective is being met, the decision timeframe for this area is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (EM-SOP-309) will be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 50 µg/L (if currently less than 50 µg/L) or a significant increase in total VOC concentration (if currently above 50 µg/L).

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 20 µg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Decision 4

Are TVOC concentrations in plume core wells above or below 50 ug/?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not, then** continue treatment.

4a. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

If yes, **then** continue operation. **If yes**, and system and the groundwater may not reach MCLs by 2030, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4e. to help with this decision). **If** no significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with monitored natural attenuation (MNA).

Decision 5

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 50 µg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than 50 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system closure and continue with MNA until MCLs are met. If not, then consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.10.1 summarizes the decision and possible decision errors for this project.

Table 12.10.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation longer than necessary, wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues, ultimate project delays. (2) Wasted resources, project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff, potential to have to restart system. (2) Continue remediation that is no longer effective.
Have the groundwater cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

Step 7: Optimize the Design

Number and Locations of Wells

The Upper Glacial monitoring well network for the OU III LIPA project consists of 17 monitoring wells. Seven of these wells are also part of the Magothy monitoring well network.

Parameters and Frequency

A summary of the proposed 2025 sampling program for this project is shown in Table 12.10.2.

Table 12.10.2 Proposed 2025 Sampling Frequency for the Upper Glacial and Magothy System Monitoring Well Locations

Well ID	Sampling Frequency	Parameters
000-101	Semi-Annual	8260 Low Level
000-102	Semi-Annual	8260 Low Level
000-104	Semi-Annual	8260 Low Level
000-105	Semi-Annual	8260 Low Level
000-130	Semi-Annual	8260 Low Level
000-131	Semi-Annual	8260 Low Level
000-425	Semi-Annual	8260 Low Level
000-445	Semi-Annual	8260 Low Level
000-446	Semi-Annual	8260 Low Level
000-447	Semi-Annual	8260 Low Level
000-448	Semi-Annual	8260 Low Level
000-449	Semi-Annual	8260 Low Level
000-450	Semi-Annual	8260 Low Level
000-451	Semi-Annual	8260 Low Level
000-452	Semi-Annual	8260 Low Level
000-458	Semi-Annual	8260 Low Level
000-459	Semi-Annual	8260 Low Level

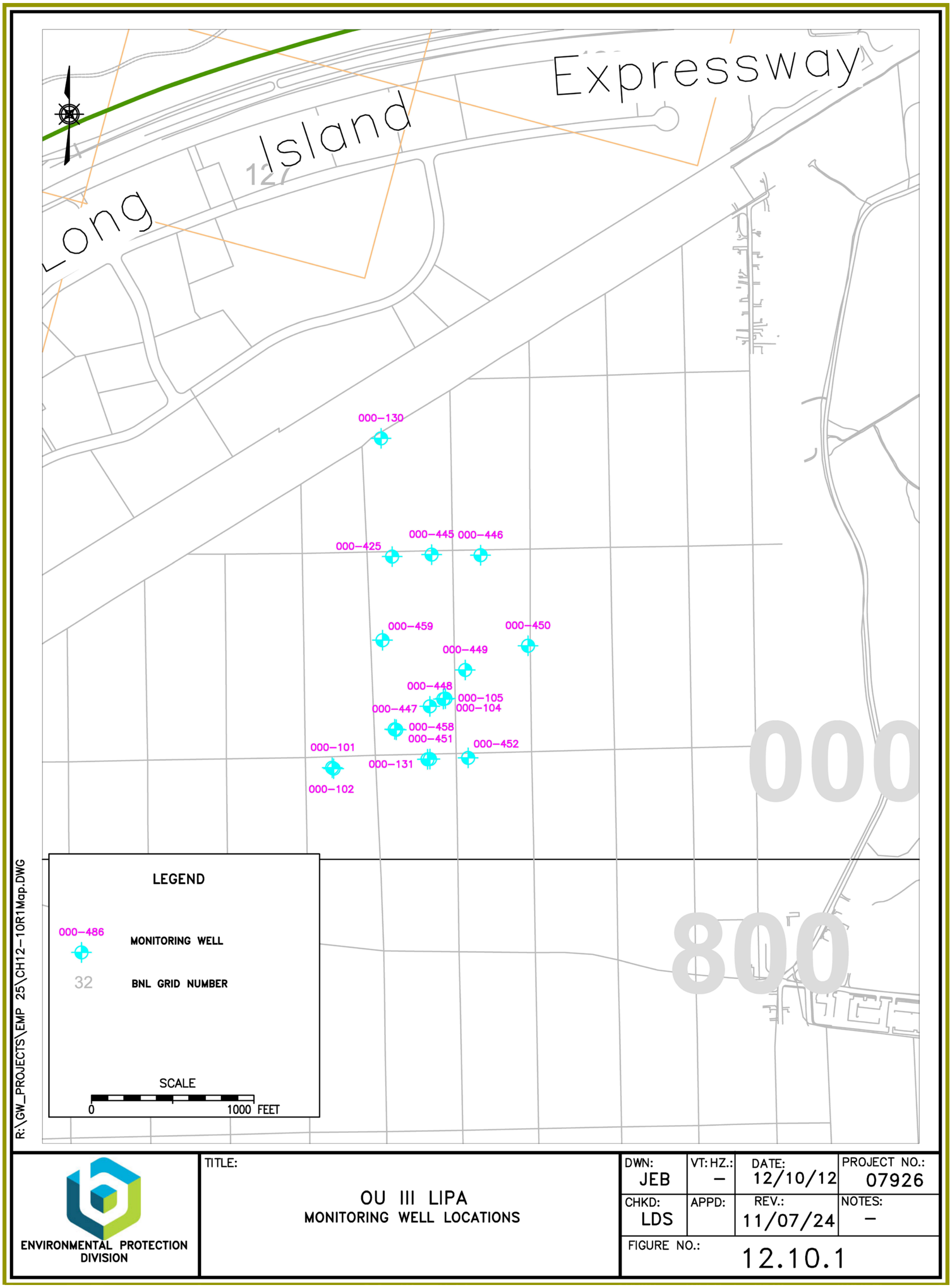

Figure 12.10.1 OU III LIPA Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.11 OU III AIRPORT

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no proposed changes for the Operational Unit (OU) III Airport Pump and Treat System groundwater monitoring program for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

The OU III Airport remediation system consists of six groundwater extraction wells along the northern boundary of the Brookhaven Airport. The wells are designed to remediate VOC contamination residing in the deep portion of the Upper Glacial aquifer. The contamination in this area had migrated off site prior to the startup of the OU I (RA V) South Boundary treatment system in December 1996 and consists primarily of 1,1,1-trichloroethane (1,1,1-TCA), tetrachloroethylene (PCE), and carbon tetrachloride (CCl4). The contamination consists of commingled plumes from several sources, including the chemical/animal holes, former landfill, and OU IV area. The plume is migrating in a southerly direction with groundwater flow.

This system is designed to achieve the OU III Record of Decision (ROD) objectives of preventing or minimizing plume growth and meeting Maximum Contaminant Levels (MCL) in the Upper Glacial aquifer by 2030. The system will address the highest VOC concentration portion of the plume (above 50 μg/L).

The monitoring well network for the OU III Airport project consists of 31 wells, all of which are located from Crestwood Drive to the northern portion of the Brookhaven Airport between Wellwood Drive and Sleepy Hollow Drive. Well locations are shown on Figure 12.11.1. The wells will be sampled quarterly and analyzed for VOCs. The monitoring schedule is provided in Table 12.11.2.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
X Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment has been defined south of the Brookhaven National Laboratory (BNL) site. In response, a groundwater remediation system has been constructed to treat this plume. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decision

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are TVOC concentrations in plume core wells above or below 10 ug/L for the OU III Airport?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into five decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3, 4, and 5)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1 and 2)
- Bypass detection wells (Decisions 1 and 4)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Location of existing wells relative to flow patterns (Figure 12.37.1)
- Evaluation of capture zone for extraction wells
- Action Levels
- Analytical methods and detection limits as described in the BNL Quality Assurance Program Plan (QAPP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Crestwood Drive to the north
- East of Lockwood Drive
- West of Girald Drive
- Northern portion of Brookhaven Airport
- Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase of the monitoring program.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (EM-SOP-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume perimeter or bypass detection wells to above 10 µg/L (if currently less than 10 µg/L) or a significant increase in total VOC concentration (if currently above 50 µg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope based on the four most recent consecutive samples and this trend is consistent with professional judgment and the total VOC concentration is less than 10 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 10 µg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Decision 4

Are TVOC concentrations in plume core wells above or below 10 ug/L for the Airport?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not, then** continue treatment. **If not**, and treatment has occurred for at least ten years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

4a. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

If yes, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4e. to help with this decision). **If** no significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with monitored natural attenuation (MNA).

Decision 5

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 10 µg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than 10 µg/l, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.11.1 summarizes the decision and possible decision errors for this project.

Table 12.11.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Has the plume been controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues–ultimate project delays. (2) Wasted resources; project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff; potential to have to restart system. (2) Continue remediation that is no longer effective.
Have the groundwater cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the OU III Airport project consists of 31 wells, all of which are located between Crestwood Drive and the northern portion of Brookhaven Airport, as shown in Table 12-13.2.

Parameters and Frequency

A summary of the proposed 2025 sampling program for this project is shown in Table 12.11.2.

Well ID	Sampling Frequency	Parameters
000-428	Semiannually	8260 Low Level
800-100	Semiannually	8260 Low Level
800-101	Semiannually	8260 Low Level
800-102	Semiannually	8260 Low Level
800-103	Semiannually	8260 Low Level
800-104	Semiannually	8260 Low Level
800-105	Semiannually	8260 Low Level
800-106	Semiannually	8260 Low Level
800-108	Quarterly	8260 Low Level
800-126	Quarterly	8260 Low Level
800-127	Quarterly	8260 Low Level
800-128	Quarterly	8260 Low Level
800-129	Semiannually	8260 Low Level
800-130	Semiannually	8260 Low Level
800-131	Quarterly	8260 Low Level
800-133	Quarterly	8260 Low Level
800-43	Semiannually	8260 Low Level
800-44	Semiannually	8260 Low Level
800-50	Semiannually	8260 Low Level
800-59	Semiannually	8260 Low Level
800-60	Quarterly	8260 Low Level
800-63	Semiannually	8260 Low Level
800-90	Semiannually	8260 Low Level
800-92	Semiannually	8260 Low Level
800-94	Semiannually	8260 Low Level
800-95	Semiannually	8260 Low Level
800-96	Semiannually	8260 Low Level
800-97	Semiannually	8260 Low Level
800-98	Semiannually	8260 Low Level
800-99	Semiannually	8260 Low Level
800-138	Semiannually	8260 Low Level

Table 12.11.2. Proposed 2025 Sampling Frequency for the OU III Airport Monitoring Wells

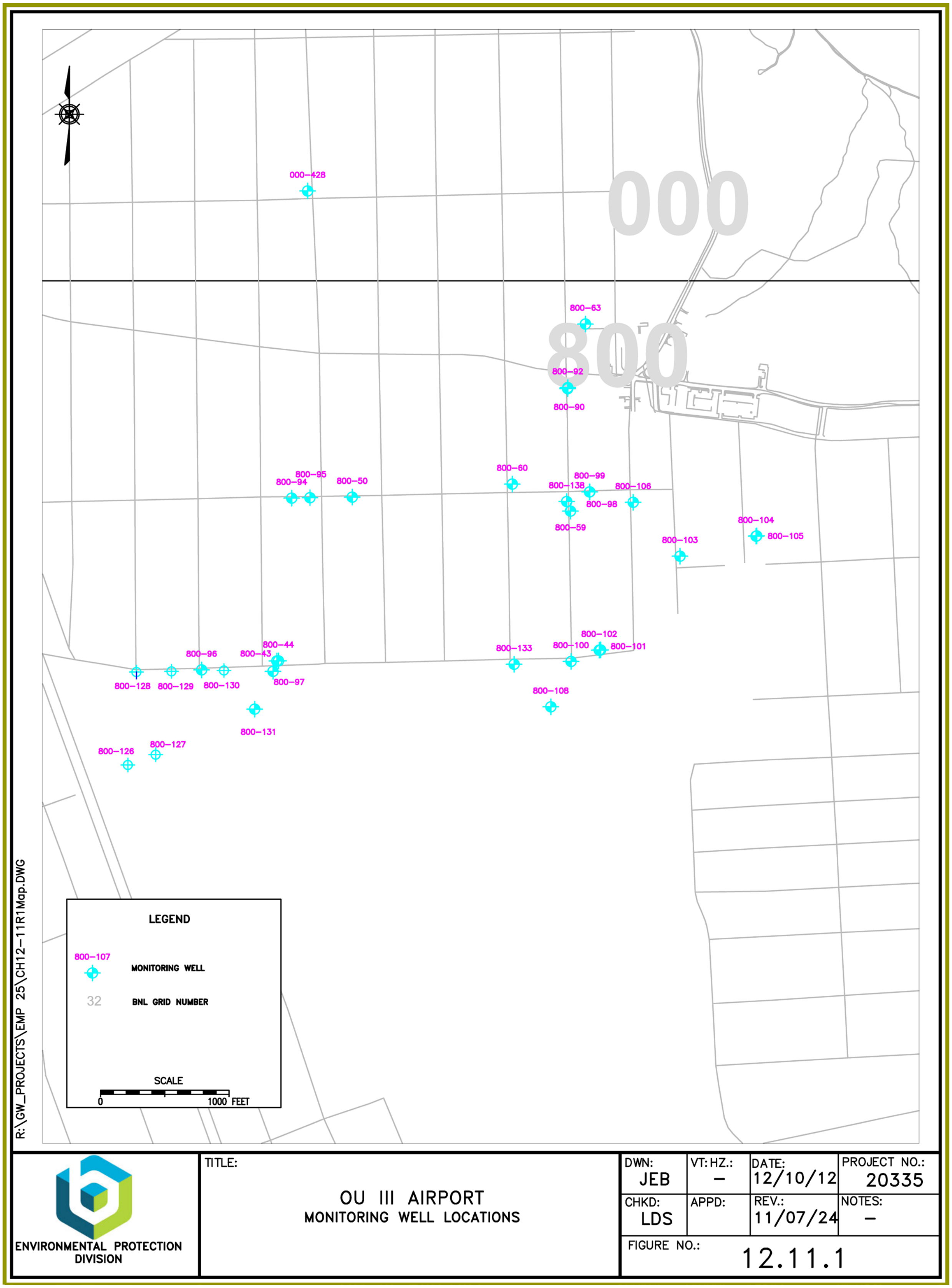

Figure 12.11.1 OU III Airport Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.12 William Floyd Sentinel Monitoring

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF PROPOSED CHANGES

There are no proposed changes to the William Floyd Sentinel Monitoring Program for calendar year (CY) 2025.

DESCRIPTION AND TECHNICAL BASIS

A network of six wells located near the western site boundary serve as sentinel wells for the Suffolk County Water Authority William Floyd Parkway Well Field located immediately west of this area. Monitoring well 109-03 was installed by the Suffolk County Department of Health Services.

The monitoring well network for this project consists of six wells that provide groundwater quality data upgradient of the William Floyd Well Field. Well locations are shown on Figure 12.12.1. The wells are sampled quarterly for analysis of volatile organic compounds (VOCs), polyfluoroalkyl substances (PFAS)/perfluorooctanoic acid (PFOA), 1,4-dioxane, gamma spectroscopy, tritium, and Sr-90, as shown in Table 12.1.1.

The contaminants of concern associated with the sources monitored by the William Floyd Sentinel Wells are VOCs and PFAS. During CY 2020, all analyte concentrations were less than the New York State groundwater standards.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater beneath the western portion of the BNL site has been impacted by low levels of VOCs and PFAS from both known and unknown sources. A groundwater remediation system is under construction to treat PFAS/PFOA originating from the Current Firehouse. This data will provide for early warning of contaminants migrating towards the public well supply field.

Step 2: Identify the Decision

The decisions for the project are:

- Is the contamination naturally attenuating as expected?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Analytical results in groundwater
- Locations of existing wells relative to flow patterns (Figure 12.12.1)
- Regulatory drivers (OU III Record of Decision [ROD])
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data

Step 4: Define the Study Boundaries

The project decision unit limits are defined by:

- William Floyd Parkway on the west
- The firebreak path on the south

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contaminants detected?

The sample results will be evaluated in context with historical data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be determined for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, including detection of previously undetected contaminants and detection of contaminants in wells where those contaminants have not previously been detected.

If contaminants are detected in any well at unusually high concentrations (relative to the historical baseline) and the results are confirmed by resampling, **then** implement actions as prescribed in the BNL Groundwater Contingency Plan.

Table 12.12.1 summarizes the decision and possible decision errors for this project.

Table 12.12.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is groundwater impacted by contaminants migrating off site?	See Step 1 for inputs.	(1) Data indicate that groundwater impacted by contaminants is flowing off site when that is not true. (2) Data indicate that there is not groundwater impacted by contaminants flowing off site when there is.	(1) Investigation and/or remediation of groundwater contamination may be undertaken by BNL when it is not warranted. (2) Delays in addressing contamination, possible actions by regulatory agencies.

Step 7: Optimize the Design

Number and Locations of Wells

The six wells are located to monitor on-site water quality immediately upgradient of the William Floyd Well Field.

Parameters and Frequency

The wells are sampled quarterly for analysis of VOCs, gamma spectroscopy, tritium, Sr-90, 1,4-dioxane, and PFAS/PFOA.

A summary of the proposed 2025 sampling program for this project is shown in Table 12.12.2

Table 12.12.2. Proposed 2025 Sampling Frequency for the Wm Floyd Sentinel Monitoring Sampling Program

Well	Sampling Frequency	Affected Parameters
109-03	Quarterly Annually Annually Annually Quarterly	8260 Low Level EPA 905 Sr-90 EPA 906 Tritium EPA 901 Gamma Spec 8270 SIM 1,4-dioxane, EPA 1633 PFAS/PFOA
117-01	Quarterly Annually Annually Annually Quarterly	8260 Low Level EPA 905 Sr-90 EPA 906 Tritium EPA 901 Gamma Spec 8270 SIM 1,4-dioxane, EPA 1633 PFAS/PFOA
117-02	Quarterly Annually Annually Annually Quarterly	8260 Low Level EPA 905 Sr-90 EPA 906 Tritium EPA 901 Gamma Spec 8270 SIM 1,4-dioxane, EPA 1633 PFAS/PFOA
117-04	Quarterly Annually Annually Annually Quarterly	8260 Low Level EPA 905 Sr-90 EPA 906 Tritium EPA 901 Gamma Spec 8270 SIM 1,4-dioxane, EPA 1633 PFAS/PFOA
117-05	Quarterly Annually Annually Annually Quarterly	8260 Low Level EPA 905 Sr-90 EPA 906 Tritium EPA 901 Gamma Spec 8270 SIM 1,4-dioxane, EPA 1633 PFAS/PFOA
117-06	Quarterly Annually Annually Annually Quarterly	8260 Low Level EPA 905 Sr-90 EPA 906 Tritium EPA 901 Gamma Spec 8270 SIM 1,4-dioxane, EPA 1633 PFAS/PFOA

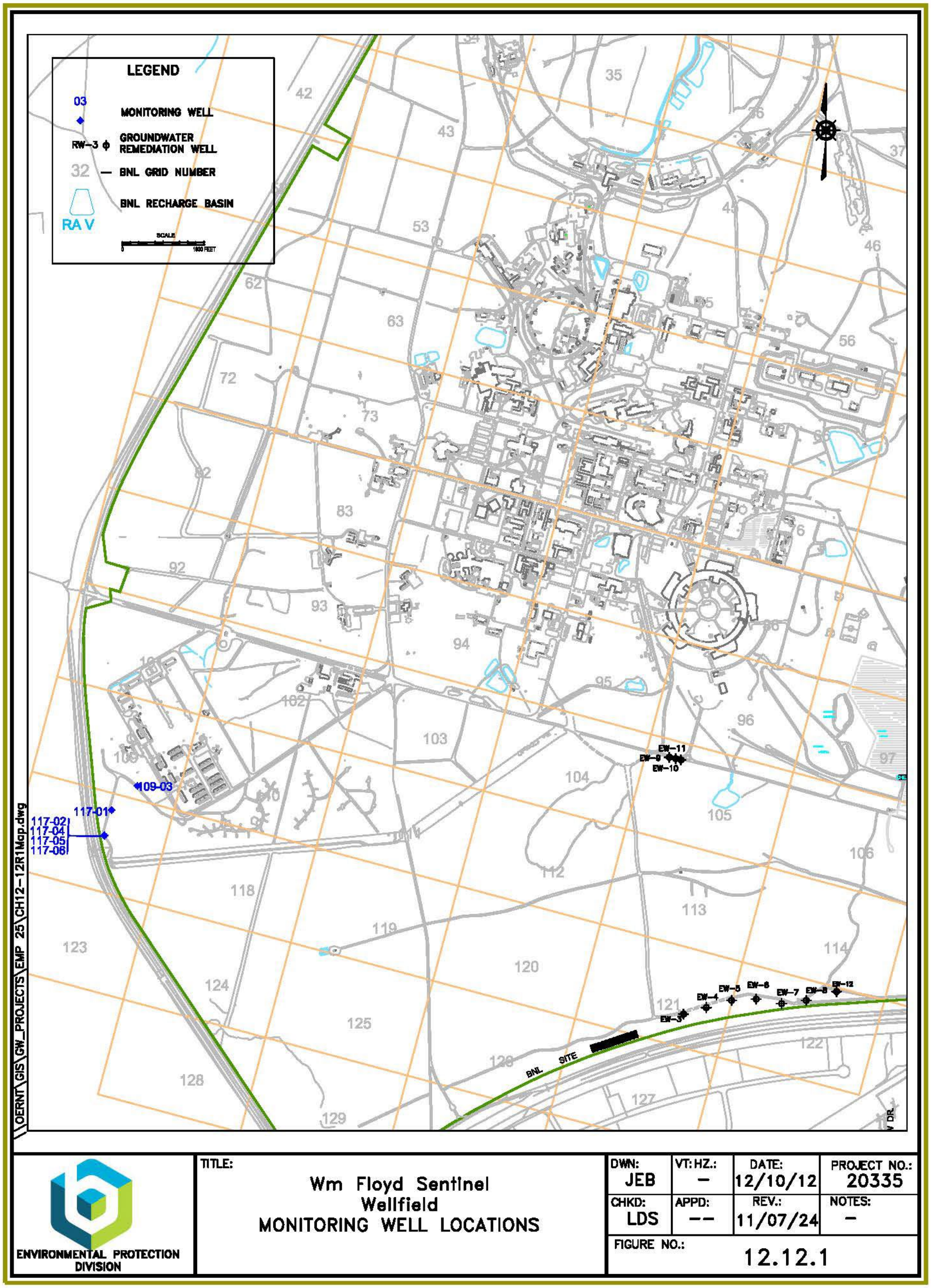

Figure 12.12.1 Wm Floyd Sentinel Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.13 OU III SOUTH BOUNDARY RADIONUCLIDE

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242

SUMMARY OF CHANGES

Due to the lack of radionuclide detections above the Drinking Water Standard (DWS) for the last 20 years, a recommendation to discontinue further sampling for the Operable Unit (OU) III South Boundary and Western South Boundary Pump and Treat Systems was submitted to regulators and approved. The 48 monitoring wells that formerly comprised this program are listed in Table 12.13.1 and shown on Figure 12.13.1.

Table 12.13.1 2025 Sampling Frequency for the South Boundary Radionuclide Monitoring Wells.

Well	Sampling Frequency
000-280	Discontinue
114-06	Discontinue
114-07	Discontinue
121-06	Discontinue
121-07	Discontinue
121-08	Discontinue
121-09	Discontinue
121-10	Discontinue
121-11	Discontinue
121-12	Discontinue
121-13	Discontinue
121-14	Discontinue
121-18	Discontinue
121-19	Discontinue
121-20	Discontinue
121-21	Discontinue
121-22	Discontinue
121-23	Discontinue
122-02	Discontinue
122-04	Discontinue
122-05	Discontinue
122-09	Discontinue
122-10	Discontinue
122-15	Discontinue
122-16	Discontinue
122-17	Discontinue
122-18	Discontinue
122-19	Discontinue

Well	Sampling Frequency
122-20	Discontinue
122-21	Discontinue
122-22	Discontinue
122-31	Discontinue
122-32	Discontinue
122-33	Discontinue
121-42	Discontinue
126-01	Discontinue
126-11	Discontinue
126-13	Discontinue
126-14	Discontinue
126-15	Discontinue
126-16	Discontinue
127-04	Discontinue
127-06	Discontinue
127-07	Discontinue
130-02	Discontinue
130-03	Discontinue
130-04	Discontinue
130-08	Discontinue

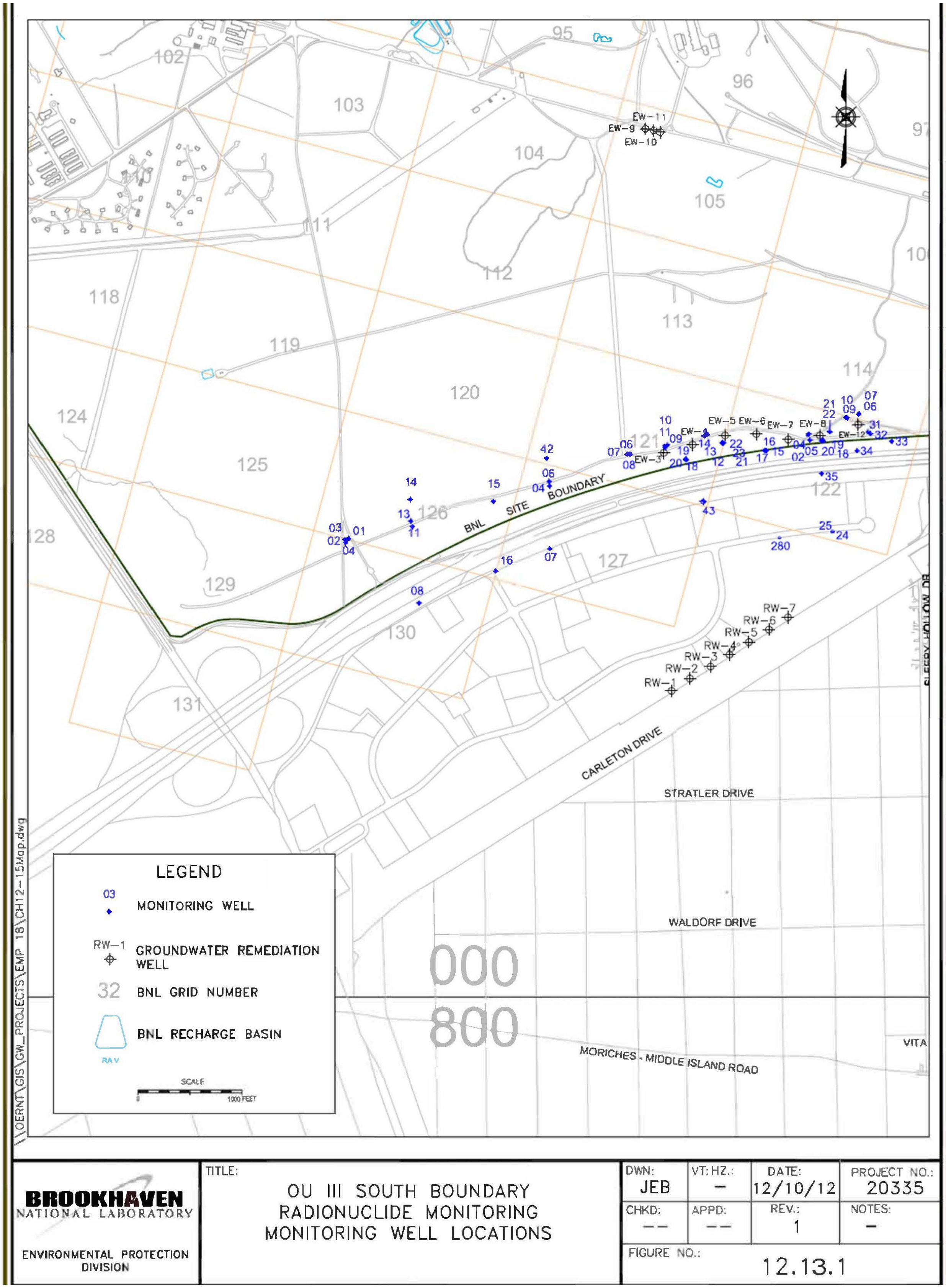

Figure 12.13.1 OU III South Boundary Radionuclide Monitoring Well Locations

See Appendix B for the monitoring program for this DQO.

12.14 OU III Brookhaven Graphite Research Reactor Waste Concentration Facility Strontium-90

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

Summary of Changes/Proposed Changes

The proposed changes for the Brookhaven Graphite Research Reactor (BGRR) Waste Concentration Facility (WCF) Groundwater Treatment System groundwater monitoring program in calendar year 2025 are as follows:

Discontinue sampling of existing monitoring wells 075-809, 075-810, 075-811, 075-415, 075-417, 075-419, 085-171, 085-285, 085-286, 085-287, 085-01, 085-406, 085-407, and 085-290 for Sr-90 analysis. This data was utilized to evaluate the presence of Sr-90 in the vicinity of extraction well FF-RW-A and is no longer needed.

Description and Technical Basis

The Operable Unit (OU) III BGRR/WCF project monitors the extent of multiple Sr-90 plumes in groundwater on site. Some of the wells included in the OU III BGRR/WCF network are also monitored for tritium as part of the OU III Area of Concern (AOC) 29 High Flux Beam Reactor (HFBR) Tritium program. The overlapping wells are sampled concurrently for both programs to avoid duplication of effort. As this summary only addresses the OU III BGRR/WCF project, evaluation of the sampling frequency and analytical parameters for the OU III HFBR Tritium project are conducted separately.

The current monitoring well network for the OU III BGRR/WCF project consists of 66 wells. The locations are shown in Figure 12.14.1. The wells are sampled annually to semi-annually for analysis of Sr-90. The monitoring schedule is provided in Table 12.14.2.

The analytical results show several distinct areas of elevated Sr-90: one emanating from the WCF and extending approximately 1,300 feet south and another beginning south of the BGRR and extending south approximately 1,200 feet. The third area of elevated Sr- 90 concentrations begins at the Pile Fan Sump area and extends south for approximately 600 feet. Variability in groundwater flow directions due to changes in pumping and recharge patterns in the plume vicinity over time have resulted in lateral spreading of the contamination.

In addition, evaluation of various scenarios for potable water supply at the BNL site has shown that if eastern supply wells 10, 11, and 12 are used as the primary source of potable water for an extended time, the capture zone for these supply wells may extend to near the

BGRR. This could result in the Sr-90 contamination being drawn into the supply wells. The BNL Water and Sanitary Planning Committee is charged with monitoring supply well usage across the site to minimize any impacts from changing groundwater flow on contaminant plumes.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

In the Upper Glacial aquifer beneath the central portion of the BNL site, there is an area of groundwater contaminated by Sr-90. In response, groundwater characterization and remediation are in progress. Data are needed to continue to track the vertical and horizontal extent of the contamination.

Step 2: Identify the Decisions

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Sr-90 analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Regulatory drivers (OU III Record of Decision [ROD])
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data
- Status of potential downgradient receptors
- Estimated retardation rate for Sr-90

Step 4: Define the Study Boundaries

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in. The horizontal extent of the study area is defined by the area of the Upper Glacial aquifer downgradient of the BGRR/WCF with detectable activities of Sr-90. Due to the slow travel time for Sr-90 in groundwater, the timeframe for decisions is 180 days.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as a significant increase in Sr-90 concentration in plume perimeter or bypass detection.

If the trend in each plume perimeter and bypass detection well has a negative or zero slope based on the four most recent consecutive samples and this trend is consistent with professional judgment, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from all wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume core and bypass detection wells. **If** the system is performing as planned, **then** actual Sr-90 concentrations in plume core and bypass detection wells will compare well to predicted values, based on model runs. A significant difference between actual and predicted concentrations indicates the need for an evaluation of the reason for the difference.

If the system is performing as planned (based on groundwater model predictions, trend analysis, and expert judgment), **then** continue to operate. **If not**, **then** consider operational adjustments and/or engineering evaluation. Note: When the majority and/or "key" wells, as defined by a subject matter expert, are performing as planned, the system as a whole is considered to be properly operating.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

All of the following decision subunits must be satisfied in order to shut down an extraction well.

4a. Are the Sr-90 concentrations in the plume core wells above or below 8 pCi/L?

This decision also applies to the plume core wells. **If** the Sr-90 concentration remain below 8 pCi/L, **then** it is reasonable to expect (based on model projections) that monitored natural attenuation of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to Maximum Contaminant Level (MCL) by 2070. **If** the Sr-90 concentration remains above 8 pCi/L, **then** consider operational adjustments and/or engineering evaluation.

4b. Has there been a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode. **If yes**, and system has operated for less than ten years, **then** continue operation. **If yes**, and system has operated for more than ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If no**, significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with Monitored Natural Attenuation (MNA).

Step 6: Specify Acceptable Error Tolerances

Table 12.14-1 summarizes the decision and possible decision errors for this project.

Table 12.14-1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Was the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Is the extent of the Sr-90 plume still defined by the existing monitoring well network?	See Step 3 for inputs.	(1) Data indicate the plume is not defined by existing wells when it is. (2) Data indicate the plume is defined by existing wells when it is not.	(1) Wasted resources evaluating, possibly constructing and sampling additional wells. (2) Potential bypass of contaminants and potential risk to downgradient receptors.
Can Sr-90 contamination impact existing or planned groundwater remediation systems?	See Step 3 for inputs.	(1) Data indicate the plume will impact systems when it will not. (2) Data indicate the plume will not impact systems when it will.	(1) Wasted resources conducting technical evaluations and possible system modifications. (2) Potential for inadequate treatment or system failure due to contamination beyond design limits.
Is the Sr-90 plume migrating toward BNL supply wells 10, 11 and 12?	See Step 3 for inputs.	(1) Data indicate the plume is migrating toward supply wells when it is not. (2) Data indicate the plume is not migrating toward supply wells when it is.	(1) Wasted resources conducting technical evaluations; loss of use of supply wells 10, 11 and 12. (2) Potential risk to receptors through ingestion of impacted water.
Is the plume controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program consists of 66 monitoring wells.

Parameters and Frequency

Monitoring wells are sampled on either an annual or semiannual schedule. Well-specific 2025 sampling frequency and parameter information is provided in Table 12.14.2.

Table 12.14-2. Proposed 2025 Sampling Frequency for the BGRR Monitoring Wells

Well	Sampling Frequency	Parameters
065-06	Annual	8260 Low Level EPA 905 Sr-90
065-160	Annual	EPA 905 Sr-90
065-162	Annual	EPA 905 Sr-90
065-163	Annual	EPA 905 Sr-90
065-164	Annual	EPA 905 Sr-90
065-169	Semiannual	EPA 905 Sr-90 Cs-137
065-170	Annual	EPA 905 Sr-90 Cs-137
065-174	Annual	EPA 905 Sr-90
065-175	Semiannual	EPA 905 Sr-90
065-176	Annual	EPA 905 Sr-90
065-178	Annual	EPA 905 Sr-90
065-360	Annual	EPA 905 Sr-90
065-361	Annual	EPA 905 Sr-90
065-362	Annual	EPA 905 Sr-90
065-363	Annual	EPA 905 Sr-90
065-364	Annual	EPA 905 Sr-90
065-365	Annual	EPA 905 Sr-90
065-405	Semiannual	EPA 905 Sr-90
065-367	Annual	EPA 905 Sr-90
065-37	Semiannual	EPA 905 Sr-90 Cs-137 EPA 906 Tritium
065-38	Semiannual	EPA 905 Sr-90
065-39	Semiannual	EPA 905 Sr-90
075-189	Annual	EPA 905 Sr-90
075-193	Annual	EPA 905 Sr-90
075-194	Annual	EPA 905 Sr-90
075-201	Annual	EPA 905 Sr-90
075-39	Annual	EPA 905 Sr-90

Well	Sampling Frequency	Parameters
075-40	Annual	EPA 906 Tritium
075-41	Annual	EPA 905 Sr-90
075-46	Annual	EPA 905 Sr-90
075-47	Semiannual	EPA 905 Sr-90
075-48	Semiannual	EPA 905 Sr-90
075-664	Monthly	EPA 905 Sr-90
075-665	Annual	EPA 905 Sr-90
075-666	Annual	EPA 905 Sr-90
075-669	Annual	EPA 905 Sr-90
075-670	Semiannual	EPA 905 Sr-90
075-671	Semiannual	EPA 905 Sr-90
075-672	Annual	EPA 905 Sr-90
075-673	Annual	EPA 905 Sr-90
075-674	Annual	EPA 905 Sr-90
075-675	Annual	EPA 905 Sr-90
075-681	Annual	EPA 905 Sr-90
075-682	Semiannual	EPA 905 Sr-90
075-683	Annual	EPA 905 Sr-90
075-684	Semiannual	EPA 905 Sr-90
075-85	Annual	EPA 905 Sr-90
075-86	Annual	EPA 905 Sr-90
075-87	Semiannual	EPA 905 Sr-90
075-705	Semiannual	EPA 905 Sr-90
075-706	Semiannual	EPA 905 Sr-90
075-707	Semiannual	EPA 905 Sr-90
065-401	Semiannual	EPA 905 Sr-90
075-699	Semiannual	EPA 905 Sr-90
075-700	Semiannual	EPA 905 Sr-90
065-402	Semiannual	EPA 905 Sr-90
075-701	Monthly	EPA 905 Sr-90
065-404	Semiannual	EPA 905 Sr-90
085-398	Semiannual	EPA 905 Sr-90
085-399	Semiannual	EPA 905 Sr-90
085-402	Semiannual	EPA 905 Sr-90
065-325	Semiannual	EPA 905 Sr-90
085-403	Semiannual	EPA 905 Sr-90
075-210	Semiannual	EPA 905 Sr-90
095-326	Semiannual	EPA 905 Sr-90
085-415	Semiannual	EPA 905 Sr-90

Figure 12.14.1OU III BGRR/WCF Monitoring Well Locations

See Appendix B for the monitoring schedule for this Data Quality Objective.

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12.15 Chemical/Animal Holes Strontium-90

DQO Start Date January 1, 2003

Implementation Date January 1, 2025

Point of Contact Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

Summary of Changes

There are no proposed changes for the Chemical/Animal Holes Strontium-90 (Sr-90) Treatment System groundwater monitoring program for calendar year 2025.

Description and Technical Basis

Between 1960 and 1966, waste, glassware containing chemical and radioactive waste, and animal carcasses containing radioactive tracers were disposed of in in unlined pits (in some cases up to 30 feet below grade) in an area directly east of the Chemical/Animal Holes area. Used glassware continued to be disposed of in shallow pits directly north of this area from 1966 through 1981. Remediation of the impacted soil in the Chemical/Animal Holes area, including waste excavation, treatment, and disposal, was completed in September 1997.

The monitoring well network for the Chemical/Animal Holes consists of 17 wells. There are three bypass detection wells located immediately downgradient from extraction well EW-3 (106-120, 106-121, and 106-122). No upgradient wells are sampled as part of this program. The wells comprising the Chemical/Animal Holes program are listed in Table 12.15.2. Well locations are shown in Figure 12.15.1. The wells have been sampled annually to semi-annually for Sr-90 analysis.

Sr-90 has routinely been detected downgradient of the Chemical/Animal Holes at levels exceeding the New York State groundwater standard. None of the sentinel wells contained Sr-90 at levels exceeding the New York State groundwater standard.

In February 2003, a Sr-90 Pilot Study began operation. The objective of this study was to evaluate the effectiveness of extraction and treatment of Sr-90 in groundwater prior to implementation of the final remedy. The Sr-90 Pilot Study, now known as the Chemical/Animal Holes Sr-90 Treatment System, currently extracts groundwater at a rate of between five to 15 gallons per minute, treats it with an ion exchange system, and discharges the groundwater to dry wells located just east of the treatment system building. In 2007, two additional extraction wells (EW-2 and EW-3) were installed. In 2018, the system was approved for shutdown and the extraction wells were placed in standby mode.

Drivers for Monitoring Being Conducted Under This Change

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

Data Quality Objective Analysis

Step 1: State the Problem

The Chemical/Animal Holes area has been an historic source of Sr-90 contamination to groundwater. In response, BNL has conducted remediation (waste excavation, treatment, and disposal) to eliminate future releases. Data are needed to confirm that the soil remediation was adequate and to track existing contaminant plumes downgradient of the Chemical/Animal Holes area. In addition, data are required during the design process in the immediate pilot study area for design decisions and potential system modifications. The pilot study was targeted for the area of high Sr- 90 concentrations.

Problem Statement: Existing Sr-90 plume has degraded groundwater quality downgradient of the Chemical/Animal Holes area and could impact downgradient receptors. Data are needed to:

- Verify that the soil source areas have been remediated.
- Track the distribution of the remaining Sr-90 concentrations that was addressed by the treatment system.
- Verify the effectiveness of the treatment system in removing Sr-90 from the groundwater.

Step 2: Identify the Decisions

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Have the groundwater cleanup goals of meeting drinking water standards been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Sr-90 results in groundwater
- Locations of existing wells relative to flow patterns
- Regulatory drivers (Operable Unit [OU] III ROD)
- Action Levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Estimated retardation rate for Sr-90
- Variability of data

Step 4: Define the Study Boundaries

The decision unit limits for this project are the area impacted by detectable activities of Sr-90 from the Chemical/Animal Holes and Former Landfill areas. The vertical limits are from the water table surface to the deep zone of the Upper Glacial aquifer.

Section 12.1 details the general sampling frequency based on the phase of the monitoring program. Due to the low-travel velocity for Sr-90 in groundwater, decisions for most wells will be made on a timeframe of 365 days. Since wells 097-313, 097-314, and 097-315 are located within critical areas to be addressed by the ongoing treatment system, decisions will be made using a timeframe of 180 days to ensure that the design of the system will be effective.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

If the detected Sr-90 activities are consistent with the groundwater model results and professional judgment, **then** continue monitoring. **If not**, **then** consider refining the conceptual model and/or conducting an evaluation to determine whether outside factors (such as additional contaminant sources) are affecting the results.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from all wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Protection Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Protection Contingency Plan may be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and sentinel wells. If the system is performing as planned, actual Sr-90 concentrations in plume perimeter and sentinel wells will compare well to predicted values, based on model runs. A significant difference between actual and predicted concentrations indicates the need for an evaluation for the reason for the difference. **If** the system is performing as planned (based on groundwater model predictions, trend analysis, and expert judgment), **then** continue to operate. **If not**, **then** consider operational adjustments and/or an engineering evaluation. Note: When the majority and/or "key" wells, as defined by a subject matter expert, are performing as planned, the system as a whole is considered to be properly operating.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

The clean-up objective is to reach maximum contaminant levels (MCLs) in the aquifer by 2040 via hydraulic control and treatment of the highest concentration Sr-90 within the capture zone of Sr-90 extraction wells. Groundwater modeling will be performed to demonstrate that the Sr-90 concentrations remaining in the groundwater after system shutdown would naturally attenuate to below MCLs by 2040. **If** evaluation of analytical results for Sr-90 in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria, **then** a petition for shutdown will be issued to the regulatory agencies.

4a. Are Sr-90 concentrations in plume core wells above or below 8 pCi/L?

If the Sr-90 concentration in each plume core well has been reduced to less than 8 μg/L, **then** proceed with pulsed operation of the system. **If not**, and treatment has occurred for less than ten years, **then** continue treatment. **If not,** and treatment has occurred for at least ten years, **then** consider performing an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2040.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after the system has been shut down completely or entered pulse pumping mode. **If yes**, **then** restart operation. **If yes**, and system has operated for more than ten years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If no**, and significant rebound is observed within a one-year time period following pulsed pumping, **then** petition for system shutdown and continue with monitored natural attenuation (MNA).

Decision 5

Has the groundwater cleanup goal of meeting drinking water standards_been achieved?

If the concentration of Sr-90 in groundwater after system shutdown remains less than 8 pCi/L for several years, **then** petition for system closure. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.15.1 summarizes the decision and possible decision errors for this project.

Table 12.15.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Protection Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays (2) Lost time in addressing problem, loss of stakeholder confidence.
Is the high-concentration Sr-90 plume addressed by the treatment system?	See Step 3 for inputs.	(1) Data indicate plume is not located in treatment system area when it is. (2) Data indicate plume is located in treatment system area when it is not.	(1) Wasted resources modifying system design, potentially inaccurate results/. (2) Potential ROD goals not being met.

Step 7: Optimize the Design

Number and Locations of Wells

The existing monitoring well network of 17 wells is sufficient.

Parameters and Frequency

Fourteen monitoring wells in the groundwater monitoring program are sampled on an annual schedule and analyzed for Sr-90. The remaining three monitoring wells are sampled and analyzed for Sr-90 on a semi-annual basis. A summary of the proposed 2025 sampling program for this project is shown in Table 12.15.2.

Table 12.15.2. Proposed 2025 Sampling Frequency for the Chemical/Animal Holes Monitoring Wells

Well ID	Sampling Frequency	Parameters
097-313	Semi-annual	EPA 905 Sr-90
097-314	Semi-annual	EPA 905 Sr-90
097-315	Semi-annual	EPA 905 Sr-90
106-100	Annual	EPA 905 Sr-90
106-101	Annual	EPA 905 Sr-90
106-103	Annual	EPA 905 Sr-90
106-104	Annual	EPA 905 Sr-90
106-105	Annual	EPA 905 Sr-90
106-119	Annual	EPA 905 Sr-90
106-125	Annual	EPA 905 Sr-90
106-136	Annual	EPA 905 Sr-90
106-16	Annual	EPA 905 Sr-90
106-49	Annual	EPA 905 Sr-90
106-94	Annual	EPA 905 Sr-90
106-95	Annual	EPA 905 Sr-90
106-98	Annual	EPA 905 Sr-90
106-99	Annual	EPA 905 Sr-90

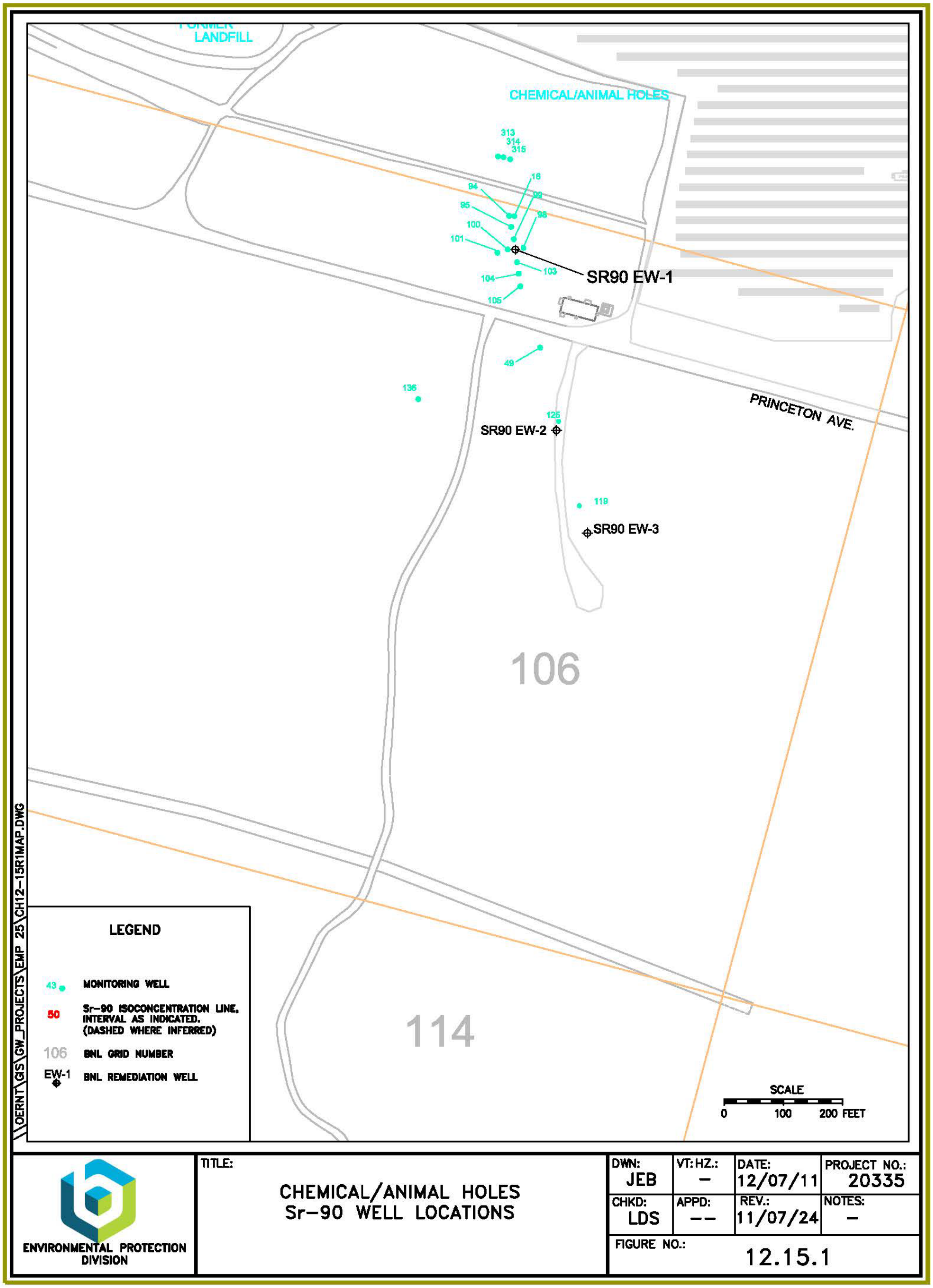

Figure 12.15.1. Chemical/Animal Holes Sr-90 Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.16 OU III HIGH FLUX BEAM REACTOR

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436
James Milligan (631) 344-4458

SUMMARY OF CHANGES

There are no changes for the High Flux Beam Reactor (HFBR) tritium groundwater monitoring program for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

In late 1996, tritium was detected in wells near the HFBR. The source of the release was traced to the HFBR spent fuel pool. In response, the fuel rods were removed from the pool for off-site disposal, the spent fuel pool was drained, and the HFBR was removed from service in 1997. Also, numerous monitoring wells were constructed to characterize the tritium plume downgradient of the HFBR. In May 1997, operation of a three-well groundwater extraction system began. This system was constructed on Princeton Avenue, approximately 3,500 feet downgradient of the HFBR to capture the tritium contamination and ensure that off-site migration of the plume would not occur. Extracted water was recharged through the RA V recharge basin.

As described in the Operable Unit (OU) III Record of Decision (ROD), the selected remedy to address the HFBR tritium plume included implementation of monitoring and low-flow extraction programs to prevent or minimize plume expansion. Because it had been demonstrated that the remaining tritium plume would naturally attenuate to below drinking water standards before reaching the BNL site boundary, the extraction system was initially placed on standby status in September 2000.

In 2007, the detection of tritium at concentrations above 25,000 pCi/L in wells at the Chilled Water Plant Road and above 20,000 pCi/L in wells along Weaver Drive necessitated the reactivation of the Princeton Avenue pumping system. After tritium concentrations in areas south of Cornell Avenue decreased to less than 20,000 pCi/L, the system was placed back on standby status in May 2013.

In 2016, monitoring was reduced to 34 wells in the immediate vicinity of the HFBR because the tritium concentrations south of Cornell Avenue attenuated to <20,000 pCi/L over the past several years. In late 2018, the monitoring well network for the OU III HFBR project was reduced to ten wells that provide groundwater quality data in the source area. The ten wells consist of three existing wells and seven recently installed wells. Well locations are shown in Figure 12.16.1. The wells are sampled quarterly for analysis of tritium.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
__X__ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater beneath the BNL site has been impacted by tritium from historical leakage from the HFBR spent fuel pool. Data are needed to verify that the tritium is naturally degrading according to the attenuation model.

Step 2: Identify the Decision

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected? Is the plume attenuating as expected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?

Step 3: Identify Inputs to the Decision

The project was divided into two decision subunits to reflect the categories of wells for which decisions will be made with respect to the tritium plume. The identified subunits and the deci sions supported by each are:

- Plume core wells located within the high concentration segment of the plume (Decisions 1, 2, 3, and 5)
- Perimeter wells located outside the high concentration segment of the plume and contain tritium at low or non-detect activities (Decisions, 2, 3, and 4)

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Tritium analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Action levels defined in the OU III ROD

- Analytical methods and detection limits
- Variability of data

Step 4: Define the Study Boundaries

The project decision unit limits are defined by:

- Rutherford Drive on the north
- Cornell Avenue on the south
- Wells 075-11 and 075-288 on the east
- Well 075-40 on the west
- Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase of the monitoring pro- gram. Due to variability in groundwater flow direction for different areas of the plume and the specific actions to be taken in response to certain observed conditions (as specified in the ROD), the project was divided into geographic segments based on the timeframe for decisions to be made for wells in these areas. The segments and timeframes for each decision subunit within the area were:

- *HFBR Area:* This segment encompasses the wells around the HFBR, including upgradient wells and the area extending to approximately 250 feet south of Temple Place. The decision timeframe for plume core and perimeter wells in the HFBR area is 90 days, due to the expected slow change in tritium activities for these wells. For the outer perimeter wells, decisions will be made using a 365-day timeframe, because perimeter wells are located between the outer perimeter wells and the plume core wells.

- *RA V Recharge Basin:* Since the treatment system has been placed in stand by status, monitoring around the recharge basin has been discontinued.

- *Brookhaven Avenue:* This segment is downgradient of the HFBR area and includes the wells along Brookhaven Avenue, except those around the RA V basin. Wells in this area measure the rate of attenuation. Decisions for plume core and perimeter wells will be made using a 90-day timeframe. As with the HFBR area, the decision timeframe for outer perimeter wells in this segment is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

- *Rowland Street:* This segment includes the wells along Rowland Street. Evaluation of data from these wells measures plume attenuation. Therefore, a timeframe for decisions of 90 days for plume core and perimeter wells in this area is warranted. As with the HFBR area, the decision timeframe for outer perimeter wells in this segment is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

- *Chilled Water Plant Road and Weaver Drive:* The wells in these two segments are located along and east of the Chilled Water Plant Road (Chilled Water Plant Road segment) and along Weaver Drive and Grove Street (Weaver Drive segment). Because data from wells in these segments will be utilized to determine whether the contingency actions specified in the ROD will be implemented, the decision timeframe for plume core and perimeter wells in these segments is 90 days. As with the HFBR area and Rowland Street segments, the decision timeframe for outer perimeter wells in these segments is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

- *Princeton Avenue:* This segment includes outer perimeter wells downgradient of the plume along Princeton Avenue and Middle Road. As with the other outer perimeter wells, because perimeter wells are located between these wells and the plume core wells, the decision timeframe is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

Due to improving plume conditions, all monitoring south of Cornell Avenue has been discontinued.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells immediately downgradient of the HFBR source area will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine whether additional source controls are needed.

Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high tritium concentrations. **If** these conditions occur, **then** the Contingency Plan will be implemented.

Decision 2

Were unexpected levels or types of contamination detected?

For each future sampling event, sample results will be evaluated in context with historic data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high tritium concentrations, or the detection of tritium in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Is the plume attenuating as expected?

If the detected tritium concentrations are consistent with the attenuation model, groundwater model results, and professional judgment, **then** continue attenuation monitoring. **If not**, **then**

consider refining the conceptual model or conducting an engineering evaluation to determine if other actions are required.

Decision 4

Has the downgradient migration of the plume been controlled?

If concentrations of tritium north of Cornell Avenue increase to a level where it is determined that downgradient plume may exceed 25,000 pCi/L in wells at the Chilled Water Plant Road or above 20,000 pCi/L in wells along Weaver Drive, sampling will resume in a select number of down-gradient wells. Exceedances of these activities will necessitate implementation of specific actions described in the ROD.

If the detected tritium activity exceeds 25,000 pCi/L in perimeter wells at the Chilled Water Plant Road or 20,000 pCi/L in perimeter wells at Weaver Drive, **then** implement the response actions prescribed in the OU III ROD.

Decision 5

Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?

If tritium concentrations from Weaver Drive to extraction well EW-16 drop below 20,000 pCi/L, **then** EW-16 will be placed in stand-by mode.

5a. Are tritium concentrations in extraction wells above or below the 20,000 pCi/L DWS?

If the tritium concentration in each plume core well has been reduced to less than 2,000 pCi/L, **then** proceed with pulsed operation of the system. **If not, then** continue treatment.

5b. Is there a significant concentration rebound in extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after the system has been shut down completely or entered pulse pumping mode. **If yes**, **then** continue operation. **If no**, significant rebound is observed within a two-year time period, **then** petition for system shutdown and continue with monitored natural attenuation (MNA).

Decision 6

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of tritium in groundwater remains less than 20,000 pCi/L for several years, **then** petition for system closure. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.16-1 summarizes the decision and possible decision errors for this project.

Step 7: Optimize the Design

Given the current knowledge of the position of the plume, based on the extensive volume of historical data, the sampling frequencies have been reduced in the following manner:

- Due to the attenuation of the plume, the monitoring program is now limited to ten wells in the immediate vicinity of the HFBR where tritium concentrations occasionally exceed 20,000 pCi/L. Therefore, sampling of 24 monitoring wells located south of Temple Place has been discontinued.

Number and Locations of Wells

The network of ten wells used for the HFBR Groundwater Monitoring Program is shown in Figure 12.16.1. Table 12.16.1 presents the decision subunits.

Table 12.16-1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unneces- sarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is the tritium plume growth minimized?	See Step 3 for inputs.	(1) Data indicate that the plume is growing when it is not. (2) Data indicate that the plume is not growing when it is.	(1) Wasted resources, loss of stakeholder confidence. (2) Potential bypass of tritium, project delays, potential risk to downgradient receptors.
Are observed conditions consistent with attenuation model?	See Step 3 for inputs.	(1) Data indicate that conditions are not consistent with model when they are. (2) Data indicate that conditions are consistent with model when they are not.	(1) Wasted resources conducting attenuation model refinements. (2) Potential bypass of tritium, project delays, potential risk to downgradient receptors.
Is the tritium plume migrating toward the zone of influence of BNL water supply wells 10, 11, and 12?	See Step 3 for inputs.	(1) Data indicate that the plume is migrating toward the supply wells when it is not. (2) Data indicate that the plume is not migrating toward the supply wells when it is.	(1) Wasted resources conducting continued unnecessary moni- toring. (2) Potential bypass of tritium, project delays, potential risk to receptors.

Has any segment of the plume migrated beyond the current monitoring network?	See Step 3 for inputs.	(1) Data indicate that plume has migrated beyond the network when it has not. (2) Data indicate that plume has not migrated beyond the network when it has.	(1) Wasted resources conducting evaluation of alternatives. (2) Potential bypass of tritium, project delays, potential risk to downgradient receptors.

Note: See also Table 12.16.2 for sampling frequency and affected parameters.

Parameters and Frequency

The 2025 monitoring schedule is shown in Table 12.16.2. The analytical parameters and sampling frequency currently conducted for this project are considered adequate.

Table 12.16.2. Proposed 2025 Sampling Frequency for the HFBR Monitoring Wells

Well	Sampling Frequency	Parameters
075-11	Quarterly	EPA 906 Tritium
075-288	Quarterly	EPA 906 Tritium
075-40	Quarterly	EPA 906 Tritium
075-802	Quarterly	EPA 906 Tritium
075-803	Quarterly	EPA 906 Tritium
075-804	Quarterly	EPA 906 Tritium
075-805	Quarterly	EPA 906 Tritium
075-806	Quarterly	EPA 906 Tritium
075-807	Quarterly	EPA 906 Tritium
075-808	Quarterly	EPA 906 Tritium

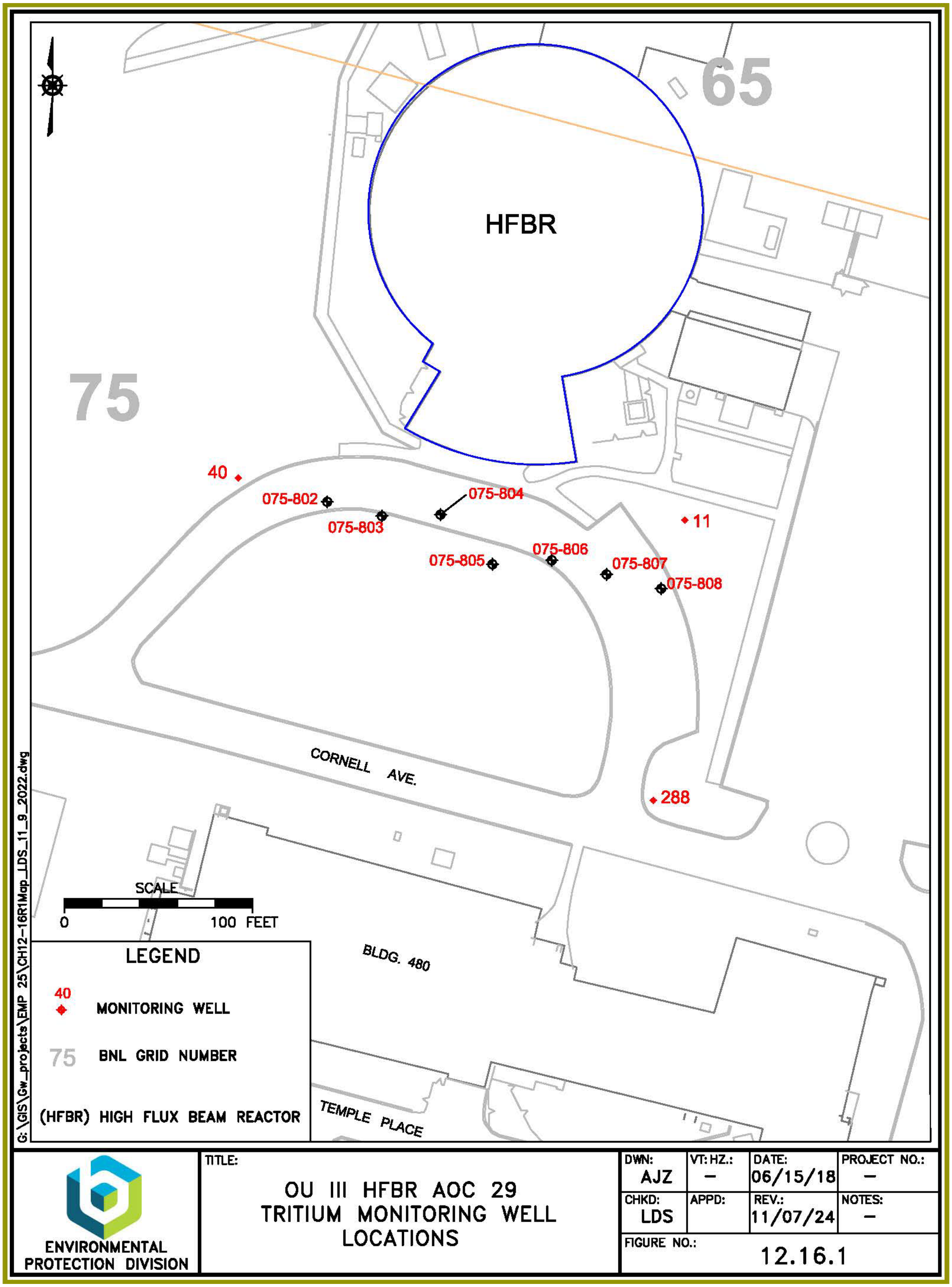

Figure 12.16.1 OU III HFBR AOC 29 Tritium Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.17 OU IV AREA OF CONCERN 6 – BUILDING 650 SUMP OUTFALL AREA

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no changes for the Operable Unit (OU) IV Area of Concern (AOC) 6 - Building 650 Sump Outfall Area monitoring program for calendar year (CY) 2025.

DESCRIPTION AND TECHNICAL BASIS

The OU IV AOC 6 project monitors a strontium-90 (Sr-90) plume emanating from contaminated soil within an area known as the Building 650 Sump Outfall Area. This area is a natural depression at the terminus of a discharge pipe from Building 650. The pipe conveyed discharges from decontamination of radioactively contaminated clothing and equipment that was conducted on an outdoor pad at Building 650 beginning in 1959. Impacted soil within the sump outfall area was excavated during CY 2002. Groundwater flow in this area is toward the south–southwest.

The monitoring well network for the OU IV AOC 6 project consists of 24 wells. The wells are located to monitor groundwater downgradient of the decontamination pad and Building 650 Sump Outfall Area. Some wells were constructed south of the leading edge of the plume to act as sentinel wells. Well locations are shown on Figure 12.17.1. In accordance with the Record of Decision (ROD) for OU IV, the wells are sampled semi-annually for analysis of Sr-90, gross alpha/beta, gamma spectroscopy, and tritium. A schedule is provided in Table 12.1.1.

In general, Sr-90 activity trends are stable for the wells within the plume, and in wells down-gradient of the plume.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater in the vicinity of Building 650 and the Building 650 Sump Outfall Area, and downgradient of these areas, has been impacted by Sr-90 at activities exceeding New York State groundwater standards. Data are needed to define the extent of the Sr-90 plume.

Step 2: Identify the Decision

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Is the plume naturally attenuating as expected?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Radionuclide analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the Brookhaven National Laboratory (BNL) Environmental Monitoring Plan
- Variability of data

Step 4: Define the Study Boundaries

The project decision unit limits are defined by:

- HO Basin (well 066-190) on the north
- Brookhaven Avenue on the south
- Railroad Street (wells 076-373 and 076-317) on the west
- HO Basin and RA V Basin on the east
- Shallow and mid-depth Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase of the monitoring program.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Decision 2

Were unexpected levels or types of contamination detected?

For each future sampling event, sample results will be evaluated in context with historic data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM- SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Is the plume naturally attenuating as expected?

If performance objectives have not been met, **then** it must be determined whether Sr-90 activities in groundwater are consistent with the attenuation model (e.g., results are on track to attenuate to less than MCLs within 30 years).

If the detected Sr-90 activities are consistent with the attenuation model, groundwater model results and professional judgment, **then** continue monitoring. If not, consider refining the conceptual model and/or conducting an evaluation to determine whether outside factors (such as additional contaminant sources) are affecting the results.

Decision 4

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of Sr-90 in groundwater is less than 8 pCi/L, **then** petition for the end of monitoring. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.17.1 summarizes the decision and possible decision errors for this project.

Table 12.17.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Are performance objectives met?	See Step 3 for inputs.	(1) Data indicate that performance objectives have not been met when they have. (2) Data indicate that performance objectives have been met when they have not.	(1) Wasted resources conducting continued unnecessary monitoring. (2) Potential bypass of contaminants, project delays, potential risk to downgradient receptors.
If not, are observed conditions consistent with attenuation model?	See Step 3 for inputs.	(1) Data indicate that conditions are not consistent with model when they are. (2) Data indicate that conditions are consistent with model when they are not.	(1) Wasted resources conducting attenuation model refinements and introducing supplements. (2) Potential bypass of contaminants, project delays; potential risk to downgradient receptors.

Step 7: Optimize the Design

Number and Locations of Wells

The existing monitoring well network consists of 24 wells. Locations are shown in Figure 12.17.1.

Parameters and Frequency

A summary of the 2025 sampling program for this project is provided in Table 12.17.2.

Table 12.17.2. Proposed 2025 Sampling Frequency for the AOC 6 Project Monitoring Wells

Well ID	Sampling Frequency	Parameters
066-189	Annually	EPA 905 Sr-90
076-07	Annually	EPA 905 Sr-90
076-04	Annually	EPA 905 Sr-90
076-181	Annually	EPA 905 Sr-90
076-182	Annually	EPA 905 Sr-90
076-184	Annually	EPA 905 Sr-90
076-22	Annually	EPA 905 Sr-90
076-24	Annually	EPA 905 Sr-90
076-13	Annually	EPA 905 Sr-90
076-168	Annually	EPA 905 Sr-90
076-169	Annually	EPA 905 Sr-90
076-25	Annually	EPA 905 Sr-90
076-262	Annually	EPA 905 Sr-90
076-06	Annually	EPA 905 Sr-90
076-28	Annually	EPA 905 Sr-90
076-317	Annually	EPA 905 Sr-90
076-373	Annually	EPA 905 Sr-90
076-415	Annually	EPA 905 Sr-90
076-416	Annually	EPA 905 Sr-90
076-418	Annually	EPA 905 Sr-90

076-419	Annually	EPA 905 Sr-90
076-420	Annually	EPA 905 Sr-90
076-421	Annually	EPA 905 Sr-90
076-20	Annually	EPA 905 Sr-90

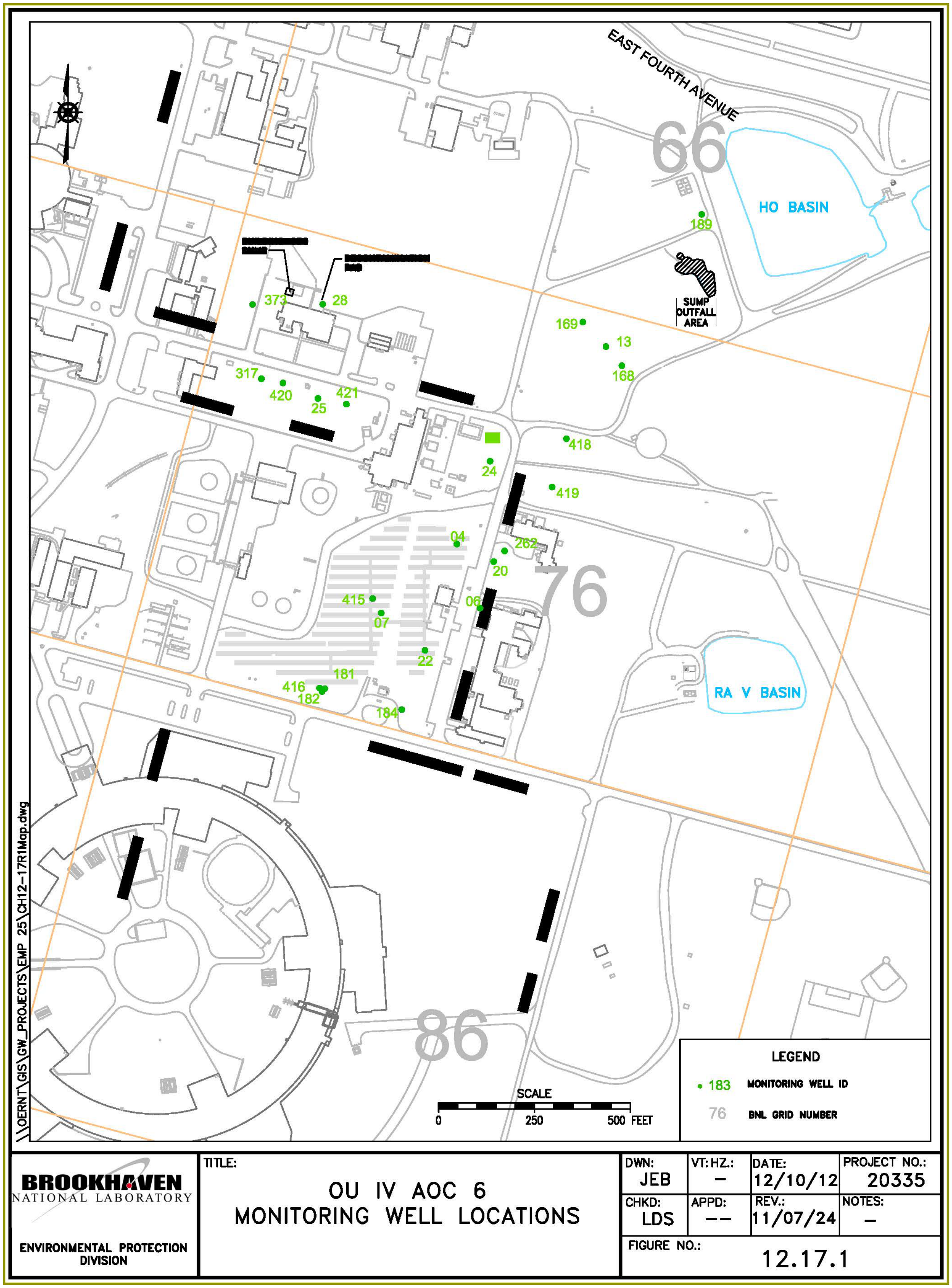

Figure 12.17.1 OU IV AOC 6 Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

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12.18 OU VI ETHYLENE DIBROMIDE

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242
Vincent Racaniello (631) 344-5436

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for the Operable Unit (OU) VI Ethylene Dibromide (EDB) Treatment System groundwater monitoring programs for calendar year (CY) 2025.

DESCRIPTION AND TECHNICAL BASIS

The monitoring well network for the OU VI EDB Project consists of 26 wells. This includes three new wells installed during 2021. Well locations are shown in Figure 12.18.1. The wells are sampled for EDB analysis. Table 12.18.2 shows the monitoring schedule for CY 2025.

The contaminant of concern associated with the OU VI plume is EDB.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
__X Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

There is an existing plume of groundwater contaminated by EDB that has migrated south of the BNL Site boundary. In response, a groundwater remediation system is currently being designed. Data are needed to confirm the vertical and horizontal extent of the EDB plume so that the design of the remediation system can be optimized.

Step 2: Identify the Decision

The decisions for the project include:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in

pulsed pumping operation?
- Have the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- EDB analytical results in groundwater
- Locations of existing wells relative to flow patterns (Figure 12.18.1)
- Regulatory drivers (OU I Record of Decision [ROD])
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data
- Status of potential downgradient receptors

Step 4: Define the Study Boundaries

The horizontal extent of the study area is the existing EDB plume and wells immediately south of the Long Island Power Authority (LIPA) right-of-way. These limits are defined by wells 000-173/000-175 to the north, wells 000-519 and 000-508 to the south, well 000-524 to the east, and well 000-498 to the west. The vertical extent of the study area is the saturated thickness of the Upper Glacial aquifer.

Because the contaminant plume has already passed the southern BNL site boundary, tracking the plume configuration over time is of critical importance. The time frame to consider analytical results is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. If the cleanup goals have not been met, it must be verified that the plume is not growing. Plume growth is defined as an increase in EDB concentration in perimeter or bypass detection wells to above 0.05 µg/L (if currently less than 0.05 µg/L).

If the trend in each perimeter and bypass detection well has a negative slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the EDB concentration is less than 0.05 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 4

4. Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends indicates that the treatment system have met the shutdown criteria of achieving the cleanup goal by 2030, **then** a petition for shutdown will be issued to the regulatory agencies.

4a. Are EDB concentrations in plume core wells above or below 0.05 µg/L?

This decision also applies to the plume core wells. It is anticipated that approximately ten to 13 years of active groundwater treatment will reduce the mean EDB concentration to less than 0.05 µg/L.

If this occurs, **then** it is reasonable to expect (based on model projections) that monitored natural attenuation (MNA) of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to MCLs by 2030. **If** the EDB concentration remains above 0.05 µg/L, **then** consider operational adjustments and/or engineering evaluation.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

If yes, **then** continue operation. **If** yes and system has operated for more than 13 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If** no significant rebound is observed within a one-year time period, **then** petition for system shutdown and continue with MNA.

Decision 5

Have the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of EDB in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 0.05 µg/L, and if the mean EDB concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than 0.05 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.18.1 summarizes the decision and possible decision errors for this project.

Table 12.18.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan activated?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff; potential to have to restart system. (2) Continue remediation that is no longer effective.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues; ultimate project delays. (2) Wasted resources; project delays.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the OU VI EDB Project consists of 26 existing wells. The locations of the wells are shown in Figure 12.18-1.

Parameters and Frequency

EDB is sampled quarterly to annually, depending on the monitoring well. A summary of sampling parameters and frequency is provided in Table 12.18.2.

Table 12.18.2. Proposed 2025 Sampling Frequency for the Ethylene Dibromide Monitoring Wells

Well ID	Current Sampling Frequency	Parameters
000-173	Annually	EPA 504 EDB
000-175	Annually	EPA 504 EDB
000-178	Semi-annually	EPA 504 EDB
000-209	Annually	EPA 504 EDB
000-283	Semi-annually	EPA 504 EDB
000-284	Semi-annually	EPA 504 EDB
000-498	Semi-annually	EPA 504 EDB
000-499	Semi-annually	EPA 504 EDB
000-500	Quarterly	EPA 504 EDB
000-501	Semi-annually	EPA 504 EDB
000-507	Semi-annually	EPA 504 EDB
000-508	Quarterly	EPA 504 EDB
000-519	Quarterly	EPA 504 EDB
000-520	Semi-annually	EPA 504 EDB
000-524	Semi-annually	EPA 504 EDB
000-527	Quarterly	EPA 504 EDB
000-549	Quarterly	EPA 504 EDB
000-550	Quarterly	EPA 504 EDB
000-567	Quarterly	EPA 504 EDB
000-568	Quarterly	EPA 504 EDB
000-570	Quarterly	EPA 504 EDB
000-571	Quarterly	EPA 504 EDB
000-572	Quarterly	EPA 504 EDB
000-580	Quarterly	EPA 504 EDB
000-581	Quarterly	EPA 504 EDB
000-582	Quarterly	EPA 504 EDB

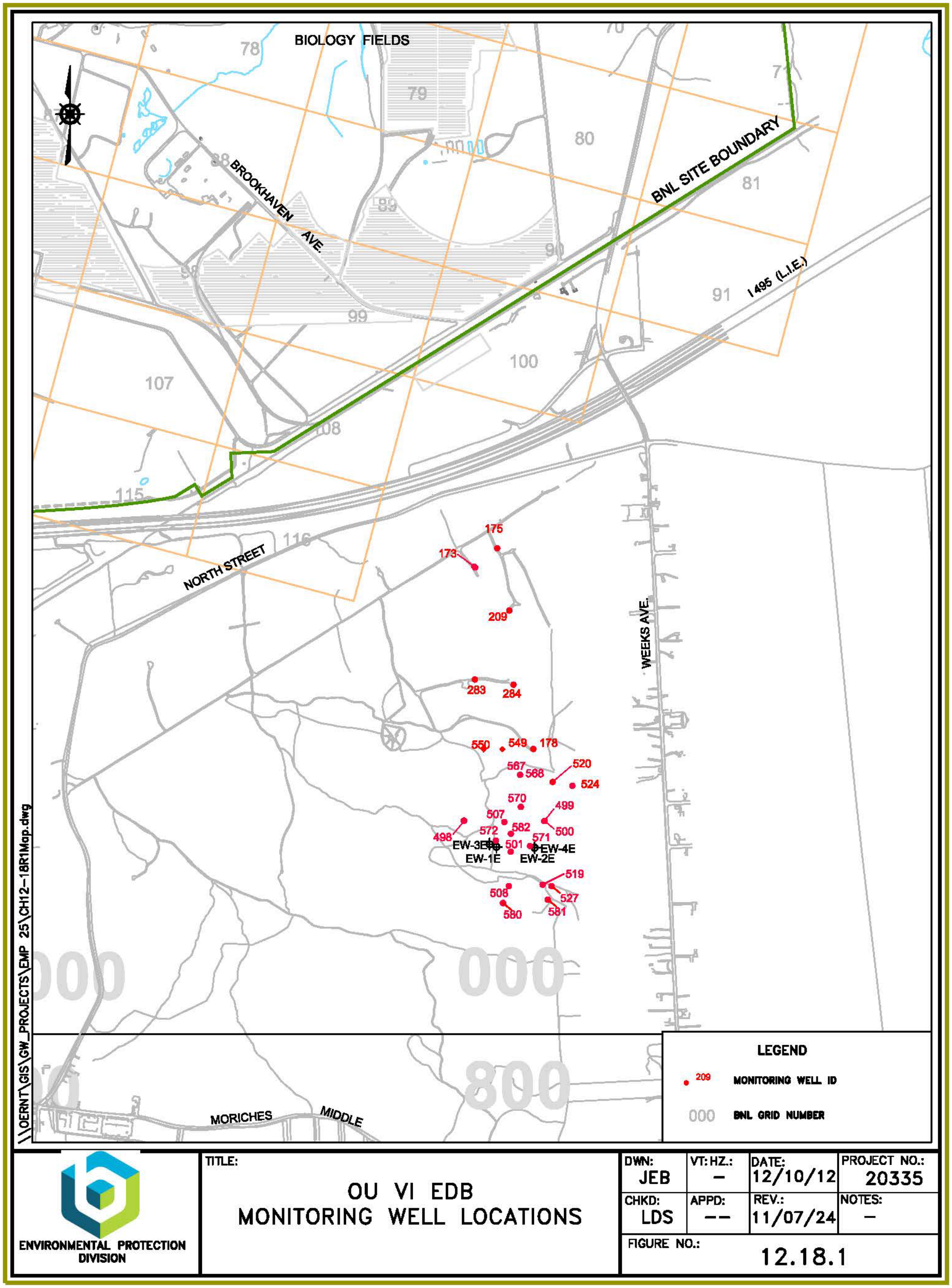

Figure 12.18.1 OU VI EDB Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.19 SITE BACKGROUND

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242

SUMMARY OF PROPOSED CHANGES

There are no changes proposed for the for the Site Background monitoring program for calendar year 2025.

DESCRIPTION AND TECHNICAL BASIS

Background water quality at Brookhaven National Laboratory (BNL) has been monitored since 1996. The current program includes nine wells located in the northwestern portion of the BNL property (017-01, 017-03, 017-04, 018-01, 018-02, 018-04, 018-05, 034-02, and 034-03). Well locations are shown in Figure 12.19.1.

Samples are collected annually and analyzed for volatile organic compounds (VOCs). Analytical results are reviewed to determine whether contaminants from off-site, upgradient sources are being transported onto the BNL facility. Historically, low levels of VOCs (less than New York State groundwater standards) have been detected in the deeper portion of the Upper Glacial aquifer and in the Magothy aquifer.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
__X Surveillance
__X Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater flow in the northwestern portion of the BNL facility within the shallow and deep portions of the Upper Glacial aquifer is typically toward the east to south-southeast and groundwater flow within the Magothy aquifer is toward the east-southeast. This is consistent with historic groundwater flow patterns at the BNL facility. Site Background wells are positioned to detect contamination migrating onto the BNL site.

PROBLEM STATEMENT

Data are needed to evaluate whether off-site, upgradient sources of groundwater contamination are impacting the BNL facility and to establish baseline/background levels of naturally occurring constituents, including metals and radionuclides, that are not impacted by BNL activities.

Step 2: Identify the Decision

Were unexpected levels or types of contamination detected?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Locations of existing wells relative to flow patterns (Figure 12.19.1)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

The study boundaries for the Site Background program are the northwestern (upgradient) portion of the BNL facility and nearby off-site areas within the Upper Glacial and shallow Magothy aquifers.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

The sample results will be evaluated in context with historical data. As part of that evaluation, circumstances that would require implementation of the Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be determined for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, including detection of previously undetected contaminants and detection of contaminants in wells where those contaminants have not previously been detected.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Step 6: Specify Acceptable Error Tolerances

Table 12.19.1 summarizes the decision and possible decision errors for this project.

Table 12.19.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is groundwater quality at BNL being impacted by off-site, upgradient source(s) of contamination?	See Step 3 for inputs.	(1) Data indicate the existence of an upgradient source when one does not exist (data indicate detected contamination is from an off-site source when it is not). (2) Data indicate that there is not an upgradient source when one does exist (data indicate detected contamination is from an on-site source when it is not).	(1) On-site contaminant source(s) will not be investigated and/or remediated and may continue to degrade groundwater quality. (2) Investigation and/or remediation of groundwater contamination may be undertaken by BNL when it is not warranted.

Because the wells included in the Site Background Program are located in the upgradient portion of the BNL facility, travel time for contamination detected in these wells to the nearest potential receptor (on-site potable supply wells) is estimated at ten years. It is therefore unlikely that decision error will result in adverse consequences to human health. The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust and BNL credibility, and wasted resources.

Step 7: Optimize the Design

Number and Locations of Wells

The number and locations of wells for this program are considered adequate.

PARAMETERS AND FREQUENCY

The analytical parameters and sampling frequency currently conducted for this project are considered adequate. Therefore, no modifications are recommended at this time. A summary of the proposed 2025 sampling frequency for the Site Background sampling program is provided in Table 12.19.2.

Table 12.19.2. Proposed 2025 Sampling Frequency for the Site Background Monitoring Wells

Well ID	Sampling Frequency	Parameters
017-01	Annually	8260 Low Level
017-03	Annually	8260 Low Level
017-04	Annually	8260 Low Level
018-01	Annually	8260 Low Level
018-02	Annually	8260 Low Level
018-04	Annually	8260 Low Level
018-05	Annually	8260 Low Level
034-02	Annually	8260 Low Level
034-03	Annually	8260 Low Level

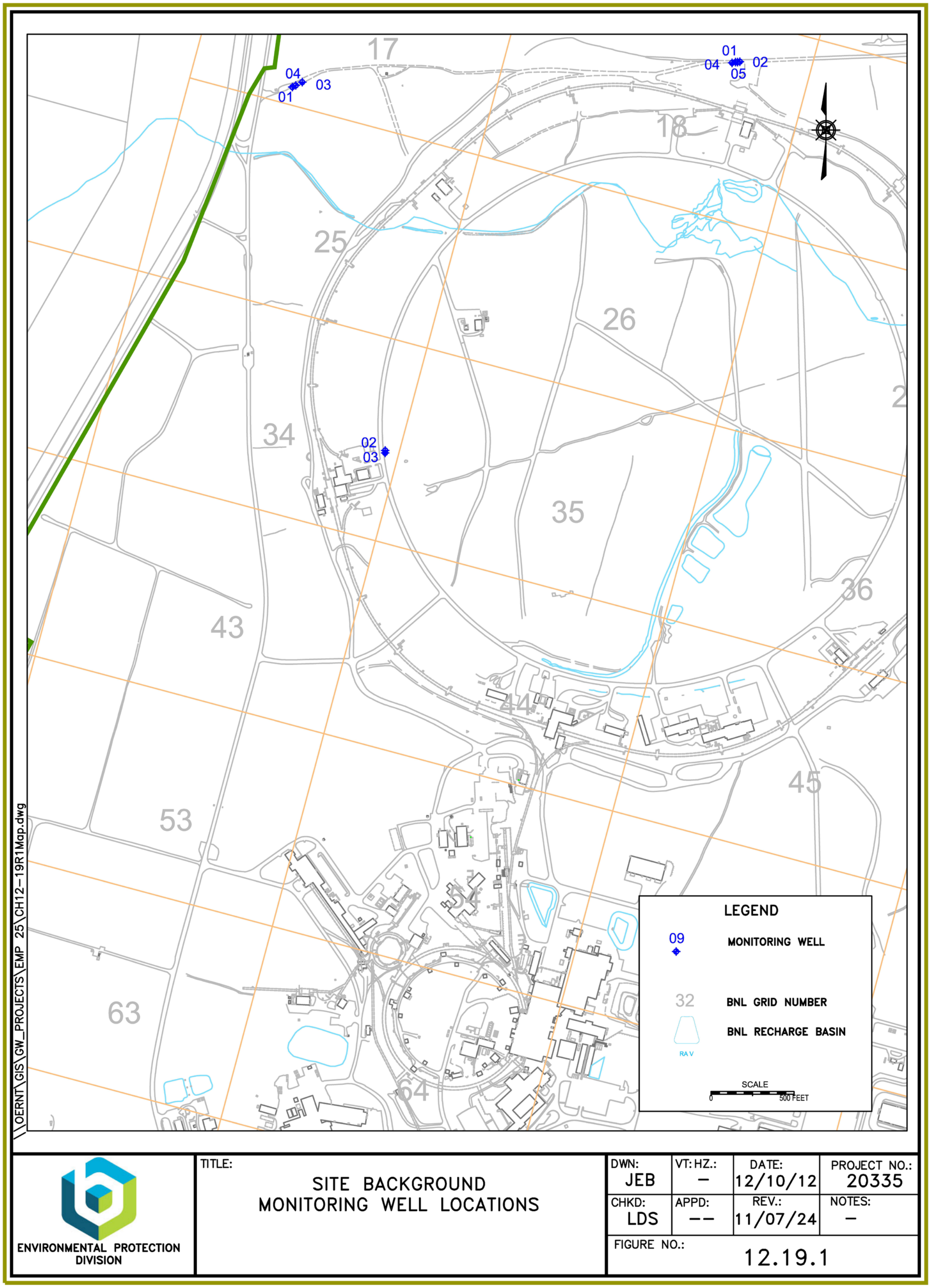

Figure 12.19.1 Site Background Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.20 CURRENT LANDFILL POST-CLOSURE

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242

James Milligan (631) 344-4458

SUMMARY OF CHANGES

The changes to the Current Landfill monitoring program for calendar year 2025 are to add PFAS EPA Method 1633 and 1,4-dioxane EPA Method 8270D SIM to the analytical list of parameters for all 12 monitoring wells on an annual basis with collection during the fourth quarter sampling round.

DESCRIPTION AND TECHNICAL BASIS

The Current Landfill operated from 1967 through 1990. Putrescible waste, sludge from the Brookhaven National Lab (BNL) Water Treatment Plant (WTP), anaerobic digester sludge from the BNL Sewage Treatment Plant (STP), and limited quantities of Laboratory waste were disposed in the landfill. The landfill was capped in accordance with the New York Code, Rules, and Regulations (NYCRR) Part 360 requirements in 1995.

The monitoring well network for the Current Landfill consists of 12 wells, including one upgradient well (087-09), three wells immediately downgradient of the landfill (087-11, 088-109, and 088-110), and eight wells further downgradient of the landfill (087-23, 087-24, 087-26, 087-27, 088-21, 088-22, 088-23, and 098-99). Well locations are shown in Figure 12.20.1. All wells except for 098-99 are sampled and analyzed for volatile organic compounds (VOCs), metals, and landfill leachate parameters. Samples from four wells are also analyzed for strontium-90 (Sr-90), tritium, and gamma spectroscopy. Well 098-99 is only sampled for VOCs.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

_X_ Compliance (NYCRR Part 360)
_X_ Support Compliance
____ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The Current Landfill has been an historic source of contamination and remains a potential source of contaminants to groundwater. In response, BNL has constructed an engineered cap over the landfill to mitigate future releases.

Problem Statement: Potential failure of the landfill cap could lead to continued releases from the Current Landfill into groundwater at levels exceeding maximum contaminant levels (MCLs).

Step 2: Identify the Decision

- Are the controls effectively improving groundwater quality below and downgradient of the landfill?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Comparison of pre- and post-capping groundwater quality by analysis of VOCs, metals, radionuclides, tritium, and landfill water quality parameter concentrations in groundwater
- Locations of existing wells relative to flow patterns
- Regulatory drivers (New York Codes, Rules, and Regulations [NYCRR] Part 360)
- Action Levels (MCLs and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in this Environmental Monitoring Plan (EMP)

Step 4: Define the Study Boundaries

The decision unit limits for this project are the immediate vicinity of the Current Landfill and the 12 wells that comprise the groundwater monitoring program. The period for which the decisions will be made depends on the individual parameters, as summarized in Table 12-20.1.

Table 12.20.1. Factors Affecting the Period for Decisions for the Current Landfill

Parameter	Historical Detection?	Relative Travel Time **	Above MCLs 2002–2024?	Trend 2002–2024	Time for Decision
VOCs	Yes	< 60 days	Yes	Stable	365 days
Tritium	Yes	< 60 days	No	Stable	365 days
Metals	Yes	Varies	Yes	Stable	2 years *
Sr-90	Yes	1,200 days	No	Stable	2 years *
Gamma spectroscopy	Yes	--	NA	Stable	2 years *
Leachate parameters	Yes	< 60 days	Yes	Stable	365 days

Notes:
* Based on trend.
** Relative travel time is approximate time for contamination to travel from waste pile to surrounding wells.

The periods over which decisions will be made were based on the low risk to potential receptors of contamination from the Current Landfill. The factors considered to determine that risk is low are:

- Engineered control (landfill cap) is a proven conventional technology with a low failure rate
- Low travel velocities for contaminants
- Absence of downgradient receptors
- Resource has already been degraded
- A groundwater pump and treat system has operated downgradient of the Current Landfill (to address historical releases from the landfill)

Step 5: Develop the Decision Rules

Decision 1

Are the controls effectively eliminating further discharges below the landfill?

The sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If for any downgradient well, the current annual mean concentration for an individual contaminant of concern exceeds the mean concentration in that well computed from data collected from that well over the past three years, and is greater than MCLs, and this result is confirmed by resampling appropriate wells, as well as by an evaluation of upgradient and downgradient conditions, **then** an evaluation will be made as to whether an increase in sampling frequency for that parameter or parameter group (for example, metals) would be appropriate. In addition, consider conducting an engineering evaluation to determine whether the capping system is performing as planned. **If** the current annual mean concentration for an individual contaminant of concern does not exceed the mean concentration in that well computed from data collected from that well over the past three years, **then** continue detection monitoring.

Notes:

a. Use concentration plots over time to visually assess data for trends and model predictions.
b. Slope analysis suggests that the goal will be achieved within the planned period (two to ten years).
c. If the water quality for the majority and/or key wells (as defined by the subject matter expert) is improving as planned, then "the system" as a whole is considered to be properly operating.

Step 6: Specify Acceptable Error Tolerances

Table 12.20.2 summarizes the decision and possible decision errors for this project.

Table 12.20.2. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Are the controls effective at eliminating further discharges to groundwater below the Current Landfill?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are.	(1) A discrete VOC contaminant slug of up to 300 feet long and 300 feet wide could exist and not be detected. (2) Delay in notifying stakeholders and taking corrective actions, prolonged operation of the OU I RA V groundwater treatment system.

There are no potential receptors immediately downgradient of the Current Landfill and groundwater travel time to the site boundary is approximately ten to 15 years. In addition, a groundwater treatment system is already operating and treating historical releases from the landfill.

Due to these factors, it is very unlikely that decision error will result in adverse consequences to human health or noncompliance with the Operable Unit (OU) I Record of Decision (ROD). The consequences of decision error relate primarily to possible enforcement actions for environmental degradation and erosion of stakeholder trust and BNL credibility.

Step 7: Optimize the Design

Number and Locations of Wells

The 12 monitoring wells around the landfill are adequate considering the potential consequences of a decision error. The current network was developed using expert judgment, groundwater models, and particle-tracking computer codes. No refinements are recommended at this time since the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small in size.

Parameters and Frequency

A summary of the proposed 2025 sampling program for this project is shown in Table 12.20.3.

Table 12.20.3. Proposed 2025 Sampling Frequency for the Current Landfill Monitoring Wells

Well ID	Sampling Frequency	Parameters
087-09	Semi-annual Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide 1633PFAS, 8270SIM 1,4-dioxane
087-11	Semi-annual Annual for PFAS, and 1,4-dioxane I	8260Low Level, *Wet Chem, TAL Metals, Cyanide 1633PFAS, 8270SIM 1,4-dioxane
087-23	Semi-annual. Annual for Rad. Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide, EPA 901 Gamma Spec, EPA 906 Tritium, EPA 905 Sr-90 1633PFAS 8270SIM for 1,4-dioxane
087-24	Quarterly (8260), Semi-annual Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide 1633PFAS, 8270SIM 1,4-dioxane
087-26	Semi-annual Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide 1633PFAS, 8270SIM 1,4-dioxane
087-27	Semi-annual, Annual for Rad Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide, EPA 901 Gamma Spec, EPA 906 Tritium, EPA 905 Sr-90 1633PFAS, 8270SIM 1,4-dioxane
088-21	Semi-annual, Annual for Rad Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide, EPA 901 Gamma Spec, EPA 906 Tritium, EPA 905 Sr-90 1633PFAS, 8270SIM 1,4-dioxan
088-22	Annual	8260Low Level, *Wet Chem, TAL Metals, Cyanide 1633PFAS, 8270SIM 1,4-dioxan
088-23	Annual	8260Low Level, *Wet Chem, TAL Metals, Cyanide

		1633PFAS, 8270SIM 1,4-dioxan
088-109	Quarterly (8260), Semi-annual, Annual for Rad Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide, EPA 901 Gamma Spec, EPA 906 Tritium, EPA 905 Sr-90 1633PFAS, 8270SIM 1,4-dioxan
088-110	Semi-annual Annual for PFAS, and 1,4-dioxane	8260Low Level, *Wet Chem, TAL Metals, Cyanide 1633PFAS, 8270SIM 1,4-dioxan
098-99	Quarterly Annual for PFAS, and 1,4-dioxane	8260 Low Level 1633PFAS, 8270SIM 1,4-dioxan

*Wet Chem includes: TSS/TDS/Sulfates/Chlorides/Alkalinity/TKN/Total Nitrogen/Nitrates/Nitrites/Ammonia

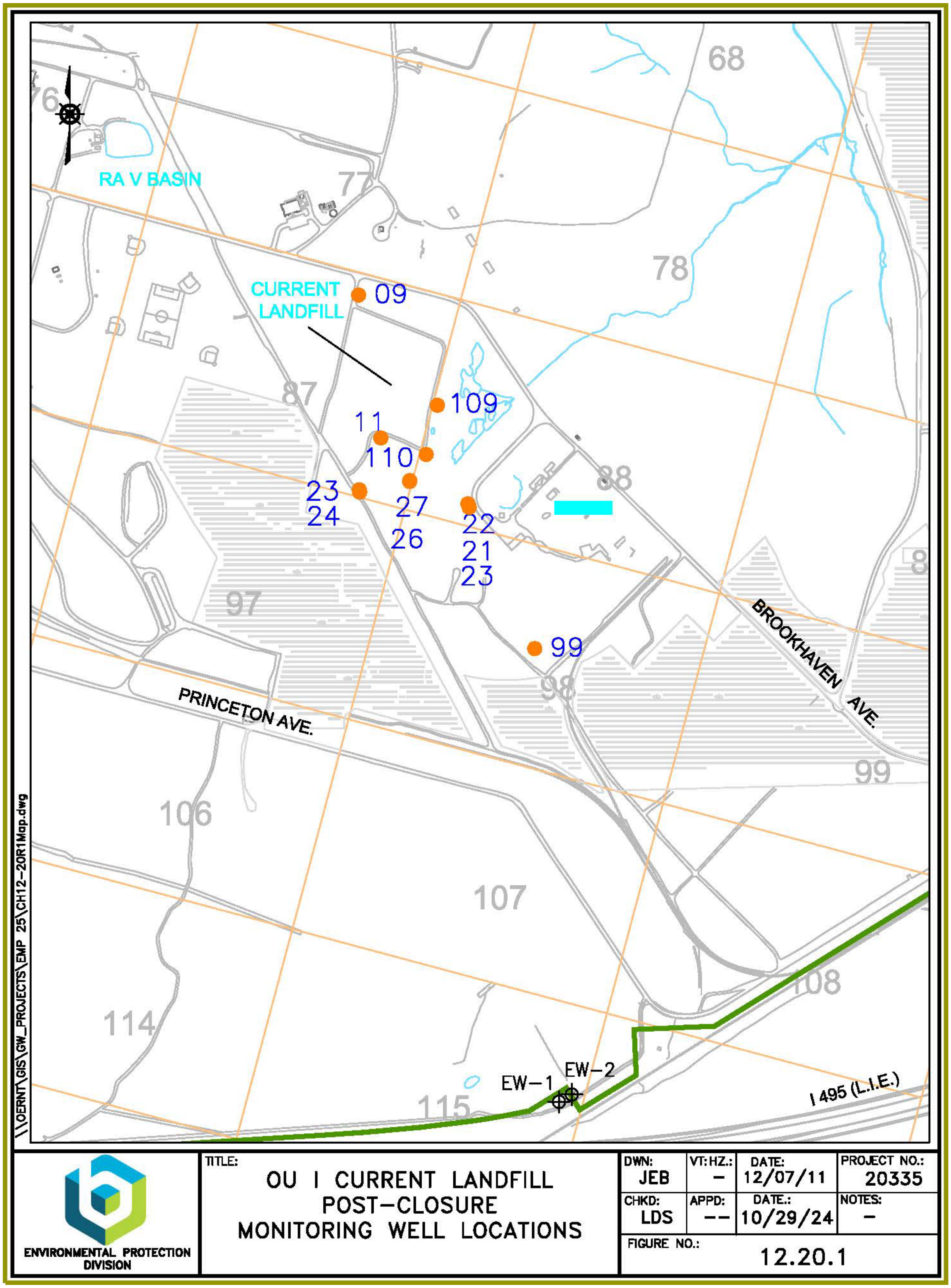

Figure 12.20.1 OU I Current Landfill Post-Closure Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.21 GROUNDWATER ELEVATION MONITORING

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Brian Barth (631) 344-2242

SUMMARY OF PROPOSED CHANGES

There are no new changes proposed for Groundwater Elevation Monitoring in calendar year (CY) 2025.

BACKGROUND

During CY 2021, the groundwater elevation measurements were obtained during two measurement events. The first was a smaller set of measurements in the southwest portion of the site which was obtained in early September to measure the influence of the William Floyd Public Supply Well Field during their peak pumping period. The routine annual monitoring program consisted of the collection of water level data using approximately 185 wells that are screened in the shallow Upper Glacial aquifer where water-pumping and recharge operations have significant transient impacts to groundwater flow directions and gradients. Multiple years of monitoring hydraulic heads in the deep Upper Glacial aquifer and the upper Magothy aquifer have demonstrated that groundwater flow directions and gradients are stable under a variety of pumping and recharge conditions; therefore, routine monitoring is not required. As necessary, Brookhaven National Laboratory (BNL) will collect water level data from wells screened in the deep Upper Glacial aquifer and upper Magothy aquifer to evaluate flow directions and gradients.

DESCRIPTION AND TECHNICAL BASIS

The purpose of the groundwater elevation monitoring program is to characterize the groundwater flow directions and rates across the BNL site and nearby off-site areas in multiple aquifers of interest to the groundwater protection and cleanup programs. The aquifers or sub-aquifers are:

- *Shallow Upper Glacial aquifer*: This portion of the aquifer is first to be impacted by any BNL releases and is currently contaminated in portions of the site. Groundwater flow direction and rate vary, depending on the discharge area (e.g., Peconic River, Carmans River, or Moriches Bay), as well as BNL water supply well and groundwater remediation well pumping and recharge basin operations.

- *Deep Upper Glacial aquifer*: This portion of the Upper Glacial aquifer is utilized by BNL's water supply wells and is also contaminated in certain on-site and off-site areas. The deep Upper Glacial aquifer is also the target of numerous groundwater remediation systems. Groundwater flow direction and rate vary, depending on the discharge area (e.g., Peconic River, Carmans River, or Moriches Bay), as well as BNL water supply well and groundwater remediation well pumping and, to a lesser extent, recharge basin operations.

- *Upper Magothy aquifer*: This aquifer is contaminated in isolated off-site areas. It is also utilized by the Suffolk County Water Authority (SCWA) for off-site community water supply purposes (BNL's plumes are not an immediate threat to these supply wells). The Magothy aquifer tends to have different flow patterns and rates (i.e., more east-southeast and slower) than the Upper Glacial aquifer.

In previous years, synoptic groundwater elevation measurements were collected from approximately 740 wells on an annual basis. In 2019, the program for the annual collection of water level measurements from approximately 185 wells was reduced significantly. Most of the wells included in the groundwater elevation monitoring program are located on site, although off- site wells constructed by BNL and by the United States Geological Survey are also measured. In addition, because wells in some areas are more closely spaced than necessary for the groundwater elevation monitoring program, only a representative number of wells are monitored and not all existing wells are included in the program.

The resulting groundwater elevation data are used to develop groundwater elevation contour maps. The information contained on these maps is utilized to evaluate horizontal groundwater flow directions and rates throughout the BNL site. These data are used to confirm that monitoring and extraction wells are located properly, to confirm that existing remediation systems are effective at capturing the targeted contamination, and that monitoring of operational and engineered controls for groundwater protection is capable of rapidly detecting an unexpected release of contamination.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

_X_ Compliance
_X_ Support Compliance
_X_ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

To monitor groundwater quality and the effectiveness of groundwater protection and cleanup activities, comprehensive groundwater flow information is required. Data are needed on an annual basis to evaluate groundwater flow directions and rates and horizontal gradients in the shallow portion of the Upper Glacial aquifer on-site and off-site. On a less frequent basis, BNL will also need to collect water level data in deep Upper Glacial and upper Magothy aquifer wells to evaluate groundwater flow directions and rates, as well as horizontal and vertical gradients between multiple aquifer segments.

Step 2: Identify the Decision

This project generates comprehensive and regional data inputs for decisions to be made in various groundwater remediation and groundwater protection projects. These decisions are not discussed here. The decisions related to this project are:

- Are the groundwater flow direction and rate data developed for this project of sufficient level of detail and confidence to support other projects?

- Is the groundwater flow system approaching a steady state condition that could justify changes in monitoring?

Step 3: Identify Inputs to the Decision

The groundwater flow inputs generated by this project that are necessary for decisions in other projects include:

- Quarterly depth to water measurements in selected wells, measured to the nearest 0.01 foot
- Measuring point elevations for measured wells, measured to the nearest 0.01 foot
- Locations of measured wells

Step 4: Define the Study Boundaries

Because wells located throughout the BNL site and off site are included in this program, the study boundaries are the groundwater watershed areas for the Upper Glacial and upper Magothy aquifers in the vicinity of the BNL site.

Step 5: Develop the Decision Rules

Decision 1

Are the groundwater flow direction and rate data developed for this project of sufficient level of detail and confidence to support other projects?

These decision rules should be applied for water levels in the shallow portion of the Upper Glacial aquifer. The data generated for each measurement round will be reviewed by BNL hydrogeologists with respect to historic data and pumping and recharge rates for supply wells and existing remediation systems.

If data generated for each measurement round are considered adequate as input for decisions to be made for other projects, **then** utilize the data for project-specific decisions. Otherwise, consider modifying the suite of wells that are measured to address the identified data gap(s).

Decision 2

Is the groundwater flow system approaching a steady state condition that could justify changes in elevation monitoring?

If, significant change in groundwater flow directions or gradients is observed during any four consecutive measuring periods, **then** continue with the existing monitoring program for that aquifer segment.

If significant change in groundwater flow direction or gradient is not observed during any four consecutive measuring periods, **then** apply expert judgment to consider reducing monitoring frequency or the number of wells used to collect the measurements.

Step 6: Specify Acceptable Error Tolerances

Table 12.21.1 summarizes the decision and possible decision errors for this project.

Table 12.21.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Are the groundwater flow direction and rate data developed for this project of sufficient level of detail and confidence to support other projects?	See Step 3 for inputs.	(1) Data indicate data are sufficient when they are not. (2) Data indicate data are not sufficient when they are.	(1) Potential for decision or monitoring errors in other projects due to inadequate data. (2) Wasted resources considering/ implementing operational or monitoring adjustments in other projects.
Is the groundwater flow system approaching a steady state condition that could justify changes in elevation monitoring?	See Step 3 for inputs.	(1) Data indicate that the groundwater system is approaching a steady state condition when it is not. (2) Data indicate that the groundwater system is not approaching a steady state condition when it is.	(1) Potential for variations in groundwater flow direction to be missed due to decreased monitoring frequency; loss of stakeholder trust. (2) Wasted resources conducting unnecessary water level monitoring.

Step 7: Optimize the Design

Number and Locations of Wells

Groundwater Elevation Monitoring program for the collection of water level data will use approximately 225 on-site and off-site monitoring wells that are screened in the shallow portions of the Upper Glacial aquifer. As necessary, BNL may periodically take water level measurements from deep Upper Glacial and upper Magothy aquifer wells to evaluate flow directions and gradients.

Frequency

Based on the volume of historic water level data, a full synoptic round of water level measurements from approximately 185 shallow Upper Glacial aquifer wells are collected annually. Additional measurement rounds will be added as necessary if conditions warrant.

See Appendix B for the monitoring program for this Data Quality Objective.

Table 12.22.1 Facility Groundwater Monitoring Schedule

Project	Sample Event	Start Date	End Date	# of Wells
Alternating Gradient Synchrotron Facility	4th Qtr.	10/01/2025	12/15/2025	48
Alternating Gradient Synchrotron Facility – g-2 Tritium Source Area and Plume	2nd Qtr.	04/01/2025	04/30/2025	5
	4th Qtr.	10/01/2025	10/31/2025	5
Brookhaven Linac Isotope Producer	2nd Qtr.	04/01/2025	05/15/2025	3
	4th Qtr.	10/01/2025	11/15/2025	4
Relativistic Heavy Ion Collider	1st Qtr.	02/01/2025	02/28/2025	13
	3rd Qtr.	08/01/2025	08/31/2025	13
Waste Management Facility	1st Qtr.	02/01/2025	02/26/2025	10
	3rd Qtr.	08/01/2025	08/31/2025	10
Sewage Treatment Plant	4th Qtr.	11/01/2025	11/15/2025	8
Motor Pool	4th Qtr.	10/01/2025	10/31/2025	2
Major Petroleum Facility (MPF) (a)	2nd Qtr.	04/01/2025	04/30/2025	8
	4th Qtr.	10/01/2025	10/31/2025	8
National Synchrotron Light Source-II	4th Qtr.	12/01/2025	12/31/2025	4

Notes:
(a) Monthly floating product measurements are also obtained from MPF wells.

Table 12.22.2 Monitoring Well Locations and Analyses

Well ID	Area	Sub Area	Decision Subunit	EPA 8260 VOCs	EPA 8270 Semi-VOCs	Metals	EPA 900 Gross Alpha/Beta	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr-90	Floating Product	Frequency (events/year)
064-46	BLIP		Upgradient						X			1
064-47	BLIP		Downgradient						X			2
064-48	BLIP		Downgradient						X			2
064-67	BLIP		Downgradient						X			2
054-08	AGS	NSRL	Downgradient						X			1
054-191	AGS	NSRL	Downgradient						X			1
064-51	AGS	Booster Beam Stop	Downgradient						X			1
064-52	AGS	Booster Beam Stop	Downgradient						X			1
064-03	AGS	B-914	Downgradient						X			1
064-53	AGS	B-914	Downgradient						X			1
064-54	AGS	B-914	Downgradient						X			1
054-62	AGS	Bkgd. J-10 Beam Stop	Upgradient						X			1
054-63	AGS	J-10 Beam Stop	Downgradient						X			1
054-64	AGS	J-10 Beam Stop	Downgradient						X			1
054-65	AGS	g-2 Beam Stop/Plume Source	Upgradient						X			1
054-66	AGS	g-2 Beam Stop	Downgradient						X			1

054-67	AGS	g-2 Beam Stop	Downgradient						X			1
054-68	AGS	g-2 Beam Stop	Downgradient						X			1
054-124	AGS	g-2 Beam Stop	Downgradient						X			1
054-125	AGS	g-2 Beam Stop	Downgradient						X			1
054-127	AGS	Fm. U-Line Target	Upgradient						X			1
054-128	AGS	Fm. U-Line Target	Downgradient						X			1
054-129	AGS	Fm. U-Line Target	Downgradient						X			1
054-130	AGS	Fm. U-Line Target	Downgradient						X			1
054-168	AGS	Fm. U-Line Stop	Downgradient						X			1
054-169	AGS	Fm. U-Line Stop	Downgradient						X			1
054-69	AGS	B-912	Upgradient						X			1
055-14	AGS	B-912	Upgradient						X			1
065-120	AGS	B-912	Downgradient						X			1
065-125	AGS	B-912	Downgradient						X			1
065-126	AGS	B-912	Downgradient						X			1
065-195	AGS	B-912	Downgradient						X			1
055-31	AGS	B-912	Downgradient						X			1
055-15	AGS	B-912	Downgradient						X			1
055-16	AGS	B-912	Downgradient						X			1
065-192	AGS	B-912	Downgradient						X			1
055-29	AGS	B-912	Downgradient						X			1
055-30	AGS	B-912	Downgradient						X			1
055-32	AGS	B-912	Downgradient						X			1
065-121	AGS	B912/g-2 Tritium Plume	Downgradient						X			1

065-122	AGS	B912/g-2 Tritium Plume	Downgradient						X			1
065-193	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
065-123	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
065-124	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
065-194	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
065-321	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
065-322	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
065-323	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
065-324	AGS	B-912/g-2 Tritium Plume	Downgradient						X			1
064-55	AGS	E-20 Catcher	Downgradient						X			1
064-56	AGS	E-20 Catcher	Downgradient						X			1
064-80	AGS	E-20 Catcher	Downgradient						X			1
054-07	AGS/g-2	g-2 Tritium Plume Source	Downgradient						X			2
054-184	AGS/g-2	g-2 Tritium Plume Source	Downgradient						X			2
054-185	AGS/g-2	g-2 Tritium Plume Source	Downgradient						X			2
064-95	AGS/g-2	g-2 Tritium Plume Source	Downgradient						X			2
054-126	AGS/g-2	g-2 Tritium Plume Source	Downgradient						X			2
025-01	RHIC	B/Y Beam Stop Area	Upgradient						X			2
025-03	RHIC	B/Y Beam Stop Area	Downgradient						X			2
025-04	RHIC	B/Y Beam Stop Area	Downgradient						X			2
025-05	RHIC	B/Y Beam Stop Area	Downgradient						X			2

025-06	RHIC	B/Y Beam Stop Area	Downgradient						X			2
025-07	RHIC	B/Y Beam Stop Area	Downgradient						X			2
025-08	RHIC	B/Y Beam Stop Area	Downgradient						X			2
034-05	RHIC	B/Y Collimator Area	Downgradient						X			2
034-06	RHIC	B/Y Collimator Area	Downgradient						X			2
043-01	RHIC	B/Y Collimator Area	Downgradient						X			2
043-02	RHIC	B/Y Collimator Area	Downgradient						X			2
044-13	RHIC	B/Y Collimator Area	Downgradient						X			2
044-14	RHIC	B/Y Collimator Area	Downgradient						X			2
044-29	RHIC	W-Line Stop	Downgradient						X			2
102-05	Motor Pool	Gasoline USTs	Downgradient	X							X	1
102-06	Motor Pool	Gasoline USTs	Downgradient	X							X	1
055-03	WMF	Bkgd.	Upgradient	X		X	X	X	X			2
055-10	WMF	Bkgd.	Upgradient	X		X	X	X	X			2
056-21	WMF	RCRA Bldg.	Downgradient	X		X	X	X	X	X		2
056-22	WMF	Rad. Bldg.	Downgradient	X		X	X	X	X	X		2
056-23	WMF	Rad. Bldg.	Downgradient	X		X	X	X	X	X		2
066-84	WMF	Rad. Bldg.	Downgradient	X		X	X	X	X	X		2
066-220	WMF	RCRA Bldg.	Downgradient	X		X	X	X	X	X		2
066-221	WMF	RCRA Bldg.	Downgradient	X		X	X	X	X	X		2
066-222	WMF	Rad. Bldg.	Downgradient	X		X	X	X	X	X		2
066-223	WMF	Rad. Bldg.	Downgradient	X		X	X	X	X	X		2

066-224	WMF	Mixed Waste Bldg.	Downgradient									0
076-16	MPF	Tank Area	Downgradient	X	X						X(a)	2
076-17	MPF	Tank Area	Downgradient	X	X						X(a)	2
076-18	MPF	Tank Area	Downgradient	X	X						X(a)	2
076-19	MPF	Tank Area	Downgradient	X	X						X(a)	2
076-25	MPF	Tank Area	Upgradient	X	X						X(a)	2
076-378	MPF	Tank Area	Downgradient	X	X						X(a)	2
076-379	MPF	Tank Area	Downgradient	X	X						X(a)	2
076-380	MPF	Tank Area	Downgradient	X	X						X(a)	2
039-87	STP	Recharge Basins - Upgrade	Downgradient			X						1
039-88	STP	Holding Ponds/Recharge B	Downgradient			X						1
039-89	STP	Holding Ponds/Recharge B	Downgradient			X						1
039-90	STP	Holding Ponds	Downgradient			X						1
039-115	STP	Recharge Basins	Downgradient			X						1
048-08	STP	Recharge Basins	Downgradient			X						1
048-09	STP	Recharge Basins	Downgradient			X						1
048-10	STP	Recharge Basins	Downgradient			X						1
086-123	NSLS-II	Linac	Downgradient						X			1
086-124	NSLS-II	Linac	Downgradient						X			1
086-125	NSLS-II	Linac	Downgradient						X			1

086-126	NSLS-II	Linac	Downgradient						X			1

Notes:

AGS: Alternating Gradient Synchrotron

BLIP: Brookhaven Linear Isotope Producer

MPF: Major Petroleum Facility

NSLS-II: National Synchrotron Light Source II

NSRL: NASA Space Radiation Laboratory

RHIC: Relativistic Heavy Ion Collider

Sr-90: Strontium-90

STP: Sewage Treatment Plant

VOCs: Volatile Organic Compounds

WMF: Waste Management Facility

(a) Floating product determination measurements to be collected monthly

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12.23 GROUNDWATER MONITORING AT THE ALTERNATING GRADIENT SYNCHROTRON

DQO START DATE	January 1, 2003
IMPLEMENTATION DATE	January 1, 2025
Point of Contact	Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year 2025 to the groundwater monitoring program for the Alternating Gradient Synchrotron (AGS) area.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Laboratory (BNL) monitors groundwater quality at the AGS facility to evaluate the effectiveness of engineered controls used to prevent rainwater infiltration into activated soil shielding. The monitoring program has demonstrated that groundwater quality had been impacted by tritium originating from activated soil shielding at the former g-2 experiment, former U-Line beam stop, and the former E-20 catcher. In these areas, rainwater was able to infiltrate activated soil shielding and leach tritium into the groundwater. Tritium concentrations were found to exceed the 20,000 pCi/L maximum contaminant level (MCL) in these three locations. BNL installed impermeable caps over the activated soil shielding areas to prevent additional rainwater infiltration.

Following these corrective actions, tritium concentrations in the former U-Line beam stop and the former E-20 catcher areas dropped to well below the 20,000 pCi/L standard. However, tritium is still periodically detected at concentrations slightly above 20,000 pCi/L in several wells down-gradient of the g-2 source area (see Data Quality Objective [DQO] Statement 12-35). Monitoring at other potential soil activation areas such as the J-10 beam stop, Booster beam stop, the NASA Space Radiation Laboratory (NSRL), Building 914 transfer tunnel, and Building 912 continue to demonstrate that groundwater has not been significantly impacted by these operations and that existing engineered controls are working. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.23.1 and 12.23.2.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
_X_ Restoration/IAG

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Secondary particles are created near beam loss points, beam targets, and beam stops. These particles have the potential to escape into the soil surrounding the accelerator tunnels or into the soils' underlying target and beam stop areas in the experimental halls. Although considerable effort is taken to design appropriate shielding and other engineering controls into these systems, many secondary particles will still interact with the soil surrounding the tunnels and underlying floors. The types of radionuclides created from this interaction include tritium, beryllium-7, carbon-11, nitrogen-13, oxygen-15, and sodium-22.

Once present in soil, some of these radionuclides can leach downward into groundwater by means of rainwater percolation. Only radionuclides with long half-lives, namely tritium ($t_{1/2}$ = 12.3 years) and sodium-22 ($t_{1/2}$ = 2.6 years), are detected in the groundwater below the AGS. Tritium has been detected at concentrations that exceed the 20,000 pCi/L drinking water standard at several locations (e.g., g-2 and BLIP). Sodium-22 is rarely detected at concentrations above the 400 pCi/L drinking water standard and is only detected in wells located close to the source areas. BNL has taken steps to either reduce the amount of radioactivity produced in soil (by means of additional shielding or modifying operating procedures) or by the construction of impermeable caps to prevent the leaching of these materials to groundwater.

Another potential source of groundwater contamination is the inadvertent release of activated water from the AGS's primary cooling water systems. To reduce this threat, the piping systems have been modified to reduce the volume of water that can be exposed to beam line losses, and piping containing high levels of tritiated water is located inside facility structures where they can be visibly inspected.

The collection of groundwater samples from wells downgradient of the soil activation areas is required to demonstrate that the operational and engineered controls are effective in protecting groundwater quality. These controls include:

- Limiting the amount of soil activation by use of internal shielding material and beam focusing
- Primary cooling water management
- Installation and maintenance of impermeable caps (geomembrane, gunite, etc.)
- Storm water management

Step 2: Identify the Decision

Are the operational and engineered controls employed at the AGS complex effective in preventing the release of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest wells downgradient of each identified soil activation area)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the AGS

- Modeled estimates or direct measurements on the amount of soil activation at each beam stop and target area
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells relative to each identified soil activation area
- Regulatory requirements (DOE Order 458.1)
- Action levels are defined by the BNL Groundwater Protection Contingency Plan.
- Analytical methods and detection limits:
  - Tritium: EPA Method 906
  - Gamma spectroscopy (optional analysis): EPA Method 901

In 2004, the routine testing of groundwater samples for sodium-22 was discontinued. Since that time, the focus has been placed on tritium because it is more mobile than sodium-22 and has a longer half-life. Therefore, the presence of tritium in groundwater is a better early indicator of a potential failure in an engineered control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the AGS complex and the nearest practicable monitoring points (i.e., "points of assessment") near each of the identified soil activation areas. The period for which decisions are made is 365 days. These timeframes are based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.
- Once the tritium migrates to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, typically 100 feet from the source) is likely to be between 130 to 275 days.
- Decision periods of 365 days are acceptable for areas where monitoring has demonstrated that current engineered and operational controls are effective (e.g., J-10 Beam Stop, Booster Beam Stop, Building 914 Transfer Tunnel, Former U-Line Target, former E-20 Catcher, and Building 912).

Step 5: Develop the Decision Rules

Are engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soil to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see environmental monitoring [EM]-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.23.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium from activated soil shielding to the groundwater?	See Step 3 for inputs	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination, potentially up to several hundred feet long, could exist and not be detected* (2) Need to re-sample well and resulting additional unplanned costs; potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

Under certain operating conditions, the source water contributing area for potable supply wells 10, 11, and 12 can extend into the northern portion of the AGS facility. The groundwater travel time from the AGS to the closest supply well (well 10) is greater than two years. This would provide sufficient time to respond to a new contaminant release. Because of existing groundwater contamination in and near the AGS complex (e.g., g-2 tritium plume, the former Waste Concentration Facility Sr-90 plume, and the former Bubble Chamber area PFAS plume), BNL limits water withdrawals from well 10 to the extent possible by placing the well into a lag operating position. Furthermore, water withdrawn from supply wells 10, 11, and 12 is treated by granular activated carbon filters to remove PFAS and VOCs prior to its distribution.

Due to these factors and additional Land Use and Institutional Controls developed for the AGS area, it is unlikely that a decision error will result in adverse consequences to human health. Consequences associated with (short-term) decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or another regulatory program.

Step 7: Optimize the Design

Number and Locations of Wells

The wells located around the AGS are biased toward detecting contamination originating from activated soils associated with current and former beam stop and target areas (see Figure 12.23.1). The wells are located as close as possible to these potential source areas to allow for early detection of contaminant releases. The current approved monitoring network allows for the timely evaluation of potential impacts and is considered adequate for meeting the acceptable risk levels of stakeholders.

Parameters and Frequency

Groundwater quality in the AGS complex is routinely evaluated using approximately 50 monitoring wells. Over 20 years of analytical data are available to assess potential impacts from activated soil shielding and the effectiveness of engineered stormwater controls. Tritium and sodium-22 have been detected in groundwater downgradient of several activated-soil shielding areas. Whereas tritium had exceeded the 20,000 pCi/L drinking water standard in several areas prior to improvements in storm water controls, sodium-22 rarely exceeded the 400 pCi/L standard. Because tritium is easily leached from activated soils, is highly mobile in groundwater, and has a longer half-life, monitoring well samples are currently only analyzed for tritium. As necessary, samples may be periodically analyzed for sodium-22. Based upon proven effectiveness of the engineered storm water controls, groundwater samples only need to be collected annually.

Table 12.23.2. Comparison of 2024 and 2025 Monitoring Program

Well	Monitoring Sub-Area	CY 2024 Sampling Frequency	CY 2025 Sampling Frequency	Affected Parameters
054-08	NSRL beam stop	Annual	Annual	None
054-191	NSRL beam stop	Annual	Annual	None
064-51	Booster beam stop	Annual	Annual	None
065-52	Booster beam stop	Annual	Annual	None
064-03	Bldg 914	Annual	Annual	None
064-53	Bldg 914	Annual	Annual	None
064-54	Bldg 914	Annual	Annual	None
054-62	Bkgd. J-10 beam stop	Annual	Annual	None
054-63	J-10 beam stop	Annual	Annual	None
054-64	J-10 beam stop	Annual	Annual	None
054-65	g-2 beam stop/plume source	Annual	Annual	None
054-66	g-2 beam stop	Annual	Annual	None
054-67	g-2 beam stop	Annual	Annual	None
054-68	g-2 beam stop	Annual	Annual	None
054-124	g-2 beam stop	Annual	Annual	None
054-125	g-2 beam stop	Annual	Annual	None
054-127	U-line target	Annual	Annual	None
054-128	U-line target	Annual	Annual	None
054-129	U-line target	Annual	Annual	None
054-130	U-line target	Annual	Annual	None
054-168	U-line stop	Annual	Annual	None
054-169	U-line stop	Annual	Annual	None
054-69	Bldg 912/U-line stop	Annual	Annual	None
055-14	Bldg 912/U-line stop	Annual	Annual	None
065-120	Bldg 912	Annual	Annual	None
065-125	Bldg 912	Annual	Annual	None
065-126	Bldg 912	Annual	Annual	None
065-195	Bldg 912	Annual	Annual	None
055-15	Bldg 912	Annual	Annual	None
055-16	Bldg 912	Annual	Annual	None
065-192	Bldg 912	Annual	Annual	None
055-29	Bldg 912	Annual	Annual	None
055-30	Bldg 912	Annual	Annual	None
055-31	Bldg 912	Annual	Annual	None
055-32	Bldg 912	Annual	Annual	None
065-121	Bldg 912/g-2 plume	Annual	Annual	None
065-122	Bldg 912/g-2 plume	Annual	Annual	None
065-193	Bldg 912/g-2 plume	Annual	Annual	None
065-123	Bldg 912/g-2 plume	Annual	Annual	None
065-124	Bldg 912/g-2 plume	Annual	Annual	None
065-194	Bldg 912/g-2 plume	Annual	Annual	None
065-321	Bldg 912/g-2 plume	Annual	Annual	None
065-322	Bldg 912/g-2 plume	Annual	Annual	None
065-323	Bldg 912/g-2 plume	Annual	Annual	None
065-324	Bldg 912/g-2 plume	Annual	Annual	None
064-55	E-20 Catcher	Annual	Annual	None
064-56	E-20 Catcher	Annual	Annual	None
064-80	E-20 Catcher	Annual	Annual	None

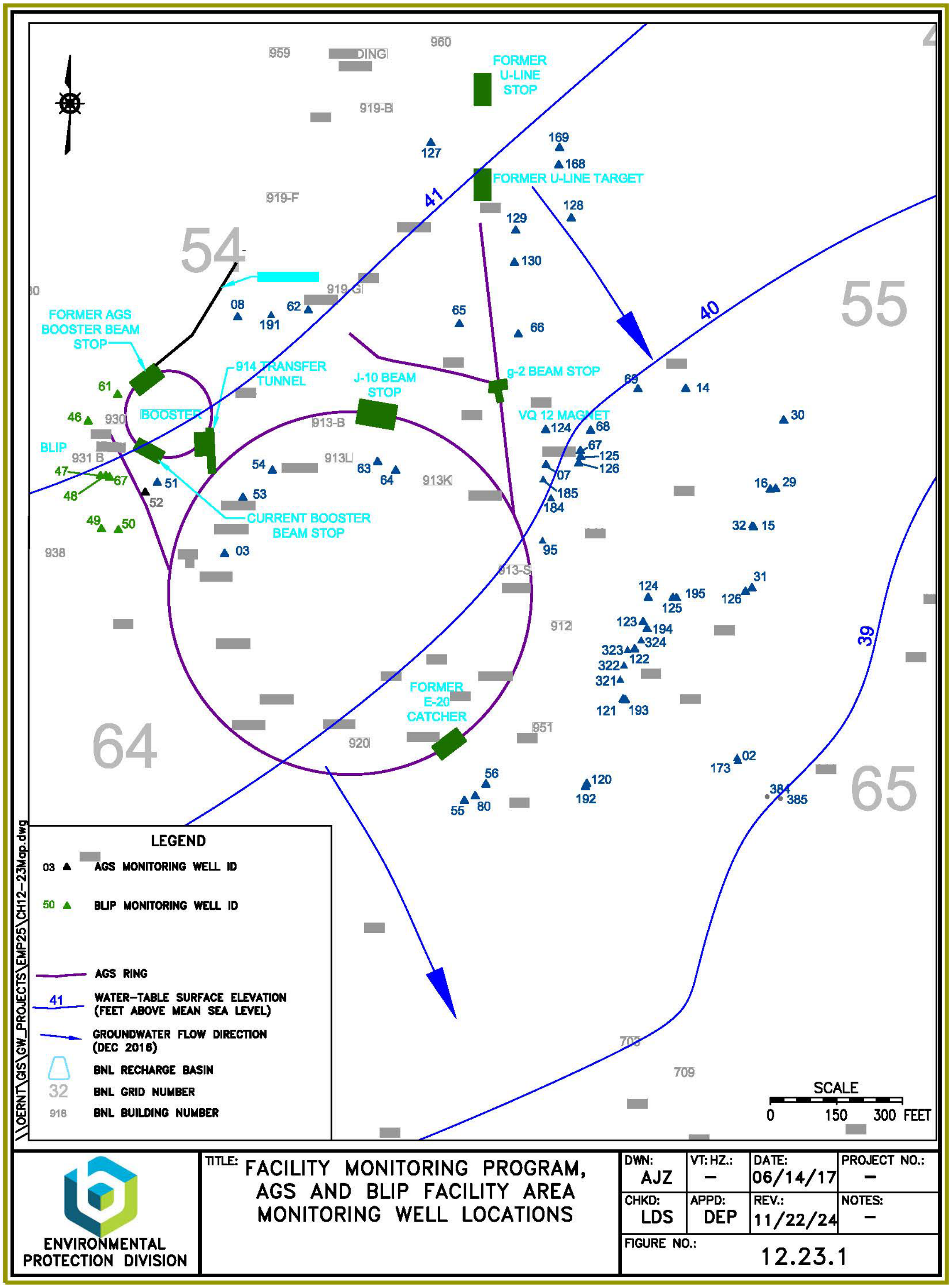

Figure 12.23.1 AGS and BLIP Facility Area Monitoring Well Locations

See Appendix B for the monitoring requirements for this DQO.

12.24 GROUNDWATER MONITORING AT THE BROOKHAVEN LINAC ISOTOPE PRODUCER

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year 2025 for the Brookhaven Linac Isotope Producer (BLIP) groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

The 1998 discovery of tritium and sodium-22 in groundwater downgradient of the BLIP indicated that rainwater was leaching these radionuclides from activated soil shielding located near the BLIP target vessel. To prevent continued rainwater infiltration, BNL made improvements to several engineered controls, including the reconnection of the building's rain gutters, sealing paved areas, construction of an impermeable cap, and the injection of a grouting material to reduce the permeability of the activated soils. In 2004 and 2015, the impermeable cap was extended over the Linac-to-BLIP spur in response to changes in beam line operations and the resulting increase in the size of the zone of activated soil shielding. Monitoring wells are used to evaluate the effectiveness of these engineered controls.

Since July 2006, tritium concentrations in groundwater downgradient of BLIP have remained below the 20,000 pCi/L drinking water standard. The g-2/BLIP/UST Record of Decision (ROD) requires continued groundwater monitoring to verify the effectiveness of the engineered controls. Because tritium concentrations have been continuously <20,000 pCi/L since mid-2006, in 2009 the monitoring frequency for the three wells immediately downgradient of BLIP was reduced from quarterly to semiannually, and monitoring of the upgradient well was reduced to annually. (Note: As described below, routine monitoring for Na-22 has been discontinued.) Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.24.1 and 12.24.2.

DRIVERS FOR MONITORING

_X_ Compliance
___ Support Compliance
_X_ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Secondary particles created at the BLIP target vessel and along the Linac to BLIP beam line have activated some of the soils that surround portions of the vessel and tunnel walls. The types of radionuclides created from this interaction include tritium, beryllium-7, carbon-11, nitrogen-13, oxygen-15, and sodium-22. Some of these radionuclides can be leached downward into groundwater by means of rainwater percolation. Only radionuclides with long half-lives such as tritium ($t_{1/2}$ = 12.3 years) and sodium-22 ($t_{1/2}$ = 2.6 years) are detected in the groundwater below the BLIP. As noted previously, BNL has taken steps to prevent the leaching of these materials to groundwater by improving rainwater management.

During 1998, rainwater management initiatives included the reconnection of the building's rain gutters, sealing paved areas, and constructing an impermeable gunite cap. In conjunction with the Environmental Restoration program, in 2000, colloidal silica grout was injected into the activated soil area to reduce the permeability of the soil. As stated above, in 2004 and 2015, the impermeable cap was extended over the Linac-to-BLIP spur in response to changes in beam line operations and the resulting increase in the size of the zone of activated soil shielding in several areas along the beam line. Another potential source of groundwater contamination could be the inadvertent release of activated water from the BLIP's primary cooling water system. However, these water systems are located inside the BLIP building and can be visually inspected.

As defined in the g-2/BLIP/Underground Storage Tank (UST) ROD, the continued collection of groundwater samples from wells downgradient of the BLIP is required to demonstrate that the operational and engineered controls are effective in protecting groundwater quality. These controls include:

- Limiting the amount of soil activation by beam focusing
- Primary cooling water management
- Reducing the permeability of the activated soils using colloidal silica grout
- Installation and maintenance of impermeable caps (gunite and asphalt)
- Conveying storm water away from the building foundation

Step 2: Identify the Decision

Are the operational and engineered controls employed at BLIP effective at preventing additional releases of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at BLIP
- Modeled estimates on the amount of soil activation near the target vessel
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells relative to the soil activation area
- Regulatory requirements are g-2/BLIP/UST ROD and DOE Order 458.1
- Action levels as described in the Groundwater Protection Contingency Plan
  - g-2/BLIP/UST ROD did not define any additional action levels
- Analytical methods and detection limits:
  - Tritium: EPA Method 906
  - Gamma spectroscopy (optional analysis for Na-22): EPA Method 901

Starting in 2004, the requirement for routine sodium-22 analyses was dropped from the monitoring program. Because tritium is more mobile than sodium-22 and has a longer half-life, the presence of high levels of tritium in groundwater would be a better early indicator of a failure in an engineered control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area immediately downgradient of BLIP. The monitoring period is 180 days, based upon a semiannual monitoring frequency. This time frame is considered adequate based upon the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be 30 to 60 days.
- Once the radionuclides have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessments, which are located approximately 50 feet from the source) is 90 days.
- Because tritium at concentrations in downgradient monitoring wells have been less than the 20,000 pCi/L drinking water standard since early-2006, a decision period of 180 days is sufficient to evaluate the effectiveness of the engineered controls. Therefore, the three wells located immediately downgradient of BLIP will be sampled on a semiannual basis. The sampling frequency for the upgradient is annually.

Step 5: Develop the Decision Rules

Are the engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soils to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan (either response Action Level 2 or 3 of the plan) would be ascertained for each sampled well or set of wells (see EM SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.24.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium and sodium-22 from activated soil shielding to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not, (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 100 feet long and 20 feet wide could exist and not be detected* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of the BLIP, and groundwater travel time to the nearest potential downgradient receptor (Potable Well 4, which is currently out of service) is greater than five years. Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require additional remedial actions.

Step 7: Optimize the Design

Number and Locations of Wells

The wells near the BLIP are biased toward detecting contamination originating from activated soils adjacent to the target vessel and to evaluate potential contamination that could originate from upgradient sources such as the LINAC-to-BLIP beam line (Figure 12.24.1). Three downgradient wells (064-47, 064-48, and 064-67) are located as close as possible to the BLIP building to enable early detection of contaminant releases. The current monitoring well network is considered adequate for meeting the acceptable risk levels of stakeholders. Because the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small, no refinements are recommended.

Parameters and Frequency

Groundwater quality at BLIP is routinely evaluated using four monitoring wells. The primary focus of the monitoring program is the detection of tritium because it is easily leached from activated soils, is highly mobile in groundwater, and has a longer half-life.

Since early 2006, tritium concentrations in groundwater immediately downgradient of the BLIP facility have remained well below the 20,000 pCi/L drinking water standard. This sustained reduction in tritium concentrations suggests that the caps and other storm water controls are effectively preventing rainwater from infiltrating the activated soil shielding, and the amount of tritium remaining in the vadose zone close to the water table has declined due to the water table flushing mechanism and by natural radioactive decay. The sampling frequency for downgradient wells 064-47, 064-48, and 064-67 is semiannual.

Table 12.24.2. Comparison of CY 2024 and CY 2025 Monitoring Programs

Well	CY 2024 Sampling Frequency	CY 2025 Sampling Frequency	Affected Parameters
064-46*	Annually	Annually	None
064-47	Semiannually	Semiannually	None
064-48	Semiannually	Semiannually	None
064-67	Semiannually	Semiannually	None

*Upgradient well

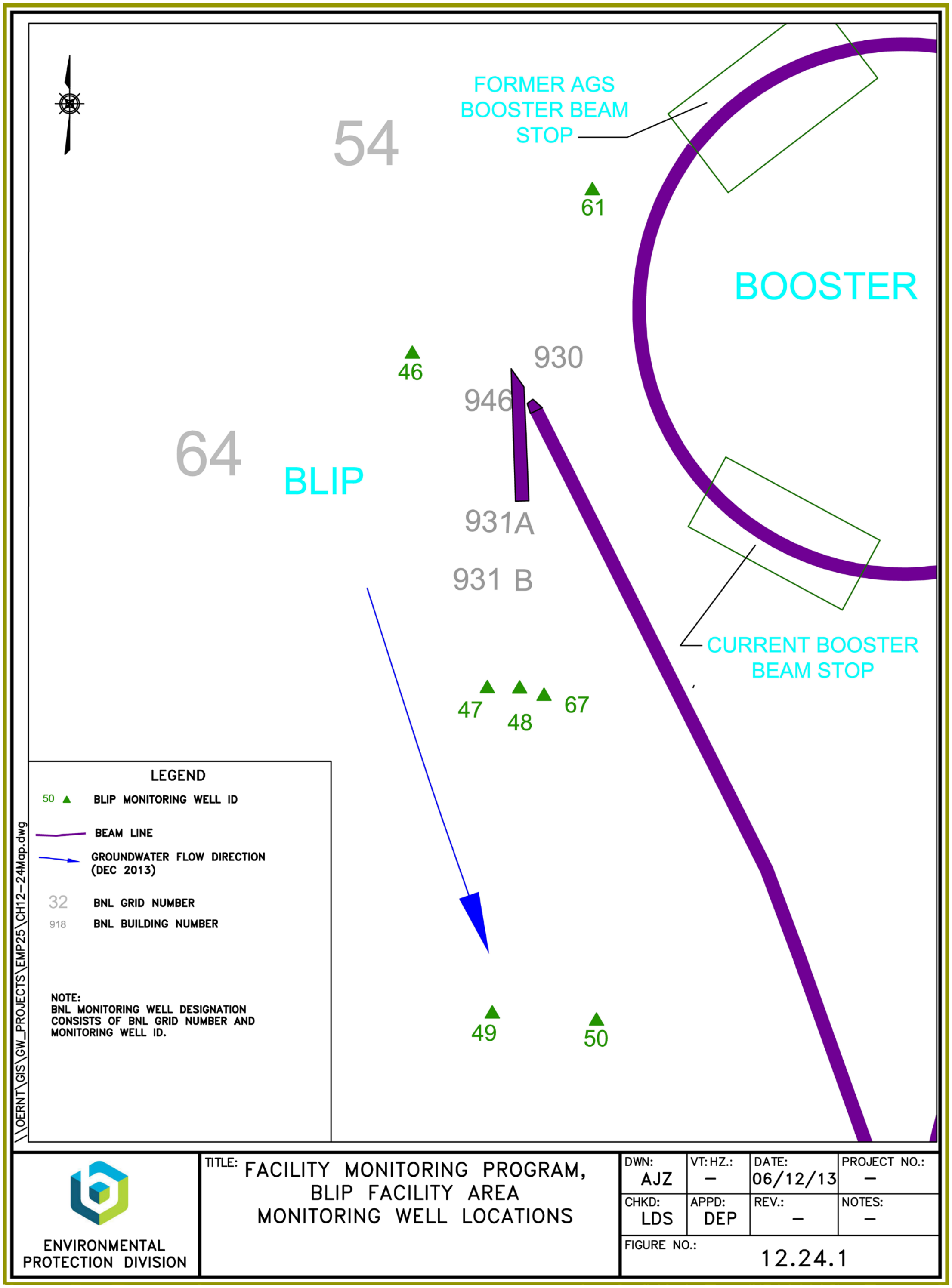

Figure 12.24.1 Facility Monitoring Program, BLIP Facility Area Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

12.25 GROUNDWATER MONITORING AT THE RELATIVISTIC HEAVY ION COLLIDER

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes in calendar year 2025 for the Relativistic Heavy Ion Collider (RHIC) monitoring program.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Laboratory (BNL) uses 13 monitoring wells to evaluate the effectiveness of the engineered (e.g., caps) and operational controls designed to protect groundwater quality near activated soil shielding at the RHIC beam stop and collimator areas. Monitoring conducted to date indicates that the controls are effectively protecting the activated soils. RHIC monitoring wells are monitored semiannually. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.25.1 and 12.25.2.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Secondary particles created near the RHIC beam stops and collimators have the potential to escape into the soil surrounding the accelerator tunnel. Although considerable effort is taken to design appropriate shielding and other engineering controls into these systems, many secondary particles will still interact with soil surrounding the tunnels and underlying floors. The types of radionuclides created from this interaction include tritium, beryllium-7, carbon-11, nitrogen-13, oxygen-15, and sodium-22. Some of these radionuclides can leach downward into groundwater by means of rainwater percolation. These leaching processes are usually quite slow, and therefore, only radionuclides with long half-lives such as tritium ($t_{1/2}$ = 12.3 years) and sodium-22 ($t_{1/2}$ = 2.6 years) are likely to be detected in the groundwater. BNL has taken steps to reduce the amount of radioactivity produced in soil by means of additional shielding or modifying operating procedures and/or to prevent the leaching of these materials to groundwater by the construction of impermeable caps.

The collection of groundwater samples from wells located downgradient of the soil activation areas is required to demonstrate that the operational and engineered controls are effective in protecting groundwater quality. These controls include:

- Limiting the amount of soil activation by use of internal shielding material and beam focusing
- Installation and maintenance of impermeable geomembrane caps over each potential soil activation area (e.g., three beam stops and two collimators)
- Storm water management

Step 2: Identify the Decision

Are the operational and engineered controls employed at RHIC effective at preventing the release of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells near each of the identified soil activation areas)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the RHIC
- Modeled estimates on the amount of soil activation at each beam stop and collimator
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells relative to each identified soil activation area
- Regulatory requirements (DOE Order 458.1)
- Action levels (as described in the Groundwater Protection Contingency Plan)
- Analytical methods and detection limits:
  - Tritium: Environmental Protection Agency (EPA) Method 906
  - Gamma spectroscopy for Na-22 (optional analysis): EPA Method 901

Starting in 2004, routine sodium-22 analyses were discontinued from the monitoring program. Focus is now placed on tritium analyses because tritium is more mobile than sodium-22 and has a longer half-life. Therefore, tritium's presence in groundwater would be a better early indicator of a failure in an engineered control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the beam stop and collimator areas within RHIC facility and the nearest practicable monitoring points (i.e., "points of assessment") near each of the identified potential soil activation areas. The period for which decisions are made is 180 days. These timeframes are based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.
- Once the radionuclides have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, typically 100 to 200 feet from the source) is approximately 130 to 260 days.

- Decision periods of 180 to 360 days are acceptable for areas where monitoring has demonstrated that current engineered and operational controls are effective.

Step 5: Develop the Decision Rules

Are the engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soils to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.25.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium and sodium-22 from activated soil shielding to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination, potentially up to several hundred feet long, could exist and not be detected* (2) Need to re-sample well and resulting additional unplanned costs; potential erosion of stake- holder confidence.

*Assumes results from one sample period were inaccurate.

There are no potential receptors (i.e., potable water supply wells) located immediately down-gradient of the RHIC beam stop and collimator areas, and groundwater travel time to the nearest potential downgradient receptor (Potable Well 10) is greater than five years. Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial action under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or other regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The 13 wells located at the RHIC are biased toward detecting contamination originating from activated soils associated with the facility's beam stops and collimators (Figure 12.25.1). The wells are located as close as possible to these potential source areas to enable early detection of contaminant releases. The current approved monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders. No additional wells are recommended for this program.

Parameters and Frequency

Groundwater monitoring wells at the RHIC beam stop and collimator areas have been monitored at least semi-annually since their installation in 1999 and 2000. Because tritium is easily leached from activated soils, is highly mobile in groundwater, and has a longer half-life than the other radionuclides detected in activated soil shielding, the primary focus of the monitoring program is for the detection of tritium. For 2019, groundwater samples will be collected on a semi-annual (180 day) basis. Samples will be analyzed only for tritium. Should tritium be detected in any of the wells, samples could also be collected to test for the presence of sodium-22.

Table 12.25.2. Comparison of 2024 and 2025 Sampling Programs

Well ID	CY 2024 Sampling Frequency	CY 2025 Sampling Frequency	Affected Parameters
025-03	Semi-annual	Semi-annual	None
025-04	Semi-annual	Semi-annual	None
025-05	Semi-annual	Semi-annual	None
025-06	Semi-annual	Semi-annual	None
025-07	Semi-annual	Semi-annual	None
025-08	Semi-annual	Semi-annual	None
034-05	Semi-annual	Semi-annual	None
034-06	Semi-annual	Semi-annual	None
043-01	Semi-annual	Semi-annual	None
043-02	Semi-annual	Semi-annual	None
044-13	Semi-annual	Semi-annual	None
044-14	Semi-annual	Semi-annual	None
044-29	Semi-annual	Semi-annual	None

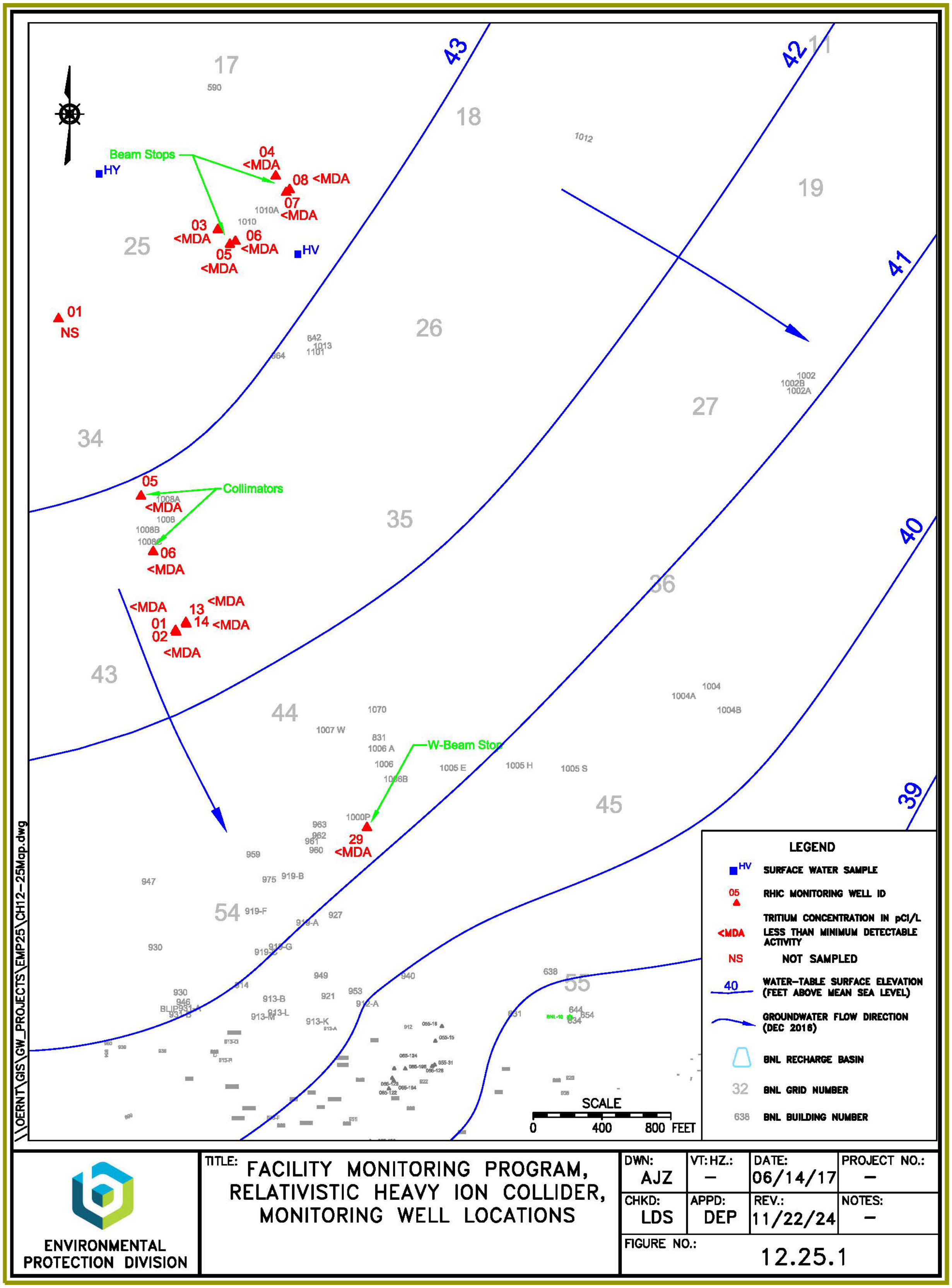

Figure 12.25.1 Facility Monitoring Program, RHIC, Monitoring Well Locations

See Appendix B for the Monitoring Program for this Data Quality Objective.

12.26 GROUNDWATER MONITORING AT THE WASTE MANAGEMENT FACILITY

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

With observed changes in groundwater flow directions in the Waste Management Facility (WMF) area due to increased use of nearby water supply Wells 11 and 12 starting in 2020 and 2022, respectively, four monitoring wells (056-21, 056-22, 056-23, and 066-84) were re-incorporated into the routine (semiannual) groundwater monitoring program starting in calendar year (CY) 2023. These wells will continue to be sampled during CY 2025.

DESCRIPTION AND TECHNICAL BASIS

The WMF is designed to safely handle, repackage, and temporarily store Brookhaven National Laboratory (BNL)-derived waste prior to shipment to an off-site disposal or treatment facility. The WMF has been designed as a state-of-the-art facility, with administrative and engineered controls that meet all applicable federal, state, and local environmental protection requirements. Moreover, institutional controls such as spill prevention plans, operations management plans, maintenance, and personnel training ensure that the facility is operated in a manner that is protective of the environment and human health. The WMF currently consists of three buildings: Operations Building (Building 860), Reclamation Building (Building 865), and Resource Conservation and Recovery Act (RCRA) Waste Building (Building 855). The former Mixed Waste Building (Building 870) is no longer used for WMF operations. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.26.1 and 12.26.2.

In addition to administrative controls (e.g., procedures and contingency plans), engineering controls have been designed for these buildings and the outlying paved areas to ensure that any spills and leaks will be contained and detected prior to a release to the environment. Outdoor storage of hazardous or mixed waste only occurs within secondary containment. Sealed floors and isolated drainage areas mitigate potential accidental releases of liquid wastes in the Reclamation Building and the RCRA Building. All storage area floors are pitched inward to ensure that any spills remain inside the buildings.

For added protection, sealed concrete floors in liquid waste handling and storage areas are underlain by 20-mil. high-density polyethylene (HDPE) tertiary containment membranes with monitoring access pipes that can be used to determine whether any leakage occurs through the concrete from the storage cells.

Spills in paved areas would be mitigated by concrete curbs and isolated drainage. (Note: The drain at the east roadway exit from the yard adjacent to the Reclamation Building and the drain northeast of the Reclamation Building do not have isolation valves but lead to the stormwater system that discharges to the Recharge Basin HO-SPDES Outfall 003. This outfall is routinely monitored under the State Pollutant Discharge Elimination System [SPDES] permit).

There are no RCRA-regulated above or belowground tanks in the WMF. However, all above and belowground storage tanks that are used to store non-RCRA-regulated waste were designed, installed, and maintained in conformance with Article 12 of the Suffolk County Sanitary Code. The underground storage tanks at the Waste Reclamation building have never been used and there are no plans for their future use. These tanks have been officially taken out of service.

The WMF is located within two years of groundwater travel to BNL potable water supply Wells 11 and 12, which are just north of the WMF site. Because of the proximity of the WMF to Wells 11 and 12, it is imperative that the engineering and administrative controls discussed above ensure that waste handling operations at the WMF do not degrade the quality of the soils and groundwater in this area. The WMF groundwater monitoring program supplements the engineered and administrative controls by providing additional means of detecting potential contaminant releases from the WMF. The groundwater monitoring requirements are defined in the facility's RCRA Part B Permit.

To account for supply well pumping induced variations in groundwater flow pathways since the groundwater monitoring program was established in 1997, five new downgradient monitoring wells were installed in late 2007. The new wells were fully integrated into the WMF monitoring program in 2008. From 1997 through the fall of 2003, WMF monitoring wells were sampled quarterly for a wide variety of organic, inorganic, and radiological constituents. Monitoring results indicate that WMF operations have not impacted groundwater quality. Based on the low probability of an undetected release of either chemical or radiological contaminants from the WMF, the quarterly monitoring frequency was reduced to a semi-annual frequency in 2004.

The adequacy of the semi-annual groundwater monitoring program is based, in part, on the assumption that a low-volume contaminant release would slowly leach into the aquifer and not result in a rapid concentration increase between sample collection periods, and secondly, because the supply wells pump large volumes of water over a large area; considerable mixing of contaminated and uncontaminated water would result in the dilution of any contaminant(s). In accordance with the BNL Groundwater Protection Contingency Plan, the monitoring program will be reevaluated immediately if a significant contaminant release to the environment were to occur in the WMF area or if the monitoring wells within the WMF were to indicate that contaminants have been released from the facility due to a previously undetected spill or leak.

DRIVERS FOR MONITORING

_X_ Compliance
___ Support Compliance
___ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The collection of groundwater samples from wells located at the WMF is required to demonstrate that controls are effective in protecting groundwater quality by means of spill prevention and early detection. Outdoor storage of hazardous or mixed waste only occurs within secondary containment. Potential accidental releases of liquid wastes in the Reclamation Building, the RCRA Building, and the Mixed Waste Building are mitigated by sealed floors and isolated drainage areas. All storage area floors are pitched inward to ensure that any spills would remain inside the building. For added protection, sealed concrete floors in liquid waste handling and storage areas are underlain by HDPE tertiary containment membranes with monitoring access pipes that can be used to determine whether there has been any leakage through the concrete from the storage cells. Spills in paved areas would be mitigated by concrete curbs and isolated drainage. All liquid waste storage tanks were designed, installed, and maintained in conformance with Article 12 of the Suffolk County Sanitary Code.

Step 2: Identify the Decision

Are the operations of the WMF impacting groundwater quality? If so, do concentrations exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the WMF
- Direction and velocity of groundwater flow
- Contaminant concentrations in groundwater
- Locations of background and downgradient wells relative to known or potential source areas
- Regulatory requirements (DOE Order 458.1; NYSDEC RCRA Part B Permit)
- Action levels:
  - Detection of volatile organic compounds (VOCs) or radionuclides at concentrations exceeding levels outlined in the BNL Groundwater Contingency Plan
- Analytical methods and detection limits:
  - VOCs: EPA Method 524.2/624
  - Tritium: EPA Method 906
  - Gamma spectroscopy: EPA Method 901
  - Gross alpha/beta: EPA Method 900
  - Strontium-90: EPA Method 905 (optional analysis if required)
  - Anions: chlorates, sulphates, and nitrates
  - Metals: EPA Method 200 Series

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area immediately downgradient of the WMF. A decision period of 180 days is sufficient to provide a secondary means of verifying that the operational and engineered controls in place at the WMF are effective. This timeframe is based on the following considerations:

- As described above, the WMF has several engineered and operational controls that are designed to prevent releases of contaminants to the environment. A more frequent monitoring program can be implemented if a leak is found or suspected.

- The time required for small volumes of contaminants to migrate through the vadose zone and reach the groundwater table is likely to be 90 days or more. It is important to note that most waste materials that are stored at the WMF are not readily mobile in soils. (See waste profile descriptions in the RCRA Part B Permit, pages 99 through 113.) Once contaminants have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, typically within 50 to 100 feet of a storage building) is 130 days.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the release of contaminants to groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan (either response Action Level 2 or 3 of the plan) would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.26.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the release of contaminants to soils and groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination, potentially up to several hundred feet long, could exist and not be detected* (2) Need to re-sample well and resulting additional unplanned costs; potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and all operational and engineered controls (i.e., inventory resolution, leak detection, secondary containment) were to fail.

BNL potable water supply wells 11 and 12 are located immediately adjacent to the WMF. Although it is possible that a decision error could result in adverse consequences to human health, the WMF is designed and operated in a manner that eliminates or limits any potential contaminant release to the environment. In addition to the groundwater monitoring program, the supply wells are also routinely monitored for the contaminants of concern in accordance with Safe Drinking Water Act (SDWA) requirements. Because these supply wells draw water from a large area (i.e., zone of contribution), it is likely that low-level contamination would undergo considerable dilution before entering the water distribution system. Furthermore, groundwater pumped from the supply wells is treated by granular activated carbon filtration prior to distribution.

Consequences associated with decision errors for this program relate primarily to impacts to BNL's water supply and possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require the short-term or long-term shut down of the supply wells, and possible remedial actions under applicable New York State regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells are located as close as possible to potential WMF source areas to allow for early detection of contaminant releases (see Figure 12.26.1). When the WMF monitoring program began in 1997, the predominant groundwater flow pathway in the WMF area was to the north. This northerly flow pattern was the result of a significant groundwater mound below recharge basin HO located to the south of the WMF and significant pumpage from water supply wells 11 and 12 located to the north of the WMF. To accommodate this northerly flow pathway, four monitoring wells were positioned between waste storage facilities and the potable supply wells, with the four remaining wells positioned to detect potential contamination from upgradient sources (e.g., Building 830, Basin HO, and the AGS research complex). However, starting in 1997, there was a significant reduction in cooling water discharges to basin HO and restrictions were placed on prolonged pumpage of water from supply wells 11 and 12. This resulted in a return to a more natural southeasterly flow pathway in the WMF area. In late 2007, five new downgradient monitoring wells were installed to account for this change in groundwater flow direction. With increased pumpage of supply Well 11 starting in 2020 and the return to service of supply Well 12 in early 2022, significant variations in groundwater flow directions within the WMF area are anticipated. To account for periodic changes in groundwater flow directions when the supply wells are active, monitoring wells 056-21 and 056-22 were reincorporated into the monitoring schedule in 2021, and wells 056-23, and 066-84 were reincorporated into the monitoring program starting in 2022. Because the monitoring well network is designed to act as a secondary means of verifying proper facility operation, the current approved monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders.

Parameters and Frequency

Groundwater quality at the WMF area is evaluated using two upgradient and eight downgradient monitoring wells during a sample period. As described in the NYSDEC-approved groundwater monitoring plan for the WMF, the monitoring wells are sampled semi-annually. Samples are analyzed semi-annually for VOCs and radioactivity, and annually for anions and metals.

Table 12.26.2. Comparison of 2024 and 2025 Sampling Programs

Well	2024 Sampling Frequency	2025 Sampling Frequency	Affected Parameters
055-03 (Upgradient Well)	Semi-annual	Semi-annual	None
055-10 (Upgradient Well)	Semi-annual	Semi-annual	None
056-21 (Downgradient Well)	Semi-annual	Semi-annual	None
056-22 (Downgradient Well)	Semi-annual	Semi-annual	None
056-23 (Downgradient Well)	Semi-annual	Semi-annual	None
066-84 (Downgradient Well)	Semi-annual	Semi-annual	None
066-220 (Downgradient Well)	Semi-annual	Semi-annual	None
066-221 (Downgradient Well)	Semi-annual	Semi-annual	None
066-222 (Downgradient Well)	Semi-annual	Semi-annual	None
066-223 (Downgradient Well)	Semi-annual	Semi-annual	None
066-224 (Downgradient Well)	None (a)	None (a)	--

(a) Following the 2012 NYSDEC approval of the closure plan for the Mixed Waste building, this well is no longer sampled on a routine basis.

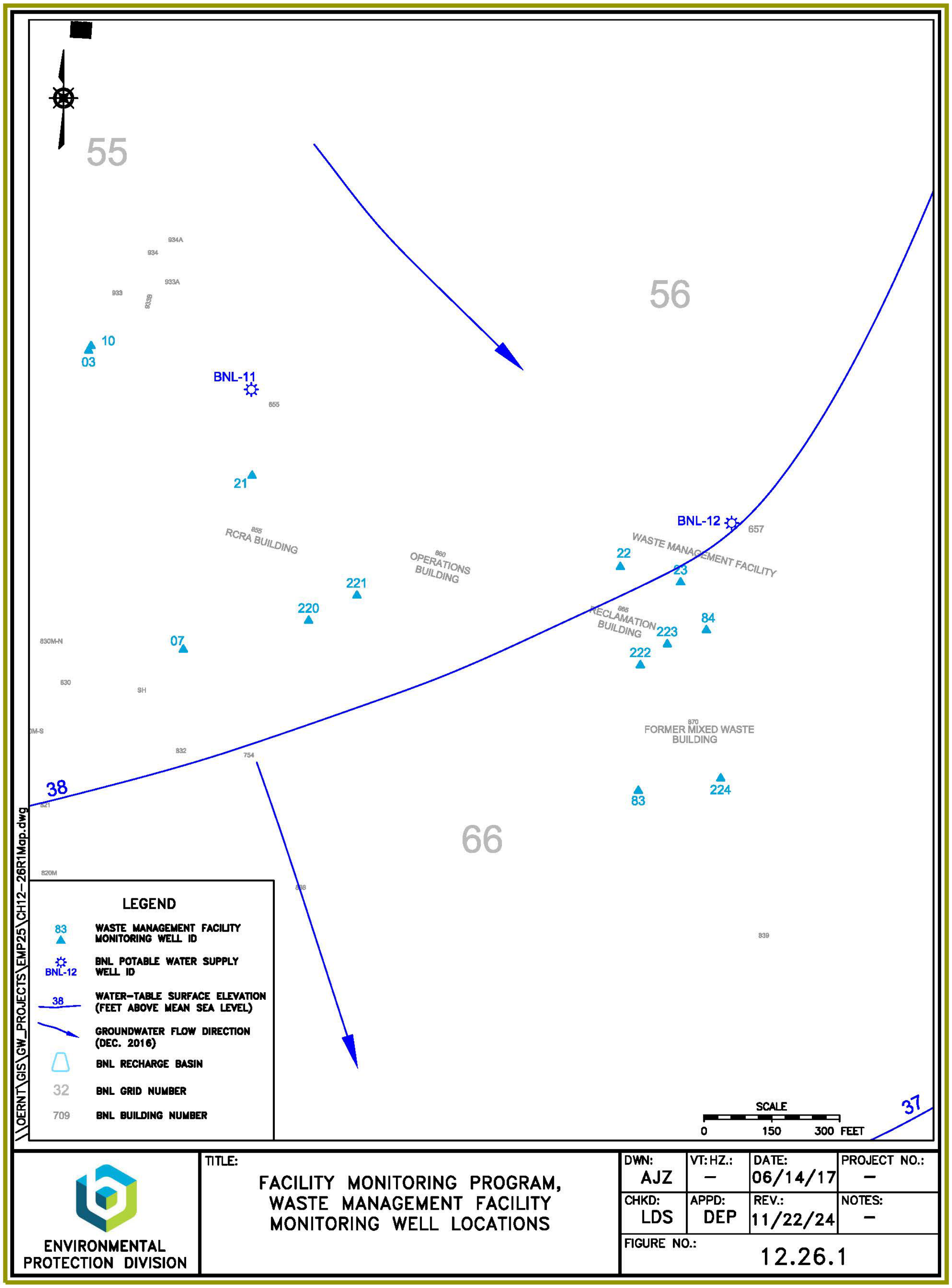

Figure 12.26.1 Facility Monitoring Program, Waste Management Monitoring Well Locations

12.27 GROUNDWATER MONITORING AT THE BROOKHAVEN MEDICAL RESEARCH REACTOR

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

The Brookhaven Medical Research Reactor (BMRR) groundwater monitoring wells were sampled every two years, with the last sampling of the wells occurring in 2022. Because tritium was not detected during the past three sample periods (2018, 2020, and 2022), the monitoring program was discontinued starting in 2024. The monitoring wells will continue to be maintained for potential post-decommissioning/demolition surveillance.

DESCRIPTION AND TECHNICAL BASIS

Tritium was detected in groundwater downgradient of the BMRR when the monitoring began in 1997, but at concentrations below the 20,000 pCi/L drinking water standard (DWS). Tritium concentrations declined from a maximum of 17,100 pCi/L in 1999 to <2,500 pCi/L since 2002. To date, no other potential BMRR-related radionuclides have been detected in groundwater. Some residual tritium remains in the vadose zone below the facility, and it is expected that some amount will migrate into groundwater by natural processes (i.e., water table fluctuation) over many years. Operational and engineered controls were implemented in 1997; since that time, all nuclear fuel was removed from the BMRR, and all primary cooling water lines were drained.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Following the discovery of tritium in groundwater downgradient of the High Flux Beam Reactor (HFBR) in 1997, Brookhaven National Laboratory (BNL) installed groundwater monitoring wells at the BMRR to evaluate any potential impacts to groundwater quality. Tritium was detected at concentrations up to 17,100 pCi/L in several of the monitoring wells directly downgradient of the BMRR facility. A 1997 review of systems and operations within the BMRR facility identified two potential sources for the tritium detected in groundwater: (1) spills that occurred during the transfer of radioactive liquids to a former aboveground storage tank, and (2) a floor drain system and associated sump that had received primary cooling water on several occasions. Primary coolant contained tritium at a concentration up to 465 µCi/L. Although small-volume releases occurred while transferring liquids to an outdoor storage tank on several occasions, the most likely source for the tritium detected in groundwater is primary cooling water discharges to the floor drain system and an associated unlined 150-gallon SU-2 sump in the basement of the BMRR.

Reactor operations records indicated 16 spills or discharges totaling nearly 800 gallons of primary water to the floor drains or directly to the SU-2 sump. The last such discharge occurred in January 1987. Although most of the primary water that was discharged was properly disposed, qualitative leak-rate testing conducted in 1997 indicated that the sump and/or floor drain piping system were not entirely leak tight and some amount of radioactive water may have leaked to the underlying soils. Furthermore, until 1997, secondary (nonradioactive) coolant water was routinely discharged to the SU-2 sump and floor drain system. Leakage of secondary water could have provided sufficient water volume to drive the tritium through the unsaturated zone and into the groundwater beneath the reactor building.

To prevent potential future releases of radioactive materials to the soils and groundwater below the BMRR, the floor drain system was abandoned in 1997. BNL also sealed the SU-2 sump and a plastic container was installed in the sump pit. A liquid sensor installed in the sump is used to detect the presence of any liquids outside the plastic container. In addition, the BMRR facility has been designated for decommissioning and demolition. Issues related to the decommissioning and demolition are not addressed in this Data Quality Objective (DQO). All nuclear fuel was removed from the facility and the activated primary cooling water was drained in 2005.

Following the removal of the fuel and primary cooling water, continued groundwater surveillance was conducted to evaluate periodic small-scale releases of residual tritium from the vadose zone beneath the reactor facility. Based on an average groundwater flow velocity of 0.75 feet per day, the travel time from the point where contaminants may enter the soils below the reactor building, migrate through the vadose zone, and travel to the monitoring wells is likely to be greater than 100 days. Since 2002, tritium concentrations in groundwater have been <2,500 pCi/L. No other reactor-related radionuclides were detected in the groundwater. Tritium was not detected in groundwater samples collected during 2018, 2020 and 2022.

Step 2: Identify the Decision

Are the controls effective at eliminating further discharges to soils and groundwater below the BMRR (i.e., are performance objectives met)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include the following:

- Maintenance of reactor structure and future decontamination and decommissioning activities
- Direction and velocity of groundwater flow
- Regulatory driver (DOE Order 458.1)
- Action levels, as described in the BNL Groundwater Protection Contingency Plan
- Analytical methods and detection limits:
  - Tritium: EPA Method 906

Step 4: Define the Study Boundaries

The decision for this program applies to the area in the immediate vicinity of the BMRR facility. Until 2022, the period for which the individual decisions was 730 days (every two years), based on the following factors:

- Tritium was not detected in groundwater samples collected during 2018, 2020, and 2022.
- Currently, there are no pathways for new releases of tritiated water. (Note: The primary cooling water system was drained in 2005.)
- No other reactor-related radionuclides have been detected in groundwater.
- There are no nearby drinking water supply wells.

Because tritium was not detected in groundwater samples collected in 2018, 2020, and 2022, the BMRR monitoring program is being discontinued.

Step 5: Develop the Decision Rules

Are the controls effective at eliminating further discharges to soils and groundwater below the BMRR?

Because tritium was not detected in groundwater samples collected in 2018, 2020, and 2022, it is likely that the amount of residual tritium in the vadose zone below the BMRR has declined to negligible levels. Therefore, the BMRR monitoring program is being discontinued starting in 2024. The monitoring wells will be maintained for potential post-decommissioning/demolition surveillance.

Step 6: Specify Acceptable Error Tolerances

Table 12.27.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of radionuclides to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to ~400 feet long and 30 feet wide could exist and not be detected* (2) Need to re-sample well (as per Groundwater Protection Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and operational and engineered controls (i.e., leak detection or secondary containment) were to fail. Note, however, that the primary cooling water system was completely drained in 2005.

There are no potential receptors immediately downgradient of the BMRR. Travel time to the nearest current potential downgradient receptor is greater than ten years. Furthermore, most homes south of BNL have been connected to public water. Contaminant concentrations have historically not exceeded the DWS and are not expected to exceed them in the future because the BMRR operations ended in 2000. The nuclear fuel has been removed and activated primary cooling water was removed during 2005. As discussed above, tritium was not detected in groundwater samples collected in 2018, 2020, and 2022. Therefore, it is very unlikely that decision error will result in adverse consequences to human health. The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions.

Step 7: Optimize the Design

Number and Locations of Wells

Three of the BMRR wells are biased toward surveillance of groundwater quality immediately downgradient of the facility. One well is immediately upgradient of the BMRR. The monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders (see Figure 12.27.1). Because the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small in area, the number and locations of the wells are sufficient to properly monitor the facility.

Parameters and Frequency

The four BMRR surveillance wells were monitored semi-annually from 1997 through 2004, with samples tested for tritium, gross alpha, gross beta, gamma spectroscopy, and occasionally for Sr-90. Because tritium was not observed at concentrations above the DWS, and declining concentration trends, the frequency of monitoring was reduced to annually starting in 2005 and then biannually starting in 2007. Because tritium was not detected during the 2018, 2020, and 2022 sample periods, monitoring of the BMRR wells was suspended starting in 2024. See Table 12.27.2 for a comparison of the 2024 and 2025 monitoring programs.

Table 12.27.2. Comparison of 2024 and 2025 Monitoring Programs

Well	2024 Sampling Frequency	2025 Sampling Frequency	Affected Parameters
084-12	None (a)	None	Tritium
084-13	None (a)	None	Tritium
084-27	Nonel (a)	None	Tritium
084-28	None (a)	None	Tritium

(a): Sampling of the BMRR wells was suspended starting in 2024.

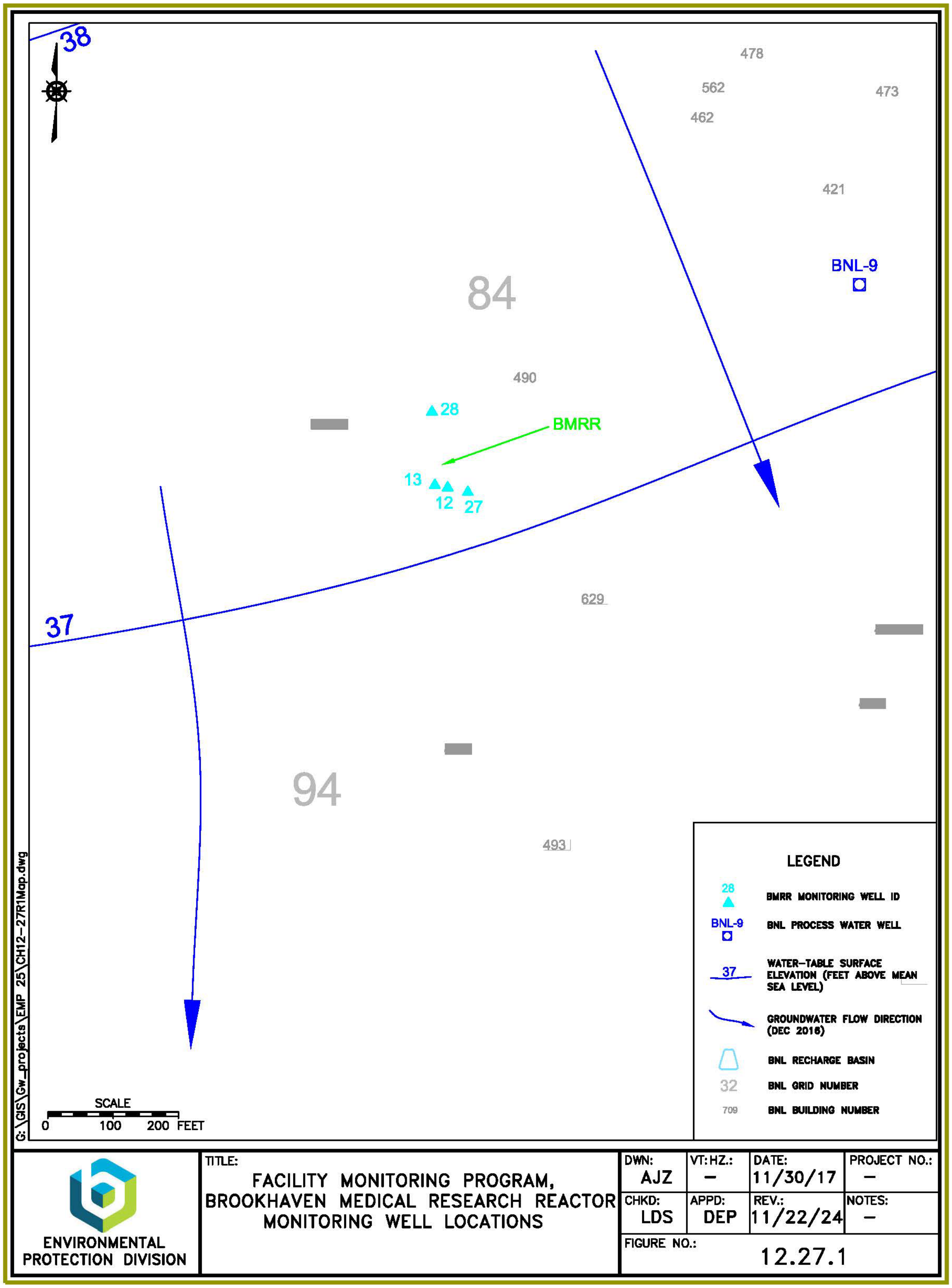

Figure 12.27.1 Facility Monitoring Program BMRR Well Locations

See Appendix B for the monitoring program for this DQO.

12.28 GROUNDWATER MONITORING AT THE SEWAGE TREATMENT PLANT

DQO START DATE January 1, 2003

Implementation Date January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year 2025 for the groundwater monitoring program at the Sewage Treatment Plant (STP).

DESCRIPTION AND TECHNICAL BASIS

The monitoring program for the STP is conducted in accordance with BNL's State Pollutant Discharge Elimination System (SPDES) permit. In the fall of 2014, STP effluent discharges were directed away from the Peconic River to newly constructed recharge basins. In addition to directly monitoring the STP effluent, the groundwater monitoring program evaluates potential impacts that the effluent may have on specific metals concentrations in the groundwater near the filter beds. The groundwater sampling parameters and frequencies are defined in the SPDES permit. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.25.1 and 12.25.2.

DRIVERS FOR MONITORING

_X_ Compliance
___ Support Compliance
___ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The STP processes sanitary sewage for BNL facilities at an average of 0.72 million gallons per day (MGD) during non-summer months and approximately 1.25 MGD during summer months. Treatment of the sanitary waste stream includes primary treatment to remove settleable solids and floatable materials, aerobic oxidation for secondary removal of the biological matter and nitrification of ammonia, and secondary clarification. Oxygen levels are regulated during the treatment process; nitrogen can be biologically removed using nitrate-bound oxygen for respiration.

Water goes through a final treatment step at the STP filter building and is then discharged to the new recharge basins (SPDES Outfall 001). The discharge is regulated under NYSDEC SPDES permit #1-4788-00032/00072.

Two emergency holding ponds are used for the emergency storage of sanitary waste in the event of an upset condition or if the influent contains contaminants in concentrations exceeding BNL administrative limits and/or SPDES permit effluent release criteria. The holding ponds are equipped with fabric-reinforced plastic liners that are heat-welded along all seams. The first lined holding pond was constructed in 1978 and has a capacity of approximately four million gallons. A second four-million-gallon lined pond was constructed in 1989. The combined capacity of nearly eight million gallons enables BNL to divert all sanitary system effluent for approximately 12 days. As part of the Phase III STP Upgrades project in 2001, the original single liners were replaced with double liners and an integrated leak detection system.

Groundwater samples are used to demonstrate that operational and engineered controls are effective in protecting groundwater quality. These controls include the following:

- BNL has developed a comprehensive pollution prevention program, which includes worker education on proper use and disposal of hazardous materials. These programs are integrated into the BNL Standards-Based Management System (SBMS).

- In accordance with BNL's current SPDES permit, the Laboratory carefully monitors the effluent from the STP and is the primary means of ensuring that BNL's engineered and operational controls are working.

Step 2: Identify the Decision

Are the operations of the STP impacting groundwater quality? If so, do concentrations exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the STP
- Direction and velocity of groundwater flow
- Sampling parameters and frequencies defined in the SPDES permit
- Locations of background and downgradient wells
- Regulatory requirements (DOE Order 458.1; DOE Order 436.1A; NYS SPDES Permit)
- Action levels, as described in the BNL Groundwater Contingency Plan
- Analytical methods and detection limits: Metals
- Nature of use of emergency holding ponds

Step 4: Define the Study Boundaries

The decision boundaries for this monitoring program apply to the area in the immediate vicinity of the STP facility, with specific emphasis on the new recharge basin area and the existing emergency holding ponds. The new SPDES permit issued in 2014 requires the collection of groundwater samples annually to determine the concentrations of specific metals (e.g., copper, iron, lead, mercury, nickel, silver, and zinc). The sampling frequency for the monitoring program is adequate based on the following:

- Influent and effluent of the STP are carefully monitored. A more frequent monitoring program can be implemented if a significant contaminant release to the sanitary system is discovered or suspected.

- Groundwater monitoring has generally demonstrated that STP operations are not significantly affecting groundwater quality in the area. All VOC, radionuclide, and anion concentrations have been below applicable water quality standards. Some metals, such as sodium, are occasionally detected at concentrations slightly above standards. However, prior testing detected the corrosion inhibitor TTA in the groundwater downgradient of the STP at concentrations that exceeded the NYS Ambient Water Quality Standard of 0.5 mg/L. BNL is no longer using TTA as a corrosion inhibitor.
- Once contaminants have migrated to groundwater, the travel time from the STP area to the site boundary is estimated to be greater than ten years. Although there is a potential for contaminated groundwater originating from the recharge basin areas to enter the Peconic River via groundwater discharge during certain hydrologic conditions, the time of travel is likely to be more than 180 days.
- There are no drinking water supply wells near the STP.
- The double liners and integrated leak detection system installed in the emergency holding ponds significantly reduce the risk of leaks of contaminated water that may be diverted to the ponds.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the introduction of contaminants to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan or SPDES required notifications would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.28.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the discharge of contaminants to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 300 feet long could exist and not be detected* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and one or more operational and engineered controls (i.e., SPDES monitoring, leak detection, secondary containment) were to fail.

There are no potable water supply wells immediately downgradient of the STP area, although during certain hydraulic conditions (i.e., seasonal water table rises), local groundwater can discharge into the nearby Peconic River. Groundwater travel time from the STP area to the BNL eastern boundary is greater than ten years and most residences east of BNL have been connected to public water. Therefore, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions under applicable NYS regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells are as close as possible to the recharge basins and holding ponds to enable early detection of contaminant releases (see Figures 12.28.1). The monitoring program consists of one upgradient and six downgradient wells near the recharge basins. Three of the wells are near the emergency holding ponds. The monitoring network will be adequate for meeting the acceptable risk levels of stakeholders.

Parameters and Frequency

As defined in the SPDES permit, the six wells monitoring the recharge basin area are sampled annually (see Table 12.28.2). The groundwater samples are analyzed for total metals with the following metals being reported to NYSDEC under the SPDES permit: copper, iron, lead, mercury, nickel, silver, and zinc.

Table 12.28.2. Comparison of 2024 and 2025 Sampling Programs – SPDES Monitoring Program

Well	2024 Sampling Frequency	2025 Sampling Frequency	Affected Parameters
039-87(a)	Annual	Annual	None
039-88 (b)	Annual	Annual	None
039-89 (b)	Annual	Annual	None
048-08 (b)	Annual	Annual	None
048-09 (b)	Annual	Annual	None
048-10 (b)	Annual	Annual	None
039-115 (b)	Annual	Annual	None
039-90 (c)	None	None	---

(a) Upgradient well for recharge basin area
(b) Well sampling required by SPDES permit
(c) Holding pond monitoring well, not monitored under SPDES permit. Sampled as needed for surveillance program.

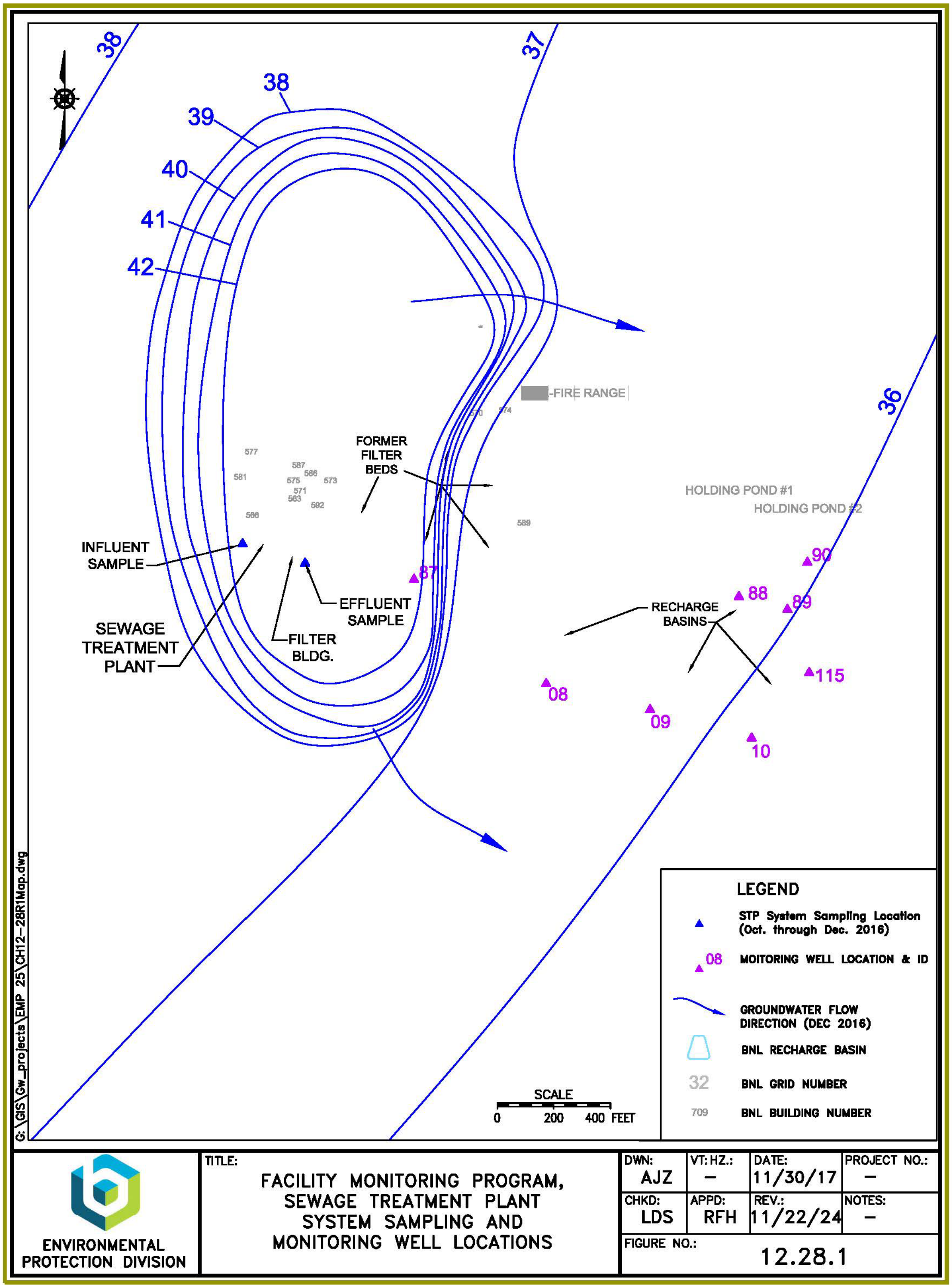

Figure 12.28.1 Sewage Treatment Plant System Sampling and Monitoring Well Locations

See Appendix B for the monitoring requirements for this Data Quality Objective.

12.29 GROUNDWATER MONITORING AT THE BNL MOTOR POOL FACILITY

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year 2025 for the groundwater monitoring program at the Motor Pool Facility.

DESCRIPTION AND TECHNICAL BASIS

In 1996, BNL installed two monitoring wells downgradient of the gasoline Underground Storage Tanks (USTs). Data from these wells indicate that current fuel storage and dispensing operations are not impacting groundwater quality. In 1999, the Laboratory installed six additional monitoring wells to evaluate the potential impact to groundwater quality from two oil spills. Although the monitoring results indicated that the two oil spills had not impacted groundwater quality, the degreasing agent 1,1,1-trichloroethane (TCA) and several gasoline by-products were observed.

Based on solvent handling and spill controls that have been in effect for the past 20 years, these contaminants are likely to have originated from historical small-scale spills resulting from vehicle maintenance activities. Semi-volatile organic compounds (SVOCs) were not detected in any samples, and sampling for these compounds was discontinued in 2002.

Although low levels of several VOCs continue to be detected in some Motor Pool area wells, since 2012 all VOC concentrations have been less than applicable drinking water standards. Starting in 2017, only wells 102-05 and 102-06, which monitor the underground storage tank area, will continue to be sampled. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.25.1 and 12.25.2.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Potential environmental concerns at the Motor Pool include the historical and current use of USTs for the storage of gasoline and waste oil, hydraulic fluids used for lift stations, and the use of solvents for parts cleaning. In August 1989, the USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms. Following the removal of the old USTs, there were no obvious signs of soil contamination. The present tank inventory includes two 8,000-gallon USTs used for the storage of unleaded gasoline, one 260-gallon UST for waste oil, and one 3,000-gallon UST for No. 2 fuel oil. The facility also has five vehicle-lift stations. In 2002, the petroleum-based hydraulic fluid for the lifts was replaced with a vegetable-based product.

In December 1996, BNL removed an underground propane tank near the Site Maintenance Facility (Building 326). During this removal, the surrounding soils had a distinct petroleum staining and smell. The soil was contaminated from a previously unknown oil spill. Although approximately 60 cubic yards of contaminated soil were removed, there was clear evidence that contaminated soil remained. In February 1998, it was discovered that hydraulic fluid was leaking from one of the lift stations in Building 423. The lift was excavated and approximately 50 cubic yards of contaminated soil were removed. In response to a New York State Department of Environmental Conservation (NYSDEC) request, the Laboratory installed six new monitoring wells in the Motor Pool (Building 423/326) area to evaluate the potential impacts of the two spills.

Groundwater monitoring is conducted to verify that the operational and engineered controls are effective in protecting groundwater quality. These controls include:

- All USTs, pump islands, and associated piping conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms.
- BNL maintains an inventory/accounting of gasoline stored in USTs at the Motor Pool.

Step 2: Identify the Decision

The decision for this monitoring program is:

Are the operations of the Motor Pool impacting groundwater quality? If so, do concentrations exceed water quality standards at the point of assessment (i.e., the closest downgradient well)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the Motor Pool
- Direction and velocity of groundwater flow
- VOC concentrations in groundwater
- Floating product determination measurements
- Locations of background and downgradient wells relative to known or potential source areas
- Regulatory requirements (DOE Order 436.1A [2023])
- Action levels (as described in the Groundwater Contingency Plan)
- Analytical methods and detection limits
  - VOCs (EPA Method 524.2)

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the Motor Pool/Site Maintenance Buildings. The period for which decisions are made is 365 days. This timeframe is based on the following:

- The USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms. A more frequent monitoring program can be implemented if a leak is found or suspected. Vegetable-based products replaced petroleum-based hydraulic fluids in the vehicle lift stations, and all solvents are properly used, stored, and disposed of.

- The time required for contaminants from small-scale petroleum hydrocarbon spills and solvent spills to migrate through the vadose zone and reach the groundwater table is likely to be 30 or more days.

- Once contaminants have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, approximately 20 feet from the USTs or historical spill areas) is 30 days.

- Fifteen years of monitoring data have confirmed that the current operational and engineered controls have been effective. Therefore, decision periods of 365 days are sufficient to provide a secondary means of verifying that the current controls are effective, and to evaluate ongoing impacts from historical solvent, oil, and gasoline spills.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the introduction of petroleum hydrocarbons and solvents to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.29.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching lead to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 480 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and all operational and engineered controls (i.e., inventory resolution, leak detection, secondary containment) were to fail.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of the Motor Pool area. Travel time from the Motor Pool area to the BNL southern boundary is greater than 15 years, and most residences south of BNL have been connected to public water. Therefore, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions under New York State regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells at the Motor Pool are biased toward detecting contamination that could originate from the UST area and petroleum-contaminated soils associated with the spills discussed above (see Figure 12.29.1). The wells are as close as possible to these potential source areas to enable early detection of any contaminant releases. The current monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders. Because the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small, no refinements are recommended. Since 2017, only wells 102-05 and 102-06, which monitor the underground storage tank area, have continued to be sampled.

Parameters and Frequency

Groundwater quality at the Motor Pool/Site Maintenance Facility area has been evaluated using monitoring wells that were installed during 1997-1999. Therefore, more than 15 years of analytical data are available to assess potential impacts from current operations and historical spills. Although low levels of several VOCs continue to be detected in some Motor Pool area wells, since 2012 all VOC concentrations have been less than applicable drinking water standards.

Groundwater samples are collected on an annual basis and are analyzed for VOCs. Floating product determination measurements are conducted in wells downgradient of the USTs.

Table 12.29.2. Comparison of CY 2024 and CY 2025 Sampling Programs

Well ID	2024 Sampling Frequency	2025 Sampling Frequency	Affected Parameters
102-05	Annual (a)	Annual (a)	None
102-06	Annual (a)	Annual (a)	None

(a): Wells downgradient of the USTs are also checked for floating product (FP).

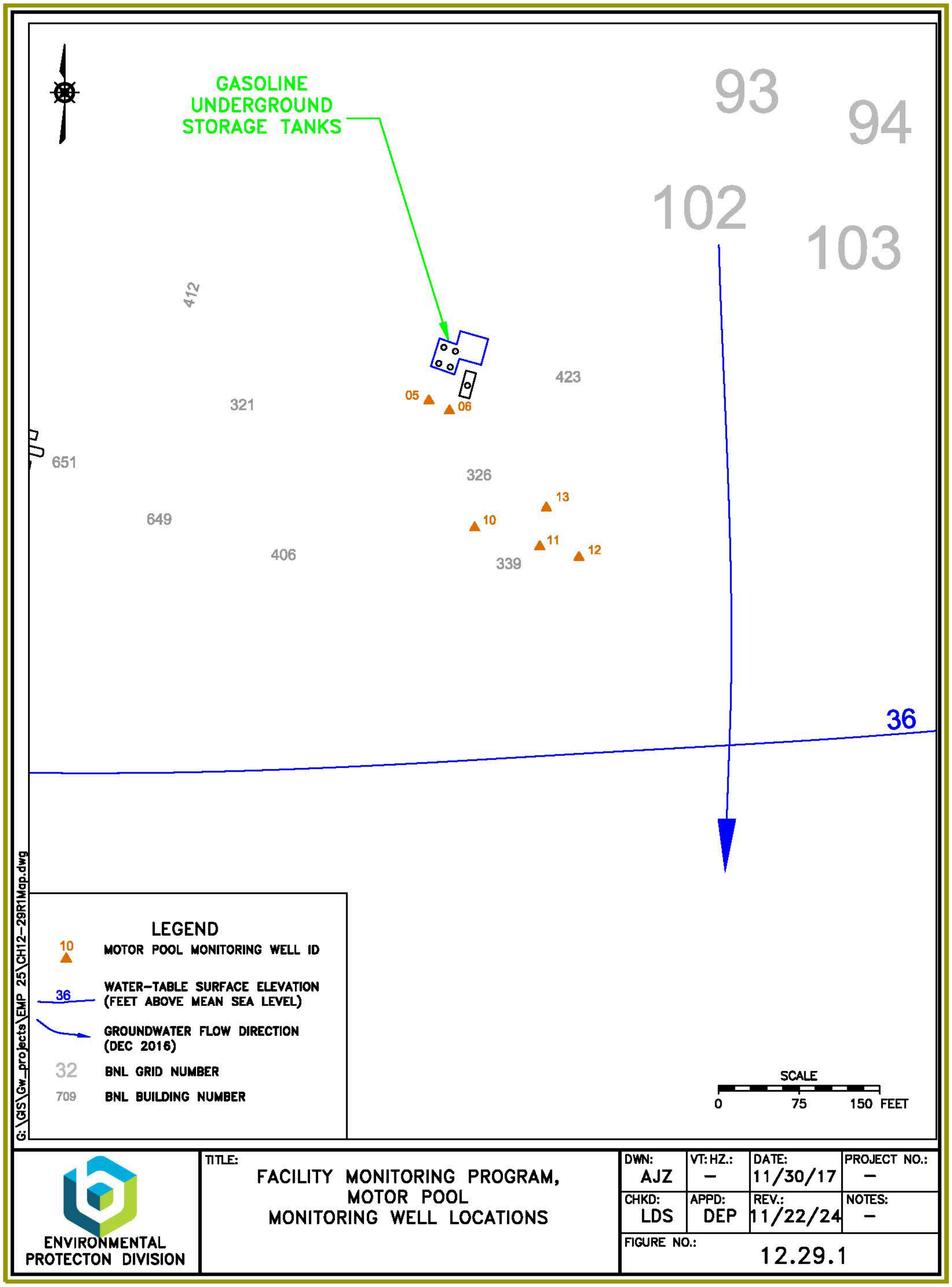

Figure 12.29.1 Facility Monitoring Program, Motor Pool Monitoring Well Locations

See Appendix B for the monitoring requirements for this Data Quality Objective.

12.30 GROUNDWATER MONITORING AT THE UPTON SERVICE STATION

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

DESCRIPTION AND TECHNICAL BASIS

In 2018, car repair and fueling operations at the Service Station were discontinued, and the underground gasoline and waste oil storage tanks were removed. Groundwater monitoring at the facility was discontinued in 2019. No groundwater samples will be collected during 2025.

Parameters and Frequency

Prior to the facility's decommissioning, groundwater quality at the service station was evaluated using the four monitoring wells listed below.

Table 12.30.1. Comparison of 2024 and 2025 Sampling Programs at the Upton Service Station

Well	2024 Sampling Frequency	2025 Sampling Frequency	Affected Parameters
085-17	None	None	----
085-235	None	None	----
085-236	None	None	----
085-237	None	None	----

12.31 GROUNDWATER MONITORING AT THE MAJOR PETROLEUM FACILITY

DQO START DATE January 1, 2003

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year 2025 to the Major Petroleum Facility (MPF) groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

In accordance with the New York State (NYS) operating license for the MPF, Brookhaven National Laboratory (BNL) routinely monitors groundwater quality downgradient of the MPF's bulk oil storage tanks. The monitoring program was initiated in the 1980s with five wells. Three additional wells were installed in 1999. In accordance with the operating license, the MPF wells are monitored semi-annually for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), and monthly for floating petroleum products. To date, no fuel-related compounds or floating products have been detected. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.25.1 and 12.25.2.

DRIVERS FOR MONITORING

_X_ Compliance
____ Support Compliance
____ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The MPF is the holding area for fuels used at the Central Steam Facility (CSF). Fuel oil for the CSF is held in a network of seven aboveground storage tanks, two of which are currently inactive. All fuel storage tanks are in bermed containment areas that have a capacity to hold >110 percent volume of the largest tank within each bermed area. The bermed areas have bentonite clay liners consisting of either Environmat (consisting of bentonite clay sandwiched between geotextile materials) or bentonite clay mixed into the native soils to form an impervious soil/clay layer. Nevertheless, there is a potential that small-scale leakage from the base of the tanks may go undetected.

The collection of groundwater samples from wells downgradient of the bulk storage area is required to demonstrate that current operational and engineered controls are effective in protecting groundwater quality. These controls include:

- The fuel storage tanks are connected to the CSF by aboveground pipelines that have secondary containment and leak detection devices.
- All fuel storage tanks are in bermed containment areas that have a capacity to hold >110 percent of the volume of the largest tank within each bermed area.
- The bermed areas have bentonite clay liners consisting of either Environmat (consisting of bentonite clay sandwiched between geotextile materials) or bentonite clay mixed into the native soils to form an impervious soil/clay layer.
- All fuel unloading operations were consolidated in one centralized building that has secondary containment features.
- BNL maintains an accurate inventory/accounting of fuel oil stored at the MPF.

Step 2: Identify the Decision

The decision for this monitoring program is:

Are the operations of the MPF impacting groundwater quality? If so, do concentrations exceed water quality standards at the point of assessment (i.e., the closest downgradient well(s)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the MPF
- Direction and velocity of groundwater flow
- SVOC concentrations in groundwater
- Floating product determination measurements
- Locations of background and downgradient wells relative to known or potential source areas
- Regulatory requirements: New York State Department of Environmental Conservation (NYSDEC) operating permit
- Action levels: detection of floating petroleum on the water table, or detection of SVOCs at concentrations exceeding levels outlined in the BNL Groundwater Contingency Plan
- Analytical methods and detection limits (as described in the Environmental Monitoring Plan)
- VOCs (EPA 8260)
- SVOCs (EPA Method 8270)
- Fuel inventory records

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediately downgradient of the MFP. A decision period of 180 days is sufficient to provide a secondary means of verifying that the operational and engineered controls in place at the MPF are effective. This timeframe is based on the following:

- As described above, the MPF has several engineered and operational controls that are designed to prevent leakage of fuel oil to the environment. The monitoring frequency for the wells can be increased if a leak is found or suspected.

- The time required for contaminants from small-scale petroleum hydrocarbons to migrate through the vadose zone and reach the groundwater table is likely to be 90 or more days.

- Once contaminants have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, approximately 100 feet from the tanks) is on the order of 130 days.
- The MPF is outside the five-year capture zone for the BNL potable water supply wells.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the introduction of petroleum hydrocarbons to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.31.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the release of contaminants to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 200 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and all operational and engineered controls (i.e., inventory resolution, leak detection, secondary containment) were to fail.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of the MPF area. Groundwater travel time from the MPF area to the BNL southern boundary is greater than 15 years, and most residences south of BNL have been connected to public water. Therefore, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions under applicable NYS regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells are as close as possible to potential MPF source areas to enable early detection of contaminant releases (see Figure 12.31.1). The current approved monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders. Because the groundwater flow direction has been relatively constant in this area in recent years, and the potential source is relatively small, no refinements are recommended.

Parameters and Frequency

Groundwater quality at the MPF area is evaluated using eight monitoring wells. Multiple rounds of analytical data are available to assess potential impacts from past and current operations. No impacts from MPF operations have been observed to date. Low levels of several VOCs (e.g., 1,1,1-TCA) are occasionally detected in several MPF wells at concentrations exceeding the New York State Ambient Water Quality Standard (NYS AWQS) of 5 µg/L. These contaminants are thought to have originated from historical solvent spills near the CSF.

In accordance with the NYSDEC operating permit, groundwater samples are required to be collected on a semi-annual basis for VOCs (by EPA Method 8260) and SVOCs (by EPA Method 8270), and the wells are checked monthly for the presence of floating petroleum.

Table 12.31.2. Comparison of 2024 and 2025 Sampling Programs

Well	2024 Sampling Frequency	2025 Sampling Frequency	Affected Parameters
076-16	Semi-annual	Semi-annual (a)	None
076-17	Semi-annual	Semi-annual (a)	None
076-18	Semi-annual	Semi-annual (a)	None
076-19	Semi-annual	Semi-annual (a)	None
076-25	Semi-annual	Semi-annual (a)	None
076-378	Semi-annual	Semi-annual (a)	None
076-379	Semi-annual	Semi-annual (a)	None
076-380	Semi-annual	Semi-annual (a)	None

(a) Monitoring wells are also checked monthly for floating petroleum

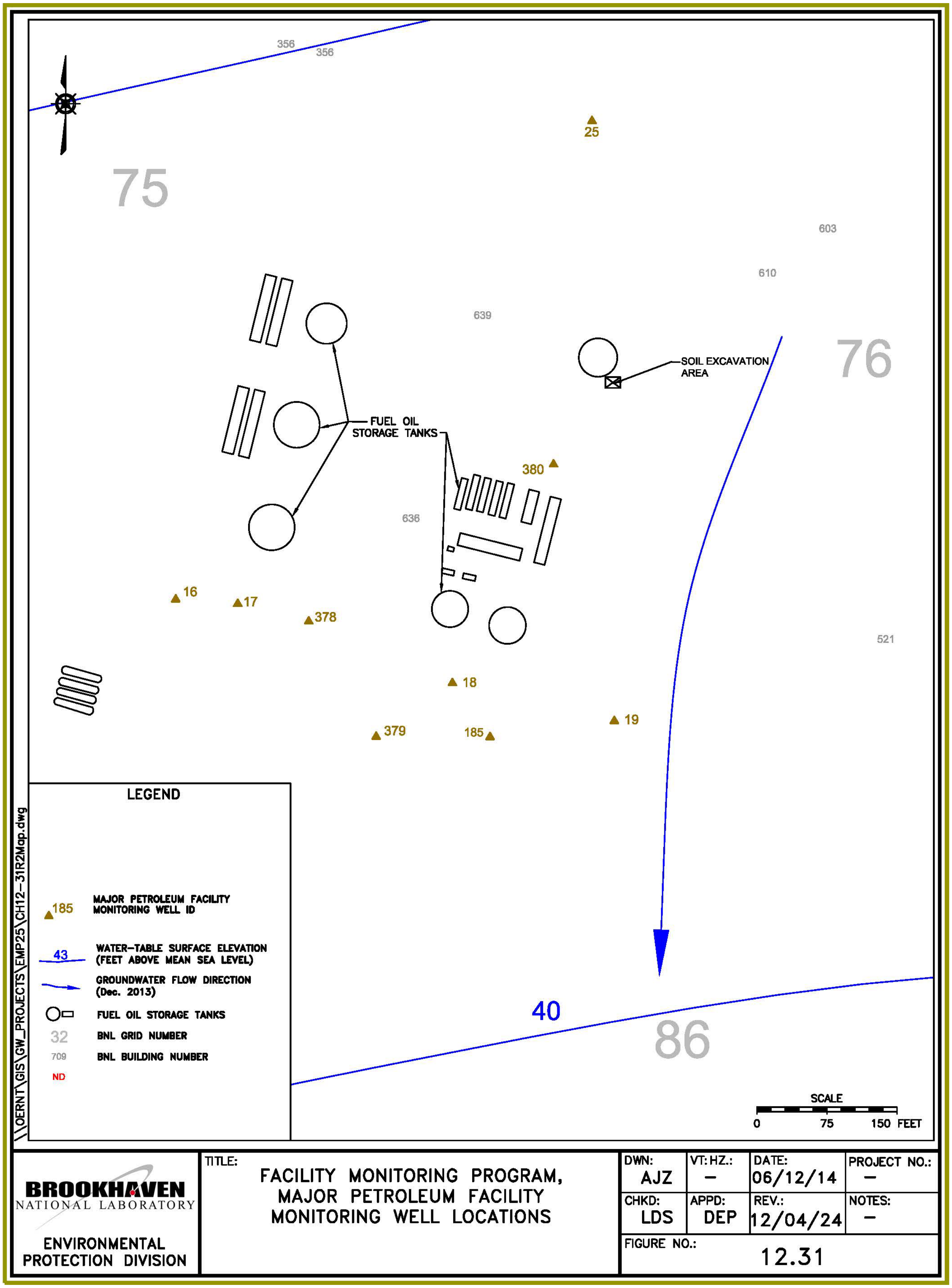

Figure 12.31.1 Upton Service Station Monitoring Well Locations

See Appendix B for the monitoring requirements for this Data Quality Objective.

12.32 GROUNDWATER MONITORING FOR THE G-2 TRITIUM SOURCE AREA

DQO START DATE January 2, 2008

IMPLEMENTATION DATE January 1, 2025

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year 2025 for the g-2 Tritium Source Area monitoring program.

DESCRIPTION AND TECHNICAL BASIS

In November 1999, tritium was detected in the groundwater near the g-2 experiment at concentrations above the 20,000 pCi/L drinking water standard. Sodium-22 was also detected in the groundwater, but at concentrations well below the 400 pCi/L drinking water standard. An investigation into the source of the contamination revealed that the tritium and sodium-22 originated from activated soil shielding located adjacent to the g-2 target building where approximately five percent of the beam was inadvertently striking the beamline's VQ12 magnet. Rainwater was able to infiltrate the activated soils and carry tritium and sodium-22 into the groundwater.

To prevent additional rainwater infiltration into the activated soil shielding, a concrete cap was constructed over the soil shielding in December 1999. Other corrective actions included refocusing the beam and improved beam loss monitoring to reduce additional soil activation, stormwater management improvements, and additional groundwater monitoring. The g-2 experiment concluded its operations in 2001. The highest tritium concentration was detected during 2002 at 3,440,000 pCi/L.

Following the concurrence from the New York State Department of Environmental Conservation (NYSDEC), a Record of Decision (ROD) was signed by the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA) in early 2007. This ROD requires continued routine inspection and maintenance of the impermeable cap, groundwater monitoring of the source area to verify the continued effectiveness of the storm water controls. Tritium concentrations in source area wells have been less than 40,000 pCi/L since 2015. Monitoring of the source area will continue for as long as the activated soils remain a potential threat to groundwater quality. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.25.1 and 12.25.2.

DRIVERS FOR MONITORING

___ Compliance
___ Support Compliance
X Surveillance
X Restoration/IAG

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Although the cap and other stormwater controls appear to be effectively protecting the activated soils, long-term monitoring is required to verify the continued effectiveness of these controls. Monitoring data indicates that natural fluctuations in the position of the water table periodically flush small amounts of residual tritium that remains close to the water table. The amount of residual tritium will be reduced by this flushing mechanism and by natural radioactive decay. For the past several years, tritium concentrations in surveillance wells located immediately downgradient of the source area were <20,000 pCi/L.

Step 2: Identify the Decision

Are the engineered controls employed at the g-2 source area effective at preventing additional leaching of tritium from the activated soil shielding? Furthermore, are the tritium concentrations in groundwater declining at the rate and within the geographical area predicted by groundwater modeling?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells
- Regulatory requirements: g-2/BLIP/UST ROD, DOE Order 458.1
- Action levels:
  - As defined in the g-2/BLIP/UST ROD, Brookhaven National Laboratory (BNL) will determine whether additional remedial actions are required if future tritium levels exceed 1,000,000 pCi/L in groundwater immediately downgradient of the g-2 source area.
- Analytical methods and detection limits:
  - Tritium: EPA Method 906

Note: The focus of the current monitoring program is on evaluating changes in tritium concentrations in groundwater immediately downgradient of the g-2 source area. Because tritium is more mobile than sodium-22 and has a longer half-life (12.6 years compared to 2.3 for sodium-22), the presence of tritium in groundwater is a better early indicator of a failure in an engineered storm water control. Based upon past results, it is expected that detectable levels of sodium-22 would only be observed in groundwater immediately downgradient of activated soil shielding source areas.

Step 4: Define the Study Boundaries

The decision for the g-2 source area monitoring program applies to the nearest monitoring wells, which are located near Building 912A, between 275 to 300 feet downgradient of the source. The period for which decisions are made is 90 days. This timeframe is based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.

- Once tritium has migrated into the groundwater, the tritium migrates at the same rate as groundwater (approximately 0.75 feet/day). The travel time between the source area and the nearest downgradient wells (near Building 912A) is expected to be approximately 365 days.

- Decision periods of 180 days are acceptable for the g-2 source area where historical monitoring has demonstrated that groundwater quality has already been significantly impacted. A decision period of 180 days is required to continually evaluate the effectiveness of engineered controls designed to prevent additional storm water infiltration.

Step 5: Develop the Decision Rules

Are engineered controls effective at preventing the leaching of radionuclides from activated soils to the groundwater? Is the plume attenuating at the rate and within the geographic area predicted by groundwater modeling?

The sample results are evaluated in context with historical data and the contingency requirements defined in the ROD. In accordance with the ROD, DOE will determine whether additional remedial actions are required for the g-2 source area or plume control if future tritium levels exceed 1,000,000 pCi/L within any section of the g-2 plume. Tritium concentrations in g-2 monitoring wells have not exceeded 1,000,000 pCi/L since January 2003, and tritium concentrations in source area wells have not exceeded 40,000 pCi/L since 2015. Monitoring has demonstrated that tritium concentrations currently decrease to less than 20,000 pCi/L via natural radioactive decay and dispersion entirely within the AGS area. The monitoring results are also evaluated in accordance with the BNL Groundwater Contingency Plan (EM-SOP-309).

Step 6: Specify Acceptable Error Tolerances

Table 12.32.1. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium from the g-2/VQ12 activated soil shielding to the groundwater?	See Step 3 for inputs	(1) Data indicate that source controls are effective when they are not. (2) Data indicate source controls are not effective when they are because of sampling or analytical error or wells not properly located.	(1) A slug of contamination potentially up to 100 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well and resulting additional unplanned costs. Potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

Although the g-2 source area is within a two-year capture zone of BNL potable supply Well 10, tritium concentrations in the g-2 source area have been less than 40,000 pCi/L since 2015. With the low tritium concentrations currently detected in groundwater, combined with dispersion and natural radioactive decay, it is unlikely that a decision error will result in adverse consequences to human health. Consequences associated with (short-term) decision errors for this program relate primarily to possible enforcement actions for continued environmental degradation, erosion of stakeholder trust, and loss of BNL credibility.

Parameters and Frequency

The g-2 source area are monitored as follows:

- Five downgradient wells located near Building 912A are sampled semiannually for tritium (Table 12.32.2). These are the closest wells downgradient of the g-2 source area.

- Ten wells located immediately downgradient of Building 912 are sampled annually for tritium as part of the AGS monitoring program (see Table 12.26.2). These wells are used to verify that tritium originating from the g-2 source area attenuates to <20,000 pCi/L by the time the impacted groundwater migrates past Building 912.

Table 12.32.2 below shows a comparison of the 2024 and 2025 monitoring program of the permanent wells.

Table 12.32.2. Comparison of 2024 and 2025 Monitoring Program – Permanent Wells

Well	Monitoring Sub-Area	2024 Sampling Frequency	2025 Sampling Frequency	Affected Parameters
054-65	Bkgd. g-2	Annual	Annual	None
054-07	g-2/VQ12 source	Semiannual	Semiannual	None
054-184	g-2/VQ12 source	Semiannual	Semiannual	None
054-185	g-2/VQ12 source	Semiannual	Semiannual	None
064-95	g-2/VQ12 source	Semiannual*	Semiannual*	None
054-126	g-2/VQ12 source	Semiannual	Semiannual	None

* Access to well 064-95 is periodically restricted because it is within a posted radiation area when AGS/RHIC is in operation.

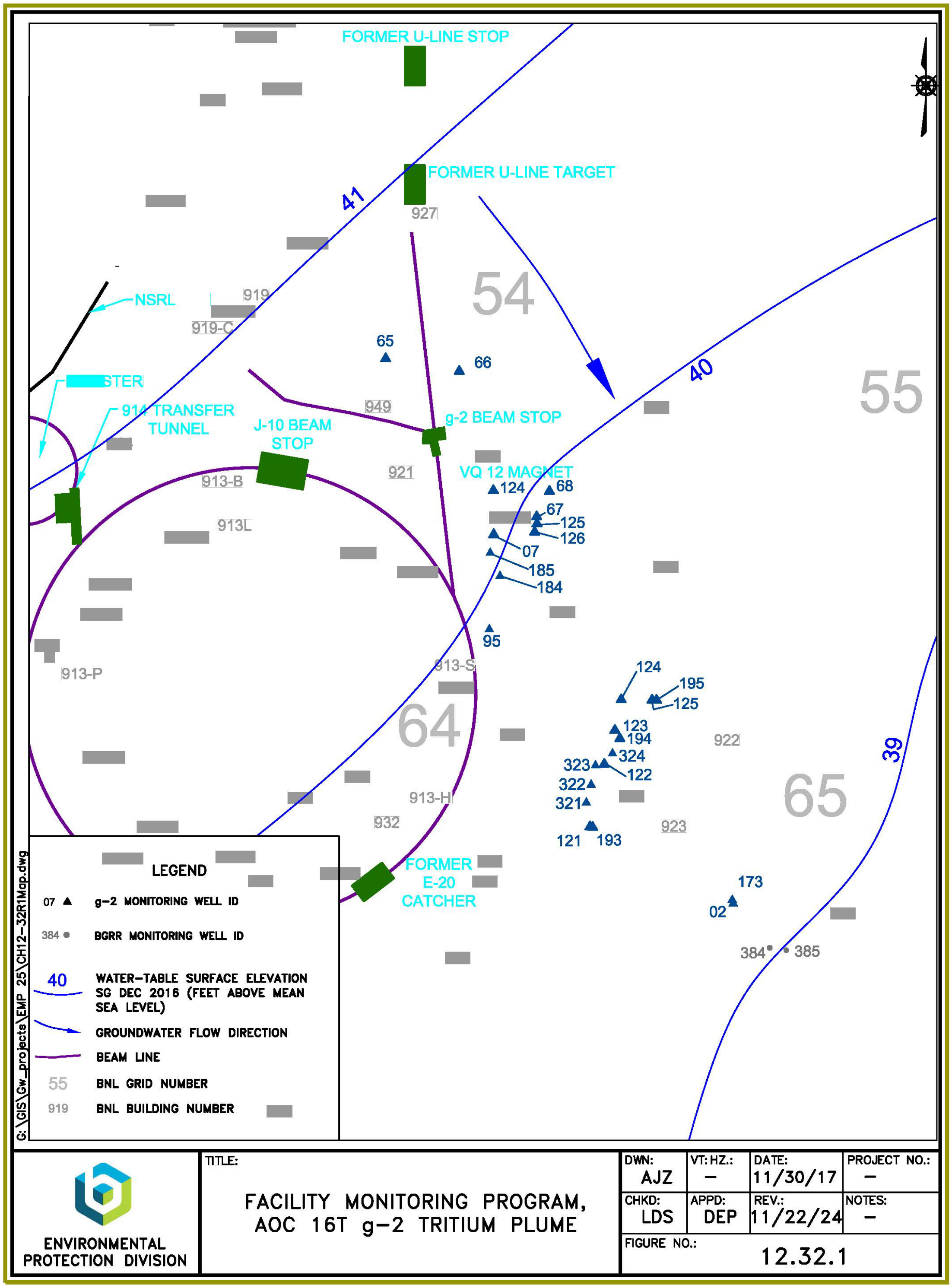

Figure 12.32.1 AOC 16T g-2 Tritium Plume

12.33 Groundwater Monitoring at the National Synchrotron Light Source II (NSLS-II)

DQO START DATE January 1, 2012

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

For calendar year 2025, continue annual sampling of the wells that monitor the National Synchrotron Light Source II (NSLS-II) beam loss areas. However, discontinue sampling upgradient wells 076-18 and 076-19 located at the Major Petroleum Facility because sufficient data have been collected from these wells to verify that tritium is not present in the shallow groundwater upgradient of the NSLS-II facility.

DESCRIPTION AND TECHNICAL BASIS

Brookhaven National Laboratory (BNL) installed four downgradient monitoring wells to evaluate the effectiveness of the engineered and operational controls designed to protect groundwater quality near anticipated low-level activated soil shielding at the NSLS-II linear accelerator (Linac)/Booster facility. The Linac/Booster facility began startup testing operations in 2012, and full-facility operations began in late 2014. The interaction of neutrons with the soils below the tunnel floor and surrounding soil shielding (berm) have the potential to create very low levels of tritium and Na-22 in the adjacent soil shielding. There is also the potential to create very low levels of tritium in the water used to cool the magnets and other accelerator components. Monitoring well sampling frequency and methods of analysis are summarized in Tables 12.25.1 and 12.25.2.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

High-energy particle interactions in water, air, and soil can produce radioactivity from spallation reactions or neutron capture in nitrogen, oxygen, or other materials. In high-energy proton accelerators, such as BNL's Alternating Gradient Synchrotron (AGS) and the Relativistic Heavy Ion Collider (RHIC), these interactions can produce significant environmental issues. However, electron accelerators, such as the NSLS-II, have significantly reduced potential for environmental impacts and can produce only about one to five percent of the induced activity of a proton accelerator.

Soil Activation: Although light source facilities throughout the world have not been found to create radiological environmental issues, analyses as required by the BNL Standards-Based Management System (SBMS) *Accelerator Safety* Subject Area have been conducted to estimate the rate of formation of tritium (^3H) and sodium-22 (^{22}Na) in the surrounding soils during the operation of the NSLS-II Linac, Booster, and Storage Ring.

In the calculations, the neutron source inside the accelerators is assumed to be at 1.2 m from the floor and 2 m from the inboard wall. The floor is 0.51 m of standard concrete in the Linac. A minimum concrete wall of 0.5 m is assumed before soil is encountered beyond the side walls. Using the methodology established in the BNL SBMS *Accelerator Safety* Subject Area, the leachable concentration created in the soil has also been calculated. Based upon published reports, it is assumed that nearly 100 percent of tritium and 7.5 percent of the Na-22 can be leached from activated soils by rainwater infiltration. A water concentration factor of 1.1 is taken due to the annual rainfall of 55 cm. (Note, the soil beneath the concrete floor is not exposed to rainfall, so the potential leaching of radioactive isotopes from the soil to the water table at these locations will be minimal.)

Table 12.33.1. Predicted Activity in NSLS-II Soil at Beam Loss Locations

Soil Loca-tion	Electron Loss (nC/s)	Electron Loss(e/s)	Neutron Flux ($n/cm^2.s$)	Neutron Flux (Av) ($n/cm^2.s$)	^3H (pCi/L)	^3H Leacha-ble (pCi/L)	^{22}Na (pCi/L)	^{22}Na Leacha-ble (pCi/L)
Linac Dump 230MeV	22	1.37E11	4.4E2	92	0.54	0.60	5.2	0.39
Linac Slit 230MeV	11	6.86E10	2.2E2	46	0.41	0.46	3.9	0.29
Booster Dump 3 GeV	15	9.36E10	3.9E3	815	4.83	5.31	46.7	3.50

Assumptions:

200 times per year the Linac and Booster are used to fill the Storage Ring from scratch. Each fill cycle lasts three minutes. Total operating time is 200 x 3 min = 10 hours.

500 hours per year of Linac and Booster study.

5,000 hours of top-off operation, 3 pulses per minute operation, effective hours of operation = 5,000 x 180/3,600 = 250 hours.

500 hours per year of operation for each beam dump and 760 hours of operation for the Linac slit.

These calculated values are well within the BNL-defined administrative Action Levels of 1,000 pCi/L for tritium and 100 pCi/L for sodium-22 (defined in the BNL *Accelerator Safety* Subject Area). Therefore, no additional engineered safeguards are required.

As a monitoring tool for soil activation levels near the Linac, about one-liter soil samples are positioned within the Linac enclosure near predicted high-loss points. These soil samples are tested periodically to estimate the buildup of sodium-22 and tritium in the surrounding soils. In addition, analysis of groundwater samples from wells installed downgradient of the Linac beam stop/Booster area are used to demonstrate that the operational and engineered controls at the NSLS-II are effective in protecting groundwater quality.

Cooling Water Activation: Activation of water used to cool the magnets and other accelerator components is estimated by a similar method. The primary reactions leading to the activation of cooling water are the bremsstrahlung interactions with ^{16}O in water. In the Linac, the highest beam loss point in a component with water cooling is the first bending magnet downstream of the Linac. Of the nuclides of concern for groundwater protection, tritium will attain saturation only after decades of operation. After 5,000 hours of continuous operation, the concentration of tritium in the Storage Ring Septum area will be only three percent of the saturation value, with an estimated concentration of only 5 pCi/L. Other smaller loss points, including the Linac bending magnet, will provide additional small increments to the total inventory of tritium within the system. The cooling water system will be tested periodically for tritium once operations have begun.

Step 2: Identify the Decision

Are the operational and engineered controls employed at NSLS-II effective at preventing the release of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest wells downgradient of the identified potential soil activation areas at the Linac)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the NSLS-II
- Modeled estimates on the amount of soil activation at Linac beam loss areas
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells relative to each identified soil activation area
- Regulatory requirements: DOE Order 458.1, Radiation Protection of the Public and the Environment
- Action levels (as described in the BNL Groundwater Protection Contingency Plan)
- Analytical methods and detection limits:
  - Tritium: Environmental Protection Agency (EPA) Method 906
  - Gamma spectroscopy (optional analysis if tritium is detected): EPA Method 901

During 2011, the focus of the NSLS-II groundwater surveillance program was the collection of pre-operation samples to establish baseline values for tritium and Na-22. Following the initial beam line testing operations during 2012, only tritium is being analyzed because it is more mobile than sodium-22 and has a longer half-life (12.6 years compared to 2.6 years). Therefore, tritium's presence in groundwater would be a better early indicator of a failure in an engineered control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the NSLS-II Linac and Booster. The period for which decisions are made is 365 days. These timeframes are based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.

- Once tritium migrates into the groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, ranging from 150 to 350 feet from the potential sources) is approximately 300 to 700 days.

- Decision periods of 365 days are acceptable for areas where monitoring has demonstrated that current engineered and operational controls are effective.

Step 5: Develop the Decision Rules

Are the engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soils to the groundwater?

The sample results are evaluated in context with historical groundwater data, including data from upgradient wells, operations of the Linac/Booster area, and measured and estimated radioactivity buildup in soil shielding. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.33.2. Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium and soium-22 from activated soil shielding to the groundwater?	See Step 3 for inputs.	Data indicate controls are effective when they are not.	A discrete slug of contamination potentially up to 100 feet long and 20 feet wide could exist and not be detected.*
		Data indicate controls are not effective when they are, due to sampling or analytical error, or wells not properly located.	Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

There are no potential receptors (i.e., potable water supply wells) to potentially contaminated groundwater in the NSLS-II Linac/Booster area and the distance to the BNL property boundary is over one mile. Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health or the environment. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial action under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or other regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells located at the NSLS-II are biased toward detecting contamination originating from activated soils associated with the facility's Linac/Booster area (Figure 12.33.1). The wells are located as close as possible to these potential source areas to enable early detection of contaminant releases. The monitoring network installed in 2011 is considered adequate for meeting the monitoring requirements under DOE Order 458.1 and acceptable risk levels of stakeholders.

Parameters and Frequency

Groundwater quality in the NSLS-II Linac/Booster area is evaluated using four downgradient monitoring wells. Until 2023, two upgradient wells from the Major Petroleum Facility monitoring program were used to evaluate background tritium levels. Because tritium is easily leached from activated soils, is highly mobile in groundwater, and has a longer half-life (12.3 years compared to 2.6 for sodium-22), the primary focus of the operations phase of the groundwater monitoring program is the detection of tritium. Groundwater samples are collected on an annual (365 day) basis. Should tritium be detected in any of the wells, samples could also be tested for the presence of Na-22. Table 12.33.3 below shows a comparison of the 2024 and 2025 sampling programs.

Table 12.33.3. Comparison of 2024 and 2025 Sampling Programs

Well ID	CY 2024 Sampling Frequency	CY 2025 Sampling Frequency	Affected Parameters
076-18 (a)	Annual	None	Tritium
076-19 (a)	Annual	None	Tritium
086-123	Annual	Annual	None
086-124	Annual	Annual	None
086-125	Annual	Annual	None
086-125	Annual	Annual	None

(a) Well is part of the MPF monitoring program and was previously sampled to determine background tritium concentrations for the NSLS-II monitoring program.

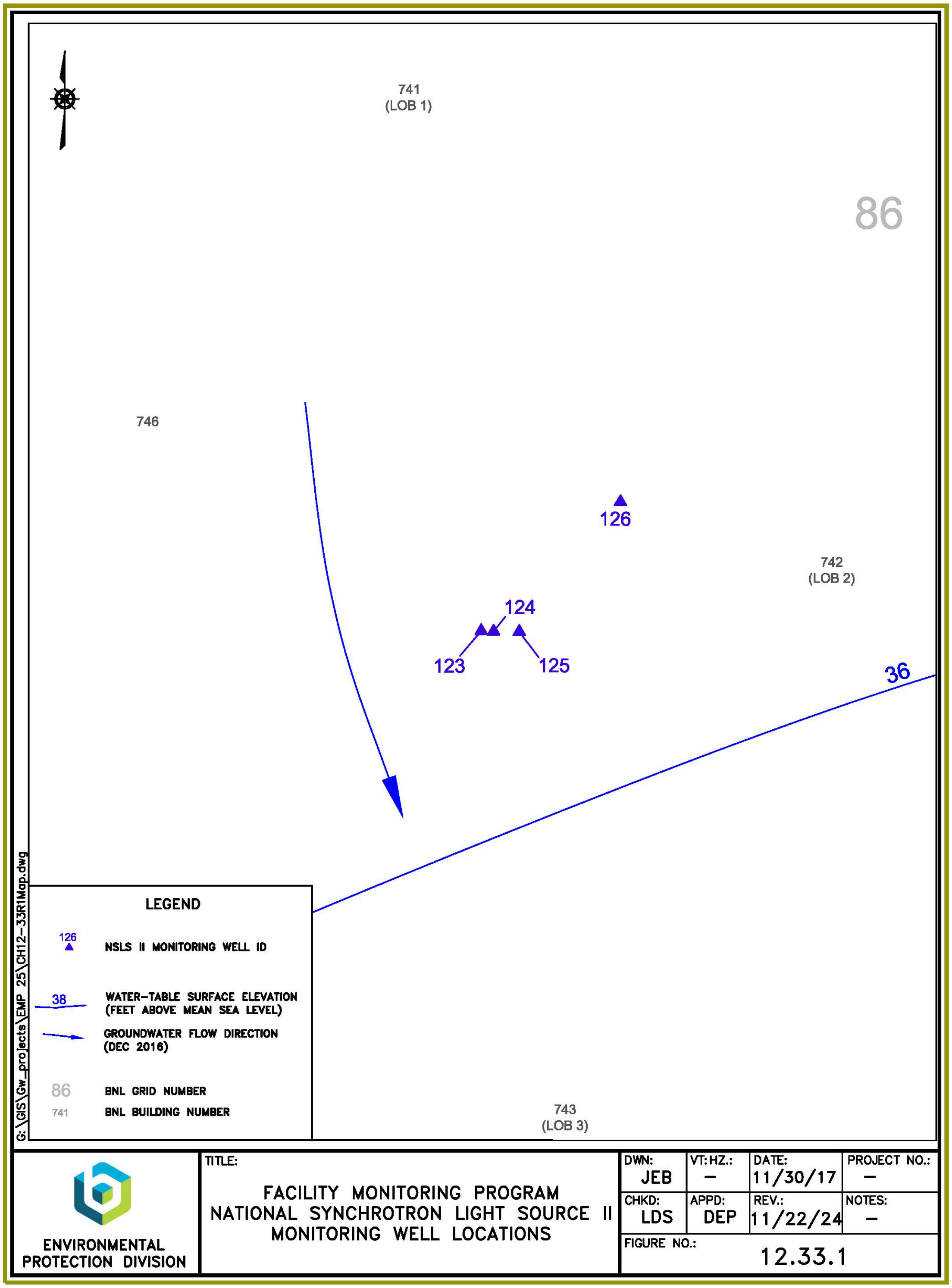

Figure 12.33.1 Facility Monitoring Program National Synchrotron Light Source II Monitoring Well Locations

See Appendix B for the monitoring program for this Data Quality Objective.

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12.34 OU X Former Firehouse Groundwater Treatment System

DQO START DATE January 1, 2023

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

Routine groundwater sampling activities related to the Former Firehouse polyfluoroalkyl substances (PFAS) treatment system began in January 2023. The monitoring program uses 42 wells to evaluate the effectiveness of the groundwater treatment system to remediate PFAS that were released to soil during firefighter training activities from 1966 through 1985. In addition to testing for PFAS, samples from select wells are also analyzed for 1,4-dioxane, which originated from the releases of the solvent 1,1,1-trichloroethane (TCA) in areas upgradient of the Former Firehouse (e.g., the Alternating Gradient Synchrotron [AGS]) and downgradient (e.g., the former Building 208 vapor degreaser facility).

DESCRIPTION AND TECHNICAL BASIS

Following the 2017 detections of PFAS in the BNL supply wells, BNL identified eight areas where Aqueous Film Forming Foam (AFFF) had been released to the ground during the period of 1966 through 2008. The available records indicated that routine firefighter training with foam occurred in three areas, at the Former Firehouse facility, at the Current Firehouse facility and at a former training area located west of BNL dormitory Building 170. Starting in 2018, BNL began a multiphase characterization effort to evaluate the impacts from the foam releases. High levels of PFAS were detected downgradient of the Former Firehouse training areas, with two PFAS chemicals, perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), detected at concentrations up to 5,210 ng/L and 736 ng/L, respectively. The New York State (NYS) drinking water standards for PFOS and PFOA is 10 ng/L. National drinking water standards for PFOS (4 ng/L), PFOA (4 ng/L), and several other PFAS were promulgated during 2024.

The Former Firehouse (former Building 99) was in operation from 1947 through 1985. Available records indicate that firefighting foam was used for training as early as 1966. Firefighters practiced with foam primarily in a training area that was located immediately west of the firehouse. A second training area was located east of the firehouse, where firefighters would periodically practice extinguishing car fires using foam. There are no available records on foam formulations or on the amount used at the Former Firehouse. Most of the training area that was located to the west of the firehouse is presently occupied by Building 725 (currently used by the Computational Science Initiative), which was constructed in the early 1980s. The Former Firehouse structure was demolished in March 1986. Following demolition, low-level radiologically contaminated soils were excavated from this area. These actions were documented in the OU III ROD (AOC 22).

Although there is no known use of solvents at the Former Firehouse that could have released 1,4-dioxane, documented releases of TCA had occurred in upgradient areas in the AGS facility located to the north-northwest. Furthermore, TCA was released from the former Building 208 degreasing facility that was in an area currently occupied by the National Synchrotron Light Source II. Solvents (primarily tetrachloroethylene) had also been released in the former Building 96 area, also located south of the Former Firehouse.

The Former Firehouse Treatment System consists of three groundwater extraction wells and a liquid phase granular activated carbon (GAC) treatment system located in a new treatment building, identified as Building 557 on the south side of Building 598. The treatment system started operations in January 2023. Treated water from the GAC filtration system is recharged to the RA V recharge basin. The OU10 Former Firehouse groundwater monitoring program consists of a network of 42 wells located near and south of the Former Firehouse (Figure 12.34.1).

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater in the vicinity of the Former Firehouse has been impacted by the release of AFFF that contained PFAS. In 2022, a groundwater remediation system was constructed to treat PFAS originating from the former foam training areas. The data obtained from this monitoring program will be used to verify the effectiveness of the treatment system to remediate the aquifer and to prevent further downgradient migration of the plume.

Step 2: Identify the Decision

The decisions for the project are:

- Were unexpected levels or types of contamination detected?
- Is the groundwater remediation system effectively capturing the PFAS plumes as expected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are PFOS/PFOA concentrations in plume core wells above or below 100 ng/L?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Analytical results for PFAS using EPA Method 1633
- Analytical results for 1,4-dioxane in select wells using Method 8270D SIM
- Locations of the groundwater monitoring wells (Figure 12.34.1)
- Regulatory drivers that will be defined in the OU X Record of Decision (ROD)
- Action levels (NYS drinking water or groundwater standards or national drinking water standards once they have been promulgated)
- Up to 10 percent of the data analyzed by contract analytical laboratories will be validated using guidance provided from BNL EM-SOP-212, Chemical Data Validation, and U.S. Department of Defense, Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by

QSM Table B-24, October 2022, or latest revision.

Step 4: Define the Study Boundaries

The project geographical limits are defined by the map boundaries depicted on Figure 12.34.1.

Separate decisions will be made in the monitoring subunits (e.g., core, perimeter, and bypass wells) described in the Former Firehouse Groundwater Treatment System O&M Manual. However, some of the decisions, such as system performance, are based on the entire system. The temporal boundaries of the study area may vary, based on the decision.

- *Plume Source Area:* Due to the need for frequent data collection during the system startup period, the timeframe for decisions for this subunit is 90 days.

- *Downgradient Plume Core and Perimeter:* The wells in this subunit define the plume horizontally, which is used to determine whether the plumes are being captured. Because the treatment system has only been in operation since January 2023, the appropriate timeframe for decisions is 180 days. The timeframe will likely be reduced to 90 days after the treatment system has been in operation for several years.

- *Bypass Detection Area:* The wells in this area indicate whether the plume capture performance objective is being met. Because the treatment system has only been in operation since January 2023, the timeframe for decisions is 180 days. The timeframe will likely be reduced to 90 days after several years of operation.

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Note: The decision rules discussed below are to be considered preliminary until the final cleanup objectives are defined in the OU X Record of Decision (ROD).

Decision 1

Were unexpected levels or types of contaminants detected?

The sample results will be evaluated in context with available characterization data gathered since 2018. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be determined. Examples of such circumstances are unusually high contaminant concentrations, including detection of previously undetected contaminants that could impact treatment system operations (e.g., detection of high levels of 1,4-dioxane that could result in exceeding the treatment system discharge limit).

If the types or concentrations of contaminants detected in any well could impact treatment system operations, and their presence and concentrations are confirmed by resampling, **then** implement actions as prescribed in the BNL Groundwater Contingency Plan.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in PFOS and/or PFOA concentrations in plume perimeter or bypass detection wells to above the 100 ng/L capture goal (if currently less than 100 ng/L).

Note: The downgradient extent of the PFAS plume will be further characterized as part of the planned OU X Remedial Investigation. Plume migration is currently being contained near East Princeton Avenue by one extraction well.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

To shut down the treatment system, the shutdown criteria of reaching less than 100 ng/L PFOS and PFOA for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Note: The shutdown criteria for this system may be modified following the Remedial Investigation/Feasibility Study.

Decision 4

Are PFOS or PFOA concentrations in plume core wells above or below 100 ng/L?

If the PFOS and PFOA concentration in each plume core well has been reduced to less than 100 ng/L, **then** proceed with pulsed operation of the system. **If not, then** continue full-time operation.

4a. Is there a significant concentration rebound in core wells and/or extraction wells following pulsed-pumping operations?

If yes, then continue treatment system operations. **If no** significant rebound is observed within a one-year period, then petition for system shutdown, maintain the system in an operationally ready mode, and continue with monitored natural attenuation (MNA).

Decision 5

Has the groundwater cleanup goal of meeting MCLs been achieved?

If PFOS and PFOA concentrations in all plume core wells are less than the 10 ng/L NYS MCL (or national standards once promulgated) over the previous two years and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system closure. If not, then consider the need for continued remediation.

Table 12.34.1 summarizes the decision and possible decision errors for this project.

Table 12.34.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation longer than necessary, wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues, ultimate project delays. (2) Wasted resources, project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff, potential to have to restart system. (2) Continue remediation that is no longer effective.
Have the groundwater cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

Step 7: Optimize the Design

Number and Locations of Wells

The 42 wells are shown on Figure 12.34.1.

Parameters and Frequency

The goal for CY 2025 is to continue sampling ten source area wells for PFAS on a quarterly basis and the remaining 32 wells for PFAS. Eleven select wells will also be sampled for 1,4-dioxane on a semiannual basis. A summary of the CY 2025 sampling program for this project is shown in Table 12.34.2.

Table 12.34.2. Proposed 2025 Sampling Frequency for the Former Firehouse Groundwater Treatment System Monitoring Wells

Well	Sampling Frequency	Analytical Parameters
075-87	Semiannually	EPA 1633 PFAS
075-809	Quarterly	EPA 1633 PFAS
075-810	Quarterly	EPA 1633 PFAS
075-811	Quarterly	EPA 1633 PFAS
085-43	Semiannually	EPA 1633 PFAS
085-384	Semiannually	EPA 1633 PFAS
085-350	Semiannually	EPA 1633 PFAS
085-404	Quarterly	EPA 1633 PFAS
085-405	Quarterly	EPA 1633 PFAS
085-406	Quarterly	EPA 1633 PFAS
086-123	Semiannually	EPA 1633 PFAS
085-407	Quarterly	EPA 1633 PFAS
085-408	Quarterly	EPA 1633 PFAS
085-409	Quarterly	EPA 1633 PFAS
085-410	Quarterly	EPA 1633 PFAS
085-411	Semiannually	EPA 1633 PFAS
085-412	Semiannually	EPA 1633 PFAS
095-170	Semiannually	EPA 1633 PFAS
095-171	Semiannually	EPA 1633 PFAS
096-84	Semiannually	EPA 1633 PFAS
096-115	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
096-117	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
096-118	Semiannually	EPA 1633 PFAS
096-122	Semiannually	EPA 1633 PFAS
096-123	Semiannually	EPA 1633 PFAS
096-124	Semiannually	EPA 1633 PFAS
096-125	Semiannually	EPA 1633 PFAS
096-126	Semiannually	EPA 1633 PFAS
096-127	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
096-128	Semiannually	EPA 1633 PFAS
096-129	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
096-130	Semiannually	EPA 1633 PFAS
096-131	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
105-43	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
105-44	Semiannually	EPA 1633 PFAS
105-72	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
105-73	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
105-74	Semiannually	EPA 1633 PFAS
105-75	Semiannually	EPA 1633 PFAS
105-76	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
105-77	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
105-78	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS

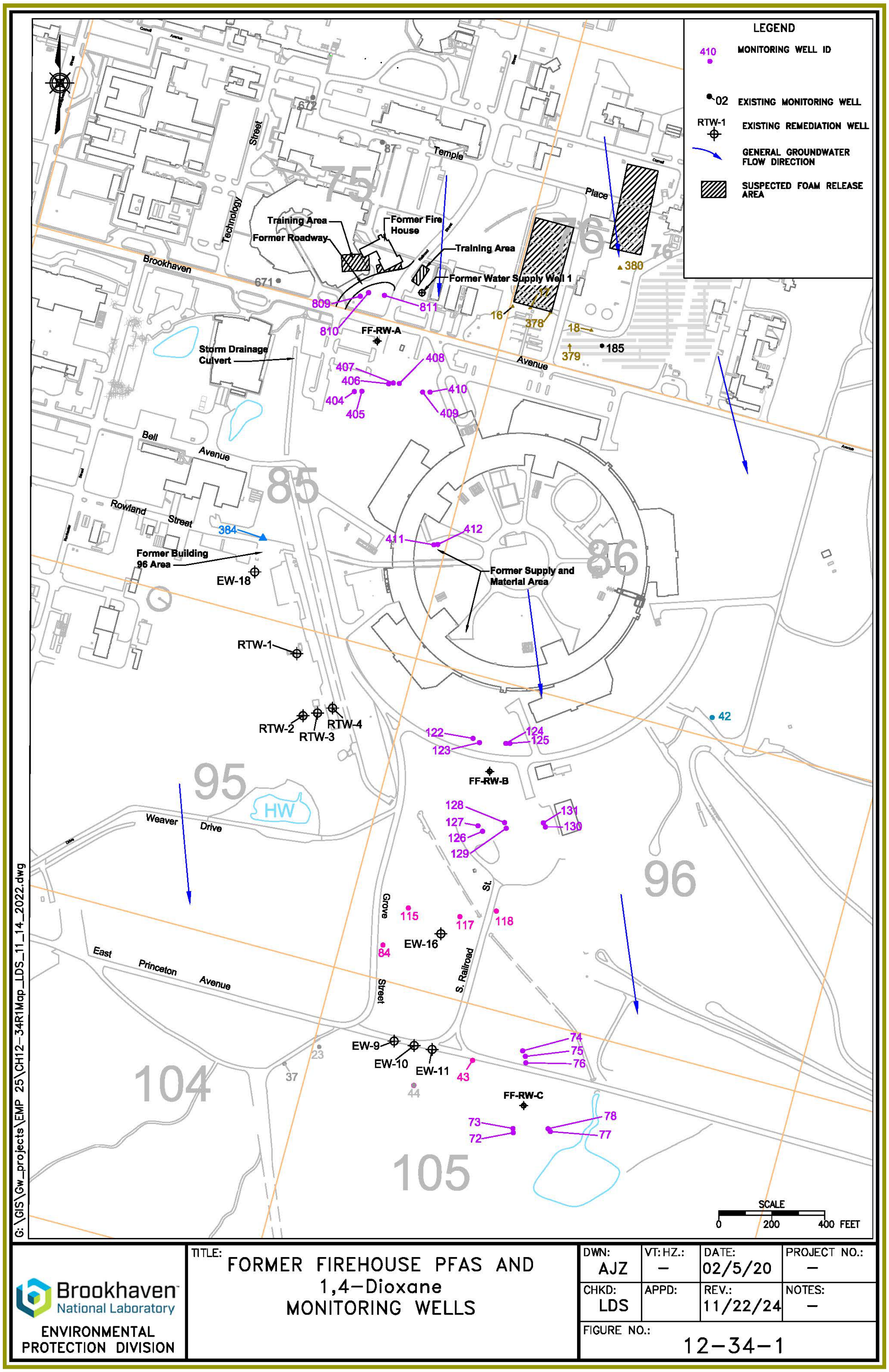

Figure 12.34.1. Locations of Former Firehouse Groundwater Treatment System Monitoring Wells

12.35 OU X Current Firehouse Groundwater Treatment System

DQO START DATE January 1, 2023

IMPLEMENTATION DATE January 1, 2025

POINT OF CONTACT William Dorsch (631) 344-5186

SUMMARY OF PROPOSED CHANGES

Routine sampling activities related to the Current Firehouse polyfluoroalkyl substances (PFAS) treatment system began in October 2022. The treatment system is designed to remediate PFAS plumes originating from firefighter training areas located at the Current Firehouse and west of Building 170. The monitoring program uses 77 wells to evaluate the effectiveness of the treatment system. In addition to testing for PFAS, samples from select wells are also analyzed for 1,4-dioxane, which originated from the releases of 1,1,1-trichloroethane (TCA) in areas upgradient of the Current Firehouse (e.g., Alternating Gradient Synchrotron) and the downgradient Paint Shop areas.

DESCRIPTION AND TECHNICAL BASIS

The Current Firehouse (Building 599) has been in continuous use since 1986. Firefighters trained with Aqueous Film Forming Foam (AFFF) that contained PFAS in the paved area along the north side of the firehouse, and in the adjacent grass and wooded areas to the north. The highest PFAS concentrations (with perfluorooctane sulfonic acid [PFOS] >10,000 ng/L) were detected downgradient of the eastern portion of the training area. A fire extinguisher training area was located to the northwest of the firehouse, and it is believed that foam had been used in this area as well. Foam released to the paved areas along the north side of the firehouse is known to have entered at least one of the drywells that are used for stormwater management. Furthermore, as part of routine maintenance of firetruck foam systems, foam may have been released to the floor drain system in the firehouse's high bay area. The floor drains are connected to BNL's sanitary system. The last known training event where AFFF was used occurred in 2008.

The parking lot west of Building 170 was used for firefighter training with AFFF from approximately 1986 through the early 1990s. During these practice sessions, foam would be directed to the pavement and the wood line area to the north. Because the parking lot is sloped to the west, foam would drain towards the western edge of the parking lot and possibly be directly sprayed into the wooded area to the west of the parking lot. The highest levels of PFOS and perfluorooctanoic acid (PFOA) were detected along the south side of the parking lot at concentrations of 8,470 ng/L and 66 ng/L, respectively. There are no available records on foam formulations or on the amount of foam that was released at the Current Firehouse or Building 170 training area. The New York State (NYS) drinking water standard for PFOS and PFOA is 10 ng/L. National drinking water standards for PFOS (4 ng/L), PFOA (4 ng/L), and several other PFAS were promulgated during 2024.

Startup testing of the Current Firehouse Treatment System began in October 2022. The monitoring well network for the Current Firehouse and Building 170 plumes consists of 77 wells (Figure 12.35.1).

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater in the vicinity of the former AFFF training areas at the Current Firehouse and Building 170 has been impacted by PFAS. In 2022, a remediation system was constructed to treat the PFAS contaminated groundwater. The data obtained from this monitoring program will be used to verify the effectiveness of the treatment system to remediate and prevent the continued downgradient migration of the plume. The data obtained from this program will also provide information needed to assess PFAS migration towards BNL's western supply well field as well as toward the Suffolk County Water Authority well field to the southwest of the BNL site.

Step 2: Identify the Decision

The decisions for the project are:

- Were unexpected levels or types of contamination detected?
- Is the groundwater remediation system effectively capturing the PFAS plumes as expected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are PFOS/PFOA concentrations in plume core wells above or below 100 ng/L?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Analytical results for PFAS using EPA Method 1633
- Analytical results for 1,4-dioxane in select wells using Method 8270D SIM
- Locations of the groundwater monitoring wells (Figure 12.35.1)
- Regulatory drivers that will be defined in the OU X Record of Decision (ROD)
- Action levels (NYS drinking water or groundwater standards or national drinking water standards once they have been promulgated)
- Up to 10 percent of the data analyzed by contract analytical laboratories will be validated using guidance provided from BNL EM-SOP-212, Chemical Data Validation, and U.S. Department of Defense, Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24, October 2022, or latest revision.

Step 4: Define the Study Boundaries

The project geographical limits are defined by the map boundaries depicted on Figure 12.35.1.

Separate decisions will be made in the monitoring subunits (e.g., core, perimeter, and bypass wells) described in the Current Firehouse Treatment System O&M Manual. However, some of the decisions, such as system performance, are based on the entire system. The temporal boundaries of the study area vary, based on the decision.

- *Plume Source Areas:* Due to the need for frequent data collection during the system startup period, the timeframe for decisions for this subunit is 90 days.

- *Downgradient Plume Core and Perimeter:* The wells in this subunit define the plume horizontally, which is used to determine whether the plumes are being captured. Because the treatment system has only been in operation since October 2022, an appropriate timeframe for decisions is 180 days. The timeframe will likely be reduced to 90 days after the system has been in operation for several years.

- *Bypass Detection Area:* The wells in this area indicate whether the plume capture performance objective is being met. Because the treatment system has only been in operation since October 2022, an appropriate decision timeframe for this area is 180 days. The timeframe will likely be reduced to 90 days after the system has been in operation for several years.

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Note: The decision rules discussed below are to be considered **preliminary** until the final cleanup objectives are defined in the OU X Record of Decision (ROD).

Decision 1

Were unexpected levels or types of contaminants detected?

The sample results will be evaluated in context with available characterization data gathered since 2018. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be determined. Examples of such circumstances are unusually high contaminant concentrations, including detection of previously undetected contaminants that could impact treatment system operations (e.g., detection of high levels of 1,4-dioxane that could result in exceeding the treatment system discharge limit).

If the types or concentrations of contaminants detected in any well could impact treatment system operations, and their presence and concentrations are confirmed by resampling, **then** implement actions as prescribed in the BNL Groundwater Contingency Plan.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in PFOS and/or PFOA concentrations in plume perimeter or bypass detection wells to above the 100 ng/L capture goal (if currently less than 100 ng/L).

Note: The downgradient extent of the plumes will be further characterized as part of the planned

OU X Remedial Investigation. Plume migration is currently being contained at West Princeton Avenue by four extraction wells.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

To shut down the treatment system, the shutdown criteria of reaching less than 100 ng/L PFOS and PFOA for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Note: The shutdown criteria for this system may be modified as a result of the Remedial Investigation/Feasibility Study.

Decision 4

Are PFOS or PFOA concentrations in plume core wells above or below 100 ng/L?

If the PFOS and PFOA concentration in each plume core well has been reduced to less than 100 ng/L, **then** proceed with pulsed operation of the system's extraction wells. **If not, then** continue full-time operation.

4a. Is there a significant concentration rebound in core wells and/or extraction wells following pulsed-pumping operations?

If yes, then continue treatment system operations. **If no** significant rebound is observed within a one-year period, then petition for system shutdown, maintain the system in an operationally ready mode, and continue with monitored natural attenuation (MNA).

Decision 5

Has the groundwater cleanup goal of meeting MCLs been achieved?

If PFOS and PFOA concentrations in all plume core wells are less than the 10 ng/L NYS MCL (or national standards once promulgated) over the previous two years and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system closure. If not, then consider the need for continued remediation.

Table 12.35.1 summarizes the decision and possible decision errors for this project.

Table 12.35.1. Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation longer than necessary, wasted resources.

Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues, ultimate project delays. (2) Wasted resources, project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff, potential to have to restart system. (2) Continue remediation that is no longer effective.
Have the groundwater cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

Step 7: Optimize the Design

Number and Locations of Wells

The 77 wells are located to monitor groundwater quality downgradient of the Current Firehouse and Building 170 PFAS source areas are shown on Figure 12.35.1.

Parameters and Frequency

The goal for CY 2025 is to continue sampling 13 Current Firehouse and Building 170 source area wells for PFAS on a quarterly basis and the remaining 63 wells for PFAS. Twenty-one select wells will also be sampled for 1,4-dioxane on a semiannual basis. A summary of the CY 2025 sampling program for this project is shown in Table 12.35.2.

Table 12.35.2. Proposed 2025 Sampling Frequency for the Current Firehouse Groundwater Treatment System Monitoring Wells

Well	Sampling Frequency	Analytical Parameters
073-01	Semiannually	EPA 1633 PFAS
073-26	Quarterly	EPA 1633 PFAS
073-27	Quarterly	EPA 1633 PFAS
073-28	Quarterly	EPA 1633 PFAS
073-29	Quarterly	EPA 1633 PFAS
073-30	Quarterly	EPA 1633 PFAS
073-31	Quarterly	EPA 1633 PFAS
073-32	Quarterly	EPA 1633 PFAS
073-33	Quarterly	EPA 1633 PFAS
074-135	Quarterly	EPA 1633 PFAS
083-01	Semiannually	EPA 1633 PFAS
083-02	Semiannually	EPA 1633 PFAS
083-05	Semiannually	EPA 1633 PFAS
083-33	Semiannually	EPA 1633 PFAS
083-34	Semiannually	EPA 1633 PFAS
083-35	Semiannually	EPA 1633 PFAS
083-36	Semiannually	EPA 1633 PFAS
083-37	Semiannually	EPA 1633 PFAS

083-38	Semiannually	EPA 1633 PFAS
083-39	Semiannually	EPA 1633 PFAS
083-40	Semiannually	EPA 1633 PFAS
083-41	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
083-42	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
083-43	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
083-44	Semiannually	EPA 1633 PFAS
083-47	Semiannually	EPA 1633 PFAS
084-03	Semiannually	EPA 1633 PFAS
084-04	Semiannually	EPA 1633 PFAS
084-28	Semiannually	EPA 1633 PFAS
084-86	Semiannually	EPA 1633 PFAS
084-87	Semiannually	EPA 1633 PFAS
084-88	Semiannually	EPA 1633 PFAS
084-89	Semiannually	EPA 1633 PFAS
084-90	Semiannually	EPA 1633 PFAS
084-91	Semiannually	EPA 1633 PFAS
084-92	Semiannually	EPA 1633 PFAS
084-93	Semiannually	EPA 1633 PFAS
084-94	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
084-95	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
084-96	Semiannually	EPA 1633 PFAS
084-97	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
084-98	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
093-04	Quarterly	EPA 1633 PFAS
093-88	Semiannually	EPA 1633 PFAS
093-89	Semiannually	EPA 1633 PFAS
093-90	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
093-91	Semiannually	EPA 1633 PFAS
093-92	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
093-93	Quarterly	EPA 1633 PFAS
093-94	Quarterly	EPA 1633 PFAS
093-95	Quarterly	EPA 1633 PFAS
093-96	Semiannually	EPA 1633 PFAS
093-97	Semiannually	EPA 1633 PFAS
093-98	Semiannually	EPA 1633 PFAS
094-275	Semiannually	EPA 1633 PFAS
094-276	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
094-277	Semiannually	EPA 1633 PFAS
094-278	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
102-12	Semiannually	EPA 1633 PFAS
102-26	Semiannually	EPA 1633 PFAS
102-27	Semiannually	EPA 1633 PFAS
102-28	Semiannually	EPA 1633 PFAS
102-29	Semiannually	EPA 1633 PFAS
102-30	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
102-31	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
102-36	Semiannually	EPA 1633 PFAS
102-37	Semiannually	EPA 1633 PFAS
102-38	Semiannually	EPA 1633 PFAS
102-39	Semiannually	EPA 1633 PFAS
102-40	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
103-02	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
103-10	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
103-30	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
103-31	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
103-32	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS

103-33	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS
103-34	Semiannually	8270D SIM 1,4-dioxane, EPA 1633 PFAS

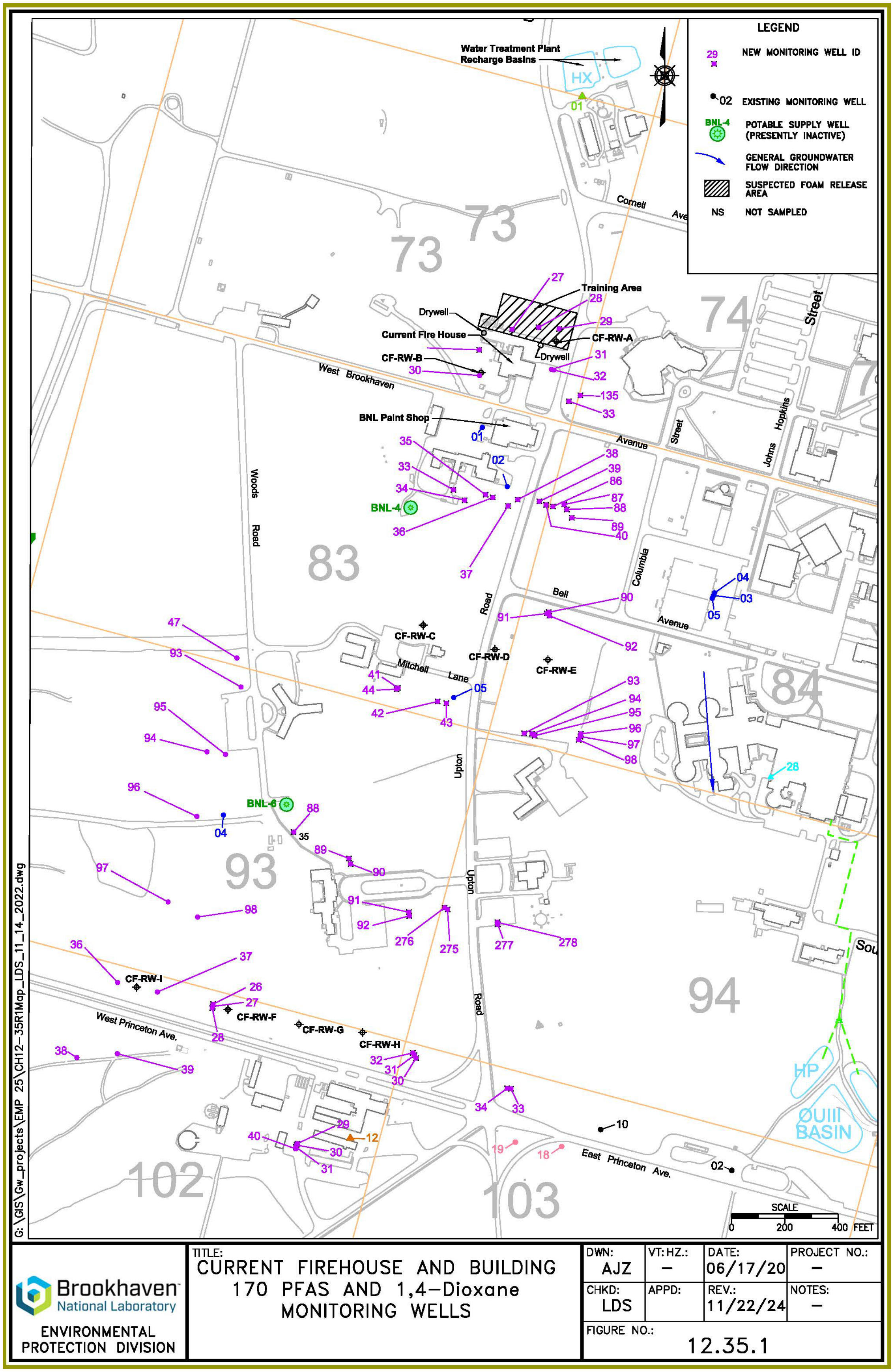

Figure 12.35.1 Current Firehouse Groundwater Treatment System Monitoring Well Locations.

13.1 Landfill Soils Gas Monitoring

DQO Start Date January 1, 2003

Implementation Date January 1, 2025

Point of Contact Brian Barth (631) 344-2242

James Milligan (631) 344-4458

Summary of Proposed Changes

There are no proposed changes for calendar year 2025.

Description and Technical Basis

The Former Landfill (Former Landfill, Interim Landfill, and Slit Trench) and the Current Landfill require post-closure monitoring in accordance with the requirements of 6 New York Codes, Rules and Regulations (NYCRR) Part 360, Solid Waste management Facilities, and the Operable Unit (OU) I Record of Decision (ROD). The monitoring period shall be a minimum of 30 years following landfill closure.

The Current Landfill was capped in 1995. Additional information regarding cap construction may be obtained from the construction certification report for the Current Landfill (CDM Federal, 1996). The Former Landfill and nearby Slit Trench were capped in November 1996 and the Interim Landfill was capped in October 1997. Additional information regarding cap construction may be obtained from the construction certification report for the Former Landfill (CDM Federal, 1997) and the Interim Landfill (PW Grosser, 1997).

Monitoring covered by this Data Quality Objective (DQO) will be soil gas monitoring of methane and hydrogen sulfide concentrations 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. Monitoring is conducted in accordance with the Final Operations and Maintenance Manual for the Current Landfill (CDM, 1996) and the Final Operations and Maintenance Manual for the Former Landfill Area (CDM, 1996). Both landfill areas contain passive venting for the controlled release of landfill gases.

In accordance with NYCRR Part 360-2.17(f), decomposition gases generated within a landfill must be controlled to avoid hazards to health, safety, and property. Measures to control decomposition gases must be undertaken when the concentration of methane or other explosive gases exceeds 25 percent of the Lower Explosive Limit (LEL) for gases in facility structures on or off site or 100 percent of the LEL for gases at or beyond the site boundary. Notification to the New York State Department of Environmental Conservation (NYSDEC) shall be made within seven days of an observed exceedance.

Each of Brookhaven National Laboratory's (BNL) landfills has soil gas monitoring networks. Since the landfills were capped, BNL has been routinely monitoring for LEL, methane, and hydrogen sulfide using a LANDTEC® GEM 5000+ under BNL procedure EM-SOP-503. The review of data collected by project managers is done in accordance with procedures to ensure data is of acceptable quality. The Current Landfill has a total of 58 sampling points for monitoring soil gas positioned along the perimeter of the landfill. The sampling points include 12 soil gas well clusters consisting of three sampling intervals per cluster and 11 soil gas well couplets consisting of two sampling intervals per couplet.

The Former Landfill has a total of 24 sampling points for soil gas monitoring, also positioned along the perimeter of the landfill. These sampling points include six well couplets consisting of two sampling points per couplet.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

_X_ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Material disposed of in the landfills decomposes, generating gases that may migrate to areas outside the landfill boundaries. These gases may be explosive at certain concentrations and may cause harm to personnel and/or property.

Step 2: Identify the Decision

Is the as-built passive venting landfill gas collection system adequate to control soil gas levels near the landfills to safe levels and prevent the off-site migration of gases at hazardous levels?

Step 3: Identify Inputs to the Decision

Soil gas monitoring data should be evaluated for the potential for hazardous conditions on site and the potential for off-site migration at the following frequency:

- Current landfill – Quarterly
- Former landfill – Annually

Since there have been little to no detections of methane during monitoring at the Former Landfill Area for more than 20 years, BNL recommended in March 2014, and the regulators concurred, that the soil gas monitoring frequency be reduced from semiannual to annual.

Step 4: Define the Study Boundaries

Landfill perimeter gas monitoring network.

Step 5: Develop the Decision Rules

Is the as-built passive venting landfill gas collection system adequate to control soil gas levels near the landfills to safe levels and prevent the off-site migration of gases at hazardous levels?

Does the BNL Environmental Incident Procedure need to be deployed? Does NYSDEC need to be notified?

Decision Rule

If the soil gas levels in the soil gas monitoring wells are <25 percent of the LEL for gases in facility structures on or off site or <100 percent of the LEL for gases at or beyond the landfill site boundary, **then** deployment of the BNL Environmental Incident Procedure and notification to NYSDEC is not required.

If the soil gas levels in soil gas monitoring wells are >25 percent of the LEL for gases in facility structures on or off site or > or equal to 100 percent of the LEL for gases at or beyond the landfill site boundary, **then** perform an evaluation to determine whether additional landfill controls are necessary and notify NYSDEC within seven days, as required.

Step 6: Specify Acceptable Error Tolerances

Design is per NYCRR Part 360 requirements.

Step 7: Optimize the Design

Design is per NYCRR Part 360 requirements. Since there have been little to no detections of methane during monitoring at the Former Landfill Area for more than 20 years, BNL recommended in March 2014, and the regulators concurred, that the soil gas monitoring frequency be reduced from semiannual to annual.

See Appendix B for the monitoring program for this DQO.

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Acronyms and Technical Terms

AGC	Annual Guideline Concentrations
AGS	Alternating Gradient Synchrotron
ALARA	As Low As Reasonably Achievable
ALMR	Annual Landfill Monitoring Report
amu	Atomic Mass Unit
ANSI	American National Standards Institute
AOC	Area of Concern
ASL	Analytical Services Laboratory
AS/SVE	Air Sparging/Soil Vapor Extraction
AWQS	Ambient Water Quality Standards
BGRR	Brookhaven Graphite Research Reactor
BLIP	Brookhaven Linac Isotope Producer
BMRR	Brookhaven Medical Research Reactor
BNL	Brookhaven National Laboratory
BOD_5	Biological Oxygen Demand
BSA	Brookhaven Science Associates
BTEX	benzene, toluene, ethylbenzene, and xylene
CA	Collider Accelerator
CAA	Clean Air Act
CASIM	Cascade Simulation
CCR	Compliance Certification Report
CCWP	Central Chilled Water Plant
CEM	Continuous Emissions Monitoring
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
CFR	U.S. Code of Federal Regulations
Ci	Curie
CO_2	carbon dioxide
COC	Chain-of-custody
Cs-137	cesium-137
CSF	Central Steam Facility
CWA	Clean Water Act
CY	calendar year
D_2O	deuterium; heavy water
DCA	1,1-dichloroethane
DCE	1,1-dichloroethylene
DCG	Derived Concentration Guide
DMR	Discharge Monitoring Report
DO	Dissolved oxygen
DOE	U.S. Department of Energy

DOELAP	Department of Energy Laboratory Accreditation Program
DQO	Data Quality Objective
DWS	Drinking Water Standards
EA	Environmental Assessment
EDB	ethylene dibromide
EDE	Effective Dose Equivalent
EIMS	Environmental Information Management System
ELAP	Environmental Laboratory Approval System
EM	Environmental Monitoring
EML	Environment Measurements Laboratory
EMP	Environmental Monitoring Plan
EMS	Environmental Management System
ER	Environmental Restoration
EPA	Environmental Protection Agency
EPD	Environmental Protection Division
ES	Environmental Surveillance
EU	Energy & Utilities, Facilities & Operations Directorate
FERN	Foundation for Ecological Research in the Northeast
FFA	Federal Facilities Agreement
FFCA	Federal Facilities Compliance Act
FY	fiscal year
FWS	U.S. Fish and Wildlife Service
GAB	gross alpha and beta
GAC	Granulated Activated Carbon
GC/ECD	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatography/Mass Spectrometry
GEL	General Engineering Laboratory (contracted)
GIS	Geographic Information System
GMR	Groundwater Monitoring Report (Site Environmental Report Volume II)
HAA5	Five Haloacetic Acids
H2M	a contracted analytical laboratory
HAP	Hazardous Air Pollutant
HEDP	hydroxyethilydene diphosphoric acid
HEPA	High Efficiency Particulate Air
HFBR	High Flux Beam Reactor
HITL	Heavy Ion Transfer Line
HQ	Headquarters
HTO	tritiated water (liquid or vapor)
HWMF	Hazardous Waste Management Facility (former)
IAG	Interagency Agreement
IC	Ion-Chromatrography
ICP/MS	Inductively Coupled Plasma/Mass Spectrometry
IO	Instrumentation Division
ISO	International Organization for Standardization

LAMR	Landfill Annual Monitoring Report
LED	Light Emitting Diode
LIE	Long Island Expressway
LINAC	Linear Accelerator
LTRA	Long Term Remedial Action
MCL	Maximum Contaminant Level
MDL	Minimum Detection Limit
MEI	Maximally Exposed Individual
MeV	million electron volts
MGD	million gallons per day
MH	manhole
MOA	Memorandum of Agreement
MPF	Major Petroleum Facility
MRC	Medical Research Center
mrem	millirem
MTBE	methyl tertiary butyl ether
MW	megawatt
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
ND	Not Detected or No Dose
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NIST	National Institute for Standards and Technology
NO_2	nitrogen dioxide
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSLS	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source-II
NYCRR	New York Codes, Rules, and Regulations
NYS	New York State
NYSAWQS	New York State Ambient Water Quality Standard
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDWS	New York State Drinking Water Standard
O&M	Operation and Maintenance
ORPS	Occurrence Reporting and Processing System
OU	Operable Unit
PE	Plant Engineering
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PFAS	per- and polyfluoroalkyl Substances
PNNL	Pacific Northwest National Laboratory

ppb	parts per billion
ppm	parts per million
PPGMBE	polypropylene glycol monobutyl ether
PRMR	Peconic River Monitoring Report
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
QAPP	Quality Assurance Program Plan
QC	Quality Control
QES	Quarterly Emission Statement
QM	Quality Management
RA	Removal Action
RACT	Reasonably Achievable Control Technology
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactive Material
RHIC	Relativistic Heavy Ion Collider
RI/FS	Remedial Investigations/Feasibility Study
ROD	Record of Decision
RTF	Radiation Therapy Facility
SARA	Superfund Amendments and Reauthorization Act
SCDHS	Suffolk County Department of Health Services
SDWA	Safe Drinking Water Act
SER	Site Environmental Report
SME	subject matter expert
SOC	synthetic organic compound
SOP	Standard Operating Procedure
SO_2	sulfur dioxide
SPCC	Spill Prevention Control and Countermeasures
SPDES	State Pollutant Discharge Elimination System
SPING	Sampler, Particulate, Iodine, and Noble Gas
Sr-90	strontim-90
STEM	Scanning Transmission Electron Microscope
STL	Severn Trent Laboratories (contracted)
STP	Sewage Treatment Plant
STR	Stack Test Report
SVOC	semivolatile organic compound
$t_{1/2}$	half-life
TAL	Target Analyte List
TCA	1,1,1-trichloroethane
TCE	trichloroethylene
TDS	Total Dissolved Solids
TEDA	triethylene diamamine
THMs	Trihalomethanes
TLD	thermoluminescent dosimeter
TOC	total organic carbon

TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
TSP	triple superphosphate
TSS	total suspended solids
TTA	tolytriazole
TVOC	total volatile organic compounds
UIC	Underground Injection Control
USC	United States Code
UST	underground storage tank
VOC	volatile organic compound
VUV	vacuum ultraviolet
WAC	Waste Acceptance Criteria
WCF	Waste Concentration Facility
WMF	Waste Management Facility
WQ	water quality
WSRRSA	Wild, Scenic, and Recreational River Systems Act
WTP	Water Treatment Plant
WTPR	Water Treatment Plant Report

The following definitions reflect the typical manner in which the terms are used for this specific document and may not apply to all situations.

A

accuracy - The degree of agreement of a measurement with an accepted reference or true value. It is 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 products - A material that has become radioactive through the process of activation.

activity - Synonym for radioactivity.

Administrative Record - A collection of documents established in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program. Consists of information upon which the CERCLA lead agency bases 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.

aerosol - A gaseous suspension of very small particles of liquid or solid.

air sparging - A method of extracting volatile organic compounds from the groundwater *in situ* (i.e., in place) using compressed air. The vapors are typically collected using a soil vapor extraction system.

air stripping - A process whereby volatile organic chemicals are removed from contaminated water by forcing a stream of air through the water in a vessel. The contaminants are evaporated into the air stream. The air may be further treated before it is released into the atmosphere.

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 elements such as radon emit alpha radiation.

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.

anion - A negatively charged ion, often written as a negative sign after an element symbol, such as Cl^-.

anthropogenic radionuclides - Radionuclides produced as a result of human activity (i.e., human-made).
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.

area of concern (AOC) - Under the Comprehensive Environmental Response, Compensation and Liability Act (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 into the environment 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.

atomic absorption (AA) - A method used to determine the elemental spectroscopy composition of a sample. In this method, the sample is vaporized and the amount of light it absorbs is measured.

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, cosmic radiation, or human-made radiation sources, including fallout.

becquerel (Bq) - A quantitative measure of radioactivity. This is an alternate measure of activity used internationally and with increasing frequency in the United States. One Bq of activity is equal to one nuclear decay per second. All references to quantities of radioactive material in this report are made in curies, followed in parentheses by the equivalent in Bq.

beta radiation - Beta radiation is composed of charged particles emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation is slightly more penetrating than alpha, but may be stopped by materials such as aluminum or Lucite panels. Naturally occurring radioactive elements such as potassium-40 emit beta radiation.

biochemical oxygen demand (BOD) - 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.

blank - A sample (usually reagent grade water) in the same type of container used for quality control of field sampling methods, to demonstrate that cross contamination has not occurred.

blowdown - Water discharged from either a boiler or cooling tower in order to prevent the build-up of inorganic matter within the boiler or tower and to prevent scale formation (i.e., corrosion).

C

cap - A layer of material, such as clay or a synthetic material (like Gunite™), used to prevent rainwater from penetrating and spreading contaminated materials. The surface of the cap is generally mounded or sloped so water will drain off.
carbon adsorption/carbon treatment - A treatment system in which contaminants are removed from groundwater, surface water, and air by forcing water or air through tanks containing activated carbon (a specially treated material that attracts and holds or retains contaminants).

carbon tetrachloride – A poisonous, nonflammable, colorless liquid, CCl_4.

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.

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.

Class GA groundwater - New York State Department of Environmental Conservation classification for high quality groundwater, where the best intended use is as a source of potable water.

closure - Under the Resource Conservation and Recovery Act (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.

Code of Federal Regulations (CFR) - A codification of all regulations developed and finalized by federal agencies in the Federal Register.

collective effective dose equivalent - A measure of health risk to a population exposed to radiation. It is the sum of the effective dose equivalents 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 Effective Dose Equivalent received over a 50-year period following the internal deposition of a radionuclide. It is expressed in rem or sieverts.

composite sample - A sample of an environmental media that contains a certain number of sample portions collected over a period of time. The samples may be collected from the same location or different locations. They may or may not be collected at equal time intervals over a predefined period of time (e.g., 24 hours).

confidence interval - A numerical range within which the true value of a measurement or calculated value lies. In this report, radiological values are shown with a 95% confidence interval, i.e., there is a 95 percent probability that the true value of a measurement or calculated value lies within the specified range.

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 that is used to cool machinery and equipment. Contact cooling water is any wastewater that contacts machinery or equipment to remove heat from the metal. Non-contact cooling water is water used for cooling purposes but has no direct contact with any process material or final product. Process wastewater cooling water is water used for cooling purposes that may have become contaminated through contact with process raw materials or final products.
curie (Ci) - A quantitative measure of radioactivity. One Ci of activity is equal to 3.7×10^{10} decays per second.

D

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.

Department of Energy (DOE) - The federal agency that sponsors energy research and regulates nuclear materials used for weapons production. DOE has responsibility for the national laboratories and the science and research conducted at these laboratories, including BNL.

derived concentration guide (DCG) - 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/immersion, water ingestion), would result in an effective dose equivalent of 100 mrem (1 mSv). The values have been established by DOE in Order 5400.5, *Radiation Protection of the Public and the Environment*. 1990, change 2, 1/7/93.

disposal - Final placement or destruction of waste.

dosimeter - A portable detection device for measuring the total accumulated exposure to ionizing radiation.

downgradient - In the direction of groundwater flow from a designated area; analogous to "downstream."

E

effective dose equivalent (EDE) - A value used to express the health risk from radiation exposure to a tissue or tissues 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. It is equal to the sum of the doses to different organs of the body multiplied by their respective weighting factors. It includes the sum of the effective dose equivalent 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 units of rem or sieverts.

effluent - Any liquid discharged to the environment, including stormwater runoff at a site or facility.

emission - Any gaseous or particulate matter discharged to the atmosphere.

environment - Surroundings in which an organization operates (including air, water, land, natural resources, flora, fauna, and humans) and their interrelation.

environmental aspect - Elements of an organization's activities, products, or services that can interact with the environment.

Environmental Assessment (EA) - A report that identifies potentially significant environmental impacts from any federally approved or funded project that may change the physical environment. If an EA identifies a "significant" impact (as defined by the National Environmental Policy Act [NEPA]), an Environmental Impact Statement is required.

environmental impact - Any change to the environment, 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 - Sampling for contaminants in air, water, sediments, soils, food stuffs, plants, and animals, either by directly measuring or by collecting and analyzing samples.

Environmental Protection Agency (EPA) - The federal agency responsible for developing and enforcing environmental laws. Although state regulatory agencies may be authorized to administer environmental regulatory programs, EPA generally retains oversight authority.

ethylene dibromide (EDB) - A colorless, nonflammable, heavy liquid with a sweet odor; slightly soluble in water, soluble in ethanol, ether, and most organic solvents. It was used as an additive in leaded gasoline, as a soil and grain fumigant, and in waterproofing preparations. 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. The U.S. Department of Health and Human Services has determined that ethylene dibromide may reasonably be anticipated to be a carcinogen.

Environmental Protection Agency (EPA) - The federal agency responsible for developing and enforcing environmental laws. Although state regulatory agencies may be authorized to administer environmental regulatory programs, the EPA retains oversight authority.

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.

feasibility study (FS) - 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.

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" to identify a specific nuclide.

grab sample - A single sample collected at one time and place.

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 on a metal mold.

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.

hazardous waste - Toxic, corrosive, reactive, or ignitable materials that can negatively affect 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 the Resource Conservation and Recovery Act (RCRA), Subtitle C.

heat input - The heat derived from combustion of fuel in a steam generating unit. It does not include the heat from preheated combustion air, recirculated flue gases, or the exhaust from other sources.

heavy water (D_2O) - A form of water containing deuterium, a nonradioactive isotope of hydrogen.

hot cell - Shielded and air controlled facility for the remote handling of radioactive material.

hydrology - The science dealing with the properties, distribution, and circulation of natural water systems.

I

inert - Lacking chemical or biological action.

influent - Liquid (e.g., 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 other sources (e.g., a sewage treatment plant).

ionizing radiation - Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. Some examples are alpha, beta, gamma, x-rays, neutrons, and light. High doses of ionizing radiation may produce severe skin or tissue damage.

isotope - Two or more forms of a chemical element having the same number of protons in the nucleus (or the same atomic number), but having different numbers of neutrons in the nucleus (or 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 – Tap water.

liquid scintillation counter - An analytical instrument used to quantify tritium, carbon-14, and other beta-emitting radionuclides.

M

maximally exposed individual (MEI) - 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.

mean sea level (MSL) - The average height of the sea for all stages of the tide. Used as a benchmark for establishing groundwater and other elevations.

minimum detection limit (MDL) - 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).

mixed waste - Waste that contains both a hazardous waste component regulated under Subtitle C of the Resource Conservation and Recovery Act (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.

N

nuclide - A species of atom characterized by the number of protons and neutrons in the nucleus.

O

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 emissions (e.g., smoke) other than water reduce the transmission of light and obscure the view of an object in the background.

operable unit (OU) - 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 operable unit can receive specific investigation and a particular remedy may be proposed. A record of decision (ROD) is prepared for each operable unit (*see* Record of Decision).

outfall - The place where wastewater is discharged.

oxides of nitrogen (NO_x) - All oxides of nitrogen, except nitrous oxide, which is expressed as nitrogen dioxide (NO_2).

ozone (O_3) - A very reactive form of oxygen formed naturally in the upper atmosphere and providing 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

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

permit - An authorization issued by a federal, state or local regulatory agency. Permits are issued under a number of environmental regulatory programs, including the Resource Conservation and Recovery Act (RCRA), Clean Air Act (CAA), Clean Water Act (CWA), and Toxic Substances Control Act (TSCA). They grant permission to operate, to discharge, to construct, etc. 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 media, such as air, soil, water, or vegetation.

pollution prevention (P2) - 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.

polychlorinated biphenyls (PCBs) - 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.

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

precision - The dispersion 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

qualifier - A letter or series of letter codes indicating that the associated value is estimated. A qualified value is an estimated value.

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

quality control (QC) - 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.

R

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.

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.

Record of Decision (ROD) - A document that records a regulator 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.

relative percent difference – A measure of precision, expressed by the formula: RPD = [(A-B)/(A+B)] x 200, where A equals the concentration of the first replicate: and B equals the concentration of the second replicate.

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. This is a risk-based value used to estimate the potential health effects to an exposed individual or population.

remedial (or remediation) alternatives - Options considered under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) for cleaning up contamination at a site, such as an operable unit (OU) or area of concern (AOC). Remedial actions are long-term activities that stop or substantially reduce releases, or prevent possible releases, of hazardous substances that are serious but not immediately life-threatening. See also feasibility study (FS) and record of decision (ROD).

remedial investigation (RI) - An investigation that includes extensive sampling and laboratory analyses to characterize the nature and extent of contamination, define the pathways of migration, and measure the degree of contamination in surface water, groundwater, soils, air, plants, and animals. Information gathered during the RI attempts to fully describe the contamination problem at the site so that the appropriate remedial action can be developed.

removal actions (RA) or 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 Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA), and that are not inconsistent with the final remedial action. Under CERCLA or Superfund, the U.S. Environmental Protection Agency may respond to releases or threats of releases of hazardous substances by starting a removal action. The purpose of the removal action is to stabilize or clean up an incident or site that poses an immediate threat to public health or welfare. Removal actions differ from remedial actions. However, removal actions must contribute to the efficiency of future remedial actions.

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).

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.

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 (Sv) - 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.

skyshine - Radiation emitted over an open-topped shielded enclosure and reflected by air so as to radiate people on the outside.

sludge - Semisolid residue from industrial or water treatment processes.

soil vapor extraction - An *in situ* (in-place) method of extracting volatile organic chemicals from soil. The chemicals are extracted by applying a vacuum to the soil and collecting the air, which can be further treated to remove the chemicals or discharged to the atmosphere.

sole source aquifer - An area defined by the U.S. Environmental Protection Agency 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.

spallation - The process by which a high energy particle striking a nucleus causes fragments to be ejected from the nucleus. The resulting atom is usually radioactive.

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; the U.S. Department of Energy; and BNL staff.

State Pollution Discharge Elimination System (SPDES) - A program under which permits are issued by the state to regulate wastewater discharges. The permit specifies the maximum discharge limits for the parameters present in the particular discharge.

stripping - A process used to remove volatile contaminants from a substance (*see also* Air Stripping).

sump - A pit or tank that catches liquid runoff for drainage or disposal.

T

thermoluminescent dosimeter (TLD) - A device used to measure radiation dose to occupational workers or radiation levels in the environment.

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

trichloroethylene (TCE) (also, 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 to people when inhaled or ingested, or through skin contact, and can damage vital organs, especially the liver (*see also* volatile organic compounds).

tritium - The heaviest and only radioactive nuclide of hydrogen, with a half-life of 12.3 years and a very low energy radioactive decay (beta emitter).

U

underground injection control (UIC) - Any hole whose vertical dimensions are larger than its largest horizontal dimensions and used for disposal of waste water.

underground storage tank (UST) - 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

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 spotted salamander), as it is too shallow to support fish, a major predator of amphibian larvae.

volatile organic compounds (VOCs) - Secondary petrochemicals, including light alcohols, acetone, trichlorethylene, perchloroethylene, dichloroethylene, benzene, vinyl chloride, toluene, and methylene chloride. These potentially toxic chemicals are used as solvents, degreasers, paints, thinners, and fuels. Because of their volatile nature, they readily evaporate into the air, increasing the potential for human exposure. Due to their widespread industrial use, they are commonly found in soil and groundwater.

W

waste minimization - An action that avoids or reduces the generation of waste by source reduction, reduces the toxicity of hazardous waste, improves energy usage, or recycling. This action is consistent with the general goal of minimizing present and future threats to human health, safety, and the environment and is associated with pollution prevention, but more likely to occur after the waste has already been generated.

water table - The water-level surface below the ground at which the unsaturated zone ends and the saturated zone begins. It is the level to which a well that is screened in the unconfined aquifer would 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.

wind rose - A diagram that shows the frequency of wind from different directions at a specific location.

ENVIRONMENTAL MONITORING PLAN MATRIX FOR CALENDAR YEAR 2025

Sampling Location	Reporting to Regulators	Reporting to Departments	Lead Organization	Sample Type	Analysis/Frequency
Air Monitoring: Surveillance - Radiological, Particulate Filter (See Chapters 5 and 6)					
P2, P4, P7, P9, NYSDOH	SER	SER	EPD	Weekly Composite	Gross alpha/beta - sampled and analyzed weekly
BLIP and Bldg. 801	SER	SER	EPD	Weekly Composite	Gross alpha/beta - sampled and analyzed weekly Bldg. 801 - Alpha and Gamma spectroscopy, sampled and analyzed monthly
HWM 865 – FLT-101, -102, -107, -108	SER	SER	EPD	On Request	Gross alpha/beta, gamma – Only on request by Waste Management
Air Monitoring: Surveillance - Radiological, Gamma Monitor (See Chapter 6)					
P2, P4, P7, P9, BLIP, Bldg. 801	SER	SER	EPD	Continuous	Real-time gamma monitoring using detector and electronics, as well as data telecommunication to active display and short-term record. BLIP, Bldg. 801 - effluent monitored actively, real time for gamma-emitting gases.
Air Emissions: Compliance, Non-Radiological (See Chapter 5)					
CSF – Boiler #6 Stack	SER/QES	Yes	EU	Continuous	Opacity - continuous emissions monitoring
CSF – Boiler #6 Stack	SER/QES	Yes	EU	Continuous	NO_x, CO_2, CO - continuous emissions monitoring
CSF – Boiler #7 Stack	SER/QES	Yes	EU	Continuous	NO_x, CO_2, CO - continuous emissions monitoring
CSF – Boiler #7 Stack	SER/QES	Yes	EU	Continuous	Opacity - continuous emissions monitoring
CSF – Tank Nos. 4, 9, and 10	SER/QES	Yes	EU	Quarterly	Sulfur and nitrogen fuel content - quarterly analysis if fuel is delivered
Satellite Boiler Fuel Storage Tanks	SER/QES	Yes	EU	Quarterly	Sulfur content – quarterly analysis if fuel is delivered
CSF - Boiler #1A Stack	SER/STR	Yes	EU	Performance Test	NO_x TSP - every five years
CSF- Boiler #5 Stack	SER/STR	Yes	EU	Performance Test	NO_x TSP - every five years
CSF - Boiler #6 Stack	SER/STR	Yes	EU	Performance Test	TSP - every five years
CSF - Boiler #7 Stack	SER/STR	Yes	EU	Performance Test	TSP - every five years
Used AC Shop Compressor Oil and Collider Accelerator Waste Separator Oil	SER/QES	Yes	EU	3-4 times per year	Cadmium, arsenic, lead, chromium, sulfur, PCBs, total halogens, flashpoint, and gross heat content - sampled and analyzed as needed
CSF – Tank Nos. 4, 9, and 10	SER/QES	Yes	EU	Quarterly	Sulfur and nitrogen fuel content - quarterly analysis
Satellite Boiler Fuel Storage Tanks	SER/QES	Yes	EU	Quarterly	Sulfur content - quarterly analysis if fuel is delivered

ENVIRONMENTAL MONITORING PLAN MATRIX FOR CALENDAR YEAR 2025

Sampling Location	Reporting to Regulators	Reporting to Departments	Lead Organization	Sample Type	Analysis/Frequency
Used AC Shop compressor oil and Collider Accelerator waste separator oil	SER/QES	Yes	EU	3-4 times per year	Cadmium, arsenic, lead, chromium, sulfur, PCBs, total halogens, flashpoint, and gross heat content - sampled and analyzed as needed
Air Emissions: Surveillance - Radiological, Silica Gel (See Chapters 5 and 6)					
P2, P4, P7, P9	SER	SER	EPD	Silica Gel	Tritium biweekly
BLIP	SER	SER	EPD	Silica Gel	Tritium - sampled weekly
HFBR T-Tube	SER	As Required	EPD	Silica gel	Tritium - sampled monthly
Air Emissions: Surveillance - Radiological, Charcoal (See Chapters 5 and 6)					
Building 801	SER, EPA	SER	EPD	Charcoal	Isotopes of noble gases – sampled monthly
Ambient Air: Surveillance - Radiological, Off-Site TLD Exchange - BNL Personnel (See Chapter 7)					
000-TLD9, 000-TLD10, 200-TLD1, 200-TLD5, 700-TLD4, 800-TLD1, 900-TLD2, 900-TLD5, 900-TLD7, 999-TLD1, and 999-TLD2	SER	SER	EPD	External Dose	Beta/gamma - exchanged quarterly
Ambient Air: Surveillance - Radiological, TLD Exchange - On-Site Locations (See Chapter 7)					
P4, S6, P7, P2, S5, 011-TLD1, 013-TLD1, 025-TLD1, 025-TLD4, 027-TLD1, 027-TLD2, 030-TLD1, 034-TLD2, 036-TLD1, 036-TLD2, 037-TLD1, 043-TLD1, 043-TLD2, 044-TLD1, 044-TLD2, 044-TLD3, 044-TLD5, 045-TLD1, 045-TLD2, 045-TLD4, 045TLD5, 049-TLD1, 053-TLD1, 054-TLD1, 054-TLD 2, 054-TLD3, 055-TLD1, 055-TLD2, 063-TLD1, 065-TLD1, 066-TLD1, 073-TLD1, 074-TLD1, 074-TLD2, 075-TLD3, 075-TLD5, 080-TLD1, 082-TLD1, 084-TLD1, 085-TLD1, 085-TLD2, 085-TLD3, 086-TLD1, 086-TLD2, 086-TLD3, 088-TLD1, 088-TLD2, 088-TLD3, 088-TLD4, 090-TLD1, 095-TLD1, 096-TLD1, 105-TLD1, 108-TLD1, 108-TLD2, 111-TLD1, 122-TLD1, 126-TLD1, 025-TLD-N2, 034-TLD-N1, 034-TLD-N2, 042-TLD-N1, 042-TLD-N2, 043-TLD-N1, 043-TLD-N2, 054-TLD-N1, 054-TLD-N2, 054-TLD-N3, 064-TLD-N1	SER	SER	EPD	Quarterly	Beta/gamma - exchanged and analyzed quarterly Neutron - chip TLD – Location Designator ending in N# - exchanged quarterly
Ambient Air: Surveillance - Radiological, TLD Exchange - Off Site Facilities (See Chapter 7)					
000-TLD-5, 400-TLD1, 600-TLD4, 800-TLD3, 800-TLD4	SER	SER	EPD	Quarterly Composite	Beta/gamma exchanged and analyzed quarterly
Precipitation: Surveillance (See Chapter 8)					
P4, S5	SER	SER	EPD	Monthly Composite	Low-level mercury, and water quality - sampled and analyzed once per quarter
Flora and Fauna: Surveillance - On-Site Terrestrial Sampling (See Chapter 8)					

Environmental Monitoring Plan Matrix For Calendar Year 2025

Sampling Location	Reporting to Regulators	Reporting to Departments	Lead Organization	Sample Type	Analysis/Frequency
Soil	SER/IAG	SER	EPD	Grab	Gamma - concurrent sampling with vegetation
Vegetation	SER/IAG	SER	EPD	Grab	Gamma – ten to 12 random locations
Deer - on site	SER	SER	EPD	Grab Sample	Gamma analysis on meat and liver - 25 samples, as available
Deer - off site	SER	SER	EPD	Grab Sample	Gamma analysis on meat and liver - 40 samples, as available
Soil/Sediment - Recharge Basins	SER	SER	EPD	Grab Sample	Gamma, S-VOCs, TAL - Metals, PCBs - ten samples for CY 2027
Flora and Fauna: Surveillance - Off-Site Terrestrial Sampling (See Chapter 8)					
Fish	SER	SER	EPD	Grab Sample - fillets	Gamma, mercury, and PCBs analysis (on site only) - 30 samples, as conditions and fish populations allow - three locations (BNL, Lower Lake, Carmans River), priority of analysis for on-site samples of mercury, PCBs, and gamma.
Surface Water	SER	SER	EPD	Grab	TAL metals, nutrients, water quality parameters - Meadow Marsh and Wooded Wetland
Water - SPDES: Compliance (See Chapter 9)					
STP Effluent (12 months/year)	DMR	Yes	EPD	24 hr. Composite	TAL metals, TDS, total phosphorous, nitrogen series - sampled and analyzed twice per month
STP Effluent (12 months/year)	DMR	Yes	EPD	24 hr. Composite	HEDP, TTA - sampled and analyzed monthly
STP Effluent (12 months/year)	DMR	Yes	EPD	Grab Sample	VOCs (EPA 624) and ketones, low-level mercury (EPA 1631), cyanide - sampled and analyzed twice per month
STP Effluent (Daily)	DMR	Yes	EU	Grab Sample	Temperature, pH, flow - sampled and analyzed daily
HN, HT-W, HS, CSF, HT-E, HW, Bldg. 1004/1002-Outfall 002B (monthly)	DMR	Yes	EPD	Grab Sample	Oil /grease and pH (VOCs EPA 624, HW only) - sampled and analyzed monthly
HX (monthly)	DMR	Yes	EPD/EU	Grab Sample	Flow (EP totalizer) and pH
HN, HT-W, HT-E, HW, CSF, HS, Bldg. 1004/1002-Outfall 002B (quarterly)	DMR	Yes	EPD	Grab Sample	HEDP, TTA, VOCs (EPA 624) at HN, TAL Metals at HN, HS, CSF, and HW (filtered) - sampled and analyzed quarterly
Bldg. 498 Central Cleaning Facility (quarterly)	DMR	Yes	EPD/EU	Grab Sample	pH, Semi-VOCs (EPA 625), TAL metals, flow - sampled and analyzed quarterly
Bldg. 902 Cooling Tower (quarterly)	DMR	Yes	EPD/CA	Grab Sample	pH, flow (CA), PPGMBE - sampled and analyzed quarterly
HS, HO, HN, HT-W, HT-E, HM-N, HM-S, HQ, HZ, Outfall 002B (Flow circular chart/strip chart exchange)	SER	SER	EPD	Grab Sample	Flow readings collected weekly - HO, HZ, HM-S, HM-N, and HQ surveillance only; not reported to regulators
Recharge Basins: Surveillance (See Chapter 9)					
HT-E, HT-W	SER	SER	EPD	24 Hr. Composite	Metals (filtered/unfiltered), anions, gross alpha/beta, tritium, and gamma - sampled and analyzed semiannually

ENVIRONMENTAL MONITORING PLAN MATRIX FOR CALENDAR YEAR 2025

Sampling Location	Reporting to Regulators	Reporting to Departments	Lead Organization	Sample Type	Analysis/Frequency
HN, HS	SER	SER	EPD	24 Hr. Composite	Anions, gross alpha/beta, tritium, and gamma – sampled and analyzed semiannually
HT-E, HT-W, HS, HO, HZ	SER	SER	EPD	Grab Sample	VOCs (EPA 624) - sampled and analyzed semiannually
HZ, HO	SER	SER	EPD	Grab Sample	Metals (filtered/unfiltered), anions, gross alpha/beta, tritium, and gamma – sampled and analyzed semiannually
HW	SER	SER	EPD	Grab Sample	Anions, gross alpha/beta, tritium, and gamma – sampled and analyzed semiannually
CSF	SER	SER	EPD	Grab Sample	Anions, VOCs (EPA 624) - sampled and analyzed semiannually
Sewage Treatment Plant: Surveillance (See Chapter 9)					
EA	SER	SER	EPD	Composite	Sr-90 and gamma - sampled weekly and composited by contract analytical laboratory for monthly analysis
	SER	SER	EPD	Composite	Gross alpha/beta, tritium - sampled and analyzed weekly
DA	SER	SER	EPD	Composite	Sr-90 and gamma - sampled weekly and composited by contract analytical laboratory for monthly analysis
	SER	SER	EPD	Composite	Gross alpha/beta, tritium - sampled and analyzed weekly
Miscellaneous Monitoring (See Chapter 9)					
MH #192, STP influent and effluent to the primary clarifier	NA	NA	EPD	Daily Performance Check	Sewer line radiological monitors daily performance checked with Cs-137 button source
Surface Water - Peconic River: Surveillance (See Chapter 10)					
HY (outside RHIC Ring)	SER	SER	EPD	Grab Sample	Gross alpha/beta, gamma, tritium, Sr-90, metals (filtered/unfiltered), anions, VOCs (EPA 624) - sampled and analyzed semiannually
HV (inside RHIC Ring)	SER	SER	EPD	Grab Sample	Gross alpha/beta, gamma, tritium- sampled and analyzed semiannually
HM-S	SER	SER	EPD	Grab Sample	Metals (filtered/unfiltered), anions, VOCs (EPA 624), Sr-90, gross alpha/beta, gamma, and tritium - sampled and analyzed semiannually
HQ	SER	SER	EPD	24 Hr. Composite	Metals (filtered/unfiltered), anions - sampled and analyzed quarterly
HQ	SER	SER	EPD	24 Hr. Composite	Sr-90, gamma- sampled and analyzed quarterly
	SER	SER	EPD	24 Hr. Composite	Gross alpha/beta, tritium - sampled and analyzed quarterly
	SER	SER	EPD	Grab Sample	VOCs (EPA 624) - sampled and analyzed quarterly

ENVIRONMENTAL MONITORING PLAN MATRIX FOR CALENDAR YEAR 2025

Sampling Location	Reporting to Regulators	Reporting to Departments	Lead Organization	Sample Type	Analysis/Frequency
HH	SER	SER	EPD	Grab Sample	Metals (filtered/unfiltered), anions, VOCs (EPA 624), gross alpha/beta, gamma, and tritium - sampled and analyzed semiannually
Potable Water: Compliance (See Chapter 11)					
Potable Wells 7, 10, 11, and 12	WTPR	Yes	EPD	Grab Sample	Gross alpha/beta, gamma, tritium, Cs-137, Sr-90 - sampled and analyzed quarterly
Potable Wells 7, 10, 11, and 12	WTPR	Yes	EU	Grab Sample	Water quality (alkalinity/calcium) - sampled and analyzed biannually
Potable Wells 7, 10, 11, 12, and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	Inorganic chemicals (IOC Groups 1, 2, 3, 4) – sampled and analyzed annually
Potable Wells 7, 10, 11, 12, and GAC systems	WTPR	Yes	EU	Grab Sample	Tolytriazole (TTA) sampled annually
Potable Well 7 and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	Iron sampled and analyzed quarterly
Potable Wells 7, 10, 11, 12, GAC systems, and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	Principle Organic Contaminants (EPA 502.2) - sampled and analyzed annually
Potable Wells 7, 10, 11,12, GAC systems, and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	Bacteriology - sampled and analyzed quarterly
Potable Water Distribution System	WTPR	Yes	EU	Grab Sample	Bacteriology - sampled and analyzed at seven locations monthly
	WTPR	Yes	EU	Grab Sample	Water Quality - sampled and analyzed quarterly at three locations
	WTPR	Yes	EU	Grab Sample	Inorganic chemicals (IOC 1, 2, 3, 4), Nitrate/Nitrite, THMs, HAA5 - sampled and analyzed semiannually
	WTPR	Yes	EU	Grab Sample	Asbestos - sampled and analyzed once per year
	WTPR	Yes	EU	Grab Sample	Lead and Copper - sampled and analyzed annually at 20 locations
Potable Wells 10, 11, 12, and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	Hexavalent Chromium – sampled and analyzed annually
Potable Wells 10, 11, 12, and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	1,4 dioxane – sampled and analyzed quarterly

Environmental Monitoring Plan Matrix For Calendar Year 2025

Sampling Location	Reporting to Regulators	Reporting to Departments	Lead Organization	Sample Type	Analysis/Frequency
Potable Wells 7, 10, 11,12, and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	SOCs - sampled and analyzed once per year
Potable Wells 7, 10, 11, 12, GAC systems, and Water Treatment Facility	WTPR	Yes	EU	Grab Sample	Perfluoroalkyl substances (PFASs) – sampled and analyzed quarterly
Points of Entry	WTPR	Yes	EU	Grab Sample	Temperature, conductivity, and pH - sampled and analyzed biweekly by operating personnel
Groundwater: Compliance (See Chapter 12)					
Major Petroleum Facility (8 wells)	MPF License SER/GMR	Yes	EPD	Grab Sample	VOCs (EPA 8260) and Semi-VOCs (EPA 8270) - sampled and analyzed semiannually
	MPF License	Yes	EPD	Grab Sample	Floating product check monthly
Waste Management Facility (8 wells)	RCRA Permit/SER/ GMR	Yes	EPD	Grab Sample	VOCs (EPA 8260), tritium, gamma, gross alpha/beta - sampled and analyzed semi-annually
STP (8 wells)	SER/GMR DMR	SER/GMR	EPD	Grab Sample	Metals (unfiltered) annually
g-2 (5 wells)	SER/GMR	SER/GMR	EPD	Grab Sample	Tritium in wells immediately downgradient of source - sampled and analyzed semiannually. Other AGS surveillance wells located downgradient of Building 912 are sampled and analyzed for tritium annually.
BLIP (4 wells)	SER/GMR	SER/GMR	EPD	Grab Sample	Tritium - sampled and analyzed semiannually to annually
Groundwater: Surveillance (See Chapter 12)					
BMRR (4 wells)	SER/GMR	SER/GMR	EPD	Grab Sample	Sampling program is suspended starting in 2024.
RHIC (13 wells)	SER/GMR	SER/GMRl	EPD	Grab Sample	Tritium - sampled and analyzed semiannually
NSLS-II (6 wells)	SER/GMR	SER/GMR	EPD	Grab Sample	Tritium - sampled and analyzed annually
AGS (48 wells)	SER/GMR	SER/GMR	EPD	Grab Sample	Tritium - sampled and analyzed annually
Motor Pool Facility (2 wells)	SER/GMR	SER/GMR	EPD	Grab Sample	VOCs - sampled and analyzed annually and checked for floating product annually
Groundwater: Environmental Restoration - Long Term Response Actions (See Chapter 12)					
Site Background (9 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually
Current Landfill (12 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed quarterly to annually.

Environmental Monitoring Plan Matrix For Calendar Year 2025

Sampling Location	Reporting to Regulators	Reporting to Departments	Lead Organization	Sample Type	Analysis/Frequency
					Anions, metals, cyanide - sampled and analyzed semiannually; Gamma, tritium, Sr-90, PFAS, 1,4-dioxane - analyzed annually
OU X Former Firehouse (42 wells)	SER/GMR	NA	EPD	Grab Sample	1,4-dioxane, PFAS/PFOA semiannually to quarterly
OU III Middle Road (34 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually to quarterly
OU VI Ethylene Dibromide (36 wells)	SER/GMR	NA	EPD	Grab Sample	EDB - sampled and analyzed annually to quarterly
Chemical/Animal Holes (17 wells)	SER/GMR	NA	EPD	Grab Sample	Sr-90 - sampled and analyzed annually to semiannually
OU I South Boundary (30 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs, Sr-90 - sampled and analyzed annually to quarterly
OU III North Street (7 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs – sampled annually
William Floyd Sentinel monitoring (6 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs, Sr-90, tritium, gamma, 1,4-dioxane, PFAS/PFOA sampled and analyzed quarterly
OU III Building 96 (35 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually to quarterly
OU III South Boundary (28 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually to quarterly
OU X Current Firehouse (77 wells)	SER/GMR	NA	EPD	Grab Sample	1,4-dioxane, PFAS/PFOA semiannually to quarterly
OU III Western South Boundary (35 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually to quarterly
OU III Magothy (21 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually to quarterly
OU III (BGRR/WCF Sr-90) (66 wells)	SER/GMR	NA	EPD	Grab Sample	Sr-90, tritium, and Cs-137 - sampled and analyzed monthly to annually. VOCs sampled annually
OU III – HFBR (10 wells)	SER/GMR	NA	EPD	Grab Sample	Tritium - sampled and analyzed quarterly
OU III –Industrial Park (40 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually and quarterly
OU IV – AOC 6 (24 wells)	SER/GMR	NA	EPD	Grab Sample	Sr-90 - sampled and analyzed annually to semiannually
OU III Long Island Power Authority (17 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed quarterly
OU III North Street East (12 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed annually. EDB sampled and analyzed quarterly and semi-annually
OU III Airport (31 wells)	SER/GMR	NA	EPD	Grab Sample	VOCs - sampled and analyzed quarterly and semi-annually
Landfill Gas and Surface Leachate Monitoring (See Chapter 13)					
BNL Landfills, Soil Gas Monitoring - Current Landfill (58 sampling points) & Former Landfill (24 sampling points)	ALMR	NA	EPD	Grab Sample	Methane and hydrogen sulfate - sampled and analyzed quarterly for the Current Landfill and annually for the Former Landfill

Note: See Appendix A for acronym definitions.

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