

Environmental Management System

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Brookhaven Science Associates (BSA), the contractor operating the Laboratory on behalf of the Department of Energy (DOE), takes environmental stewardship very seriously. As part of its commitment to environmentally responsible operations, BSA has established the Brookhaven National Lab (BNL) Environmental Management System (EMS). An EMS ensures that environmental issues are systematically identified, controlled, and monitored. Moreover, an EMS provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement.

The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard, which encompasses ideals such as compliance, sustainable operations, and community involvement. Annual audits by an independent third party are required to maintain an EMS registration, with a full recertification assessment of the entire EMS occurring every three years. During 2022, a surveillance assessment was performed with no nonconformances identified. BNL's continued conformance to the ISO 14001 Standard continues uninterrupted.

BNL documents its efforts to implement sustainable business practices into operations and infrastructure in its Site Sustainability Plan (SSP). The areas of focus are water conservation, waste reduction, recycling, purchase of environmentally friendly products, greenhouse gas management, and other adaptation and resilience planning. New this year are objectives addressing net-zero carbon-free emission goals in line with larger DOE plans to address the impacts from climate change.

In 2022, the ISO 14001-registered EMS and Pollution Prevention (P2) Program continued to contribute to the Laboratory's success in improving sustainable operations. The Lab provides strong support for the P2 Program, which seeks ways to eliminate waste and toxic materials on site and promote other sustainable business activities. The program generates new ideas to grow the Lab's existing recycling program or otherwise improve sustainable operations. In 2022, the P2 Program resulted in nearly \$1.4 million in cost avoidance or savings and resulted in the reduction or reuse of approximately 1.4 million pounds of waste. The program funded 12 new proposals, investing approximately \$15,000. The proposals involved reducing risk, promoting use of bio-friendly alternative products, small-energy efficiency projects, and promoting overall environmentally sustainable business practices. Support was also provided in 2022 to line organizations for lab cleanouts and disposal of chemicals. As a testament to its strong environmental program, the Lab received the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT) Gold Award, its seventh DOE's GreenBuy Gold Award, and third GreenBuy Superior Award.

BNL continues to address legacy environmental issues and openly communicates with neighbors, regulators, employees, and other interested parties on environmental issues and cleanup progress on site. BNL maintained a high level of communication and interaction with the community, regulators, and employees, as the Lab began to lift COVID-19 controls. In 2022, BNL hosted virtual meetings of the Community Advisory Council (CAC), Brookhaven Executive Roundtable (BER), virtual tours, a reenergized virtual speakers bureau, and monthly interagency calls with regulators. BNL is committed to transparency and open communication with its internal and external stakeholders.

BNL conducts all these activities while maintaining a commitment to environmental justice, both by considering the impacts of its activities on local disadvantaged communities during planning activities as well as community involvement activities that provide educational opportunities to students from disadvantaged communities.

2.1 INTEGRATED SAFETY MANAGEMENT AND ISO 14001

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

- *Define the scope of work:* Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.
- *Analyze the hazards:* Hazards associated with the work are identified, analyzed, and categorized.
- *Develop and implement hazard controls:* Applicable standards and requirements are identified and agreed-upon; controls to prevent and mitigate hazards are identified; the safety envelope is established; and controls are implemented.
- *Perform work within controls:* Readiness is confirmed and work is performed safely.
- *Provide feedback and continuous improvement:* Feedback information on the adequacy of controls is gathered; opportunities for improving the definition and planning of work are identified and implemented.

The seven Guiding Principles, also as defined by DOE P 450.4, are:

- *Line management responsibility for safety:* Line management is directly responsible for the protection of the workers, the public, and the environment.
- *Clear roles and responsibilities:* Clear and unambiguous lines of authority and responsibility for ensuring safety are established and maintained at all organizational levels within the Department and its contractors.
- *Competence commensurate with responsibilities:* Personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.
- *Balanced priorities:* Resources are effectively allocated to address safety, programmatic, and operational considerations. Protecting

the workers, the public, and the environment is a priority whenever activities are planned and performed.

- *Identification of safety standards and requirements:* Before work is performed, the associated hazards are evaluated and an agreed-upon set of safety standards and requirements is established which, if properly implemented, will provide adequate assurance that the workers, public, and environment are protected from adverse consequences.
- *Hazard controls tailored to work being performed:* Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.
- *Operations authorization:* The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed upon.

The integrated processes within ISMS contribute to BNL maintaining its ISO 14001 registration. The ISO 14001 Standard is globally recognized and defines the structure of an organization's EMS for purposes of improving environmental performance. The process-based structure of the ISO 14001 Standard is based on the "Plan-Do-Check-Act" improvement cycle. The ISO 14001 standard requires an organization to develop a policy, create plans to implement the policy, implement the plans, check progress and take corrective actions, and review the system periodically to ensure its continuing suitability, adequacy, and effectiveness.

The Laboratory has been officially registered to the ISO 14001 Standard since 2001. The Laboratory was the first DOE Office of Science Laboratory to achieve this registration. The certification requires the Laboratory to undergo annual audits by an accredited, third-party registrar to assure that the system is maintained. BNL's external certification organization, ERM Certification Verification Services, conducted an external surveillance audit of BNL's conformance to the ISO 14001 Standard in August 2022 with no nonconformances, verifying the Laboratory's continued conformance to the Standard. BNL's certification to the standard remains valid until September 27, 2024.

2.2 ENVIRONMENTAL, SAFETY, SECURITY, AND HEALTH POLICY

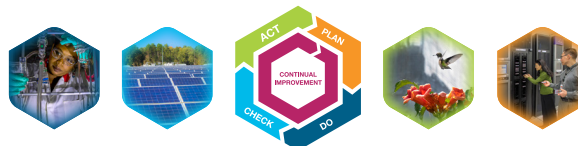
The cornerstone of an EMS is a commitment to environmental protection at the highest levels of an organization. BNL's environmental commitments are incorporated into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy. The policy continues as a statement of the Laboratory's intentions and principles regarding overall environmental performance. It provides a framework for planning and action and is included in employee, guest, and contractor training programs. The ESSH Policy is posted throughout the Laboratory and on the BNL website at <http://www.bnl.gov/esh/policy.php>. The Policy's goals and commitments focus on compliance, pollution prevention, community outreach, and continual improvement:

- **Environment:** We protect the environment, conserve resources, and implement sustainable business practices that protect our future.
- **Safety:** We maintain a safe workplace. We plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers, and guests.
- **Security:** We protect people, property, information, computing systems, and facilities.
- **Health:** We protect human health within our boundaries and in the surrounding community.
- **Compliance:** We achieve and maintain compliance with applicable ESSH requirements.
- **Community:** We maintain open, proactive, and constructive relationships with our employees, neighbors, regulators, the U.S. Department of Energy, and other stakeholders.
- **Continual Improvement:** We continually improve ESSH performance.

2.3 PLANNING

The planning requirements of the ISO 14001 Standard require BNL to identify the environmental aspects and impacts of its activities, products, and services; evaluate applicable compliance obligations; establish objectives and targets; create action plans to achieve the objectives and targets; and identify and address risks and opportunities that can impact the success of the EMS.

Environmental, Safety, Security, and Health Policy



This document is a statement of Brookhaven National Laboratory's Environmental, Safety, Security, and Health (ESSH) policy. Brookhaven Lab is a world leader in scientific research and performs this work in an environmentally responsible, safe, and secure manner.

I expect every employee, contractor, and guest to take personal responsibility for adhering to the following principles:

Environment	We protect the environment, conserve resources, and implement sustainable business practices that protect our future.
Safety	We maintain a safe workplace. We plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers, and guests.
Security	We protect people, property, information, computing systems, and facilities.
Health	We protect human health within our boundaries and in the surrounding community.
Compliance	We achieve and maintain compliance with applicable ESSH requirements.
Community	We maintain open, proactive, and constructive relationships with our employees, neighbors, regulators, the U.S. Department of Energy, and other stakeholders.
Continual Improvement	We continually improve ESSH performance.

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

Signed 
Doon Gibbs, Director

October 13, 2021



2.3.1 Environmental Aspects

An "environmental aspect" is any element of an organization's activities, products, and services that can impact the environment. As required by the ISO 14001 Standard, BNL evaluates its operations, identifies the aspects that can impact the environment, and determines which of those impacts are significant. The Laboratory's criteria for significance are based on actual and perceived impacts of its operations and on regulatory requirements. BNL uses its work planning process to identify and review environmental aspects associated with activities. A Process Assessment Procedure is used for facilities and equipment or for deeper analysis of activities not sufficiently covered by work planning. Evaluations are documented on work plans and Process Assessment Forms (PAFs).

Environmental professionals work closely with Laboratory personnel to ensure that work plans, PAFs, and other related reviews thoroughly capture all aspects, requirements, and associated

environmental controls. Aspects and impacts are evaluated annually to ensure that they continue to reflect stakeholder concerns and changes in regulatory requirements.

2.3.2 Compliance Obligations

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

BNL follows DOE Order 436.1, Departmental Sustainability, which is based on federal executive orders that establish sustainability goals for federal agencies focusing on reducing carbon emissions to address climate change issues, with guidance, recommendations, plans, and numerical targets. DOE 436.1 provides requirements and responsibilities for managing sustainability within DOE to ensure facilities are working towards sustainability goals established in its Strategic Sustainability Performance Plan (SSPP). New expectations set through recent changes on the federal level have been flowed down to BNL through the SSP reflecting the expectations in Executive Orders (EO) 14057, Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, December 8, 2021, and EO 14008, Tackling the Climate Crisis at Home and Abroad, January 27, 2021, which set new federal-level sustainability goals. All of the goals related to the new executive orders are consolidated in the Federal Sustainability Plan (www.sustainability.gov/federal-sustainability-plan/). Each DOE facility is required to have an SSP in place detailing the strategy for achieving these long-term goals along with due dates and a requirement to provide an annual status. These requirements will influence the future of the Laboratory's EMS program and have been incorporated into BNL's SSP, which can be found in Appendix E and identifies the DOE SSP goals, the Laboratory's performance in 2022, and future planned actions and contributions.

2.3.3 Objectives and Targets

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

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

Additional laboratory-level objectives and targets are developed on a fiscal year (FY) schedule through the implementation of the business planning process as well as in the SSP. For FY 2022, BNL's environmental objectives included addressing emerging contaminants in drinking water, supporting the Lab's scientific mission by providing environmental support to significant research projects, supporting building demolition and legacy clean-up issues, maintaining ISO 14001 certification, and furthering progress on SSP objectives relating to energy conservation, water conservation, fleet management, clean/renewable energy, sustainable buildings, green procurement, electronics stewardship, and organizational resilience.

2.3.4 Environmental Management Programs

The Environmental Protection Division (EPD) takes on the largest role for developing action plans for implementing institutional environmental priorities, while other organizations within BNL develop action plans as applicable to their

operations. The plans detail how the organization will achieve its environmental objectives and targets, as well as commit the resources necessary to successfully implement both Laboratory-wide and facility-specific programs. BNL has a budgeting system designed to ensure that priorities are balanced and provide resources essential to the implementation and control of the EMS. The Laboratory continues to review, develop, and fund important environmental programs to further integrate environmental stewardship into all facets of its missions.

2.3.4.1 Compliance

BNL has an extensive program to ensure that the Laboratory remains in full compliance with all applicable environmental regulatory requirements and permits. Legislated compliance is outlined by the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs), Clean Water Act (e.g., State Pollutant Discharge Elimination System [SPDES]), Safe Drinking Water Act (SDWA), Resource Conservation and Recovery Act (RCRA), and other programs. Other compliance initiatives at the Laboratory involve special projects, such as monitoring drinking water systems for emerging contaminants, establishing a wildland fire program, increasing on-site pollinator habitat, retrofitting or replacing air conditioning equipment refrigerants, and managing legacy facilities. See Chapter 3 for a list of regulatory programs to which BNL subscribes and a thorough discussion of these programs and their status.

2.3.4.2 Groundwater Protection

BNL's Groundwater Protection Program is designed to prevent negative impacts to groundwater and restore groundwater quality by integrating pollution prevention efforts, monitoring, groundwater restoration projects, and communicating performance. The Laboratory has developed a Groundwater Protection Contingency Plan that defines an orderly process for quickly verifying the results and taking corrective actions in response to unexpected monitoring results (BNL 2018). Key elements of the groundwater program are full, timely disclosure of any off-normal occurrences and regular communication on the performance of the program.

Chapter 7 and SER Volume II, Groundwater Status Report, provide additional details about this program, its performance, and monitoring results for 2022.

2.3.4.3 Waste Management

In alignment with Departmental sustainability goals communicated via the 2022 DOE SSP process, this section has been updated to better illustrate BNL's waste streams and process towards net-zero waste generation. Base calculations have been modified for accuracy so that diversion percentages are not directly comparable to the history, but more clearly reflect the Lab's full waste profile. Explanations for specific changes will be noted in the text.

Due to the world-class research it conducts, BNL generates a wide range of wastes. These wastes include materials common to many businesses and industries, such as municipal solid waste (MSW) and non-hazardous construction and demolition (C&D) debris. As per Figure 2-2, BNL generated 256 tons of MSW and 196 tons of C&D waste during 2022.

The Laboratory's unique scientific activities also generate specialized waste streams that are subject to additional regulation and special handling, including radioactive, hazardous, industrial, and mixed waste. BNL's Waste Management Facility (WMF), operated by the EPD, is responsible for collecting, storing, transporting, and managing the disposal of these specialized wastes. This facility was designed for handling hazardous, industrial, radioactive, and mixed waste, and is comprised of two staging areas: a facility for hazardous, industrial, and mixed waste in Building 855, regulated by RCRA, and a reclamation building for radioactive material in Building 865. The RCRA building is managed under a permit issued by the New York State Department of Environmental Conservation (NYSDEC).

These buildings are used for short-term storage of waste before it is packaged or consolidated for off-site shipment to permitted treatment and disposal facilities. Waste can either be generated from routine operations, defined as ongoing industrial and experimental operations, or from non-routine, defined by waste generated by remediation projects, facility decommissioning

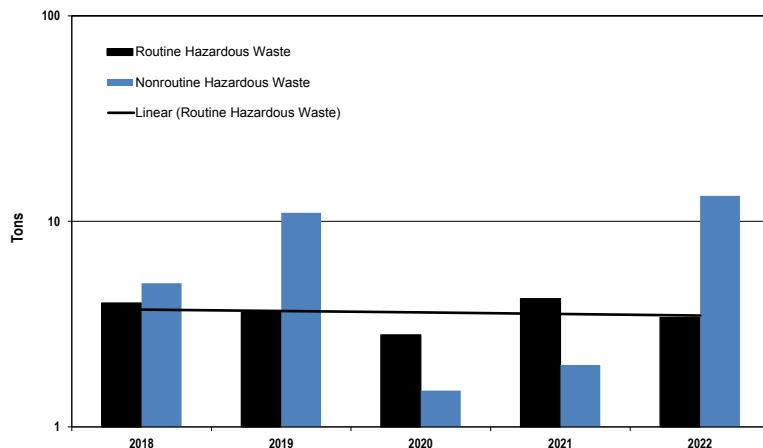


Figure 2-1a. Hazardous Waste Generation from Routine and Nonroutine Operations, 2018 – 2022.

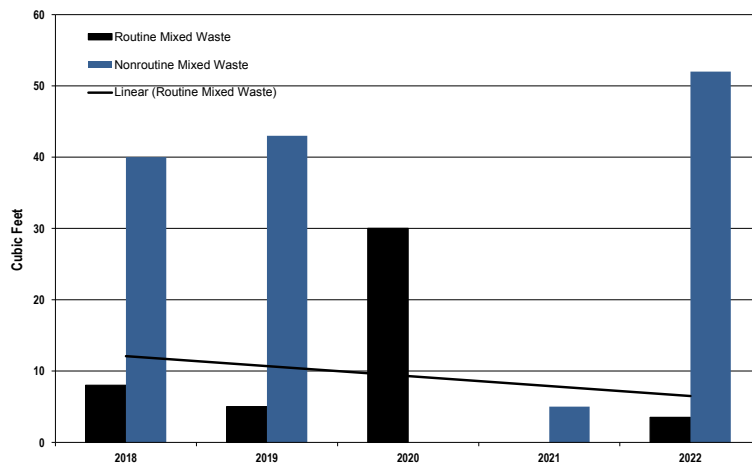


Figure 2-1b. Mixed Waste Generation from Routine and Nonroutine Operations, 2018 – 2022.

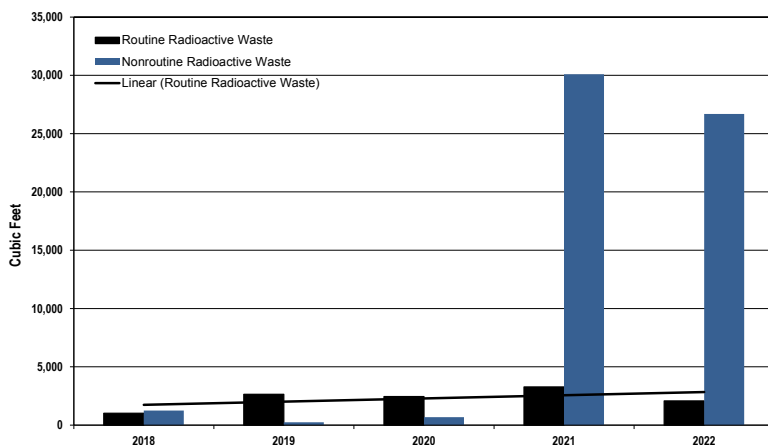


Figure 2-1c. Radioactive Waste Generation from Routine and Nonroutine Operations, 2018 – 2022.

activities, or one-time events (e.g., lab cleanouts). In 2022, BNL generated the following types and quantities of waste from routine operations:

- Hazardous waste: 3.8 tons
- Mixed waste: 3.5 ft³ (0.05 tons)
- Radioactive waste: 2,787 ft³ (228 tons)

Hazardous waste from routine operations decreased somewhat during 2022, as shown in Figure 2-1a, but is still reflective of normal generation patterns. Routine hazardous waste comes from a variety of Laboratory operations across site. Waste generation from nonroutine operations can vary significantly from year to year as various decommissioning and remedial actions are conducted. A large portion of the nonroutine hazardous waste during 2022 was generated by decommissioning a lithium bromide chiller in the Chilled Water Plant.

Routine mixed waste consisting of various miscellaneous materials such as lead, light bulbs, and circuit boards for 2022 is shown in Figure 2-1b. The increase in nonroutine mixed waste represents disposal of HEPA filters from the Building 650 Hot Laundry demolition that occurred during 2021.

Routine radioactive waste generated primarily from BNL's medical isotope research program shows a trend towards more waste generation as isotope production increases as shown in Figure 2-1c. The non-routine radioactive waste disposed of was generated during the demolition of the former Brookhaven Medical Research Reactor stack (Building 491) during 2021.

2.3.4.4 Pollution Prevention and Waste Minimization

The BNL Pollution Prevention (P2) Program reflects national and DOE pollution prevention goals and policies and represents an ongoing effort to make pollution prevention and waste

minimization an integral part of BNL's operating philosophy.

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

- Eliminate or reduce emissions, effluents, and waste at the source where possible, as practicable towards a goal of net-zero waste generation;
- Procure environmentally preferable products (known as "affirmative procurement");
- Conserve natural resources and energy;
- Promote transition to low-carbon emitting technology;
- Reuse and recycle materials;
- Achieve or exceed BNL/DOE waste minimization, P2, recycling, and affirmative procurement goals;
- Comply with applicable requirements (e.g., New York State Hazardous Waste Reduction Goal, executive orders, etc.);
- Reduce waste management costs;
- Improve employee and community awareness of P2 goals, plans, and progress.

The BNL P2 and recycling programs have achieved long-term reductions in waste generated by routine operations that are balanced by increases in waste generation caused by Laboratory growth. Overall waste trends can be seen in Figure 2-2 with past swings in C&D debris generated as the site was cleared for the the Science User Support Center (SUSC) currently under construction. Site development activities will continue to focus on the demolition of buildings with continued contribution to this waste stream. Radioactive and mixed wastes are not included in this analysis. The recent decrease in MSW generation is associated with the reduction in staff working on site during the COVID pandemic and is expected to increase again with the return to close to normal staff levels on site.

BNL's EMS establishes objectives and targets to drive sustainable business practices, including the annual P2 Program that provides funds to purchase equipment or other materials to either reduce an environmental risk or reduce or eliminate a waste stream. Table 2-1 describes all the waste streams that were diverted from disposal as MSW during 2022, and provides the number of pounds of materials reduced, reused, or recycled, as well as the estimated cost benefit of each project.

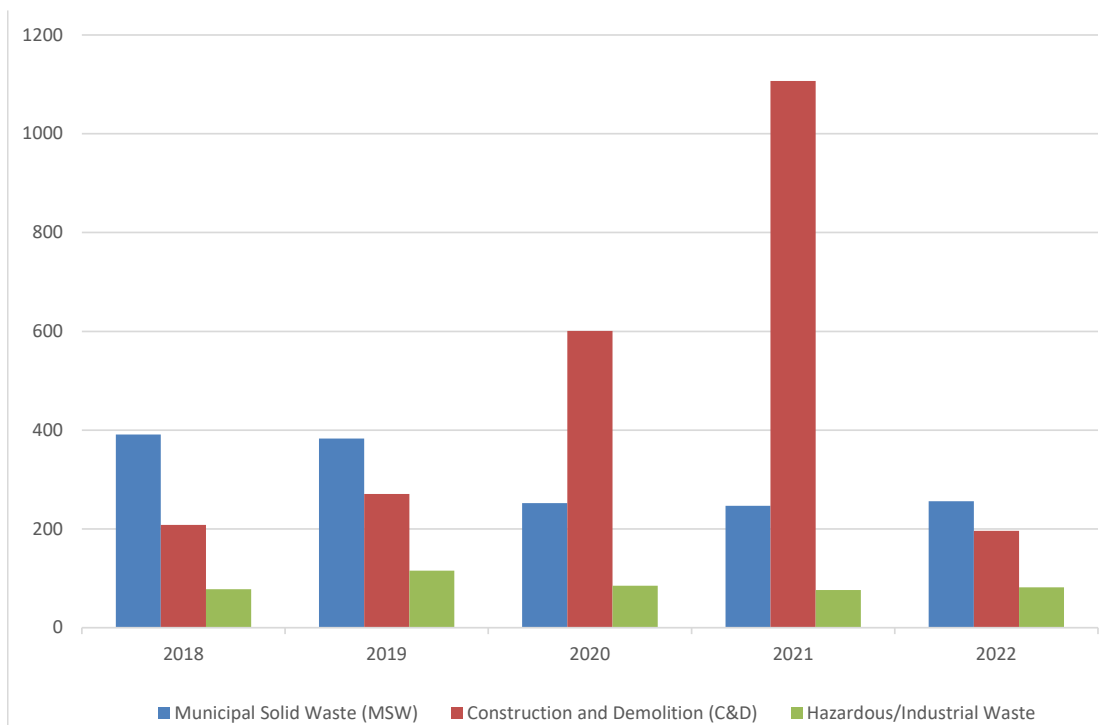


Figure 2-2. Waste Disposal in Tons, 2018 - 2022.

CHAPTER 2: ENVIRONMENTAL MANAGEMENT SYSTEM

Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2022.

Municipal Solid Waste (MSW) Recycled	Tons	Estimated Cost Savings	Project Description Details
Office Paper	35.1	\$11,106	Collected and transported to a transfer facility for recycling along with regular trash, daily construction and demolition debris (C&D) from daily maintenance activities, and other recyclables. Savings are based on cost to dispose of as trash at \$240/ton vs. recycling at a flat fee of \$13K for all paper and cardboard and no cost/revenue for bottles and cans.
Cardboard	58.8		
Bottles/Cans	6.6		
Printer Toner Cartridges	0.6	\$137	Savings are based on cost to dispose of as trash based vs. recycling at \$0 cost/revenue.
Metals	338.1	\$108,184	Cost avoidance was based on disposal as trash, plus revenue based on \$0.04/lb.
Tires	9.8	\$2,354	Truck tires were sent for recycling from the motor pool at \$0 cost/revenue. Cost savings were based on cost to dispose of as trash at \$240/ton.
Blasting Garnet	0.0	\$0	Garnet used in machine shop was sent for recycling at \$0 cost/revenue. Cost savings were based on cost to dispose of as regulated industrial waste. No garnet was recycled during 2022.
Electronic Waste	78.1	\$81,203	Cost avoidance was based on disposal as trash, plus revenue based on \$0.40/lb.
Total Tons of Material Recycled for 2022:	527	\$202,984	Total Savings Achieved
Total Tons of MSW Disposed of for 2022:	256	67%	Total Diversion from a MSW Landfill
Construction and Demolition Debris Recycled	Tons	Estimated Cost Savings	Project Description Details
Building 197 East Side Demolition (Metal)	17	\$1,700	Recycled at \$0 cost/revenue. Savings based on the cost to landfill at \$0.05/lb
Building 197 East Side Demolition (Concrete)	128	\$12,800	Crushed offsite for reuse. Savings based on the cost to landfill at \$0.05/lb
Total Tons Demolition-Related C&D Debris Diverted From a C&D Landfill For 2022:	145	\$14,500	Total Savings Achieved
Other Regulated Waste Streams (Hazardous/Industrial Waste) Recycled	Tons	Estimated Cost Savings	Project Description Details
Used Oil (Motor Pool, Oil Skimmer) (Sent for Energy Recovery)	5	\$4,456	Used motor oil from automobiles and compressor oil condensers is sent to a vendor for energy recovery. In 2022, they collected 1,271 gallons (5 tons) for \$1,275, which avoided the costs for disposal as used oil at \$43.81/drum plus the cost of 24 shipping drums at \$195/drum.
Lead Scrap (Recycled)	4	\$6,298	Cost avoidance was based on \$0.52/lb for disposal as hazardous waste, plus revenue based on \$0.30/lb.
Lead Acid Batteries (Recycled)	14	\$11,478	Avoided universal waste disposal costs of \$0.40/lb. for lead and sulfuric acid batteries by sending directly for recycling at \$0 cost/revenue.
Total Tons of Material Diverted for 2022:	23	\$22,232	Total Savings Achieved
Total Tons "Other" Waste Disposed for 2022:	82	22%	Total Diversion from Other Disposal/Treatment (Hazardous Waste, Used Oil, Waste Water)

(continued on next page)

Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2022.

Materials Resued Onsite (Not included in diversion calucations)	Tons	Estimated Cost Savings	Project Description Details
Carbon Reuse - GW Cleanup Systems	28	\$90,000	Sent offsite for regeneration then returned for re-use. Savings are based on the cost to buy new carbon. Additional savings for avoiding disposal as industrial waste are not included as the value is unknown.
Electronic Reuse	11	\$1,138,985	The Laboratory resues electronic equipment if possible. If not reused, the electronics would provide scrap metal revenue at \$0.40/lb. Savings are based on the cost of purchasing the reused items as new items minus the scrap value.
Concrete Reuse	0	\$0	Concrete from demolitions was stored onsite and crushed for reuse in other construction projects (sidewalks, parking lots). No on-site stored concrete was crushed for reuse during 2022.
Blasocut Machining Coolant	0	\$0	Central Shops Division operates a recycling system that reclaims Blasocut, an aqueous machining coolant. Recycling involves aeration, centrifuge, and filtration. Due to transitional staff and operational issues, the system was not used during 2022.
Total Tons of Material Diverted for 2022:	39	\$1,228,985	Total Cost Avoidance Achieved

Total of All Material Recycled or Reused: 695 Tons

Total Savings and Cost Avoidance from Recycling and Reuse: \$1.4 Million

The P2 program also provides funding for the line organizations to implement new hazard reduction or sustainability ideas. During 2022, the program funded 12 new proposals, investing approximately \$15,000. The proposals involved reducing risk, promoting use of bio-friendly alternative products, improving small energy-efficiency projects, and promoting overall environmentally sustainable business practices.

The implementation of P2 opportunities, recycling programs, and conservation initiatives has reduced both waste volumes and management costs. In 2022, these efforts resulted in nearly \$1.4 million in cost avoidance or savings and approximately 695 tons (1.4 million pounds) of materials being reduced, recycled, or reused annually.

In 2022, BNL collected approximately 338 tons of scrap metal for recycling. Cardboard, office paper, bottles and cans, construction debris, motor oil, lead, automotive and uninterrupted power supply (UPS) batteries, electronic scrap, fluorescent light bulbs, and tires were also recycled. Table 2-1 shows the total number of tons

of the materials recycled. The baseline recycling rate goal for federal facilities is 50 percent. BNL's annual average recycling rate for MSW diversion consistently outperforms the baseline. The 2022 annual recycling rate was 67 percent. This calculation was changed to better delineate MSW from hazardous waste streams. Used motor oil, lead scrap, lead batteries, and fluorescent bulbs are regulated hazardous and industrial waste streams that are being recycled. In the past, credit was taken for recycling these waste streams against the Laboratory's MSW disposal. These recycling streams have been pulled out and will be counted against the hazardous and industrial waste streams as shown in Table 2-1. Also, only the hazardous waste stream was being counted in the past. The industrial waste that had been left out of this calculation in the past refers to any waste that is not RCRA hazardous waste, but still can't be disposed of as MSW based on New York State solid waste regulations, used oil requirements, or other regulation. This waste stream is mainly made up of used oil and other

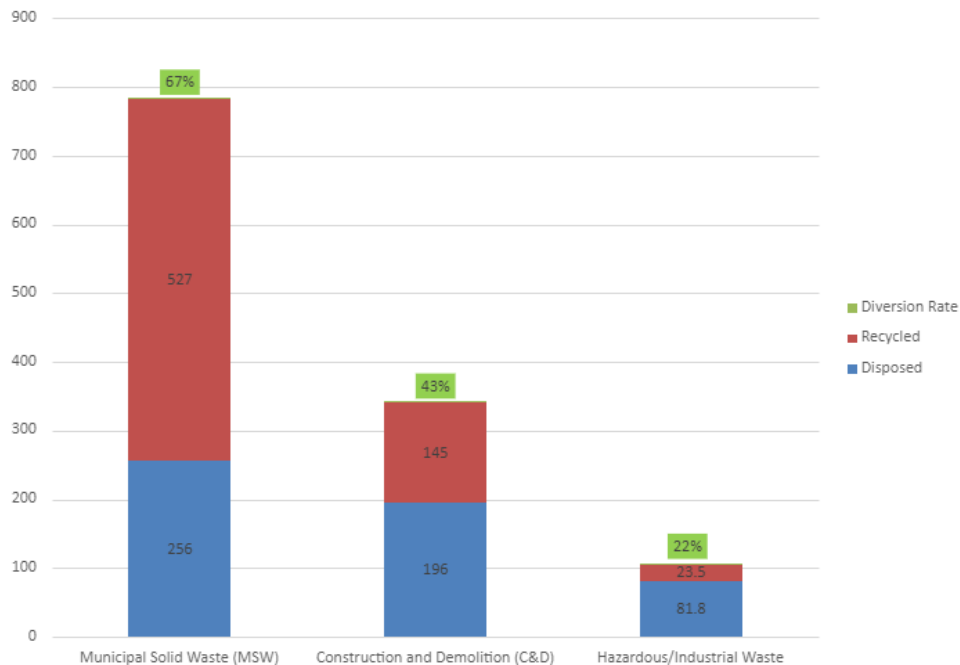


Figure 2-3. Waste Diversion in Tons, 2022.

lubricants and machining fluids, wastewater that cannot be discharged to the sanitary or storm-water system, and low toxicity chemicals that do not meet the definition of the RCRA hazardous waste. Waste streams that are collected onsite and recycled for on-site reuse have been taken out of the recycling calculation to maintain consistency with the calculation in the SSP. Figures 2-2 and 2-3 were developed to better illustrate BNL's overall waste generation along with its diversion accomplishments.

In 2022, BNL's sustainability program was once again honored by receiving the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT) Award for purchasing EPEAT-registered electronic products which meet strict environmental criteria that address the full product lifecycle, from energy conservation to toxic materials to product longevity and end-of-life management. BNL also received a seventh DOE's GreenBuy Gold Award and third GreenBuy Superior Award. The GreenBuy Award recognizes DOE sites for purchases of materials that are energy and water efficient and made from bio-based or recycled content material. The GreenBuy Superior Award identifies BNL as a site that has achieved GreenBuy Gold status five or more times.

2.3.4.5 Water Conservation

BNL's water conservation program has achieved dramatic reductions in water use since the mid-1990's. The Laboratory continually evaluates water conservation as part of facility upgrades or new construction initiatives. These efforts include more efficient and expanded use of chilled water for cooling and heating/ventilation and air conditioning (HVAC) systems to reduce use of once-through cooling water for other systems. The Laboratory's goal is to reduce the consumption of water and reduce the possible impact of clean water dilution on Sewage Treatment Plant (STP) operations.

Figure 2-4 shows the 20-year trend of water consumption. Staff returning to work post-COVID resulted in a slight increase in water use from last year. However, the water intensity (gallon/gross square foot) continues to decrease. In each of the past ten years, the water consumption total was approximately half the 1999 total—a reduction of nearly a half billion gallons per year. Moreover, BNL has shifted its wastewater treatment in recent years to primarily an aquifer recharge system. This method of wastewater rejection significantly reduces the Lab's impact on the depletion of the sub-surface sole source aquifer that supplies all Long Island communities, including native and

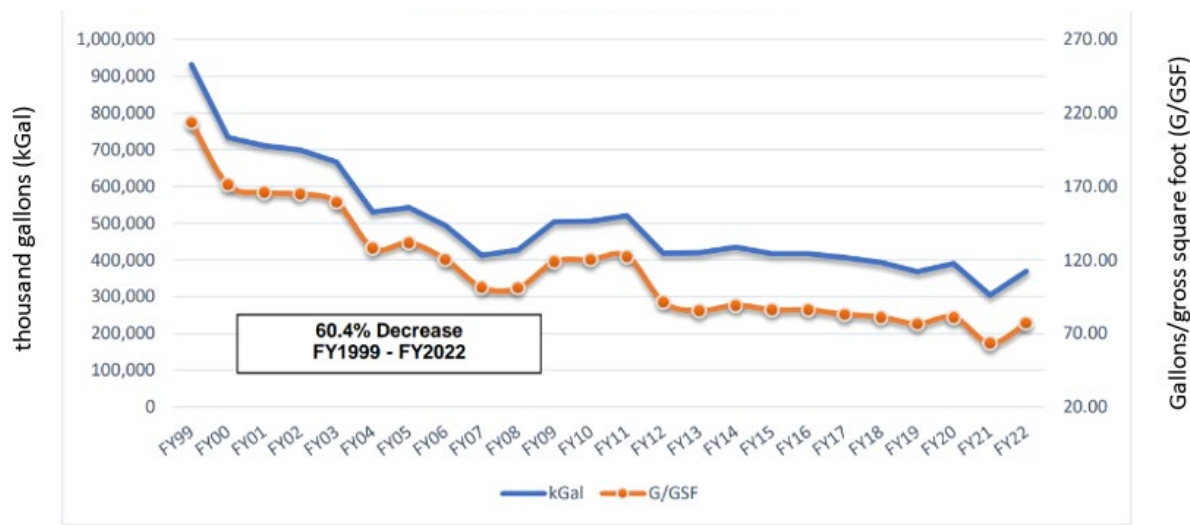


Figure 2-4. Annual Potable Water Use, 1999 - 2022.

disadvantaged communities, thus aiding environmental justice goals. This aquifer recharge also prevents run-off and the conveyance of surface pollutants to local waterways.

2.3.4.6 Energy Management and Conservation

The Laboratory's Energy Management Group continues to reduce energy use and costs by identifying and implementing cost-effective, energy-efficient projects; monitoring energy use and utility bills; and assisting in obtaining the least expensive energy sources possible. The group is responsible for developing, implementing, and coordinating BNL's energy management efforts and assisting DOE in meeting the energy and sustainability goals in EO 13834, DOE Order 436.1, and the U.S. Secretary of Energy's initiatives. The Laboratory's SSP addresses all aspects of the DOE energy, water, transportation, and other sustainability goals. In the future, the SSP will reflect new goals as directed by the DOE as part of the Federal Site Sustainability Plan. The goals will be focused on a reduction of carbon emissions emitted by federal facilities to reduce the impact of climate change.

BNL has more than 4.8 million square feet of building space. Many scientific experiments at the Laboratory use particle beams generated and accelerated by electricity, with the particles controlled and aligned by large electromagnets. In

2022, BNL used 258 million kilowatt hours (kWh) of electricity, 382,000 gallons of fuel oil, 8,580 gallons of propane, and 568 million cubic feet of natural gas. Fuel oil and natural gas are used to produce steam at the Central Steam Facility (CSF).

Responding to market conditions, fuel oil and natural gas have been historically used whenever each respective fuel is least expensive. Given the price disparity between natural gas and oil, the Laboratory will continue to purchase natural gas over oil in the future, further reducing greenhouse gas (GHG) emissions. In 2022, natural gas prices once again continued to be lower than fuel oil prices. However, BNL burned its supply of #6 fuel oil for heat in anticipation of the upcoming ban of the use of #6 fuel oil recently enacted by New York State, as well as emptied the tanks to hold #4 fuel oil. Additional #2 fuel oil was also burned for upcoming tank testing. As a result, 2022 usage reflects a one-year spike in fuel oil usage. Additional information on natural gas and fuel oil use can be found in Chapter 4.

New York State still has electric load reduction curtailment programs when the New York Independent System Operator expects customer demand to meet or exceed the available supply. In return for reducing its electrical load, BNL would receive credit for megawatts reduced on each curtailment day. However, BNL's participation is dependent on the operation of the Relativistic Heavy Ion Collider

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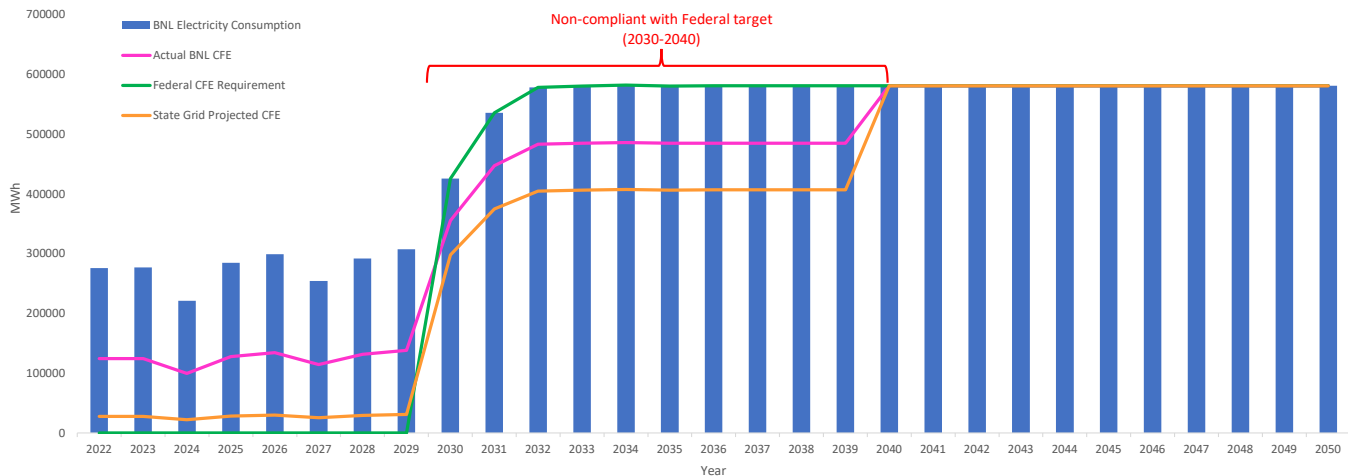


Figure 2-5. Carbon Free Electricity Targets

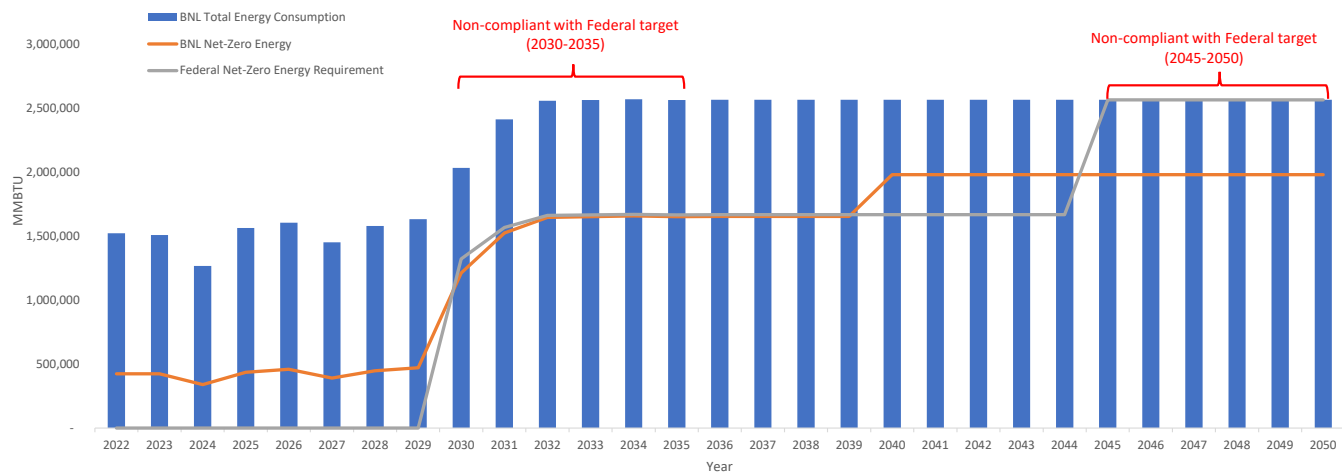


Figure 2-6. Net-Zero Emissions Goals

(RHIC) which operates at 25 megawatts (MW). RHIC plans to operate through 2025, including summer run times, so further program participation is unlikely.

In 2022, BNL's energy supply included 121 million kWh of clean, renewable hydropower energy, 644,500 kWh of on-site generated solar photovoltaic (PV), and 24 million kWh of purchased renewable energy certificates (REC). The Laboratory will continue to seek alternative energy sources to meet its future energy needs, support federally required "green" initiatives, and reduce energy costs.

In 2011, BP Solar completed construction of the Long Island Solar Farm (LISF) on BNL property. The array is one of the largest solar PV arrays (32

MW) in the Northeast and spans 195 acres with more than 164,000 panels. BNL worked extensively with Long Island Power Authority (LIPA), BP Solar, the State of New York, and other organizations to evaluate the site and develop the project, with LIPA purchasing the output through a 20-year Power Purchase Contract.

The LISF is expected to produce an average of 44 million kWh of power for Long Island and has been performing over 50 million kWh/year. As an outcome of allowing this large array to be constructed on site, the Laboratory has developed a solar research program that looks at impacts of climate change on large utility-scale PV systems, as well as research and development for solar

power storage and inverter efficiencies. The Federal Energy Management Program (FEMP) recognizes the importance of the efforts of BNL and the DOE Brookhaven Site Office to host the LISF and provides credit toward BNL's SSP renewable energy goal.

In May 2015, the Laboratory completed the installation of the first phase of the solar PV research array as part of the Northeast Solar Energy Research Center (NSERC). In 2016, the array was increased to 816 kW with substantial funding assistance from the Sustainability Performance Office (SPO). In 2022, the NSERC generated 644,500 kWh of electricity for use on-site offsetting 365 MT CO₂e.

To reduce energy use and costs at non-research facilities, several activities were continued or undertaken by the BNL Energy Management Group in 2022:

- *NYPA Power Contract:* The contract has been extended to 2030 for overall power with a five-year provision for hydropower and the intent of extending the hydropower to 2030. The contract includes 15 MW of renewable (nearly zero GHG) hydropower. This contract saved over \$25 million in 2022.
- *DOE Sustainability Initiative:* The Energy Management Group continues to provide substantial support to the Federal/DOE-wide Sustainability Initiative and has created a BNL Sustainability Leadership Team. The team has developed a formal site-wide sustainability program beyond DOE requirements, participates in one of three subcommittees for DOE on sustainability initiatives, and provides numerous evaluations and estimates on energy use, GHG, renewable energy, and energy-efficiency options.
- *Continued progress occurred on several initiatives included in BNL's annual SSP in 2022, such as the following:* New electric, chilled water, and steam meter installations; funding for energy conservation initiatives; the purchase of RECs in meeting BNL's SSP goal; and training various parties on energy conservation initiatives.
- *Energy Conservation:* Energy and water evaluations are completed for 25 percent of the site each year. Cost-effective projects are identified and proposed for funding, as appropriate.
- *High Performance Sustainability Buildings (HPSB):* Substantial completion of various energy and water conservation projects has achieved compliance in the EPA Portfolio Manager program. BNL is currently on target to meet or exceed the HPSB goal.
- *Renewable Energy:* Project support continues for the LISF and NSERC facilities and annual purchases of REC's to meet targeted goals.
- *Central Chilled Water Facility (CCWF):* The CCWF continues to utilize a 3.2-million-gallon chilled water storage tank to reduce peak electric demand by producing and storing chilled water during the night.
- *Natural Gas Purchase Contract:* BNL is currently saving over \$2 million per year using natural gas compared to oil.
- *Energy Savings:* Work continues in the replacement of aging, inefficient T-40 fluorescent lighting fixtures with new, high-efficiency T-8 lighting fixtures and/or LED fixtures, as appropriate. Typically, 200 to 300 fixtures are replaced annually, saving tens of thousands of kWhs each year and reducing costs by several thousand dollars.
- *Retro-commissioning:* During the winter of 2022, the Energy Management team conducted an extensive effort expected to yield summer savings by retro-commissioning the following cooling equipment campus wide:
 - Air-side economizer controls systems
 - Building-level chilled water station and control valves
 - Building level chilled water flow meters
- *Demand Response:* The Energy Management team has also performed an audit of the controls system with regards to demand response and has programmed the following demand response scenarios to curtail summer usage:
 - Tier 1 – Raising office area cooling setpoints by 1 °F
 - Tier 2 – Raising office area cooling setpoints by an additional 1 °F and humidity setpoints by 10 percent
 - Tier 3 – Raising office area cooling setpoints by a total of 4 °F and humidity setpoints an additional 10 percent



Northeast Solar Energy Research Center (NSERC)

In previous editions of this document, there was focus on EO 13834 which addressed the Energy Utilization Intensity of covered buildings. However, more recently, federal sustainability goals have revoked and superseded EO 13834, becoming increasingly broader with regards to sustainability. The new orders address sustainability targets for the entire federal building portfolio and all procurements with emissions impacts on those facilities. Most notable in those orders are the carbon-free electricity (CFE) and net-zero federal building portfolio goals. Detailed expectations are anticipated to be captured in the new DOE O 436.1A, Departmental Sustainability, expected to be finalized during 2023. DOE O 436.1A sets forth a path of best practices to achieve the federal goals of 100 percent carbon-free electricity for federal facilities by 2030 and establishing a net-zero building portfolio by 2045. Along similar lines, New York has set forth goals via the Climate Leadership and Community Protection Act (CLCPA, 2019) which will ultimately support BNL's objective to meet the Federal executive order goals.

As shown in Figure 2-5, BNL will continue to make progress towards CFE through the 2030 target; however, major increases in electricity use are expected in 2030 resulting from the future Electron Ion Collider. BNL expects to meet the CFE goal by 100 percent in 2040 when the state achieves its CFE goal.

Having net-zero emissions on campus means all the BTU's used by the building portfolio are from carbon-free sources, including fossil fuels like those fired at the Central Steam Facility plant in addition to electricity. The EO states 65 percent

of the federal buildings portfolio shall be net-zero emissions by 2030; BNL interprets this as the goal stating 65 percent of its energy (BTUs) shall come from zero emissions sources. The EO goes on to state that 100 percent of the federal buildings portfolio shall be net-zero emissions by 2045; BNL interprets this as 100 percent energy (BTUs) shall be zero emissions.

Given BNL's dependence on fossil fuel for heating, this goal is much more challenging as the infrastructure for a carbon-free source of heating does not yet exist and funding for such an infrastructure overhaul does not yet exist. As shown in Figure 2-6, BNL will make progress towards a net-zero buildings portfolio; however, dependence on fossil fuel and current funding availability do not allow the Lab to achieve this goal by 2050.

2.3.4.7 Natural and Cultural Resource Management Programs

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

2.3.4.8 Environmental Restoration

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress in 1980. As part of CERCLA, EPA established the National Priorities List, which identifies sites where clean-up of past contamination is required. BNL was placed on the list with 27 other Long Island sites, 12 of which are in Suffolk County. Each step of the CERCLA cleanup process is reviewed and approved by DOE, EPA, and NYSDEC, under an Interagency Agreement (IAG). This agreement was formalized for BNL in 1992. Although not formal signatories of the IAG, the New York State Department of Health and the Suffolk County Department of Health Services

(SCDHS) also play key roles in the review process.

Most of the contamination at the Laboratory is associated with past accidental spills and outmoded practices for handling, storing, and disposing of chemical and radiological material. BNL follows the CERCLA process, which includes the following steps:

- Conduct a remedial investigation to characterize the nature and extent of contamination and assess the associated risks;
- Prepare a feasibility study and proposed plan to identify and evaluate remedial action alternatives and present the proposed alternative;
- Issue a Record of Decision (ROD), which is the corrective action agreed to by DOE, EPA, and NYSDEC;
- Perform the Remedial Design/Remedial Action, which includes final design, construction specifications, and carrying out the corrective action selected; and
- Perform removal actions (time critical or non-time critical) under the CERCLA process.

In 2022, BNL's nine active groundwater treatment systems removed approximately 53 pounds of volatile organic compounds (VOCs) and 0.3 millicurie (mCi) of strontium-90 (Sr-90) and returned one billion gallons of treated water to the sole source aquifer. In accordance with a CERCLA Action Memorandum to conduct a Time Critical Removal Action, construction of two groundwater treatment systems to address PFAS contamination from the former and current Firehouse/Building 170 source areas was completed. The treatment system for the current Firehouse/Building 170 PFAS plume began operation in October 2022, while the former Firehouse treatment system began operation in January 2023. Groundwater characterization data and modeling identified the need to modify the Operable Unit (OU) VI ethylene dibromide treatment system with additional extraction wells to capture deeper contamination.

These groundwater systems are operated in accordance with Operations and Maintenance manuals. Institutional controls were also monitored and maintained for the cleanup areas in accordance with the RODs to help ensure the remedies remain protective of human health and the environment. An annual evaluation of these

controls was submitted to the regulatory agencies. Table 2-2 provides a description of each OU and a summary of environmental restoration actions taken. See Chapter 7 and SER Volume II, Groundwater Status Report, for further details.

In 2022, BNL continued the surveillance and maintenance of the Brookhaven Graphite Research Reactor (BGRR) and the High Flux Beam Reactor (HFBR). In mid-2022, the comprehensive CERCLA Five-Year Review Report was made available to the public. This report evaluates the environmental monitoring and remediation activities over the previous five years and their protectiveness of human health and the environment.

2.4 IMPLEMENTING THE ENVIRONMENTAL MANAGEMENT SYSTEM

2.4.1 Structure and Responsibility

All employees at BNL have clearly defined roles and responsibilities in key areas, including environmental protection. Supervisors are required to work with their employees to develop and document Roles, Responsibilities, Accountabilities, and Authorities (R2A2). BSA has clearly defined expectations for management and staff which must be included in the R2A2 document. Under the BSA performance-based management model, senior managers must communicate their expectation that all line managers and staff take full responsibility for their actions and be held accountable for ESSH performance. Environmental and waste management technical support personnel assist the line organizations with identifying and carrying out their environmental responsibilities. Environmental Compliance Representatives (ECRs) are deployed to organizations throughout the Laboratory as an effective means of integrating environmental planning and sustainability into the work planning processes of the line organizations. A comprehensive training program for staff, visiting scientists, and contractor personnel is also in place, thus ensuring that all personnel are aware of their ESSH responsibilities.

2.4.2 Communication, Community Involvement and Environmental Justice

In support of BNL's commitment to open communication and community involvement, the Stakeholder Relations Office (SRO) develops

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Table 2-2. Summary of BNL 2022 Environmental Restoration Activities.

Project	Description	Environmental Restoration Actions
Soil Projects	Operable Unit (OU) I/II/III/VII	<ul style="list-style-type: none"> Performed inspections, monitoring, and maintenance of institutional controls for cleanup areas.
Groundwater Projects	OU III/V/VI	<ul style="list-style-type: none"> Continued operation of seven groundwater treatment systems that remove volatile organic compounds (VOCs) and one system that removes strontium-90 (Sr-90). Removed 53 pounds of VOCs and 0.3 mCi of Sr-90 during the treatment of 1.0 billion gallons of groundwater. Since the first groundwater treatment system started operating in December 1996, approximately 7,819 pounds of VOCs and 34 mCi of Sr-90 have been removed, while treating approximately 30 billion gallons of groundwater. Collected and analyzed approximately 1,216 sets of groundwater samples from 581 monitoring wells. Installed 34 temporary wells and collected multiple samples from each location. Based on additional data collected and groundwater flow and transport modeling, additional groundwater extraction wells are needed to remediate ethylene dibromide identified in the deeper portion of the aquifer in the OU VI plume.
	OU X (PFOS/PFOA/1,4-Dioxane)	<ul style="list-style-type: none"> Completed construction of two PFAS groundwater treatment systems downgradient of the current Firehouse/Building 170 and Former Firehouse facilities. This work was performed as a time-critical removal action under CERCLA to address new Areas of Concern (AOC) 33 (PFOS and PFOA) and 34 (1,4-Dioxane). The current Firehouse/Building 170 system began operation in October and the Former Firehouse system began operation in January 2023. 95 new monitoring wells were installed to monitor the current Firehouse/Building 170 and the Former Firehouse PFAS plumes.
Peconic River	OU V	<ul style="list-style-type: none"> A population survey of fish in the on-site portion of the Peconic River was performed under BNL's Environmental Surveillance Program. An insufficient number of fish was identified to support sampling.
Reactors	Brookhaven Graphite Research Reactor (BGRR)	<ul style="list-style-type: none"> Continued long-term surveillance and maintenance, including repair to a hole in the rollup door on the west side of Building 701, cleaning up peeling paint and drywall accumulating in the former offices, and repair to a piece of flashing on the roof of one of the below ground duct protective covers. Coordinated with BNL researchers on the planned Quantum Network experiment to be installed on the roof of the BGRR.
	High Flux Beam Reactor (HFBR)	<ul style="list-style-type: none"> Continued long-term surveillance and maintenance, including repair to the equipment and generator room doors.
	Former Stack (Building 705)	<ul style="list-style-type: none"> The final Stack Demolition Closeout Report was issued to the regulators in April.
	Brookhaven Medical Research Reactor (BMRR)	<ul style="list-style-type: none"> Continued surveillance and maintenance activities. Demolition of the BMRR stack was completed in September. The Closeout Report was issued to the regulators in January 2023.
Former Buildings 810/811	Former Radiological Liquid Processing Facility	<ul style="list-style-type: none"> Maintained institutional controls of the area.
Building 801	Inactive Radiological Liquid Holdup Facility	<ul style="list-style-type: none"> Performed routine surveillance and maintenance of the facility.
Former Building 650	Inactive Radiological Decon Facility	<ul style="list-style-type: none"> Maintained institutional controls of the area.

best-in-class communications, science education, government relations, and community involvement programs that advance the science and science education missions of the Laboratory. The SRO contributes to the public's understanding of science, enhances the value of the Laboratory as a community, and ensures that internal and external stakeholders are properly informed and have a voice in decisions of interest and importance to them. The SRO also works to maintain relationships with BNL employees and external stakeholders, such as neighbors, business leaders, elected officials, and regulators to provide an understanding of the Laboratory's science and operations, including environmental stewardship and restoration activities, and to incorporate community input into BNL's decision-making process.

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

The SRO's Media and Communications Office manages programs to increase internal stakeholder awareness, understanding, and support of Laboratory initiatives; fosters two-way communications; and updates internal stakeholders on BNL priorities, news, programs, and events.

The SRO's Office of Educational Programs manages various education initiatives and programs that support the scientific mission at BNL and the DOE. Programs include Summer Science Explorations for grades four through 12, the Science Learning Center, and the DOE's Science Undergraduate Learning Internship in science, technology, engineering, math, and postdoctoral programs.

2.4.2.1 Communication Forums

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

- The Brookhaven Executive Roundtable

(BER), established in 1997 by DOE's Brookhaven Site Office, meets routinely to update local, state, and federal elected officials and their staff, regulators, and other government agencies on environmental and operational issues, as well as scientific discoveries and initiatives.

- The Community Advisory Council (CAC), established by BNL in 1998, advises Laboratory management primarily on environmental, health, and safety issues related to BNL that are of importance to the community. The CAC is comprised of 26 member organizations and individuals representing civic, education, employee, community, environmental, business, and health interests. The CAC sets its own agenda in cooperation with the Laboratory, and meets six times a year. The CAC is one of the primary ways the Laboratory keeps the community informed. Meetings are open to the public and are announced on the BNL homepage calendar and on the Stakeholder Relations website which links to the CAC webpage, meeting agendas, and past meeting presentations and minutes. An opportunity for public comment is provided at each meeting. Organizations interested in participating on the CAC are encouraged to attend meetings and make their interest known.
- Monthly teleconference calls are held with parties to the Laboratory's Interagency Agreement and other federal, state, and local regulators to update them on project status. The calls also provide the opportunity to gather input and feedback and to discuss emerging environmental findings and initiatives.
- Stakeholder Relations also manages several outreach programs that provide opportunities for stakeholders to become familiar with the Laboratory's facilities and research projects. Outreach programs include:
 - Tour Program: Opportunities to learn about BNL are offered to college, university, professional, and community groups. Tour groups visit the Laboratory's scientific machines and research facilities and meet with scientists to discuss research. Agendas are developed to meet the interests of the groups and may include sustainability

and environmental stewardship issues. As post-COVID Laboratory activities returned to normal, the tour program resumed in a limited capacity during 2022.

- **Summer Sundays:** Held on four Sundays each summer, these open houses enable the public to visit BNL science facilities, experience hands-on activities, and learn about research projects and environmental stewardship programs. In 2019, more than 4,700 visitors participated in the program. However, due to the continued COVID-19 pandemic, Summer Sundays was offered only virtually in 2021. In 2022, Summer Sundays were offered at external venues with whom the Lab partners, such as the Vanderbilt Planetarium, the Long Island Museum, and the solar array at the Sisters of St. Joseph's. Lab scientists gave lectures and attendees had an opportunity to take part in hands-on scientific activities. Bringing the show "on the road" gave the Lab an opportunity to bring its science into underserved communities and to increase its reach.

The Laboratory also participates in and hosts various outreach events throughout the year such as festivals, workshops, BNL's Earth Day celebration at the Jones Beach Nature Center, and the Port Jefferson Mini-Maker Faire. Brown bag lunch meetings for employees are held periodically and cover topics of interest, including project updates, newly proposed initiatives, wildlife management concerns, updates regarding COVID-19, and employee benefits information. However, these types of outreach events remained limited in 2022 due to ongoing impacts from the COVID-19 pandemic.

The SRO's Media & Communications Office issues press releases to news and media outlets and the Internal Communications Office publishes electronic and printed weekly employee newsletters, such as Brookhaven This Week and The Brookhaven Digest. In addition, a Director's Office web-based publication, Monday Memo, is issued bi-weekly to employees and focuses on topics important to the Laboratory population. Additionally, several virtual all-hands meetings were held throughout 2022 to maintain communications with staff.

The Laboratory maintains an informative

web-site at www.bnl.gov, where these publications, as well as extensive information about BNL's science and operations, past and present, are posted. In addition, employees and the community can subscribe to the Laboratory's e-mail news service.

Community members can ask questions or comments by clicking on the "Let us know" link found under "Listening to you" on the Stakeholder Relations website at www.bnl.gov/stakeholder/. Community members can also subscribe to the weekly e-newsletter, Brookhaven This Week, found on the Media Communications webpage at www.bnl.gov, which keeps Lab employees and the community informed about happenings at BNL, explains some of the science behind Laboratory research, and invites subscribers to educational and cultural events.

The COVID-19 pandemic did not stop BNL from proactively communicating with its internal and external stakeholders through many virtual platforms during 2022. Monthly interagency calls were held and as stated above, all the traditional Summer Sunday open house forums were held externally. Additionally, all regularly scheduled CAC and BER meetings were held virtually to ensure continued and timely communication with the community.

2.4.2.2 *Community Involvement in Cleanup Projects*

In 2022, BNL updated stakeholders virtually on the progress of environmental clean-up projects, additional initiatives, and health and safety issues via mailings, briefings, and presentations given at CAC and BER meetings. These topics included the following:

- *New York's Clean Energy Future:* The CAC was informed about BNL's role with regard to meeting New York State's clean energy agenda, including decarbonizing the energy system, integration of renewables, current and future energy storage technologies, and the vision for the New York Center for Grid Innovation.
- *Climate Science to Solutions:* The CAC was informed about how the Lab's climate modeling tools are used to determine climate trends and the Lab's study of aerosols and their impact on climate and solar power.
- *Center for Functional Nanomaterials:* The CAC

was informed about exciting stories of nanoscience discoveries including invisible glass, catching radioactive gases, nanoscience-based home COVID tests, and how nature offers a model for nanoscience technologies.

- *Nuclear and Particle Physics:* The CAC learned about high energy physics and its uses in computing, software, detectors, and electronics. They also heard about how nuclear physics is important in the development of medical isotopes and an update on the Electron Ion Collider.
- *Natural & Cultural Resources:* The CAC received updates on BNL's natural resources, such as deer and fire management, and the risk to the Long Island Pine Barrens from the southern pine beetle.
- *Overview of Research Partnerships:* The Office of Research Partnerships provided an overview to the CAC about research partnership agreements, technology transfer, and intellectual property (IP) and how all are steps in a sequence that helps take detector research to invention, IP protection, marketing, licensing, productization, and royalties.
- *Environmental Updates:* In 2022, the CAC also received environmental updates such as the general status of the groundwater contaminant plumes and remediation systems; the demolition and decommissioning of the HFBR Stack and the Brookhaven Medical Research Reactor Stack; emerging contaminants PFAS and 1,4 Dioxane in groundwater; proposed NYS drinking water standards for these contaminants; national emission standards for hazardous air pollutants; the DOE's PFAS roadmap; and the BNL SSP.

2.4.2.3 Environmental Justice

Brookhaven Lab is committed to increasing environmental justice efforts and creating avenues for participation for disadvantaged and marginalized communities in environmental decision making in line with elements of EO 14008 and Justice 40 Initiatives. These programs are a unique opportunity for people from a wide array of communities, including disadvantaged communities, to meet scientists, participate in hands-on science activities, visit world-class research facilities, enjoy science

shows, and more. For example, the CAC draws members from local communities that have been designated as disadvantaged by New York State based on their disadvantaged communities' criteria, giving them a voice in how the Laboratory's activities impact their immediate environment.

In 2022, the Lab launched a new program, Science in the Community, to bring its programs into the field and make them more accessible, especially to disadvantaged communities. All of the Lab's Science in the Community programming is free and features hands-on activities for students. One such program, offered annually for the last two years and expected to continue, is the Lab's partnership with the Jones Beach Energy and Nature Center. Additionally, the Lab's Earth Day activities feature a special emphasis on the importance of renewable energy, climate solutions, and preserving the environment, and are planned to occur in conjunction with Take Your Child to Work Day to increase the impact of the messages on a wider, more diverse audience.

Brookhaven Lab also has a robust workforce development program which includes many programs specifically designed to give opportunities to students from traditionally underrepresented and underserved communities. These programs include the following:

- STEM-PREP Summer Institute, Alliances for Graduate Education, and the Professoriate Predominantly Undergraduate Institutions, Community College Internship, Student Partnership for Advanced Research and Knowledge, Day in the Life of a River, and a Science at Home program with activities and lessons that students and their parents can do almost anywhere.
- Brookhaven Lab also has Memorandums of Understanding with Historically Black Colleges and Universities and Minority Serving Institutions to further establish diverse and inclusive workforce development programs. The Lab's Diversity, Equity, and Inclusion (DEI) Office coordinates additional programs such as the National Consortium for Graduate Degrees for Minorities, the Professional Associates Program for Women and Minorities, the African American Advancement Group Scholarship Program, and the Mow Shiah Lin Scholarship.

2.4.3 Monitoring and Measurement

BNL's EMS specifies requirements for conducting general surveillance to determine impact from site operations to the environment. 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 the public and environment from site operations.

BNL's EMS includes an Environmental Monitoring Program (EMP) which is a comprehensive, site-wide program that identifies potential pathways for exposure of the public and employees, evaluates the impact activities have on the environment, and ensures compliance with environmental permit requirements. The EMP defines how the Laboratory will monitor effluents and emissions to ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. The plan uses the EPA Data Quality Objective approach for documenting the decisions associated with the monitoring program. In addition to the required triennial update, an annual electronic update is also prepared. The monitoring programs are reviewed and revised, as necessary, to reflect

changes in permit requirements, changes in facility-specific monitoring activities, or the need to increase or decrease monitoring based on a review of previous analytical results.

As shown in Table 2-3, in 2022, there were 5,342 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges under the Environmental Monitoring Program. Specific sampling programs for the various media are described further in Chapters 3 through 8.

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

2.4.3.1 Compliance Monitoring

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

Air emissions monitoring is conducted at reactors no longer in operation, accelerators, and other radiological emission sources, as well as the CSF. Real-time, continuous emission monitoring

Table 2-3. Summary of BNL Sampling Program Sorted by Media, 2022.

Environmental Media	No. of Sampling Events(a)	Purpose
Groundwater	1396	Groundwater is monitored to evaluate impacts from past and present operations on groundwater quality under the Environmental Restoration, Environmental Surveillance, and Compliance sampling programs. See Chapter 7 and SER Volume II, Groundwater Status Report, for further detail.
On-Site Recharge Basins	50	Recharge basins used for wastewater and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes. See Chapter 5 for further detail.
Potable Water	17	Potable water wells and the BNL distribution system are monitored routinely for chemical and radiological parameters to ensure compliance with Safe Drinking Water Act requirements. In addition, samples are collected under the Environmental Surveillance Program to ensure the source of the Laboratory's potable water is not impacted by contamination. See Chapters 3 and 7 for further detail.
Sewage Treatment Plant (STP)	139	The STP influent and effluent and several upstream and downstream Peconic River stations are monitored routinely for organic, inorganic, and radiological parameters to assess BNL impacts. The number of samples taken depends on flow. For example, samples are scheduled for collection at Station HQ monthly, but if there is no flow, no sample can be collected. See Chapters 3 and 5 for further detail.
Precipitation	10	Precipitation samples are collected from two locations to determine levels of mercury present in rain to support long-term monitoring of atmospheric disposition of mercury.
Air – Tritium	234	Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess environmental tritium levels. See Chapter 4 for further detail.

(continued on next page)

Table 2-3. Summary of BNL Sampling Program Sorted by Media, 2022 *(concluded)*.

Environmental Media	No. of Sampling Events(a)	Purpose
Air – Particulate	330 52 NYSDOH	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. Samples are also collected for the New York State Department of Health Services as part of their program to assess radiological air concentrations statewide. See Chapter 4 for further detail.
Fauna	93	Fish and deer are monitored to assess impacts on wildlife associated with past or current BNL operations. See Chapter 6 for further detail.
Flora	12	Vegetation is sampled to assess possible uptake of contaminants by plants and fauna, since the primary pathway from soil contamination to fauna is via ingestion. See Chapter 6 for further detail.
Soils	52	Soil samples are collected as part of the Natural Resource Management Program to assess faunal uptake, during Environmental Restoration investigative work, during the closure of dry-wells and underground tanks, and as part of preconstruction background sampling.
Miscellaneous	563	Samples are collected periodically from potable water fixtures and dispensers, manholes, and spills to assess process waters and to assess sanitary discharges.
Groundwater Treatment Systems Monitoring	668	Samples are collected from groundwater treatment systems operated under the Comprehensive Environmental Response, Compensation, and Liability Act program. The Laboratory has nine operating groundwater treatment systems. See discussion in Chapter 7.
State Pollutant Discharge Elimination System (SPDES)	343	Samples are collected to ensure that the Laboratory complies with the requirements of the New York State Department of Environmental Conservation-issued SPDES permit. Samples are collected at the STP, recharge basins, and four process discharge sub-outfalls to the STP.
Flow Charts	510	Flowcharts are exchanged weekly as part of BNL's SPDES permit requirements to report discharge flow at the recharge basin outfalls.
Floating Petroleum Checks	102	Tests are performed on select petroleum storage facility monitoring wells to determine if floating petroleum products are present. The number of wells and frequency of testing is determined by NYSDEC licensing requirements (e.g., Major Petroleum Facility), NYSDEC spill response requirements (e.g., Motor Pool area), or other facility-specific sampling and analysis plans.
Radiological Monitor Checks	452	Daily instrumentation checks are conducted on the radiation monitors located in Buildings 569 and 592. These monitors are located 30 minutes upstream and at the STP. Monitoring at these locations allows for diversion of wastes containing radionuclides before they are discharged to the Sewage Treatment Plant recharge basins.
Quality Assurance/Quality Control Samples (QA/QC)	319	To ensure that the concentrations of contaminants reported in the Site Environmental Report are accurate, additional samples are collected. These samples detect if contaminants are introduced during sampling, transportation, or analysis of the samples. QA/QC samples are also sent to the contract analytical laboratories to ensure their processes give valid, reproducible results.
Total number of sampling events	5342	The total number of sampling events includes all samples identified in the Environmental Monitoring Plan (BNL 2021), as well as samples collected to monitor Environmental Restoration (CERCLA) projects, air and water treatment system processes, and by the Environmental Protection Division Field Sampling Team as special requests. The number does not include samples taken by Waste Management personnel, waste generators, or Environmental Compliance Representatives for waste characterization purposes.

Notes:

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

equipment is installed and maintained at some of these facilities, as required by permits and other regulations. At other facilities, samples are collected and analyzed periodically to ensure compliance with regulatory requirements. Analytical data are routinely reported to the permitting agencies. See Chapters 3 and 4 for details.

Wastewater monitoring is performed at the point of discharge to ensure that the effluent complies with release limits in the Laboratory's SPDES permits. Twenty-four point-source discharges are monitored—12 under BNL's SPDES Permit and 11 under equivalency permits issued to the Environmental Restoration Program for groundwater treatment systems. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly, and monitored for organic, inorganic, and radiological parameters. Monthly discharge monitoring reports that provide analytical results and an assessment of compliance for that reporting period are filed with the NYSDEC. See Chapter 3, Section 3.6, for details.

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

2.4.3.2 Restoration Monitoring

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

2.4.3.3 Surveillance Monitoring

Surveillance monitoring is performed, in addition to compliance monitoring, to assess potential environmental impacts that could result from routine facility operations. The BNL Surveillance Monitoring Program involves collecting samples of ambient air, surface water, groundwater, flora, fauna, and precipitation.

Samples are analyzed for organic, inorganic, and radiological contaminants. Additionally, data collected using thermoluminescent dosimeters (i.e., devices that measure radiation exposure) strategically positioned on- and off-site is routinely reviewed under this program. Control samples (also called background or reference samples) are collected on and off the site to compare Laboratory results to areas that could not have been affected by BNL operations.

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

2.4.4 EMS Assessments

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

The approach for the ISO14001 program self-assessment includes evaluating programs and processes within organizations that have environmental aspects to verify conformance to the ISO14001 Standard. The assessment is performed by qualified external assessors or BNL staff members who do not have line responsibility for the work processes involved. Progress toward achieving environmental objectives is monitored,

as are event-related metrics to determine the overall effectiveness of the EMS. The assessment determines if there are Laboratory-wide issues that require attention, and facilitates the identification and communication of best management practices used in one part of the Laboratory that could improve performance in other parts of the Lab.

Compliance assessments are also performed by BNL staff members who do not have line responsibility for the work processes involved to ensure that operations are in compliance with Laboratory requirements that reflect external compliance requirements. These assessments verify the effectiveness and adequacy of management processes (including self-assessment programs) at the division, department, directorate, and Laboratory levels. Special investigations are conducted to identify the root causes of events and identify corrective actions and lessons learned if regulatory noncompliance or impact occurs to correct the problem and prevent reoccurrence.

BNL management routinely evaluates progress on key environmental improvement projects. The Laboratory and DOE periodically perform assessments to facilitate the efficiency of assessment activities and ensure that the approach to performing the assessments meets DOE expectations.

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

2.5 ENVIRONMENTAL STEWARDSHIP AT BNL

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

and pollution prevention projects have reduced costs, minimized waste generation, and reused and recycled significant quantities of materials. BNL is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and progress. Now, the Laboratory is moving towards net-zero goals for carbon-free emissions and other efforts to address climate change concerns.

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

The Site Environmental Report is an important communication mechanism, as it summarizes BNL's environmental programs and performance each year. New efforts to reduce carbon emissions as a means to addressing climate change impacts will be integrated into BNL's EMS in the future as directed by DOE as part of the Federal Sustainability Plan.

BNL is often asked to share its experiences, lessons learned, and successes. Additional information about the Laboratory's environmental programs is available on BNL's website at <http://www.bnl.gov>.

For over 75 years, the unique, leading-edge research facilities and scientific staff at BNL have made many innovative scientific contributions possible. Today, BNL continues its research mission while focusing on cleaning up and protecting the environment.

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