2 Environmental Management System

One of Brookhaven National Laboratory's highest priorities is ensuring that the Laboratory's environmental performance measures up to its world-class status in science. Brookhaven Science Associates (BSA), the contractor operating the Laboratory on behalf of DOE, takes environmental stewardship very seriously. As part of BSA's commitment to environmentally responsible operations, they have established the BNL Environmental Management System (EMS). One measure of an effective EMS is recognition of good environmental performance. In 2004, BNL operations led to seven awards from a diverse stakeholder group, as follows.

- *EPA Environmental Quality Award for developing and managing the Upton Ecological and Research Reserve, a 530-acre conservation area on the BNL site.*
- *DOE Office of Science Best in Class Award, DOE Pollution Prevention Award, and White House Closing the Circle Award in recognition of leadership and management in developing and integrating BNL's EMS into its operational and business systems.*
- *DOE Office of Science Pollution Prevention Accomplishment Award for implementing an innovative process, Mixed Waste Elimination through Process Modification.*
- *Long Island Pine Barrens Society award for "Outstanding Contribution to Long Island's Environment" for BNL's comprehensive cleanup of contamination within the Pine Barrens on site, and for BNL programs of research, education, and community involvement.*
- *Evelyn Liblit Environmental Stewardship Award for BNL's commitment to environmental protection and its very successful and longstanding recycling program. The award was presented by the Waste Reduction and Management Institute of Stony Brook University.*

In addition, BNL was accepted into EPA's prestigious Performance Track Program, which is discussed in Section 2.3.4.9.

An EMS ensures that environmental issues are systematically identified, controlled, and monitored. Moreover, an EMS provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement. The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard, with additional emphasis on compliance, pollution prevention, and community involvement.

Annual audits are required to maintain EMS registration. Recertification audits of the entire EMS occur every 3 years. In 2004, an EMS Recertification Audit determined that BNL remains in conformance with the ISO 14001 Standard.

The Laboratory continued its strong support of the Pollution Prevention Program in 2004. This program seeks ways to eliminate waste and toxic materials and is the preferred approach to resolving environmental issues at BNL. In 2004, pollution prevention projects had saved more than $1.6 million and resulted in the reduction or reuse of approximately 2.2 million pounds of waste. Also in 2004, the BNL Pollution Prevention Council funded eight new proposals, investing approximately $86,000. Anticipated annual savings from the projects are estimated at $60,500, for an average payback period of 1.3 years. The ISO 14001-registered EMS and the nationally recognized Pollution Prevention Program continue to contribute to BNL's success in promoting pollution prevention.

BNL also continues to address legacy issues under the Environmental Restoration Program and is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and cleanup progress on site.

2.1 BROOKHAVEN NATIONAL LABORATORY AND ISO 14001 STANDARD

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 standard requires an organization to develop an environmental policy, create plans to implement the policy, implement the plans, check progress and take corrective actions, and review the system annually to ensure its continuing suitability, adequacy, and effectiveness. To gain registration to the ISO 14001 Standard, an organization must comply with a set of 17 requirements that are listed and described in Table 2-1.

BNL's EMS was officially registered to the ISO 14001 Standard in July 2001 and was the first DOE Office of Science Laboratory to obtain third-party registration to this globally recognized environmental standard. To achieve registration, the Laboratory underwent an independent audit of its EMS to verify that the system conformed to all ISO 14001 requirements and that it was effectively implemented. The certification also requires BNL to undergo annual audits by an accredited registrar to assure that the system is maintained.

In 2004, an EMS Recertification Audit determined that BNL remains in conformance with the ISO 14001 Standard. In its recommendation for continued certification, NSF-International Strategic Registrations, Ltd. (NSF-ISR) highlighted five examples of BNL's continual improvement, which include methods for documenting management input, internal auditing practices, and the work planning and environmental review process. The auditors also identified five minor nonconformances and three opportunities for improvement. A corrective action plan was prepared to track the minor nonconformances to closure.

On November 15, 2004, the ISO14001:1996 Standard was revised. The new standard, ISO 14001:2004, places a greater emphasis on the EMS as a tool to manage environmental aspects and on improved environmental performance. During future audits at BNL, NSF-ISR will assess BNL's conformance with the new standard. Changes to the standard are reflected in the elements listed in Table 2-1.

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. In 2004, BNL incorporated the principles of its previous Laboratory-wide Environmental Stewardship Policy into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy. This new workplace policy, issued and signed by the Laboratory director, makes clear BNL's commitments to

Table 2-1. Elements of the Environmental Management System (EMS): Implementation of ISO 14001 at BNL.

Environmental Policy	The Environmental, Safety, Security, and Health Policy is a statement of BNL's intentions and principles regarding overall environmental, safety, security, and health performance. It provides a framework for planning and action. In the policy, BNL has reaffirmed its commitment to compliance, pollution prevention, cleanup, community outreach, and continual improvement.
Environmental Aspects and Impacts	When operations have an environmental aspect, BNL implements the EMS to minimize or eliminate any potential impact. As required by the ISO 14001 Standard, BNL evaluates its operations, identifies the aspects of operations that can impact the environment, and determines which of those potential impacts are significant. BNL has determined that the following aspects of its operations have the potential to affect the environment: ▪ Waste generation ▪ Atmospheric emissions ▪ Liquid effluents ▪ Storage or use of chemicals and radioactive materials ▪ Natural resource usage — power and water consumption ▪ Historical and cultural resources ▪ Environmental noise ▪ Disturbances to endangered species/protected habitats ▪ Soil activation ▪ Historical contamination ▪ Other facility-specific compliance aspects
Legal and Other Requirements	BNL has implemented and continues to improve the Standards Based Management System (SBMS), a BNL web-based system designed to deliver Laboratory-level requirements and guidance to all staff. New or revised requirements (e.g., new regulations) are analyzed to determine their applicability, and to identify any actions required to achieve compliance. This may involve developing or revising BNL documents or operating procedures, implementing administrative controls, providing training, installing engineered controls, or increasing monitoring.
Objectives, Targets, and Programs	BNL's Performance Based Management System is designed to develop, align, balance, and implement the Laboratory's strategic objectives, including environmental objectives. Objectives and targets are developed by Fiscal Year (FY). The following objectives and targets, established in FY 2003, were continued in FY 2004: ▪ Maintain and improve the EMS ▪ Achieve full compliance with applicable environmental requirements ▪ Integrate pollution prevention into work planning and expand participation witin the Laboratory ▪ Improve communications, trust, and relationships with stakeholders on environmental programs ▪ Fully implement the BNL Groundwater Protection Program ▪ Ensure responsible stewardship of natural and historical resources on site ▪ Implement environmental restoration projects efficiently Organizations within BNL develop action plans detailing how they will achieve their objectives and targets and commit the necessary resources to successfully implement both Laboratory-wide programs and facility-specific programs. BNL has a Pollution Prevention Program to conserve resources and minimize waste generation. BNL also has a budgeting system designed to ensure that priorities are balanced and that resources essential to the implementation and control of the EMS are provided.
Resources, Roles, Responsibilities, and Authorities	All employees at BNL have specific roles and responsibilities in key areas, including environmental protection. Environmental and waste management technical support personnel assist the line organizations with developing and meeting their environmental responsibilities. Every BNL employee is required to develop a Roles, Responsibilities, Accountabilities, and Authorities document signed by the employee, their supervisor, and the supervisor's manager. Specifics on environment, safety, and health performance expectations are included in these documents.
Competence, Training, and Awareness	Extensive training on EMS requirements has been provided to staff whose responsibilities include environmental protection. The training program includes general environmental awareness for all employees, regulatory compliance training for selected staff, and specific courses for managers, internal assessors, EMS implementation teams, and operations personnel whose work can impact the environment.
Communication and Community Involvement	BNL continues to improve processes for internal and external communications on environmental issues. The Laboratory solicits input from interested parties such as community members, activists, civic organizations, elected officials, and regulators. This is accomplished primarily through the Community Advisory Council and the Brookhaven Executive Roundtable. At the core of the communication and community involvement programs are the Environmental Safety, Security, and Health Policy and the Community Involvement Plan.
Documentation	BNL has comprehensive, up-to-date Laboratory-wide environmental documents describing the EMS. Using the SBMS, staff can access detailed information on regulatory requirements, Laboratory-wide procedures, and manuals on how to control processes and perform work at BNL in a way that protects the environment. The SBMS has improved the quality, usability, and communication of Laboratory-level requirements.

(continued on next page)

Table 2-1. Elements of the Environmental Management System (EMS): Implementation of ISO 14001 at BNL *(concluded).*

Control of Documents	The SBMS includes a comprehensive document control system to ensure effective management of procedures and other requirements documents. When facilities require additional procedures to control their work, document control protocols are implemented to ensure that workers have access to the most current versions of procedures.
Operational Control	Operations at the Laboratory are evaluated for the adequacy of current controls to prevent impacting the environment. As needed, additional administrative or engineered controls are identified, and plans for upgrades and improvements are developed and implemented.
Emergency Preparedness and Response	BNL has an emergency preparedness and response program and specialized staff to provide timely response to hazardous materials or other environmental emergencies. This program includes procedures for preventing, as well as responding to, emergencies.
Monitoring and Measurement	Effluent and emission monitoring helps ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. BNL has a comprehensive, sitewide Environmental Monitoring Program. Monitoring results are reported to regulatory agencies and are summarized annually in the Site Environmental Report. In addition, BNL tracks and trends its progress and performance in achieving environmental objectives and performance measures.
Evaluation of Compliance	Specific environmental legislation and regulations are evaluated and assessed on a program- or facility-specific basis. BNL has established a documented procedure for periodically evaluating its compliance with relevant environmental regulations. This procedure is often integrated in an organization's Environmental, Safety, and Health inspection process, which is performed in a prioritized fashion by a team of experts, including one on environmental regulatory issues. Periodically, the environmental support organizations will perform a regulatory assessment in a particular topical area to verify the compliance status of multiple organizations throughout the Laboratory. Lastly, external regulatory agencies and/or technical experts may conduct independent audits of compliance.
Nonconformity, and Corrective and Preventive Actions	BNL continues to improve processes that identify and correct problems. A Lessons Learned Program to prevent recurrences, a sitewide Self-Assessment Program, and an electronic web-based assessment and action tracking system have been implemented.
Control of Records	EMS-related records, including audit and training records, are maintained to ensure integrity, facilitate retrieval, and protect them from loss.
Internal Audit	To periodically verify that the EMS is operating as intended, audits are conducted. These audits, which are part of the sitewide Self-Assessment Program, are designed to ensure that any nonconformance to the ISO 14001 Standard is identified and addressed. An independent accredited registrar also conducts ISO 14001 registration audits. In addition, compliance with regulatory requirements is verified through routine inspections, operational evaluations, and periodic audits.
Management Review	In addition to audits, a management review process has been established to involve top management in the overall assessment of environmental performance, the EMS, and progress toward achieving environmental goals. This review also identifies, as necessary, the need for changes to, and continual improvement of, the EMS.

environmental stewardship, the safety of its employees, and the security of the site. The policy continues as a statement of BNL's intentions and principles regarding overall environmental performance. It provides a framework for planning and action and is included in employee, guest, and contractor training programs. The ESSH Policy is posted throughout the Laboratory and on the BNL website at www.bnl.gov/eshq/ESSH.asp. It contains the following goals and commitments that focus on compliance, pollution prevention, cleanup, community outreach, and continual improvement:

- Meet all applicable ESSH laws and BNL's Standards-Based Management System (SBMS), Integrated Safety Management, and Integrated Safeguards and Security Management requirements. The environmental requirements include more than 100 local, state, and federal laws and regulations; DOE Directives; Executive Orders; and numerous operating permits.
- Integrate hazard prevention/reduction, pollution prevention/waste minimization, resource conservation, security, and compliance into all BNL activities during planning and decision making. Adopt cost-effective practices that eliminate, minimize, or mitigate environmental impacts, including conserving natural re-

sources and adhering to the policy known as "E-ALARA": ensuring that emissions, effluents, and waste generation are As Low As Reasonably Achievable.

- Define, prioritize, and aggressively prevent, correct, and/or clean up existing environmental, security, and occupational safety and health problems. This commitment encompasses removal or treatment of contamination caused by historical practices. It also includes strengthening the BNL Environmental Monitoring Program to ensure that controls designed to protect the environment are working, and to provide early detection of potential threats to the environment (see Section 2.4.3).
- Work with stakeholders to help them address their ESSH needs. Openly communicate with stakeholders about program planning, progress, and performance (see Section 2.4.2).
- Continually improve the EMS and the Laboratory's environmental performance. Establish appropriate environmental objectives and performance indicators to guide these efforts and measure progress. To maintain certification, BNL employs proactive measures to prevent problems. When problems do occur, the approach is to investigate the root cause and take corrective actions, as appropriate.

2.3 PLANNING

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

2.3.1 Environmental Aspects

An environmental aspect is any element of an organization's activities, products, and services that can interact with 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. BNL's criteria for significance are based on actual and perceived impacts of its operations and on regulatory requirements. BNL utilizes several processes to identify and review environmental aspects. Key among these is the Process Assessment Procedure. This procedure is an evaluation that is documented on a Process Assessment Form (PAF). The PAF consists of a written process description, a detailed process flow diagram, a regulatory determination of all process inputs and outputs, identification of pollution prevention opportunities, and identification of any Assessment, Prevention, and Control measures that should be considered. Environmental professionals work closely with Laboratory personnel to ensure that environmental requirements are integrated into each process. Aspects and impacts are evaluated annually to ensure that the significant aspects and potential impacts continue to reflect stakeholder concerns and changes in regulatory requirements. BNL's list of aspects and significant criteria remained unchanged in 2004.

2.3.2 Legal and Other Requirements

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

2.3.3 Objectives and Targets

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

- Significant environmental aspects
- Risk and vulnerability (primarily, threat to the environment)
- Legal requirements (laws, regulations, permits, enforcement actions, and memorandums of agreement)
- Commitments (in the ESSH Policy, to regulatory agencies, and to the public)
- Importance to DOE, the public, and other stakeholders
- Current and past performance trends

Laboratory-level objectives and targets are developed on a Fiscal Year (FY) schedule. In FY 2004 (October 1, 2003 through September 30, 2004), BNL's environmental objectives included:

- Maintain and improve the EMS
- Achieve full compliance with applicable environmental requirements
- Integrate pollution prevention into work planning and expand participation within the Laboratory
- Improve communications, trust, and relationships with stakeholders on environmental programs
- Fully implement the BNL Groundwater Protection Management Program
- Ensure responsible stewardship of natural and cultural resources on site
- Implement environmental restoration projects efficiently

2.3.4 Environmental Management Programs

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

The Laboratory has developed and funded several important environmental programs to further integrate environmental stewardship into all facets of BNL's missions.

2.3.4.1 Compliance

BNL has an extensive system to help ensure full compliance with all applicable environmental regulatory requirements and permits. Legislated compliance is outlined by the National Emission Standards for Hazardous Air Pollutants (NESHAPs), State Pollutant Discharge Elimination System (SPDES), and Resource Conservation and Recovery Act (RCRA). Other compliance at BNL involves special projects or initiatives, such as upgrading petroleum and chemical storage tank facilities, upgrading the sanitary sewer system, closing underground injection control devices, retrofitting or replacing air conditioning equipment refrigerants, and managing legacy waste. See Chapter 3 for a thorough discussion of these programs and their status.

2.3.4.2 Groundwater Protection

BNL's Groundwater Protection Management Program is designed to prevent impacts to groundwater and to restore groundwater quality by integrating pollution prevention efforts, monitoring groundwater restoration projects, and communicating performance. BNL has also developed a Groundwater Protection Contingency Plan that defines an orderly process for quickly taking corrective actions in response to unexpected monitoring results. Key elements of the groundwater program are the full and timely disclosure of any off-normal occurrences and regular communication on the performance of the program. Chapter 7 provides additional details about this program and monitoring results for 2004.

2.3.4.3 Waste Management

As a byproduct of the world-class research it conducts, BNL generates a large range of waste. This includes materials common to many businesses and industries, such as aerosol cans, batteries, paints, and oils. However, BNL's unique scientific activities also generate waste streams that are subject to additional regulation and special handling, including radioactive, hazardous, and mixed waste.

BNL's Environmental and Waste Management Services Division (EWMSD) is responsible for the collection, transportation, storage, and off-site disposal of waste generated at BNL. The

BNL Waste Management Facility (WMF) was designed for handling hazardous, industrial, radioactive, and mixed waste and is comprised of three staging areas: a facility for hazardous waste, regulated by RCRA; a mixed-waste building for waste that is both hazardous and radioactive; and a reclamation building for radioactive material. The RCRA and mixed-waste buildings are 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. In 2004, BNL generated the following types and quantities of waste from routine operations:

- Hazardous waste: 6.2 tons
- Mixed waste: 65 ft^3
- Radioactive waste: 4,786 ft^3

While waste generation rates for 2004 were similar to 2003, these quantities represent significant reductions from previous years, as shown in Figures 2-1a through 2-1c. Routine operations are defined as ongoing industrial and experimental operations. The picture is not complete, however, without consideration of waste generated from nonroutine or one-time events and waste generated from environmental restoration activities. BNL is currently cleaning up facilities and areas containing radioactive and chemical contamination resulting from historical operations. Waste recovered through restoration and decommissioning activities is managed by the Environmental Restoration (ER) group with oversight by BNL's EWMSD. Nonroutine waste includes construction and demolition waste, environmental restoration waste, legacy waste, lead-painted debris, lead shielding, and PCB waste. Figures 2-1d through 2-1f show wastes generated under the ER Program, as well as nonroutine operations. Waste generation from these activities has varied significantly from year to year. This was expected, as environmental restoration activities moved from remedial investigations and feasibility studies to remedial actions, which have changed annually based on the progress of BNL's cleanup schedule.

2.3.4.4 Pollution Prevention and Minimization

The BNL Pollution Prevention (P2) Program is an essential element for the successful accomplishment of BNL's broad mission. It reflects the national and DOE pollution prevention goals and policies and represents an ongoing effort to make pollution prevention and waste minimization an integral part of the BNL operating philosophy.

DOE has incorporated pollution prevention and waste reduction goals into its contract with BSA, BNL's ESSH Policy, and the critical outcomes associated with the Laboratory's operating contract. Key elements of the P2 Program include:

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

Proposals for funding pollution prevention opportunities are submitted to the BNL P2 Council. In January 2004, the P2 Council announced the winners of the Pollution Prevention funding competition. Eight proposals were funded, investing approximately $86,000. The anticipated annual savings from these projects is estimated at $60,500, for an average payback period of 1.3 years.

The efforts of the BNL P2 and recycling programs have achieved significant reductions in waste generated by routine operations, as shown

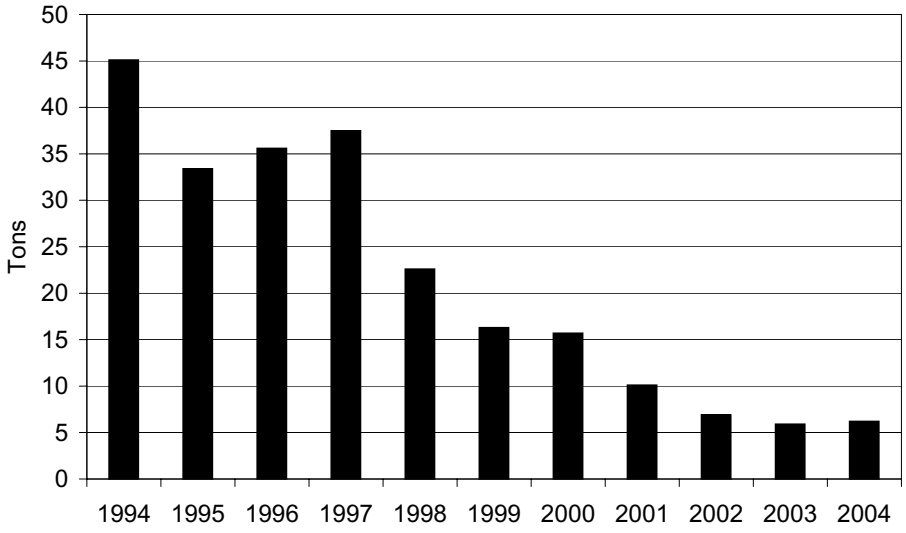

Figure 2-1a. Hazardous Waste Generation from Routine Operations, 1994 – 2004.

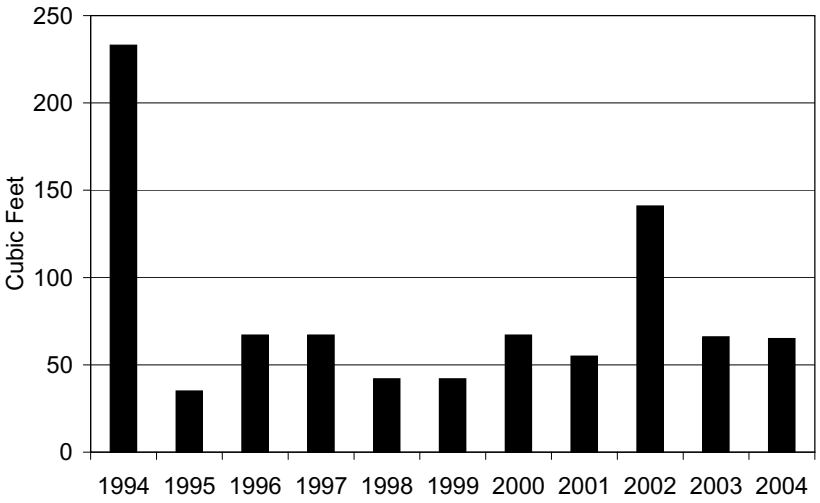

Figure 2-1b. Mixed Waste Generation from Routine Operations, 1994 – 2004.

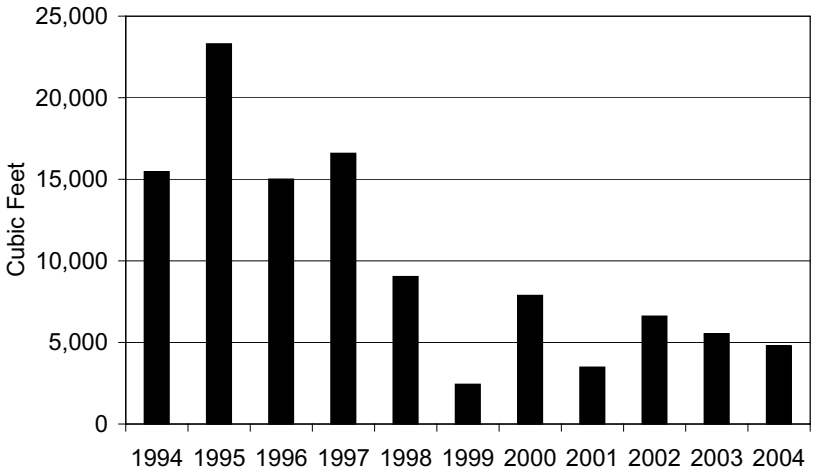

Figure 2-1c. Radioactive Waste Generation from Routine Operations, 1994 – 2004.

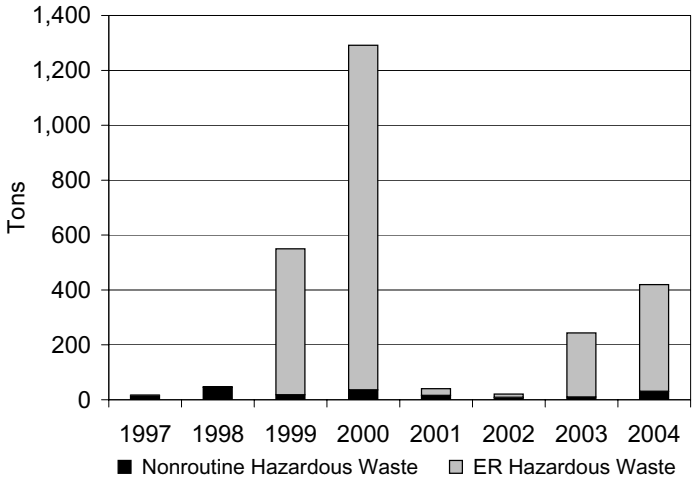

Figure 2-1d.
Hazardous Waste Generation from ER and Nonroutine Operations, 1997 – 2004.

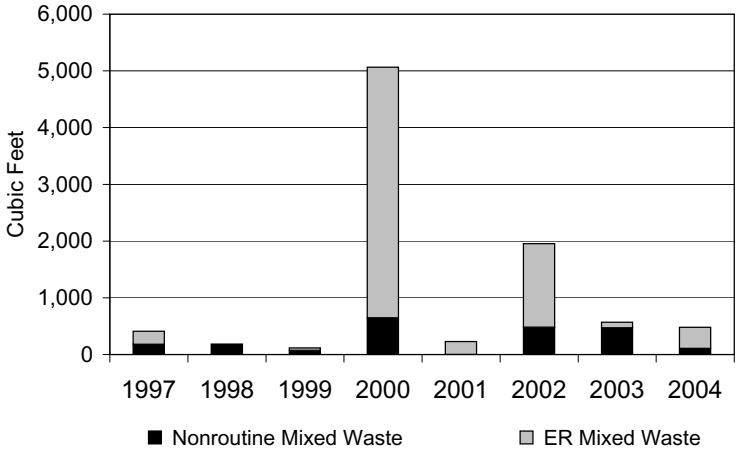

Figure 2-1e.
Mixed Waste Generation from ER and Nonroutine Operations, 1997 – 2004.

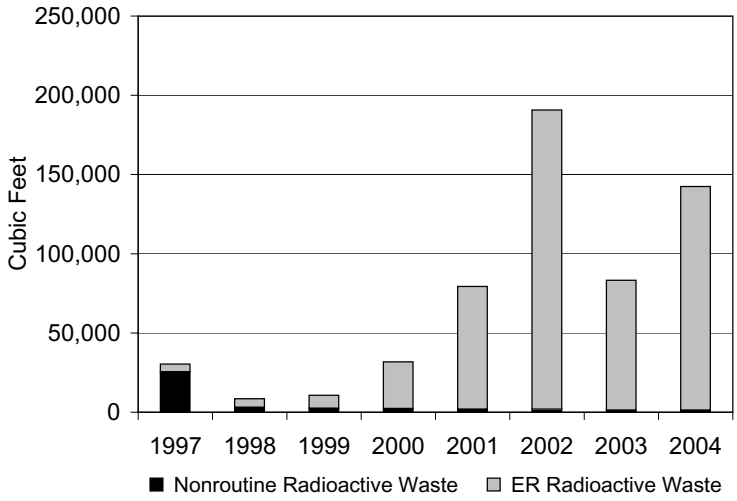

Figure 2-1f.
Radioactive Waste Generation from ER and Nonroutine Operations, 1997 – 2004.

in Figures 2-1a through 2-1c. This continues a positive trend and is further evidence that pollution prevention planning is well integrated into the Laboratory's work planning process. These positive trends are also driven by EMS emphasis on preventing pollution and establishing objectives and targets to reduce environmental impacts.

Implementation of pollution prevention opportunities, recycling programs, and conservation initiatives has significantly reduced both waste volumes and management costs. In 2004, these efforts resulted in more than $1.6 million in cost avoidance or savings and approximately 2.2 million pounds of materials being reduced, recycled, or reused. Table 2-2 describes the projects that were implemented through 2004 and includes the number of pounds of materials reduced, reused, or recycled and the estimated cost benefit of each project.

BNL also has an active and successful solid waste recycling program, which involves all employees. In 2004, BNL collected more than 185 tons of office paper for recycling. Cardboard, bottles and cans, construction debris, motor oil, scrap metals, lead, automotive batteries, printer and toner cartridges, fluorescent light bulbs, drill press machine coolant, and antifreeze are also recycled. Table 2-3 shows the total number of tons (or units) of the materials recycled in 2004.

2.3.4.5 Water Conservation

BNL has a strong water conservation program and has achieved dramatic reductions in water use since the mid 1990s. The Laboratory continually evaluates water conservation as part of facility upgrades or new construction initiatives. These efforts include more efficient and expanded use of chilled water for cooling and heating, ventilation and air conditioning systems, and reuse of once-through cooling water for other systems such as cooling towers. BNL's goal is to reduce the consumption of potable water and reduce the possible impact of clean water discharges on Sewage Treatment Plant operations. Figure 2-2 shows the 10-year trend of water consumption. As of 2004, BNL has used less than half as much water as was used in 1995—over 800 million gallons less.

2.3.4.6 Energy Management and Conservation

Since 1979, BNL's Energy Management Group has been working to reduce energy use and costs by identifying cost-effective, energy-efficient projects, by monitoring energy use and utility bills, and by assisting in obtaining the least expensive energy sources possible. The group is responsible for developing, implementing, and coordinating BNL's *Energy Management Plan* (2003a).

BNL has more than 4 million square feet of building space. Many BNL scientific experiments use particle beams generated and accelerated by electricity, with the particles controlled and aligned by large electromagnets. In 2004, BNL used approximately 276 million kilowatt hours (kWh) of electricity, 4.5 million gallons of fuel oil, 39.1 thousand gallons of propane, and 710 thousand ft^3 of natural gas. Fuel oil and natural gas produce steam at the Central Steam Facility (CSF). Due to market conditions, fuel oil was predominately used in 2004, resulting in a cost savings of approximately $940,000. See additional information on natural gas and fuel oil use in Chapter 4.

BNL is a participant in the Long Island Power Authority's (LIPA) Peak Load Reduction Curtailment Program. Through this program, the Laboratory has agreed to reduce electrical demand during critical days throughout the summer when LIPA expects customer demand to meet or exceed the company's available supply. In return, BNL receives a rebate for each megawatt reduced on each critical day. In 2004, participation in this program produced a rebate of $24,000. The Laboratory's participation is significant to LIPA; BNL's portion represents more than 12 percent of the 95-megawatt load-curtailment program total, making the Laboratory one of the single largest program contributors. BNL also agreed to keep electric loads at a minimum during the summer, in part by curtailing operations at RHIC. This scheduling allowed BNL to earn over $1 million in electric billing credits from the New York Power Authority (NYPA) as discussed below.

In 2004, a project to reduce the energy necessary to dry compressed air from the Central Chilled Water Facility went into operation. The

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

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
Automotive Waste	Substitution	510	Hazardous Waste	$1,020	$1,000	$1,000	In 2004, solvent-based brake cleaners were replaced, reducing the hazards associated with their use and disposal.
Mercury Utility Devices	Substitution	60	Hazardous Waste	$1,750	$2,500	$1,750	Approximately 60 lb of mercury-containing devices were removed from Buildings 463 and 490 in 2004. Savings are based on the cost of one mercury spill and cleanup.
PCB Oils	Retrofill	1,200	Hazardous Waste	$2,850	$3,450	$2,850	Approximately 150 gal of PCB-laden oil were removed from the ATF Klystron in 2004. Savings are based on the cost of one PCB spill and cleanup.
Organic Solvents	Substitution	678	Hazardous Waste	$1,355	$36,500	$26,000	Life Sciences purchased a Microwave Peptide Synthesizer in 2004 to significantly reduce the amount of hazardous wastes generated. Saves ~1,000 work hours/year (reflected in cost savings).
Organic Solvents	Purification/ Reuse	480	Hazardous Waste	$960	$24,000	$10,915	The primary cost saving of the BES solvent purification system, new in 2004, is in not purchasing new solvent.
Cooling Water	Reuse	80,000	Deionized water	$0	$6,000	$10,000	A closed-cycle water recycling system for the Building 480 melt spinner was purchased in 2004. This saves a minimium of 10,000 gal of ultra-pure water and extends the life expentancy of equipment worth $100,000.
PCB Oils	Removal	3,110	Hazardous Waste	$6,220	$10,000	$2,850	In 2004, ~300 gal of pure PCB oil were drained from the transformer and rectifier in Building 901 (former PET Facility). Also removed were 30 PCB capacitors and 11 PCB transformers. Savings are based on the cost of one PCB spill and cleanup.
Mercury Utility Devices	Substitution	40	Hazardous Waste	$2,300	$2,500	$1,750	The Occupational Medical Clinic replaced mercury-containing equipment with non mercury-containing equipment in 2004. Savings are based on the cost of one mercury spill and cleanup.
Radioactive Waste	Source Reduction	1,500	Radioactive Waste	$6,000	$0	$6,000	A sorting table was purchased in 2003 for the Waste Yard, so clean waste could be sorted from radioactive waste.
Radioactive Emissions	Emission Reduction	0	Radioactive Emissions			$0	A shroud was installed over the 16-inch diameter shaft in the Hot Cell of the BLIP, isolating cooling water from the rapidly moving air of the exhaust system and allowing radiological decay within the water system. Slowing the diffusion into the hot cell air will effectively reduce gaseous emissions into the exhaust stack, as these radionuclides have very short half lives.
Radioactive Waste generated through wet chemistry	Waste Minimization	30	Mixed waste/ Liquid Radioactive Waste	$17,600	$0	$22,500	The 2003 purchase of a Kinetic Phosphorescence Analyzer (KPA) system for uranium analysis eliminates mixed waste generation in this chemistry laboratory, reduces by 90% the volume of liquid waste, reduces by 90% the amount of radioactive material handled, minimizes exposure to uranium by laboratory personnel, and decreases labor time by 75%.

(continued on next page)

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

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
Radioactive Waste from labeled chemicals	Waste Minimization/ Volume Reduction	0	Solid Radioactive Waste	$2,168	$0	$2,168	A vial crusher for glass vials, pipettes, and other glassware was purchased in 2003.
Radioactive and Mixed Wastes from radio-labeled chemicals	Waste Minimization	112	Mixed Waste	$27,690	$0	$27,690	A microplate scintillation counter to reduce mixed waste generation was purchased in 2003.
Pump Oil	Substitution	51	Hazardous Waste / Industrial Waste	$3,520	$0	$3,520	In 2003, oil-displacement pumps were replaced with dry pumps for both laboratory and research aircraft missions.
Photographic Waste	Substitution	3,840	Hazardous Waste / Industrial Waste	$7,600	$0	$16,489	This photographic processor, purchased in 2003, reduces the amount of chemicals used and waste generated by up to 80%.
Electrophoretic Mini-Gels	Microscale Chemical Use	2,200	Hazardous Waste - Lab Pack	$10,400	$0	$10,400	This 2002 purchase minimized silver waste from silver-staining electrophoretic mini-gels. Savings reflect avoided waste disposal costs and lower material purchase costs ($6,000).
Hydraulic Oil	Product Substitution	1,000	Industrial Waste	$15,000	$0	$15,000	In 2002, garbage trucks were retrofitted with steel-braided hydraulic lines and vegetable-based hydraulic oil. This project reduced the potential for reportable spills and associated cleanup costs.
Hydraulic Oil	Product Substitution	3,000	Industrial Waste	$26,000	$0	$26,000	Hydraulic lift bays in the Motor Pool Shop were retrofitted to vegetable-based hydraulic oil in 2002. This project minimized the potential for petroleum-based hydraulic oil leaks and spills and associated cleanup costs.
Sewage Sludge	Volume Reduction	234,000	Radioactive Waste	$910,000	$0	$910,000	In 2002, disposal of 60,000 gal of radioactive Sewage Treatment Plant liquid waste by a contractor would have cost $910,000. Instead, the waste was dried using rolloffs, absorbent, and lime and shipped via rail to a disposal facility. A second drying bed was built to dry sludge (96% volume reduction) from the anaerobic sludge digester.

(continued on next page)

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

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
CO^2 Snow Cleaning	Source Reduction	0	Hazardous Waste / Industrial Waste	$5,000	$0	$0	In 2002, equipment was purchased to evaluate CO^2 snow cleaning for NSLS, Instrumentation, and CAD applications. This project has the potential to reduce solvent usage (hazwaste), and aqueous cleaning wastes (industrial waste). So far, success has been limited, due to condensation.
Film and other radioisotopic imaging	Substitution	300	Hazardous Waste / Industrial Waste	$22,000	$0	$22,000	In 2002, replacement of film-based autoradiography and other radioisotopic imaging with a Phosphor Imager reduced hazardous waste generation by 200 lb and industrial waste generation by 100 lb. Additional projected savings are in annual supply costs and labor reduction.
Digital Imaging System	Substitution	282	Hazardous Waste / Radioactive Waste / Industrial Waste	$25,000	$0	$25,000	Reduction of hazardous (134 lb), radioactive (80 lb), and industrial (68 lb) waste with purchase of a digital imaging system in 2002. Additional projected savings are in annual supply costs and labor reduction.
Fluorescence-Based Assay	Substitution	200	Mixed Waste	$30,550	$0	$30,550	In 2002, a project was funded for development of a fluorescence-based assay for the DNA-dependent protein kinase (DNA-PKcs), replacing the phosphorus-33 assay.
Lead Acid Batteries	Recycled	9,800	Hazardous Waste	$19,600	$0	$19,600	Estimate 40 lbs/battery and avoided disposal costs as hazardous waste.
Ion Exchange wastewater	Source Reduction	1250	Hazardous and Sanitary Wastewater	$2,500	$100	$2,400	In 2000, prefilters were added to the deionization system to polish makeup water entering the ion exchange system. This extended the useful life of the ion exchange resins, requiring less frequent regeneration. The regeneration process generates hazardous and sanitary waste. There is a small annual cost for replacement supplies.
Tritium Exit Signs	Source Reduction	568	Mixed Waste	$119,280	$10,650	$108,630	In 2004, 142 tritium exit signs were removed from service, returned to the manufacturer, and replaced with energy-efficient light-emitting diode (LED) signs. This ongoing project reduces the risk of tritium gas release and avoids eventual disposal as mixed waste.
Cooling Water	Reuse	34,850	Radioactive Waste	$80,155	$0	$80,155	Approximately 18,000 gal (153,000 lb) of cooling water were reused in the main magnet cooling water system, avoiding disposal as radioactive wastewater.
Short Half-life waste	Decay in Storage	627	Radioactive Waste	$1,499	$0	$1,499	Short half-life isotopes, particularly phosphorus-32 and phosphorus-33, are frequently used in Life Sciences experiments. In 2004, wastes from these operations (10 ft^3) were managed in accordance with BNL decay-in-storage requirements, rendering the wastes eligible for volumetric release.

(continued on next page)

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

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
Lubricating Oil	Energy Recovery	8,000	Industrial Waste	$16,500	$500	$16,500	In 2004, ~8,000 lb (1,000 gal) of lubricating oils were collected, tested for suitable use as waste oil fuel, and used for energy production at the Central Steam Facility. Avoided disposal cost was $16,500. Cost of testing ($500) was offset by fuel use savings ($.50/gal).
Cooling Tower Chemicals	Source Reduction	6,375	Industrial Waste	$15,000	$0	$15,000	In 2001, ozone water treatment units were installed on cooling towers at two RHIC experiments to provide biological control of cooling water. These systems eliminate the need for water treatment chemicals (typically toxic biocides), save labor, and reduce analytical costs for monitoring cooling tower blowdown.
Blasocut Machining Coolant	Recycled/ Reused	51,600	Industrial Waste	$103,200	$0	$114,500	Central Shops Division operates a recycling system that reclaims Blasocut machining coolant and supplies it Laboratory-wide. 6,450 gal (51,600 lb) of Blasocut lubricant were recycled in 2004. Recycling involves aeration, centrifuge, and filtration. This avoids cost of disposal as industrial waste plus an avoided cost of procurement of 6 drums of concentrate ($800/drum) and 130 drums for waste ($50/drum). Cost of recycle is estimated to be the same as cost of procurement and preparation of proper dilution for use.
Used Motor Oil	Energy Recovery	30,880	Industrial Waste	$65,660	$0	$65,660	Used motor oil from the motor pool and the on-site gas station is picked up for free by Strebel's Laundry Service and used to fire their waste oil dryers. In 2004, 3,860 gal of oil were picked up, avoiding cost for disposal and 78 drums for shipping ($50/drum).
Office Paper	Recycled	370,000	Sanitary Waste	$16,650	$0	$16,650	Estimate $90/ton for avoiding disposal as trash.
Cardboard	Recycled	358,000	Sanitary Waste	$16,110	$0	$16,110	Estimate $90/ton for avoiding disposal as trash.
Scrap Metal	Recycled	256,000	Sanitary Waste	$11,520	$0	$11,520	Estimate $90/ton for avoiding disposal as trash.
Bottles/Cans	Recycled	44,000	Sanitary Waste	$1,980	$0	$1,980	Estimate $90/ton for avoiding disposal as trash.
Construction Debris	Recycled	734,000	Sanitary Waste	$16,515	$0	$16,515	Estimate $45/ton for avoiding disposal as trash.
	TOTALS	2,238,543		$1,611,152	$97,200	$1,661,151	

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

Table 2-3. BNL Recycling Program Summary.

Recycled Material	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Mixed paper	155	136	197	220	106	196	204	370	336	246	209	182	185
Cardboard	21	81	164	85	101	103	97	124	132	127	157	176	179
Bottles/Cans	12	12	18	11	15	21	22	21	20	29	19	23	22
Tires	9	21	7	11	17	18.6	11.5	15.2	0	0	3.5	12.3	11
Construction debris	809	495	495	627	837	799	527	352	243	289	304	334	367
Used motor oil (gallons)	–	–	4,000	3,350	4,275	4,600	3,810	3,570	3,295	3,335	1,920	3,920	3,860
Metals	201	210	33	153	158	266	64	47	534	38	48	193	128
Lead	–	–	–	–	–	4.4	3.7	0.7	2.5	0	0	–	5
Automotive batteries	–	5	0.81	0.72	6.8	4.3	2.1	1.1	2.2	4.8	6.3	4.6	5
Printer/Toner cartridges (units)	–	–	–	–	–	–	1,480/175	1,575/510	–	363	449	187	105
Fluorescent bulbs (units)	–	–	–	–	13,664	12,846	867	25,291	5,874	17,112	25,067	13,611	12,592
Blasocut coolant (gallons)	–	–	–	–	–	–	–	3,575	7,500	10,660	8,180	5,030	6,450
Antifreeze (gallons)	–	–	–	–	55	276	448	145	110	200	0	165	325
Tritium exit signs (each)	–	–	–	–	–	–	–	–	185	190	28	181	142
Smoke detectors (each)	–	–	–	–	–	–	–	–	–	171	40	0	0
Road base											2,016	0	2,666

Notes:
All units are tons unless otherwise noted.
– Denotes not recycled in that year or data not available.

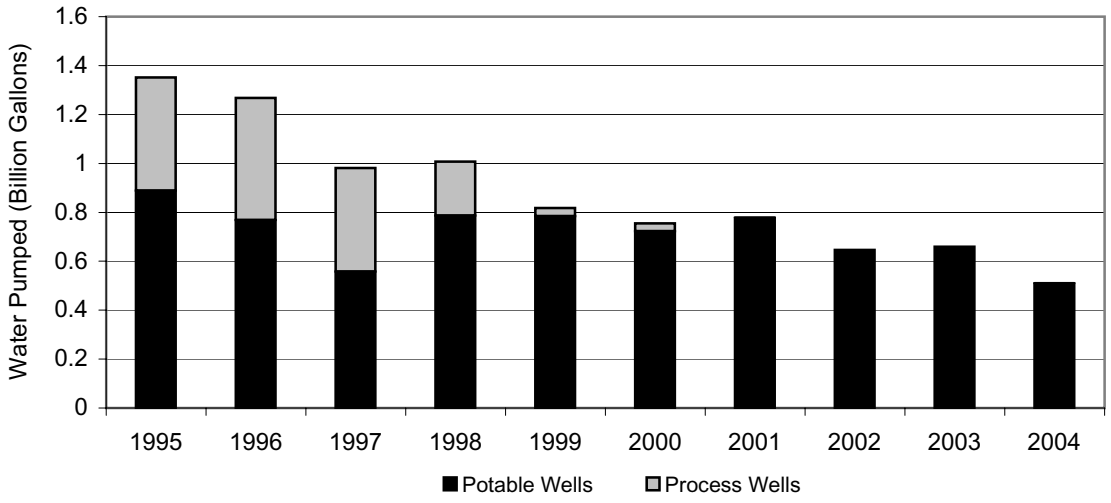

Figure 2-2. BNL Water Consumption Trend.

new energy-efficient drying system is estimated to save over 265,000 kWh and $14,000 annually.

The National Energy Conservation Policy Act, as amended by the Federal Energy Management Improvement Act of 1988 and the Energy Policy Act of 1992, requires federal agencies to apply energy conservation measures and to improve federal building design to reduce energy consumption per square foot. Current goals at BNL are to reduce energy consumption per square foot, relative to 1985, by 20 percent in 2000, 30 percent by 2005, and 35 percent by 2010. BNL's energy use in 2004 was 23 percent less than in 1985 (see Figure 2-3).

BNL also maintains a contract with NYPA that resulted in an overall cost avoidance of $14 million in 2004. Participation in NYPA's 2004 Load Curtailment Program produced an additional rebate worth $1 million. BNL will continue to seek alternative energy sources to meet future energy needs, support federally required "green" initiatives, and reduce energy costs. Plans for a 65,000-ft^2 Research Support Building and 94,500-ft^2 Center for Functional Nanomaterials qualify for Leadership in Energy and Environmental Design certification under the U.S. Green Building Council, a coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable, and healthy places to live and work.

2.3.4.7 Natural and Cultural Resource Management Programs

BNL continues to enhance its Natural Resource Management Program in cooperation with the U.S. Fish & Wildlife Service and the Upton Ecological and Research Reserve Technical Advisory Group (TAG). BNL also continues to enhance its Cultural Resource Management Program. A BNL Cultural Resource Management Plan has been developed to identify and manage properties that are determined to be eligible or potentially eligible for inclusion on the National Register of Historic Places. For more information about these programs, see Chapter 6.

2.3.4.8 Environmental Restoration

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress on December 11, 1980. As part of CERCLA, EPA established the National Priorities List (NPL), which identifies sites where cleanup of past contamination is re-

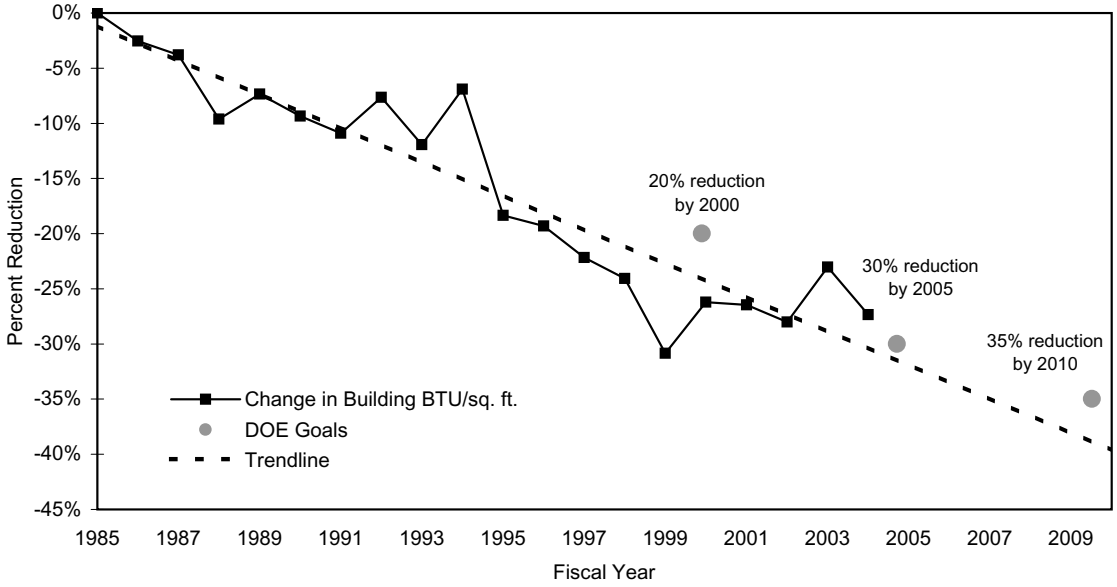

Figure 2-3. BNL Building Energy Performance, 1985 – 2010

quired. BNL is listed on the NPL, with 27 other Long Island sites, 12 of which are in Suffolk County (see http://www.epa.gov/superfund/sites/npl/ny.htm).

Each step of the Superfund cleanup process is reviewed and approved by DOE, EPA, and NYSDEC, under a contract called the "Interagency Agreement." This agreement was formalized in 1992. Most of the contamination at BNL is associated with past accidental spills and outmoded practices for handling, storing, and disposing of chemical and radiological waste.

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 list and evaluate Remedial Action alternatives and present the proposed best alternative
- Issue a Record of Decision (the remedy/corrective action agreed to by DOE, EPA, and NYSDEC)
- Perform the Remedial Design/Remedial Action, which includes final design, construction specifications, and carrying out the remedy selected

The BNL site was initially divided into seven Operable Units (OUs), some of which were later combined (OU I/VI and OU II/VII). Significant progress was made in environmental restoration in 2004. Table 2-4 provides a description of each OU and a summary of environmental restoration actions taken. The goal is to complete cleanup activities and install all groundwater treatment systems by 2006 (see Chapter 7 and Volume II of the SER, *Groundwater Status Report*, for further details).

2.3.4.9 EPA Performance Track Program

BNL was accepted into the EPA's Performance Track Program in 2004. The program recognizes top environmental performance among participating U.S. facilities of all types, sizes, and complexity, both public and private. Performance Track was established by EPA as the "gold standard" for facility-based environmental performance—a standard that participating members strive to attain as they "meet or exceed their performance commitment." Under this program, partners provide leadership in many areas, including preventing pollution at its source. The program currently has just over 360 members nationwide.

The Performance Track Program requires that sites commit to several improvement goals for a 3-year period and report on the progress of these goals annually. Below is a brief description of BNL's goals and the progress for 2004.

- *Increase BNL's land and habitat conservation***.** Due to the demolition of several buildings, the Laboratory recovered open land and began to implement habitat conservation under the BNL *Natural Resource Management Plan* (2003b) and the *BNL Wildland Fire Management Plan* (2003c). These plans call for managing vegetation through various means, including planting native vegetation, recovering construction (demolition) sites, and reintroducing prescribed fires to manage the ecosystem. In 2004, BNL conducted its first prescribed fire on a 7-acre parcel of land. Two acres of surrounding grassed firebreak and 5 acres of oak forest were put into a fire rotation to ensure the health of the forest, which will be continually monitored. In addition, 9 acres of formerly mowed areas are being reverted back to native trees and shrubs. In total, BNL recovered 16 acres of land toward a 30-acre goal by 2006.
- *Reduce radioactive air emissions*. BNL's initial reduction of radioactive air emissions concentrates on emissions from the Brookhaven Linac Isotope Producer. In 2003, BNL released approximately 3,725 curies of short-lived isotopes (with half-lives less than 30 minutes) from this facility. In 2004, an emissions reduction of 27 percent was realized due to reduced hours of operation. Additional reductions are expected in 2005 with the use of a lucite enclosure around the target assembly to minimize evaporative and gaseous losses from the beam interactions with the target cooling water. The overall radiological air

Table 2-4. Summary of BNL 2004 Environmental Restoration Activities.

Project	Description	Environmental Restoration Program Actions
Soil Projects	OU I OU II OUVII	▪ Mobilized contractor and commenced the soil remediation at the former Hazardous Waste Management Facility. ▪ Mobilized the contractor and commenced the underground storage tank (UST) removal and soil remediation at the Waste Concentration Facility. ▪ Completed excavation and disposal of PCB-contaminated soil at the Building 96 former scrap yard.
Groundwater Projects	OU III	▪ Completed construction and began operations of four groundwater treatment systems to treat volatile organic compounds (VOCs) that have migrated beyond BNL property in East Yaphank and Manorville (Industrial Park East, North Street, North Street East, and LIPA/Airport). ▪ Continued operations of the Stronitum (Sr-90) groundwater treatment system for the Chemical Holes plume, as well as the remaining VOC treatment systems. ▪ Completed construction of an on-site Sr-90 groundwater treatment system for the Brookhaven Graphite Research Reactor (BGRR)/Waste Concentration Facility groundwater plume. ▪ Applied the oxidizer potassium permanganate to degrade VOC contamination at the Building 96 groundwater plume. ▪ Regulators approved a Petition for Shutdown of the Carbon Tetrachloride groundwater treatment system. The system was placed on standby in August and will continue to be monitored and restarted, if necessary. ▪ Continued monitoring of the High Flux Beam Reactor (HFBR) tritium plume. ▪ An Explanation of Significant Differences (ESD) to the Operable Unit (OU) III Record of Decision (ROD) was prepared, reviewed by the regulators, and made available to the public to obtain their input. The ESD proposed active treatment of the Magothy aquifer VOC contamination, changes to the overall cleanup timeframe for the Sr-90 plumes, and documented the need for no further action for Building 96 anomalies. ▪ Continued characterization and monitoring of tritium in groundwater from g-2 activated soil. A milestone extension request was approved by the regulators that called for the collection of additional groundwater monitoring data, followed by the preparation and submittal of a Focused Feasibility Study and ROD in 2006. ▪ During 2004, 1.5 billion gallons of groundwater were treated and 652 pounds of VOCs were removed. Since the first groundwater treatment system started operating in December 1996, approximately 4,800 pounds of VOCs have been removed from more than 8.4 billion gallons of groundwater.
	OU IV	▪ Continued groundwater monitoring.
	OU VI	▪ Completed construction and began operation of a groundwater treatment system to treat ethylene dibromide that has migrated beyond BNL property in Manorville.
	Groundwater Monitoring	▪ Completed the BNL 2003 Groundwater Status Report. ▪ Collected and analyzed 1,889 groundwater samples from 703 monitoring wells. ▪ Updated the Environmental Monitoring Plan.
Peconic River	OU V	▪ Completed the Phase 1 on-site remediation of the Peconic River. ▪ Commenced the Phase 2 off-site remediation of the Peconic River. ▪ DOE signed the ROD and forwarded to the Regulatory Agencies for approval.
Reactors	BGRR	▪ Completed the draft ROD for the end state of the BGRR and submitted for regulatory approval. ▪ Removed the below grade duct filters and most of the primary liner.
	HFBR	▪ Continued long-term surveillance and maintenance activities.
	BMRR	▪ Reactor startup source and all sensitive nuclear material removed; reactor control rods removed; mercury-containing equipment removed; Halon system inventory removed; hazardous chemicals such as cadmium and gadolinium nitrite removed; Building 492 well house charcoal filtration system removed; all associated piping removed and capped; and miscellaneous D_2O (heavy water) formerly used as shielding removed.

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emissions reduction goal is 30 percent by 2006.

- *Reduce BNL's use of ozone-depleting substances (ODS), specifically Class I ODS.* In 2003, BNL's baseline inventory of ODS included 124,446 pounds of CFC-11 equivalent. ODS reduction activities in 2004 included: the replacement of a 130-ton CFC-11 chiller normally containing 550 pounds of refrigerant, with an 80-ton HFC-134a (non ozone-depleting) chiller; recovery/reclamation of refrigerant from two 650-ton CFC-11 chillers normally containing 1,400 pounds CFC-11 each, af-

ter the associated building was connected to BNL's Central Chilled Water Facility; recovery of refrigerant from two 110-ton CFC-11 chillers normally containing 550 pounds of CFC-11 each, after the associated building was connected to BNL's Central Chilled Water Facility; and shipment of 5,284 pounds of excess Halon 1301 and approximately 175 pounds of excess Halon 1011 to the DOE Savannah River Site ODS Repository. In total, BNL reduced its ODS inventory to 67,135 CFC-11 equivalent pounds and is working toward meeting its overall site inventory reduction of 65,500 pounds by 2006.

- *Reduce BNL's hazardous materials use*. BNL will concentrate on facility-wide mercury reduction for its initial hazardous material reduction goal. In 2004, BNL conducted an in-depth inventory of mercury-containing devices. Currently, there are approximately 400 to 500 pounds of mercury throughout the site. Most of this inventory is from instrumentation (e.g., thermometers, thermostats, and pressure-regulating devices). Approximately half of the inventory is considered nonessential and can be replaced by devices that do not contain mercury. In 2004, the following efforts to reduce the BNL mercury inventory were implemented: removed and disposed of approximately 260 elemental mercury thermometers; removed and disposed of 13 pounds of elemental mercury from research laboratory spaces; and removed and disposed of approximately 20 mercury-bearing devices including electrodes, psychrometers, and barometers/manometers. By the end of 2004, the total BNL mercury inventory was approximately 393 pounds.
- *Other contributions to improve site conditions*. Although this is not specifically reported to EPA under the Performance Track program, in 2004 BNL consolidated operations to facilitate the demolition of 37,294 ft^2 of inefficient building space formally containing lead and asbestos materials. Also, some laboratories in Buildings 463, 480, 490, 510, and 815 were renovated. These renovations resulted in the elimination of hazardous materials such as lead, asbestos, and radiological contamination, while offering the opportunity to install energy-efficient fixtures; lighting; heating, ventilation and air conditioning systems; and fume hoods.

2.4 IMPLEMENTING THE ENVIRONMENTAL MANAGEMENT SYSTEM

2.4.1 Structure and Responsibility

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

2.4.2 Communication and Community Involvement

A goal of BNL's EMS is to ensure commitment to communications and community outreach. Through this commitment, the Laboratory continues to develop and maintain positive, proactive, and constructive relationships with its employees, regulators, and the

community; promote open and honest communication on environmental performance; and actively seek and consider input from stakeholders. To help build these relationships, Laboratory staff regularly participate in on- and off-site meetings with regulators, elected and appointed officials, legislative committees, employees, and community members to discuss projects. Presentations, roundtables, workshops, canvassing, on-site tours, and official public comment periods all help to ensure input is gathered so that issues important to stakeholders are addressed and the values of the community are considered.

Several forums for communication have been established to facilitate dialogue with key stakeholders. The Brookhaven Executive Roundtable, established by DOE in 1997, meets bimonthly and enables BNL and DOE representatives to update staff from the offices of local, state, and federal elected officials and regulatory agencies on the Laboratory's operational issues, environmental issues, and science initiatives. The Community Advisory Council (CAC), established in 1998, provides input to the Director of the Laboratory on issues of importance to the community, including environmental stewardship and remediation activities. Members consist of representatives from many stakeholder groups, including civic, health, environmental, union, business, education, and employee organizations. The CAC meets monthly in sessions open to the public, and sets its own agenda in cooperation with the Laboratory.

Communication with employees helps ensure that staff is knowledgeable of the Laboratory's environmental policy, how their work can impact the environment, and what can be done to prevent such impacts. BNL encourages information flow from management to employees, and back up to management, recognizing that employees are an excellent source of information, issues, and ideas. Employees and retirees regularly interact with their neighbors and community groups, acting as the Laboratory's envoys. They provide information about Laboratory science, gather feedback, and respond to concerns.

In 2004, significant progress was made to advance several large proposed cleanup projects, that have been of significant importance to BNL stakeholders:

- In May 2004, DOE and BNL solicited public comment regarding the cleanup of affected portions of the Peconic River, both on and off site, to be sure that decisions made were considerate of community expectations and protective of human health and the environment. The preferred recommendation was that 6 to 12 inches of sediment be removed from areas where contaminants had been deposited by outmoded historic disposal methods. Sediment would also be removed from areas identified as "preferential" sources of methylmercury, the form of organic mercury found in the environment that accumulates in fish and human tissue. Since part of the off-site area targeted for cleanup is located within Suffolk County parkland, the plan set more stringent cleanup goals for that area, giving the county the greatest flexibility for future use of the property. The $11.5 million project is expected to result in an estimated 92 percent reduction of mercury and 93 percent removal of PCBs in on- and off-site river sediment. Other co-located contaminants will also be removed. The plan includes habitat restoration and long-term monitoring of surface water, sediment, and fish to evaluate the effectiveness of the cleanup.
- In August 2004, a draft plan for cleanup of the Brookhaven Graphite Research Reactor (BGRR) was submitted to the community for comment. The preferred recommendation called for the removal of the reactor pile and biological shield, accessible pockets of contaminated soil, and the fuel canal structure. It also called for the completion of actions that are currently underway or planned for this facility, followed by long-term response actions, including water-infiltration management, surveillance and maintenance, and institutional controls. The plan would result in the removal of more than 99 percent of the radionuclides found within the BGRR complex.

- In December 2004, DOE sought public comment on plans to remove chemical solvents from portions of the Magothy aquifer just south of the Laboratory that have been impacted by past operations on site. The recommendation was to operate groundwater extraction wells for approximately 10 years to capture high concentrations of chemicals and prevent additional contamination from entering the Magothy aquifer. The cleanup plan also called for 55 years of continued monitoring to ensure the proposed remedy is working. The plan addressed Sr-90 groundwater contamination on site, and called for 10 years of active treatment, followed by up to 70 years of monitoring and data analysis, to ensure that the cleanup is working and that contamination does not reach the site boundary.

Once DOE reviews the public comments, final decisions for each of these cleanup remedies will be made. The final decisions will be documented in Records of Decisions that are expected to be finalized in 2005. The Laboratory worked closely with EPA Region II, NYSDEC, New York State Department of Health (NYSDOH), and Suffolk County Department of Health Services (SCDHS) to resolve issues on plans, priorities, and corrective actions. The CAC also provided input regarding each of the plans. These discussions led to the development of the draft cleanup plans listed above.

Also in 2004, the CAC and BNL co-sponsored a free, one-day workshop on fleet-maintenance pollution-prevention techniques, capitalizing on the work the Laboratory has done in this area. More than 50 participants attended from a variety of institutions, including the towns of Brookhaven, Huntington, Oyster Bay, and Southold; Northrop Grumman Corporation; Suffolk County Water Authority; and United Parcel Service. Workshop speakers included BNL experts as well as guest speakers from NYSDEC and KeySpan. Alternative-fuel vehicles, vegetable-based hydraulic fluids, and re-refined motor oil were a few of the technologies discussed that the Laboratory uses to protect the environment while reducing waste disposal costs through pollution prevention.

The Laboratory maintains an informative website at http://www.bnl.gov; issues press releases and e-mail updates; and publishes *discover Brookhaven* (the Laboratory's science magazine), *the Bulletin* (a weekly employee newsletter), and *Laboratory Link* (a monthly brief on research activities) to keep the public and employees informed about the Laboratory's research, activities, and issues, including those related to the environment. Employees and the community may subscribe to BNL's e-mail update service at http://lists.bnl.gov/mailman/listinfo/bnl-announce-l, which is a listing of all public mailing lists available at the Laboratory.

In 2004, BNL celebrated Earth Day with a variety of employee and community activities, including environmental stewardship awards, a student art contest involving children from local elementary schools, and a 4-mile running race. The Laboratory also participated with other local organizations and businesses in the two-day Heckscher State Park Spring Festival, using interactive displays to promote environmental awareness. BSA contributed corporate funds in support of these events as part of their commitment to environmental stewardship.

Also in 2004, the Laboratory hosted more than 30,600 visitors to the site, including students, teachers, and other community members who participated in "Summer Sunday" open houses, science-museum visits, site tours, and other outreach programs.

These are just some of the highlights of the many achievements and advances made within the BNL's environmental management program during 2004. These achievements and advances were the result of the commitment to excellence in Laboratory operations made by BNL management, employees, and many other stakeholders.

2.4.3 Monitoring and Measurement

Effluents and emissions are monitored to ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. BNL's Environmental Monitoring Program is a comprehensive, sitewide program that: identi-

fies potential pathways for exposure of the public and employees; evaluates what impact BNL activities have on the environment; and ensures compliance with environmental permit requirements. The monitoring program is reviewed and revised, as necessary or on an annual basis, to reflect changes in permit requirements, changes in facility-specific monitoring activities, or the need to increase or decrease monitoring based on a review of previous analytical results.

As required under DOE Order 450.1, *Environmental Protection Program*, BNL prepares an *Environmental Monitoring Plan, Triennial Update* (BNL 2003e), which outlines annual sampling goals by media and frequency. The plan uses the EPA Data Quality Objective approach for rationalizing the decisions associated with the monitoring program. In addition to the required triennial update, EWMSD prepares an electronic update each year.

In 2004, there were 8,031 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges under the Environmental Monitoring Program, as shown in Table 2-5. Specific sampling programs for the various media are described further in Chapters 3 through 8 and SER Volume II, *Groundwater Status Report*.

There are three components to the Environmental Monitoring Program: compliance, restoration, and surveillance monitoring, as described below.

2.4.3.1 Compliance Monitoring

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

- *Air emissions monitoring* is conducted at reactors, accelerators, and other radiological emission sources, as well as the CSF. Real-time, continuous emission monitoring equipment is installed and maintained at some of these facilities, as required by permits and other regulations. At other facilities, samples are collected and analyzed periodically to ensure compliance with regulatory requirements. Analytical data are routinely reported to the permitting authority. See Chapters 3 and 4 for details.
- *Wastewater discharge monitoring* is performed at the point of discharge to ensure that the effluent complies with release limits in BNL's SPDES permits. Twenty-four point-source discharges are monitored under the BNL program: 12 under the ER Program and 12 under the SPDES permit. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly and monitored for organic, inorganic, or radiological parameters. Monthly reports that provide analytical results and an assessment of compliance for that reporting period are filed with the permitting agency. See Chapter 3, Section 3.6 for details.
- *Groundwater monitoring* is also performed in accordance with permit requirements. Specifically, monitoring of groundwater is required under the Major Petroleum Facility License for the CSF and the RCRA permit for the WMF. Extensive groundwater monitoring is also conducted under the ER Program, as required under the Records of Decision for many of the OUs or Areas of Concern (see Chapter 7 and Volume II of the SER, *Groundwater Status Report*, for details). Additionally, to ensure that the Laboratory maintains a viable potable water supply, groundwater is monitored as required by SCDHS.

2.4.3.2 Restoration Monitoring

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

This program typically involves collecting soil and groundwater samples to determine the lateral and vertical extent of the contaminated area. Samples are analyzed for organic,

Table 2-5. Summary of BNL 2004 Sampling Program Sorted by Media.

Environmental Media	No. of Sampling Events*	Purpose
Groundwater	1,889 ER 318 ES/C	Groundwater is monitored to evaluate impacts from past and present operations on groundwater quality, under the Environmental Restoration (ER), Environmental Surveillance (ES), and Compliance (C) sampling programs. See Chapter 7 and SER Volume II.
On-Site Recharge Basins	78	Recharge basins used for wastewater and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes. See discussion in Chapter 5.
Potable Water	38 ES 158 C	Potable water wells and the BNL distribution system are monitored routinely for chemical and radiological parameters to ensure compliance with Safe Drinking Water Act requirements. In addition, samples are collected under the Environmental Surveillance Program to ensure the source of the Laboratory's potable water is not impacted by contamination. See discussion in Chapters 3 and 7.
Sewage Treatment Plant (STP)	426	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 discussion in Chapters 3 and 5.
Precipitation	8	Precipitation samples are collected from two locations to determine if radioactive emissions have impacted rainfall, and to monitor worldwide fallout from nuclear testing. The data are also used, along with wind speed, wind direction, temperature, and atmospheric stability to help model atmospheric transport and diffusion of radionuclides. See discussion in Chapter 4.
Air – Tritium Filters	262	Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess environmental tritium levels. Due to several years of nondetectable measurements and the shutdown of the High Flux Beam Reactor (HFBR), monitoring was reduced from weekly to once per month in several areas of the site in 1999. See discussion in Chapter 4.
Air – Particulate Filters	470 ES/C 53 NYSDOH	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. Samples are also collected for the New York State Department of Health Services (NYSDOH) as part of their program to assess radiological air concentrations statewide. See discussion in Chapter 4.
Air – Charcoal	64	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. See discussion in Chapter 4.
Fauna	102	Fish, deer, and small mammals are monitored to assess impacts on wildlife associated with past or current BNL operations. See discussion in Chapter 6.
Flora	9	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 discussion in Chapter 6.
Soils	114	Soil samples are collected as part of the Natural Resource Management Program to assess faunal uptake, during Environmental Restoration investigative work, during the closure of drywells and underground tanks, and as part of preconstruction background sampling.
Miscellaneous	470	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 and Remediation Monitoring	1,318	Samples are collected from groundwater treatment systems and as long-term monitoring after remediation completion under the Comprehensive Environmental Response, Compensation, and Liability Act Program. The Laboratory had 12 operating groundwater treatment systems in 2004. See discussion in Chapter 7.
Vehicle Monitor Checks	250	Materials leaving the Laboratory pass through the on-site vehicle monitor that detects if radioactive materials are present. Any radioactive material discovered is properly disposed of through the Waste Management Program. The vehicle monitor is checked on a daily basis.
State Pollutant Discharge Elimination System (SPDES)	218	Samples are collected to ensure that the Laboratory complies with the requirements of the New York State Department of Environmental Conservation (NYSDEC)-issued SPDES permit. Samples are collected at the STP, recharge basins, and four process discharge sub outfalls to the STP.
Flow Charts	577	Flowcharts are exchanged weekly as part of the Laboratory's SPDES permit requirements to report discharge flow at the recharge basin outfalls.
Floating Petroleum Checks	104	This test is performed on select petroleum storage facility monitoring wells to determine if floating petroleum products are present. The number of wells and frequency of this 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.

(continued on next page)

Table 2-5. Summary of BNL 2004 Sampling Program Sorted by Media *(concluded).*

Environmental Media	No. of Sampling Events*	Purpose
Radiological Monitor Checks	732	Daily instrumentation checks are conducted on the radiation monitors located in Buildings 569 and 592. These monitors are located 30 minutes upstream and at the STP. Monitoring at these locations allows for diversion of wastes containing radionuclides before they are discharged to the Peconic River.
QA/QC samples	373	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. Quality Assurance/Quality Control (QA/QC) samples are also sent to the contracted analytical laboratories to ensure their processes give valid, reproducible results.
Total number of sampling events	8,031	This number includes all the samples identified in the *Environmental Monitoring Plan* (BNL 2004), as well as samples collected to monitor Environmental Restoration projects and air and water treatment system processes and by the Environmental and Waste Management Services 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.

Note:
* 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,VOCs) can be collected during a single sample event.

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. Followup monitoring of groundwater is conducted in accordance with a Record of Decision with regulatory agencies.

2.4.3.3 Surveillance Monitoring

Pursuant to DOE Order 450.1, surveillance monitoring is performed in addition to compliance monitoring, to assess potential environmental impacts that could result from routine facility operations. The BNL Surveillance Monitoring Program involves collecting samples of ambient air, surface water, groundwater, flora, fauna, and precipitation. Samples are analyzed for organic, inorganic, and radiological contaminants. Additionally, data collected using thermoluminescent dosimeters (devices to measure radiation exposure) strategically positioned on and off site are routinely reviewed under this program. Control samples (also called background or reference samples) also are collected on and off site to compare BNL 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. Groundwater restoration and surveillance data are discussed in detail in SER Volume II.

2.4.4 EMS Assessments

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

- *Self-assessment* is the systematic evaluation of internal processes and performance. The approach for the environmental self-assessment program includes evaluating programs and pro-

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

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

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

2.5 ENVIRONMENTAL STEWARDSHIP AT BNL

BNL has unprecedented knowledge of its potential environmental vulnerabilities and current operations due to programs such as the Facility Review Disposition Project, 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 BNL's compliance status and pollution prevention projects have reduced costs, minimized waste generation, and reused and recycled significant quantities of materials.

The Laboratory is openly communicating with neighbors, regulators, employees, and other interested parties on issues and progress. To regain and maintain stakeholder trust, BNL will continue to deliver on commitments and demonstrate improvements in environmental performance. The Site Environmental Report is an important communication mechanism, as it summarizes BNL's environmental programs and performance each year. Additional information about BNL's environmental programs is available on BNL's website at http://www.bnl.gov. The Laboratory continues to pursue other mechanisms to communicate data in a more user friendly, visual, and timely manner.

The existing BNL EMS is viewed as exemplary within DOE. Due to external recognition of BNL's knowledge and unique experience implementing the EMS program, several DOE facilities and private universities have invited BNL to extend its outreach activities and share its experiences, lessons learned, and successes. BNL's environmental programs and projects have been recognized with national and regional awards.

Audits have consistently observed a high level of management involvement, commitment, and support for environmental protection and the EMS. Audits and EMS management reviews have noted the following improvements made since BSA began managing the Laboratory:

- The EMS has been strengthened, integrated with other BNL management systems, and formalized.

- Line ownership for environmental stewardship has been established, key roles and responsibilities have been identified and clarified, and expectations have been made explicit.
- A comprehensive environmental training program has been implemented.
- From the process evaluation project, BNL has improved its understanding of environmental aspects, waste streams, and applicable requirements.
- There is much greater formality with regard to control of EMS documents, manuals, and procedures. Procedures and requirements have been updated, and environmental management programs have been improved.
- BNL has been very successful in achieving environmental goals and critical outcomes. There have been successes in ISO 14001 Standard registration and recertification, compliance improvements (e.g., facility modifications, implementation of SBMS, enhanced operational controls), and increased environmental knowledge and awareness on the part of management, employees, contractors, and visitors.
- Communication on environmental issues has improved, occurs at the highest levels of management, and reporting is more formal. Managers are better informed about environmental aspects, issues, and performance.
- Core EMS teams representing many organizations have been formed. A consensus process is used to develop the system, improving acceptance and support.
- There has been strong implementation of the EMS throughout organizations, and cultural change has been notable.

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

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