Chapter 2

Environmental Management System

In 2000, BNL continued to implement and enhance its Environmental Management System to ensure that it operates in an environmentally responsible manner. The Laboratory's Environmental Management System conforms to the international standard on environmental management known as ISO 14001, with increased emphasis on compliance assurance, pollution prevention, and community outreach. Nine BNL organizations have been officially registered to the ISO 14001 Standard, affirming the Laboratory's leadership position as the first Long Island-based operation and the first DOE Office of Science facility to achieve this accreditation.

Under the Environmental Management System, compliance and other environmental considerations are fully integrated into the planning, decision-making, and implementation phases of all site activities. Existing industrial and experimental processes onsite have been evaluated for regulatory compliance and pollution prevention opportunities, and actions are being taken to improve BNL's compliance status and eliminate potential sources of environmental impact. In 2000, pollution prevention projects saved more than $2,265,512 and resulted in the reduction or reuse of over 3,367,593 pounds (1.53 million kilograms) of industrial, sanitary, radioactive, and hazardous waste, and 63,500,000 gallons (240 million liters) of water.

The Laboratory continues to address historical issues under the Facility Review Project and the Environmental Restoration Program. A comprehensive program to monitor environmental quality is in place. The Laboratory is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and progress.

2.1 ENVIRONMENTAL STEWARDSHIP UNDER BROOKHAVEN SCIENCE ASSOCIATES

During 2000, BNL continued to implement and improve its Environmental Management System (EMS) under the leadership of Brookhaven Science Associates, LLC (BSA). An EMS is a methodology for managing the environmental aspects of an organization's operation in order to

- identify how operations can potentially impact the environment,
- define and prioritize what needs protection and how to do it,
- monitor, measure, and communicate what is done and how it is done, and
- continually improve environmental protection programs.

An EMS includes planning; establishing responsibilities; instituting procedures, practices, and processes; and dedicating resources to develop, implement, and achieve environmental commitments. The purpose of an EMS is to ensure that programs are managed in an environmentally responsible manner that protects the ecosystem and human health. The ultimate goal is to improve environmental performance and environmental quality.

BNL's EMS uses the International Organization for Standardization ISO 14001 Standard, *Environmental Management Systems - Specification with Guidance for Use* (ISO 1996) as a model. ISO 14001 is a consensus standard developed by an international consortium of industry, government, and environmental groups. This system has been adopted by not-for-profit organizations such as BNL, as well as by the private sector at companies such as Lucent Technologies, IBM, and Motorola. BNL refers to its EMS as an ISO 14001 "Plus" system, since it has enhanced emphasis on compliance, pollution prevention, and community outreach. The EMS is integrated with the Laboratory's other management systems such as training and emergency preparedness, and is part of the sitewide Integrated Safety Management System.

BNL has invested more than $2,000,000 in a three-year project to develop and implement the EMS. The project is fundamentally and systematically changing the way the Laboratory operates. Under the project, existing EMS elements and other management systems were identified, revamped or enhanced, and integrated with each other. An ISO 14001 EMS consists of 17 major elements. Figure 2-1 shows the relationship between the program elements. Table 2-1 summarizes how BNL is satisfying each element. The following sections describe some of the key components of BNL's EMS in more detail. Sections 2.2 and 2.3 describe major environmental programs that are part of the EMS.

2.1.1 SIGNIFICANT ENVIRONMENTAL ASPECTS

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 impacts are significant. Environmental management programs are used to control and manage those aspects to prevent the impacts. Table 2-2 provides a list of BNL's significant environmental aspects. BNL's criteria for significance is based on both actual and perceived impacts of its operations and regulatory requirements. For example, because the Laboratory is situated over a sole source aquifer that provides drinking water, protection of groundwater is a high priority and possible impact to it is a significant concern. Because of concerns on the part of the surrounding community, radioactivity in any environmental media (air, water, soil) is also deemed a significant aspect. As the EMS matures, impacts will be reevaluated as necessary to ensure that the significant aspects and potential impacts continue to reflect the concerns of stakeholders and changes in regulatory requirements, and to incorporate new aspects or impacts that have been identified.

2.1.2 EMS PROJECT AND REGISTRATION STATUS

Shortly after BSA assumed management of BNL in March 1998, DOE entered into a voluntary Memorandum of Agreement (MOA) with EPA to address concerns about BNL's environmental programs (EPA/DOE 1998). A copy of the MOA is available on the BNL website at <http://www.doe.bnl.gov/epa/EPA1.htm>. Among other things, the MOA committed DOE to implementing an ISO 14001 "Plus" EMS on a very aggressive schedule. At that time, the initiative lacked a project manager with clear roles and responsibilities, personnel resources had not been completely identified, funding was not authorized, and there was general lack of ownership for environment, health, and safety areas by line management.

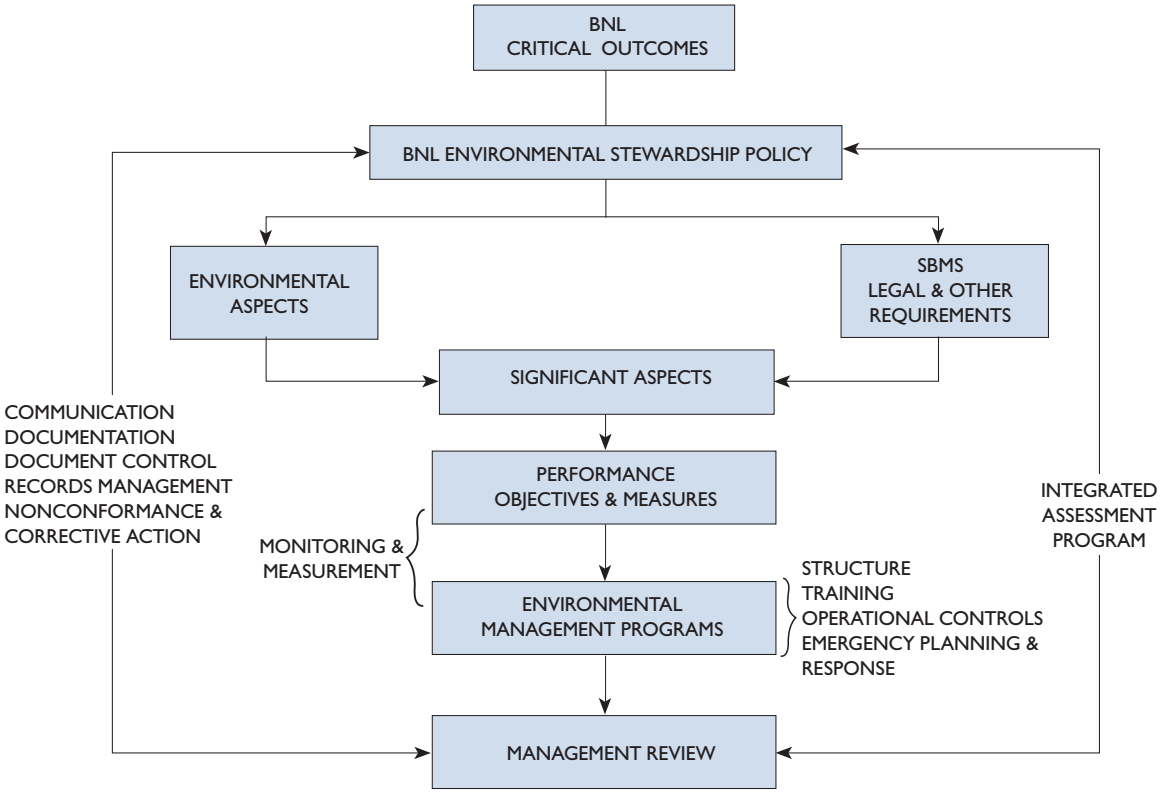

Figure 2-1. Key Elements of the BNL EMS and Their Relationship to Each Other.

The EMS project began on June 1, 1998. Even before the MOA was signed, BSA had decided to go beyond what the DOE operating contract required, electing to ultimately register the entire Laboratory to the ISO 14001 Standard, as opposed to self-declaring that they had a conforming system. The registration process involves rigorous audits by an American National Standards Institute Registrar Accreditation Board. The independent auditors evaluate BNL's conformance to the standard, whether the program is effectively implemented, and whether an effective assessment and corrective action program is in place. While the significance of ISO 14001 registration may not be as meaningful to the general public as it is to the environmental and regulatory community, BSA believes that it is important from a trust and credibility standpoint to undergo the third party review. The ISO 14001 EMS is a valuable blueprint, and registration is a recognized mechanism that the outside world can judge.

BNL has pursued a phased approach, registering high profile facilities first. The project started with a pilot phase involving the Relativistic Heavy Ion Collider (RHIC) Project, the Reactor Division, and the Waste Management Division. During the first two years of the EMS project, BNL developed institutional requirements (see Section 2.1.5) and implemented these program requirements throughout all organizations in the Laboratory. Deployment of the EMS in the balance of facilities began in July 1999 and was completed ahead of schedule in July 2000. An official ISO 14001 registration audit resulted in the August 1999 registration of the RHIC Project. In September 2000, the following eight facilities also obtained registration: the Biology Department, Medical Department, Brookhaven LINAC Isotope Producer and Target Processing Laboratory, Collider-Accelerator Department, Superconducting Magnet Division, Reactor Division, Environmental Restoration Division, and the Waste Management Division. A copy of BNL's registration certificate for these facilities is found in Figure 2-2.

After undergoing an independent, internal audit of conformance at the remaining facilities, all BNL organizational units self-declared

Table 2-1. Elements of the Environmental Management System: Implementation of ISO 14001 "Plus" at BNL.

Environmental Policy	The Environmental Stewardship Policy is a statement of BNL's intentions and principles regarding overall environmental performance. It provides a framework for planning and action. In the policy, BNL has reaffirmed its commitments to compliance, pollution prevention, cleanup, community outreach, and continual improvement.
Environmental Aspects	When operations have an environmental aspect, BNL implements the EMS to minimize or eliminate any potential impact. 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/cultural resources • Environmental noise • Disturbances to endangered species/protected habitats • Soil activation • Historical contamination • Other facility-specific compliance aspects
Legal and other Requirements	New or revised requirements (e.g. new regulations) are analyzed to determine their applicability to the Laboratory, and to identify whether actions are required to achieve compliance. This may involve developing or revising Laboratory documents or operating procedures, implementing administrative controls, providing training, installing engineered controls, or increasing monitoring.
Objectives and Targets	BNL establishes environmental objectives and performance measures to drive improvements to the EMS and ultimately, environmental performance. They focus on the environmental aspects that can have a significant impact, address stakeholder concerns, and align with commitments made in the environmental policy. Objectives and targets are developed by Fiscal Year (October 1 through September 30). In Fiscal Year 2000 they included: • Achieve excellent performance in environmental protection (e.g., minimize permit exceedances, spills, and tritium releases). • Complete key environmental improvement projects in a timely manner (e.g., Process Evaluation, EMS, Groundwater, Environmental Restoration). • Minimize waste generation and eliminate legacy wastes. • Enhance the responsiveness and effectiveness of Laboratory communications. Individual organizations augment these Labwide goals with specific goals applicable to their programs.
Environmental Management Program *and* *Pollution Prevention**	Organizations within BNL develop action plans detailing how they will achieve their objectives and targets and commit the necessary resources to successfully implement both Labwide 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.
Structure and Responsibility	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 their environmental responsibilities. The Deputy Director for Operations manages the ESH&Q Directorate and leads environmental protection efforts. He is responsible for coordinating the implementation of the EMS within BNL and reporting on performance to senior management, and utilizes the staff of the Environmental Services Division to accomplish this task.
Training, Awareness, and Competence	BNL developed a comprehensive environmental training program in 1999, and in 2000 completed the training of staff, visitors, and contractors to ensure they are competent to carry out their environmental responsibilities. This training program includes general environmental awareness for all employees, regulatory compliance training for select staff, and specific courses for managers, internal assessors, EMS implementation teams, and operations personnel whose work can impact the environment.
Communication *and* *Community Outreach**	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, primarily through the Citizens Advisory Committee and/ or the Brookhaven Executive Roundtable. The Commitment Control Tracking System is used to track and ensure response to communication from external interested parties.

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

EMS Documentation	BNL has a comprehensive, up-to-date set of Laboratory-wide environmental documents describing its EMS program. A web-based system called the Standards Based Management System (SBMS) provides access to regulatory requirements, Laboratory-wide procedures, and manuals that tell staff how to control processes and perform work at BNL in a way that protects the environment. SBMS has improved the quality, usability, and communication of Laboratory-level requirements.
Document Control	SBMS contains a comprehensive document control system to ensure effective management of procedures and other system documents. When facilities require additional procedures to control their work, document control protocols are implemented to ensure that workers have access to the current versions of procedures.
Operational Control	Through the Process Evaluation Project, work planning and control, experimental design review and EMS implementation, operations at the Laboratory are evaluated for adequacy of current controls to prevent impacts to the environment. As needed, additional administrative or engineered controls are identified and plans for upgrades and improvements are developed and implemented. Key operational control procedures are documented either in SBMS or in facility-specific internal Standard Operating Procedures/work instructions.
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. Results are reported to regulatory agencies and summarized annually in this Site Environmental Report. In addition, BNL tracks and trends its progress and performance in achieving environmental objectives and performance measures.
Nonconformance and Corrective and Preventive Actions *and Compliance Assurance**	BNL continues to improve processes to identify and correct problems. This includes implementation of a Lessons Learned Program to prevent recurrences, a robust Self-Assessment Program, and an electronic web-based assessment and action tracking system.
Records	EMS related records, including audit and training records, are maintained to ensure integrity, facilitate retrieval, and to protect them from loss.
EMS Audit	To periodically verify that the EMS is operating as intended, audits are conducted. These audits, conducted as 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.

* The italicized items Pollution Prevention, Community Outreach, and Compliance Assurance are not specific elements of ISO 14001, but they are a part of BNL's enhanced EMS.

conformance with the ISO 14001 Standard in August 2000. This is a formally recognized status option available to organizations that satisfy all the requirements. BNL exceeded the requirements for ISO 14001 self-declaration by undergoing an external audit in October 2000 by an independent registrar. This audit provided assurance to BSA that its system was effectively implemented, and also satisfied a milestone in the DOE/EPA MOA. The BNL organizations that self-declared conformance are: Director's Office/Community Involvement, Government and Public Affairs; Chemistry Department; Physics Department; Instrumentation Division; National Synchrotron Light Source; Energy, Environment, and National Security Directorate; Facilities and Operations Directorate; Environment, Safety, Health, and Quality Directorate; and the Finance and Administration Directorate. A registration audit for the entire Laboratory is scheduled for completion in June of 2001.

Table 2-2. BNL's Criteria for Significant Environmental Aspects.

Environmental Aspect	Criteria for Significant Aspects
Regulated Industrial Waste Generation	a) Any amount of regulated industrial waste generation.
Hazardous Waste Generation	a) Any amount of hazardous waste generation.
Radioactive Waste Generation	a) Any amount of radioactive waste generation.
Mixed Waste Generation	a) Any amount of mixed waste generation.
Regulated Medical Waste Generation	a) Any amount of regulated medical waste generation.
Atmospheric Discharges	a) Any process that requires a point source air permit or inclusion in the Title V permit as an emission unit, or contributes to a regulated emission point. b) Operations or activities that use engineering controls to reduce hazardous air pollutant or radionuclide emissions. c) Radioactive emissions that require monitoring (continuous or confirmatory) per 40 CFR 61 subpart H of the National Emission Standards for Hazardous Air Pollutants.
Liquid Discharges	a) Radionuclides that are detectable at the point of discharge from the facility. b) Discharges of any of the chemicals listed on the BNL State Pollutant Discharge Elimination System Permit. c) Operations or activities that use engineering controls to reduce the quantity or concentration of pollutant. d) Existence of underground injection control devices.
Storage or Use of Chemicals or Radioactive Materials (potential for accidental release or contamination)	a) Storage or use of chemicals or radioactive materials requiring engineering controls as specified in BNL procedures. b) System configuration requires back-flow prevention in accordance with the protection. c) Transportation of chemicals or dispersible radioactive materials. d) Storage or use of PCBs as specified in BNL procedures. e) Any underground pipes or ducts that contain chemical and/or radioactive material/ contamination. f) Storage or use in quantities capable of resulting in a reportable spill, as defined in BNL procedures.
Water Consumption	a) Total organizational water consumption greater than 650,000 gallons per day. b) Continuous (24 hrs/day), permanent (to continue for the foreseeable future) once-through water use greater than 4 gallons per minute (gpm) that discharges to the sanitary sewer system. c) Daily (8 hrs/day), permanent, once-through water use greater than 10 gpm that discharges to the sanitary sewer system. d) Continuous use greater than 10 gpm, or daily use greater than 15 gpm for a period greater than 60 days that discharge to the sanitary sewer system.
Power Consumption	a) Total organizational power consumption greater than 58 M KWh/yr.
Historical Monuments/ Cultural Resources (groundwater, soil)	a) Any modification to a historically significant structure (e.g., BGRR, Cosmotron building, and World War I foxholes/trenches). b) Proposed modification to known archaeologically significant area(s) or discovery of archaeologically significant material (lithic scatter, bone, foundations, etc.)
Sensitive/Endangered Species And Sensitive Habitats (including Pine Barrens)	a) Potential for habitat destruction, harm or harassment within 850 feet of a critical habitat (*recharge basins, vernal pools, natural and manmade ponds and waterways*). b) Disturbance within 100 feet of a regulated wetland (*that is already not identified as a critical habitat*). c) Disturbance within ½ mile of the Peconic River. d) Activity affecting five or more acres of undeveloped land.
Environmental Noise	a) Exceed ordinance levels [7am-10pm: 55 dba; 10pm-7am: 50 dba (20 min. average)] at property boundary or offsite location.
Historical Contamination (groundwater, soil)	a) Pre-existing contamination (radiological or nonradiological) causing remedial activities resulting in costs in excess of $50,000.
Soil Activation	a) Any soil activation.

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Table 2-2. BNL's Criteria for Significant Environmental Aspects *(concluded).*

Environmental Aspect	Criteria for Significant Aspects
Transuranic Waste	a) Generation or potential to generate any radioactive waste stream classified as transuranic waste (i.e., contains greater than 100 nanocuries per gram of trans-uranium isotopes).
Other	a) Other compliance requirement specific to an organization or aspect that could impact the environment (e.g., asbestos research). b) Any historical or legacy issue.

Source: *Identification of Significant Aspects and Impacts Subject Area, SBMS*

2.1.3 ENVIRONMENTAL STEWARDSHIP POLICY

The cornerstone of an EMS is a commitment to environmental protection at the highest levels of the organization. One of the early steps in the EMS project was strengthening and communicating an environmental policy (reproduced in Figure 1-1 in Chapter 1). The Environmental Stewardship Policy is included in training programs, and is posted throughout the Laboratory and on the BNL website.

The Environmental Stewardship Policy contains the following goals and commitments:

- Achieve and maintain compliance with applicable environmental requirements. These requirements include over 50 sets of local, state, and federal laws and regulations; 16 DOE Directives; seven Executive Orders; and approximately 65 operating permits (see Chapter 3).
- Integrate pollution prevention, waste minimization, and resource conservation into

Figure 2-2. BNL ISO 14001 Registration Certificate.

Laboratory activities during the planning, decision-making, and implementation phases. Conserve natural resources. Ensure that environmental emissions, effluents, and waste generation are As Low As Reasonably Achievable (a concept known as "Environmental-ALARA"—see discussion in Section 5.3).

- Define, prioritize, and remedy existing environmental problems. This commitment encompasses removal or treatment of contamination caused by historical practices. It also includes strengthening the environmental monitoring program to ensure that controls designed to protect the environment are working, and to provide early detection of a potential threat to the environment (see Section 2.3.8).
- Emphasize continual improvement. Employ proactive measures to prevent problems. When problems do occur, investigate the root cause and take corrective actions as appropriate.
- Openly communicate with neighbors, regulators, employees, and organizations about program progress and performance (see Section 2.3.10).

2.1.4 STRUCTURE AND RESPONSIBILITY

Once the environmental policy was in place, roles and responsibilities for implementing the EMS needed to be defined. One key to the success of BSA's approach to environmental stewardship has been leadership. At Laboratory meetings and in memorandums, the Director has reaffirmed his personal commitment to environmental protection and his expectation that all staff participate in this way of doing business. BNL has reorganized environmental protection, waste management, restoration, and the community involvement programs to better integrate and elevate these functions within the organizational structure.

BSA also more clearly defined expectations for staff and management. In the past, as is often the case, responsibility for environment, safety, and health had been relegated to the support organizations. Now, under the BSA management model, senior management has communicated their expectation that all line managers take full responsibility for environment, safety, and health performance, and that line managers and staff be held accountable. Every BNL employee was 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. A comprehensive training program for staff, visiting scientists, and contractor personnel was completed (see Section 2.1.6), thus ensuring that all personnel are aware of their environmental responsibilities.

BNL also implemented an Environmental Compliance Representative program in 1998. These environmental professionals are deployed to the field, supporting the research and operational organizations full time. The Environmental Compliance Representatives team with Subject Matter Experts to provide technical support on compliance and pollution prevention, and assist in the development and implementation of the EMS within line organizations.

2.1.5 STANDARDS BASED MANAGEMENT SYSTEM

In order to implement the compliance commitments in the Environmental Stewardship Policy, BNL implemented and continues to improve on a tool called Standards Based Management System (SBMS). SBMS is a web-based system designed to deliver Laboratory-level requirements and guidance to all staff in a user-friendly format. All labwide procedures reside in this system. Up-to-date "Subject Areas" on a variety of environmental topics were developed in 1999 and 2000 by teams of researchers and environmental protection professionals, with input from regulatory agencies. Existing standards for work and research planning and control have been upgraded to ensure that reviews by qualified ES&H staff occur early in the planning process, and that adequate measures to control hazards and risks are incorporated during the design phase. The information provided in SBMS focuses on what staff need to know to do their work in an environmentally responsible manner and translates requirements into a format and language that are easily understandable. Figure 2-3 lists the environmental protection and some of the other key subject areas that support the EMS. During 2000, several of these subject areas underwent a review and improvement cycle.

ENVIRONMENTAL PROTECTION SUBJECT AREAS

Drinking Water
Environmental Assessments
Environmental Evaluation of Industrial Processes and Experimental Research
Environmental Monitoring
Groundwater Protection Contingency Plan
Hazardous Waste Management
Identification of Significant Environmental Aspects and Impacts
Liquid Effluents
Mixed Waste Management
NEPA and Cultural Resource Evaluation
Nonradioactive Airborne Emissions
Oil/PCB Management
Pollution Prevention and Waste Minimization
Radioactive Airborne Emissions
Radioactive Waste Management
Regulated Medical Waste Management
Spill Response
Storage and Transfer of Hazardous Materials
Underground Injection Control

KEY SUPPORT SUBJECT AREAS

Calibration
Correspondence and Commitment Tracking
Community Involvement in Laboratory Decision-Making
Facility Use Agreements
Graded Approach for Quality Requirements
Hazard Analysis
Integrated Assessment
Internal Controlled Documents
Investigation of Incidents, Accidents, and Injuries
Lessons Learned
Nonconformance, Corrective and Preventive Action
Operational Readiness Evaluation
Records Management
Requesting SBMS Variances
Requirements Management
Roles, Responsibilities, Accountabilities, and Authorities
Training and Qualification

Figure 2-3. Environmental Management System and Supporting Subject Areas in the Standards Based Management System. Labwide requirements are contained in SBMS Subject Areas, available online at <https://sbms.bnl.gov>

2.1.6 STAFF TRAINING AND AWARENESS

Extensive training on EMS requirements has been provided to staff whose responsibilities involve environmental protection. In total, approximately 12,000 hours of environmental training were provided between 1998 and 2000.

- All staff and visiting scientists working at BNL for more than two months are required to take a computer-based training course developed by BNL to provide a basic level of environmental awareness. The course discusses the EMS, reviews basic environmental requirements, and describes the impacts of noncompliance. Contractors and short-term visitors take a modified training program covering the key points.
- Training sessions were conducted to introduce key staff to the EMS Subject Areas. Subject matter experts from the BNL environmental protection program prepared and presented this training.
- Staff whose work could directly impact the environment were given job-specific training focused on implementing processes and controls to minimize environmental impacts.
- The top three levels of management attended a training program that provided them with an overview of the EMS.
- Teams responsible for coordinating the implementation of the EMS within each organizational unit were provided in-depth training on ISO 14001 requirements and techniques.
- To support the Laboratory's Integrated Assessment Program (see Section 2.1.7), select individuals were trained to perform EMS internal audits.

2.1.7 PERFORMANCE BASED MANAGEMENT SYSTEM AND INTEGRATED ASSESSMENT PROGRAM

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

- Significant environmental aspects

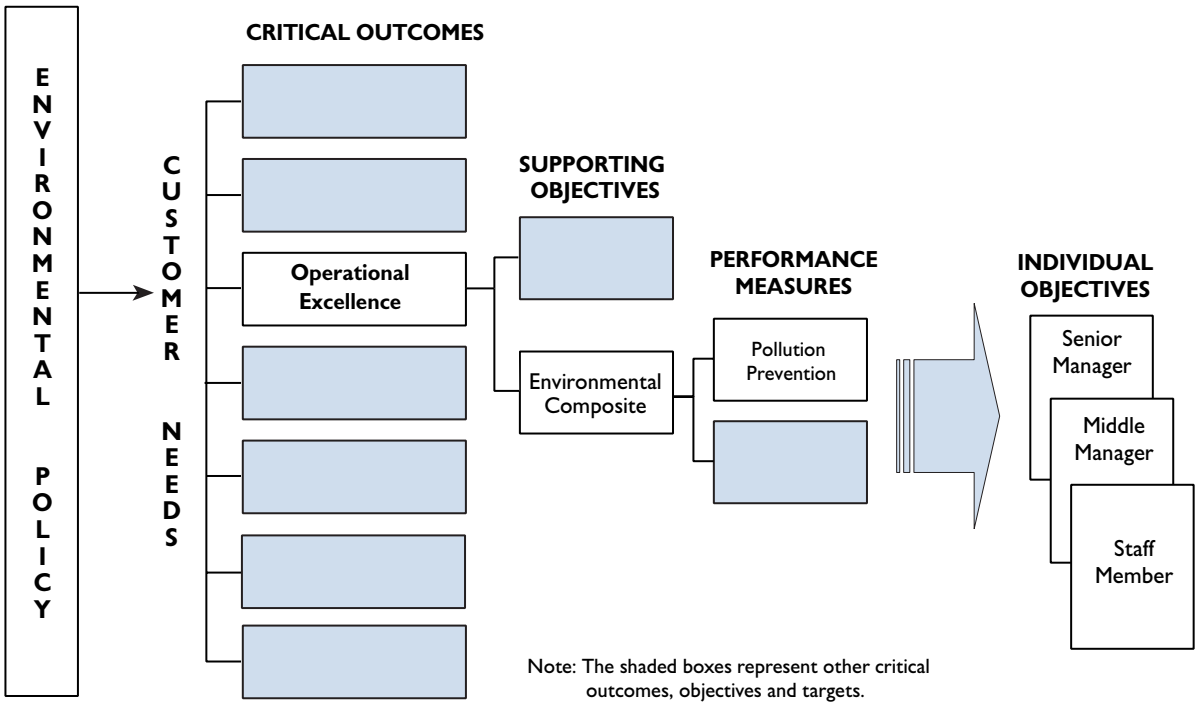

Figure 2-4. Hierarchy of Environmental Objectives at BNL — an example for operational excellence.

- Risk and vulnerability (primarily threat to the environment)
- Legal requirements (laws, regulations, permits, enforcement actions)
- Commitments (in the Environmental Stewardship Policy, to regulatory agencies, to the public)
- Importance to DOE, the public, and other stakeholders.

Responsibilities for achieving these expectations are assigned at all relevant levels of the organization, starting with senior management and flowing down to the individual level. The following example illustrates this flow down (also see Figure 2-4). Under the Fiscal Year 2001 Operational Excellence *critical outcome,* BNL had an objective to integrate pollution prevention/waste minimization and resource conservation into all planning and decision making. A related *performance objective* was to reduce hazardous, mixed, and low-level radioactive routine waste streams. The *performance measure* was to reduce all three wastestreams below Fiscal Year 2000 levels. At the Department level, this could translate into an *organizational goal* to develop and implement an action plan to reduce waste generation. A staff member might have an *individual goal* to learn and comply with the Pollution Prevention and Waste Minimization Subject Area requirements, and to purchase environmentally preferable products.

This approach helps employees understand how their work relates to Laboratory-level performance objectives, so they can align their efforts toward achieving BNL missions. It also ensures that Laboratory operations are conducted in accordance with the expectations established by the DOE and BNL management. Through performance based management, BSA focuses environmental management improvement initiatives on addressing the priorities of DOE, regulatory agencies, and the community. Specifically, in 2000, emphasis was placed on developing and implementing the EMS, enhancing the Laboratory's groundwater protection program, improving pollution prevention programs, achieving and maintaining compliance, and expediting environmental restoration.

One key element of the BNL's Performance Based Management Program is routine and systematic assessment processes. The Integrated Assessment Program was established to monitor progress towards achieving high priority improvements, as well as routine expectations such as compliance with environ-

mental regulations. Areas for improvement are identified and tracked to completion.

The primary elements of BNL's Integrated Assessment Program are described below.

Self-assessment is the evaluation of internal processes and performance. The approach for the environmental self-assessment program includes evaluating programs and processes within organizations that have environmental aspects. Conformance to ISO 14001 EMS requirements is verified, progress towards 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. Management also conducts assessments to evaluate Laboratory environmental performance from a programmatic perspective, to determine if there are Labwide 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. Laboratory management also routinely evaluates progress on key environmental improvement projects. BNL periodically teams with the local DOE office to perform assessments in order to facilitate the efficiency of assessment activities and ensure that the approach to performing the assessments meets DOE expectations.

Peer Review is used to evaluate and independently verify the adequacy of engineering designs and operational controls, as well as the accuracy of documents.

Independent Oversight independently verifies the effectiveness and adequacy of the self-assessment programs at the division, department, directorate, and Laboratory levels. Special investigations are also conducted to identify the root causes of problems, corrective actions, and lessons learned.

The Integrated Assessment Program is augmented by programmatic, *external audits* conducted by DOE. Corporate offices of Battelle Memorial Institute and BSA subcontractors also perform periodic independent reviews. As noted in Section 2.1.2, an independent third party conducts ISO 14001 registration audits. BNL is also subject to extensive oversight by external regulatory agencies (see Section 3.14 of Chapter 3). As a result of the MOA with EPA, the Integrated Safety Management verification and validation process conducted by DOE headquarters, DOE-BSA contractual requirements, and the phased implementation of the EMS project, more than 60 audits and self-assessments by both internal and external auditors have been conducted in the last three years to evaluate BNL's EMS and environmental programs. That number does not include self-assessments. For example, in one year, the Collider-Accelerator Department conducted 15 quality assurance assessments; 104 "Tier 1" environment, safety, and health facility walkthroughs; 52, 90-day hazardous waste storage area inspections; and 144 hazardous waste satellite accumulation area inspections. Other organizations within BNL conducted similar types of self-assessments.

Results of all assessment activities related to environmental performance are included, as appropriate, throughout this report.

2.2 SPECIAL ENVIRONMENTAL PROJECTS

In addition to the EMS project, the Laboratory developed and funded a set of projects designed to further integrate environmental stewardship into all facets of BNL's missions. Two key projects are described below.

2.2.1 THE FACILITY REVIEW PROJECT

BNL has had an active Environmental Restoration Program onsite since 1989, when the site was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (see description in Section 2.3.9 below). However, after a tritium leak from the High Flux Beam Reactor spent fuel storage pool, and strontium-90 contamination emanating from a sump at the inactive Brookhaven Graphic Research Reactor were discovered in 1997, BNL senior management realized that their understanding of potential environmental vulnerabilities was incomplete. To assess and address historical problems, BNL initiated the Facility Review Project in April of 1997.

The Facility Review Project was a comprehensive examination of all site facilities, existing or demolished, to identify any past or current activities with the potential to degrade the environment. During this project, BNL reviewed the entire operating history of the site and more than 900 systems, facilities, and operations including tanks, pipes, sumps,

Table 2-3. Category, Risk Rank, Number, and Status of Issues Identified in the Facility Review Project, as of December 31, 2000.

Category	Rank: Type of Issue	Number	Dispositioned
75 High Priority Issues	High Priority: Potential to impact groundwater above drinking water standards	75	56 (75%)
1,175 Operational Issues (responsible organization still exists) needing further evaluation	Rank 1-3: Potential to impact groundwater, but not above drinking water standards	176	130 (74%)
	Rank 4-6: Lower priority, requiring engineering controls or documentation	999	38 (4%)
500 Legacy Issues (responsible organization does not exist) needing further evaluation	Rank 1-3: Potential to impact groundwater, but not above drinking water standards	212	9 (4%)
	Rank 4-6: Lower priority, requiring engineering controls or documentation	288	6 (2%)
Total		**1,750**	**239 (14%)**

cesspools, storage areas, historical discharges, and current and past operating practices. Twenty-eight individuals from fifteen other DOE facilities provided high-level technical and management support during the review. A final report was issued on October 7, 1998 (BNL 1998b).

The report identified 75 issues as the highest priority due to the potential to contaminate groundwater above drinking water standards. Additionally, over 1,675 issues that had the *potential* to impact the environment were identified as needing further evaluation. These were further subdivided into operational and legacy issues. In March 2000 the Facility Review Disposition Project Plan (BNL 2000a) was approved. This three year project provides the mechanisms needed to rank risk, schedule, and disposition the issues identified during the Facility Review Project of 1997. BNL continues to work closely with the Suffolk County Department of Health Services to identify and rank the issues. A database shared between BNL and Suffolk County tracks progress in addressing these issues. See Table 2-3 for a breakdown of the number of issues and their status.

The initial focus has been on issues with the highest potential to have a negative impact on the environment, especially groundwater. Legacy issues will be the focus of efforts in 2001 to accelerate closure.

2.2.2 THE PROCESS EVALUATION PROJECT

BNL conducted an extensive evaluation of its experimental and industrial processes to determine compliance requirements, and evaluate and minimize or eliminate potential impact to the environment. One of the MOA requirements was "evaluate all experimental and industrial-type operations at BNL for the purpose of identifying all waste streams produced" on a very aggressive schedule. All high priority processes were to be evaluated within one year, with the balance completed the following year.

BSA realized that this effort could provide an unprecedented level of knowledge of operations, and form a strong technical basis for the EMS and other environmental improvement programs. The scope was expanded by BNL and efforts were managed under the Process Evaluation Project. A process mapping technique was used to develop flow diagrams showing all inputs and outputs to and from processes (see Figure 2-5, an example of a process map for the Boiler Test Facility). Process inputs are the materials used in a process. A multi-media evaluation of outputs (wastes, effluents, and air emissions) from each process was performed. A formal regulatory evaluation of all outputs (waste description, determination, and handling) was conducted to determine compliance requirements. Pollution prevention opportunities and best management practices were identified and are being evaluated. To date:

- Over 145 industrial processes (e.g., machining, painting, electronics) and 1,821 research experiments were evaluated, ahead of the schedule established in the MOA. The final report was submitted to EPA on June 22, 2000 (BNL 2000b).
- Approximately 181 corrective actions were identified. Many of the corrective actions

required sampling and analysis of waste streams formally characterized using process knowledge. As of December 31, 2000, 170 (94%) of the corrective actions have been closed. The remaining 11 are being tracked to closure.

- 188 assessment, prevention, and control measures were identified. These were recommendations for more formal controls such as routine inspections or written procedures. Of these, 98 (52%) have been implemented and closed, and the remainder are being tracked to closure.
- Over 251 pollution prevention opportunities were identified. An example of a pollution prevention opportunity is substitution of nontoxic materials for hazardous chemicals, resulting in the elimination of hazardous waste generation. At the end of the calendar year, 142 (52%) had been evaluated or had already been implemented.

The approximate cost of $1,600,000 for this project was borne by BNL line organizations (60%) and overhead funding (40%). The methods used to evaluate industrial processes and experiments during this project have been integrated into BNL work planning tools, thus institutionalizing the effort and ensuring lasting value. This project is unique in the DOE complex, and probably more comprehensive than what has been done in the private sector. Along with the EMS Project, the Process Evaluation Project was recently selected for a DOE National Pollution Prevention Award for Excellence in Environmental Management. EPA Region II also recommended both projects for inclusion in President Clinton's Library of Accomplishments.

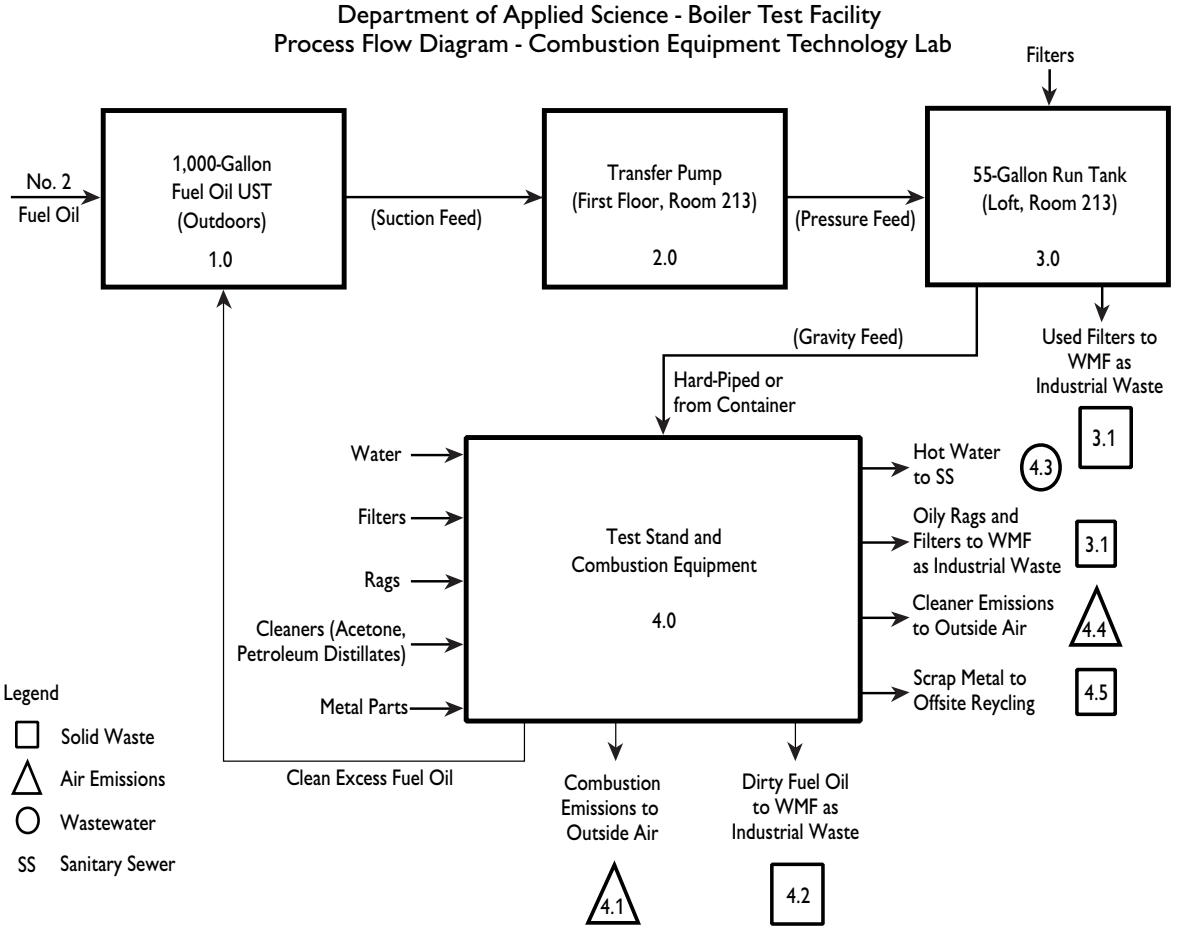

Figure 2-5. Process Map Example. BNL has evaluated almost 2,000 industrial and research processes onsite, and produced process maps like this one, showing inputs, outputs and regulatory requirements. (The codes on the figure refer to text in the process evaluation report.)

2.3 KEY ENVIRONMENTAL MANAGEMENT PROGRAMS

In addition to the projects described above, a number of programs designed to protect the environment are part of BNL's EMS. Some of the key programs are described below.

2.3.1 COMPLIANCE

BNL has an extensive program to ensure full compliance with all applicable environmental regulatory requirements and permits. Some activities, such as the National Emission Standards for Hazardous Air Pollutants compliance program, are routine. Others are special projects or initiatives, such as removing and upgrading storage tanks, upgrading the sanitary sewer system, closing underground injection control devices, retrofitting or replacing air conditioning equipment refrigerants, managing legacy waste, and diverting cooling tower blowdown. See Chapter 3 for a discussion and status of these programs.

2.3.2 GROUNDWATER PROTECTION

BNL has developed a Groundwater Protection Management Program that focuses on preventing impacts to groundwater and restoring groundwater quality. Groundwater protection programs at most sites rely solely on groundwater monitoring. In contrast, BNL uses monitoring primarily as a tool to determine whether operational or engineered controls are effectively protecting groundwater. BNL has also developed a Groundwater Protection Contingency Plan that defines an orderly process for taking corrective actions quickly in response to unexpected monitoring results. A key element of that plan and the groundwater program is full and timely disclosure to interested parties. Chapter 7 provides addi-

Bldg. 860 contains offices for technical and professional staff. Staff are responsible for providing support to the Laboratory to facilitate pick-up, storage, and offsite disposal of hazardous, radioactive, and mixed waste.

Hazardous Waste Management

Bldg. 855 is used for the storage of BNL's industrial, hazardous and polychlorinated biphenyl (PCB) solid, liquid, and gaseous wastes. This building was designed and built to provide tertiary containment for stored wastes to prevent environmental contamination should a spill occur. This was accomplished through the use of sealed concrete floors and an impervious liner placed under the building that exceeds regulatory requirements.

Wastes from various research and maintenance activities are typically generated in quantities of five gallons or less. These wastes are stored in containment trays placed on shelves within secondarily contained storage rooms, referred to as lab pack rooms. Wastes stored in these rooms are segregated by hazard class to prevent incompatible materials from reacting.

Some wastes such as liquid wastes from photographic processing and waste oils are collected in 55-gallon drums, and stored in drum storage bays. These bays provide the space needed to maneuver and inspect larger containers. As in the lab pack rooms, wastes are placed into the drum storage bays by hazard class to segregate incompatible materials. Containment is provided by concrete floors (coated with a chemically resistant sealant), which are pitched to sealed collection sumps.

Figure 2-6. BNL Waste Management Facility.

Radioactive Waste Management

Bldg. 865 is used for the sorting, repackaging, and temporary storage of solid low level radioactive wastes generated by BNL research and maintenance activities. Typical radioactive wastes consist of paper, plastic, glass, and metal. Most radioactive wastes are received at the Waste Management Facility in plastic bags. After receipt, most of these bags are consolidated into metal bins where they may be further consolidated through compaction. Metals, glass, and heavy objects that could puncture a bag are sometimes packaged directly into these bins or other appropriate container.

Prior to shipment offsite, bins containing waste are stored in below grade concrete vaults. Bins are inserted into and removed from these vaults via an overhead crane. Only solid radioactive wastes are stored in Bldg. 865.

Mixed Waste Management

Bldg. 870 is used for the storage of mixed wastes. These are wastes that are both hazardous and radioactive. This building is similar in design to the Hazardous Waste Storage Building, Bldg. 855. Most mixed wastes are generated by research activities and are typically in quantities of five gallons or less.

Building 870 is comprised of storage bays that provide secondary containment. Small waste items are stored within containment trays on shelves in the bays. Typical mixed wastes include radioactively contaminated acids and alcohols, mercury-containing apparatus, and lead used in shielding applications. Mixed wastes are stored in this building prior to offsite treatment and disposal.

tional details about the Groundwater Protection Management Program and monitoring results for 2000.

2.3.3 WASTE MANAGEMENT

The goal of BNL's Waste Management Program is safe and efficient management of waste from generation to offsite disposal. The program emphasizes pollution prevention/waste minimization (see Section 2.3.4). It ensures that there is a defined pathway and budget for disposing of any waste generated, and also that BNL complies with applicable regulatory and permit requirements. This includes DOE Order 435.1 (1999), *Radioactive Waste Management*, which requires that all wastes be disposed of within one year of receipt, thus avoiding excess waste accumulation.

BNL has a Waste Management Facility and Wastewater Processing Facility. The Waste Management Facility is a permitted waste storage facility (New York State Department of Environmental Conservation (NYSDEC) Permit No. 1-422-00032/00102-0) consisting of four operations Buildings: 855, 860, 865, and 870. See Figure 2-6 for photographs and a description of the operations in each of these buildings.

Figure 2-7. The Waste Management Facility Hot Cell. A hot cell for the management of high-activity radioactive waste was recently constructed in Bldg. 865. The hot cell allows the operator to manipulate and package wastes through the use of mechanical arms. The side walls contain 172,000 lbs. of recycled lead bricks.

Also see Section 4.1.8.1 in Chapter 4 for a description of equipment in Building 865.

The Laboratory completed an upgrade to Building 865 in 2000 with the construction of a hot cell. This project reused 172,000 pounds (77,400 kg) of lead bricks, avoiding $405,000 in materials purchase and mixed waste disposal costs (see Figure 2-7). The hot cell will allow management of high-level radioactive wastes in a safer, more cost-effective manner. Use of the hot cell is expected to begin in 2001 pending the completion of a readiness review.

Mixed wastes present a special disposal challenge, as they contain both hazardous and radioactive constituents. In 2000, BNL shipped over 400 cubic feet (11 cubic meters) of mixed waste offsite for treatment and disposal. Much of this waste had been in storage for years due to the lack of treatment options. During that time, it was monitored by NYSDEC and managed according to the *BNL Site Treatment Plan* (BNL 1997). See Section 2.3.4 for a description of BNL's program to minimize future generation of mixed waste.

The Water Processing Facility (Building 810/811) and the Tritiated Water Evaporator Facility (Building 802) are used to manage liquid wastes. Bulk quantities of radioactive wastewater are stored in tanks at the Building 810/811 facility. The wastewater is stored in permitted tanks for either onsite processing or offsite treatment and disposal. Building 802 processing consists of evaporating tritiated wastewater, which has been treated for the removal of heavy radioisotopes and particulates, under the controls imposed by an existing air permit. In addition to wastewaters managed in Buildings 811 and 802, approximately 68,000 gallons (257,000 liters) of water from the spent fuel pool of the High Flux Beam Reactor were disposed of offsite in 2000 as part of the decommissioning process. (Note: Offsite shipment of all spent fuel from the High Flux Beam Reactor was completed in 1997.)

In addition to the Waste Management and Water Processing Facilities, BNL has nineteen 90-Day Hazardous Waste Accumulation Areas, with the closure of one such area occurring in 2000. There are also approximately 200 Hazardous Waste Satellite Accumulation Areas, where small quantities of hazardous waste are managed at or near the point of generation. Trained staff following standard operating procedures manage the areas.

In 2000, BNL generated the following types and quantities of waste from routine operations:

- Hazardous Waste: 15.7 tons (14.2 metric tons)
- Mixed Waste: 67 cubic feet (1.9 cubic meters)
- Radioactive Waste: 7,885 cubic feet (223 cubic meters)

These quantities represent significant reductions from previous years, as can be seen in Figures 2-8a through f. In 2000, radioactive and mixed waste generation did increase from 1999 levels, due to a more vigorous experimental program at the Alternating Gradient Synchrotron. Construction/demolition wastes, environmental restoration wastes, legacy waste, lead-painted debris, lead shielding, PCB waste, and other wastes determined to be nonroutine are not included in these totals or in Figures 2-8a through 2-8f.

Routine operations are defined as on-going industrial and experimental operations. The picture is not complete however, without consideration of wastes generated from 'nonroutine' or one time events and waste generated from environmental restoration activities. Figures 2-8g, h and i show wastes generated under the Environmental Restoration Program. Waste generation from these activities is growing significantly. This is to be expected as environmental restoration activities transition from remedial investigations and feasibility studies to remedial actions. The purpose of remedial actions is to remove waste or contaminants from the environment. Thus, as the environmental restoration program enters the active cleanup phase, waste volumes from nonroutine operations and remedial actions will continue to rise. The pollution prevention program recognizes this, and will continue to target these waste streams for minimization.

2.3.4 POLLUTION PREVENTION/WASTE MINIMIZATION

The EMS provides a mechanism for systematically evaluating and implementing value-added pollution prevention opportunities at the Laboratory. A strong Pollution Prevention/Waste Minimization Program is an essential facet of the EMS. The BNL Pollution Prevention Program goes beyond national and DOE pollution prevention goals and policies, and represents an ongoing effort to make

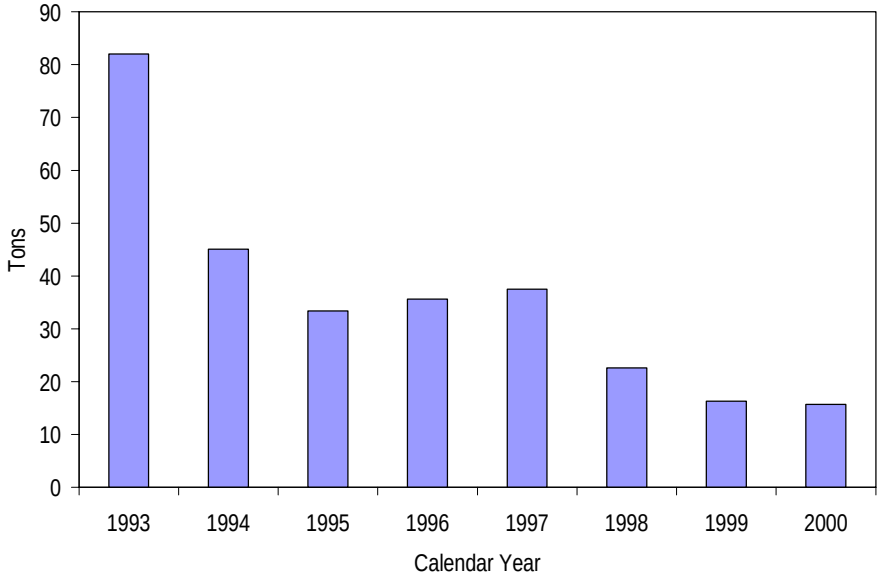

Figure 2-8a. Routine Hazardous Waste Generation, 1993-2000.

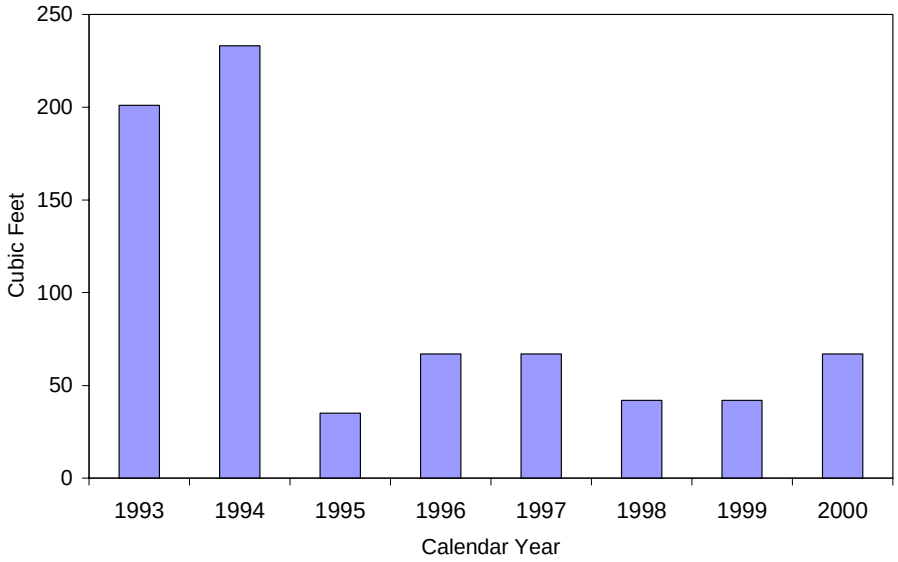

Figure 2-8b. Routine Mixed Waste Generation, 1993-2000.

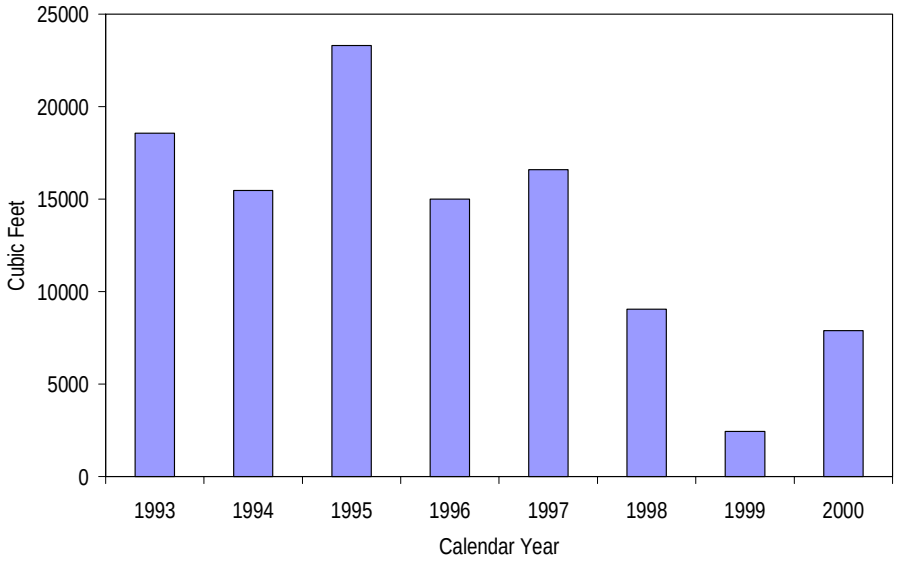

Figure 2-8c. Routine Radioactive Waste Generation, 1993-2000.

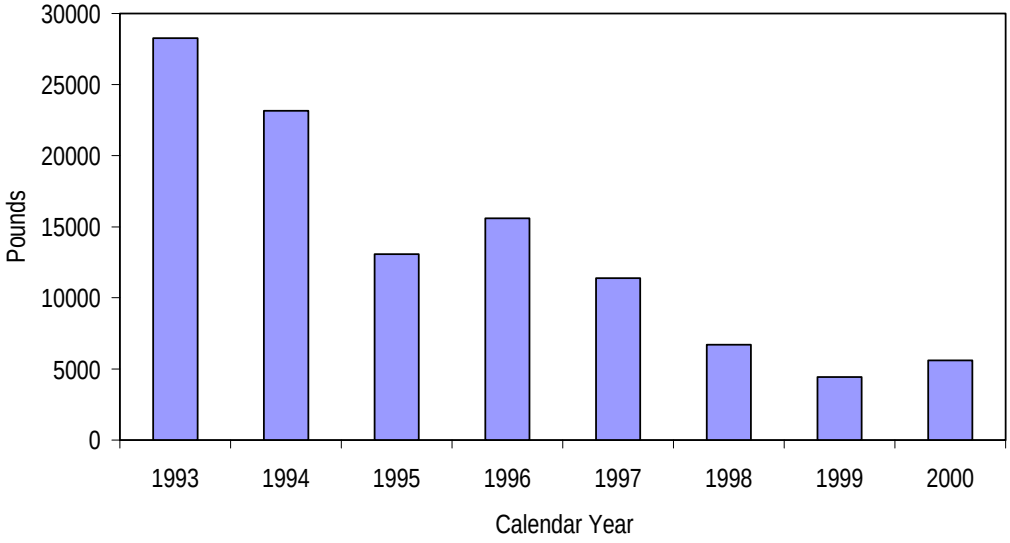

Figure 2-8d. Hazardous Photographic Waste Generation, 1993-2000. Hazardous waste from Photography and Graphics Arts has been reduced by nearly 80% since 1993. The reductions were achieved primarily by implementing process and technology changes including conversion to digital photography and digital photographic processing. The required equipment was purchased using pollution prevention funds. The project has had an excellent return on investment.

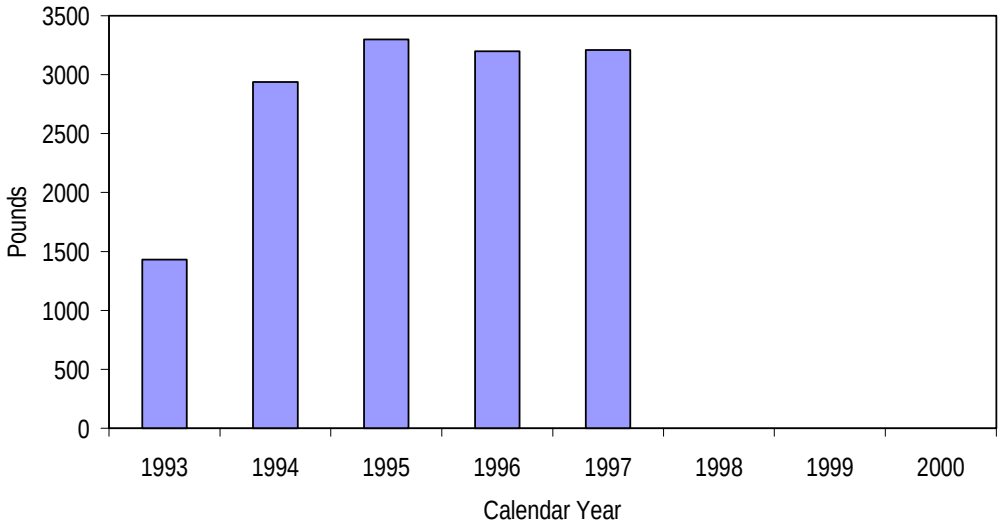

Figure 2-8e. NSLS Beam Tube Cleaning Waste Generation, 1993-2000. Prior to 1998, beam tubes used at the National Synchrotron Light Source were cleaned using acids and solvents. The cleanliness specifications for the beam tubes are extremely demanding, and the cleaning operations generated significant quantities of hazardous waste. While planning for an upgrade of the cleaning facility, a pollution prevention opportunity assessment was conducted on the cleaning process. Scientists worked closely with plant engineering and environmental protection staff to develop a completely new cleaning process that relies on ultrasonic agitation using nonhazardous cleaning solutions. The new process ultimately cleaned better than the more hazardous process and completely replaced it, eliminating hazardous waste generation from this operation.

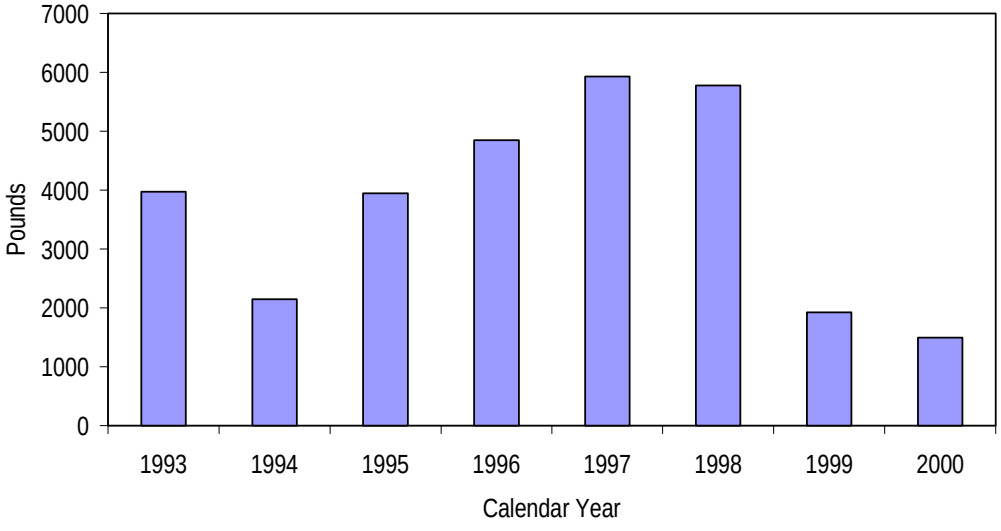

Figure 2-8f. Hazardous Paint Waste Generation, 1993-2000. Hazardous waste from painting operations has been reduced by nearly 75% since 1998. Latex paints have replaced oil-based paints in most routine applications, eliminating the need for solvent cleanup and reducing hazardous waste generation.

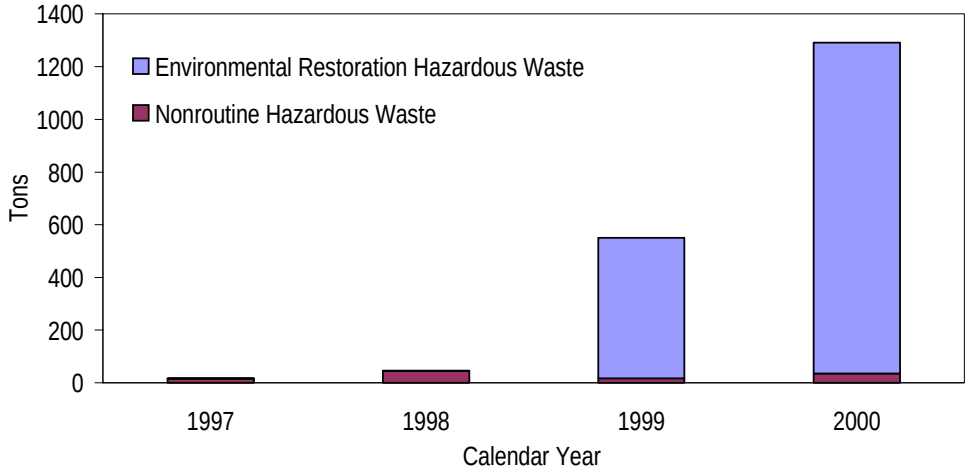

Figure 2-8g. Environmental Restoration and Nonroutine Hazardous Waste Generation from the ER Program, 1997-2000. Figures 2-8g, h, and i show the nonroutine waste not included in the totals in Section 2.3.3, as well as other hazardous, mixed, and radioactive wastes generated by the Environmental Restoration Program. As expected, waste volumes have increased dramatically as the environmental cleanup moves from the investigation phase to active remediation.

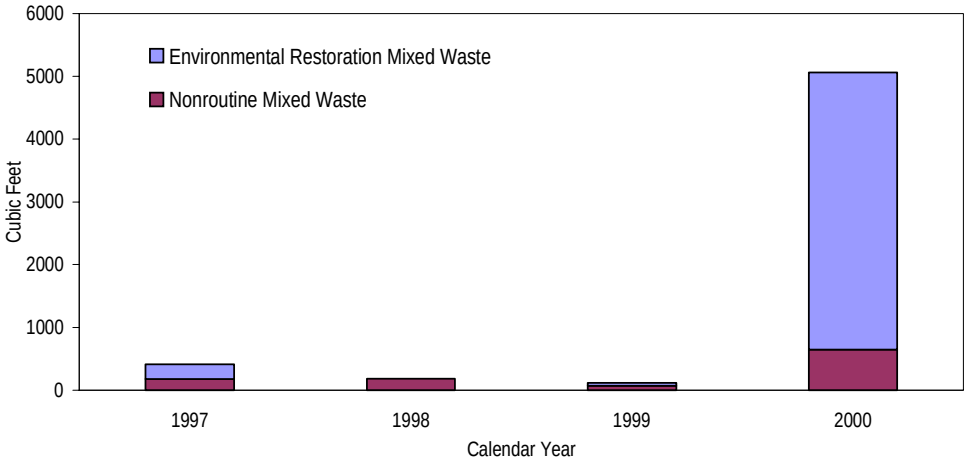

Figure 2-8h. Environmental Restoration and Nonroutine Mixed Waste Generation from the ER Program, 1997-2000.

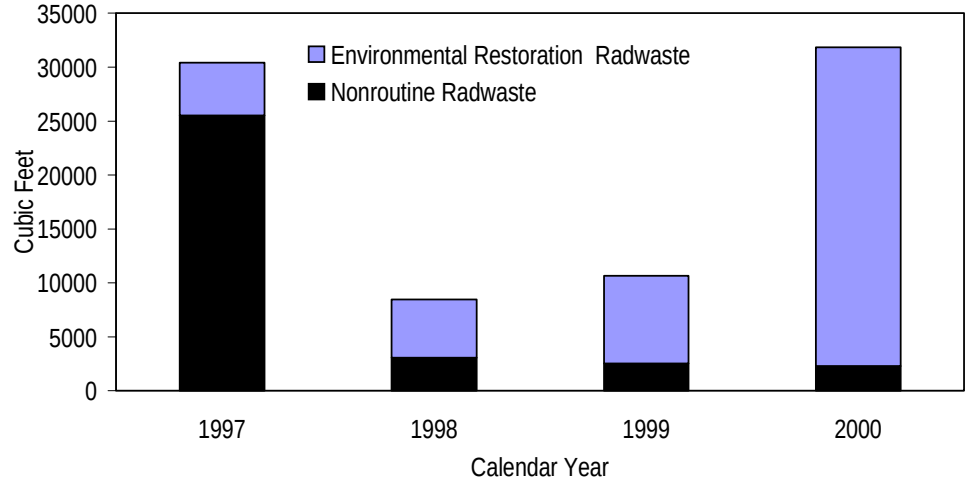

Figure 2-8i. Environmental Restoration and Nonroutine Radioactive Waste Generation from the ER Program, 1997-2000.

pollution prevention and waste minimization an integral part of the BNL operating philosophy.

The following are key elements of BNL's Pollution Prevention Program:

- Improving employee awareness of and involvement in pollution prevention goals, plans, and progress.
- Evaluating experimental and industrial processes during the planning stages for ways to eliminate or reduce the use of chemicals, and the generation of waste, liquid effluents, and air emissions where possible at the source.
- Ensuring that environmental effluents, emissions, and wastes are As Low As Reasonably Achievable ("E-ALARA"— See Section 5.3 of Chapter 5 for a discussion of the application of E-ALARA to effluents containing radionuclides.)
- Procuring environmentally preferable products, also known as "affirmative procurement." For example, BNL only purchases paper made from recycled content.
- Conserving natural resources and energy. BNL's energy and water conservation programs are described in Sections 2.3.5 and 2.3.6 of this chapter.
- Employing practices such as reusing and recycling materials, substituting nonhazardous chemicals, and segregating hazardous and nonhazardous wastestreams to avoid cross-contamination.
- Achieving or exceeding BNL and DOE waste minimization, pollution prevention, recycling, and affirmative procurement goals.
- Complying with applicable requirements (e.g., New York State hazardous waste reduction goal, Executive Orders).
- Reducing waste management costs and identifying sustainable funding mechanisms for the evaluation and implementation of pollution prevention opportunities.

Pollution prevention has been successfully integrated into key work planning tools at BNL. Procedures for experimental review, industrial process assessment, nonroutine work planning, and facility design review all incorporate assessment of pollution prevention opportunities. Environmental Compliance Representatives provide expertise to identify and evaluate pollution prevention opportunities. The EMS objective and target setting process provides a platform for opportunity implementation, and the EMS management review process ensures results are measured and tracked. The sustained efforts of the BNL pollution prevention and recycling programs have achieved significant reductions in waste generated by routine operations. From 1993 to 2000, BNL reduced routine hazardous waste generation by 81%, mixed waste by 67% and radioactive waste by 57%.

The Laboratory is also assessing environmental restoration projects for pollution prevention opportunities. For example, DOE expects to save over $800,000 by implementing the recommendations from an assessment on the BGRR decommissioning project. The recommendations are to segregate and reuse soil and debris during excavation, recycle or reuse crushed concrete onsite as fill, reuse lead shielding, and schedule offsite waste shipments with other organizations for bulk cost savings.

BNL has had an active and successful solid waste recycling program for many years. The recycling program involves all employees. In 2000, BNL collected over 336 tons (304.8 metric tons) of paper for recycling. Office staff collect recyclable paper in designated containers at their work stations. Custodial staff collect and consolidate paper to central locations, where it is shipped to the Brookhaven Town recycling facility. In addition to paper, many other kinds of materials are collected under the recycling program, including cardboard, bottles and cans, tires, construction debris, motor oil, scrap metals, lead, automotive batteries, printer and toner cartridges, fluorescent light bulbs, machine coolant, and antifreeze. Table 2-4 shows the total number of tons (or units) of these materials recycled in 2000, along with trends since 1992, when BNL started tracking performance in this area.

BNL has operated a rideshare program since 1995. BNL assists employees in finding suitable rideshare partners by maintaining a ride-matching database. The Laboratory provides a guaranteed ride service for program participants, and subsidizes the cost of a defensive-driving course for employees active in ridesharing partnerships. Some organizations are piloting a flexible work schedule with extended hours, which eliminates one to two days of travel every two weeks.

BNL complies with Executive Order 13148 (2000), *Greening the Government Through Leadership in Environmental Management.* With

Table 2-4. Recycling Program Summary (CY 2000).

Recycled Material	1992	1993	1994	1995	1996	1997	1998	1999	2000
Mixed Paper	155	136	197	220	106	196	204	370	336
Cardboard	21	81	164	85	101	103	97	124	132
Bottles/Cans	12	12	18	11	15	21	22	21	20
Tires	9	21	7	11	17	18.6	11.5	15.2	0[a]
Construction Debris	809	495	495	627	837	799	527	352	243
Used Motor Oil (gallons)	-	-	4000	3350	4275	4600	3,810	3,570	3,295
Metals	201	210	33	153	158	266	64	47	534
Lead	-	-	-	-	-	4.4	3.7	0.7	2.5
Automotive Batteries	-	5	0.81	0.72	6.8	4.3	2.1	1.1	2.2
Printer/Toner Cartridges (units)	-	-	-	-	-	-	1480/175	1575/510	-[b]
Fluorescent bulbs (units)[c]	-	-	-	-	13,664	12,846	867	41,124	23,515
Blasocut™ Coolant (gallons)	-	-	-	-	-	-	-	3,575	7500
Antifreeze (gallons)	-	-	-	-	55	276	448	145	110
Tritium Exit Signs (each)[d]	-	-	-	-	-	-	-	-	185

Notes:
All units are tons unless otherwise noted.
- Denotes either not recycled in that year or data not available.
[a] No outlet for the recycling is currently available.
[b] Data not available from recycler.
[c] BNL has been replacing many fluorescent bulbs with non-mercury bulbs that do not contain hazardous materials.
[d] Removed 80 tritium signs in 2000.

the exception of hydroseeding to reestablish damaged landscape, lawn areas are not watered, fertilized, or sprayed with pesticides. This reduces the need for mowing, which in turn reduces air emissions from mowers and tractors. When areas other than lawns are identified for revegetation, they are planted with grasses, wildflowers, or trees native to the Northeast, when available and appropriate. In December 2000, BNL initiated an Integrated Pest Management assessment to evaluate whether there are additional opportunities to reduce pesticide use in agricultural experiments, landscape maintenance, and buildings onsite. The final report will be issued in 2001 and is expected to identify current good practices and opportunities for improvement. (See additional discussion in Chapter 3, Section 3.11.)

Implementation of pollution prevention opportunities, recycling programs, and conservation initiatives has significantly reduced both waste volumes and management costs. In 2000 alone, these efforts have resulted in $2,265,512 in documented cost savings and over 3,367,593 pounds (1.53 million kg) of materials (hazardous, radioactive, mixed, industrial and sanitary) being reduced, recycled, or reused. Table 2-5 describes the projects that were implemented in 2000, and includes the amount of materials reduced, reused, or recycled, along with the estimated cost benefit of each project. If it included water and energy conservation projects, the numbers would be even higher. See Figure 2-9 for reductions in water consumption and Figure 2-10 for reductions in building energy use.

2.3.5 WATER CONSERVATION

BNL has a strong water conservation program and has achieved dramatic reductions in water usage since the mid-1990s. The Laboratory continuously 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 process and heating, ventilation, and air conditioning systems, and reuse of once-through cooling water for other systems such as cooling towers. The goal is to reduce the consumption of potable water and reduce the impacts of clean water discharges on Sewage Treatment Plant operations. Figure 2-9 shows the six-year trend of water consumption. In 2000, BNL continued to reduce its water use. A comparison of 1999 and 2000 figures shows a 63,500,000 gallons (240 million liters) reduction

Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000).

Waste Description	Reduced, Reused, Recycled or Conserved	Pounds Reduced, Reused, Recycled or Conserved in 2000	Waste Type	Potential Costs for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Benefit	Project Description
Photographic Waste	Segregation	2,975	Hazardous Waste	$14,875	$10,000	$4,875	Photography and GraphicArts Division implemented a pollution prevention project funded by the P2 Council that segregates hazardous fixer from non-hazardous developer. This reduces the hazardous waste stream by approximately 350 gal. (2,975 lbs.) annually, avoiding hazardous waste disposal costs of approximately $14,875.
Mercury	Reused	25	Hazardous Waste	$1,000	$0	$1,000	Medical Department staff filtered and recycled approximately 0.4 gal. of mercury rather than disposing of the mercury as hazardous waste. This avoided disposal costs estimated at $1,000.
Chemicals (various)	Reused	6,000	Hazardous Waste	$30,000	$0	$56,000	As part of the HFBR facility stabilization project, Reactor Division staff redistributed 1,300 chemicals to researchers around the Laboratory. Reuse of these materials (estimated at 6,000 lbs.) avoided disposal costs of $30,000 and material costs estimated at $26,000.
Borated Polyethylene Sheets	Reused	1,188	Hazardous Waste	$5,940	$0	$5,940	As part of the HFBR facility stabilization project, Reactor Division staff transferred 1,188 lbs. of borated polyethylene sheets, used as neutron shields, to the National Synchrotron Light Source for reuse, avoiding disposal costs of $5,940.
Hydrogen Gas cylinders	Reused	6,200	Hazardous Waste	$31,000	$0	$31,000	As part of the HFBR facility stabilization project, Reactor Division staff returned 31 cylinders (estimated at 200 lbs./cylinder) of hydrogen gas to the vendor, avoiding disposal costs of $31,000.
Sulfuric Acid	Reused	20,040	Hazardous Waste	$100,200	$0	$100,200	As part of the HFBR facility stabilization project, Reactor Division staff contacted the vendor of this material and arranged a return of 1,200 gal. (20,040 lbs.) of sulfuric acid for no cost. This transaction avoided disposal costs of $100,200.
Boron Trifluoride Gas-Filled Detectors	Reused	200	Hazardous Waste	$1,000	$0	$1,000	Boron trifluoride gas filled detectors were returned to the manufacturer for reuse, avoiding disposal as hazardous waste. Approximately 200 lbs. of material was returned for an estimated savings of $1,000.
Lead Acid Batteries	Recycled	7,250	Hazardous Waste	$36,250	$0	$36,250	Avoided disposal costs as hazardous waste at $5.00/ lb.,assuming 50 lbs./battery, for a total savings of $36,250.

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Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000) *(continued).*

Waste Description	Reduced, Reused, Recycled or Conserved	Pounds Reduced, Reused, Recycled or Conserved in 2000	Waste Type	Potential Costs for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Benefit	Project Description
Ion Exchange Wastewater	Source Reduction	1,250	Hazardous and Sanitary wastewater	$2,000	$500	$1,500	Prefilters were added to the deionization system to polish make up 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 wastewaters. The project is estimated to have eliminated 40 gal. of hazardous waste and 200 gal. of sanitary wastewater. Approximately $2,000 in disposal costs are avoided annually.
Solvents	Decay in Storage	85	Mixed	$10,000	$0	$10,000	Ten one-gallon bottles of High Pressure Liquid Chromatography solvent, characterized as mixed waste due to phosphorus-32 contamination, was allowed to decay in through ten half-lives in accordance with the decay in storage requirements. This allowed the material to be recharacterized and disposed as hazardous waste instead of much more costly mixed waste. This is estimated to have saved $10,000.
Shield Block (concrete)	Reused	668,000	Radioactive	$1,295,920	$0	$1,295,920	In excess of 600,000 lbs. of shield block were reused onsite by Plant Engineering and Collider Accelerator Department. Approximately 500,000 lbs. of activated shield block went to the Collider Accelerator Dept. for reuse as shielding for beam lines. Approximately 168,000 lbs. of block was reused by Plant Engineering for shielding at the scrap yard. This avoided disposal costs of approximately $1,295,920 (estimate 6,680 cubic feet at $194/cubic foot).
Radioactive Wastewater	Reused	3,400	Radioactive Wastewater	$14,800	$0	$14,800	As part of the HFBR facility stabilization project, Reactor Division Staff collected and reused approximately 400 gal. (3,400 lbs.) of contaminated water during leak testing of piping systems, avoiding disposal costs of $14,800 ($37.00/gal).
Tritium Exit Signs	Source Reduction	800	Radioactive	$38,800	$12,000	$26,800	Removed 80 tritium exit signs from service and returned to the manufacturer. Replaced with energy efficient light emitting diode (LED) signs. Project reduced risk of tritium gas release and avoided disposal as radioactive waste. Savings from avoided disposal costs estimated at $38,800 (200 ft^3 at $194/$ft^3$), less $12,000 implementation cost, for total savings of $26,800.

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Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000) *(continued).*

Waste Description	Reduced, Reused, Recycled or Conserved	Pounds Reduced, Reused, Recycled or Conserved in 2000	Waste Type	Potential Costs for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Benefit	Project Description
Filters	Decay in Storage	1,920	Radioactive Waste	$9,312	$0	$9,312	Filters from the air handlers in the Linear Accelerator facility become contaminated with beryllium-7, a short-lived isotope eligible for decay. The filters were allowed to decay for over ten half-lives in accordance with the decay in storage requirements. They were surveyed and released as undetectable for disposal as industrial waste. This avoided disposal costs estimated at $9,312.
Antifreeze	Recycled	935	Industrial	$4,675	$0	$5,675	Antifreeze was sent for recycling, for an estimated avoided disposal cost of $4,675 (935 lb. at $5.00/lb.) and material savings of $1000.
Blasocut™ Machining Coolant	Recycled/Reused	60,000	Industrial	$304,800	$0	$304,800	Central Shops Division operates a recycling system that reclaims Blasocut™ machining coolant and supplies it labwide. 7,500 gallons of Blasocut lubricant were recycled in 2000. Recycling involves aeration, centrifuge, and filtration. Avoids cost of disposal as industrial waste ($5.00/lbs.), plus an avoided cost of procurement of 6 drums of concentrate ($800/drum) for a total savings of $304,800. Cost of recycle is estimated to be the same as cost of procurement and preparation of proper dilution for use.
Used Motor Oil	Recycled	23,065	Industrial	$115,325	$0	$115,325	Estimate avoided disposal cost of $115,325 (23,065 lbs. at $5.00/lb.).
Office Paper	Recycled	672,940	Sanitary	$26,918	$0	$26,918	Estimate $80/ton for disposal as trash.
Cardboard	Recycled	263,960	Sanitary	$10,558	$0	$10,558	Estimate $80/ton for disposal as trash.
Scrap Metal	Recycled	1,069,340	Sanitary	$42,774	$0	$42,774	Estimate $80/ton for disposal as trash.
Bottles/Cans	Recycled	39,020	Sanitary	$15,608	$0	$15,608	Estimate $80/ton for disposal as trash.
Construction Debris	Recycled	486,440	Sanitary	$19,458	$0	$19,458	Estimate $80/ton for disposal as trash.
Cooling Tower Packing	Reused	11,880	Sanitary	$2,000	$0	$2,000	As part of the HFBR facility stabilization project, Reactor Division Staff returned 192 ft^3 (11,880 lbs.) of cooling tower packing material to the vendor at no cost, avoiding handling and landfill charges estimated at $2,000.

(continued on next page)

Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000) *(concluded)*.

Waste Description	Reduced, Reused, Recycled or Conserved	Pounds Reduced, Reused, Recycled or Conserved in 2000	Waste Type	Potential Costs for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Benefit	Project Description
Supplies and Equipment	Reused	11,000	Sanitary	$126,000	$0	$136,000	As part of the HFBR facility stabilization project, Reactor Division staff sought users for supplies and equipment through placement of ads in the *Brookhaven Bulletin*. This resulted in the transfer of approximately $126,000 worth of supplies and avoided disposal costs of approximately $10,000.
Granular Charcoal	Reused	9,680	Sanitary	$6,300	$0	$6,300	As part of the HFBR facility stabilization project, Reactor Division staff returned twenty-one 55-gallon drums (9,680 lbs.) of granular activated charcoal to the vendor at no cost, avoided handling and landfill charges estimated at $6,300.
Totals		**3,367,593**		**$2,265,513**	**$22,500**	**$2,280,013**	

in water use for 2000 alone. The total annual reduction since 1995 is 600,000,000 gallons (2.3 billion liters).

Installing a temperature-controlled throttling valve for process cooling at the AGS resulted in the most significant savings. By measuring the outlet temperature of the cooling water, the valve is either opened or closed to minimize water flow and achieve optimal temperatures. The benefits of this change, which was completed in 1999, were fully realized in 2000.

There are numerous environmental and economic benefits of this change. First, the switch to domestic water increased heat exchanger efficiency, reduces exchanger down time, and eliminates the need to add corrosion inhibiting chemicals. A secondary benefit of the AGS water conversion project was reduced equipment maintenance and improved water discharge quality. Under the former cooling system, main magnet heat exchangers at the AGS were back-flushed several times each week to remove iron deposits. Using potable water, these exchangers are now backflushed no more than twice a year. Performance of the recharge basin that receives this discharge has improved as a result. The basin was previously scraped every 12-18 months to remove iron scale that clogs soil pores and prevents leaching. The basin has not been scraped in three years and is still fully operational, with no signs of excess water accumulation. Scraping the basin generates 1,000 cubic yards (765 cubic meters) of iron-rich soil that presents disposal problems.

Another key project, which was initiated in 2000, is connecting Building 555 to the central chilled water system. Chilled water will be used to cool the heating, ventilation, and air conditioning systems and replace the old cooling towers. Not only will this project result in less water use, but it will also reduce chemicals stored and used for corrosion control. Once fully connected to the central chilled water system, the cooling towers will be taken out of service.

2.3.6 ENERGY MANAGEMENT AND CONSERVATION

BNL has over 4 million square feet (371,600 square meters) of building space. Many BNL scientific experiments use particle beams generated and accelerated by electricity with the particles controlled and aligned by large electro-magnets. Fuel and natural gas are used to

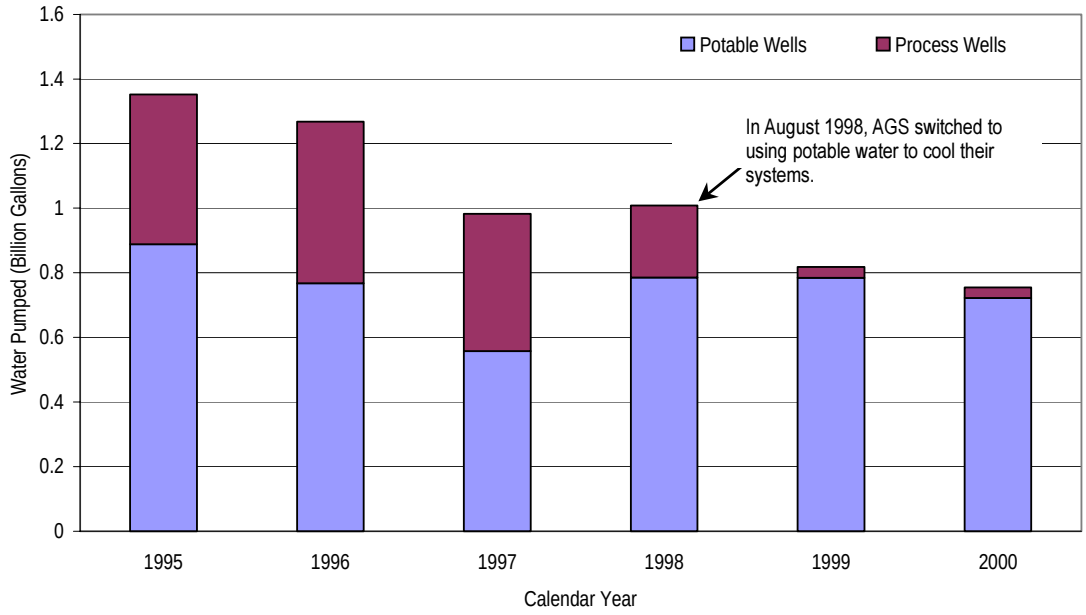

Figure 2-9. Water Consumption Trend, 1995-2000.

produce steam at the Central Steam Facility. In 2000, BNL used over 300,560,811 KWh of electricity, 1,335,157 gallons (5.1 million liters) of fuel oil and propane, and 475,150,000 cubic feet (13.5 cubic meters) of natural gas. Natural gas use started in FY 1997, and is displacing some of the historic fuel oil use. (See additional information on fuel use in Chapter 5.)

In 2000, the Laboratory spent approximately $19 million for energy. To help deal with large energy expenditures, as well as meet DOE goals for energy conservation, BNL's Energy Management Group was established in 1979. It works to reduce BNL's energy use and costs by identifying cost-effective energy efficiency projects, monitoring energy use and utility bills, and assisting in obtaining the least expensive energy sources possible. It is responsible for the development, implementation, and coordination of BNL's Energy Management Plan.

In 2000, several energy management projects were completed. These include a Controls System Optimization Project, which recommissioned the existing energy management control

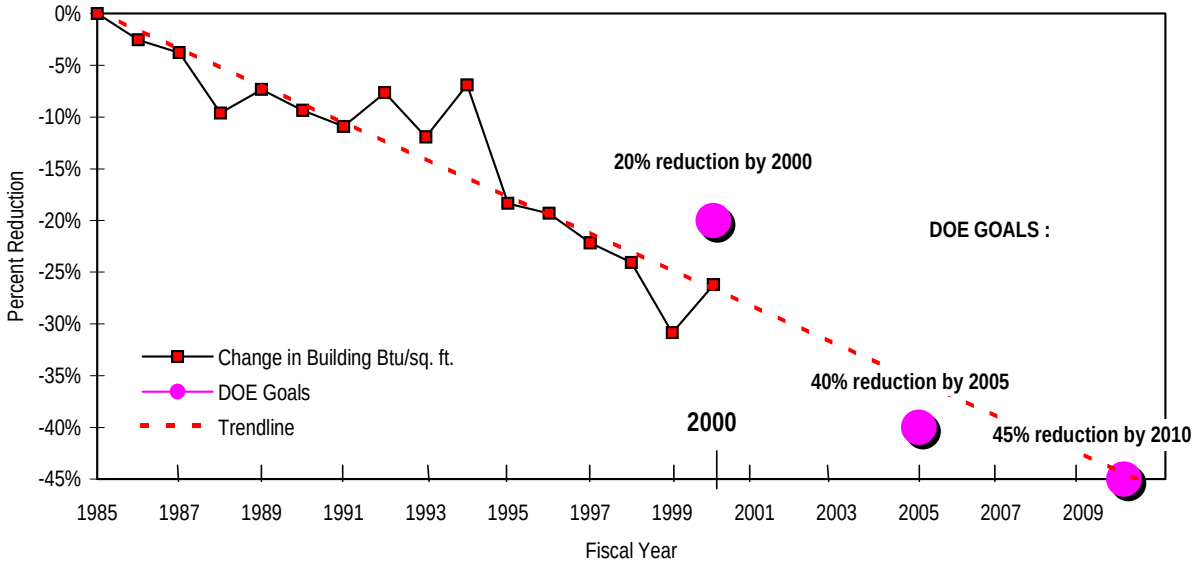

Figure 2-10. Building Energy Performance Since 1985.

system in five buildings, and installation of a side-stream filter at the Central Chilled Water Facility to improve heat transfer and energy efficiency. In addition, BNL continues to expand the energy management control system in new buildings and building additions. By controlling temperature set points and operating schedules, energy management control systems can reduce a building's energy use by at least 10%.

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 improve federal building design in order to reduce energy consumption per square foot. Current goals are to reduce energy consumption per square foot, relative to 1985, by 20% in 2000, 40% by 2005 and 45% by 2010. BNL more than met the DOE national goal for 2000, with energy use per square foot 26% less than in 1985 (see graph in Figure 2-10). Energy use rose from 1999 to 2000 because of the weather and start-up of the RHIC facility.

A lighting project to replace exit signs containing tritium with light emitting diode signs was also completed in 2000. Eighty tritium signs were taken out of service and returned to the manufacturer, eliminating the risk of radioactive release. The manufacturer exchanged the tritium signs with highly efficient, nonradioactive, light emitting diode signs which use only three watts of electricity and have an expected useful life of 80 years.

BNL's Energy Management Group also orchestrated a demonstration and test of fuel cells at the Laboratory in 2000. In cooperation with the Long Island Power Authority, Plug Power, and New York State Energy Research & Development Authority, three fuel cells were installed at the Laboratory as part of DOE's strategic effort to develop alternatives to large-scale power plants.

2.3.7 NATURAL AND CULTURAL RESOURCE MANAGEMENT

The Laboratory continues to develop, enhance, and implement its natural resource program, building on a foundation established by the Wildlife Management Plan. Over the past year, BNL has begun to develop a cultural resource program 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 two programs, refer to Chapter 6.

2.3.8 ENVIRONMENTAL MONITORING

The Laboratory has established a comprehensive Environmental Monitoring Program. This program identifies potential pathways for exposure of the public and the environment, as well as evaluating what impact BNL activities may be having on the environment. It also ensures compliance with environmental permit requirements.

The monitoring program is reviewed, and revised as necessary, 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 upon the review of previous analytical results. As required under DOE Order 5400.1 (1988), BNL's *Environmental Monitoring Plan, Triennial Update* (BNL 2000b) outlines annual sampling goals by specific media and frequency. The 2000 plan also specifies the data quality objectives associated with the monitoring program.

There were a total of 6,004 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges in 2000 under the Environmental Monitoring Program, as shown in Table 2-6. That number does not include samples taken to characterize wastes for disposal purposes nor nonroutine samples collected in support of restoration characterization activities. Specific sampling programs for the various media are described further in Chapters 4 through 7.

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

2.3.8.1 COMPLIANCE MONITORING

Compliance monitoring is conducted to ensure that wastewater effluent, air emissions, and groundwater monitoring data comply with limits in regulations and permits 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:

- *Air emissions monitoring* is conducted at reactors, accelerators, and other radiological

Table 2-6. Summary of BNL Sampling Program Sorted by Media (CY 2000).

Environmental Media	Total # of Sampling Events*	Purpose
Groundwater	2,530	To evaluate impacts of past and present operations on groundwater quality, under the Environmental Restoration, Environmental Surveillance and Compliance programs.
Onsite Recharge Basins	178	Recharge basins used for wastewater and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes.
Potable Water	231	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 and for environmental surveillance purposes.
Sewage Treatment Plant	1,007	The STP influent and effluent and several downstream Peconic River stations are monitored routinely for organic, inorganic, and radiological parameters to assess BNL impacts on the estuary. The number of samples taken depends on flow—e.g., samples are scheduled for collection at Station HQ three times per week, 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 and direction, temperature and atmospheric stability, to help model atmospheric transport and diffusion of radionuclides.
Air - Tritium	369	Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess tritium levels downwind of the reactors. Due to several years of nondetectable measurements, and the shutdown of the HFBR, monitoring was reduced from weekly to monthly in several areas of the site in 1999. See discussion in Chapters 4 and 8.
Air - Particulate	504	Gamma analysis is performed on samples of particulate matter collected from air samples. The purpose is determine whether there has been impact from BNL operations.
Air - Charcoal	158	Charcoal samples are used to assess for radioiodines, which could be released in reactor emissions.
Fauna	90	Fish, deer and small mammals are monitored to assess impacts on wildlife associated with past (or current) BNL operations.
Flora	63	Since the primary pathway from soils to fauna is via ingestion, vegetation is sampled to assess uptake of contaminants by plants and hence tofauna. This number includes 33 samples taken of farm produce.
Soils	347	Soil samples are collected from adjacent farms and other local areas to confirm that Laboratory emissions have no impact on surrounding areas. Soil samples are also collected in conjunction with Environmental Restoration investigative work.
Miscellaneous	519	Samples are collected periodically from manholes and other locations to assess compliance with regulatory requirements. This number includes samples taken by the ESD field sampling team for Plant Engineering (e.g., collected during sewer line cleanouts).
Total Number of Sampling Events in 2000	**6,004**	This number includes all the samples identified in the EMP (BNL 2000b) plus samples collected by the ESD field sampling team as special requests. The number does not include samples collected to monitor Environmental Restoration air and water treatment system processes, or samples taken by Waste Management Division, waste generators or Environmental Compliance Representatives for waste characterization purposes.

* In one sampling event, multiple samples may be collected from a single location. For example, a separate sample for tritium, gross-alpha beta, and VOC's may be collected from a groundwater monitoring well during one event.

emission sources, as well as the Central Steam Facility. Real-time, continuous emission monitoring or periodic sample collection equipment is installed and maintained at these facilities, as required by permit conditions. Analytical data are routinely reported to the permitting authority. See Section 3.5 of Chapter 3 for details.

- *Wastewater discharge monitoring* is performed at the point of discharge to ensure that the effluent complies with release limits in BNL's permits. Fifteen point source discharges are monitored under the BNL program: three under the Environmental Restoration Program and twelve under the State Pollutant Discharge Elimination System permit. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly and monitored for organics, inorganics, and radiological parameters. Monthly reports that provide analytical results and an assessment of compliance for that reporting period are filed with the permitting agency. See Section 3.6 of Chapter 3 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 Central Steam Facility, and the Resource Conservation and Recovery Act permit for the Waste Management Facility. Extensive groundwater monitoring is also conducted under the ER program as required under the Records of Decision for many of the Operable Units or Areas of Concern. See Chapter 7 for details. Additionally, to ensure that the Laboratory maintains a viable potable water supply, groundwater is monitored as required by the New York State Department of Health. See Section 3.7 of Chapter 3 for details on potable water supply monitoring programs and results.

2.3.8.2 RESTORATION MONITORING.

Restoration monitoring is performed to determine overall impacts of past operations, to delineate the real extent of contamination, and to ensure that removal actions are effective and remedial systems are performing as designed (under the Comprehensive Emergency Response, Compensation and Liability Act [CERCLA] and Resource Conservation and Recovery Act).

This program typically includes collection of soil and groundwater samples in order to determine the lateral and vertical extent of the contaminated area. Samples are analyzed for organics, inorganics, and radiological contaminants, and the analytical results are compared with guidance, standards or background concentrations. Areas where impacts have been confirmed are fully characterized, and if necessary, remediated to mitigate continual impacts. Follow-up monitoring of groundwater is conducted in accordance with a Record of Decision.

2.3.8.3 SURVEILLANCE MONITORING.

Surveillance monitoring is conducted to further monitor what impact, if any, BNL operations have on the environment (pursuant to DOE Order 5400.1). The focus of the environmental surveillance program is assessing potential environmental impacts resulting from routine facility operations. This program includes collection of ambient air, surface water, groundwater, flora, fauna, and precipitation samples. Samples are analyzed for radiological, organic, and inorganic contaminants. Additionally, routine reviews of data collected by thermoluminescent dosimeters (devices to measure radioactive exposure) placed onsite and offsite are performed under this program.

Control samples (also called background or reference samples) are also collected on and off the site to compare BNL results to areas that could not have been impacted 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 remainder of this Site Environmental 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.

2.3.9 ENVIRONMENTAL RESTORATION

In 1980, the U.S. Congress enacted CERCLA to ensure that sites with historical

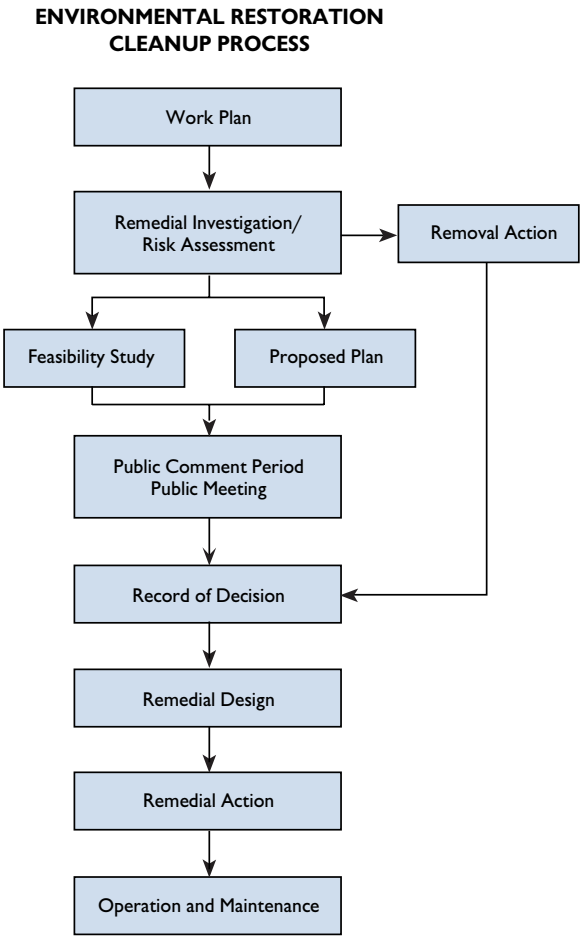

Figure 2-11. CERCLA Process.

contamination were cleaned up. As part of CERCLA, EPA established the National Priorities List, also known as the NPL. The NPL is a list of sites nationwide where cleanup of past contamination is required. BNL is listed on the NPL, along with 31 other sites located on Long Island (including 16 in Suffolk County) (see <http://www.epa.gov/superfund/sites/npl/ny.htm>). The majority of contamination at BNL is associated with past accidental spills and practices for chemical and radiological material handling, storage, and disposal.

BNL follows the CERCLA process (see Figure 2-11), which includes:

- conducting a *Preliminary Assessment* (review of historical documents, interviews with employees, site reconnaissance),
- conducting a *Site Inspection* (which often includes sampling),
- conducting a *Remedial Investigation* (to characterize the nature and extent of contamination and assess the associated risks),
- preparing a *Feasibility Study* and *Proposed Plan* (to list and evaluate remedial action alternatives and present the proposed alternative),
- issuing a *Record of Decision* (the remedy/corrective action agreed to by DOE, EPA, and NYSDEC), and
- performing the *Remedial Design/Remedial Action* (which includes final design, construction specifications, and carrying out the remedy selected).

At each step, EPA distinguishes between sites that do or do not require further action, based on potential threat to human health and the environment. An expedited cleanup action, called a *Removal Action*, can also be conducted. This requires an *Engineering Evaluation/Cost Analysis*, which evaluates and recommends specific cleanup actions. The selected action is then documented in an *Action Memorandum*, the equivalent of a Record of Decision.

The goal of the BNL's Environmental Restoration Program is to complete onsite cleanup activities and install all groundwater treatment systems by 2006 or earlier. The Laboratory has made substantial progress in characterizing and removing sources of contamination (e.g., underground tanks) and in treating or removing the groundwater and soil contamination resulting from past disposal practices. It has also worked to advance the decontamination and decommissioning of the Brookhaven Graphite Research Reactor (BGRR).

Groundwater cleanup efforts have included monitoring existing groundwater wells; installing new, permanent groundwater monitoring wells; capping three onsite landfills; installing and operating groundwater treatment systems both on and off Laboratory property; and coordinating the extension of public water service in nearby neighborhoods. During 2000, 1,001,342,000 gallons (3.8 billion liters) of groundwater were treated and 700 pounds (318 kg) of volatile organics were removed. Since the first groundwater treatment system started operating in December 1996, approximately 2,300 pounds (1,040 kg) of volatile organic compounds have been removed from more than 3,066,842,400 gallons (11.6 billion liters) of groundwater. See Chapter 7 for more information.

Soil cleanup efforts have included the excavation and sorting of debris and soil from 55 waste pits and the removal of 2,640 cubic yards (2020 cubic meters) of landscaping soils from

a and b. Substantial progress was made in 2000 in the decommissioning of the BGRR. For example, five sections of the aboveground ducts (left) were removed from the support structure and lowered to the ground for cutting and packaging prior to offsite disposal. In March, the Pile Fan Sump (right) and surrounding soils were excavated.

c. Excavation of isolated areas of contaminated landscaping soil began in May 2000 and was completed in September. Excavated areas were backfilled with clean soil and reseeded.

d. To protect groundwater beneath the Brookhaven Linac Isotope Producer, silicon grout was injected beneath the building in May and June 2000 to encapsulate activated soil.

e. In February 2000, DOE and BNL proposed a cleanup plan for Operable Unit V, which includes the BNL Sewage Treatment Plant and the Peconic River. Opportunities for public comment included public meetings and workshops.

f. In August 2000, a public meeting was held to discuss a pesticide ethylene dibromide. A groundwater treatment system will be installed to remove this chemical from the aquifer.

Figure 2-12. Environmental Restoration Actions Taken During 2000.

various areas on the Laboratory site. In addition, substantial progress has been made in shipping materials from an onsite storage yard to offsite disposal facilities in preparation for the cleanup of BNL's former Hazardous Waste Management Facility.

Progress at the BGRR has included excavation of the Pile Fan Sump and surrounding soils, and the removal and offsite disposal of five large cooling fans from the reactor's fan house. A Removal Action to address the reactor's aboveground air ducts is also underway.

2.3.9.1 ENVIRONMENTAL RESTORATION PROGRAM PROGRESS BY OPERABLE UNIT (OU)

Historical facility records and sampling have been used to determine where contamination might be present on the site today. These areas were geographically grouped into Operable Units (OU) (see *Areas of Concern at BNL, Upton,*

Table 2-7. Environmental Restoration Program Progress by Operable Unit (CY 2000).

Operable Unit/ Project	Description and *Contamination Type*	Environmental Restoration Program Actions in 2000
OU I	Former Hazardous Waste Management Area, Landfills, and Disposal Pits *Radiological Soil Contamination, primarily cesium-137*	♦ Excavated and shipped 2,640 cubic yards of contaminated landscape soils. ♦ Completed restoration of excavated areas. ♦ Completed Landfill Monitoring Report for EPA/DEC review. ♦ Shipped wastes from four Underground Storage Tanks at Bldg. 811. ♦ Shipped five rail cars with the remaining glass holes debris to Envirocare (a permitted Treatment, Storage, and Disposal Facility). ♦ Issued Request for Proposal for remedial actions at Bldg. 811 and Bldg. 650. ♦ Continued operation of the OU I south boundary pump and treat system (formerly known as RA V).
OU II/VII	AGS Scrapyard & Soil Contamination *Radiological Soil Contamination, primarily cesium-137 & strontium-90*	♦ Applied a silicon grout barrier to soil beneath the Brookhaven Linac Isotope Producer (BLIP). Completed barrier installation in June 2000. ♦ Issued draft completion report for BLIP project.
OU III	Potable Supply Wells/ Spills *Chemical and radiological groundwater contamination primarily VOCs, tritium & strontium-90*	♦ Completed construction of groundwater treatment system for volatile organic compounds (VOCs) in the Former Scrapyard & Drum Storage Area south of Bldg. 96. Completed startup testing of the system. ♦ Excavated and shipped approximately 1,100 cubic yards of PCB-contaminated soil from the Former Scrapyard & Drum Storage Area. ♦ Awarded construction contract for the Middle Road groundwater treatment system. ♦ EPA approved the OU III Record of Decision on June 20, 2000. ♦ Continued operation of the carbon tetrachloride pump and treat system. ♦ Continued operation of the OU III south boundary groundwater pump and treat system. ♦ Removed 1,378 lbs. of VOCs from the aquifer using all treatment systems. ♦ Continued installation of Geoprobes™ to monitor HFBR tritium plume. ♦ Continued the low-flow pumping of tritiated groundwater along Temple Place. ♦ Continued operation of tritium pump and recharge system until September 29, 2000, when the system was placed on standby.
OU IV	Central Steam Facility Spill & Bldg. 650 Sump Outfall *Chemical and radiological soil and groundwater contamination*	♦ Completed monitoring of the Air Sparge/Soil Vapor Extraction System (AS/SVE). Submitted formal petition for shutdown of the system. ♦ Continued interim remedy monitoring for the Bldg. 650 Sump and Sump Outfall Area.
OU V	Sewage Treatment Plant & Peconic River *Heavy metal and radiological sediment and soil contamination, primarily mercury, silver, copper & cesium-137*	♦ Finalized Plutonium Contamination Characterization and Radiological Dose and Risk Assessment Report. ♦ Finalized OU V Proposed Plan and held 90-day Public Comment Period. ♦ Presented proposed OU V remedy to interested community members at two Roundtable Meetings and a Public Meeting. ♦ Completed supplemental sampling of soil at Sewage Treatment Plant. ♦ Held two-day Peconic River Remedial Alternatives Workshop that was attended by more than 100 people. Sixteen vendors gave presentations in four sessions. ♦ Initiated development of conceptual engineering drawings of the Peconic River to help identify locations for additional sampling.
OU VI	Biology Fields *Pesticide groundwater contamination-ethylenedibromide (EDB)*	♦ Completed OU VI Contingency Remedy Evaluation. ♦ Continued monitoring of EDB plume. ♦ Released fact sheet/PRAP and conducted 30-day public comment period. ♦ Presented proposed OU VI remedy at a public meeting during the comment period.
Groundwater Monitoring	Ongoing Sitewide Project	♦ Completed 1999 Sitewide Groundwater Monitoring Report. ♦ Completed BNL Groundwater Monitoring Program Quality Assurance Project Plan. ♦ Collected and analyzed over 2,180 groundwater samples from 18 monitoring programs.
Brookhaven Graphite Research Reactor (BGRR) Decommissioning	Radiologically contaminated water and fans *primarily cesium-137.*	♦ Completed removal of the Pile Fan Sump and surrounding soils. ♦ Released BGRR Removal Action Alternatives Study for public comment. ♦ DOE signed Action Memorandum approving the removal of the BGRR aboveground ducts as a time critical Removal Action. ♦ Removed fans from BGRR fan house.

New York - A Reference Handbook. [BNL 1998a]). Table 2-7 provides a description of each OU (I-VII) and a summary of the environmental restoration actions taken during 2000 (see Figures 2-12a through f). Chapter 7 has a more detailed discussion of groundwater monitoring and restoration programs. A map of the OUs is found in Figure 2-13.

Significant progress was made in the BGRR Decommissioning Project and the High Flux Beam Reactor (HFBR) Project. The following activities were successfully completed at the BGRR in 2000:

- The Pile Fan Sump, associated piping, and contaminated soils were removed. The soil remediation indicated levels near background for the contaminants of concern, cesium-137 and strontium-90 (see Figure 2-12b).
- Removal of the aboveground ducts began in 2000 with the removal of the aboveground primary air cooling ducts over the Fan House (Bldg. 704) roof (see Figure 2-12a).
- The five primary air cooling fans were removed from their respective fan rooms in the Fan House.
- The graphite pile was fully characterized. The data obtained during characterization will be compiled, analyzed, and used to document the levels of contaminants identified in the pile.
- The graphite pile was sealed from Building 701. All openings on the biological shield wall of the graphite pile were sealed using various techniques and covers that permit surveillance and monitoring of the effectiveness of the seals.
- The Canal House (Bldg. 709), Water Treatment House (Bldg. 709A), equipment, and associated soils were characterized in accordance with an approved sampling and analysis plan to provide data for the preparation of the Engineering Evaluation and Cost Analysis.

With regard to the HFBR, on June 20, 2000, the EPA signed the OU III Record of Decision. In September, pumping of tritiated groundwater from the HFBR tritium plume was implemented along Temple Place. By the end of the year, 65,020 gallons (246,126 liters) of contaminated water had been removed from the highest activity areas of the HFBR tritium plume and disposed of offsite. During this process, numerous Geoprobes™ and monitoring wells were installed to maintain definition of the area of maximum concentration of the HFBR plume

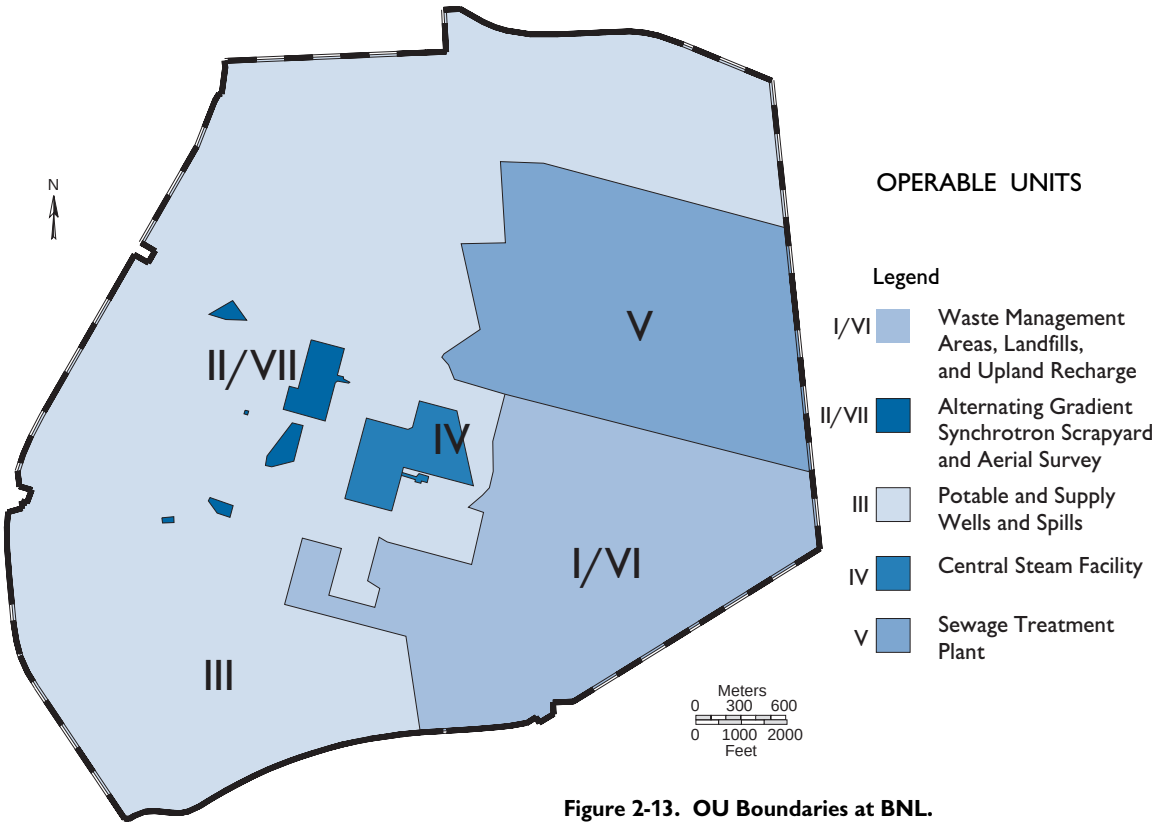

Figure 2-13. OU Boundaries at BNL.

and to guide the pumping initiative. In addition, routine groundwater monitoring continued to define the remainder of the plume.

2.3.9.2 OPERABLE UNIT V – THE PECONIC RIVER

Operable Unit V received substantial attention during 2000. The Proposed Plan was issued for public comment in February. Two community information sessions, a public meeting and a workshop held in February and March were attended by more than 50 people (see Figure 2-12e).

In response to community requests, DOE extended the public comment period through May 15, 2000. Hundreds of comments were received during the comment period, most addressing the proposal to excavate contaminated sediment from the Peconic River. After considering comments and concerns expressed by community members and regulatory agencies, the Department decided to re-examine its plans to clean up the contaminated sediment.

On June 2, 2000, DOE mailed a letter to interested parties describing the planned path forward for OU V. In this letter, the Department committed to further consider sediment cleanup alternatives that would minimize disruption of wetlands, including an additional evaluation of phytoremediation. Phytoremediation is the use of plants to absorb contaminants from the sediments. DOE also pledged to offer additional opportunities for community involvement.

To fulfill these commitments, DOE sponsored a two-day workshop on remedial alternatives for the Peconic River in December 2000. At this workshop, which was attended by more than 100 people, 16 companies from across the nation made presentations. The presentations were grouped into sessions on phytoremediation, sediment removal, wetlands restoration/constructed wetlands, and other alternative technologies. Key stakeholders assisted in selecting presenters at a November 17, 2000 planning meeting and will comment on the workshop's results at a wrap-up meeting on January 2001. Workshop proceedings are available online at <http://web.ead.anl.gov/TechCon/projects/peconic/resources/index.cfm>.

2.3.10 COMMUNICATION AND COMMUNITY INVOLVEMENT

When BSA was awarded the contract to manage BNL in 1998, they made a commitment to establish an effective partnership between DOE, the Laboratory, and a full range of community members to address issues that affect quality of life in the community. At the core of the communication and community involvement programs are the Environmental Stewardship Policy and the Community Involvement Policy and Plan.

As discussed in Section 2.1.3, the Environmental Stewardship Policy contains a commitment to maintain a positive, proactive, and constructive relationship with the community and regulators, and to promote open communication on environmental performance. The Community Involvement Policy and Plan were written with input from both internal and external stakeholders, and document BSA's efforts to ensure the public will be kept informed of issues; that the Laboratory will actively seek and consider input from regulators, stakeholders, and the general public; and that opportunities will continue to be provided for an open, two-way exchange of information, knowledge, and perspectives.

The Laboratory continues efforts to improve working relationships with regulatory agencies by sharing information and working to resolve issues on plans, priorities, and corrective actions of importance to the regulators. The Laboratory meets regularly with regulators from the New York State Department of Environmental Conservation, the U.S. EPA Region II, and the Suffolk County Department of Health Services. Suffolk County inspectors have a permanent office onsite.

Another forum for communication is the Brookhaven Executive Roundtable, which was established by DOE in August 1997. The Roundtable is made up of representatives from elected officials and regulatory agencies. In addition, the Community Advisory Council was established in September 1998 to advise the Laboratory Director on issues of importance to their organizations. The Council consists of representatives from more than 30 varied stakeholder groups, including civic, business, union, health, education, employee, and environmental organizations. Both the Roundtable and the Council meet regularly, and are provided with frequent updates on Laboratory activities, environmental issues, and progress. Community representatives provide BNL with feedback and

recommendations that are considered in the Laboratory's decision-making processes. During 2000, numerous presentations with question and answer sessions were conducted at the Roundtable and Council meetings on topics such as the Groundwater Protection Program, groundwater monitoring results and corrective actions, the Groundwater Contingency Plan, the E-ALARA program, the Upton Ecological and Research Reserve, the EMS, the Landtrek Project, and the 1999 Site Environmental Report.

Stakeholders are provided with many other opportunities to learn about and provide input on issues of importance to them—from working groups to roundtables to one-on-one interactions with managers and subject matter experts. Input is actively sought to help the Laboratory make better decisions that take the community's values and perspectives into account. Public outreach activities include briefings to local civic and community groups; meetings and presentations to local, state, and federal regulators and elected officials; and regular interactions with the business and educational community. Laboratory Envoys, who are well educated about BNL and its issues, regularly interact within individuals and groups in the community, gathering feedback, and responding to concerns. In 2000, the Laboratory hosted over 35,000 visitors, including students and community members who participated in the Summer Sunday tour program and an Environmental Fair held in the fall. The Laboratory also has an informative website <www.bnl.gov>, issues press releases, publishes the *Brookhaven Bulletin* (a weekly employee newsletter), *cleanupdate* (a periodic newsletter on environmental cleanup), *Laboratory Link* (a monthly brief on research and environmental issues for community members), and issues e-mail updates to inform the public and staff about environmental issues. Section 6.8 in Chapter 6 discusses additional outreach activities associated with the natural resource program.

In 2000, BNL celebrated the 30th anniversary of Earth Day with a variety of activities involving BNL staff and the community, including environmental awards, an art contest, a race, onsite birding field trips and displays. (See Figure 2-14.) BSA contributed corporate funds in support of events as part of their commitment to environmental stewardship. Many community organizations also helped sponsor the activities and awards.

Another innovative program that BNL worked on in 2000 is the Landtrek project, which is an extension of the BNL Environmental Information Management System. The BNL Landtrek project, developed with support from DOE headquarters, provides environmental monitoring data to the public and BNL staff and managers over the Internet. Community and staff input were solicited to determine the level of interest in this data and how it should be presented. Based on this input, a developmental website was released that included an overview of BNL's monitoring activities and current groundwater monitoring data for two BNL facilities (the Brookhaven Linac Isotope Producer and the Brookhaven Medical Research Reactor). The database is found at <http://www.landtrek.org/LandTrek/Projects/bnl/bnl/>. Information on the project can also be found at <http://www.bnl.gov/esd/landtrek.htm>. BNL plans to expand the Landtrek website in the future by providing additional data on other BNL facilities and environmental media.

2.4 ENVIRONMENTAL STEWARDSHIP AT BNL TODAY

In 2000, BNL invested more than $26 million in the environmental management system, pollution prevention, groundwater protection, environmental restoration programs, and information management systems designed to improve the Laboratory's environmental systems and performance. These systems and programs are a high priority for BNL, which takes its commitment to be a good neighbor and a responsible steward of the environment very seriously.

BNL now has an unprecedented knowledge of potential environmental vulnerabilities and current operations. Compliance assurance programs are improving BNL's compliance status. Pollution prevention projects have reduced costs 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. BNL must continue to deliver on commitments and demonstrate real improvements in environmental performance in order to regain the stakeholders' trust. This annual Site Environmental Report is an important communication mechanism, as it summarizes BNL's environ-

a. Environmental awards were presented to two BNL employees, a middle manager and senior manager (Dr. Satoshi Ozaki, shown here with Dr. Marburger) who have championed environmental protection at BNL, and went above and beyond their jobs to promote pollution prevention.

b. Environmental awards were presented to Suffolk County/East End students from the 3rd - 5th grades whose artwork was selected for publication in the 1999 Site Environmental Report. Over 250 students submitted entries. Artwork by Ariel Grant (shown here) was featured on the cover of the 1999 report.

c. The Earth Week celebration culminated with a four-mile race through the Pine Barrens onsite. Over 130 runners participated.

d. Environmental Services Division employees package 157 pounds of food, donated to the Long Island Cares Food Bank as part of the runners' entry fee.

Figure 2-14. Earth Week 2000 Events at BNL.

mental programs and performance for the 2000 calendar year. Additional information about BNL's environmental programs is available on BNL's website at <www.bnl.gov>. Environmental project plans, status reports, procedures, and more are accessible to the general public on the Internet at <http://www.bnl.gov/esd/>. The Laboratory is pursuing other mechanisms to communicate data in a more user friendly, visual, and timely manner, such as the BNL Landtrek project, which is viewed as a model in the DOE complex.

BNL's EMS includes a commitment to continual improvement. The Laboratory fulfills

this commitment by establishing performance goals, developing action plans to achieve these goals, and periodic assessing performance. These processes are implemented within the context of the broader, Labwide efforts to improve the management systems. Although only one or two cycles of implementation have occurred within most organizations at BNL, improvements to the EMS have already been possible due to the pilot facility implementation. Lessons learned, tools, and procedures developed by these first organizations were incorporated into the base program and made available to the balance of facilities.

The existing BNL EMS is viewed as exemplary in the DOE complex. In a letter to the DOE-Brookhaven Area Office, the manager of DOE-Chicago cited the EMS as a noteworthy example for consideration by other DOE facilities, and said he was very pleased by the Laboratory's demonstrated commitment to environmental management (San Martin 2000). Nine BNL facilities have been registered to the ISO 14001 standard. BNL is still the only DOE National Laboratory that has achieved ISO 14001 registration. Due to external recognition of BNL's knowledge and unique experience implementing the ISO 14001 EMS program, several DOE facilities and private universities invited BNL to extend its outreach activities and share its experiences, lessons learned, and successes. As noted above, BNL's environmental programs and projects have been recognized with regional and national awards.

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

- The EMS, which was built on an existing foundation, has been strengthened, integrated with other BNL management systems, and formalized. BNL has looked at everything in a more systematic way.
- There is now line ownership for environmental stewardship, key roles and responsibilities have been identified/clarified, and expectations have been clarified.
- A comprehensive environmental training program has been established.
- Organizations have an improved understanding of environmental aspects, waste streams, and applicable requirements from the process evaluations.
- 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 registration, compliance improvements (e.g., facility modifications, implementation of SBMS, enhanced operational controls), and increased environmental knowledge and awareness on the part of management, employees, and visiting scientists.
- Communications on environmental issues have improved, occur at the highest levels of management, and reporting is more formal. Managers are better informed about aspects, issues, and performance.
- Core EMS teams cutting across organizations have been formed, and the consensus process used to develop the system has improved buy-in.
- There has been strong penetration of the EMS throughout organizations, and cultural change has been sweeping.

For 50 years, the unique, leading-edge facilities at BNL have made many innovative scientific contributions possible. Today, BNL continues its research mission while paying much closer attention to 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." This reflects BNL's desire to balance world-class research with environmentally responsible operations.

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