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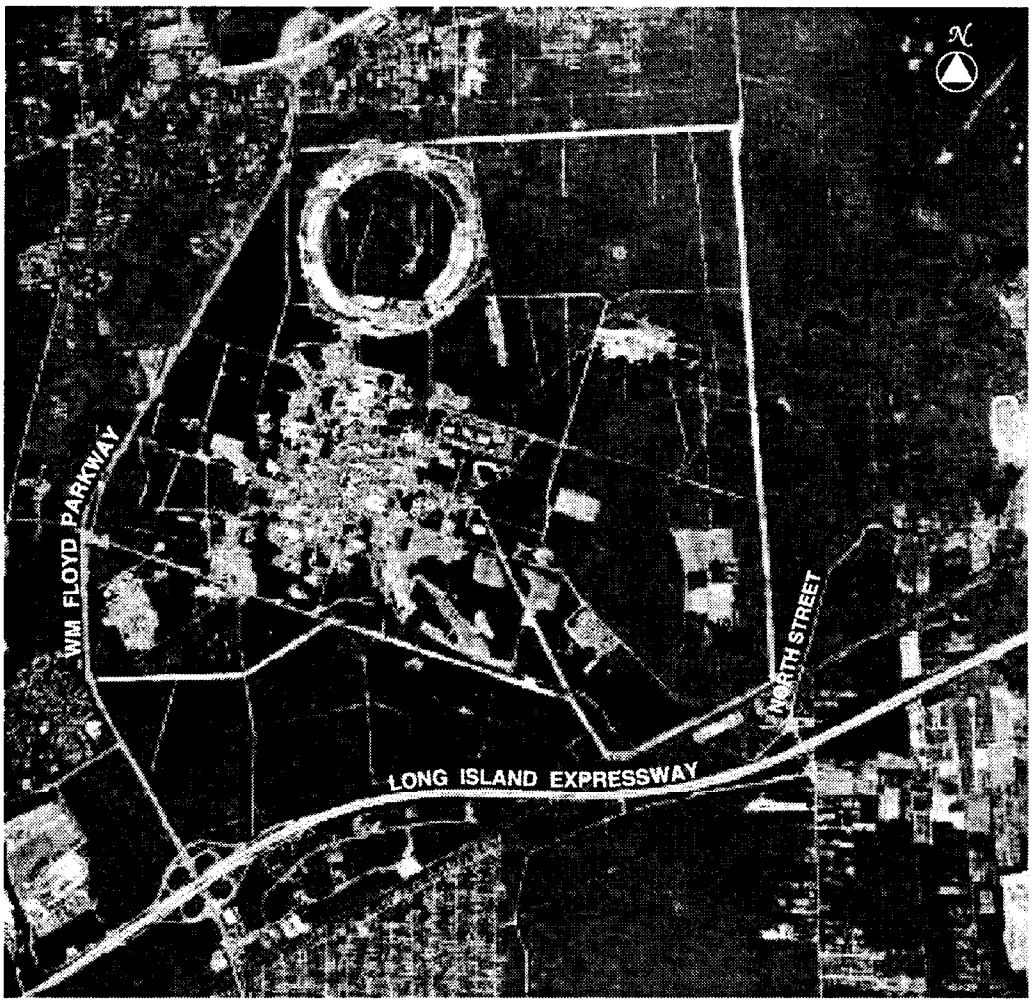
BNL 52555

BROOKHAVEN NATIONAL LABORATORY

GROUNDWATER PROTECTION MANAGEMENT PROGRAM DESCRIPTION

December 23, 1998



BROOKHAVEN
NATIONAL LABORATORY

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BNL-52555

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GROUNDWATER PROTECTION MANAGEMENT PROGRAM DESCRIPTION

December 23, 1998

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Brookhaven National Laboratory
Groundwater Protection Management Program Description

Executive Summary

The Department of Energy Order 5400.1, "General Environmental Protection Program" requires development and implementation of a groundwater protection program. The primary goal of this document, the Groundwater Protection Management Program (GPMP) description, is to ensure that plans for groundwater protection, management, monitoring and restoration are fully defined, integrated and managed in a cost-effective manner that is consistent with Federal, State and local regulations.

The BNL GPMP includes policy, strategy, requirements and regulations applicable to groundwater protection, and an overview of groundwater resources. The BNL GPMP consists of four main elements: 1) prevention; 2) monitoring; 3) restoration; and 4) communication.

Prevention: BNL has initiated a three-phased project to: 1) identify past or current activities with the potential to impact environmental quality; 2) conduct a BNL-wide review of all experiments and industrial-type operations to determine the potential impacts of those activities on the environment and integrate pollution prevention/waste minimization, resource conservation, and compliance into planning, decision-making and implementation; and 3) develop and implement an Environmental Management System. These activities are designed to prevent further pollution of the sole source aquifer underlying the BNL site.

Monitoring: BNL has an extensive groundwater monitoring network designed to evaluate groundwater contamination from historical and active operations. Groundwater monitoring is being conducted under two programs – the Environmental Monitoring Program designed to satisfy DOE and New York State monitoring requirements for active research and support facilities, and the Environmental Restoration Program for monitoring related to BNL's obligations under the Comprehensive Environmental Response, Compensation, and Liability Act. Data Quality Objectives, plans and procedures, sampling and analysis, quality assurance, data management, and well installation, maintenance and abandonment programs will be integrated to optimize the groundwater monitoring system.

Restoration: BNL was added to the National Priorities List in 1989. Twenty-nine Areas of Concern have been grouped into six Operable Units. Remedial Investigation/Feasibility Studies have been conducted for each Operable Unit. A primary goal of the Environmental Restoration program is remediating soil and groundwater contamination, and preventing additional groundwater contamination from migrating off-site. To that end, contaminant sources (e.g., contaminated soil, underground tanks, etc.) are being removed or remediated to prevent further contamination of groundwater, and contaminated groundwater is being remediated.

Communication: BNL has a community involvement, government and public affairs program to ensure that BNL communicates with the community in a consistent, timely and accurate manner. The majority of communications regarding groundwater protection have been associated with the Environmental Restoration Program. A number of communication mechanisms are in place, such as web pages, mailings, briefings and roundtables.

List of Acronyms

AGS	Alternating Gradient Synchrotron
AEA	Atomic Energy Act
AMSL	Above Mean Sea Level
AOC	Area of Concern
ASL	Analytical Services Laboratory
BGRR	Brookhaven Graphite Research Reactor
BHG	Brookhaven Group
BLIP	Brookhaven LINAC Isotope Producer
BMRR	Brookhaven Medical Research Reactor
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CSF	Central Steam Facility
CT	Carbon Tetrachloride
CY	Calendar Year
DCA	1,1-dichloroethane
DCE	1,1- dichloroethylene
DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
DOE-BHG	DOE Brookhaven Group
DOE-CH	DOE Chicago Operations Office
DQO	Data Quality Objective
EDB	Ethylene Dibromide
EIMS	Environmental Information Management System
ESD	Environmental Services Division
EMS	Environmental Management System
EM	Environmental Monitoring
EPA or USEPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERD	Environmental Restoration Division
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FUA	Facility Use Agreement
FY	Fiscal Year
GPIIP	Groundwater Protection Implementation and Integration Plan
GPMP	Groundwater Protection Management Program
GW	Groundwater
HFBR	High Flux Beam Reactor
HWMF	Hazardous Waste Management Facility
IAG	Interagency Agreement
LINAC	Linear Accelerator
MCL	Maximium Contaminant Levels
mg/L	Micrograms per Liter
MLD	Millions of Liters Per Day
MPF	Major Petroleum Facility
MRC	Medical Research Center
MTBE	Methyl Tertiary Butyl Ether
NEPA	National Environmental Policy Act
NPL	National Priorities List
NYSAWQS	New York State Ambient Water Quality Standard
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health

List of Acronyms

NYSDWS	New York State Drinking Water Standard
OU	Operable Unit
PCE	Tetrachloroethylene
PEP	Process Evaluation Project
pCi/L	PicoCuries per Liter
PRAP	Preferred Remedial Alternative Plan
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SCDHS	Suffolk County Department of Health Services
SCSC	Suffolk County Sanitary Code
SPDES	State Pollution Discharge Elimination System
SCWA	Suffolk County Water Authority
STP	Sewage Treatment Plant
TCA	1,1,1-trichloroethane
TCE	Trichloroethylene
UIC	Underground Injection Control
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WCF	Waste Concentration Facility
WMF	Waste Management Facility
WTP	Water Treatment Plant

Brookhaven National Laboratory
Groundwater Protection Management Program Description

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1. PURPOSE AND CONTENT OF THIS DOCUMENT

U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program," requires all DOE facilities to establish a Groundwater Protection Management Program (GPMP). The primary goal of Brookhaven National Laboratory's (BNL) GPMP is to ensure that plans for groundwater protection, management, monitoring, and restoration are fully defined, integrated, and managed in a cost-effective manner that is consistent with Federal, State, and local regulations.

This document outlines current and proposed activities related to protection of the sole source aquifer underlying BNL. The BNL GPMP includes policy, objectives, strategy, requirements and regulations applicable to groundwater protection, an overview of groundwater resources (quality, quantity and uses), programs to prevent groundwater pollution, potential sources of groundwater pollution, a summary of the groundwater monitoring program, and programs to communicate with stakeholders about the groundwater program. In addition, the GPMP briefly describes an initiative to improve integration of sitewide groundwater programs.

The BNL GPMP will be reviewed annually and updated at least every three years.[1] This is done as part of the continual improvement aspect of BNL's Environmental Management System (EMS), and to ensure that the groundwater program is effective and reflects current operational practices at BNL. Figure 1 depicts how the GPMP relates to other BNL documents and programs.

2. APPROACH

2.1 BNL Environmental Protection Policy

BNL's environmental stewardship policy is found in Appendix B. With regard to groundwater, BNL is committed to protecting groundwater resources existing beneath and downgradient of BNL from further chemical and radionuclide releases, and remediating existing contaminated groundwater.

2.2 Groundwater Protection Management Program Goals

The goals and objectives of the BNL GPMP are to:

- Comply with all applicable groundwater protection and remediation requirements;
- Employ best management practices (including pollution prevention programs) to ensure that BNL facilities and operations are designed, constructed, operated, and maintained in a manner that is protective of groundwater and surface water quality;
- Conduct waste management practices in a manner that is protective of groundwater and surface water resources, including implementing comprehensive waste minimization practices and safe waste storage and disposal practices (including management of investigation derived wastes);
- Institute water consumption controls aimed at controlling unnecessary groundwater withdrawals to minimize undesirable deviations in contaminant plume pathways;
- Analyze the hydrogeologic regime to support groundwater protection, management, and remediation initiatives;

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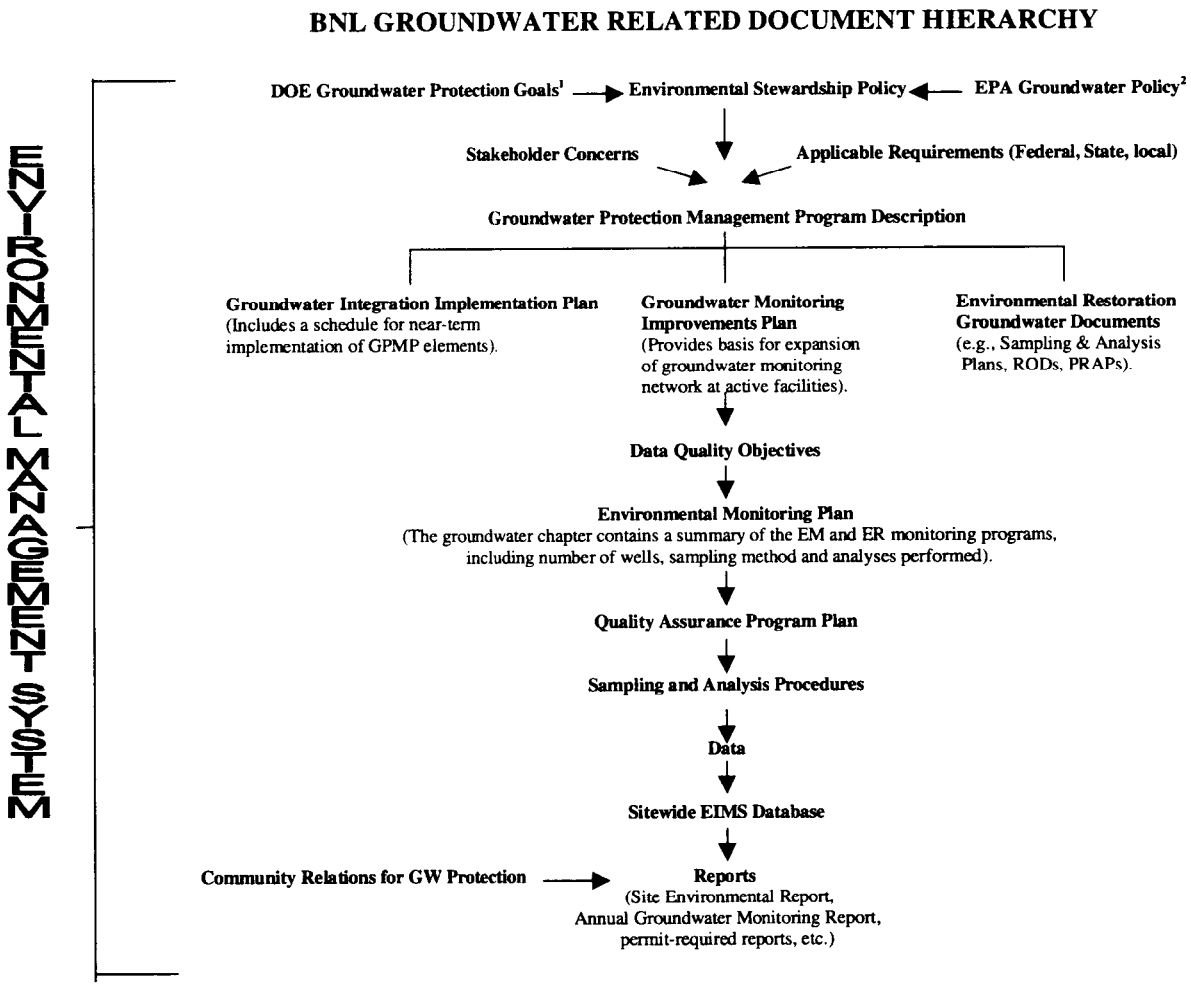
[1] This document replaces the document entitled *Groundwater Protection, Brookhaven National Laboratory, Pursuant to DOE Order 5400.1*, dated June 11, 1990 (Dames and Moore, 1990).



[1] Groundwater Protection Goals in DOE Order 5400.1
[2] EPA (1991)

Figure 1: BNL Groundwater Protection Management Program Document Hierarchy

- Conduct groundwater monitoring in a cost effective manner, based upon a technically sound sampling and analysis strategy;
- Conduct effluent monitoring at BNL facilities to provide timely information regarding BNL operations that could potentially adversely affect groundwater resources;
- Remove or contain historical actual and potential sources of groundwater contamination and remediate existing contaminated groundwater to an extent commensurate with its potential risk to public health and the environment;
- Conduct well construction, maintenance, and abandonment practices in a technically sound and cost-effective manner; and,
- Inform and cooperate with stakeholders (Federal, State, and local authorities and the public) on groundwater protection and remediation issues.

2.3 Applicable Requirements

The requirements for the protection, preservation and restoration of groundwater resources are addressed in a number of Federal, New York State, and local laws and regulations. Performance standards for groundwater monitoring at these facilities are specified in regulations promulgated under the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), DOE Orders, and State and local regulations. An overview of these groundwater protection requirements is presented in Appendices C.1 through C.4. BNL's goal is to comply with applicable requirements, and the following strategies are designed to ensure that this occurs.

2.4 Groundwater Protection Strategy

The groundwater protection strategy for implementing this policy and achieving these goals is based on four elements:

1. **Prevention** of contaminants from ever entering the groundwater flow system;
2. **Monitoring** groundwater as well as other environmental media;
3. **Restoration** of existing degraded soil and groundwater; and,
4. Improvement of internal and external **communication.**

Prevention: To protect groundwater resources from further contamination, BNL has implemented a three-phased project to: 1) identify past or current activities with the potential to impact environmental quality; 2) conduct a BNL-wide review of all experiments and industrial-type operations to determine the potential impacts of those activities on the environment and integrate pollution prevention/ waste minimization, resource conservation, and compliance into planning, decision-making and implementation; and 3) develop and implement an Environmental Management System. The prevention element is described in more detail in Section 5.0 of this document.

Monitoring: BNL has an extensive groundwater monitoring network designed to evaluate groundwater contamination from historical and active operations. Groundwater monitoring is being conducted under two programs - the Environmental Monitoring (EM) Program and the Environmental Restoration (ER) Program. The EM Program is designed to satisfy DOE monitoring requirements for active research and support facilities, and to satisfy the monitoring requirements of New York State operating permits for two support facilities (the Major Petroleum Facility, and the new Waste Management Facility). The Environmental Restoration Program conducts groundwater monitoring related to BNL's obligations under CERCLA (i.e., remedial investigation, landfill closure, and remediation system monitoring). Data Quality Objectives, well installation procedures, sampling and analysis, data management, and well maintenance and abandonment programs will be properly integrated to optimize the groundwater

monitoring system. The monitoring element is described in more detail in Section 6.0 of this document.

Restoration: BNL was added to the National Priorities List in 1989. Twenty-nine Areas of Concern have been grouped into six Operable Units. Remedial Investigation/Feasibility Studies have been conducted for each Operable Unit. A primary goal of the Environmental Restoration program is remediating soil and groundwater contamination, and preventing additional groundwater contamination from migrating off-site. To that end, contaminant sources (e.g., contaminated soil, underground tanks, etc.) are being removed or remediated to prevent further contamination of groundwater. The performance objectives for groundwater restoration are: 1) minimize contaminant plume growth; 2) meet drinking water standards in groundwater for all volatile organic compounds, strontium-90 and tritium; and 3) complete cleanup of the groundwater in Upper Glacial aquifer in thirty years or less, and the Magothy aquifer within sixty years. The restoration element is described in more detail in Section 7.0 of this document.

Communication: BNL has a community involvement, government and public affairs program to ensure that BNL communicates with the community in a consistent, timely and accurate manner. The majority of communications regarding groundwater protection have been associated with the Environmental Restoration program. A number of communication mechanisms are in place, such as web pages, mailings, briefings and roundtables. The communication element is described in more detail in Section 9.0 of this document.

3. SITE INFORMATION

3.1 BNL Mission

Brookhaven National Laboratory is a Department of Energy research facility.[2] BNL's mission is to conceive, design, construct, and operate facilities to conduct complex fundamental scientific studies. The Laboratory is committed to produce excellent science in a safe, environmentally benign manner with the cooperation, support and appropriate involvement of its many stakeholders.

The Laboratory carries out basic and applied research in the physical, biological, and environmental sciences and in selected energy technologies. Programs include:

- High energy physics, presently centered on the operation of the Alternating Gradient Synchrotron (AGS);
- Nuclear physics, with emphasis on heavy ions, kaons, and low energy physics;
- Life sciences and nuclear medicine, focused on fundamental life processes and their alteration by radiation and chemical pollutants, and on medical applications of nuclear techniques;
- Materials science, centered on utilization of the National Synchrotron Light Source and High Flux Beam Reactor;
- Chemical sciences, with emphasis on fundamental research into chemical and physical phenomena underlying energy-related transfer, conversion, and storage systems; and,
- Transferring to industry the knowledge and accomplishments of BNL research activities in order to support the nation's goal of achieving leadership in basic and applied sciences. BNL also maintains close interaction with scientific personnel from universities and industry, and aids in the education of scientists and engineers through cooperative research programs.

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[2] BNL is managed for DOE by Brookhaven Science Associates, LLC, under DOE Contract No. DE-AC02-98CH10886. The contract is administered by the DOE Chicago Operations Office (DOE-CH), through the DOE Brookhaven Group (DOE-BHG).

At BNL, there are over 350 experimental and support facilities, waste storage facilities, and former waste disposal facilities where hazardous or non-hazardous materials are currently or have previously been managed, including above and below ground storage tanks, landfills, liquid and solid waste management areas, scrap and storage yards.

3.2 Site Description

BNL is situated on 21.3 square kilometers (2,130 hectares), and is located close to the geographic center of Suffolk County on Long Island, New York, approximately 97 km (60 miles) east of New York City (Figure 2). An estimated 1.3 million persons reside in Suffolk County, 430,000 of whom live in Brookhaven Township, where BNL is located (LILCO, 1997). Approximately 8,000 persons reside within a half kilometer of the BNL boundary. Although much of the land area within a 16 km radius of BNL remains either forested or cultivated, there has been an increase in residential housing development in areas surrounding the site. Although there have been no major construction projects in the vicinity since 1978, detailed plans for two shopping centers, a corporate park, and several thousand single and multiple family dwellings have recently been approved for areas within 15 km of BNL, predominantly to the north, west, and south of the site.

3.3 Site Hydrogeology and Water Resources

The hydrogeology of the BNL site was initially studied by the U.S. Geological Survey in the late 1940's and early 1950's under a cooperative agreement with the Atomic Energy Commission. Since these initial studies, groundwater flow patterns and groundwater quality have been impacted by a significant increase in the number of BNL research facilities and subsequent demands for water. Since the early 1990's, BNL has been conducting extensive subsurface investigations to better define the hydrogeological setting of the BNL site and surrounding areas. The BNL hydrogeologic characterization programs have included soil borings, geophysical logging, the installation of monitoring wells and piezometers, water level measurements, aquifer pumping tests, and groundwater modeling.

3.3.1 Hydrogeology

The BNL site is underlain by approximately 400 m (1,300 ft) of unconsolidated Pleistocene and Cretaceous sediments overlying Precambrian bedrock. The unconsolidated sediments, subdivided from youngest to oldest, are:

- Upper Pleistocene deposits (Upper Glacial aquifer),
- Gardiners Clay (Gardiners Clay confining unit),
- Magothy Formation (Magothy aquifer), and
- Raritan Formation (Raritan Clay confining unit and Lloyd aquifer).

Table 1 provides a description of the geologic and hydraulic properties of the geologic units underlying the BNL site.[3] A brief description of the Upper Pleistocene deposits, Gardiners Clay, and Magothy formation is provided below, and a generalized hydrogeologic cross section through Long Island and the BNL site is presented in Figure 3.

3.3.1.1 Upper Pleistocene Deposits/Upper Glacial Aquifer

Geology: The Upper Pleistocene deposits at BNL primarily consist of 40 m to 60 m (130 ft to 200 ft) of broadly stratified glacio-fluvial outwash deposits composed of silica-rich medium to coarse-grained sand and gravel. Thin layers of silt and clay have been observed within the outwash deposits, but do not represent significant barriers to groundwater flow. Near surface silt and clay deposits are located

[3] Detailed discussions on the geology and hydrology of the BNL site can be found in deLaguna (1963), Faust (1963), Warren *et al.* (1968), and the *BNL Regional Groundwater Model Report* (G& M, 1996).

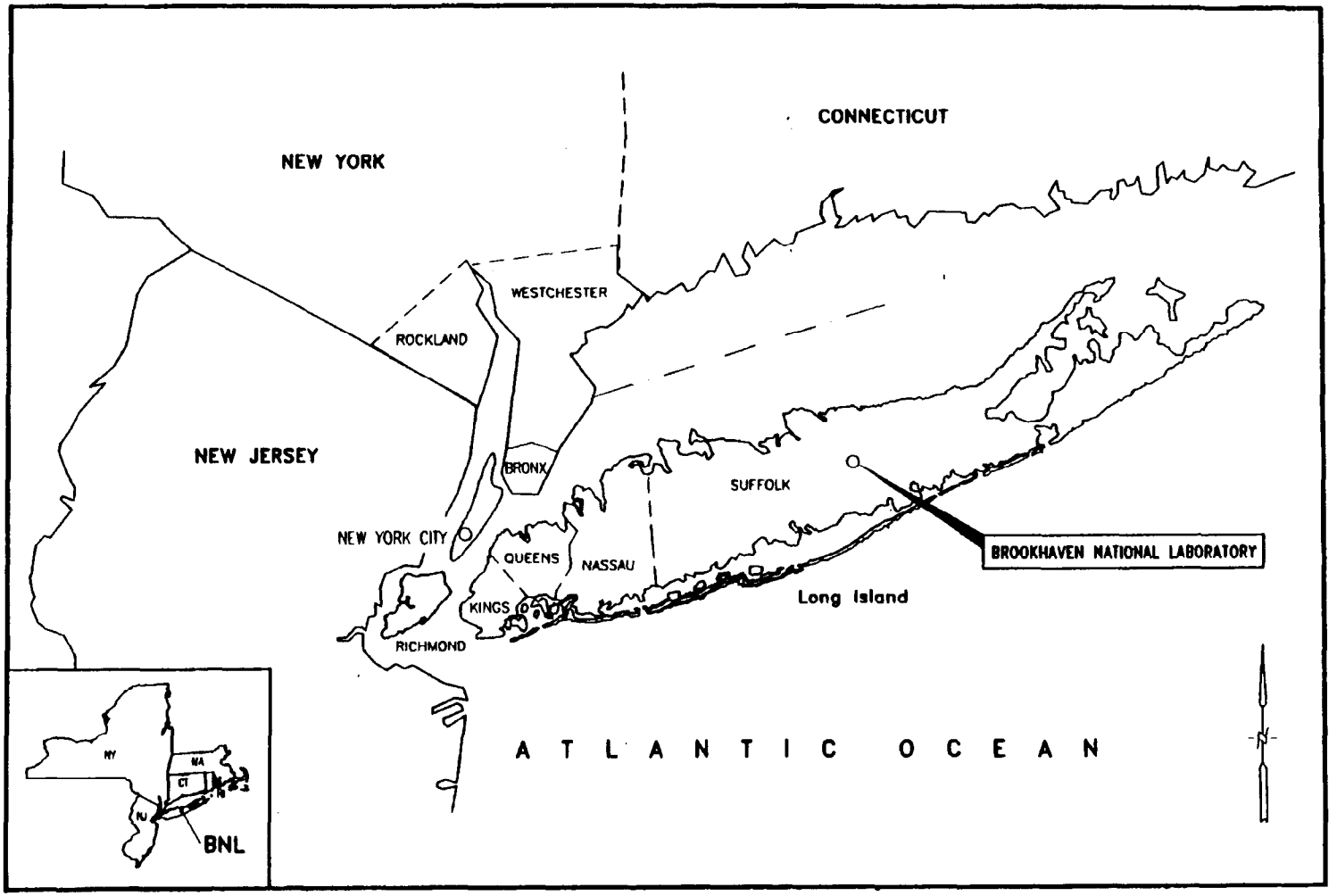

Figure 2: BNL Location Map

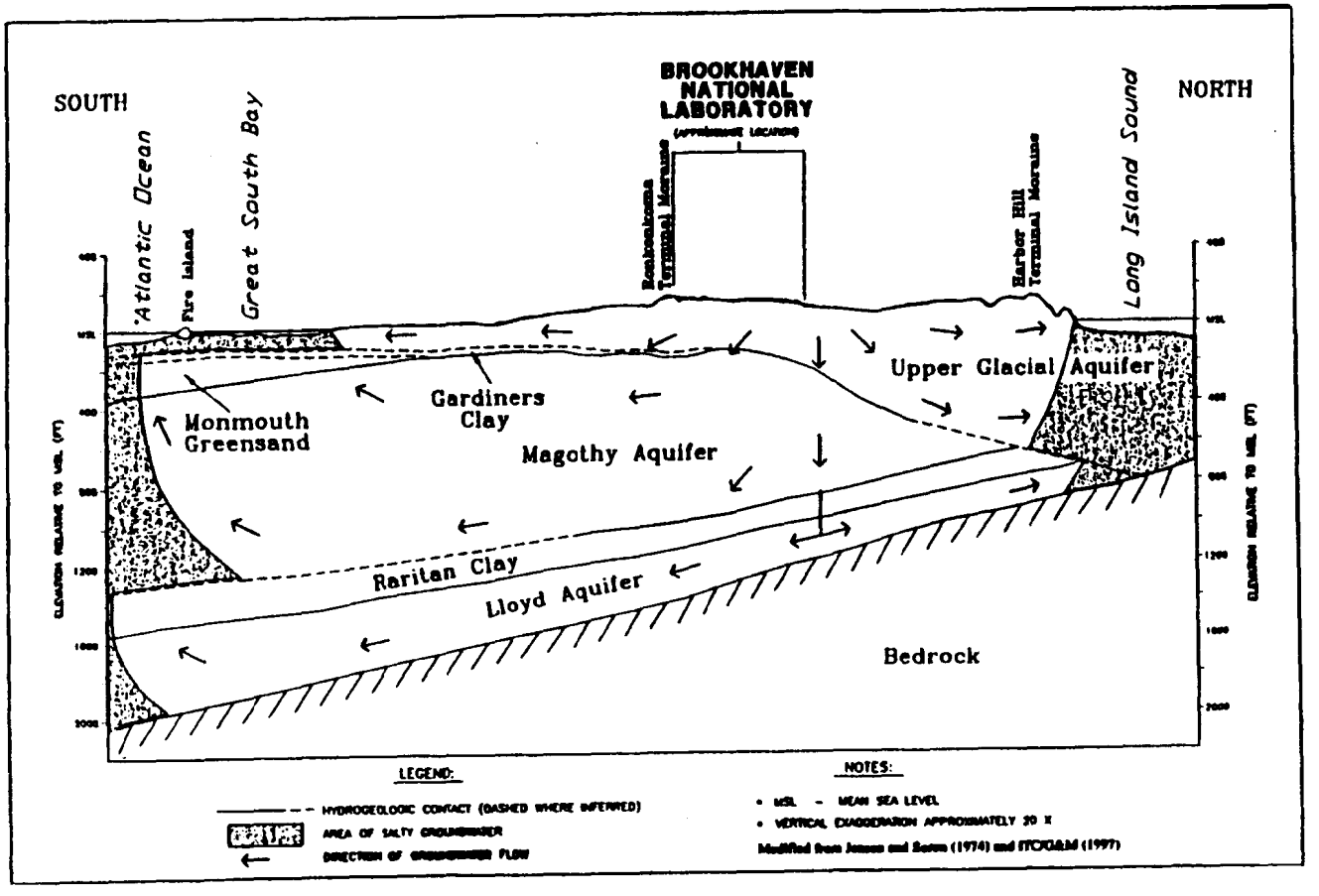

Figure 3: Generalized Geologic Cross Section in the Vicinity of Brookhaven National Laboratory

System	Series	Geologic Unit	Hydrogeologic Unit	Character of Deposits	Water-Bearing Properties
Quaternary	Holocene	Recent deposits: Salt marsh deposits, stream alluvium, shoreline deposits, and fill	Recent deposits	Sand, gravel, clay, silt, organic mud, peat, loam, and shells. Colors are gray, brown, green, black, and yellow.	Beach deposits are highly permeable; marsh deposits poorly permeable. Locally hydraulically connected to underlying aquifers.
	Pleistocene	Upper Pleistocene deposits	Upper Glacial aquifer	Till composed of clay, sand, gravel, and boulders, forms Harbor Hill and Ronkonkoma terminal moraines. Outwash deposits consist of quartzose sand, fine to very coarse, and gravel, pebble to boulder sized. Also contains lacustrine, marine, and reworked deposits.	Till is poorly permeable. Outwash deposits are moderately to highly permeable. Glaciolacustrine and marine clay deposits are mostly poorly permeable but locally have thin, moderately permeable layers of sand and gravel. Average horizontal hydraulic conductivity is approximately 200 ft/d; conductivity of moraine material is approximately 50 percent of outwash deposits; anisotrophy is approximately 10:1.
		Gardiners Clay	Gardiners Clay	Clay, silt, and few layers of sand. Colors are grayish green and brown. Contains marine shells and glauconite.	Poorly permeable conditions constitute a confining layer of underlying aquifer. Some sand lenses may be permeable. Average vertical hydraulic conductivity is approximately 0.001 ft/d.
Cretaceous	Upper Cretaceous	Matawan Group-Magothy Formation; undifferentiated	Magothy aquifer	Sand, fine to medium clayey in part; interbedded with lenses and layers of coarse sand and sandy and solid clay. Areas of thick solid clay have been found locally in upper zones. Gravel is common in basal zone. Sand and gravel are quartzose. Lignite, pyrite, and iron oxide concentrations are common. Colors are gray, white, red, brown, and yellow.	Most layers are poorly to moderately permeable; some are highly permeable locally. Water is unconfined in uppermost parts; is confined elsewhere. Average horizontal hydraulic conductivity is 50 ft/d; anisotropy is approximately 100:1.
		Raritan Formation; unnamed clay member	Raritan confining unit	Clay, solid and silty; few lenses and layers of sand. Lignite and pyrite are common. Colors are gray, red, and white, commonly variegated.	Poorly to very poorly permeable; constitutes confining layer for underlying Lloyd aquifer. Average vertical hydraulic conductivity is approximately 0.001 ft/d.
		Raritan Formation; Lloyd Sand member	Lloyd aquifer	Sand, fine to coarse, and gravel, commonly with clayey matrix; some lenses and lenses of solid and silty clay; locally contains thin lignite layers. Sand and most gravel are quartzose. Colors are yellow, gray, and white; clay is red locally.	Poorly to moderately permeable. Water is confined by overlying Raritan Clay. Average horizontal hydraulic conductivity is 40 ft/d; anisotropy is approximately 10:1.
Paleozoic and Precambrian		Bedrock	Bedrock	Crystalline metamorphic and igneous rocks; muscovite-biotite schist, gneiss, and granite. A soft clayey zone of weathered bedrock locally is more than 70 ft thick.	Poorly permeable to virtually impermeable; constitutes lower boundary of groundwater reservoir. Some hard fresh water is contained in joints and fractures but is impractical to develop in most places.

Modified from Smolensky et al. (1989).
ft/d Feet per day.

Table 1: Hydrogeologic Units in the Vicinity of Brookhaven National Laboratory, Upton, New York

along the lowlands of the Peconic River watershed. Although the full areal extent of these deposits has not been determined, their presence is inferred beneath marshes and areas of ponded water, which are wide-spread in the eastern portion of the site (see Warren *et al.*, 1968).

Hydrology: Groundwater in the Upper Glacial aquifer beneath BNL generally exists under unconfined conditions. However, in the areas along the Peconic River where low permeability near surface silt and clay deposits exist, semi-confined conditions may occur. Depth to groundwater varies from less than one meter below land surface within the lowlands near the Peconic River, to as much as 23 m (75 ft) in the higher elevation areas located in the central and western portions of the site. The groundwater table is in the Upper Glacial aquifer. Shallow groundwater flow directions in the BNL area are influenced by natural drainage systems, varying between being eastward along the Peconic River, southeastward toward the Forge River, and southward toward the Carmans River (Figure 4). Additionally, supply well pumping and recharge induced stresses on the aquifer system are considerable in the central area of the site. Groundwater flow directions in the southwest corner of the site are also influenced by municipal water supply pumpage.

In most areas of the site, the natural groundwater flow velocity within the Upper Glacial aquifer is estimated to be approximately 0.23 meters per day (m/d) (0.75 ft/d) (see Geraghty and Miller, 1996). However, flow velocities in recharge areas may be as high as 0.35 m/d (1.45 ft/d), while velocities up to 8 m/d (28 ft/d) have been calculated for areas near BNL potable and process supply wells (Woodward-Clyde Consultants, 1993). The BNL site is located within a Suffolk County Department of Health Services (SCDHS) designated deep-flow recharge area for the Magothy and Lloyd aquifers (Koppleman, 1978; SCDHS, 1987). Comparison of water level measurements from Glacial aquifer and Magothy aquifer wells indicate significant downward flow across the BNL site (G&M, 1996).

3.3.1.2 Gardiners Clay Aquitard

Geology: The Gardiners Clay is Pleistocene (Sangamon) in age, and unconformably overlies the Magothy formation. The Gardiners Clay deposits at BNL are discontinuous, and where present are composed of green-gray, silty and sandy clay ranging from 0.3 m to 4 m (2 ft to 15 ft) in thickness. Thin sand and gravel zones have been observed within the Gardiners, which may further reduce the effectiveness of this unit as a barrier to vertical groundwater flow. Where present, the Gardiners acts as a confining to semi-confining unit between Upper Glacial and Magothy aquifers.

On a regional scale, the Gardiners Clay has a wedge-shaped geometry which thickens to the south to a maximum of 46m (150 ft) in the Great South Bay area (deLaguna, 1963). The northern limit of the Gardiners Clay as a continuous unit is thought to be approximately 3.2 km (2 miles) south of BNL (Doriski and Wilde-Katz, 1983; Soren and Simmons, 1987; Smolensky *et al.*, 1989).

Hydrology: To date, very little information exists on the hydraulic characteristics of the Gardiners Clay deposits at BNL. Limited studies by Warren *et al.* (1968) indicate that the permeability of the Gardiners Clay is approximately 0.3 gallons per day per square foot (gpd/ft^2). Sandy and silty zones that have been observed within the Gardiners Clay may reduce the unit's ability to restrict vertical groundwater movement. However, a hydraulic head differential across the Gardiners Clay has been observed in the southeast corner of BNL, between a shallow Upper Glacial well and a nearby upper Magothy well, indicating that the clay is sufficiently impermeable to restrict the downward movement of groundwater in this area. Due to the lack of continuous Gardiners Clay deposits, however, the Upper Glacial and Magothy aquifers may be hydraulically connected in a number of areas across the BNL site. In some areas of the site where the Gardiners Clay is absent, glacial sediments have been found to lie directly upon sandy zones or clay units within the uppermost Magothy.

3.3.1.3 Magothy Formation/Magothy Aquifer

Geology: The Magothy formation is characterized by Cretaceous aged terrestrial to transitional marine (deltaic) interbedded gray sand, gravel, silt, and clay. In the BNL area, the Magothy ranges from 244 m to 271m (800-890 ft) in thickness (deLaguna, 1963). The basal 30 m to 46 m (100-150 ft) of the

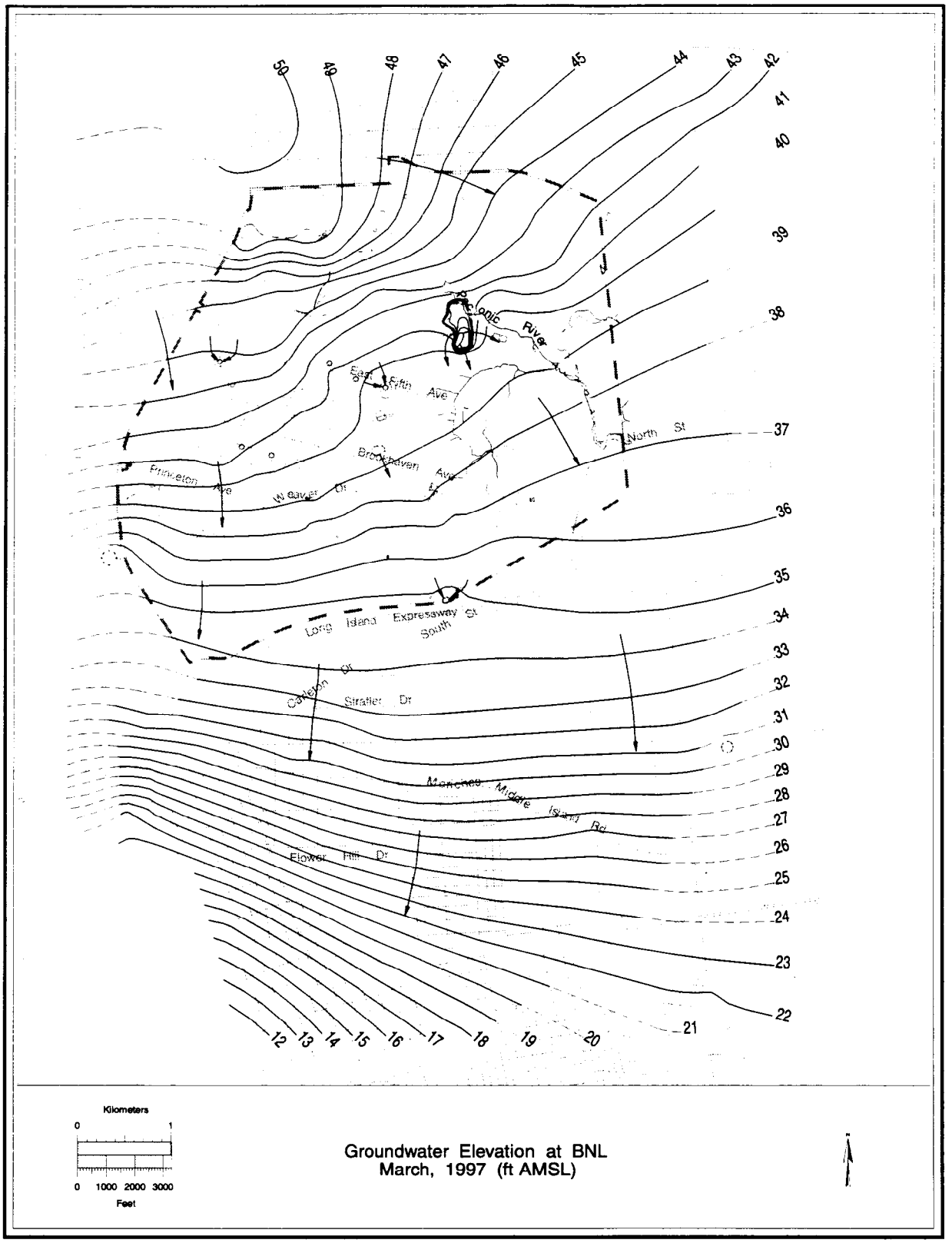

Figure 4: Water Table Map

Magothy is composed primarily of coarse sand and gravel. Numerous discontinuous clay deposits are found within the uppermost Magothy underlying the BNL site. An erosional unconformity exists between the Magothy formation and the overlying Pleistocene deposits (Gardiners Clay or glacial deposits). Within the BNL area, the upper surface of the Magothy Formation ranges from 24 m to 49 m (80-160 ft) below mean sea level. Two significant erosional valleys have been identified at BNL. With a relief of 21m (70 ft) or more, the erosional valleys reflect severe post-Gardiners erosion, which could have resulted from a combination of glacial scouring and the release of large amounts of glacial melt water. The erosional valleys were later filled with glacial sands and gravel, and reworked Magothy and Gardiners Clay sediments. The glacial sediments that fill these valleys rest directly upon Magothy sands or discontinuous clay layers within the upper Magothy.

Hydrology: The Magothy aquifer is the thickest hydrogeologic unit on Long Island. Where it is overlain by Gardiners Clay, groundwater in the Magothy aquifer exists under confined conditions. Where the Gardiners Clay is absent, sand-rich zones within the uppermost portions of the Magothy may be hydraulically connected with the Upper Glacial aquifer. In these areas, the uppermost sections of the Magothy are under unconfined conditions. However, due to the presence of numerous discontinuous clay layers within the upper Magothy, the degree of confinement is likely to increase with depth. Although the upper Magothy clay units appear to be discontinuous, these clay units are likely to form significant local barriers to groundwater movement.

Data on the hydraulic characteristics of the Magothy aquifer below the BNL site are limited. Busciolano *et al.* (1998) provide recent data on groundwater flow directions within the Magothy, with flow directions being similar to the Upper Glacial aquifer, but less affected by surface drainage patterns. It is estimated that groundwater flow velocities within the Magothy may range between 0.009 to 0.43 m/d (0.03 to 0.14 ft/d) (Warren *et al.*, 1968).

3.3.2 Groundwater Classification and Use

In Nassau and Suffolk Counties of Long Island, New York, drinking water supplies are obtained exclusively from groundwater aquifers (e.g., the Upper Glacial aquifer, the Magothy aquifer, and to a limited extent the Lloyd aquifer). The U.S. Environmental Protection Agency (USEPA) has designated these three water-bearing units as a Sole Source Aquifer System.[4] Water in this system underneath the BNL site is classified as "Class GA Fresh Groundwater" by the State of New York.[5]

3.3.2.1 BNL Water Supply

The Magothy aquifer is currently the most widely used aquifer for public water supply (Soren and Simmons, 1987). In the BNL area, only Suffolk County Water Authority (SCWA) supply wells actively withdraw water from the Magothy aquifer.

The Upper Glacial aquifer is also widely used on Long Island for both private and public water supply. Drinking water and process water supplies at BNL are obtained exclusively from on-site wells that draw water from the Upper Glacial aquifer. BNL currently operates and maintains six drinking (potable) water/process water supply wells (Wells 4, 6, 7, 10, 11, and 12), two wells dedicated for process water supply (Wells 9 and 105), and an extensive water distribution system.[6] Three additional process supply wells (Wells 101, 102, and 103) are currently maintained in an inactive state for use as an emergency source of secondary non-contact coolant water for the Alternating Gradient Synchrotron (AGS) facility. Locations of the BNL potable and process supply wells are shown in Figure 5.

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[4] This designation of the "Nassau/Suffolk Aquifer System" was made on June 21, 1978, pursuant to Section 1424(e) of the Safe Drinking Water Act.

[5] 6NYCRR Parts 700-705.

[6] The BNL supply wells are operated under NYSDEC Long Island Well Permit #1-4722-00032/00113 granted to the DOE on September 14, 1998. BNL submits an annual Water Pumpage Report to the NYSDEC, which summarizes total pumpage for all BNL potable and process supply wells, and remediation wells.

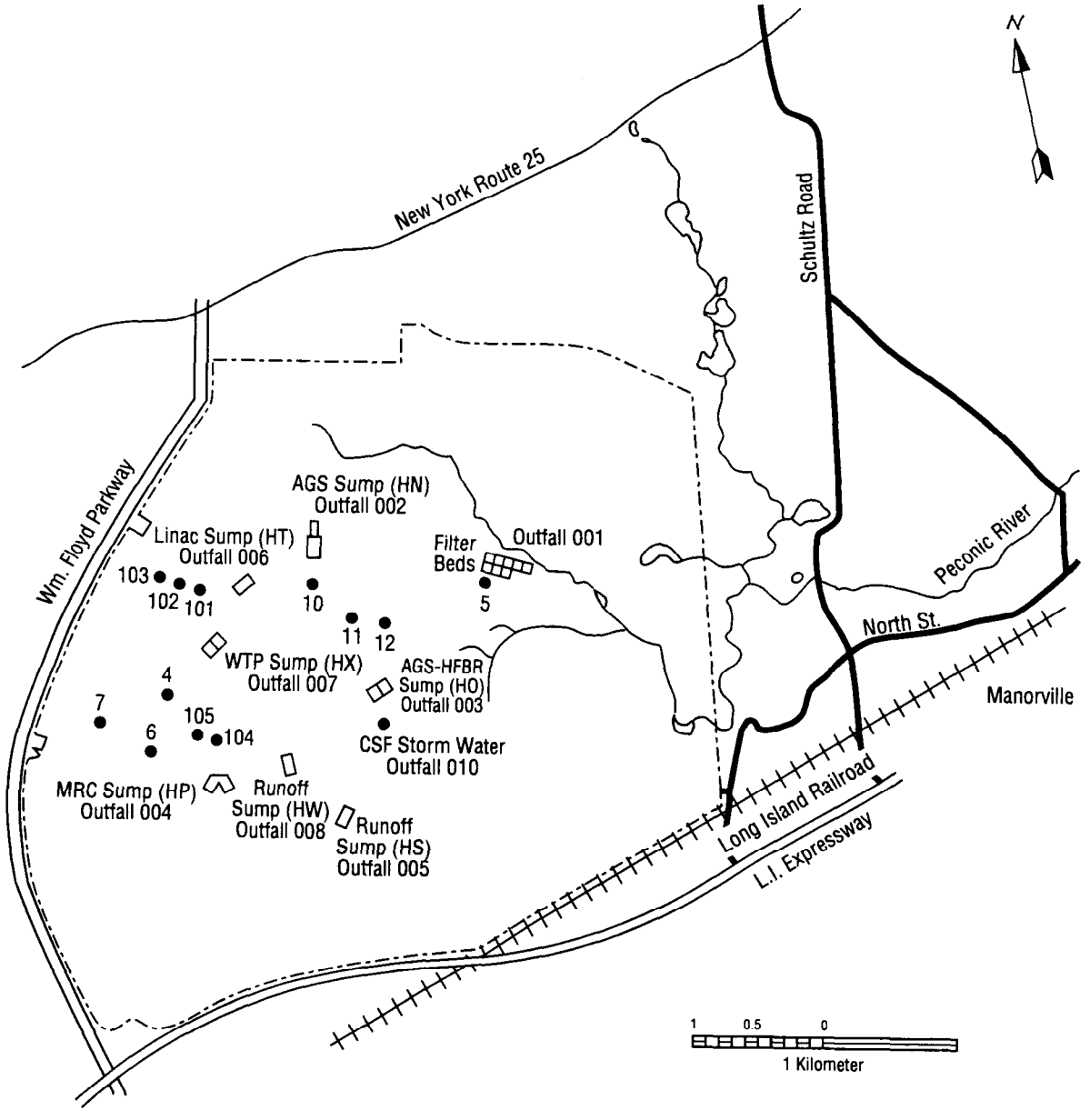

Figure 5: Locatins of BNL Potable Supply Wells and Recharge Basins

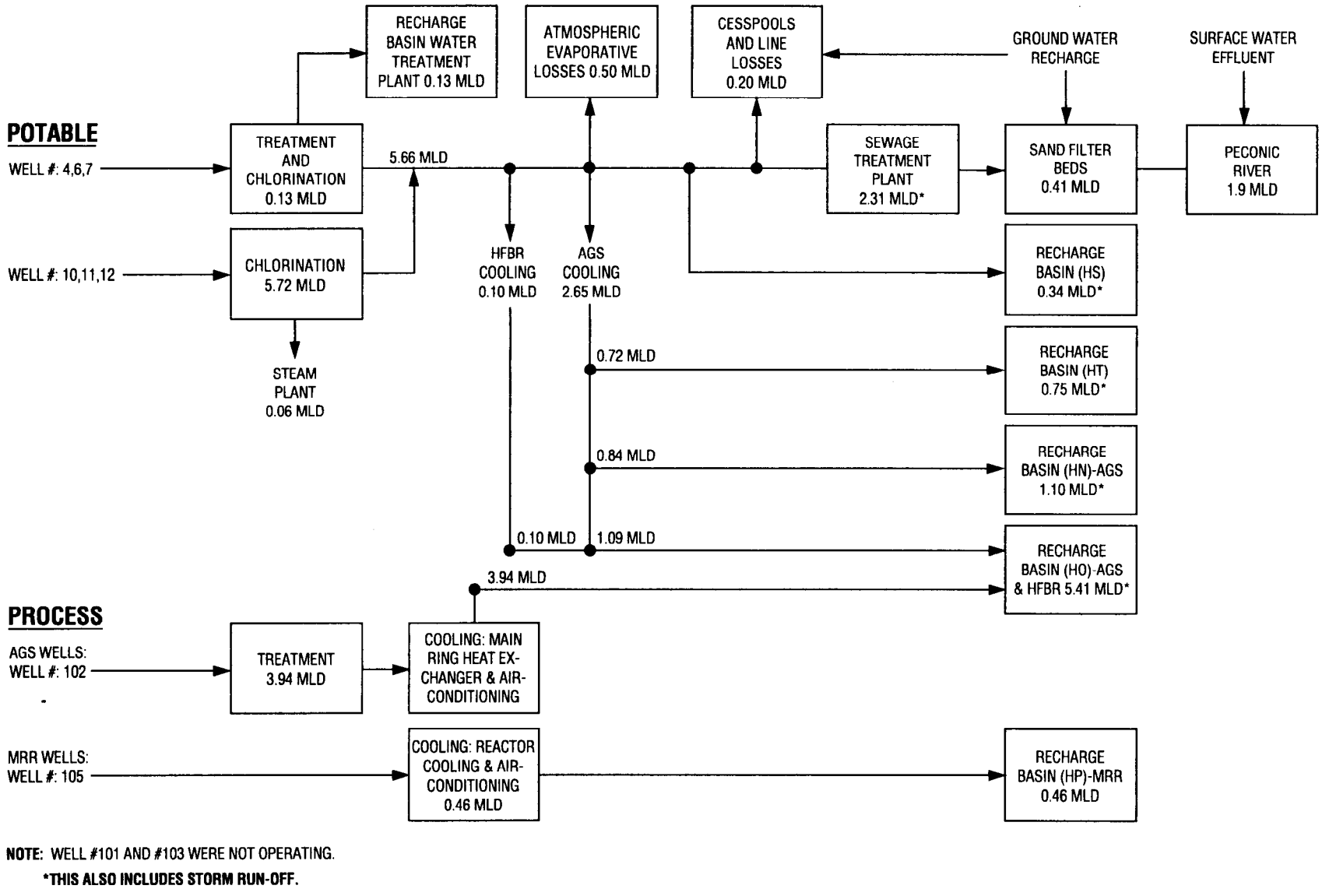

Figure 6: Schematic of BNL Water Supply Use and Flow for 1997

Figure 6 provides an overview of water use and water recharge for the BNL site for 1997. During maximum water usage at BNL, up to 23 million liters per day (MLD) are pumped from the Upper Glacial aquifer. Most of this water is returned to the aquifer by way of recharge basins and discharge of Sewage Treatment Plant effluent to the Peconic River (see Section 3.3.3). The BNL potable/process supply wells are screened within the Upper Glacial aquifer, and most wells are capable of delivering up to 4,500 liters per minute (lpm) (1,200 gallons per minute) to the potable water system. The potable/process wells are used in rotation to meet the daily water supply requirements for the site.

3.3.2.2 Potable Water Treatment

Potable water obtained from BNL Supply Wells 4, 6, and 7 contains naturally occurring iron at concentrations that exceed NYS Drinking Water Standards (NYSDWS). Before entering the distribution system, this water is treated at the BNL Water Treatment Plant (WTP) using a conventional lime softening process to precipitate the iron from solution. Chlorination of the water supplied from Wells 4, 6, and 7 is accomplished by the use of chlorine gas at the WTP, and individual chlorine gas dosing systems are installed at Wells 10, 11, and 12. Water obtained from the Upper Glacial aquifer is naturally slightly acidic, with a pH in the range of 5.5 to 6.5. To reduce the corrosivity of the water, sodium hydroxide is added to maintain the pH of the potable water at approximately 8. By increasing the alkalinity of the water, the dissolution of lead from older soldered pipe joints is reduced. Occasionally, water pumped from some of the water supply wells may contain VOCs at concentrations slightly exceeding NYS DWS. Water obtained from Potable Supply Wells 10, 11, and 12 is treated at the wellhead using large capacity carbon filters, whereas water from Wells 4, 6, and 7 is treated at the Water Treatment Plant by the use of air stripping towers.

3.3.2.3 Water Supply Management

Managing groundwater consumption at BNL and understanding the effects of groundwater withdrawals on the regional hydrogeologic regime are important components of the BNL GPMP. The Upper Glacial aquifer is highly permeable, and yields significant quantities of water throughout the BNL area. The present rate of groundwater pumpage at BNL, coupled with significant recharge after use (recharge of >75% when combining sewer line losses and discharges to the Sewage Treatment Plant and recharge basins), results in only a minor net loss in the quantity of water stored in the Upper Glacial aquifer. However, since pumping of supply wells and subsequent recharge of this water does cause significant changes in groundwater (and possibly contaminant) flow directions and velocities, conservation of water by minimizing pumping is important. Since the early 1990's, total pumpage from the potable wells has been reduced from approximately 12 MLD to 6 MLD (Figure 7). This reduction has been realized by the implementation of water conservation projects, which have included distribution system upgrades to prevent water loss and the identification of wasteful water use practices.

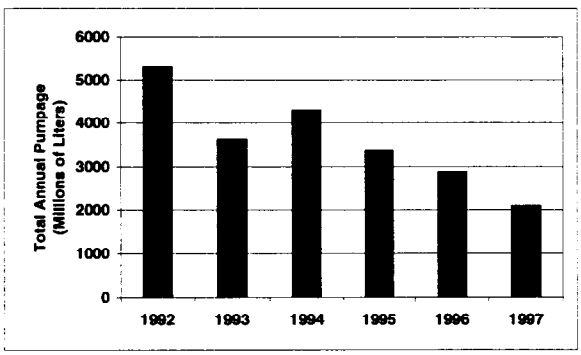

Figure 7: Summary of BNL Potable Water Supply Pumpage from 1992 through 1997

Assessment of future water supply requirements are outlined in the BNL Water Utility Master Plan, 1989-2000 (BNL, 1989). The Master Plan includes an assessment of needed water supply system upgrades (e.g., new distribution lines, treatment and storage facilities, and well modifications and replacements), daily water demands, fire fighting capabilities, and predicted growth. Based upon assessments of predicted growth in employee population and potential water demands for planned future research and support facilities, the current supply well network is capable of providing adequate supply of both potable and non-contact coolant water for the site. However, in order to maintain proper flow and pressure conditions, modifications to the existing distribution system may be required.

3.3.2.4 Off-Site Public Water Supply

The Suffolk County Water Autority (SCWA) operates a number of public water supply well fields in the vicinity of BNL. The locations of the nearby SCWA supply wells are shown in Figure 8. The closest of these, the William Floyd Well Field, is located 0.2 km to the southwest of BNL. The William Floyd well field yields approximately 4.5 MLD from two Upper Glacial wells and one Magothy aquifer well.

As part of the ER activities, approximately 1,500 homes in the neighboring North Shirley, East Yaphank and Manorville areas have been connected to SCWA supply. This initiative was undertaken as a precautionary measure to eliminate any possible future exposure to groundwater contaminants originating from BNL. Homeowners who preferred not to be connected to SCWA supply continue to be serviced by individual, small capacity wells (<80 lpm) that are typically screened in the uppermost 15 m (50 ft) of the Upper Glacial aquifer.

3.3.3 Surface Water Quality and Classification

BNL is located near the western boundary of the Manorville drainage basin, which forms the upper drainage area or head waters of the Peconic River (Figure 9). The Peconic River drains in an easterly direction into Flanders Bay, and then into the Great Peconic Bay.

Surface waters at BNL are classified by the State of New York as "Class C Fresh Surface Water" (6NYCRR Part 700-705). The best usage of Class C surface water is fishing; and is suitable for fish survival and propagation, and primary and secondary contact recreation.

Surface water bodies at BNL include the Peconic River, its tributaries (including associated wetlands) and isolated kettle ponds. These surface water bodies are in hydraulic communication with the Upper Glacial aquifer. Water levels and flow rates in the tributaries are strongly influenced by the position of the water table. Under natural conditions, flow in the Peconic River and its tributaries is derived primarily from groundwater discharge and surface water runoff. These surface water bodies are essentially dry during periods of regional drought. During periods of drought, BNL Sewage Treatment Plant (STP) effluent discharge to the Peconic River comprises the majority of the flow in the river, and most of the river flow recharges before reaching the BNL site boundary.

4. KNOWN OR POTENTIAL SOURCES OF CONTAMINATION

On December 21, 1989, the BNL site was identified as a federal Superfund site under the Comprehensive Environmental Response and Liability Act (CERCLA) program and placed on the National Priorities List (NPL). Twenty-nine areas of concern (AOCs) have been identified through both EM and ER monitoring activities (see Figure 10). AOCs are areas where there have been releases to the environment of a hazardous substance, pollutant or contaminant. The characteristics of each AOC have been documented in the BNL Site Baseline Report (SAIC, 1992, and subsequent revisions). The 29 AOCs have been grouped into six Operable Units (OUs) based upon relative proximity of AOCs, similarity of contamination problems, similar geology and hydrology, and similar phases of remedial action to be performed. All of the OUs contain source areas that are known or suspected to have affected groundwater quality at the site. The AOCs/OUs are discussed in Section 4.1.

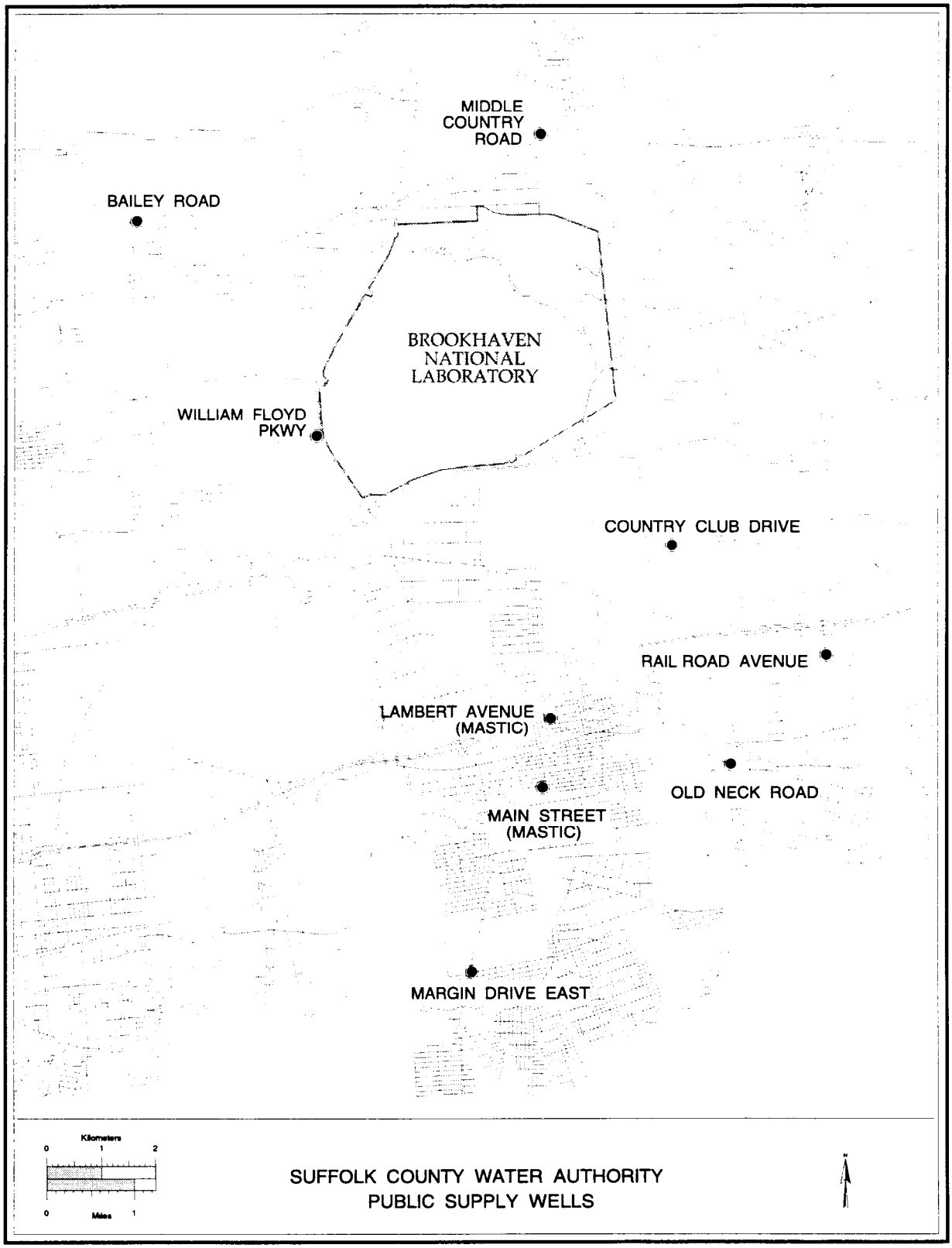

Figure 8: Locations of Suffolk County Water Authority Public Supply Wells in the Vicinity of BNL

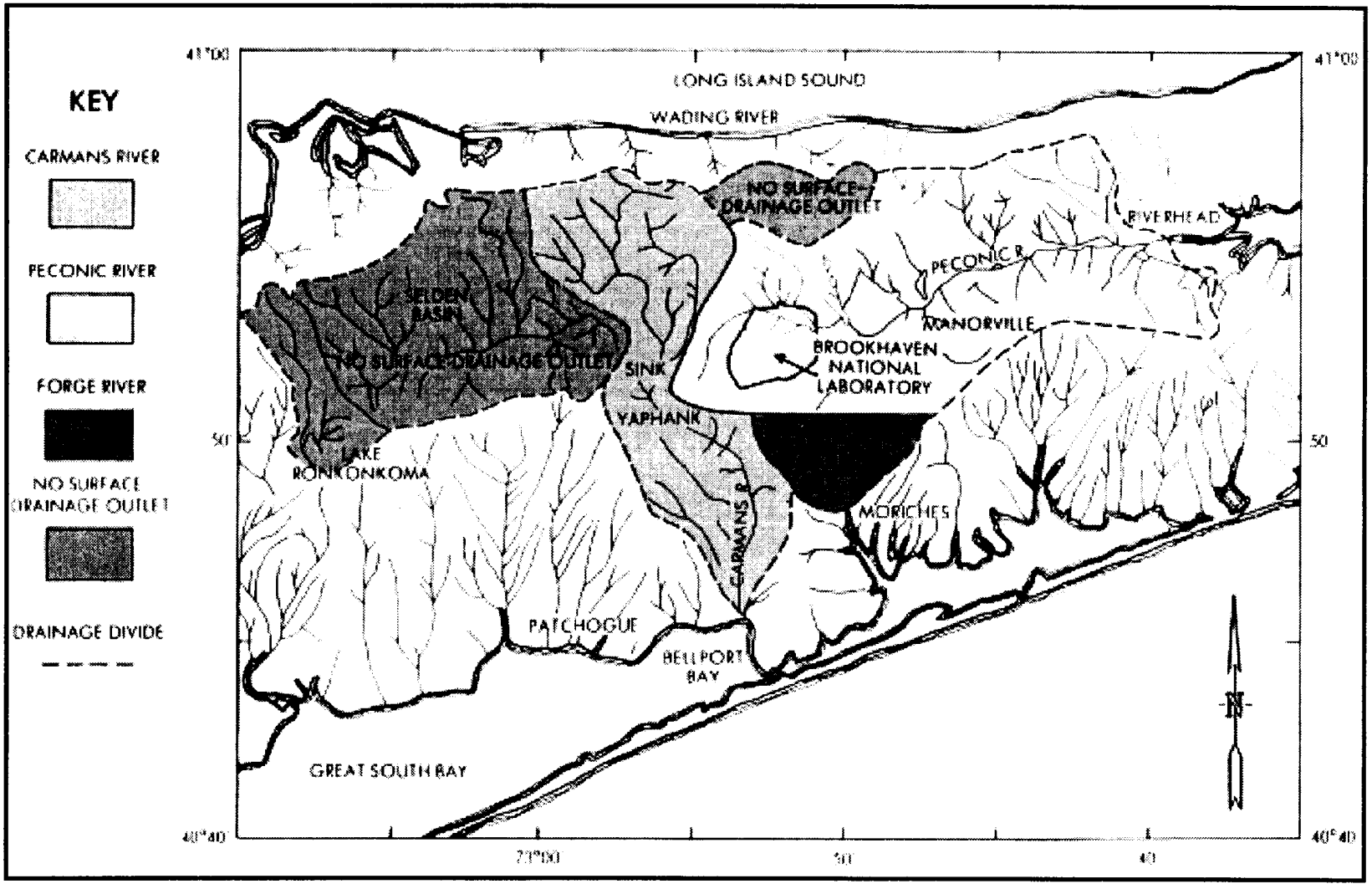

Figure 9: Regional Surface Water Drainage Basins in the Viciniaty of BNL

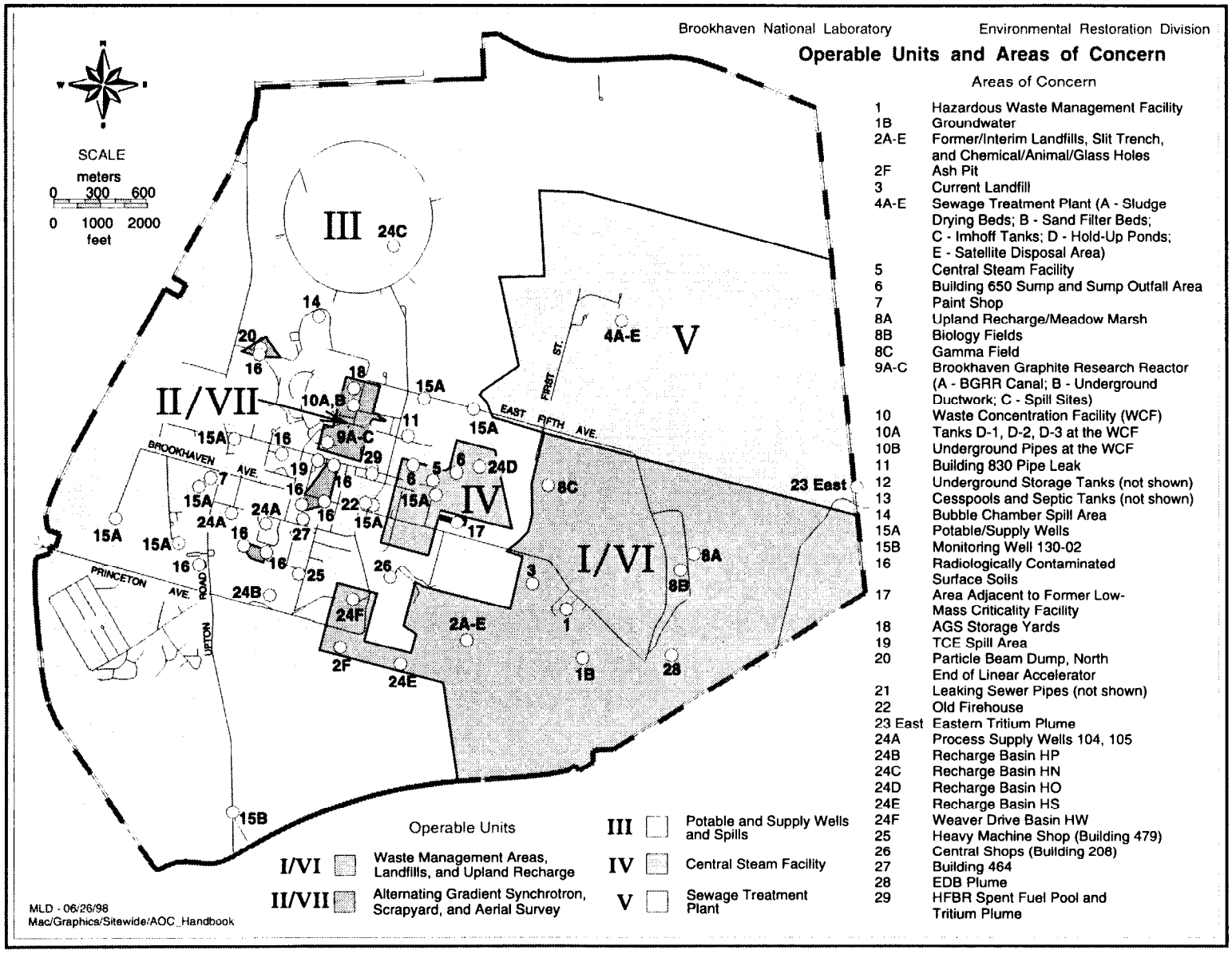

Figure 10: Map of BNL CERCLA Areas of Concern/Operable Units

In addition to the defined AOCs that are being investigated and remediated as part of the Environmental Restoration Program, activities at a number of other active research and support facilities have resulted in low-level groundwater contamination or have the potential to impact groundwater quality. These facilities are discussed in Section 4.2.

4.1 CERCLA Areas of Concern/Operable Units

The AOCs were initially grouped into seven OUs (OUs I through VII) based upon relative proximity of AOCs, similarity of contamination problems, similar geology and hydrology, and similar phases of remedial action to be performed (see SAIC, 1992). Two of the OUs (II and VII) were later combined into a single project. Under the ER Program, Remedial Investigations/Feasibility Studies (RI/FSs) have been conducted for OUs I, III, IV, V and VI and the RI for OU II/VII has been conduted. The FS for OU II/VII (contaminated soils) will be covered by the OU I FS. A brief description of each of the OUs follows.

- **Operable Unit I:** The OU I AOCs deal with both chemical and radiologically contaminated soils and groundwater at the former Hazardous Waste Management Facility (HWMF),[7] and the Former Landfill and Current Landfill areas. As a result of historical waste handling and disposal practices and accidental spills, soil and groundwater within the HWMF has been contaminated with VOCs and radionuclides. Groundwater investigations have detected VOCs such as 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1-dichloroethane (DCA), and 1,1-dichloroethylene (DCE). Radionuclides such as tritium and strontium-90 have also been detected in the groundwater. Residual contaminants of concern found in the soils at the facility are cesium-137 and strontium-90.

- **Operable Unit II/VII:** The OU II/VII areas of concern are primarily associated with radiologically contaminated soils. OU II/VII consists of four AOCs, including the Waste Concentration Facility (WCF), Aerial Radioactivity Monitoring System Results, an area adjacent to the former Low-Mass Criticality Facility, and the Alternating Gradient Synchrotron (AGS) Storage Yard. The nature and extent of contamination in these AOCs was evaluated during the OU II/VII RI/RA (ITC, 1998). A total of 23 areas containing low-level radiologically contaminated surface soils have been identified (AOC 16). The dominant isotopes found in these soils are cesium-137, sodium-22, manganese-54, cobalt-60, and thorium-230 (see CDM Federal, 1997; BNL, 1998a).

- **Operable Unit III:** The primary concern in this OU is contaminated groundwater originating from chemical and radiological releases that have occurred in the developed, central portion of the site. Twelve AOCs have been investigated as part of the OU III RI/FS (ITC/G&M, 1998c).[8] Some of the more significant defined source areas that have impacted groundwater include: 1) multiple solvent spill areas located within the AGS Complex[9] (AOC 14); 2) TCA releases in the Supply and Materiel/Building 208 area (AOC 26); 3) the discharge of the solvents PCE, TCA, and CT in the former Building 96 area (AOC identification number pending); 4) strontium-90 releases at the WCF; 5) strontium-90 from the Former Landfill/Chemical Holes area; 6) strontium-90 releases from the BGRR; and 7) the tritium release from the HFBR spent fuel pool.

- **Operable Unit IV:** The primary areas of concern in OU IV are the 1977 Oil/Waste Solvent Spill (AOC 5) near the Central Steam Facility and the Building 650 Sump and Sump Outfall (AOC 6) (see CDM Federal, 1994, BNL, 1998b). In 1977, approximately 23,000 gallons of Number 6 fuel oil mixed with mineral spirits was released to soils from a ruptured transfer

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[7] The HWMF was in operation from 1947 through December 1997.

[8] Additionally, groundwater concerns associated with radiologically contaminated soils from Operable Unit II/VII were also transferred into the Operable Unit III RI/FS.

[9] Cesspools/Septic Tanks and the Bubble Chamber spill site.

pipe. Soils and groundwater were impacted as a result of this spill. Residual VOCs and semivolatile organic compounds (SVOCs) have been detected in soils. Groundwater investigations have detected high levels of toluene, xylenes, ethylbenzene, and PCE in wells near the spill site, with total VOC concentrations typically in the range of 4,000 µg/L.[10] At Building 650, drainage from historical outdoor decontamination of heavy equipment was routed to a drain system which emptied into a natural depression (known as the Building 650 Sump Outfall) located 240 m (800 ft.) to the northeast of the facility. Soils in the sump outfall are contaminated with cesium-137, europium-152, europium-154, strontium-90, radium-226, uranium-235/238, plutonium-239/240, americium-241, and cobalt-60.

- **Operable Unit V**: The areas of concern for OU V include: the Sewage Treatment Plant (STP) (AOC 4a through 4e); leaking sanitary lines (AOC 21); and the eastern tritium plume (AOC 23 East). The primary concern in this OU is the historical contaminant discharges to the STP, which has been in continuous operation since 1947. The remedial investigation has identified contaminated soils near the STP filter beds, contaminated sediments within the Peconic River and an off-site TCE plume (ITC/G&M, 1998a; ITC/G&M, 1998b).

- **Operable Unit VI**: The primary concern in this OU is a plume of ethylene dibromide (EDB) contaminated groundwater that has migrated off-site (AOC 28). EDB was used as a pesticide to sterilize soils in the Biology Department's agricultural research fields in the 1960s and 1970s (CDM Federal, 1996c).

4.2 Groundwater Quality near Active Research and Support Facilities (Non-CERCLA) - Areas of Potential Contamination

Several active or planned facilities have inventories of hazardous or radioactive materials that could potentially create groundwater contamination problems if there were leaks in piping systems or tanks. Others have operations that create the potential for groundwater contamination by the direct activation of soils.[11] Although groundwater quality at a number of these active facilities has already been impacted, currently available information indicates that the levels of contamination are either below or only slightly above applicable groundwater standards. See Figure 11 for a map of these facilities. A brief description of these facilities is provided below.

- **Alternating Gradient Synchrotron Complex**: Secondary particles created near AGS beam targets and stops have the potential to activate soils surrounding the accelerator tunnels or soils underlying target and beam dump areas in the experimental hall areas. Identified areas where soil activation could be occurring are: Building 912 (main experiment hall); AGS Booster Beam Scraper; E-20 Beam Catcher; Building 914 (transfer tunnel); g-2 Beam Target and Dump; J-10 Beam Dump; and the former U-Line Target area. The radionuclides of primary concern because of their potential to impact groundwater quality are tritium and sodium-22.

- **Relativistic Heavy Ion Collider (RHIC)**: Secondary particles that will be created at the RHIC beam stop and collimator areas are expected to produce tritium and sodium-22 in soils immediately surrounding those areas.

- **Brookhaven LINAC Isotope Producer (BLIP)**: Secondary particles created near the BLIP target vessel are likely to cause significant activation of soils within a four to five foot radius of the vessel. Tritium (up to 54,000 pCi/L) and sodium-22 (up to 151 pCi/L) have recently been detected in groundwater samples collected directly downgradient of BLIP.

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[10] The *OU IV Record of Decision* was signed in March 1996.

[11] Active research and support facilities that have the potential to impact groundwater quality are described in the *BNL Groundwater Monitoring Improvements Plan for FY 1998 and FY 1999* (Paquette, 1998).

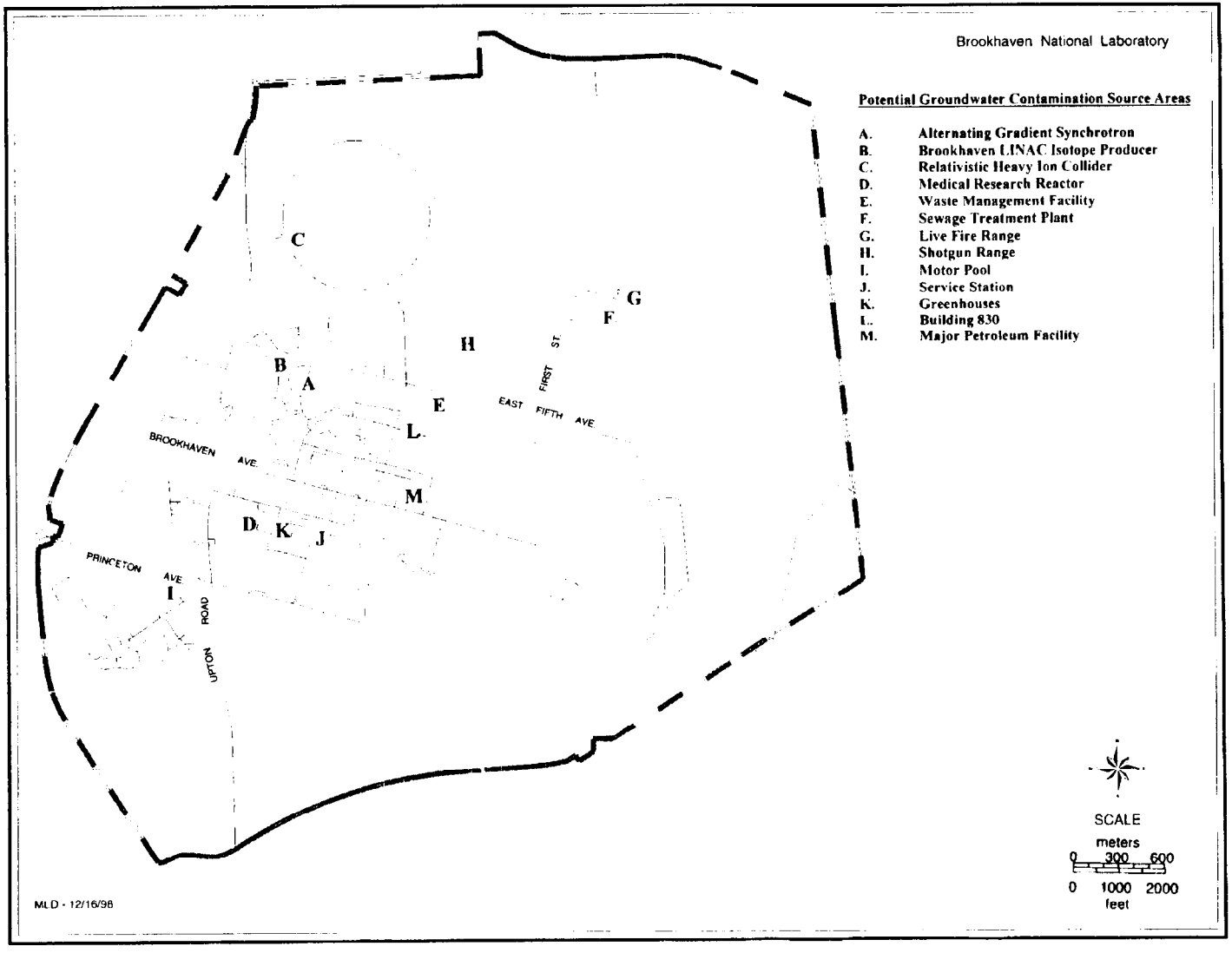

Figure 11: Potential AOCs Map

- **Brookhaven Medical Research Reactor (BMRR):** The BMRR's primary cooling water system consists of a recirculation piping system that contains 2,550 gallons of water. The tritium concentration in the primary water is currently 465 mCi/L. Historical discharges of primary water to a floor drain system located in the basement of the BMRR have resulted in the creation of a low-level tritium plume with a maximum concentration of 11,800 pCi/L.

- **Sewage Treatment Plant Sand Filter Bed Area:** Due to past chemical and radiological releases to the sanitary system, the filter bed sands have been contaminated with radionuclides and heavy metals. These radionuclides and heavy metals continue to leach from the sand filter beds at a slow rate (Schroeder *et al.*, 1998). As much as 15% of the water released to the filter beds is subject to direct groundwater recharge.

- **Sewage Treatment Plant (STP) Emergency Hold-up Ponds:** The STP's lined emergency holding ponds are not equipped with secondary containment and leak detection devices. Although the Laboratory performs routine maintenance on these ponds, the possibility exists that undetected leaks could occur.

- **Major Petroleum Facility (MPF):** The MPF is the holding area for fuel used at the Central Steam facility. A potential undetected release of either free product or dissolved hydrocarbon products from the above ground storage tanks is of concern.

- **Site Maintenance and Motor Pool Area:** Potential environmental concerns at the Motor Pool include the historical use of underground storage tanks for the storage of gasoline and waste oil, hydraulic fluids used for lift stations, and the use of solvents for parts cleaning. The only environmental concern associated with the Site Maintenance facility (Building 326) is the 1996 discovery of a historic oil spill directly south of the building.

- **On-site Gasoline Service Station:** Potential environmental concerns at the Service Station include the historical use of underground storage tanks for the storage of gasoline and waste oil, hydraulic fluids used for lift stations, and the use of solvents for parts cleaning.

- **Live-Fire (Rifle) and Shotgun Ranges:** The use of on-site rifle and shotgun ranges may impact groundwater quality. Whereas most bullets are screened from the soils at the rifle range, it is estimated that several thousand pounds of lead shot is deposited on the surface of the shotgun range annually.

- **Waste Management Facility:** In December 1997, BNL began operating a new, state-of-the-art Waste Management Facility. Although the new WMF is designed and operated in a manner that meets all applicable Federal, State, and local environmental protection requirements, a groundwater monitoring program was established to provide a secondary means of verifying the effectiveness of the facility's engineering and operations controls.

5. PREVENTION

BNL has established a series of programs that are designed to prevent, to the greatest extent possible, the release of hazardous and radioactive materials to the environment. These program elements are described below.

5.1 Environmental Management System (EMS)

An Environmental Management System (EMS) is being developed at BNL within the framework of a sitewide integrated Environment, Safety and Health Management System and based on the ISO 14000 Standard (Briggs, 1998). The goals of the EMS include ensuring that BNL conducts its work and manages the Laboratory facilities in a cost effective and efficient manner, while protecting workers, the public and the environment. The EMS seeks to integrate environmental protection, pollution prevention, compliance assurance, remedial actions, and communication into all aspects of the Laboratory's mission. The GPMP applies the principles of the BNL EMS, and integrates them into its design and implementation. Key elements of the EMS that the GPMP supports include the following:

- **Environmental Policy**: The GPMP program is designed to support the lab-wide environmental stewardship policy, including the commitment to regulatory compliance, pollution prevention and continuous improvement;
- **Objectives and Targets**: The GPMP sets goals that establish the framework for the groundwater protection program;
- **Legal and Other Requirements**: The GPMP identifies the requirements applicable to the groundwater protection program, and incorporates these into Laboratory programs and procedures to ensure regulatory compliance;
- **Environmental Management Program**: The Groundwater Protection Integration Implementation Plan (GPIIP) will contain plans for achieving the goals and objectives of the GPMP. The Lab-wide efforts (such as development of standards and procedures) needed to support the GPMP are being developed;
- **Communications**: The GPMP has a communication element that is integrated with the BNL Strategic Communications Plan, utilizing the newly established BSA Community Involvement/ Public Affairs infrastructure for both internal and external communications;
- **Monitoring and Measurement**: One of the four elements of the GPMP is monitoring the Laboratory's impact on the environment; and,
- **Records**: Records for the sampling program will be recorded and maintained in a centralized, integrated database.

In addition, a number of the programs described below are designed to anticipate and prevent environmental problems, and are being conducted or established within the EMS framework.

5.2 Environment, Safety and Health Standards

BNL has established a series of procedures that describe requirements designed to prevent, to the greatest extent possible, the release of hazardous and radioactive material to the environment. These standards include ES&H Standard 6.1.0, BNL Environmental Protection Overview. Specifically, the standards address the requirements of the National Environmental Policy Act (NEPA), radiological and non-radiological liquid effluents, air emissions, and hazardous and mixed wastes. BNL is the in the process of updating these standards to ensure they are adequate and complete.

5.3 NEPA and Permit Compliance Review

BNL's implementation of the NEPA process is detailed in ES&H Standard 6.1.1. The NEPA review and documentation process is initiated during the preliminary planning phases of a project. Permit applications and reviews are generally conducted during the detailed design phase, as the necessary project-specific design specifications become available.

5.4 Facility Use Agreements (FUAs)

Facility Use Agreements (FUA) establishing "landlord-tenant"requirements, roles and responsibilities are currently being instituted at BNL. The FUAs will establish an "operating envelope" designed to comply with applicable regulatory requirements (including regulatory permits) and protect groundwater resources from specific activities occurring in that facility. Each agreement will reference environmental/groundwater protection criteria or programs that must be implemented. Furthermore, the FUAs will describe each department's responsibilities to design, construct and maintain their facilities in a manner that protects groundwater resources. This includes administrative and/or engineered controls such as the development of standard operating procedures and/or operational procedures that require long-term inspection and maintenance of systems, and the construction or use of devices or structures designed to protect groundwater. The FUAs will also identify monitoring requirements associated with each facility.

5.5 Facility Design Reviews

All proposed plans for major construction projects for new facilities or significant improvements to existing facilities are reviewed to ensure that the design elements meet all applicable regulatory requirements, and that potential environmental vulnerabilities are identified. The design review process is described in ES&H Standard 1.3.0. All facilities that have the potential to store and handle radioactive and/or hazardous materials, or those that may directly activate soils (e.g., accelerator facilities such as the AGS and RHIC) must possess design features that are specifically intended to protect groundwater and surface water resources. At RHIC, for example, although the potential radionuclide concentrations in soil pore water are predicted to be well below drinking water standards, landfill-type geo-membrane caps will be constructed over the RHIC's collimator and beam stop areas as an added measure of groundwater protection.

- **Internal Review**: The design review process used by BNL is described in ES&H Standard 1.3.0. An internal review for each project is coordinated by the Plant Engineering program. The review of project plans focuses on the soundness of design with respect to environmental regulations (including measures taken to ensure groundwater protection), worker health and safety, and fire protection. For major facilities or operations that have the potential to produce conditions that could risk the health and safety of the public and employees, or that may impact environmental quality, a Safety Analysis Report, Safety Analysis Document, or an Environmental Impact Statement may be required.

- **External Review**: Following the completion of detailed drawings and specifications (Title II or 90% design stage), there may be a need to obtain regulatory agency approval (including necessary permits) to construct and/or operate the facility as a whole, or certain facility components. Facility components or apparatus that may require regulatory design review and permitting include: 1) storage tanks, associated piping, and other storage facilities for hazardous or radioactive materials; 2) construction activities near designated wetlands and the Peconic River; and, 3) air and liquid effluent release points. If an external review is required, BNL submits review documents to the DOE Brookhaven Group (BHG) for subsequent transmittal to agencies such as the USEPA, New York State Department of Environmental Conservation (NYSDEC), and the SCDHS.

- **Operational Readiness Reviews**: Before a new or significantly modified facility is operated at BNL, an Operational Readiness Review (ORR) is conducted (see ES&H Standard 1.3.2). The ORR identifies the status or operational readiness of a facility before startup to ensure that all engineered safeguards and procedures are in place. The ORR also ensures that BNL line management is aware of their responsibility for environmental protection aspects of their operations.

5.6 Process Review (Routine Processes and Experiments)

BNL has developed a Process Evaluation Project (PEP) Management Plan (Goode, 1998). The PEP provides the framework for an integrated, Laboratory-wide review of all experiments and industrial-type operations. The goal of the PEP is to identify all waste streams generated at the Laboratory to ensure that they are properly managed. Operations, experiments, and waste streams where equipment malfunctions and deterioration, operator errors, and discharges or emissions may potentially cause or may lead to releases of hazardous waste or pollutants to the environment, or that potentially pose a threat to human health or the environment, will be identified during the process evaluation. Processes will be modified, as necessary, to ensure protection of groundwater resources.

As part of BNL's Work Planning initiative, a systematic program to review each existing research project will be implemented to ensure all research activities are evaluated for environmental, safety and health impacts. Experiments will be evaluated in accordance with ES&H Standard 1.3.5i. The Experimental Research Evaluation includes the identification and evaluation of safety issues, environmental releases, and waste generation, and provides for the identification of potential pollution

prevention and waste minimization initiatives. During 1998, the BNL experimental process inventory included approximately 1900 experiments, including approximately 1500 short-term experiments conducted at the National Synchrotron Light Source.

Industrial processes will be evaluated by the preparation of process flow diagrams, written process descriptions, a regulatory determination of all processes (including air emissions and liquid effluents), identification of pollution prevention opportunities, and the identification of any assessment, prevention or control measures that should be considered. The PEP inventory numbers approximately 130 industrial processes, and includes typical industrial activities such as: machining and milling operations; photographic developing; vehicle maintenance; metal cleaning and plating; electronic assembly; utilities; and other site services.

The PEP also involves deploying environmental professionals known as Environmental Compliance Representatives (ECRs) to the field to proactively integrate environmental compliance and pollution prevention initiatives into Laboratory programs. The ECRs provide technical assistance to develop and implement environmental protection activities needed to ensure compliance with all applicable environmental requirements.

5.7 Pollution Prevention and Waste Minimization Opportunity Assessments and Programs

The goal of BNL's Waste Minimization/Pollution Prevention (Wmin/P2) Program is to prevent the generation of waste (solid, hazardous/mixed and radioactive), and minimize the generation of waste that cannot be prevented. BNL's Wmin/P2 Plan (Goode, 1994) establishes the Wmin/P2 program for the site. The pollution prevention program at BNL focuses on identifying and using cost-effective opportunities for waste reduction. Such opportunities are identified by formal Pollution Prevention Opportunity Assessments, Waste Minimization Working Groups, employee suggestions, and the PEP.

Those opportunities that are found to have environmental, economic and technical viability will be further pursued. An example of implementation of a pollution prevention approach that will help protect groundwater is the Live-Fire Range, where predominantly copper jacketed or Teflon coated bullets are used, and the bermed area is screened annually to remove spent bullets.

5.8 Waste Management Program

5.8.1 Waste Management at the Point of Generation

- **Hazardous Waste Management**: ES&H Standard 6.2.1 describes the requirements for establishing, operating, and closing accumulation areas for (RCRA) hazardous waste at BNL. Each generator of hazardous waste is required to collect and store all accrued hazardous waste in a Satellite Accumulation Area located at or near the point of waste generation. Before or when the quantity of hazardous waste at a satellite area reaches the maximum allowable quantity set forth in the Standard, the waste must be transferred to a department's approved 90-Day Accumulation Area. These waste materials are then transferred to the WMF.

- **Radioactive Waste Management**: The interim accumulation and disposition of radioactive and mixed wastes (i.e., wastes that contain both radioactive and RCRA defined hazardous constituents) are described in ES&H Standard 6.2.2. Each generator of Mixed-Low-Level Radioactive Waste (LLRW) is required to collect and store all accrued waste in a Satellite Accumulation Area located at or near the point of waste generation. Mixed-LLRW are considered RCRA hazardous wastes, and are stored in a segregated area in each department's 90-Day Accumulation Area. These waste materials are then transferred to the WMF. An environmental monitoring program has been established for the WMF as required by DOE Order 5820.2A and NYSDEC operating permit.

- **Investigation Derived Wastes (IDW):** Investigation Derived Wastes (IDW) are those wastes generated during environmental investigations. These wastes include contaminated subsurface soils brought to the surface during well drilling,contaminated groundwater pumped from wells during well development and sampling, decontamination fluids, and contaminated personal protective equipment. These wastes are managed in compliance with the substantive environmental protection requirements, as required by CERCLA.

5.8.2 Centralized Waste Management

- **Waste Management Facility:** In December 1997, BNL began operating a new Waste Management Facility (WMF) located close to the geographic center of the site. The WMF is the central receiving area for BNL's hazardous and radioactive waste, and is designed to safely handle, repackage, and temporarily store these waste materials prior to shipment to an off-site disposal or treatment facility.
- **Solid Waste Disposal:** BNL generates and accumulates non-hazardous solid wastes, which are shipped to the Brookhaven Town Landfill for recycling or disposal. BNL has not operated an on-site solid waste disposal facility (i.e. landfill) since 1990.

5.8.3 Training

- **Waste Management Training Programs:** Waste generators are trained on regulatory compliance and on the importance of preventing pollution and minimizing waste generation.

5.9 Spill and Release Reporting and Response

The BNL Emergency Plan (BNL, 1996b), the Spill Prevention, Control, and Countermeasures (SPCC) Plan (BNL, 1997b), and several ES&H Standards have been developed in order to properly respond to, remediate and report spills of chemical or radioactive materials at the BNL site. Spill response procedures are described in ES&H Standard 6.1.6 and the Environmental Services Division's Standard Operating Procedure RP-SOP-5. In response to requirements described in DOE Order 232.1, BNL also has established an Occurrence Reporting System that is used to report "Emergency Occurrences," "Unusual Occurrences," and "Off-Normal Occurrences" to the DOE, New York State, Suffolk County and other agencies. The procedures used for the BNL Occurrence Reporting and Processing System (ORPS) are described in ES&H Standard 1.1.0.

5.10 Controlled Use of Fertilizers and Pesticides

Except for limited and controlled use of fertilizers in the BNL Biology Department's greenhouses and agricultural fields, fertilizers are not applied on a routine basis at BNL. Fertilizers may occasionally be used during initial stages of grass growth (e.g., hydroseeding) following new construction projects. Insecticides, herbicides, and pesticides are occasionally used at the BNL site. As per regulatory requirements under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), BNL maintains an inventory of all chemicals stored at various facilities, and records of all chemical applications. All applicator personnel are trained and certified by the NYSDEC for the safe handling and application of these chemicals, and each certified applicator submits an annual report to the NYSDEC that indicates the types and quantities of pesticides used during the year.

5.11 Underground Injection Control

The goal of the BNL Underground Injection Control (UIC) program is to prevent the discharge of contaminants that could jeopardize groundwater quality. The Laboratory's program falls under the auspices of the EPA UIC program, wherein UIC devices are subject to inventory, sampling, analysis, and closure, if necessary. The SCDHS has been the primary point of contact for enforcement and fieldwork for the EPA. The BNL site has only Class V injection wells, which are generically defined as wells used for injecting fluids, and are deeper than their widest surface dimension. BNL Class V

injection wells include sanitary and other wastewater disposal systems including, but not limited to, drywells, cesspools, septic tanks, and leach fields. During the 1997 EPA Multimedia Audit, concerns were raised regarding the completeness of the Class V inventory on file with EPA. A revised inventory was prepared and submitted for EPA review and evaluation. This effort is ongoing. In 1999, the BNL Plant Engineering Program will be evaluating all storm water drainage systems to ensure that all drywells have been identified and included in the EPA inventory. Following this survey and EPA's review, the Laboratory will seek funding required for the proper characterization and possible abandonment of the drywells if necessary. The abandonment of Class V injection wells is coordinated with the SCDHS and EPA, and SCDHS cleanup guidelines are utilized to assess potential soil remediation requirements.

5.12 Control of Toxic and Hazardous Materials Storage Facilities

The 1987 Suffolk County/BNL Agreement requires the Laboratory to comply with the environmental requirements of Suffolk County Sanitary Code (SCSC) Articles 6, 7, 10, and 12. BNL has made significant progress toward bringing all toxic and hazardous materials storage facilities into compliance. By definition, storage facilities include above ground storage tanks, underground storage tanks (USTs), drum storage areas, piping systems, and closed-loop cooling water systems that contain toxic or hazardous liquids. Since 1987, 60 of a total of 85 USTs have been excavated, removed or properly abandoned in place with SCDHS oversight and approval. Of the remaining 25 USTs used for the storage of fuel oils, waste oils or gasoline products, all have been upgraded to meet Suffolk County (SC) Article 12 requirements for secondary containment, leak detection devices, and overfill alarms, where required. BNL plans to upgrade all remaining active storage facilities (i.e., drum storage areas and above ground storage tanks) by 2001. Inactive storage facilities located at the BGRR and WCF will be removed or abandoned as part of the ER Program.

5.13 Wellhead Protection Program for Potable Supply Wells

BNL will establish a wellhead protection program pursuant to SDWA regulations, which emphasizes pollution prevention as a primary means of protecting drinking water supplies. The wellhead protection program will be designed to protect on-site drinking water sources and ensure that BNL operations are not adversely impacted due to loss of one or more supply wells from contamination. The development of BNL's wellhead protection program will consist of six primary tasks: 1) documenting the location of all BNL production and potable water wells; 2) delineating wellhead protection areas using the BNL Regional Groundwater Model to define capture zones/source areas for each potable supply well; 3) identifying and ranking potential and known sources of groundwater contamination; 4) identifying suitable locations for new supply wells, including identifying areas where new supply wells should not be installed due to present groundwater contamination and the likelihood of diverting contaminant plumes toward supply wells; 5) developing plans for the control and/or remediation of known contaminant source areas, upgrading existing facilities, and incorporating engineering and operational controls for new facilities; and, 6) developing wellhead protection plans, including additional procedures needed for assessing the potential impact of new construction on groundwater quality and the use of appropriate engineering and operational controls. Implementation of this program will be discussed in the Groundwater Protection Integration Implementation Plan (GPIIP).

Many of the required wellhead protection program elements are already in place. For example: 1) BNL maintains an extensive groundwater monitoring well network to ensure that known and potential contaminant source areas are assessed; 2) known contaminant sources and contaminated groundwater are being remediated under the CERCLA process; 3) many potential source areas have either been removed, upgraded, or are scheduled to be upgraded (e.g., above ground storage tanks, underground storage tanks, leaking sewer lines, cesspools/septic tanks); 4) BNL currently reviews all new construction designs for potential impact to groundwater resources; and 5) the BNL Regional Groundwater Model has been used to define the capture zones (or water source areas) for each potable water supply well (Geraghty and Miller, 1998).

6. MONITORING

Groundwater monitoring program elements include: installation of monitoring wells; planning and scheduling; quality assurance; sample collection; sample analysis; data analysis and interpretation; and reporting. There are two main programs involved with groundwater monitoring, the EM surveillance program and the ER monitoring program. These programs are coordinated to ensure completeness and to prevent any duplication of effort in the installation and abandonment of wells, and the sampling and analysis of groundwater. Additional integration efforts are planned (see Section 8). Appendix E provides an overview of the number of monitoring wells used for each program.

6.1 BNL Groundwater Monitoring Programs - Design and Implementation

DOE Order 5400.1, Chapter IV - Environmental Monitoring Requirements states that "Groundwater that is or could be affected by DOE activities shall be monitored to determine the effects of operations on groundwater quality and quantity and to demonstrate compliance with DOE requirements and applicable federal, state and local laws and regulations." The goals of the monitoring element of the BNL GPMP are to:

- Comply with regulatory requirements for groundwater monitoring (see Appendix C for a summary of drivers);
- Obtain data for the purpose of determining baseline groundwater quality and quantity conditions;
- Identify existing and potential groundwater contamination sources and maintain surveillance of these sources;
- Provide data to permit the early detection of groundwater contamination;
- Provide a reporting mechanism for communicating the groundwater quality information;
- Provide data upon which decisions can be made regarding management and protection of groundwater resources and the need for remedial actions;
- Demonstrate compliance with and implementation of all applicable regulations and DOE Orders;
- Evaluate the long-term effectiveness of landfill capping systems;
- Evaluate the effectiveness of groundwater remediation systems, and provide the data necessary for decisions on the current and future operations of these systems;
- Provide data to evaluate natural attenuation and other non-evasive remedial actions; and,
- Provide a status report of the nature and extent of identified plumes.

6.2 Groundwater and Drinking Water Monitoring Standards

As noted previously, the groundwater beneath the BNL site is considered by NYS as Class GA groundwater. The best usage of Class GA groundwater is as a source of potable water supply. As such, federal drinking water standards, NYS Drinking Water Standards (NYS DWS), and NYS Ambient Water Quality Standards (NYS AWQS) for Class GA groundwater have been used as groundwater protection and remediation goals for the sole source aquifer underlying BNL. The BNL groundwater surveillance program uses wells (which are not utilized for drinking water supply) to monitor research and support facilities where there is a potential for environmental impact, or in areas where past waste handling practices or accidental spills have already degraded groundwater quality. BNL evaluates the potential impact of radiological and non-radiological levels of contamination by comparing analytical results to NYS and DOE reference levels and background water quality levels. Non-radiological data from groundwater samples collected from surveillance wells are usually compared to NYS Ambient Water Quality Standards (6 NYCRR 703.5). Radiological data are compared to the NYS DWS (for tritium,

strontium-90 and gross beta), NYS AWQS (for gross alpha and radium 226/228), and SDWA/DOE Derived Concentration Guides (DCGs) (for determining the 4 mrem/yr dose for other beta/gamma-emitting radionuclides). Contaminant concentrations that are below these standards are also compared to background values to evaluate the potential effects of facility operations. The detection of low concentrations of facility-specific VOCs or radionuclides may provide important early indications of a contaminant release, and allow for the timely investigation into the identification and remediation of the source.

6.3 Monitoring Potable Water Supplies

For drinking water supplies, the Federal maximum contaminant levels (MCLs) set forth in 40 CFR 141 (primary MCLs) and 40 CFR 143 (secondary MCLs) apply. In addition, DOE Order 5400.5, Radiation Protection of the Public and Environment, establishes DCGs for radionuclides not covered by existing Federal or State regulations.

In NYS, the SDWA requirements pertaining to the distribution and monitoring of public water supplies are applicable to any water supply which has at least five service connections or regularly serves at least 25 individuals. The Laboratory supplies water to a population of approximately 3,500 employees and visitors and must, therefore, comply with these regulations. The SCDHS - Bureau of Drinking Water specifies the annual minimum monitoring requirements for all potable-water suppliers.

BNL prepares an annual Potable Water System Sampling and Analysis Plan that outlines sampling procedures and schedules for monitoring BNL's potable water supply system. Routine monitoring of the potable wells and the potable water distribution system by BNL exceeds the prescribed minimum monitoring requirements. The monitoring program consists of: monthly bacteriological analyses; quarterly analyses for Principal Organic Compounds (POCs); annual analysis for Synthetic Organic Compounds (SOCs) and pesticides; semi-annual inorganic chemicals analyses; and annual analyses of micro-extractables and asbestos. Potable water samples are collected by BNL personnel, and are analyzed by New York State Department of Health (NYSDOH) certified contractor laboratories using standard USEPA methods. BNL prepares monthly Water System Operations Reports which are submitted to the SCDHS - Bureau of Drinking Water. These reports include a summary of all analytical data. In addition to the SCDHS requirements, BNL maintains a supplemental sampling and analysis program for the BNL potable well system that includes more frequent analyses for radionuclides.

6.4 Active Facility (Non-CERCLA) Monitoring

One of the lessons learned from the discovery of the tritium release at the High Flux Beam Reactor was the need for improved monitoring of active facilities that have the potential to impact groundwater quality. The Groundwater Monitoring Improvements Project examined the operations of active research and support facilities, and re-examined historical groundwater data to identify potential contaminant source areas (non-CERCLA) that may have been overlooked or given a low priority due to apparently low levels of contamination. This evaluation was performed concurrently with the 1997 Facility Review Project (Royce, 1997; Royce and Collins, 1997). Known or suspected contaminant source areas that have been or are currently being studied, closed or remediated under the ER Program were not part of the review.

The BNL Groundwater Monitoring Improvements Plan (Paquette, 1998) provides a summary review of: 1) the operational history of each facility requiring improvements in its groundwater monitoring program; 2) identification of potential contaminant source areas (e.g., underground storage tanks and beam stop areas); 3) review of the historical and current groundwater monitoring programs and available groundwater data; 4) recommendations for necessary groundwater monitoring upgrades or improvements at each facility; and, 5) a prioritized schedule for the installation of new wells.

An important premise of the BNL GPMP is that groundwater monitoring is, in itself, not protective of groundwater quality. Rather, groundwater resources can only be adequately protected by the prevention and/or timely remediation of future contaminant releases (see the protection programs presented in

Section 5). However, groundwater monitoring is one means to evaluate the effectiveness of prevention programs. The new wells to be installed as part of the Groundwater Monitoring Improvements Project will be positioned as close as possible to potential source areas within each of the identified facilities. Once in place, the improved groundwater monitoring network will provide BNL with timely information related to potential impacts that facility operations may have on groundwater quality, and on the adequacy of its pollution prevention programs. If unexpected levels of contamination are detected, appropriate investigations into the source of the contamination and/or remedial measures can be taken. BNL is in the process of developing a Groundwater Contingency Plan that will describe the process used by BNL management to respond to the unexpected detection of contaminants in groundwater. BNL is committed to reaching an agreement with the DOE and regulatory agencies for establishing administrative limits and a "point of compliance" for each facility. The point of compliance is a predetermined monitoring location or set of locations where the collection and analysis of groundwater samples or measurements are used to demonstrate compliance with applicable groundwater protection standards (i.e., NYS DWS, NYS AWQS, etc.) or other specified permit requirements.

Assessment of the adequacy of the BNL groundwater monitoring well network is an ongoing process. The need for additional monitoring wells at either new or significantly modified facilities is identified during the BNL Facility Design Review process (see Section 5.5). The currently active BNL research and support areas that require routine surveillance of groundwater quality as required by DOE Order 5400.1 are described below. The wells used to monitor these facilities include new wells installed as part of the Groundwater Monitoring Improvements Project and appropriately located older wells.

6.4.1 Monitoring of Potential Radiological Source Areas

- **AGS Area**: The AGS groundwater monitoring program will consist of monitoring approximately 40 shallow wells. These wells will be used to evaluate the potential effects of activated soils created near AGS beam targets and stops.
- **BLIP Facility**: The BLIP groundwater monitoring program will consist of monitoring six shallow Upper Glacial aquifer wells. These wells will be used to evaluate the impact of activated soils that surround the BLIP target vessel, and to evaluate the effectiveness of recent and proposed remedial measures (e.g., sealing and capping of the area surrounding the BLIP, improved storm water drainage, operational modifications, and possible soil grouting).
- **RHIC Area**: The RHIC groundwater monitoring program will consist of monitoring 12 shallow Upper Glacial aquifer wells installed near the RHIC collimator and beam stop areas. The wells will also be used to evaluate the effectiveness of the landfill-type caps constructed over the collimator and beam stop areas.
- **BMRR Area**: The BMRR groundwater monitoring program will consist of monitoring five shallow Upper Glacial aquifer wells. The wells will be used to verify that new operational and engineering controls are effective in preventing future environmental releases.
- **Building 830**: The Building 830 groundwater monitoring program will consist of monitoring four shallow Upper Glacial aquifer wells. The wells will be used to verify that the operational and engineering controls for the building's cobalt-60 source pool and the decommissioned hot cells and associated transfer canal are effective in preventing future environmental releases.
- **STP Area**: The STP Groundwater Monitoring Program will consist of the monitoring of 18 shallow Upper Glacial aquifer wells located near the STP's filter beds, emergency hold-up ponds, and along the Peconic River (on-site). The wells will be used to verify that operational and engineering controls and effluent monitoring systems are effective in preventing future environmental releases.

- **Waste Management Facility**: The new Waste Management Facility groundwater monitoring program consists of eight shallow to middle Upper Glacial aquifer wells. The wells are used to verify that the facility's engineering and operational controls are effective in preventing environmental releases.

6.4.2 Monitoring of Potential Chemical Source Areas

- **Motor Pool**: The Motor Pool groundwater monitoring program will consist of monitoring eight shallow Upper Glacial aquifer wells to evaluate the potential impact of several historical solvent and oil spills and to verify that engineering and operational controls for USTs containing gasoline products are effective in preventing environmental releases.
- **Gasoline Station**: The Gasoline Station groundwater monitoring program will consist of monitoring five shallow Upper Glacial aquifer wells. The wells will be used to verify that engineering and operational controls for USTs containing gasoline and waste motor oil products are effective in preventing environmental releases.
- **Major Petroleum Facility**: The MPF groundwater monitoring program was established in 1986 as part of the NYSDEC licensing requirements for the facility. The program consists of monitoring eight shallow Upper Glacial aquifer wells designed to detect both free product and dissolved hydrocarbon products.
- **Live Fire Range**: The Live-Fire Range groundwater monitoring program will consist of monitoring two shallow Upper Glacial aquifer wells. The wells will be used to verify that range operations are not impacting groundwater quality.
- **Shotgun Range**: The Shotgun Range groundwater monitoring program will consist of monitoring three shallow Upper Glacial aquifer wells. The wells will be used to verify that lead shot deposited on the surface of the range is not impacting groundwater quality.
- **STP Area**: (see 6.4.1 above).
- **Waste Management Facility**: (see 6.4.1 above).
- **Greenhouse Areas**: The Biology Department Greenhouse Area groundwater monitoring program will consist of monitoring two shallow Upper Glacial aquifer wells. These wells will be used to evaluate the potential impacts to groundwater from historical use of pesticides and metals in the greenhouses.

6.5 Environmental Restoration Groundwater Monitoring Program (CERCLA)

Beginning in 1997, the ER Program established the Sitewide Groundwater Monitoring Program to integrate and manage all groundwater sampling, analytical, and database activities required for the various CERCLA long-term groundwater surveillance programs (i.e., post-RI/FS or post-closure). This program includes:

- **Background Monitoring**: Provides information on background groundwater quality for the BNL site. Background quality is defined as the quality of groundwater that is completely unaffected by BNL operations. Analytical parameters for groundwater samples also include the contaminants of concern that have been identified through the groundwater characterization work performed as part of the various remedial investigations and removal actions at BNL;
- **Pre-Record of Decision Monitoring**: Addresses the short-term monitoring of plumes to track their movement following the Remedial Investigation characterization and prior to remedial action;
- **Post-Record of Decision Monitoring:** Addresses the long-term monitoring of plumes to track their movement following the initiation of remediation systems, including:

1. Source Removal Effectiveness: Includes monitoring of wells installed to verify that remediation projects such as the capping of previously used landfills are performing to design specifications; and,

2. Treatment System/Hydraulic Containment Effectiveness: Includes monitoring the performance of active pump-and-treat systems to verify that they are capturing and removing contaminants as designed; and,

- **Outpost Monitoring**: Consists of wells located downgradient of the leading edge of contaminant plumes. Sampling of these wells provides for early warning of the arrival of the leading edge of the plume.

6.5.1 Background Monitoring

The site background monitoring program provides groundwater quality data from a network of 13 wells located in the northern portion of the site (and off-site to the north), upgradient from the developed areas of BNL (central portion of the BNL site). These wells are also situated downgradient of potential contaminant sources to the north of BNL.

6.5.2 Operable Unit I/Removal Action V

The OU I/Removal Action V Monitoring Program is comprised of 50 monitoring wells that are monitored on a quarterly basis. The wells are located downgradient of the Current Landfill, and within and downgradient of the former Hazardous Waste Management Facility. (Post-closure compliance monitoring for the Current Landfill is described in Section 6.5.7, below.) The OU I/RA V monitoring program was initiated in January 1997 following the start-up of the RA V South Boundary Extraction Wells (EW-1 and EW-2), which are designed to remediate the VOC plumes originating from the Current Landfill and Hazardous Waste Management Facility. Data from the associated monitoring program are used to evaluate the effects of this pumping on the contaminant plumes, and provide the data necessary for making decisions on the future operation of the extraction wells. The monitoring program is described in the RA V Process System Operation and Maintenance Manual (BNL, 1997a).

6.5.3 Remedial Unit III

The OU III Remedial Action Monitoring Program is comprised of 90 monitoring wells located from the north-central portion of the site to the southern site boundary and off-site. This program was initiated in June 1997 following the start-up of the OU III southern boundary groundwater remediation system. The monitoring wells are sampled on a quarterly basis.

The monitoring program is specifically designed to address the following groundwater contamination and plume issues:

- Volatile organic compound (VOC) plumes with sources in the AGS, Supply and Materiel (specifically Building 208) and former Building 96 areas.

- Strontium-90 impacts from the WCF, Pile Fan Sump, Brookhaven Graphite Research Reactor (BGRR), and Former Landfill/Chemical Holes areas.

- The southern boundary groundwater remediation system uses six groundwater extraction wells (EW-3 through EW-8). The monitoring program will characterize the effects of this pumping on the contaminant plume and provide data necessary for decisions on the current and future operations of the extraction wells.

- Outpost wells are located to the south (downgradient) end of the defined extent of the offsite OU III VOC plumes. These outpost wells will be monitored to provide data on the future downgradient migration of the plume. Outpost wells are also situated in the southeastern

portion of BNL directly upgradient of the SCWA Parr Village Well Field on William Floyd Parkway. These wells would provide early warning of contaminant migration towards the well field.

6.5.4 Operable Unit IV (AOC 5)

The OU IV AOC 5 Remedial Action Monitoring Program consists of 18 monitoring wells located in the vicinity of the 1977 Oil/Solvent Spill Area. Contaminants of concern in this area include TCA, TCE, PCE, toluene, ethylbenzene, xylenes, and semi-VOCs. The monitoring program is discussed in detail in the *Operable Unit IV Air Sparge/Soil Vapor Extraction System Operations, Maintenance, and Monitoring Plan* (BNL, 1997c).

6.5.5 Operable Unit IV (AOC 6) Pre-ROD Monitoring

The OU IV AOC 6 Remedial Action Monitoring Program consists of monitoring wells located in the vicinity of the Building 650 Reclamation Facility and the Sump Outfall Area. Strontium-90 and gross beta activity are the primary contaminants of concern in this area. The monitoring plan is discussed in detail in the *Operable Unit IV - Area of Concern 6 Interim Remedy Monitoring Plan* (BNL, 1998c).

6.5.6 Former Landfill

The Former Landfill Post-Closure Monitoring Program is outlined in the *Former Landfill Operations and Maintenance Manual* (CDM Federal, 1996b). The monitoring well network for the Former Landfill was designed in accordance with post-closure operation and maintenance requirements specified in 6 NYCRR Part 360, Solid Waste Management Facilities, dated December 31, 1988. The requirements specify that the well network be monitored on a quarterly basis for a minimum period of five years, upon which BNL may petition the New York State Department of Environmental Conservation (NYSDEC) to modify the frequency of such requirements based on supporting data.

6.5.7 Current Landfill

The Current Landfill Post-Closure Monitoring Program is outlined in the *Current Landfill Operations and Maintenance Manual* (CDM Federal, 1996a). A network of 11 monitoring wells is situated adjacent to the landfill in both upgradient and downgradient locations and is monitored on a quarterly basis. The monitoring well network for the Current Landfill was designed in accordance with post-closure O&M requirements specified in 6 NYCRR Part 360, Solid Waste Management Facilities, dated December 31, 1988. The requirements specify that the well network be monitored on a quarterly basis for a minimum period of five years, upon which BNL may petition the NYSDEC to modify the frequency of such requirements based on supporting data.

6.5.8 Operable Unit I/IV Pre-ROD Monitoring

The OU I/IV Groundwater Monitoring Program consists of 28 monitoring wells located in an area downgradient of OU IV source areas southward to the site boundary and off-site. This program was initiated during 1997 and will provide groundwater quality data from key wells until the completion of the OU III FS under which plumes monitored by this program will ultimately be addressed. Contaminants of concern for the OU I/IV plume include TCA, DCA, CT, PCE, TCE, and several radionuclides.

6.5.9 Operable Unit III HFBR Tritium Plume (AOC 29) Pre-ROD Monitoring

The HFBR Tritium Plume Monitoring Program was initiated in June 1997, and is outlined in the ER *Sitewide Groundwater Monitoring Program Sampling and Analysis Plan* (BNL, 1998d). A total of 88 wells extending from the HFBR to the site boundary are monitored on a quarterly basis.

6.5.10 Operable Unit V Pre-ROD Monitoring

The OU V Pre-ROD Monitoring Program incorporates a total of 34 monitoring wells located in the vicinity of and downgradient of the STP. Contaminants of concern for OU V include TCA, TCE, metals, and tritium. This monitoring program is designed to monitor VOC and tritium contamination resulting from historical releases at the STP that are moving downgradient of the STP and off-site. The monitoring program is discussed in the ER *Sitewide Groundwater Monitoring Sampling and Analysis Plan* (BNL, 1998d).

6.5.11 Operable Unit VI Pre-ROD Monitoring

The primary contaminant of concern for the OU VI plume is ethylene dibromide (EDB). The OU VI Pre-ROD groundwater monitoring program consists of 16 monitoring wells primarily located downgradient of the Biology Fields in the southeastern corner of BNL, south to the site boundary, and off-site. This program was initiated in June 1997 and will continue as outlined in the Operable Unit VI ROD. The wells are monitored on a semi-annual basis.

6.6 Liquid Effluent Monitoring Program

Liquid effluent monitoring is performed for radiological and non-radiological effluent streams. Because potential chemical and radioactive liquid waste discharged to the sanitary system and recharge basins can quickly degrade surface water and groundwater (Upper Glacial aquifer) quality, BNL's effluent monitoring and control system is a key element in the overall Groundwater Protection Program. These effluents are monitored to determine compliance with applicable DOE Orders, regulatory and permit requirements, and to evaluate the effectiveness of effluent treatment and control systems.

- **Sewage Treatment Plant**: The STP discharge to the Peconic River is governed by a NYSDEC State Pollution Discharge Elimination System (SPDES) permit. BNL's STP treated effluent is discharged to the Peconic River at SPDES permitted outfall number 001. In accordance with the BNL SPDES permit, twenty-seven (27) parameters are reported in the monthly Discharge Monitoring Report (DMR) which is submitted to both the NYSDEC and the SCDHS. Seventeen parameters including nitrogen, metals, organic, biological oxygen demand (BOD5), total suspended solids, fecal coliform, and cyanide are analyzed by NYSDOH-certified contractor laboratories. The remaining parameters (flow, settleable solids, residual chlorine, and pH) are recorded and analyzed by the STP operators (see Schroeder *et al.*, 1998).

- **Recharge Basins**: The Laboratory maintains seven recharge basins for the discharge of process-cooling waters, storm-water runoff, and, in the case of recharge basin HX (Outfall 007), water-filter backwash from the WTP. Cooling water is discharged to basins HN (Outfall 002), HO (Outfall 003), HP (Outfall 004), HS (Outfall 005), and HT (Outfalls 006A and 006B); storm water is discharged to basins HN, HO, HS, HT, HW (Outfall 0008) and the CSF (Outfall 010). The SPDES permit requires that BNL monitor these discharges monthly for flow, pH, and oil and grease, and quarterly for certain metals and VOCs (see Schroeder *et al.*, 1998).

6.7 Monitoring Well Installation, Maintenance and Abandonment

- **Monitoring Well Installation**: The determination of the effects of BNL operations on groundwater quality can only be accomplished through the proper installation and management of an established monitoring well network. Monitoring well installations at BNL are coordinated by ER and EM project hydrogeologists. Procedures for the installation of most monitoring wells are described in the *BNL Technical Guide for the Installation of Monitoring Wells and Piezometers* (Paquette and Dorsch, 1996a). Procedures for the installation of temporary wells (e.g., Geoprobe and vertical profile wells) are described in ER Program work plans such as the OU III RI/FS Sampling and Analysis Plan (ITC/G&M, 1994). These procedures are consistent with the well installation guidelines required by the USEPA and the NYSDEC for both CERCLA and RCRA groundwater investigations. All wells are installed by NYS licensed

well drilling contractors, and well installation procedures are overseen by professional geologists/hydrogeologists.

- **Well Maintenance**: Proper well maintenance is essential to optimize the functioning of the wells, and to ensure the collection of representative groundwater samples and accurate groundwater elevation data. During groundwater sampling and water level activities, the condition of each monitoring well is examined. Problems such as broken or non-operating locks, damaged or missing well identification tags, damaged protective casings or well casings, and inoperable sample pumps are documented in field notes and reported to the project manager/hydrogeologist. Typically, most repairs are minor, and are performed by BNL sampling personnel. Repairs to protective casing or well casings are usually performed by NYS licensed well drilling contractors.

- **Well Abandonment**: Monitoring wells that are either damaged beyond repair or determined to be of no future use for the collection of groundwater samples or water level data are properly abandoned. Abandonment procedures are outlined in the *BNL Technical Guide for the Abandonment of Inactive Supply Wells, Injection Wells, and Monitoring Wells* (Paquette and Dorsch, 1996b). Plans for all well abandonments are coordinated and approved by both the ER and EM Project hydrogeologists. Documentation for well abandonments is maintained in the ER Program's Environmental Information Management System (EIMS). BNL will develop plans to abandon monitoring wells that are no longer needed using the DQO process.

6.8 Sample Collection, Analysis and Data Management

The following text describes programs in place prior to implementation of the Groundwater Monitoring Integration Initiative. See Section 8.0 for details on changes that will result from this initiative.

- **Sample Collection**: The methods used in the collection of groundwater samples, surface water samples, and hydrogeologic measurements (i.e., geological data and water level measurements) for the EM Program are described in the Environmental Monitoring Standard Operating Procedures and in project-specific work plans. Samples and measurements collected for the ER Program are described in specific OU RI/FS Sampling and Analysis Plans and the annual *ERD Sitewide Groundwater Monitoring Program, Sampling and Analysis Plan* (see BNL, 1998d). Samples and measurements collected for the EM Program are listed in the *Environmental Monitoring Plan* (Naidu *et al.*, 1997). At the time of collection in the field, sample procedures, observations and other pertinent information are documented in bound field logbooks and standardized forms. All sample identification numbers are documented on standardized BNL Chain-of-Custody forms.

- **Sample Analysis**: The specific analytical methods used for the BNL ER and EM Programs are listed in the annual *Environmental Monitoring Plan* (Naidu *et al.*, 1997), the *ERD Sitewide Groundwater Monitoring Program, Sampling and Analysis Plan* (BNL, 1998d), and other project-specific sampling and analysis plans. EPA approved methods are used for performing analyses. For the ER Program, most analyses are performed by NYSDOH certified contractor laboratories. For the EM Program, the BNL Analytical Services Laboratory (ASL) performs most analyses. The ASL is certified by the NYSDOH for each of the analyses performed. However, samples collected for compliance with SPDES or other regulatory permits are usually analyzed by NYSDOH certified contractor laboratories.

- **Data Quality Assurance**

  ER Program: As noted above, the offsite contractor laboratories that perform the radiological and chemical analyses for the ER Program are certified by the NYSDOH and participate in the Environmental Laboratory Approval Program (ELAP). The contractor laboratories are required to perform all analytical work in accordance with the *ERD Statement of Work for Hazardous*

Chemical and Radiochemical Analytical Services (BNL, 1998f). In addition, contractor laboratories are audited periodically to verify competence in analytical methodology and implementation of a comprehensive QA program. Field quality control samples are collected. At least five percent of the total number of samples collected are duplicated to evaluate the precision of the methods used. Matrix spike/matrix spike duplicates for organic analyses are also performed. *The ERD Calendar Year 1998 Sitewide Groundwater Monitoring Program Quality Assurance Project Plan* (BNL, 1998e) describes the QA program and the QC requirements followed during the sitewide groundwater sampling program. Project organizational structure, documentation requirements, sample custody requirements, acceptance criteria, audit and corrective action provisions, and guidance on the collection of QA/QC samples are also described in this document.

EM Program: Quality assurance procedures for the EM Program are described in detail by Schroeder et al. (1998). The BNL ASL participates in the DOE Environmental Measurements Laboratory (EML) QA Program and the EPA National Exposure Research Laboratory Performance Evaluation Study. All contractor labs used for groundwater analyses are NYSDOH certified. The BNL ASL and contractor labs have established standard operating procedures to calibrate instruments, analyze samples, and check quality control. Depending upon the analytical method, quality control checks include the analysis of blanks or background concentrations, use of Amersham or National Institute for Standards and Technology (NIST) traceable standards, and analysis of reference standards, spiked samples, and duplicate samples. All analytical results are validated by BNL ASL supervisors, by assuring data completeness and accuracy.

- **Management of Environmental Data**: Environmental data are being acquired routinely during ongoing ER and EM Programs. These programs currently maintain individual electronic and hard copy data management systems. BNL's ER Program maintains an Environmental Management Information System consisting of an environmental data management system platform linked with a geographic information system (GIS).

- **Data Interpretation and Reporting**: Results of the BNL EM and ER programs are routinely analyzed and assessed by project managers and/or hydrogeologists. Facility monitoring results are compared to existing baseline and background data and applicable regulatory standards (e.g., NYS DWS, NYS AWQS, and DCGs). Results are reported to the regulatory agencies and general public in a number quarterly, semiannual and annual reports required by DOE Orders, NYS permit requirements, Suffolk County requirements, and CERCLA. Groundwater data are summarized in the annual Site Environmental Report. The discovery of contaminants in groundwater near an active facility requires proper response and notification. As noted previously, BNL is in the process of developing a "Groundwater Continqency Plan" that will describe the process used by BNL management to respond to the unexpected detection of contaminants in groundwater.

7. RESTORATION

BNL's Environmental Restoration Program focuses on remediation of soil and groundwater contamination and preventing additional contamination from migrating off the BNL site. To date, a number of source control measures have been implemented and groundwater remediation systems have been placed into operation or are being designed. The performance objectives for groundwater restoration are: 1) minimize contaminant plume growth; 2) meet drinking water standards in groundwater for all volatile organic compounds, strontium-90 and tritium; and 3) complete cleanup of the groundwater in Upper Glacial aquifer in thirty years or less, and the Magothy aquifer within sixty years. The remedial actions conducted to date are discussed below.

7.1 CERCLA Groundwater Treatment Systems

Four groundwater treatment systems are currently operating at BNL, and a fifth system will be operational in 1999. Figure 12 shows the locations of the four currently operating systems. A brief description of the groundwater treatment systems that were operational during 1997 is presented below.

- **South Boundary Remediation System for OU III:** Construction of the OU III pump-and-treat system was completed in June 1997. The system uses six wells to extract VOC contaminated groundwater that originated from a number of sources located in the developed central portion of the BNL site. The water is pumped approximately one mile north to an air-stripping tower located near the BNL Medical Department complex. The contaminated water is treated by use of an air stripper tower, where air from a powerful blower is used to separate the VOCs from the water. The VOC removal efficiency is close to 100 percent. The clean water is discharged to a nearby recharge basin, and the VOCs stripped from the water are released into the air at concentrations below State and Federal emissions standards. The system processes approximately 2,300 liters (600 gal.) of water per minute.

- **South Boundary Remediation System for OU I (Removal Action V):** This pump-and-treat system was completed in December 1996. The system uses two extraction wells to remove contaminated groundwater that originated from the Current Landfill (now closed and capped) and the former HWMF. The water is pumped approximately one mile north to an air stripper system. This system processes more than 2,600 liters (700 gal.) of water per minute. Like the OU III treatment system, the RA V system removes close to 100 percent of the chemical contamination through an air stripping treatment system. The clean water is discharged to a nearby recharge basin, and the VOCs stripped from the water are released into the air at concentrations below State and Federal emissions standards.

- **HFBR Tritium Plume Remediation System (OU III):** This groundwater pump and recharge system was constructed as an interim remedial action in response to the discovery of the HFBR tritium plume, and has been in operation since May 1997. Three groundwater extraction wells were installed approximately 1,100 m (3,500 ft) south of the HFBR. The tritiated groundwater (generally <2,000 pCi/L) is pumped from the aquifer at a rate of about 450 lpm (120 gpm) and piped north to a treatment facility located adjacent to the RA V treatment system. Because the tritiated water also contains (commingled) VOCs that originated from another source(s), the water is treated by passing it through a granular carbon filter to remove the VOCs before the water is discharged to the RA V recharge basin. This interim remediation system is designed to prevent the further southward migration of the HFBR tritium plume while long-term remediation options are evaluated as part of the OU III FS.

- **Air Sparging/Soil Vapor Extraction System for OU IV:** This remediation system, which has been in operation since November 1997, combines two technologies to remove VOC and semi-volatile contaminants from soil and groundwater located near the BNL Central Steam Facility. The system uses air sparging and soil vapor extraction which forces pressurized air into the groundwater to "bubble" or strip these volatile compounds out of the water and soil and into a vapor phase. Powerful vacuum pumps then recover the resulting vapors and pipe them to a nearby treatment facility where the VOC vapors are removed by a granular carbon filter system before the air is released into the atmosphere.

- **Off-site Groundwater Treatment System for OU III:** A fifth groundwater remediation system is expected to be operational in 1999. The system will be constructed south of the BNL site to remove VOC contamination that has migrated to an industrial area located between the Long Island Expressway and the residential areas of North Shirley. This remediation system

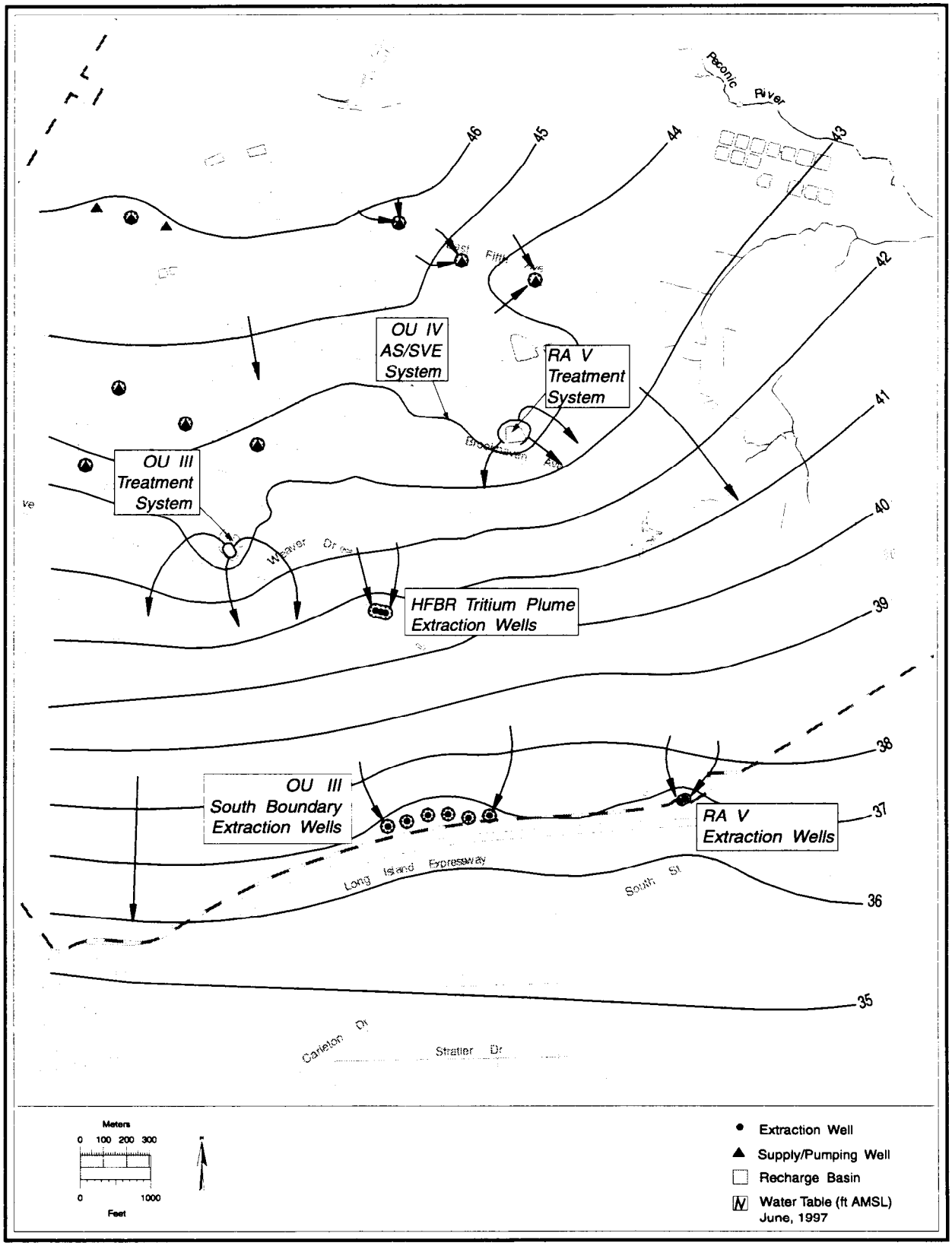

Figure 12: Location Map of BNL Groundwater Remediation Systems

will consist of a series of innovative "in-well sparging" wells. Although in-well sparging systems use the same air stripping treatment concept as the OU III south boundary systems, all treatment and recharge occurs within the same well.

7.2 Landfill Capping

The ER Program's Removal Action VI consisted of the capping of three landfills, and the excavation of 55 chemical/glass/animal disposal pits.

- **Landfills:** In 1995, the Current Landfill was capped using an impermeable geomembrane cover designed to prevent precipitation from entering the landfill, and leaching contaminants into the groundwater. In 1996 and 1997, the Former Landfill and nearby Interim Landfill were covered by similar geomembrane caps. To ensure that the landfill caps remain effective, longterm maintenance and monitoring programs have been established.

- **Chemical/Animal Pits and Glass Holes:** During the summer of 1997, BNL conducted the bulk excavation and removal of the contents of approximately 55 shallow (as deep as 10 m [32 ft] below land surface) disposal pits located adjacent to the Former Landfill and Interim Landfill. During the excavation process, waste materials were separated from surrounding soils. Some of the surrounding soils were found to be contaminated with hazardous and/or radioactive materials. The waste materials removed from these pits were sorted and characterized, and then processed according to State and Federal guidelines. All wastes and contaminated soils will be disposed of at approved off-site disposal facilities.

7.3 Cesspool and Septic Tank Removals

The ER Program's Removal Action III consisted of the removal of 33 cesspools and septic tanks located adjacent to 24 buildings and trailers located throughout the BNL site. These cesspools and septic tanks received industrial waste, which in some cases may have contained radioactive substances. These remedial activities were completed in 1995 and 1996, and are documented in the Removal Action III Close-Out Report (BNL, 1996a).

7.4 Storage Tank Removals

- **Removal Action I:** Three 380,000 liter (100,000 gal.) capacity above ground liquid radioactive waste storage tanks located at the WCF were dismantled and removed in 1994/1995. Wastes generated from these tanks were shipped off-site. The concrete foundations of the tanks were sealed. The contaminated concrete foundations and surrounding soils will be remediated according to the selected remedy in the Operable Unit I Record of Decision.

- **Removal Action II:** Thirteen underground storage tanks that contained or had contained liquid radioactive waste were excavated, emptied, and removed. Six additional USTs at the WCF that contain radioactive sludges will be removed in 1999/2000.

8. GROUNDWATER PROTECTION PROGRAM INTEGRATION INITIATIVE

The groundwater protection and restoration programs currently maintain separate procedures and databases. Because the ER Program has changed from one of characterization to long-term monitoring, incorporating all groundwater sampling and analysis activities into one program would be beneficial in both planning and implementation of the groundwater-monitoring program. Laboratory-wide integration of groundwater data management activities and services will also improve the efficiency and cost effectiveness of the groundwater program.

The objectives of groundwater protection program integration initiative are to:

- Manage, protect and restore the groundwater resource in a coordinated fashion;

- Ensure consistency and coordination on procedures, planning, projects, and systems. This will enable cost-effective, valid application of data for analysis and modeling of the entire groundwater flow system and contaminant transport; and,
- Accomplish timely reporting and interpretation of high quality groundwater data.

Integration of the BNL groundwater protection elements will occur over a period of time. The schedule and project plan for this initiative will be included in the Groundwater Protection Implementation and Integration Plan (GPIIP). (Note: The GPIIP will also address implementation of the other elements of the groundwater program described in this Groundwater Protection Management Program Description, including organizational roles and responsibilities.) The concepts of the initiative are shown in a service model form in Figure 13.

A central activity to the integration initiative will be to integrate the two databases currently in use: the ESD database and the ERD Environmental Information Management System (EIMS). Both systems are Oracle-based. The ESD system currently contains data from environmental surveillance monitoring programs conducted pursuant to DOE Order 5400.1 and other environmental regulatory requirements (e.g., permit required reporting). The EIMS contains sub-surface monitoring data (including groundwater, surface water, soil, air, and remediation system performance data, wells construction and geologic data) to support the CERCLA program. EIMS support includes visualization, modeling, and graphics functions. Development of the sitewide data management system will involve at least four phases, as depicted in Figure 14. Phased integration of the database and other aspects of the program (i.e., sampling and analysis) are necessary to ensure program continuity and milestone delivery. These four phases, as currently conceptualized, include:

I. Pilot Phase: Integrate the 1998 and newly generated groundwater data into one database, using the ERD EIMS as the integration platform. These data will be accessible to all groundwater staff for evaluation and reporting purposes. During this phase the ESD database will be operated in parallel;

II. Integrate data from the other environmental media monitoring programs (e.g., air, surface water, etc.) into the sitewide database. As soon as the sitewide database is fully operational, the ESD database will be "frozen" in time, functioning as a historical database;

III. Evaluate organizational changes that may be needed to support the integrated program. The historical data from the ESD Division database will be imported into the sitewide database as needed, over time; and

IV. The groundwater monitoring program is fully integrated. Staff, equipment, and procedures are combined based on decisions made in Phase 3, supporting all divisions and departments across the lab.

Concurrent with the database integration activities, BNL plans to:

1. Establish and implement a sitewide Quality Assurance Project Plan (QAPP);
2. Establish consistent, sitewide procedures for sampling (e.g., sampling methodology, purge water disposition, etc.) and data handling (e.g., recording field measurements and logbooks);
3. Establish Data Quality Objectives (DQOs) (see USEPA, 1994) to ensure that the rationale for the monitoring programs is well understood and defined (future well installation, parameters sampled, and monitoring frequency), and that the programs for collecting the data are designed to meet the requirements and optimize the groundwater monitoring network;
4. Establish well installation, maintenance and abandonment procedures, plans and schedules;
5. Establish uniformity in vendor laboratory services (procurement, contracting, and electronic data delivery);

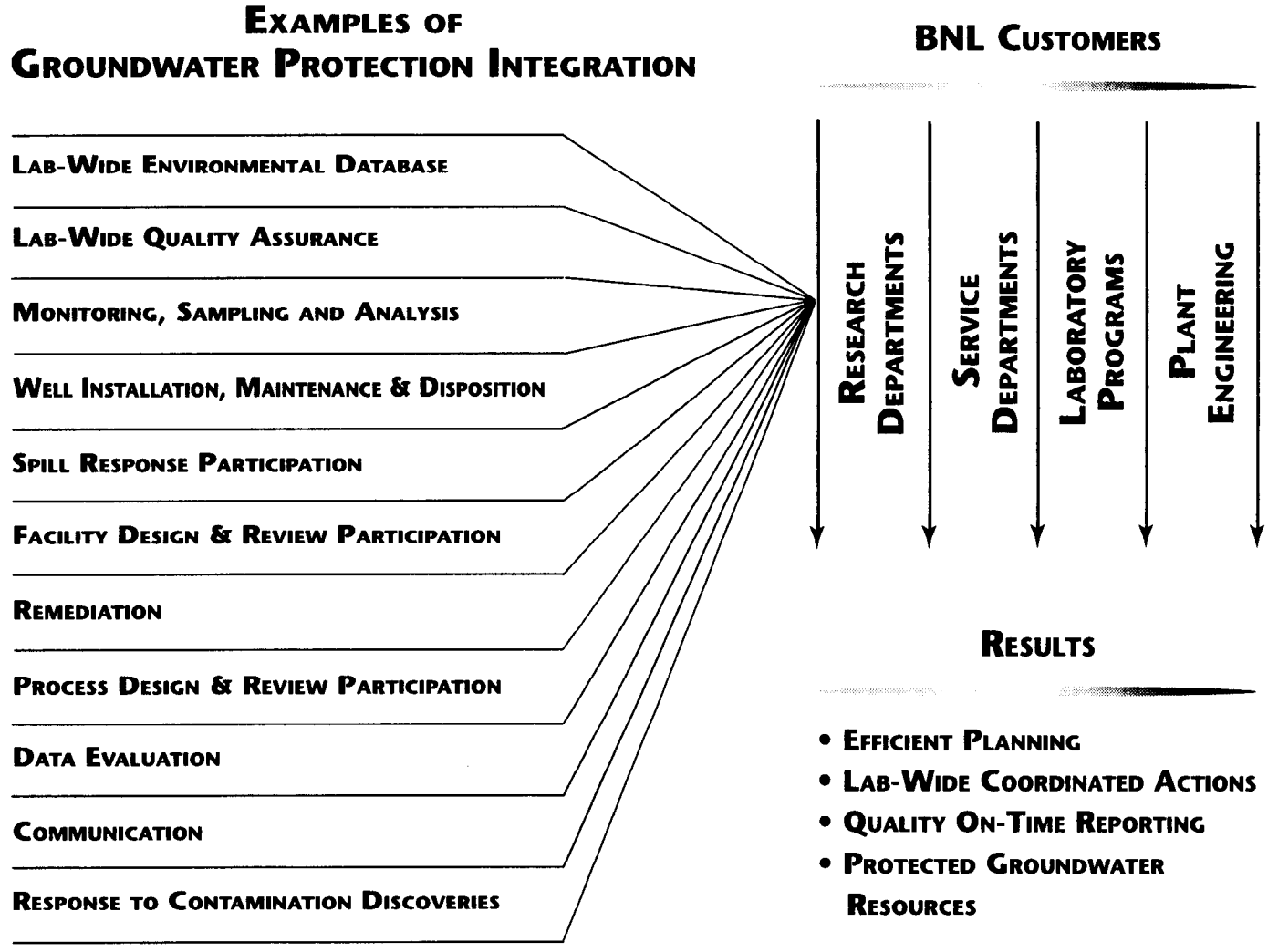

Figure 13: BNL Groundwater Protection Service Model Concept

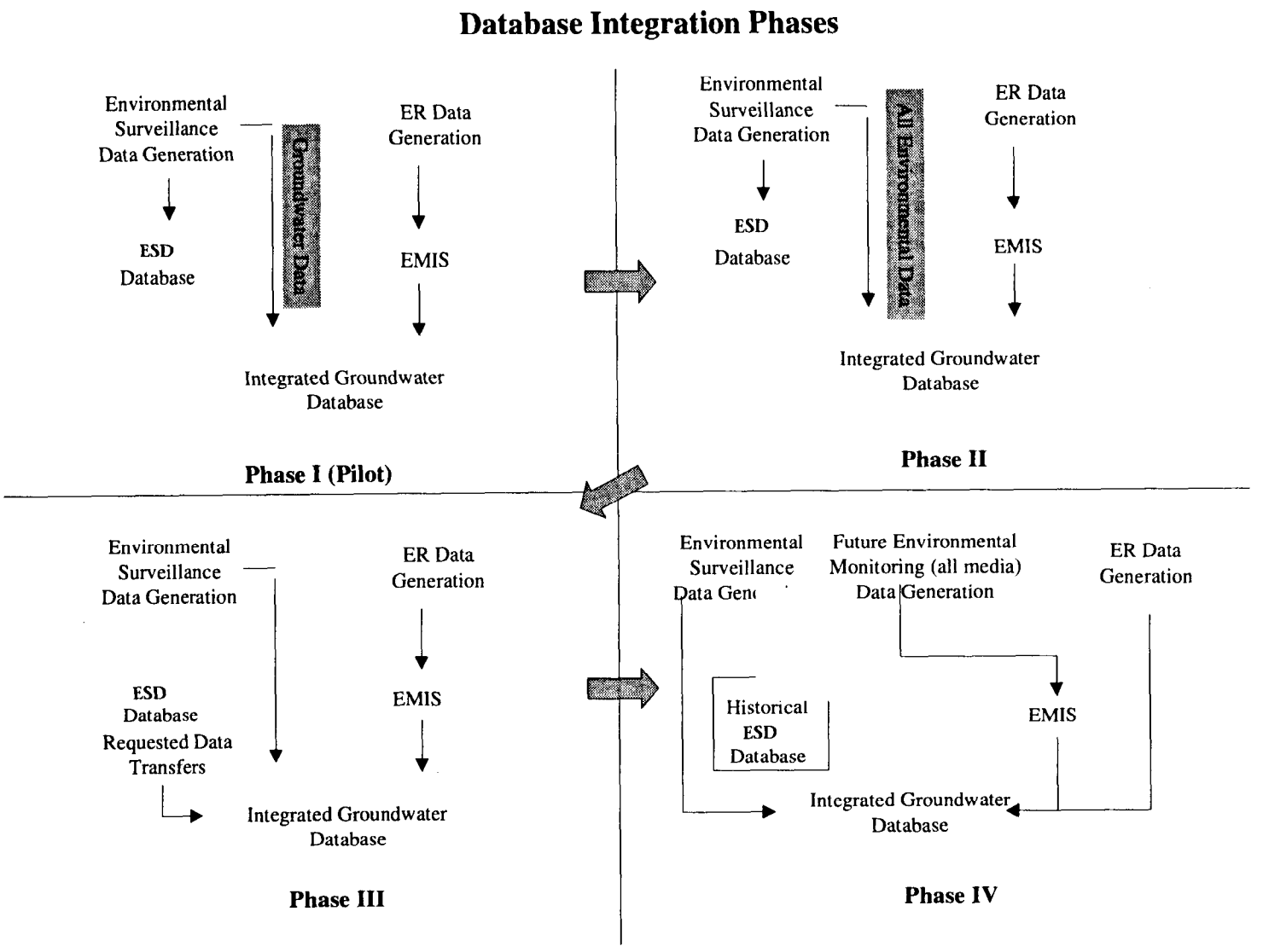

Figure 14: Database Integration

6. Formalize a peer review process for environmental reports; and,

7. Integrate non-CERCLA groundwater programs into ongoing and planned community relations activities, as appropriate.

Figure 15 depicts the general concepts of the integrated groundwater protection program. Across the top of the figure are examples of internal agreements, external regulations/agreements, and internal infrastructure needs involving or requiring groundwater support. Below those, are the organizational units and programs within BNL that need groundwater services support. Those programs, departments or divisions will request basic services supplied by the Integrated Groundwater Program. These services are shown inside the double-headed arrows. The bottom part of Figure 15 shows the resources that will be integrated into the groundwater program. They include data management systems, people and equipment, and other EMS program elements such as procedures, a quality assurance program, etc.

9. COMMUNICATION

In March 1998, the BNL Community Involvement Program was combined with Public Affairs Office creating the Community Involvement, Government and Public Affairs (CI/G/PA) Division. The integration of these two programs has improved BNL's ability to communicate with the community in a consistent, timely and accurate manner. In addition, as one of BSA's contractual performance measures with the Department of Energy for Fiscal Year 1998, BNL developed a Community Involvement Policy. This policy was developed with community input and accepted by both the DOE and the Laboratory's stakeholders (see attached policy as Appendix D).

The CERCLA process has driven the majority of communication and community involvement activities related to environmental restoration and protection. The CI/G/PA Program coordinates these communication activities for the ER Program. Each remediation project under the ER Program has a community relations plan that identifies scheduled activities for community involvement and input.

At present, most non-CERCLA groundwater issues are not managed in the context of a community relations plan. As part of the Groundwater Integration Initiative, non-CERCLA groundwater issues will be integrated into ongoing and planned community relations activities when appropriate. If warranted, separate community involvement activities will be planned and implemented, in consultation with CI/G/PA. In cases where a site-specifiec community relations plans exists (e.g., RHIC and BGRR), groundwater protection issues will be addressed as a key element.

It is important to keep the community and regulators informed about groundwater quality near BNL facilities. In response to this need, BNL plans to improve the timeliness and access of groundwater monitoring program results. It is also important to ensure that BNL line managers are aware of the impacts, if any, that their facilities are having on groundwater quality, and enable them to initiate appropriate corrective actions in a timely manner.

9.1 Internal and External Communication Avenues

The CI/G/PA Program uses the following avenues for communicating with stakeholders:

- Brookhaven Bulletin: a publication that is primarily internal, but is also mailed to BNL retirees and key stakeholders;
- Labwide E-mails: a mechanism used to inform and educate employees;
- Cleanupdate: a quarterly newsletter sent to the ER Program's Community Mailing List; it provides updates and information on environmental remediation topics;
- Press Releases/Announcements: a mechanism to inform the media about BNL accomplishments and activities;
- Periodic mailings to stakeholders: a mailing list of over two thousand names and addresses of

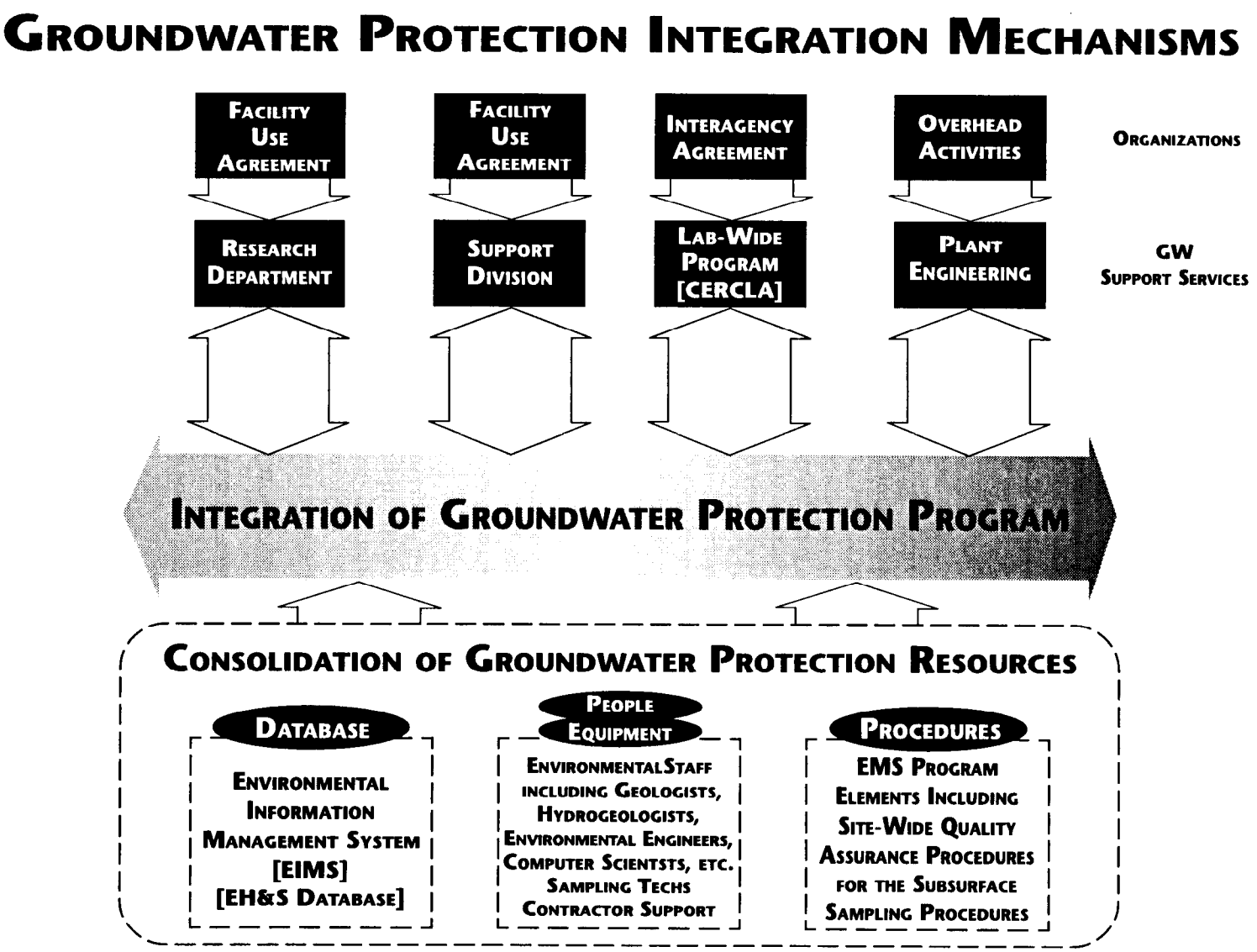

Figure 15: General Concepts of the BNL Integrated Groundwater Protection Program

interested individuals and key stakeholders who want to be informed of BNL activities relating to the environment;

- BNL Webpage: information source available to users of the Internet. Each division maintains its own webpage and is linked to the main Lab-wide homepage, which also provides general information about BNL.
- Civic Briefings: BNL's Community Involvement staff briefs thirteen local civic groups on a regular basis. Messages are prepared based on recent research and environmental activities at the Laboratory.
- Elected Official Briefings: periodic updates are provided to elected officials on issues of interest to their constituencies.
- Open Houses and Summer Sunday Tours: offered to the public since 1967, open houses and tours have brought over four hundred thousand visitors to the BNL site.
- Administrative Record: a complete history of Superfund activities at BNL can be found in this official collection of documents available in three local libraries (Shirley, Longwood and BNL Research Library). In addition, a complete set of BNL's Site Environmental Reports can be found in these libraries.
- Brookhaven Executive Roundtable: this ad hoc group, composed of regulators, Federal, State and local elected officials, representatives and key stakeholders, works with the Department of Energy to ensure open and timely communication on DOE and BNL issues.
- BNL Community Advisory Council: a newly formed group comprised of key stakeholders, which will provide input regarding Laboratory decisions that may affect the community and the general public.

9.2 Community Involvement Activities

9.2.1 Planned and Ongoing CERCLA-related Community Relations Activities

Groundwater protection issues will be addressed by the community relations plan for each remediation project. The integration of the restoration process and overall groundwater protection management will be a key element in each community relations plan. All communication will reflect BNL's commitment to groundwater protection.

9.2.2 Internal Groundwater Coordination Committee

BNL will evaluate the need to establish an internal Groundwater Coordination Committee. The committee could serve to facilitate regular communications on groundwater protection initiatives among research and support programs that include activities affecting groundwater quality and quantity, and improve integration of the four major aspects of the groundwater protection program (i.e., prevention, monitoring, restoration and communication). The committee would be composed of, but not limited to, groundwater project managers and scientists, water supply personnel, representatives from departments/facilities having the potential to impact groundwater beneath the site, and personnel from DOE-BHG.

9.2.3 External Groundwater Advisory Committee

BNL will evaluate the need to re-establish the Groundwater Advisory Committee (GAC) or a similar communication mechanism. The GAC was first established in 1991 to review and provide guidance on BNL's effort to characterize the hydrology and geology of the BNL site. The original GAC consisted of individuals from BNL, DOE, USGS, USEPA, NYSDEC, and the SCDHS. The new committee could be used to facilitate regular communications on future groundwater protection activities, and could include groundwater professionals from academia such as faculty from the State University of New

York at Stony Brook's Long Island Groundwater Research Institute and interested community members, as well as representatives from the original participating agencies.

9.2.4 Communications with Regulatory Agencies

Direct communication with regulatory agencies regarding technical issues is the responsibility of DOE/BNL management and technical staff. CI/G/PA provides support services to management and technical staff to ensure effective communication with regulatory agencies. These support services include presentation skill training, critiques of presentations, coordinating dry-runs, aid in developing presentation materials and handouts, and post-presentation feedback.

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Appendix B

Brookhaven National Laboratory
Environmental Stewardship Policy

These environmental commitments provide the framework within which BNL employees, contractors, guests, and visitors will conduct their job-related activities.

Policy: It is Brookhaven National Laboratory's (BNL) policy to integrate environmental stewardship into all facets of the Laboratory's missions. We will manage our programs in a manner that protects the ecosystem and public health.

In support of this policy, BNL makes the following commitments:

- We are committed to achieving compliance with applicable environmental requirements.
- In consideration of the potential impacts of our activities on the environment, we will integrate pollution prevention/waste minimization, resource conservation, and compliance into all of our planning and decision-making. We will adopt cost-effective practices that eliminate, minimize or mitigate environmental impacts.
- We will define, prioritize, and aggressively correct and clean up existing environmental problems.
- We will work to continually improve our environmental management system and performance. We will establish appropriate environmental objectives and performance indicators to guide these efforts and measure our progress.
- We will maintain a positive, proactive, and constructive relationship with our neighbors in the community, regulators, DOE, and our other stakeholders. We will openly communicate with stakeholders on our progress and performance.

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

John H. Marburger

John H. Marburger, Laboratory Director

11/19/98

Date

Appendix C.1
BNL Groundwater Protection Management Program
Major Federal Regulations Related to Groundwater Protection

Regulation	Codification	Description
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	40 CFR 300, 302, 355, 370	CERCLA provides the regulatory framework for the remediation of releases of hazardous substances and cleanup of inactive hazardous substance disposal sites.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	40 CFR 162-171	FIFRA governs the manufacture and use of biocides, specifically the use, storage, and disposal of all pesticides and pesticide containers and residues.
Federal Water Pollution Control Act or Clean Water Act (CWA)	40 CFR 109-140, 230, 231, 401, 403	CWA regulates the quality of wastewater discharged to waters of the United States.
National Environmental Policy Act (NEPA)	10 CFR 1021, 40 CFR 1500-1508	NEPA establishes a broad national policy to conduct federal activities in ways that promote the general welfare and are in harmony with the environment. NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.
Resource Conservation and Recovery Act (RCRA)	40 CFR 260-280	RCRA governs the generation, storage, handling, treatment, and disposal of hazardous waste. Underground storage tanks and spill release cleanup are also regulated under this Act.
Safe Drinking Water Act (SDWA) of 1974 Safe Drinking Water Act Reauthorization of 1996	40 CFR 141-149	SDWA identifies maximum contaminant levels (MCLs) and governs the distribution and monitoring of public water supplies. The reauthorization requires states to establish Source Water Assessment Programs.
Toxic Substances Control Act (TSCA)	40 CFR 700-766	TSCA regulates the handling, storage and disposal of wastes containing PCB concentrations greater than 50 ppm.

Appendix C.2
BNL Groundwater Protection Management Program
DOE Orders Related to Groundwater Protection

DOE Order/Guidance	Order Number	Description
General Environmental Protection Program	5400.1	Establishes program requirements, authorities, and responsibilities for DOE operations ensuring compliance with Federal, State, and local environmental protection laws and regulations, Executive Orders, and internal DOE policies.
Hazardous and Radioactive Mixed Waste Program	5400.3	Establishes programs to ensure that hazardous and radioactive mixed wastes are managed in accordance with Atomic Energy Act (AEA) and RCRA.
Comprehensive Environmental Response, Compensation, and Liability Act Requirements	5400.4	Establishes DOE CERCLA policies and procedures, including response to new releases or potential releases of hazardous substances.
Radiation Protection of the Public and the Environment	5400.5	Establishes radiation standards for the protection of the public in the vicinity of DOE facilities. The order establishes an annual dose equivalent from drinking water supplies operated by DOE at 4 mrem, and notes that liquid effluent from DOE activities will not cause public drinking water systems to exceed EPA MCLs.
NEPA Compliance Program	451.1A	Establishes internal DOE responsibilities, authorities and procedures to implement NEPA.
Safety Analysis and Review System	5481.1B	Establishes procedures for performing safety analyses for DOE operations, including the identification of hazards, their elimination and control, assessment of risk, and document management authorization of the operation.
Environmental Safety and Health Appraisal Program	G414.1-1	Establishes procedures for the conduct of independent DOE surveys of environmental programs.
Radioactive Waste Management	5820.2A	Established policies and guidelines for managing radioactive and mixed wastes, and contaminated facilities.
General Design Criteria	6430.1A	Provides guidance to ensure that the design and construction of DOE facilities are adequate for their intended purpose and consistent with health, safety, security and environmental protection requirements.
Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance	DOE/EH-0173T	Provides guidance for conducting effluent monitoring and groundwater surveillance at DOE sites.

Appendix C.3
BNL Groundwater Protection Management Program
Major New York State Regulations Related to Groundwater Protection

Regulation	Codification	Description
NY Public Water Supply Requirements	10 NYCRR 5-1 (Part 5 of NYS Sanitary Code)	Establishes Maximum Contaminant Levels, monitoring and reporting requirements for potable water supply systems.
NY Water Quality Regulations for Surface Waters and Groundwaters	6 NYCRR 700-705	Establishes NYSDEC Ambient Groundwater and Surface Water Quality Standards.
NY Hazardous Solid Waste Management Facilities	6 NYCRR 360	Pertains to disposal of solid wastes disposed of at land disposal facilities (e.g., landfills).
NY Hazardous Waste Management Systems	6 NYCRR 370-376	Pertains to hazardous waste identification, management, and disposal.
NY State Pollutant Discharge Elimination System (SPDES)	6 NYCRR 750-758	Establishes the guidelines for SPDES related permits, monitoring and reporting.
NY Wild, Scenic and Recreational Rivers Act	Environmental Conservation Laws, Article 15, Title 27	Designates the Peconic River at BNL as a Scenic River, restricts activities within 800 meters of the river.

Appendix C.4
BNL Groundwater Protection Management Program
Suffolk County Regulations Related to Groundwater Protection

Regulation	Codification	Description
Suffolk County Article 7 - Water Pollution Control	SCSC Article 7	Establishes controls for the discharge of sewage, industrial and other wastes, toxic or hazardous materials and storm water runoff.
Suffolk County Article 12 - Toxic and Hazardous Materials Storage and Handling Controls	SCSC Article 12	Establishes toxic and hazardous materials storage and handling controls for above ground and below ground storage facilities. Includes provisions for installation, inspection and abandonment of these facilities.

Appendix D

BROOKHAVEN NATIONAL LABORATORY

COMMUNITY INVOLVEMENT POLICY STATEMENT

It is Brookhaven National Laboratory policy to consistently incorporate credible, effective, public participation processes into program operations, planning activities, and decision-making processes. This means that BNL managers and employees will:

- Actively seek and consider public input on Laboratory decisions.
- Inform the public in a timely manner, of key upcoming decisions, decisions made, progress on ongoing activities, emerging technologies, and opportunities for economic diversity.
- Incorporate or otherwise respond to the views of regulators, stakeholders, and the general public in making decisions.
- Provide opportunities for the public to have input in an open, two-way exchange of information, knowledge and perspectives.

Brookhaven National Laboratory's policy is intended to bring a broad range of diverse viewpoints and values early into program operations, planning activities and decision-making processes to enable the Laboratory to make informed decisions and to build mutual understanding between the Laboratory and its stakeholders.

April 14, 1998

Appendix E
BNL Groundwater Protection Management Program
Overview of Groundwater Monitoring Programs
for 1999

EM Program Monitoring Area	Groundwater Monitoring Wells		
	Total Number of Wells*	On-Site	Off-Site
Alternating Gradient Synchrotron	42	42	
Biology Department Greenhouses	2	2	
Brookhaven LINAC Isotope Producer	6	6	
Brookhaven Medical Research Reactor	5	5	
Building 830	5	5	
Live-Fire Range	2	2	
Major Petroleum Facility	8	8	
Motor Pool	8	8	
Relativistic Heavy Ion Collider	12	12	
Service Station	5	5	
Sewage Treatment Plant	19	19	
Shotgun Range	3	3	
Waste Management Facility	8	8	
Potable Supply Wells	6	6	
Process Supply Wells	2	2	
ER Program Monitoring Area	**Total Number of Wells***	**On-Site**	**Off-Site**
Operable Unit I - Current Landfill	11	11	
Former Landfill	7	7	
Removal Action V	50	45	5
OU I/IV	19	14	5
Operable Unit III - Remedial Action	88	65	23
HFBR Tritium Plume	88	88	
Operable Unit IV - AOC 5	18	18	
AOC 6	23	23	
Operable Unit V	34	13	21
Operable Unit VI	16	13	3
Site Background	13	10	3
Sitewide/Regional Groundwater Elevation Levels	650**	~600	~50

* Number of wells used for each monitoring program is subject to change.
** Includes wells used for water quality determinations at active facilities and OUs/AOCs.