7 Groundwater Protection

The Brookhaven National Laboratory (BNL) Groundwater Protection Management Program is made up of four elements: prevention, monitoring, restoration, and communication. BNL has implemented aggressive pollution prevention measures to protect groundwater resources. BNL's extensive groundwater monitoring well network is used to verify that prevention and restoration activities are effective. In 2004, BNL collected groundwater samples from 828 monitoring wells during 2,207 individual sampling events. Twelve groundwater remediation systems removed 652 pounds of volatile organic compounds and returned approximately 1.5 billion gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation in December 1996, BNL has removed 4,808 pounds of volatile organic compounds by treating nearly 8.4 billion gallons of groundwater.

7.1 THE BNL GROUNDWATER PROTECTION MANAGEMENT PROGRAM

The primary goal of BNL's Groundwater Protection Management Program is to ensure that plans for groundwater protection, management, monitoring, and restoration are fully defined, integrated, and managed in a manner that is consistent with applicable federal, state, and local regulations. BNL's program helps to fulfill the environmental monitoring requirements outlined in DOE Order 450.1, *Environmental Protection Program.* This program is described in the *BNL Groundwater Protection Management Program Description* (Paquette et al. 2002). The BNL Groundwater Protection Program consists of four interconnecting elements: 1) preventing pollution of the groundwater, 2) monitoring the effectiveness of engineered and administrative controls at operating facilities and groundwater treatment systems, 3) restoring the environment by cleaning up contaminated soil and groundwater, and 4) communicating with stakeholders on groundwater protection issues. BNL is committed to protecting groundwater resources from further chemical and radionuclide releases, and to remediating existing contaminated groundwater.

7.1.1 Prevention

As part of BNL's Environmental Management System, the Laboratory has implemented a number of pollution prevention activities that are designed to protect groundwater resources (see Chapter 2). BNL has established a work control program that requires all experiments and industrial operations be reviewed to determine the potential impacts of these activities on the environment. This program enables BNL to integrate pollution prevention and waste minimization, resource conservation, and compliance into planning and decision-making. Efforts have been implemented to achieve or maintain compliance with regulatory requirements and to implement best management practices designed to protect groundwater (see Chapter 3). Examples include upgrading underground storage tanks (USTs), closing cesspools, and adding engineered controls (e.g., barriers to prevent rainwater infiltration that could move contaminants out of the soil and into groundwater) and administrative controls (e.g., reducing the toxicity and volume of chemicals in use or storage). Samples from groundwater monitoring wells are used to confirm that these controls are working.

7.1.2 Monitoring

BNL's groundwater monitoring network is designed to evaluate the impacts of groundwater contamination from former and current operations and to track cleanup progress (see Table 7-1). Results from groundwater monitoring are used to verify that protection and restoration efforts are working. Groundwater monitoring is focused on two general areas: 1) Environmental Surveillance (ES) monitoring, designed to satisfy DOE and New York State monitoring requirements for active research and support facilities, and 2) Environmental Restoration (ER) monitoring related to BNL's obligations under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This monitoring is coordinated to ensure completeness and to prevent duplication of effort in the installation, monitoring, and abandonment of wells. The monitoring program elements have been integrated and include data quality objectives; plans and procedures; sampling and analysis; quality assurance; data management; and the installation, maintenance, and abandonment of wells. These elements were integrated to create a cost-effective monitoring system and to ensure that water quality data are available for review and interpretation in a timely manner.

Table 7-1. Summary of BNL Groundwater Monitoring Program, 2004.

	Environmental Restoration Program	Environmental Surveillance Program
Number of wells monitored	703	125
Number of sampling events	1,889	318
Number of analyses performed	4,456	692
Number of results	74,315	7,548
Percent of nondetectable analyses	92	90
Number of new wells installed (a)	56	0
Number of wells abandoned	0	0

Notes:
(a) Permanent wells only. Single-use temporary wells used for characterization are not included.

7.1.3 Restoration

BNL was added to the National Priorities List in 1989 (see Chapter 2 for a discussion of BNL's ER Program). To help manage the restoration effort, 30 separate Areas of Concern were grouped into seven Operable Units (OUs). Remedial Investigation/Feasibility Studies have been conducted for each OU, and the focus is now on installing and operating cleanup systems. Contaminant sources (e.g., contaminated soil and USTs) are being removed or remediated to prevent further contamination of groundwater. All remediation work is carried out under the Interagency Agreement involving EPA, the New York State Department of Environmental Conservation (NYSDEC), and DOE.

7.1.4 Communication

BNL's Community Education, Government and Public Affairs (CEGPA) Program ensures that BNL communicates with the community in a consistent, timely, and accurate manner. A number of communication mechanisms are in place, such as press releases, web pages, mailings, public meetings, briefings, and roundtable discussions. Specific examples include routine meetings with the Community Advisory Council and the Brookhaven Executive Roundtable (see Chapter 2). In addition, quarterly and annual technical reports that summarize data, evaluations, and program indices are prepared.

7.2 GROUNDWATER PROTECTION PERFORMANCE

Since 1998, the BNL Groundwater Protection Management Program has been tracking progress toward preventing new contamination of the aquifer system. The Laboratory has made significant investments in environmental and groundwater protection, and is making progress in achieving its goal of preventing new groundwater impacts. A new groundwater impact is defined as the detection and confirmation of unusual or off-normal groundwater monitoring results. The *Groundwater Protection Contingency Plan* (BNL 2000) is designed to ensure that appropriate and timely actions are taken if unusual or off-normal results are observed. The contingency plan provides guidelines for evaluating the source of the problem, notifying stakeholders, and implementing appropriate corrective actions.

Since 1998, BNL has installed several hundred permanent and temporary monitoring wells as a result of a comprehensive evaluation of known or potential contaminant source areas. Using this enhanced monitoring system, BNL identified 10 new groundwater impacts during 1998 through 2001 (see Figure 7-1). No additional impacts have been identified since 2001. Five of the 10 identified impacts were determined to be from historical (or "legacy") contaminant releases, and the other five were related to active science operations and environmental protection activities. In all 10 cases, BNL thoroughly investigated the cause of the contamination and took corrective actions as necessary to eliminate or limit the level or magnitude of these impacts. The Laboratory will continue efforts to prevent new groundwater impacts, and is vigilant in measuring and communicating its performance in groundwater protection.

7.3 GROUNDWATER MONITORING

Elements of the groundwater monitoring program include installing monitoring wells; planning and scheduling; developing and following quality assurance procedures; collecting and analyzing samples; verifying, validating, and interpreting data; and reporting. Monitoring wells (which are not used for the drinking water supply) are used to evaluate BNL's progress in restoring groundwater quality, to comply with regulatory permit requirements, to monitor active research and support facilities, and to assess the quality of groundwater entering and leaving the site.

BNL monitors research and support facilities where there is a potential for environmental impact, as well as areas where past waste handling practices or accidental spills have already degraded groundwater quality. The groundwater beneath the BNL site is classified by New York State as Class GA groundwater, which is defined as a source of potable water supply. Federal drinking water standards (DWS), New York State DWS, and New York State Ambient Water Quality Standards (NYS AWQS) for Class GA groundwater are used as goals for groundwater protection and remediation. BNL evaluates the potential impact of radiological and nonradiological contamination by comparing analytical

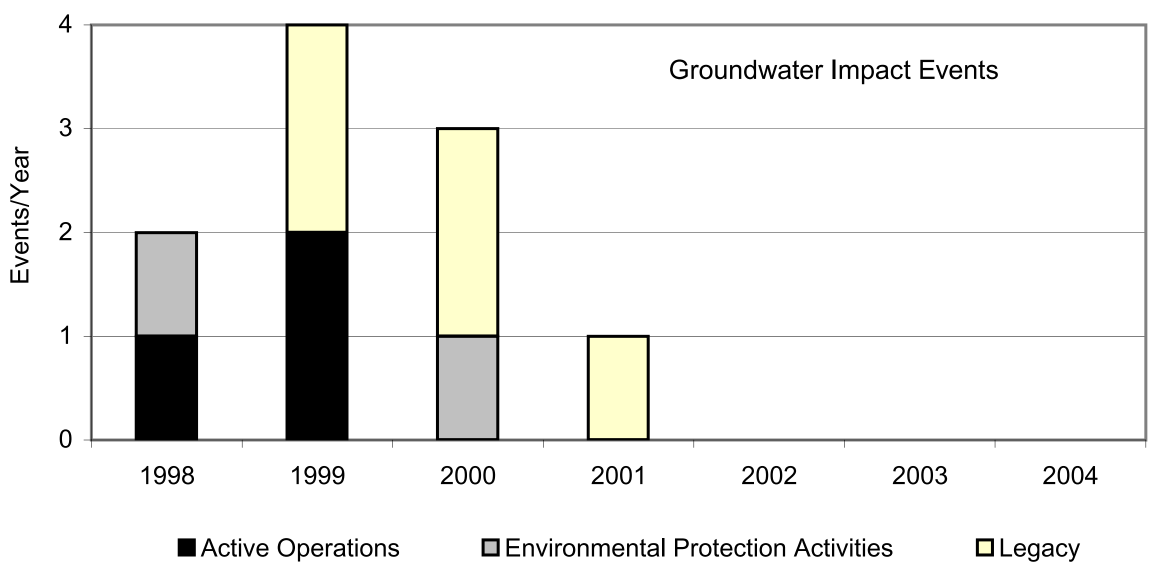

Figure 7-1. Groundwater Protection Performance, 1998 – 2004.

results to these standards. Contaminant concentrations that are below these standards are also compared to background values to evaluate the potential effects from facility operations. The detection of low concentrations of facility-specific volatile organic compounds (VOCs) or radionuclides may provide important early indications of a contaminant release and allow for timely identification and remediation of the source.

Groundwater quality at BNL is routinely monitored through a network of approximately 828 on- and off-site wells (see SER Volume II, *BNL Groundwater Status Report*, for details). In addition to water quality assessments, water levels are routinely measured in more than 875 on- and off-site wells to assess variations in the direction and velocity of flow. Groundwater flow directions in the vicinity of BNL are shown in Figure 7-2.

Among the active facilities that have groundwater monitoring programs are the Sewage Treatment Plant and Peconic River area, Service Station Motor Pool, Waste Management Facility, Central Steam Facility and adjacent Major Petroleum Facility, Alternating Gradient Synchrotron, Relativistic Heavy Ion Collider, Waste Concentration Facility, and several other smaller facilities. Inactive facilities include the former Hazardous Waste Management Facility, two former landfill areas, the Brookhaven Graphite Research Reactor (BGRR), High Flux Beam Reactor (HFBR), and the Brookhaven Medical Research Reactor (BMRR). As the result of detailed groundwater investigations conducted over the past 15 years, six significant VOC plumes and eight radionuclide plumes have been identified (see Figures 7-3 and 7-4).

7.4 SUPPLEMENTAL MONITORING OF WATER SUPPLY WELLS

As discussed in Chapter 3, BNL is classified as a public water purveyor and maintains water supply wells and associated treatment facilities for the distribution of potable water on site. This water is also used for cooling water purposes at a number of facilities. Most of BNL's water supply is obtained from a network of six large-capacity wells (wells 4, 6, 7, 10, 11, and 12). A seventh well, number 9, is a small-capacity well that supplies process water to a facility where biological research is conducted. This well is not routinely monitored. The locations of the supply wells are shown in Figure 7-2.

The quality of the BNL potable water supply is monitored as required by the Safe Drinking Water Act (SDWA), and the analytical results are reported to the Suffolk County Department of Health Services. As required by SDWA, BNL also prepares an annual Water Quality Consumer Confidence Report (BNL 2005b) that is distributed to all employees and guests. Results of the SDWA-required monitoring are described in Chapter 3.

All of BNL's supply wells are screened within the Upper Glacial aquifer. Because of the proximity of the potable supply wells to known or suspected groundwater contamination plumes and source areas, BNL conducts a supplemental potable supply well monitoring program that includes testing for VOCs, anions, metals, and radiological parameters. During 2004, the BNL potable water system fully complied with all drinking water requirements. To better understand the geographical source of BNL's drinking water and to identify potential sources of contamination within these geographical areas, BNL prepared the *Source Water Assessment for Drinking Water Supply Wells* (Bennett et al. 2000). In 2003, the New York State Department of Health prepared a Long Island Source Water Assessment for all potable water supply wells on Long Island (Summary Report NYSDOH 2003). The source water assessments are designed to serve as management tools in further protecting Long Island's sole source aquifer system.

7.4.1 Radiological Results

During 2004, samples collected quarterly from supply wells 6, 7, 11, and 12 were analyzed (see Table 7-2) for gross alpha and gross beta activity, tritium, and Sr-90. Because low levels of tritium were detected in a monitoring well at the Waste Management Facility, nearby supply wells 11 and 12 were tested for tritium more frequently. (Note: Well 10, which was used infrequently during 2004, was only sam-

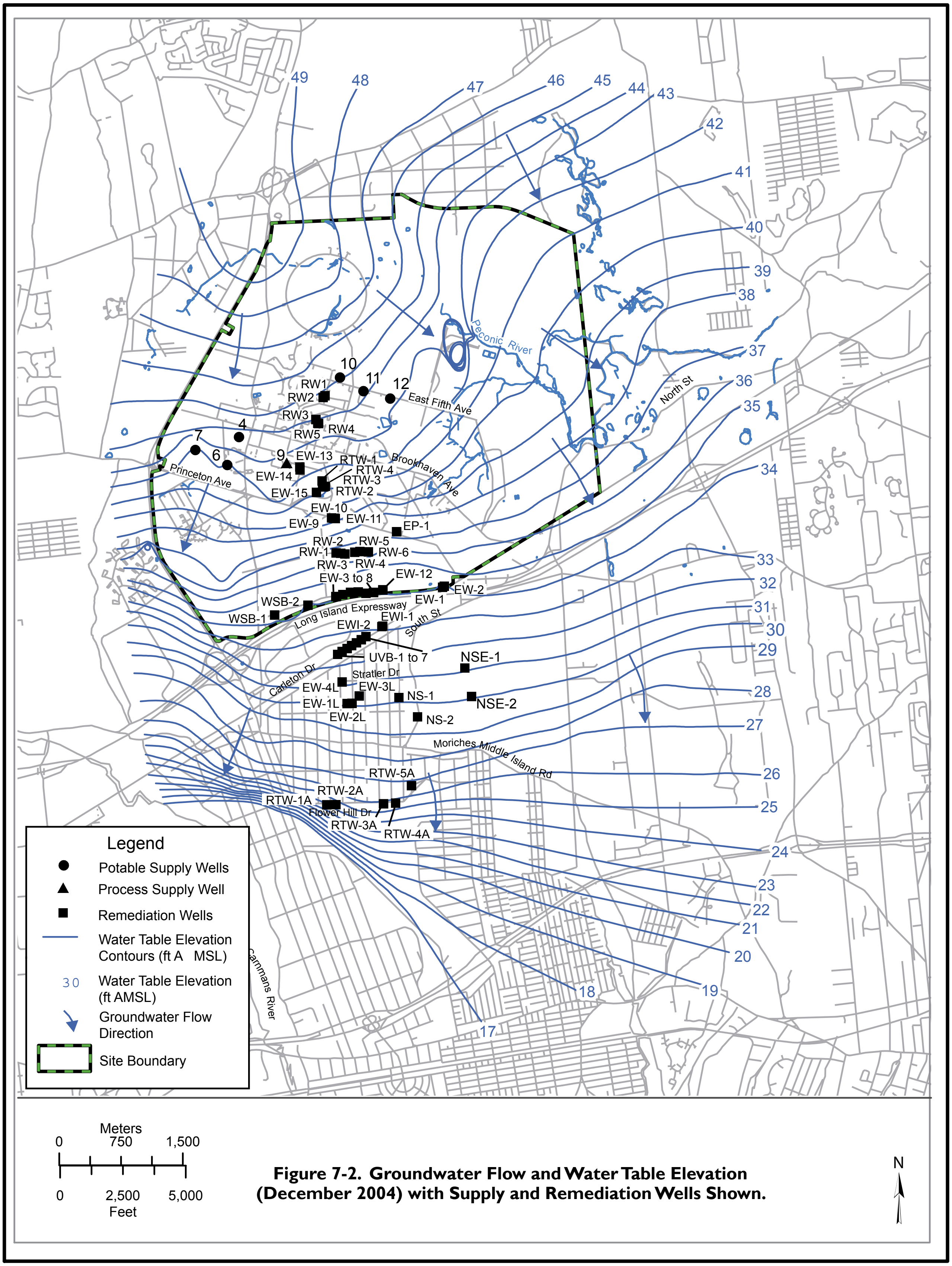

Figure 7-2. Groundwater Flow and Water Table Elevation (December 2004) with Supply and Remediation Wells Shown.

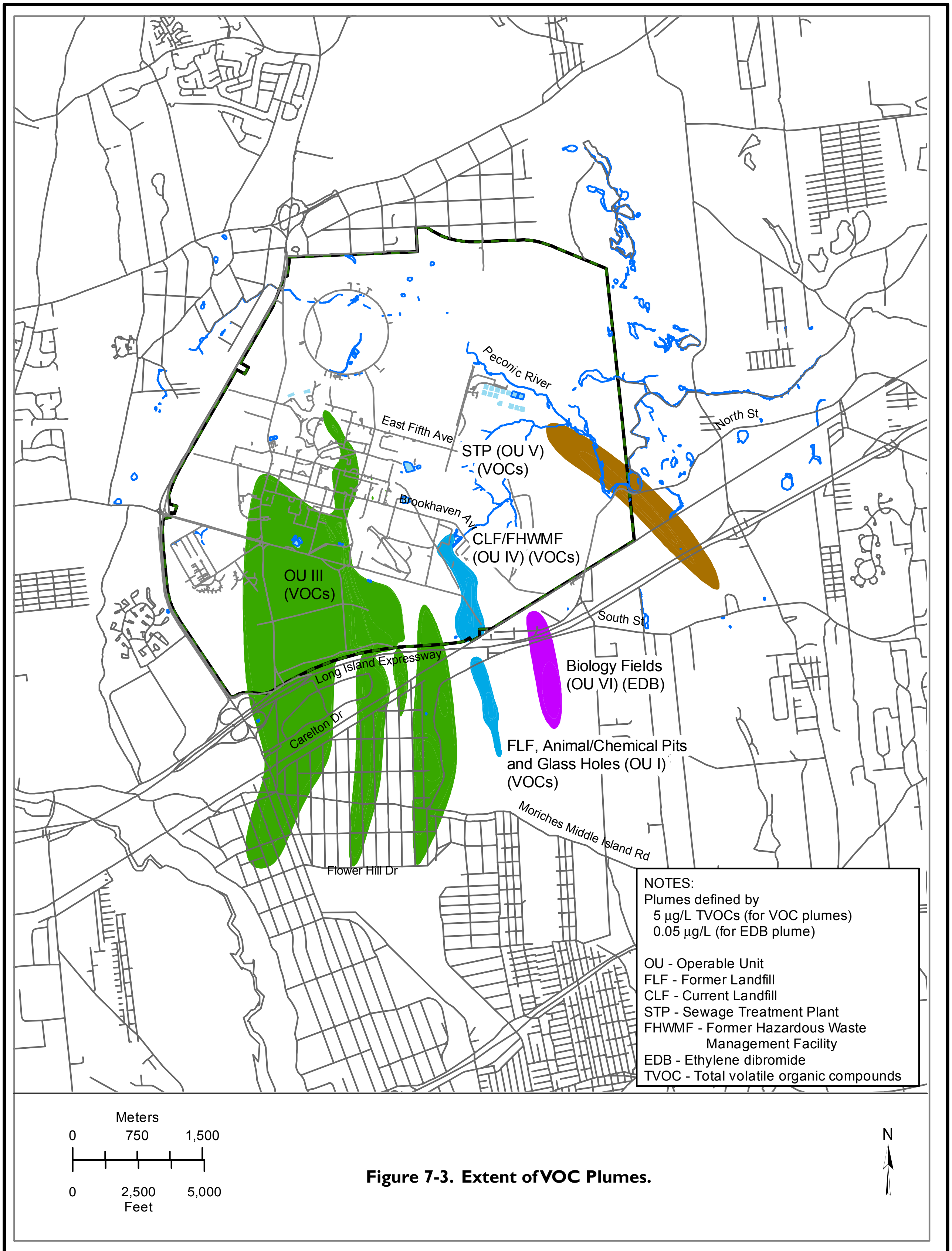

Figure 7-3. Extent of VOC Plumes.

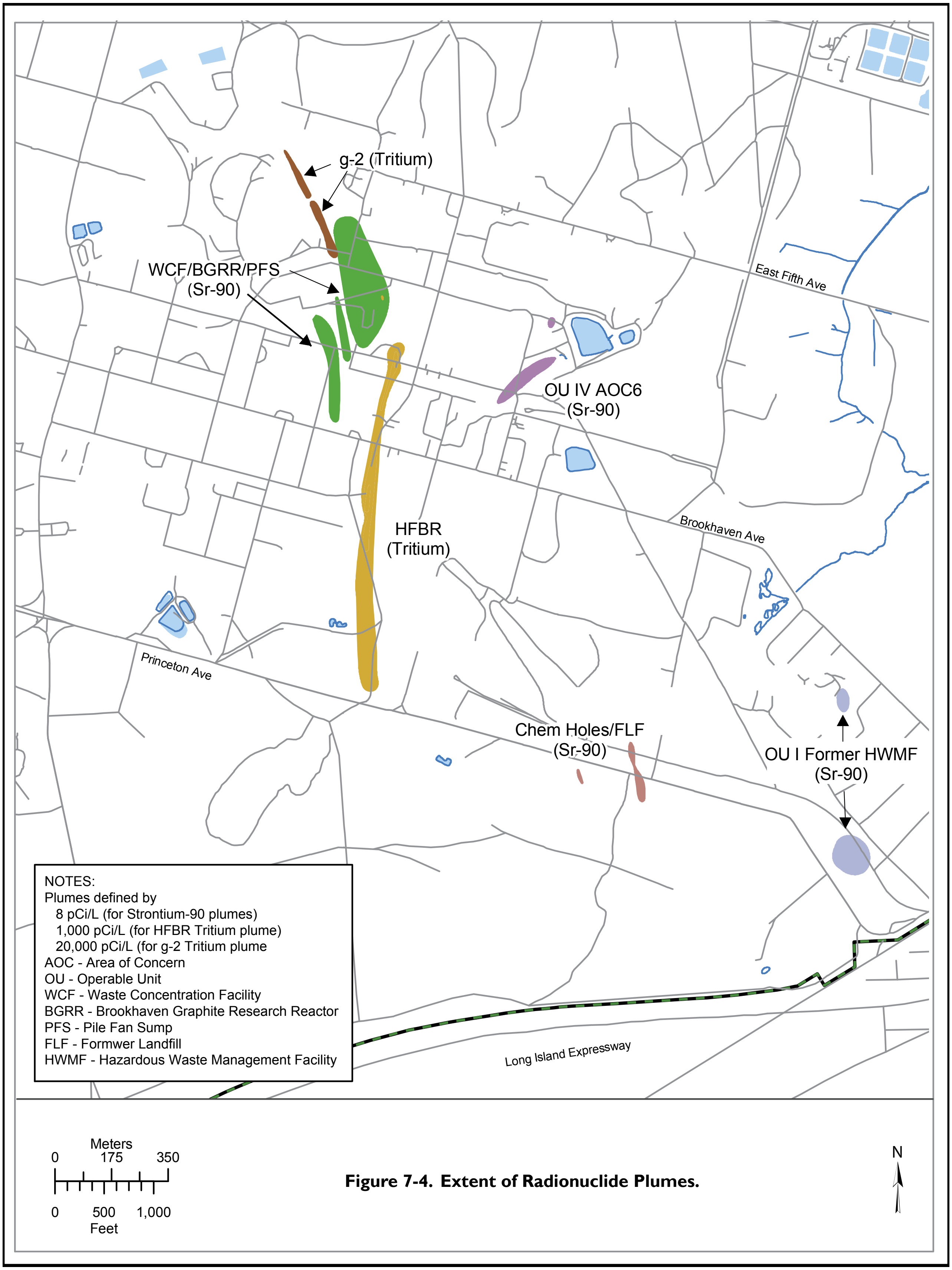

Figure 7-4. Extent of Radionuclide Plumes.

Table 7-2. Potable Well Radiological Analytical Results.

Potable Well ID		Gross Alpha	Gross Beta	Tritium
		pCi/L		
Well 4	Samples	WS	WS	WS
	Max.	–	–	–
	Avg.	–	–	–
Well 6	Samples	4	4	4
	Max.	< 0.74	2.20 ± 1.20	< 310
	Avg.	0.36 ± 0.37	1.53 ± 0.56	-28 ± 25
Well 7	Samples	4	4	4
	Max.	< 0.88	< 1.60	< 310
	Avg.	0.04 ± 0.28	0.69 ± 0.48	1 ± 66
Well 11	Samples	4	4	8
	Max.	< 0.09	< 1.70	< 300
	Avg.	0.09 ± 0.30	0.77 ± 0.40	79 ± 77
Well 12	Samples	4	4	8
	Max.	< 0.87	2.40 ± 1.30	340 ± 220
	Avg.	0.41 ± 0.32	1.48 ± 0.76	106 ± 107
SDWA Limit (pCi/L)		15 (a)	4 mrem (b)	20,000

Notes:
See Figure 7-2 for well locations.
All values presented with a 95% confidence interval.
Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.
WS = Well shut down due to operational problems.
(a) Excluding radon and uranium.
(b) The drinking water standards were changed from 50 pCi/L (concentration based) to (dose based) in late 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.

pled under the compliance monitoring program described in Chapter 3.) Nuclide-specific gamma spectroscopy was also performed for potable well samples. Average gross activity levels in the potable water wells were consistent with those of typical background water samples. In 2004, tritium was the only BNL-related radionuclide that was observed above the minimum detection limit in the potable water samples. That tritium reading, from supply well 12, was 340 pCi/L; the minimum detection limit was 310 pCi/L and the DWS set by New York State and the SDWA is 20,000 pCi/L. Tritium was not detected in subsequent samples from this well.

7.4.2 Nonradiological Results

In addition to the quarterly SDWA compliance samples described in Section 3.7 of Chapter 3, BNL collected supplemental VOC samples from active supply wells during the year. These samples were analyzed for VOCs following either EPA Standard Method 524 or 624. Trace levels of chloroform continued to be routinely detected in samples from most wells, with a maximum concentration of 1.5 µg/L observed during 2004. The DWS for chloroform is 80 µg/L. Low levels of several other VOCs (e.g., 1,1,1-trichloroethane [TCA], bromodichloromethane, and dibromochloromethane) were occasionally detected, but at concentrations well below applicable DWS. Samples were also analyzed for metals and anions one time during the year from wells 6, 7, 11, and 12 (see Tables 7-3 and 7-4). As in previous years, iron was the only parameter detected at concentrations greater than the DWS, which is 0.3 mg/L for iron. Iron levels in wells 6 and 7 were 4.71 and 2.06 mg/L, respectively. Because high levels of iron are naturally present in some portions of the Upper Glacial aquifer on the western side of the BNL site, water obtained from wells 4, 6, and 7 is treated at the BNL Water Treatment Plant to reduce iron levels before distribution.

7.5 ENVIRONMENTAL SURVEILLANCE PROGRAM

BNL's ES Program includes groundwater monitoring at 10 active research facilities (e.g., accelerator beam stop and target areas) and support facilities (e.g., fuel storage facilities). During 2004, 125 groundwater wells were monitored during 318 individual sampling events. Detailed descriptions and maps related to the ES groundwater monitoring program can be found in SER Volume II, *Groundwater Status Report.*

Although no new impacts to groundwater quality were discovered during 2004, groundwater quality continues to be impacted at four facilities, as follows: continued high levels of tritium at the g-2/VQ-12 area of the Alternating Gradient Synchrotron (AGS) facility; tritium at the Brookhaven Linac Isotope Producer (BLIP) facility, and low-level VOCs at the Motor Pool/Facility Maintenance area and the Service

Station. Significant monitoring results for these areas are described below.

- Although tritium continues to be detected at concentrations above the 20,000 pCi/L drinking water standard in wells immediately downgradient of the g-2/VQ-12 source area in the AGS facility, the levels are much lower than those observed in 2002 and 2003. Tritium concentrations reached a maximum of 3,440,000 pCi/L in 2002 and have shown a steady decline, dropping to 93,200 pCi/L by October 2004.
- In January 2004, tritium concentrations slightly exceeded the 20,000 pCi/L standard in one well immediately downgradient of BLIP, with a concentration of 24,500 pCi/L. Tritium concentrations declined to less than the DWS limit of 20,000 pCi/L for the remainder of the year.
- At the Motor Pool/Site Maintenance area, the solvents TCA and 1,1-dichloroethane (DCA) continued to be detected at concentrations greater than the NYS AWQS of 5 µg/L, but at concentrations that were lower than those observed during 2003. TCA was detected at concentrations up to 38 µg/L, and DCA was detected at concentrations up to 13 µg/L. The gasoline additive methyl tertiary butyl ether (MTBE) was also detected, with a maximum observed concentration of 18 µg/L. The NYS AWQS for MTBE is 10 µg/L.
- At the Service Station, VOCs associated with petroleum products and solvents continued to be detected in several monitoring wells directly downgradient of the station, but at concentrations that were lower than those observed during 2003. Petroleum-related compounds detected in groundwater included m/p xylene at 67 µg/L, o-xylene at 79 µg/L, 1,2,4-trimethylbenzene at 16 µg/L, and 1,3,5-trimethylbenzene at 24 µg/L. The solvent tetrachloroethylene (TCE) was detected in several wells at a maximum concentration of 20 µg/L. MTBE was also detected, at a maximum concentration of 14 µg/L.

Table 7-3. Potable Water Supply Wells Water Quality Data.

Potable Well ID		Chlorides	Sulfates	Nitrate and Nitrite
		mg/L	mg/L	mg/L
Well 4	N	WS	WS	WS
	Value	—	—	—
Well 6	N	1	1	1
	Value	20.9	12.8	2.7
Well 7	N	1	1	1
	Value	22.7	9.0	3.1
Well 11	N	1	1	1
	Value	17.9	< 0.5	5.6
Well 12	N	1	1	1
	Value	20.8	11.5	5.8
NYS DWS		250	250	10
Typical MDL		4	4	1

Notes:
See Figure 7-2 for location of wells.
Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.
N = Number of samples
NYS DWS = New York State Drinking Water Standard
MDL = Minimum Detection Limit
WS = Well shut down due to operational problems.

Although the engineered stormwater controls appeared to be effectively protecting the g-2/VQ-12 and BLIP source areas, monitoring data suggested that the continued release of tritium in both areas appeared to be caused by the flushing of residual tritium from the vadose (or unsaturated) zone following significant natural periodic rises in the local water table. It is expected that the amount of tritium remaining in the vadose zone close to the water table will decline over time due to this flushing mechanism and by natural radioactive decay (the half-life of tritium is 12.3 years).

Monitoring of the leak detection systems at both vehicle maintenance facilities indicated that the gasoline storage tanks and associated distribution lines were not leaking. Furthermore, evaluation of vehicle maintenance operations

Table 7-4. Total Metals Concentration Data for Potable Water Supply Well Samples.

Well ID		Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Na	Ni	Pb	Sb	Se	Tl	V	Zn
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Well 4 *	N	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS
	Value	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Well 6 *	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 2.0	< 50.0	3.0	23.8	< 2.0	< 2.0	0.7	1.9	11.0	4.71	< 0.2	71.1	14.7	3.2	< 3.0	< 5.0	1.4	0.46	< 5.0	6.2
Well 7 *	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 2.0	< 50.0	1.3	20.3	< 2.0	< 2.0	0.48	< 5.0	4.3	2.06	< 0.2	57.9	16.1	1.2	< 3.0	< 5.0	< 5.0	< 5.0	< 5.0	5.7
Well 11	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 2.0	< 50.0	0.71	26.4	< 2.0	< 2.0	7.5	< 5.0	7.5	0.05	< 0.2	< 5.0	15.1	0.41	< 3.0	< 5.0	< 5.0	1.4	< 5.0	3.8
Well 12	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 2.0	< 50.0	< 5.0	28.7	< 2.0	0.04	1.0	< 5.0	5.7	< 0.05	< 0.2	< 5.0	16.0	0.51	1.3	< 5.0	< 5.0	0.9	< 5.0	4.8
NYS DWS		100	SNS	50	2000	4	5	SNS	100	1300	0.3	2	300	SNS	SNS	15	6	50	2	SNS	5000
Typical MDL		1.0	2.2	3.0	1.8	0.7	1.1	0.1	1.0	2.0	0.08	0.1	5.0	1.0	1.1	1.3	0.9	5.0	0.7	5.5	4.0

Notes:
See Figure 7-2 for location of wells.
Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.
* Water from these wells is treated at the Water Treatment Plant for color and iron reduction prior to site distribution.

MDL = Minimum Detection Limit
NYS DWS = New York State Drinking Water Standard
SNS = Drinking Water Standard not specified
WS = Well shut down due to operational problems

in 2004 indicated that all waste oils and used solvents were being properly stored and recycled. Therefore, it is believed that the contaminants detected in groundwater at these facilities originated from historical vehicle maintenance activities, and were not related to current operations.

7.6 ENVIRONMENTAL RESTORATION GROUNDWATER MONITORING PROGRAM

The mission of the Environmental Restoration Groundwater Monitoring Program is to monitor the contaminant plumes on and off site. The monitoring results are used to track the progress that the groundwater treatment systems are making toward plume remediation. In 2004, a total of 703 groundwater wells were monitored, in 1,889 individual sampling events.

Maps showing the main VOC and radionuclide plumes are provided as Figures 7-3 and 7-4, respectively. Detailed descriptions and maps related to the ER Groundwater Monitoring Program can be found in SER Volume II. Highlights of the ER Groundwater Monitoring Program are described below.

- During 2004, high levels of tritium were periodically detected in groundwater immediately downgradient of the HFBR, especially in wells 075-43 and 075-245. Tritium concentrations in monitoring well 075-43, located on the HFBR lawn, increased to 378,000 pCi/L in February. As this high level slug of tritium continued to migrate downgradient, in October it was detected in well 075-245, located just south of Cornell Avenue, at a concentration of 433,000 pCi/L. Similar to the g-2/VQ-12 and BLIP source areas described in Section 7.5, the periodic detection of high levels of tritium downgradient of the HFBR indicates that residual tritium continues to be flushed out of the unsaturated zone close to the water table by natural water table fluctuations. It is expected that the amount of tritium remaining in the vadose zone close to the water table will decline over time due to this flushing mechanism and by natural radioactive decay. In the downgradient section of the plume, south of Brookhaven Avenue, the highest tritium concentration was detected in the vicinity of Grove and Rowland Streets, where a tritium concentration of 55,000 pCi/L was detected in temporary well 085-344. The leading edge of the plume, as defined by concentrations greater than the 20,000 pCi/L drinking water standard, is estimated to be just north of the Chilled Water Plant Road. Monitoring data indicate that the plume continues to attenuate as expected.

- Monitoring in the Building 96 area indicated that concentrations of VOCs (primarily PCE and TCA) downgradient of treatment well RTW-1 were less than the 5 µg/L NYS AWQS. As a result of this concentration reduction, downgradient treatment wells RTW-2, -3, and -4 were placed in standby mode in July 2004. However, higher levels of VOC contamination continued to be detected in the "silt zone" source area north of RTW-1. Starting in June 2004, additional groundwater characterization work was performed in the silt zone source area using temporary and permanent wells. High levels of VOCs were found, with PCE concentrations up to 3,800 µg/L and TCA concentrations up to 160 µg/L. An *in situ* method of chemical oxidation was chosen to treat this contamination. As a result, potassium permanganate was injected into the silt zone source area in late 2004 and early 2005.
- The operation of the OU III Carbon Tetrachloride Treatment System has significantly reduced carbon tetrachloride levels in groundwater near the former UST source area. Carbon tetrachloride levels in that area decreased from a high concentration of 179,000 µg/L in November 1998 to 63 µg/L in November 2004. The highest carbon tetrachloride concentration during 2004 was 230 µg/L, detected in well 095-301, near the southernmost extent of the plume. As a result of the 99.9 percent decrease in the maximum carbon tetrachloride concentrations within the plume, a petition to shut down the treatment system was sent to the regulatory agencies (BNL 2004b). This petition was approved by the regulatory agencies in July, and the treatment system was placed in standby mode in August 2004.
- During 2004, 22 new groundwater monitoring wells were installed to enhance the well network downgradient of Sr-90 source areas near the BGRR and Waste Concentration Facility (WCF). The highest Sr-90 concentration observed within the BGRR plume was 1,240 pCi/L in a temporary well installed immediately south of Building 901, near Cornell Avenue. Sr-90 concentrations up to 706 pCi/L were observed downgradient of the WCF. Construction of the BGRR/WCF groundwater treatment system was completed in December 2004, and startup testing will begin in January 2005.
- During 2004, BNL installed 34 new off-site groundwater monitoring wells to help monitor the effectiveness and progress of the off-site groundwater treatment systems.

7.7 GROUNDWATER TREATMENT SYSTEMS

The primary mission of the Laboratory's Environmental Restoration Program is to remediate soil and groundwater contamination and prevent additional contamination from migrating off the BNL site. The cleanup goals are to 1) prevent or minimize plume growth, and 2) reduce contaminant concentrations in the Upper Glacial aquifer to below NYS Maximum Contaminant Level (MCL) standards.

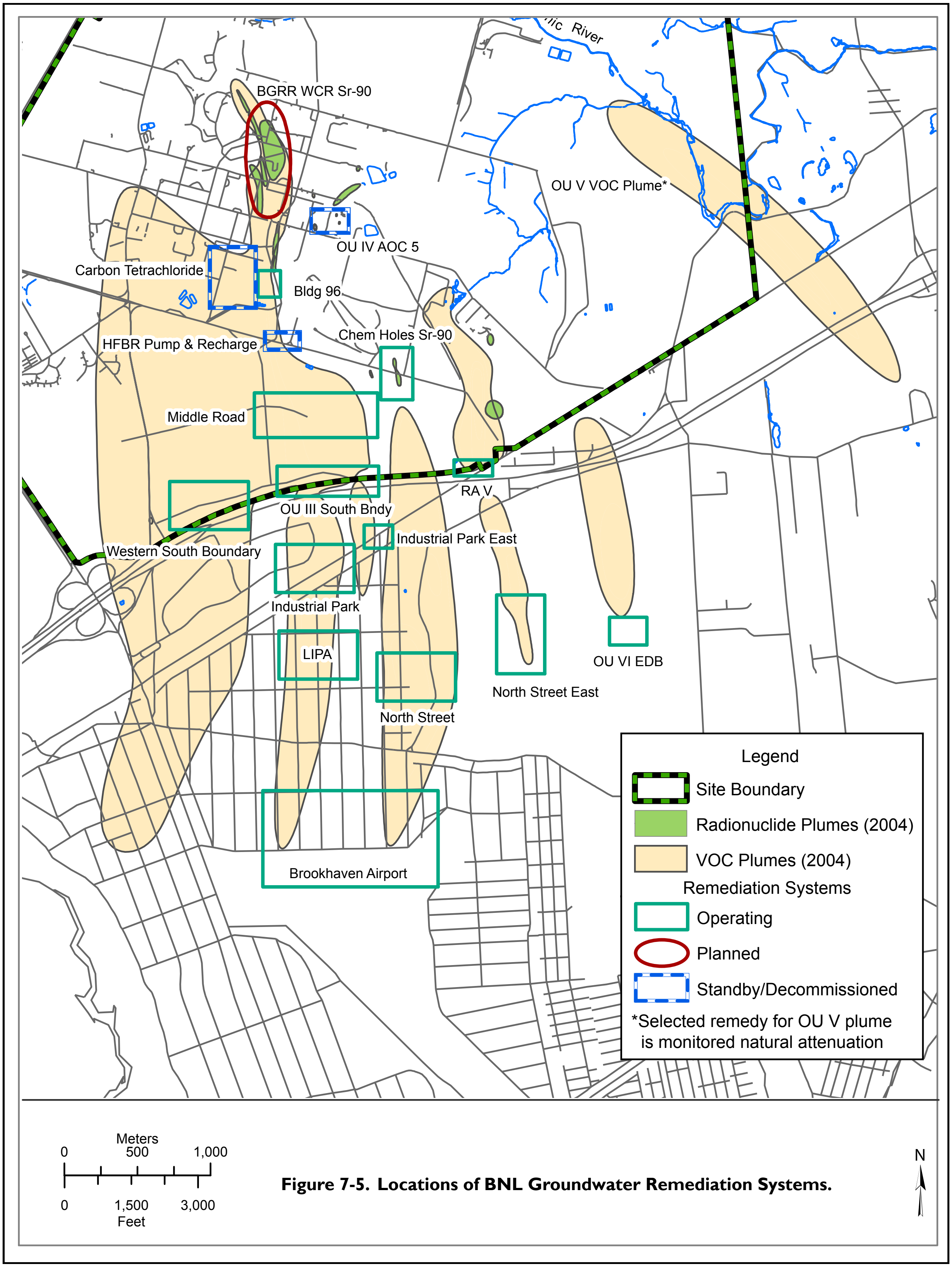

Figure 7-5. Locations of BNL Groundwater Remediation Systems.

Table 7-5. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2004.

		1997–2003		2004	
Remediation System	**Start Date**	**Water Treated** (Gallons)	**VOCs Removed** (Pounds) (e)	**Water Treated** (Gallons)	**VOCs Removed** (Pounds) (e)
OU I South Boundary	12/1996	2,424,780,000	297	271,495,000	16
OU III HFBR Tritium Plume (a)	05/1997	241,528,000	180	Not in Service	0
OU III Carbon Tetrachloride (d)	10/1999	150,146,300	341	17,775	7
OU III Building 96	02/2001	98,265,416	55	24,600,000	12
OU III Middle Road	10/2001	614,353,550	364	194,000,000	156
OU III South Boundary	06/1997	2,254,859,850	2,104	310,000,000	172
OU III Western South Boundary	09/2002	213,048,000	22	144,000,000	10
OU III Industrial Park	09/1999	789,928,330	758	177,000,000	80
OU III Industrial Park East	05/2004	Not in Service	0	57,113,000	17
OU III North Street	06/2004	Not in Service	0	144,702,000	115
OU III North Street East	06/2004	Not in Service	0	84,000,000	5
OU III LIPA/Airport	06/2004	Not in Service	0	134,444,000	62
OU IV AS/SVE (b)	11/1997	(c)	35	Decommissioned	0
OU VI EDB	08/2004	Not in Service	0	20,000,000	<1 (f)
Total		6,786,909,446	4,156	1,542,597,775	652

		2003		2004	
Remediation System	**Start Date**	**Water Treated** (Gallons)	**Sr-90 Removed** (mCi)	**Water Treated** (Gallons)	**Sr-90 Removed** (mCi)
OU III Chemical Holes Sr-90	02/2003	3,834,826	0.88	1,226,000	0.39

Notes:
(a) System was shut down and placed in standby mode on September 29, 2000.
(b) System was shut down on January 10, 2001, and decommissioned in 2003.
(c) Air Sparging/Soil Vapor Extraction (AS/SVE) system performance is measured by pounds of VOCs removed per cubic feet of air treated.
(d) System was shut down and placed in standby mode in August 2004.
(e) Values are rounded to the nearest whole number.
(f) Ethylene dibromide (EDB) was not detected in the treatment system influent during 2004. However, other low-level VOCs not attributable to BNL were detected; the results were all below Maximum Contaminant Levels (MCLs), and were potentially the result of analytical laboratory contamination.

Based on additional information obtained during the Strontium-90 Pilot Study and Magothy aquifer characterization, BNL prepared the *OU III Explanation of Significant Differences* (BNL 2004a), which was submitted to the public for review in December 2004. This report identified changes to the OU III cleanup goal time frames. For the BGRR/WCF and Chemical Holes Sr-90 plumes, MCLs must be reached within 70 years and 40 years, respectively. Cleanup of the Magothy aquifer VOC contamination must meet MCLs within 65 years. With NYSDEC concurrence, the EPA approved the *Explanation of Significant Differences* in early 2005.

All of the 16 planned groundwater remediation systems have been constructed. The HFBR Pump and Recharge System has remained in standby mode since September 2000, the OU IV Air Sparging/Soil Vapor Extraction System was decommissioned in 2003, and the Carbon Tetrachloride Plume Treatment System was placed in standby mode in August 2004 following regulatory agency approval. Furthermore, because VOC concentrations in three of the four Building 96 recirculation wells remained significantly low, those wells were shut down and placed in standby mode in July 2004.

In 2004, BNL continued to make significant progress in restoring groundwater quality on site by having twelve groundwater remediation systems in active operation. Figure 7-5 shows the locations of the groundwater treatment systems. Table 7-5 provides a summary of pounds of VOCs and curies (Ci) of radioactivity removed, and gallons of water treated during 1997–2004. During 2004, 652 pounds of VOCs and 0.39 mCi of Sr-90 were removed from the groundwater and more than 1.5 billion gallons of treated groundwater were returned to the aquifer. To date, approximately 4,800 of the estimated 25,000 to 30,000 pounds of VOCs in the aquifer have been removed. It is expected to take up to 10 years of aquifer treatment before widespread improvements in groundwater quality at BNL are achieved. Even so, some noticeable improvements in groundwater quality are evident in the OU I South Boundary, OU III South Boundary, OU IV, Building 96, and Carbon Tetrachloride areas. Detailed information on the groundwater treatment systems can be found in SER Volume II.

REFERENCES

Bennett, D., D. Paquette, K. Klaus, and W. Dorsch. 2000. *Brookhaven National Laboratory, Source Water Assessment for Drinking Water Supply Wells*. BNL-52608. Brookhaven National Laboratory, Upton, NY. December 27, 2000.

BNL 2000. *Groundwater Protection Contingency Plan*. Brookhaven National Laboratory, Upton, NY. Standards Based Management System Subject Area. September 2000.

BNL 2004a. *OU III Explanation of Significant Differences (Draft)*. Brookhaven National Laboratory, Upton, NY. December 2004.

BNL 2004b. *Petition to Shut-down, OU III Carbon Tetrachloride Groundwater Treatment System*. Brookhaven National Laboratory. Upton, NY. June 8, 2004.

BNL 2005. *2004 BNL Water Quality Consumer Confidence Report*. Brookhaven National Laboratory Bulletin – Bulletin Special Edition. Upton, NY. May 31, 2005.

DOE 2003. DOE Order 450.1, *Environmental Protection Program*. U.S. Department of Energy, Washington, DC.

NYSDOH. 2003. *Long Island Source Water Assessment Summary Report*. New York Sate Department of Health June 23, 2003.

Paquette, D.E., D.B. Bennett, and W.R. Dorsch. 2002. *Brookhaven National Laboratory, Groundwater Protection Management Program Description*. BNL Report 52664. Brookhaven National Laboratory, Upton, NY. May 31, 2002.