7

Groundwater Protection

Brookhaven National Laboratory's (BNL) Groundwater Protection Management Program is made up of four elements: prevention, monitoring, restoration, and communication. The Laboratory has implemented aggressive pollution prevention measures to protect groundwater resources. An extensive groundwater monitoring well network is used to verify that prevention and restoration activities are effective. In 2007, BNL collected groundwater samples from 850 monitoring wells during 2,289 individual sampling events. Twelve groundwater remediation systems removed 198 pounds of volatile organic compounds and returned approximately 1.2 billion gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation in December 1996, the Laboratory has removed 5,897 pounds of volatile organic compounds by treating 12.8 billion gallons of groundwater. During 2007, two groundwater treatment systems removed approximately 5.2 millicuries of strontium-90 while remediating 10 million gallons of groundwater. Since 2003, BNL has removed approximately 16.7 millicuries of strontium-90 from the groundwater while remediating 34.5 million 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 federal, state, and local regulations. The program helps to fulfill the environmental monitoring requirements outlined in DOE Order 450.1, Environmental Protection Program. The 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. The Laboratory 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 the assessment of all experiments and industrial operations to determine their potential impact on the environment. The program enables the Laboratory 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, 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). BNL's comprehensive groundwater monitoring program is used to confirm that these controls are working.

7.1.2 Monitoring

The Laboratory's groundwater monitoring network is designed to evaluate the impacts of groundwater contamination from former and current operations and to track cleanup progress. Each year, BNL collects several thousand groundwater samples from an extensive network of on- and off-site monitoring wells (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) Long Term Response Actions (LTRA) monitoring related to the Laboratory's obligations under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). These monitoring programs are 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 are 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, 2007.

	Long Term Response Actions Program	Environmental Surveillance Program
Number of wells monitored	725	125
Number of sampling events	2,049	240
Number of analyses performed	5,967	664
Number of results	78,815	7,678
Percent of nondetectable analyses	91	92
Number of permanent wells installed	21	5
Number of temporary wells installed	52	19
Number of wells abandoned	36	0

7.1.3 Restoration

BNL was added to the National Priorities List in 1989. To help manage the restoration effort, 30 separate Areas of Concern were grouped into six Operable Units (OUs). Remedial Investigation/Feasibility Studies have been conducted for each OU, and the focus is currently on operating cleanup systems. Contaminant sources (e.g., contaminated soil and underground storage tanks) are being removed or remediated to prevent further contamination of groundwater. All remediation work is carried out under an 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 Office ensures that the Laboratory communicates with its stakeholders 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, Section 2.4.2). Quarterly and annual technical reports that summarize data, evaluations, and program indices are prepared. In addition, BNL has developed a Groundwater Protection Contingency Plan (BNL 2003) that provides a formal process to promptly communicate off-normal or unusual monitoring results to Laboratory management, DOE, regulatory agencies, and other stakeholders, including the public and employees.

7.2 GROUNDWATER PROTECTION PERFORMANCE

BNL has made significant investments in environmental protection programs, and is making progress in achieving its goal of preventing new groundwater impacts. No new impacts to groundwater quality have been identified since 2001. A new impact is defined as the detection and confirmation of previously unidentified groundwater contamination. The Groundwater Protection Contingency Plan, mentioned earlier as a communications tool, also 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 verifying the data, evaluating the source of the problem, notifying stakeholders, and implementing appropriate corrective actions. The Laboratory will continue efforts to prevent new groundwater impacts, and is vigilant in measuring and communicating its performance.

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 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 that enters and exits the site.

The Laboratory 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 site is classified by New York State as Class GA groundwater, which is defined as a source of potable water. 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 results to the standards. Contaminant concentrations that are below the standards are also compared to background values to evaluate the potential effects of 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.

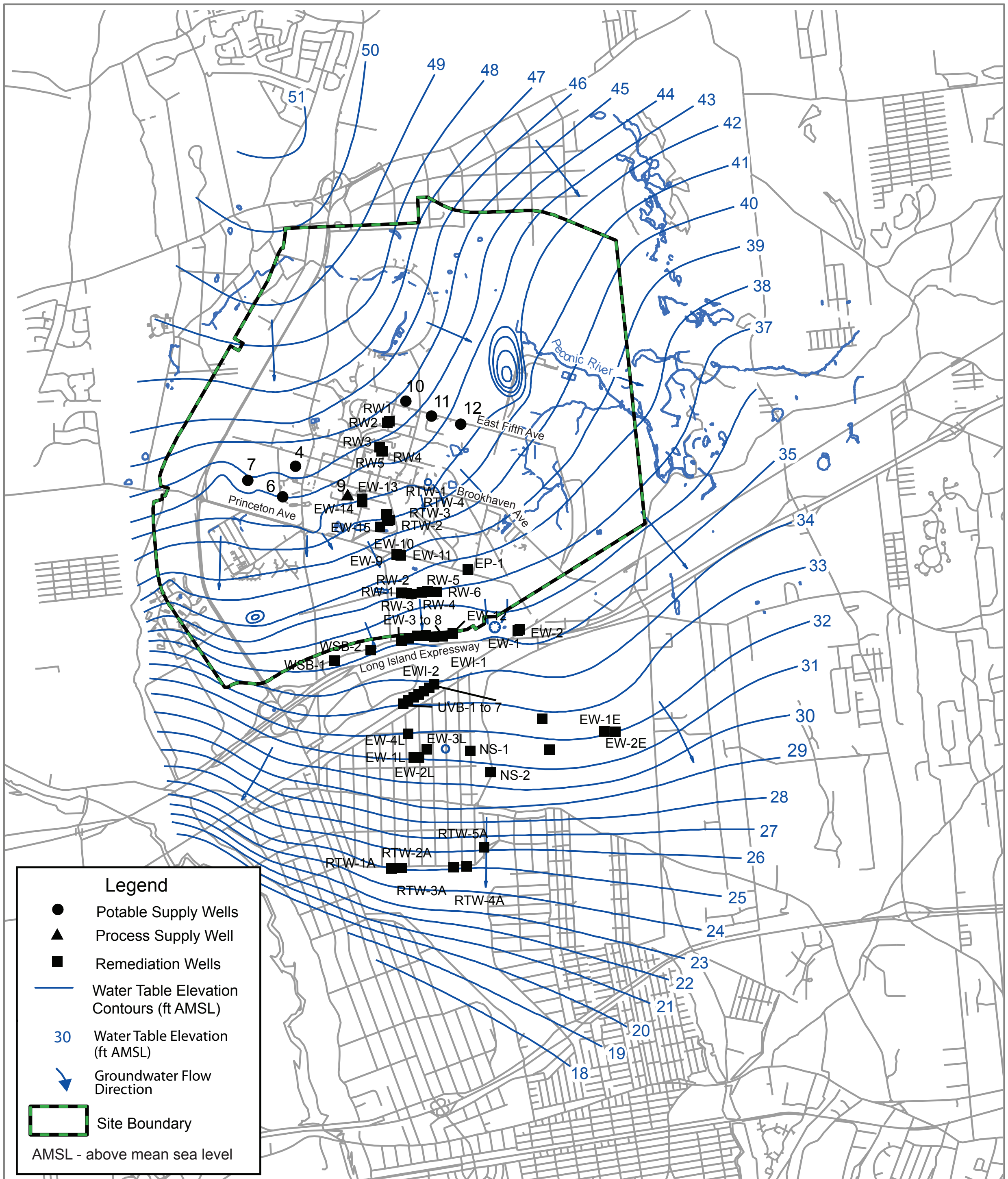
Groundwater quality at BNL is routinely monitored through a network of approximately 850 on-site and off-site wells (see SER Volume II, Groundwater Status Report, for details). In addition to water quality assessments, water levels are routinely measured in more than 875 on- and off-site wells to assess variations in the direction and velocity of groundwater flow. Groundwater flow directions in the vicinity of the Laboratory are shown in Figure 7-1.

The following active facilities have groundwater monitoring programs: the Sewage Treatment Plant (STP) area, Waste Management Facility (WMF), Major Petroleum Facility (MPF), Alternating Gradient Synchrotron (AGS), Relativistic Heavy Ion Collider (RHIC), and several vehicle maintenance and petroleum storage facilities. Inactive facilities include the former Hazardous Waste Management Facility (HWMF), two former landfill areas, Waste Concentration Facility (WCF), Brookhaven Graphite Research Reactor (BGRR), High Flux Beam Reactor (HFBR), and Brookhaven Medical Research Reactor (BMRR). As a result of detailed groundwater investigations conducted over the past 15 years, six significant VOC plumes and eight radionuclide plumes have been identified (see Figures 7-2 and 7-3).

7.4 SUPPLEMENTAL MONITORING OF WATER SUPPLY WELLS

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 in limited operation and is not routinely monitored. The locations of the supply wells are shown in Figure 7-1. All of the Laboratory's supply wells are screened within the Upper Glacial aquifer.

As described in Chapter 3, the quality of the BNL potable water supply is monitored as required by the Safe Drinking Water Act



Meters
0 750 1,500
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Feet

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Figure 7-1. Groundwater Flow and Water Table Elevation (December 2007) with Supply and Remediation Wells Shown.

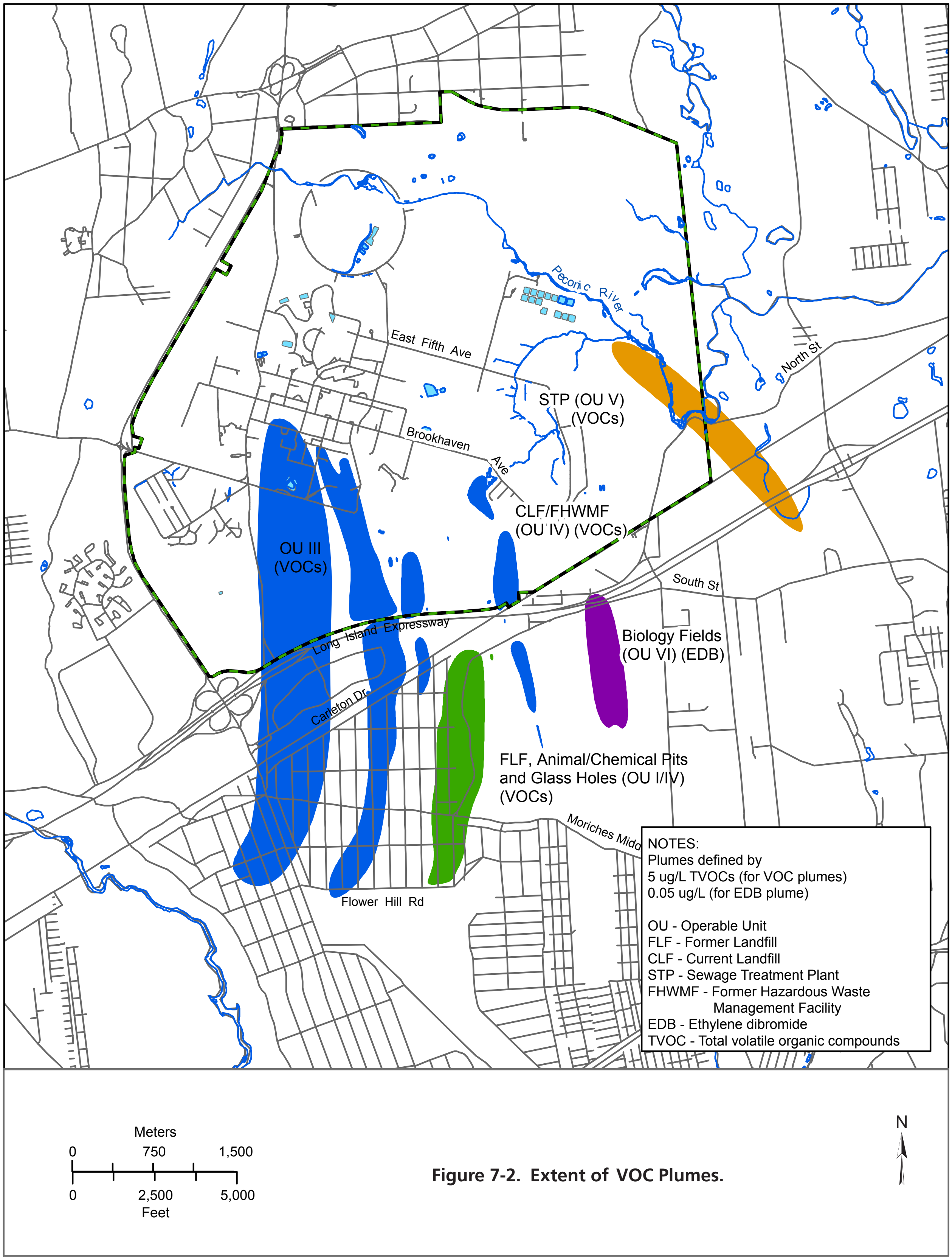

Figure 7-2. Extent of VOC Plumes.

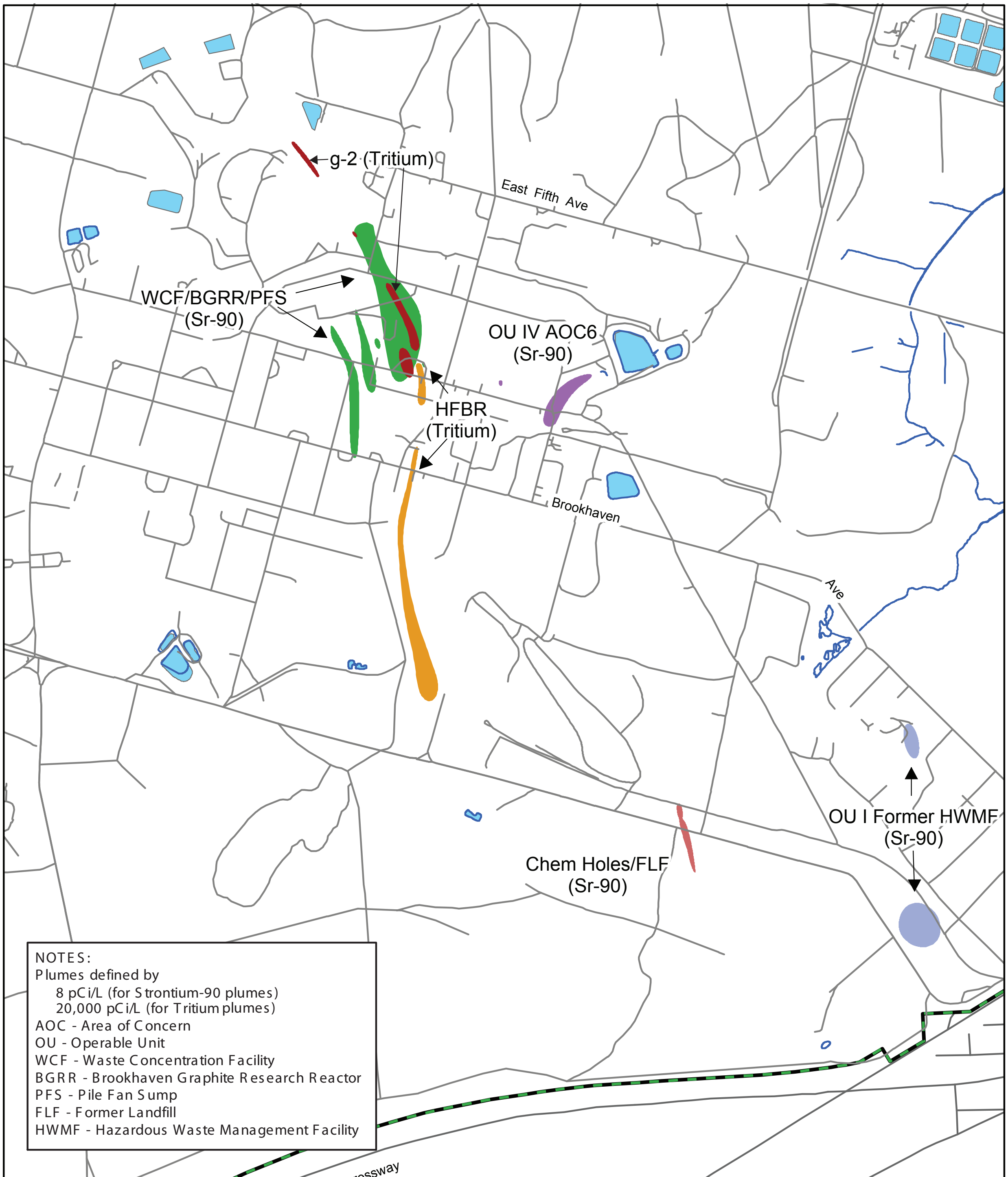

Figure 7-3. Extent of Radionuclide Plumes.

(SDWA), and the analytical results are reported to the Suffolk County Department of Health Services (SCHDS). During 2007, the BNL potable water system fully complied with all drinking water requirements. The Laboratory conducts supplemental sampling of the water supply that goes beyond the minimum SDWA required testing. This additional testing is conducted because some of the potable supply wells are near known or suspected groundwater contamination plumes and source areas. This program includes additional testing for VOCs, anions, metals, and strontium-90 (Sr-90) and tritium, which are known to have contaminated the groundwater in several areas of the site.

To better understand the geographical source of the Laboratory's drinking water and to identify potential sources of contamination within these geographical areas, BNL prepared a Source Water Assessment for Drinking Water Supply Wells (Bennett et al. 2000). In 2003, the New York State Department of Health (NYSDOH) prepared a source water assessment for all potable water supply wells on Long Island, including the BNL potable supply wells (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 2007, samples collected from the six potable supply wells were analyzed for gross alpha and gross beta activity, tritium, and Sr-90 (see Table 7-2). Nuclide-specific gamma spectroscopy was also performed. All radioactivity levels in the potable water well samples were consistent with those of typical background water samples.

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. The samples were analyzed for VOCs following either EPA Standard Method 524 or 624. As in past years, low levels of several VOCs (e.g., chloroform, 1,1,1-trichloroethane [TCA], bromodichloromethane, and dibromochloromethane) were occasionally detected in the supply wells, but at concentrations well below the applicable drinking water standards (DWS). Samples were also analyzed for metals and anions one time during the year (see Tables 7-3 and 7-4). As in previous years, iron (Fe) was the only parameter detected at concentrations greater than the DWS, which is 0.3 mg/L. The iron levels in wells 4, 6, and 7 were 1.4 mg/L, 3.4 mg/L, and 2.4 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 Laboratory

Table 7-2. Potable Well Radiological Analytical Results.

Potable Well ID		Gross Alpha	Gross Beta	Tritium	Sr-90
		pCi/L			
Well 4	Samples	4	4	4	4
	Max.	< 1.43	< 2.57	< 370	< 0.66
	Avg.	0.33 ± 0.21	1.05 ± 0.32	86.32 ± 131.97	0.17 ± 0.23
Well 6	Samples	4	4	4	4
	Max.	1.97 ± 1.24	< 2.75	< 370	< 0.77
	Avg.	0.88 ± 0.75	0.48 ± 0.79	18.78 ± 122.64	-0.05± 0.12
Well 7	Samples	4	4	4	4
	Max.	< 1.97	< 259	< 370	< 0.75
	Avg.	0.6 ± 0.38	1.19 ± 1.18	-12.55 ± 94.82	-0.13 ± 0.11
Well 10	Samples	1	1	1	1
	Max.	< 0.98	< 1.95	< 370	< 0.40
	Avg.	N/A	N/A	N/A	N/A
Well 11	Samples	4	4	4	4
	Max.	2.37 ± 1.23	2.78 ± 1.07	<370	< 0.75
	Avg.	1.03 ± 0.88	1.51 ± 0.97	127.38 ± 152.3	0.2 ± 0.39
Well 12	Samples	4	4	4	4
	Max.	< 1.52	2.99 ± 1.8	< 370	< 0.75
	Avg.	0.65 ± 0.44	1.97 ± 0.69	84.6 ± 71.78	-0.03 ± 0.04
SDWA Limit (pCi/L)		15 (a)	4 mrem (b)	20,000	8

Notes:
See Figure 7-1 for well locations.
All values presented with a 95% confidence interval.
Potable Well #10 has been shut down since 2000 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. Corresponding gamma analyses verified that no nuclide exceeded the 4 mrem limit.

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

Potable Well ID		Chlorides	Sulfates	Nitrate and Nitrite
		mg/L		
Well 4	N	1	1	1
	Value	22.5	8.6	0.3
Well 6	N	1	1	1
	Value	18.8	8.6	0.17
Well 7	N	1	1	1
	Value	25	10.2	0.29
Well 11	N	1	1	1
	Value	25	10	0.6
Well 12	N	1	1	1
	Value	27.3	9.8	0.47
NYS DWS		250	250	10
Typical MDL		4	4	1

Notes:
See Figure 7-1 for well locations.
Potable Well #10 has been shut down since 2000 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

site, water obtained from wells 4, 6, and 7 is treated at the BNL Water Treatment Plant to reduce iron levels to below the 0.3 mg/L DWS before it is distributed.

7.5 ENVIRONMENTAL SURVEILLANCE PROGRAM

BNL's Environmental Surveillance (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 and waste management facilities). During 2007, groundwater samples were collected from 125 wells during 240 individual sampling events. Nineteen temporary wells were also installed to characterize the g-2 tritium plume, which resulted in the collection of 291 groundwater samples from multiple depth intervals. 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 have been discovered since 2001, groundwater quality continues to be impacted at two BNL facilities: continued periodic high levels of tritium at the g-2 tritium source area, and continued high levels of VOCs at the Upton service station. Highlights of the surveillance program are as follows:

- Tritium continues to be detected in the g-2 source area monitoring wells, at concentrations above the 20,000 pCi/L DWS. During 2007, the maximum tritium concentration in source area wells was 94,900 pCi/L, in January. Tritium concentrations were less than 50,000 pCi/L during the second half of the year. Although the engineered stormwater controls are effectively protecting the activated soil shielding at the source area, monitoring data indicate that the continued release of tritium appears to be related to the flushing of residual tritium from the deep vadose zone following natural periodic fluctuations in the local water table. The amount of tritium remaining in the deep vadose zone is expected to decrease over time due to this flushing mechanism, and by natural radioactive decay.
- Monitoring of the downgradient areas of the g-2 tritium plume was accomplished using a combination of permanent and temporary wells. The highest tritium concentration was 198,000 pCi/L, observed in temporary well GP-73 installed approximately 250 feet northwest of the HFBR. The plume was tracked to the area immediately south of the HFBR, where a tritium concentration of 83,000 pCi/L was detected in temporary well GP-84. As a result of natural radioactive decay and dispersion in the aquifer, the tritium plume (as defined by concentrations >20,000 pCi/L DWS) appears to be breaking up into discrete segments.
- Since April 2006, all tritium concentrations in the Brookhaven Linear Isotope Producer (BLIP) facility surveillance wells have been less than the 20,000 pCi/L DWS. The maximum tritium concentration during 2007 was 13,100 pCi/L. These results indicate that the engineered stormwater controls are effectively protecting the activated soil shielding, and that the amount of residual tritium in the

deep vadose zone is diminishing.

- At the Upton service station, VOCs associated with petroleum products and solvents continue to be detected in several monitoring wells directly downgradient of the station at concentrations that exceed the DWS. During 2007, high levels of VOCs were detected during the October sample round, with total xylenes detected at 140 µg/L, ethylbenzene at 15 µg/L, 1,2,4-trimethylbenzene at 35 µg/L, and the solvent PCE at a concentration of 14 µg/L. Monitoring of the leak detection systems at the service station indicates that the gasoline storage tanks and associated distribution lines are not leaking. Furthermore, evaluation of current vehicle maintenance operations indicates that all waste oils and used solvents are being properly stored and recycled. Therefore, it is believed that the contaminants detected in groundwater originate from historical vehicle maintenance activities and are not related to current operations.

7.6 LONG TERM RESPONSE ACTIONS GROUNDWATER MONITORING PROGRAM

The LTRA groundwater monitoring program is used to track the progress that the groundwater treatment systems are making toward plume remediation (see Section 7.7, below). During 2007, the LTRA program monitored 725 monitoring wells during 2,049 individual groundwater sampling events. Also in 2007, 52 temporary wells were installed, which resulted in the collection of 542 groundwater samples from multiple depth intervals.

Maps showing the main VOC and radionuclide plumes are provided

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	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Well 4 *	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	26	< 2.0	< 2.0	< 5.0	< 5.0	143	1.39	< 0.2	130	15.9	< 10	<3.0	< 5.0	< 5.0	< 5.0	< 5.0	36.5
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	< 5.0	23.1	< 2.0	< 2.0	< 5.0	< 5.0	13.1	3.4	< 0.2	123	11.9	17.4	<3.0	< 5.0	< 5.0	< 5.0	< 5.0	17.8
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	62.3	< 5.0	22.7	< 2.0	< 2.0	< 5.0	< 5.0	8.9	2.37	< 0.2	61.2	16.4	< 10	<3.0	< 5.0	< 5.0	< 5.0	< 5.0	262
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	< 5.0	27.8	< 2.0	< 2.0	< 5.0	< 5.0	14	0.03	< 0.2	< 5.0	16.6	< 10	< 3.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
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	< 5.0	28.1	< 2.0	< 2.0	< 5.0	< 5.0	7.2	0.04	< 0.2	< 5.0	15.6	< 10	< 3.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10
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		2.0	50	5.0	20.0	2.0	2.0	5.0	5.0	10.0	0.05	0.2	5.0	0.3	10.0	3	5.0	5.0	5..0	5.0	10.0

Notes:
See Figure 7-1 for location of wells.
Potable Well #10 has been shut down since 2000 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
NS = Well was not in operation during sample period

as Figures 7-2 and 7-3, respectively. Detailed descriptions and maps related to the LTRA groundwater monitoring program can be found in SER Volume II, Groundwater Status Report. Highlights of the program are described below.

- The HFBR Pump and Recharge system was re-started in December 2007 as per the OU III Record of Decision (ROD) contingency that was triggered in November, 2006. A new extraction well (EW-16) was constructed several hundred feet north of Princeton Avenue, and is being operated together with one of the existing extraction wells (EW-11) located near Princeton Avenue. The system is expected to be operated for several years.
- Building 96 source area extraction well RTW-2 (which was on standby during 2006) was placed back in service in October 2007 due to increasing PCE concentrations in the groundwater. An ion exchange system was added to the treatment system for extraction well RTW-1, because hexavalent chromium (VI) was detected in nearby monitoring wells at concentrations exceeding the DWS.
- Due to the persistently high levels of PCE observed in the groundwater at the Building 96 source area, in late 2007 BNL initiated an engineering evaluation to assess potential additional remedial alternatives. The evaluation is examining alternatives such as soil excavation, additional groundwater extraction wells, soil mixing with vapor extraction, electrical resistance heating, and injecting hydrogen release compounds. The evaluation will include additional geological characterization to better define the extent of a near-surface silt layer, which is believed to contain residual PCE contamination that is being slowly released to the groundwater.
- Two additional extraction wells were installed for the Chemical Holes Sr-90 system in 2007. The additional extraction wells were necessary to meet the cleanup goal of reducing Sr-90 levels to below DWS by 2040.
- An additional extraction well (RTW-6A) was installed at the Airport System, and began operating in November 2007. The additional extraction well was necessary to capture and treat the western portion of the VOC plume in this area.
- Groundwater samples that were collected during the g-2 tritium plume characterization effort described earlier identified higher than expected Sr-90 concentrations in the vicinity of the HFBR. This contamination represents the downgradient portion of the WCF Sr-90 plume. Based on preliminary groundwater modeling results, it is likely that several additional extraction wells will be necessary in order to achieve the OU III Environmental Services Division goal of reducing Sr-90 levels to below the 8 pCi/L DWS by 2070. Additional characterization work will be performed in this area in 2008.

7.7 GROUNDWATER TREATMENT SYSTEMS

The primary mission of the LTRA program is to operate and maintain groundwater treatment systems and prevent additional groundwater contamination from migrating off site. The cleanup objectives will be met by a combination of active treatment and natural attenuation. The specific cleanup goals are as follows:

- Achieve maximum contaminant levels (MCLs) for VOCs in the Upper Glacial aquifer by 2030
- Achieve MCLs for VOCs in the Magothy aquifer by 2065
- Achieve MCLs for Sr-90 at the BGRR in the Upper Glacial aquifer by 2070
- Achieve MCLs for Sr-90 at the Chemical Holes in the Upper Glacial aquifer by 2040

During 2007, BNL continued to make significant progress in restoring groundwater quality. Figure 7-4 shows the locations of 14 groundwater treatment systems in operation. Table 7-5 provides a summary of the amount of VOCs and Sr-90 removed from the aquifer since the start of active remediation in December 1996. During 2007, 198 pounds of VOCs and approximately 5.2 mCi of Sr-90 were removed from the groundwater, and more than 1.2 billion gallons of treated groundwater were returned to the aquifer. To date, 5,897 pounds of VOCs have been removed from the aquifer, and noticeable improvements in groundwater quality

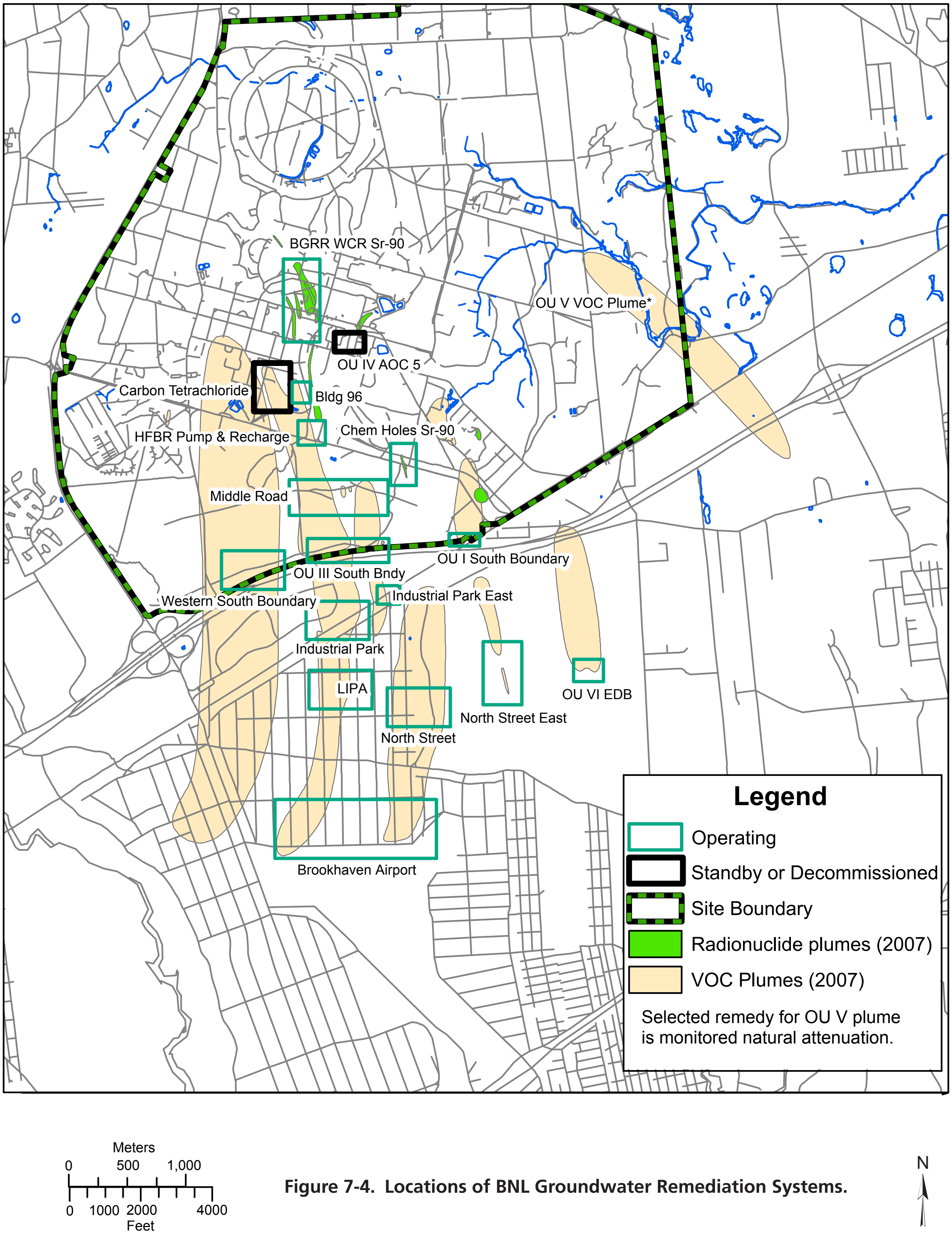

Figure 7-4. Locations of BNL Groundwater Remediation Systems.

Table 7-5. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2007.

		1997-2006		2007	
Remediation System	**Start Date**	**Water Treated** (Gallons)	**VOCs Removed** (Pounds) (e)	**Water Treated** (Gallons)	**VOCs Removed** (Pounds) (e)
OU I South Boundary	12/1996	3,047,314,000	331	137,000,000	6
OU III HFBR Tritium Plume (a)	05/1997	241,528,000	180	7,450,000	0
OU III Carbon Tetrachloride (d)	10/1999	153,538,075	349	Not in Service	0
OU III Building 96	01/2001	135,497,416	71	2,800,000	<1
OU III Middle Road	10/2001	1,139,411,550	707	128,000,000	34
OU III South Boundary	06/1997	3,048,952,850	2,537	136,000,000	32
OU III Western South Boundary	09/2002	531,647,000	45	71,000,000	4
OU III Industrial Park	09/1999	1,234,478,330	967	130,000,000	43
OU III Industrial Park East	06/2004	226,172,000	29	61,000,000	4
OU III North Street	06/2004	503,122,000	232	186,000,000	36
OU III North Street East	06/2004	357,976,000	16	71,000,000	4
OU III LIPA/Airport	08/2004	675,887,000	200	171,000,000	35
OU IV AS/SVE (b)	11/1997	(c)	35	Decommissioned	0
OU VI EDB	10/2004	333,711,000	(f)	138,000,000	(f)
Total		**11,616,851,220**	**5,699**	**1,239,250,000**	**198**

		2003–2006		2007	
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	10,004,826	2.32	2,400,000	0.27
OU III BGRR/WCF Sr-90	06/2005	14,551,000	9.25	7,600,000	4.9
Total		**24,555,826**	**11.57**	**10,000,000**	**5.17**

Notes:
(a) System was reactivated in late 2007 as a contingency action.
(b) System was shut down on January 10, 2001 and decommissioned in 2003.
(c) Air Sparging/Soil Vapor Extraction (AS/SVE) system performance was 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) Because EDB has only been detected at trace levels in the treatment system influent, no removal of VOCs is reported.

BGRR = Brookhaven Graphite Research Reactor
EDB = ethylene dibromide
HFBR = High Flux Beam Reactor
LIPA = Long Island Power Authority
WCF = Waste Concentration Facility
VOCs = volitile organic compounds

are evident in the OU I South Boundary, OU III South Boundary, OU III Industrial Park, OU III Industrial Park East, OU III North Street, OU IV, Building 96, and Carbon Tetrachloride areas. Also to date, the Chemical Holes Strontium-90 System has removed 2.6 mCi of Sr-90, and the BGRR/Waste Concentration Facility Strontium-90 System has removed 14.2 mCi of Sr-90. Detailed information on the groundwater treatment systems can be found in SER Volume II, Groundwater Status Report.

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