Chapter 8

GROUNDWATER PROTECTION

Groundwater protection at BNL is addressed by both prevention and minimization environmental emissions, and active remediation in areas where past operations have impacted groundwater quality. All remediation work is carried out under the Interagency Agreement (IAG) among the DOE, EPA, and NYSDEC.

The strategy for protecting groundwater at the BNL site includes the following elements:

- Reviewing engineering designs and conducting environmental assessments for new and existing facilities to ensure that potential environmental impacts are fully evaluated and reduced to the lowest possible level, or eliminated;
- Upgrading existing facilities to reduce the risk of accidental release of contaminants to the environment (i.e., upgrading underground storage tanks, replacing of deteriorated sewer lines, constructing new waste management facilities using best available environmental prevention technologies);
- Responding promptly and remediating spills to prevent contaminant migration to surface waters and groundwater;
- Conducting groundwater and surface water monitoring programs at active facilities that have the potential to impact the environment, so that accidental contaminant releases are detected quickly;

Groundwater Sampling

- Conducting groundwater monitoring programs at inactive chemical and radioactive materials storage and disposal sites and spill areas to assess the distribution and movement of existing groundwater contamination;
- Conducting environmental restoration in areas where soils and groundwater were contaminated by chemicals and radionuclides from past accidental spills, storage, or disposal;
- Implementation of waste minimization practices to reduce the volume and toxicity of all wastes, and using best management practices to manage and properly dispose of generated wastes; and,
- Implementation of a Pollution Prevention Awareness Program to ensure that employees are cognizant of their responsibilities for the proper storage, use, and disposal of chemicals in the work place.

8.1 Groundwater Surveillance

Groundwater quality at BNL is routinely monitored through a network of approximately 220 on-site and 40 off-site surveillance wells. Surveillance wells are generally used to monitor specific facilities where degradation of the groundwater is known or suspected to have occurred, to fulfill permit requirements, and to assess the quality of groundwater entering or leaving the site at BNL boundaries. Monitored facilities include the following: the Sewage Treatment Plant/Peconic River Area, Meadow Marsh-Upland Recharge Area, Waste Management Facility (WMF), "Current" Landfill, Former Landfill, Ash Repository, Central Steam Facility/Major Petroleum Facility (CSF/MPF), AGS, Waste Concentration Facility (WCF), Supply and Materiel, and several other smaller facilities.

Groundwater quality is also routinely monitored at all active potable supply wells and process supply wells. Figures 8-1 through 8-14 show the wells located in specific areas of concern (AOCs). In addition to groundwater quality assessments, water levels are measured from over 500 on-site and off-site wells to assess variations in directions and velocities of groundwater flow.

8.1.1 Potable Water and Process Supply Wells

During 1997, approximately 10.25 million liters per day (MLD) were pumped from the BNL potable and process-water supply network. This network consists of six potable supply wells (Wells 4, 6, 7, 10, 11, and 12) and five secondary cooling/process water supply wells (Wells 9, 101, 102, 103, and 105); all are screened entirely within the Upper Glacial aquifer. Due to continued modifications of the treatment system at the Water Treatment Plant, only wells 10, 11, and 12 supplied drinking water in 1997. Wells 102 and 103 provided the secondary cooling water at the AGS, and Well 9 supplied process water to the Biology Department's fish house. Secondary-cooling water for the Brookhaven Medical Research Reactor (BMRR) was supplied exclusively from Well 105.

The radiological sampling data discussed in Section 8.1.1.2 is compared to Federal and New York State Drinking Water Standards.

Grab samples were obtained quarterly from Potable Wells 10, 11 and 12 and analyzed for radioactivity, water quality indices, metals, and VOCs. Regulatory compliance samples were collected and analyzed in accordance with the BNL Potable Water System Sampling Plan. The results of the regulatory compliance samples were discussed in Chapter 2.

Process Supply Wells 9, 102, 103, and 105 were used periodically during 1997 and were analyzed for water quality, inorganic and organic contaminants. Water chemistry analyses (i.e., pH and conductivity) were also performed for Well 102 by the AGS facility operators, as needed, to meet their operational requirements.

8.1.1.1 Non-radiological Analyses

Potable Wells 10, 11, and 12 were used to supply potable water to the BNL community during CY 1997. The NYSDOH governs the quality of potable water supplies and requires that the water purveyor routinely monitor the supply for organic, bacteriological, and inorganic constituents. The NYSDOH requirements (under authority of the SDWA) are implemented by the SCDHS. Monitoring requirements for 1997 included quarterly analyses for Principal Organic Compounds (POCs), monthly bacteriological analyses, annual analyses for asbestos, micro-extractables, Synthetic Organic Compounds (SOCs) and pesticides, and annual inorganic and lead and copper analyses. Potable water samples were collected by BNL personnel and analyzed by an NYSDOH-certified contractor laboratory using standard methods of analysis. All analytical data were submitted to the SCDHS as required by Chapter I, Part 5 of the NYS Sanitary Code. The full details of the potable water compliance sampling and analysis program are discussed in detail in Chapter 2.

Potable Wells 4, 6 and 7, which are typically used to supply water to the BNL Water Treatment Plant (WTP), remained out of service in 1997 due to the continued improvements to the WTP.

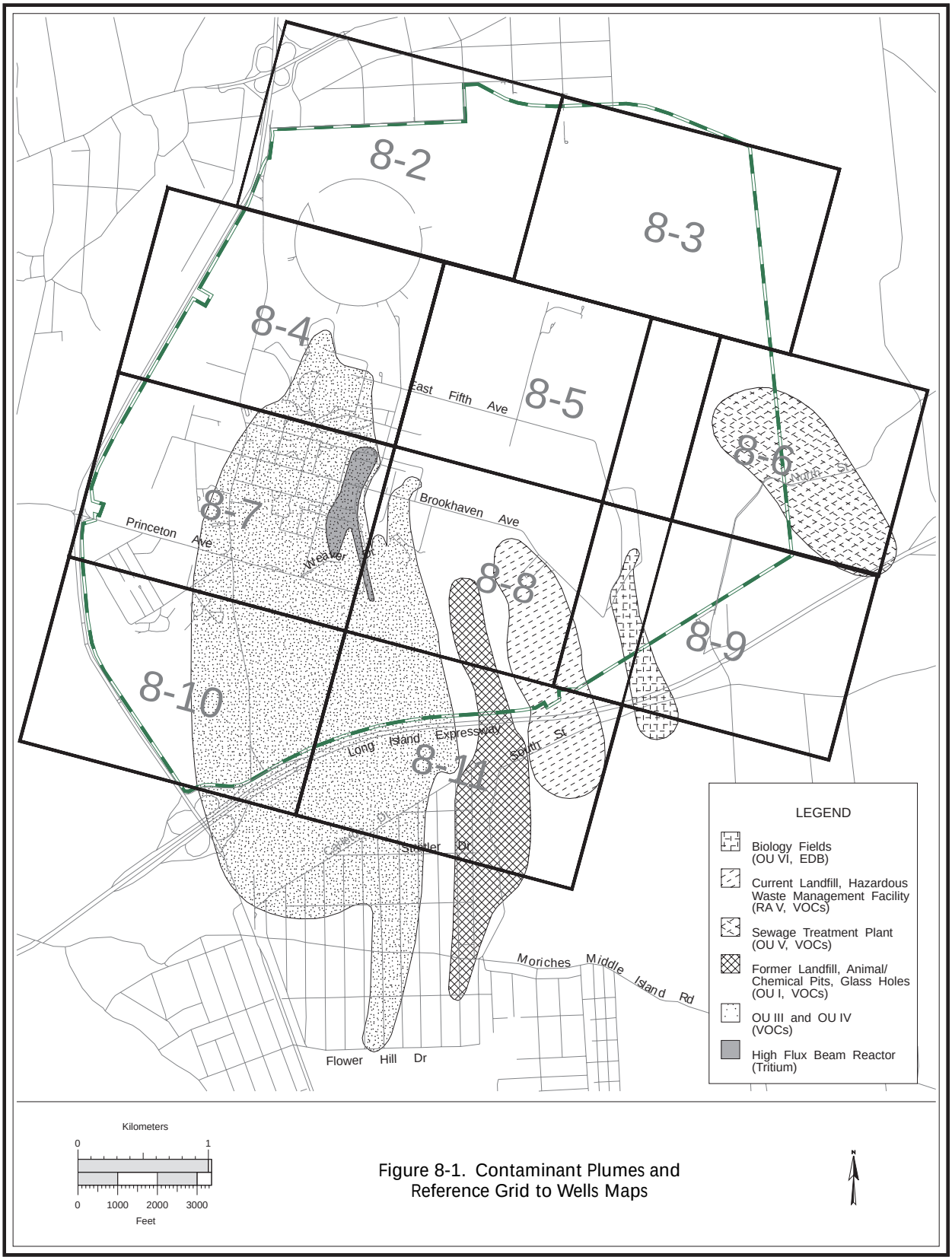


Figure 8-1. Contaminant Plumes and Reference Grid to Wells Maps

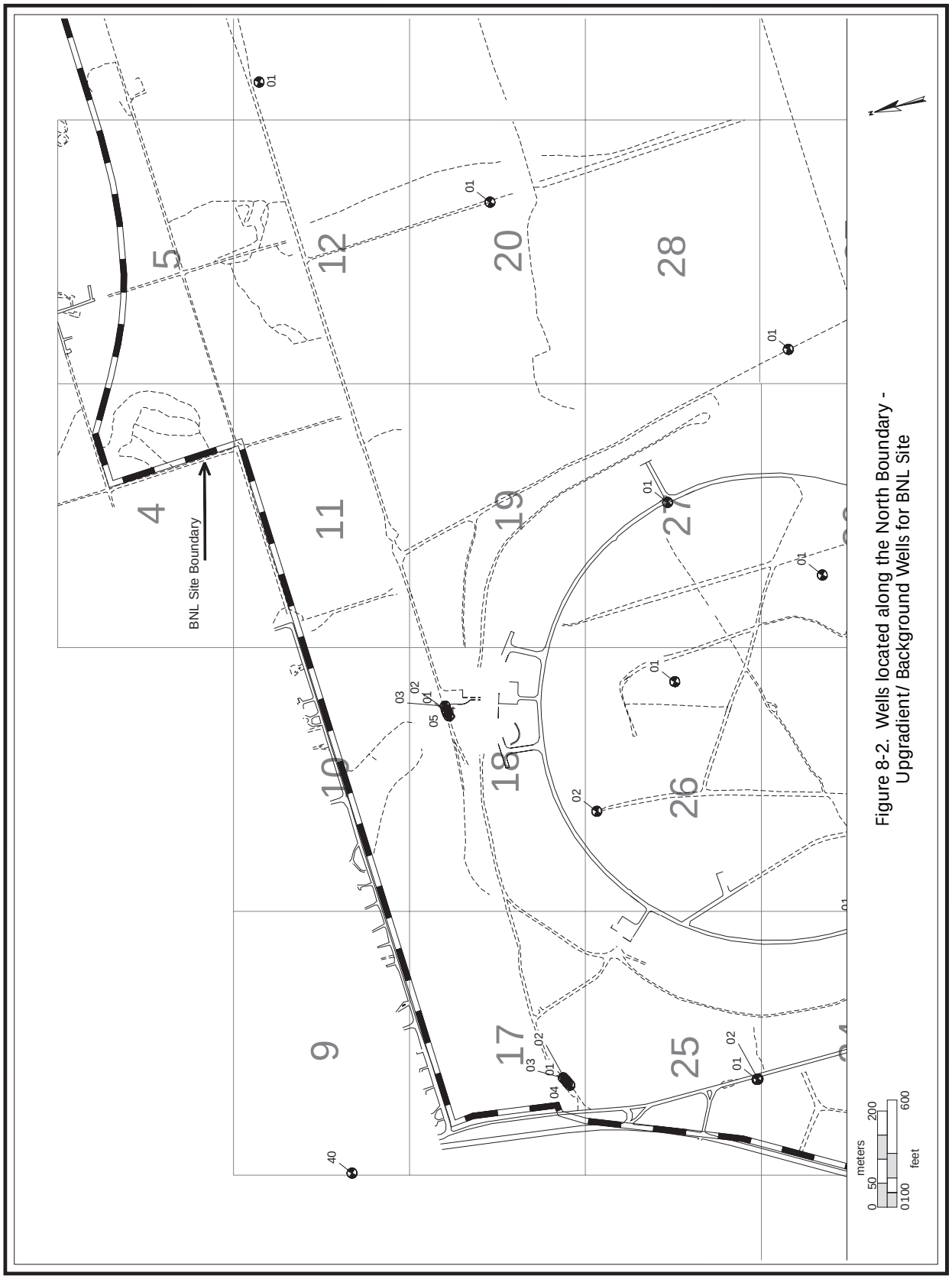


Figure 8-2. Wells located along the North Boundary - Upgradient/ Background Wells for BNL Site

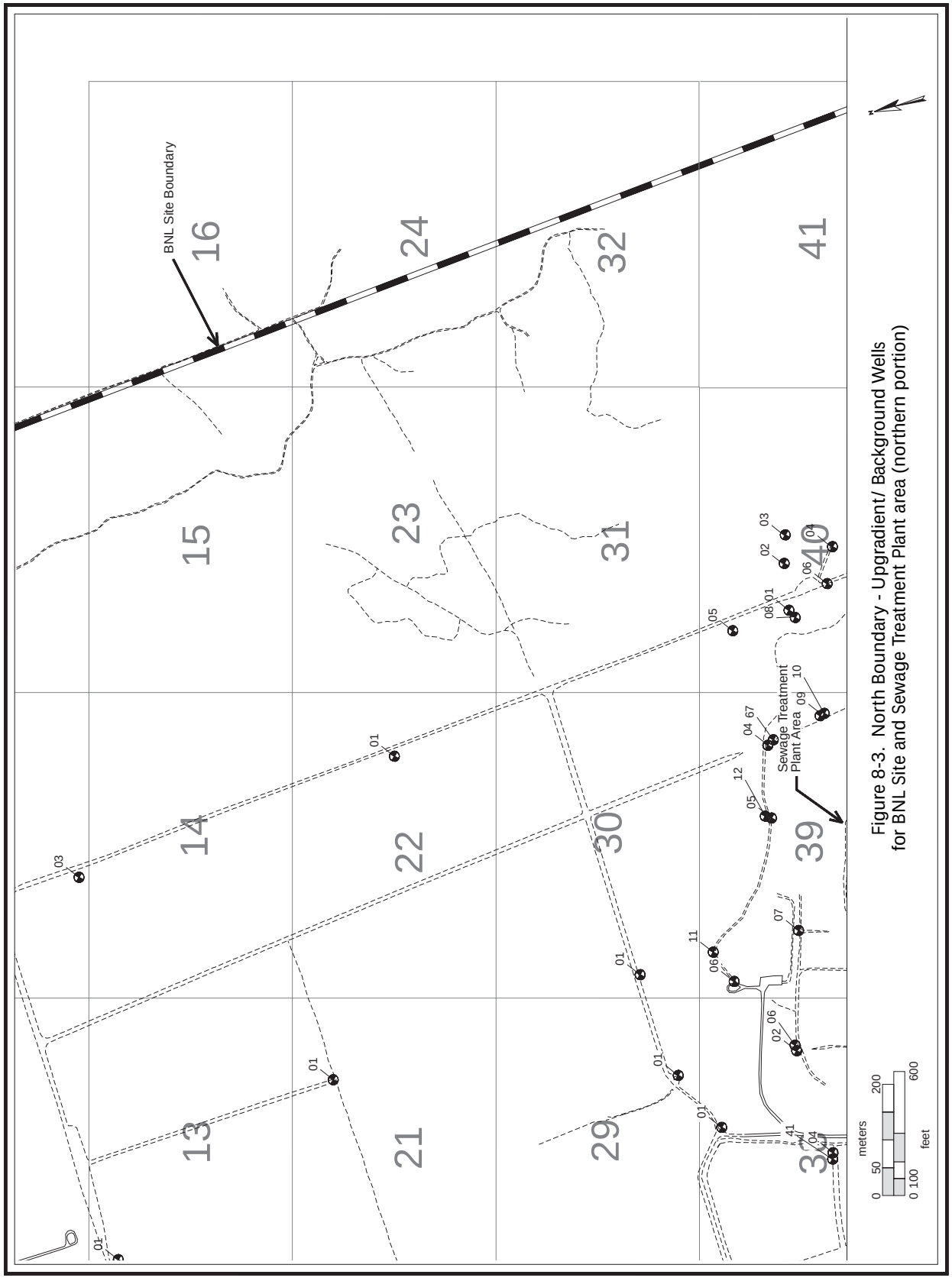


Figure 8-3. North Boundary - Upgradient/ Background Wells for BNL Site and Sewage Treatment Plant area (northern portion)

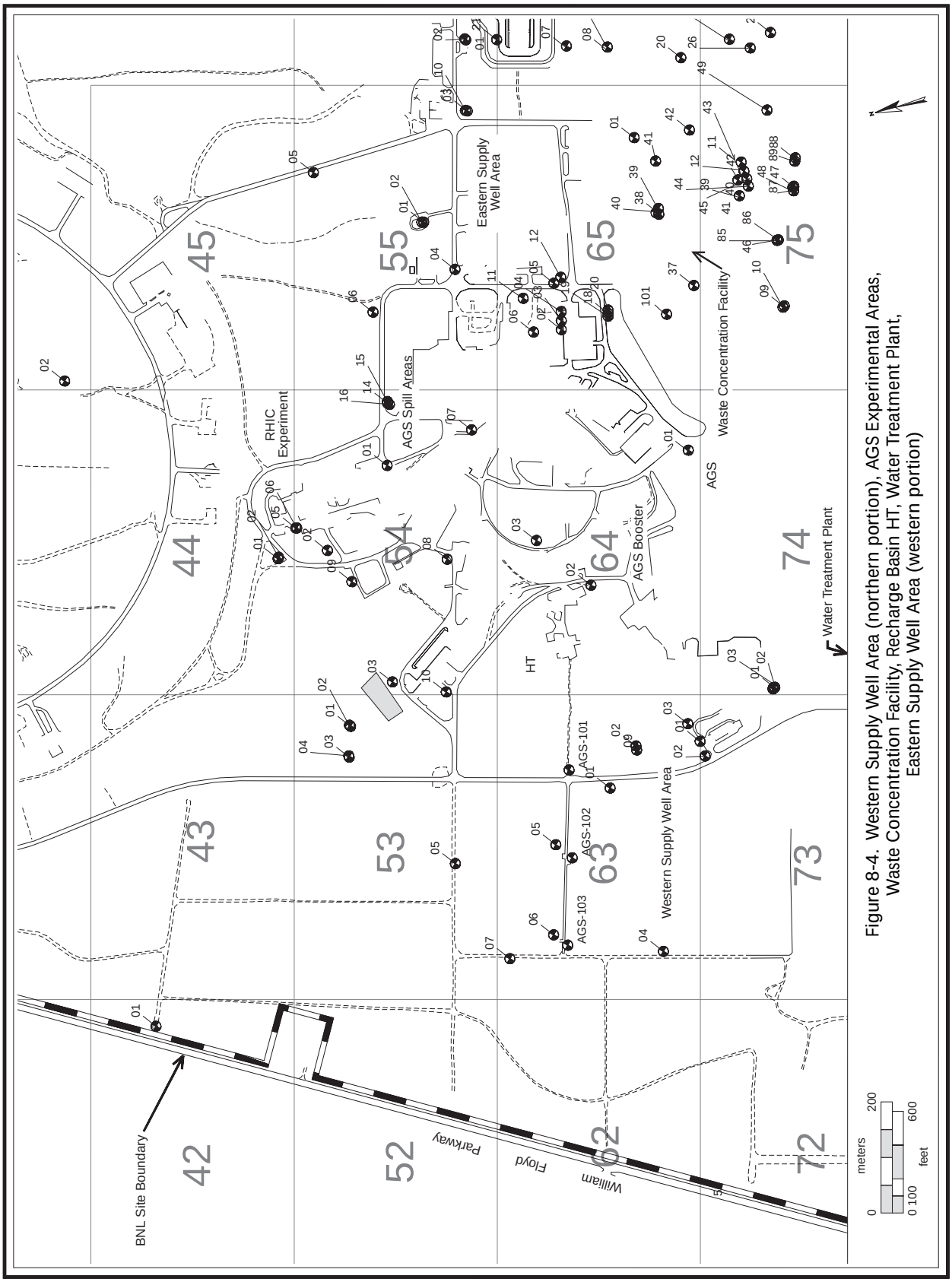


Figure 8-4. Western Supply Well Area (northern portion), AGS Experimental Areas, Waste Concentration Facility, Recharge Basin HT, Water Treatment Plant, Eastern Supply Well Area (western portion)

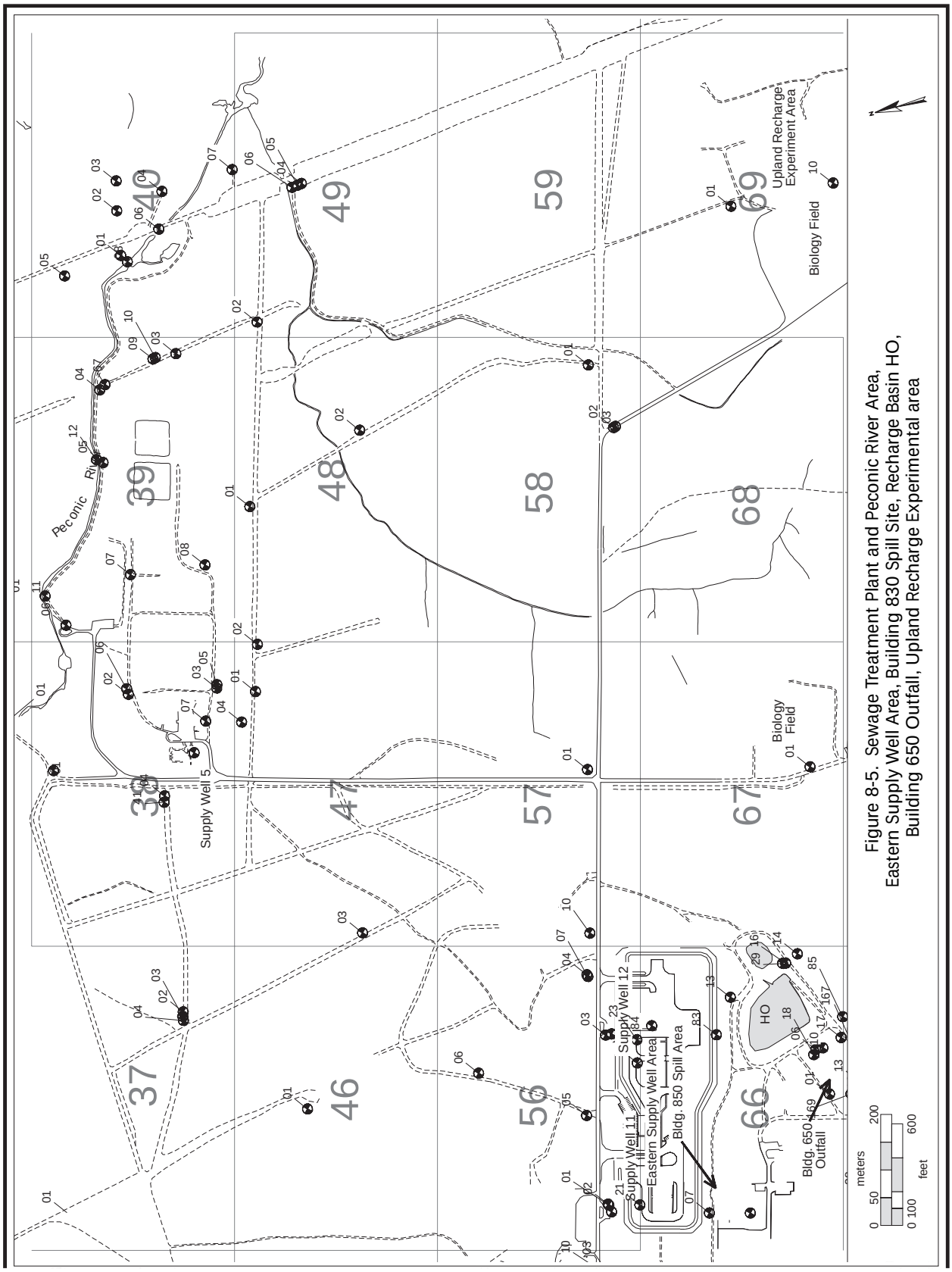


Figure 8-5. Sewage Treatment Plant and Peconic River Area, Eastern Supply Well Area, Building 830 Spill Site, Recharge Basin HO, Building 650 Outfall, Upland Recharge Experimental area

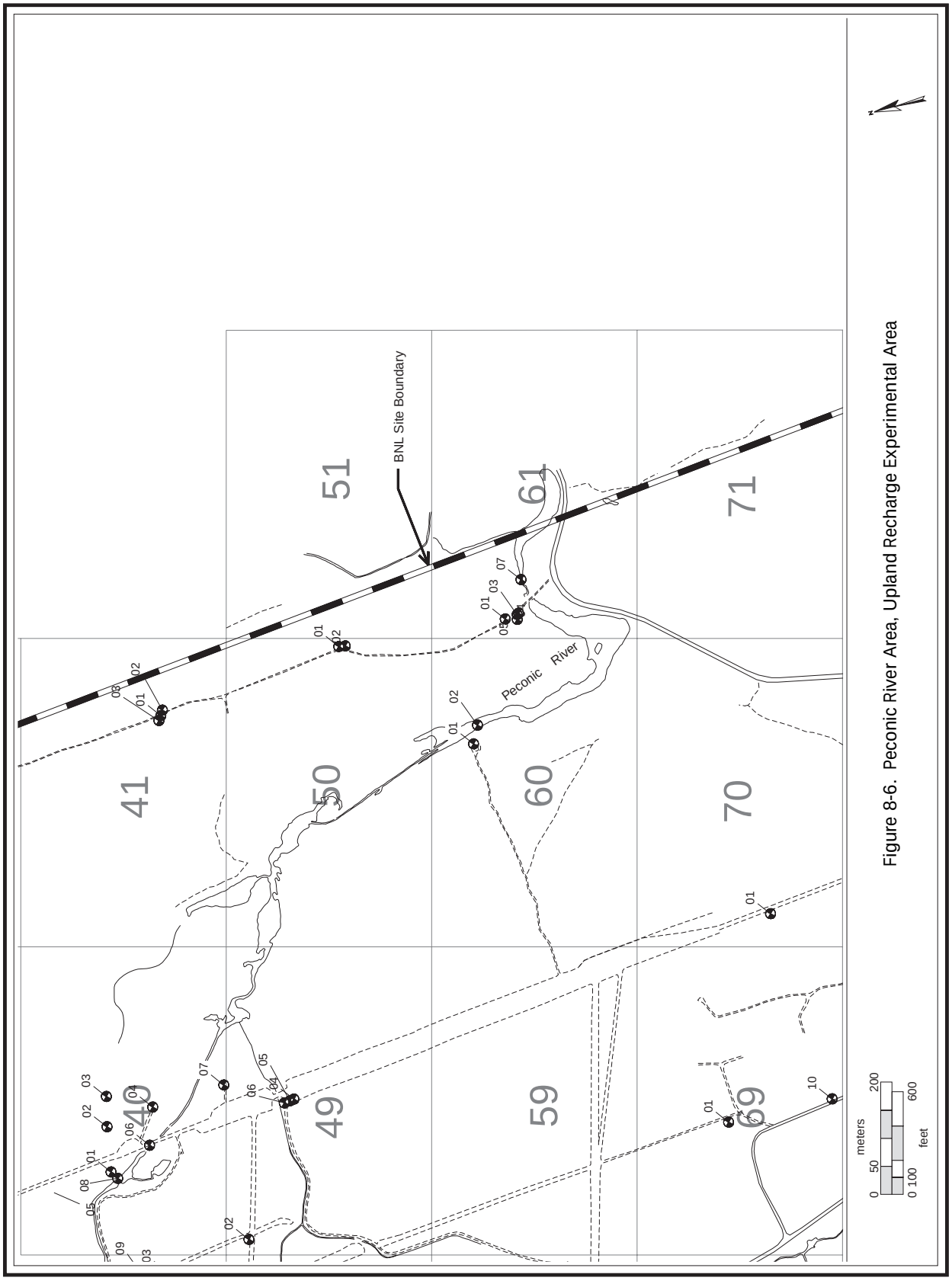


Figure 8-6. Peconic River Area, Upland Recharge Experimental Area

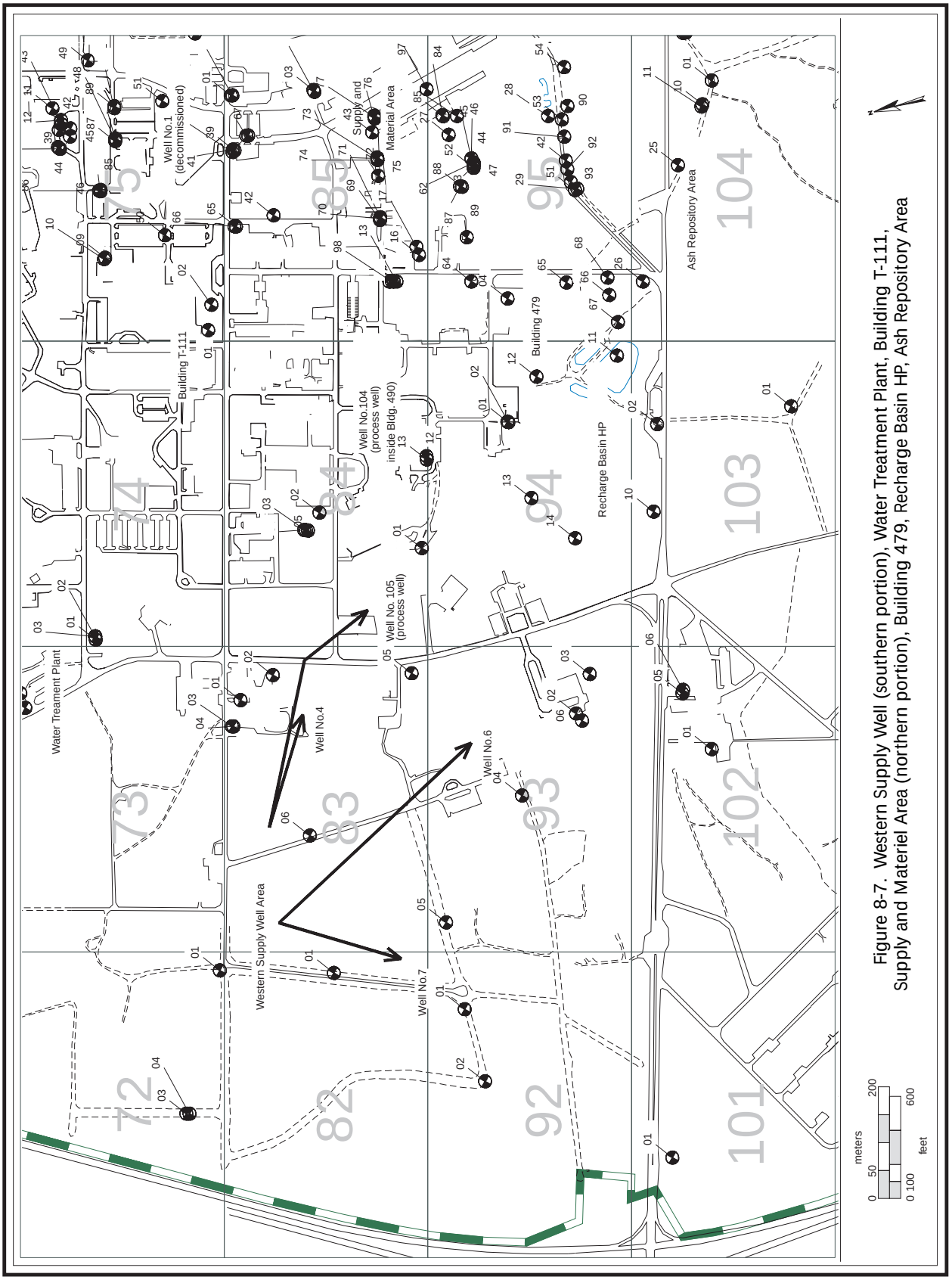


Figure 8-7. Western Supply Well (southern portion), Water Treatment Plant, Building T-111, Supply and Materiel Area (northern portion), Building 479, Recharge Basin HP, Ash Repository Area

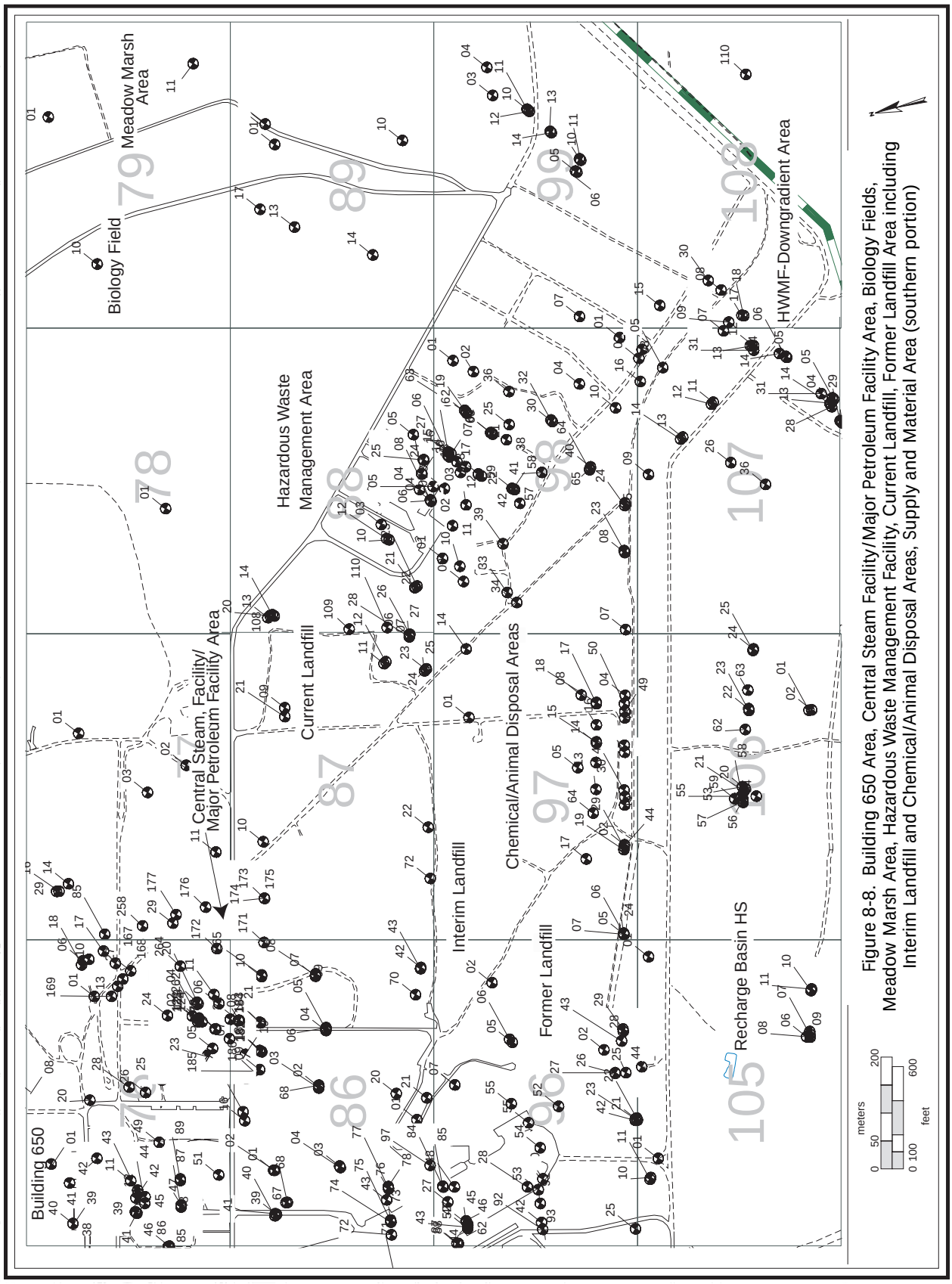


Figure 8-8. Building 650 Area, Central Steam Facility/Major Petroleum Facility Area, Biology Fields, Meadow Marsh Area, Hazardous Waste Management Facility, Current Landfill, Former Landfill Area including Interim Landfill and Chemical/Animal Disposal Areas, Supply and Material Area (southern portion)

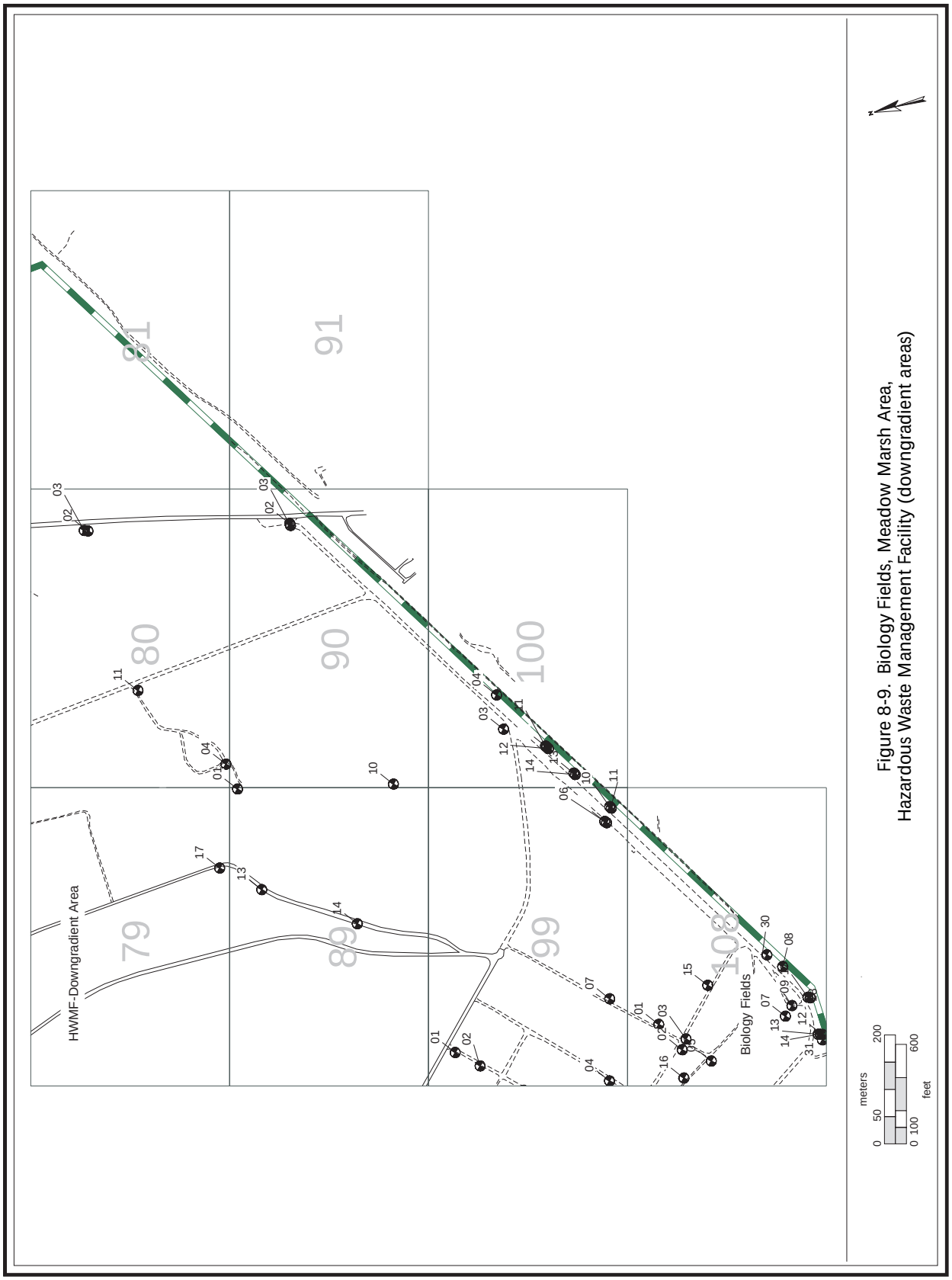


Figure 8-9. Biology Fields, Meadow Marsh Area, Hazardous Waste Management Facility (downgradient areas)

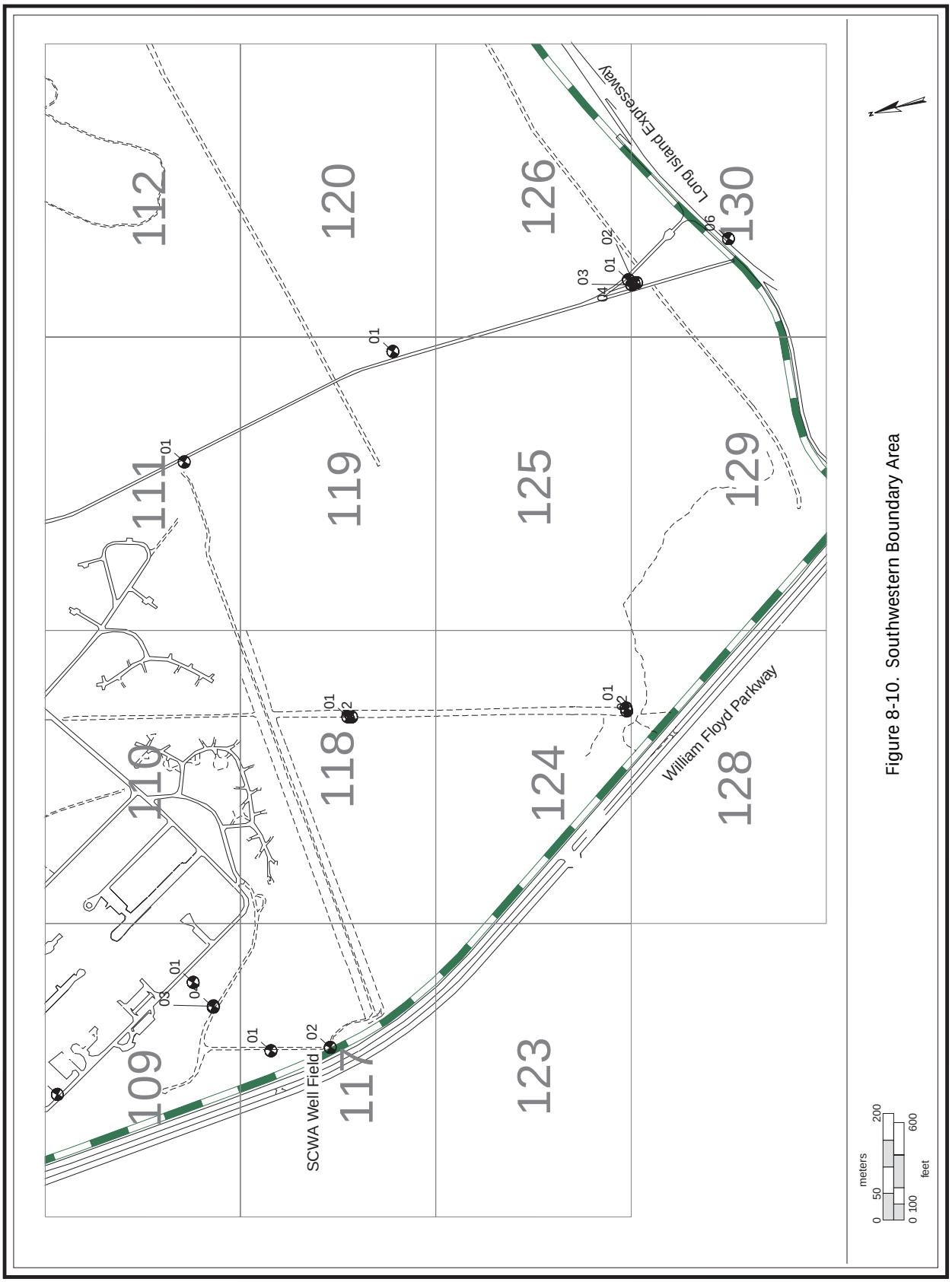


Figure 8-10. Southwestern Boundary Area

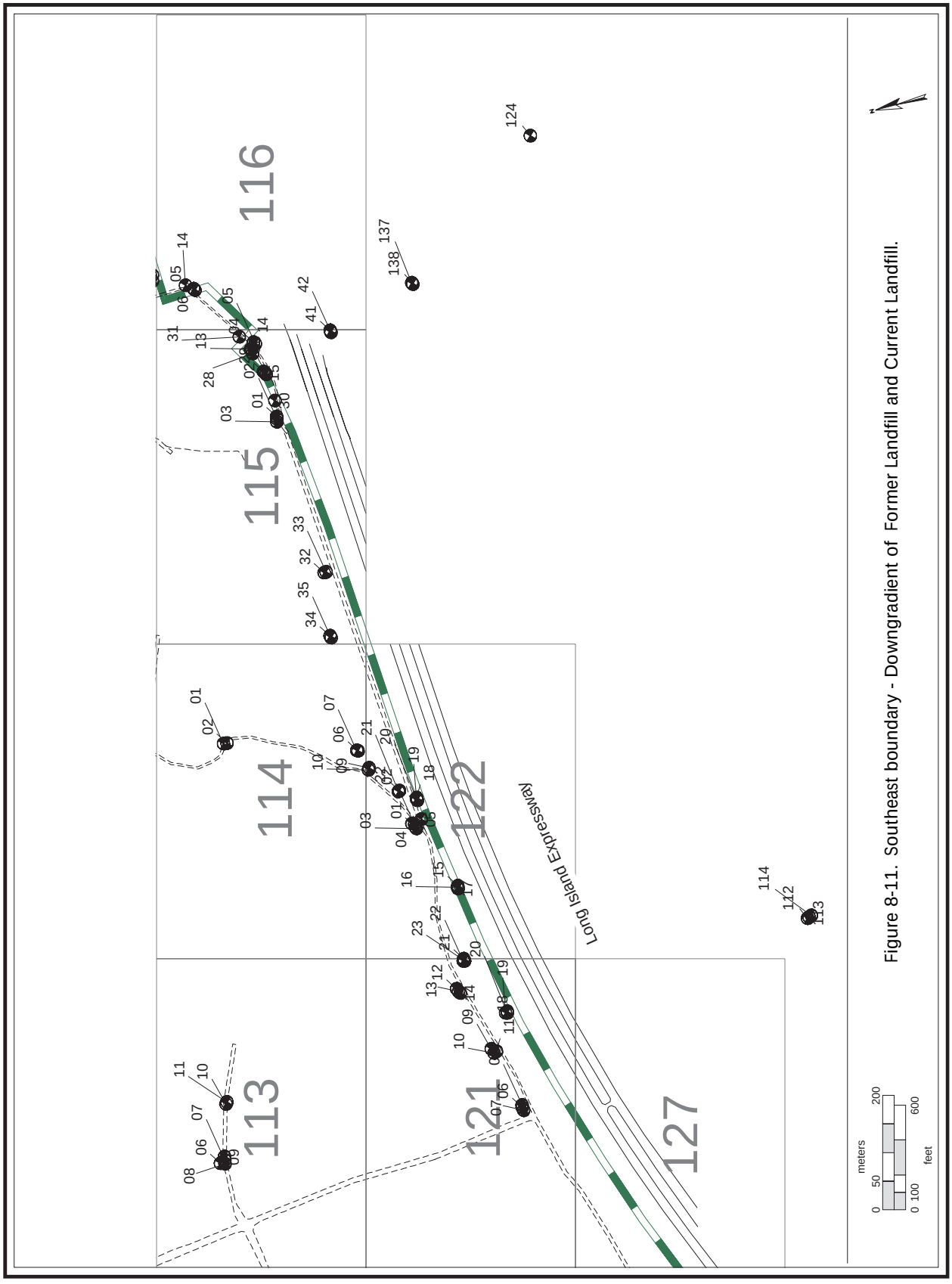


Figure 8-11. Southeast boundary - Downgradient of Former Landfill and Current Landfill.

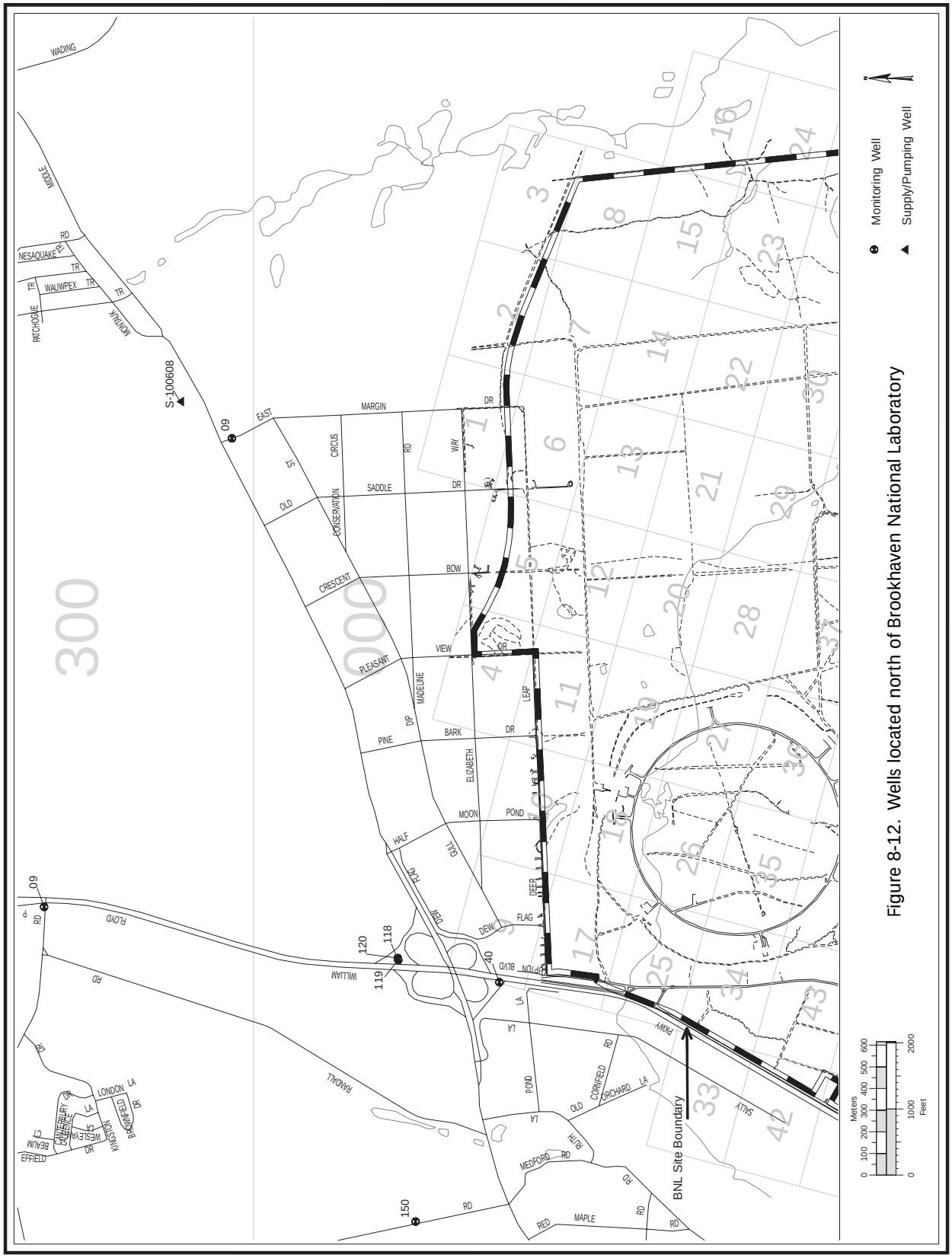


Figure 8-12. Wells located north of Brookhaven National Laboratory

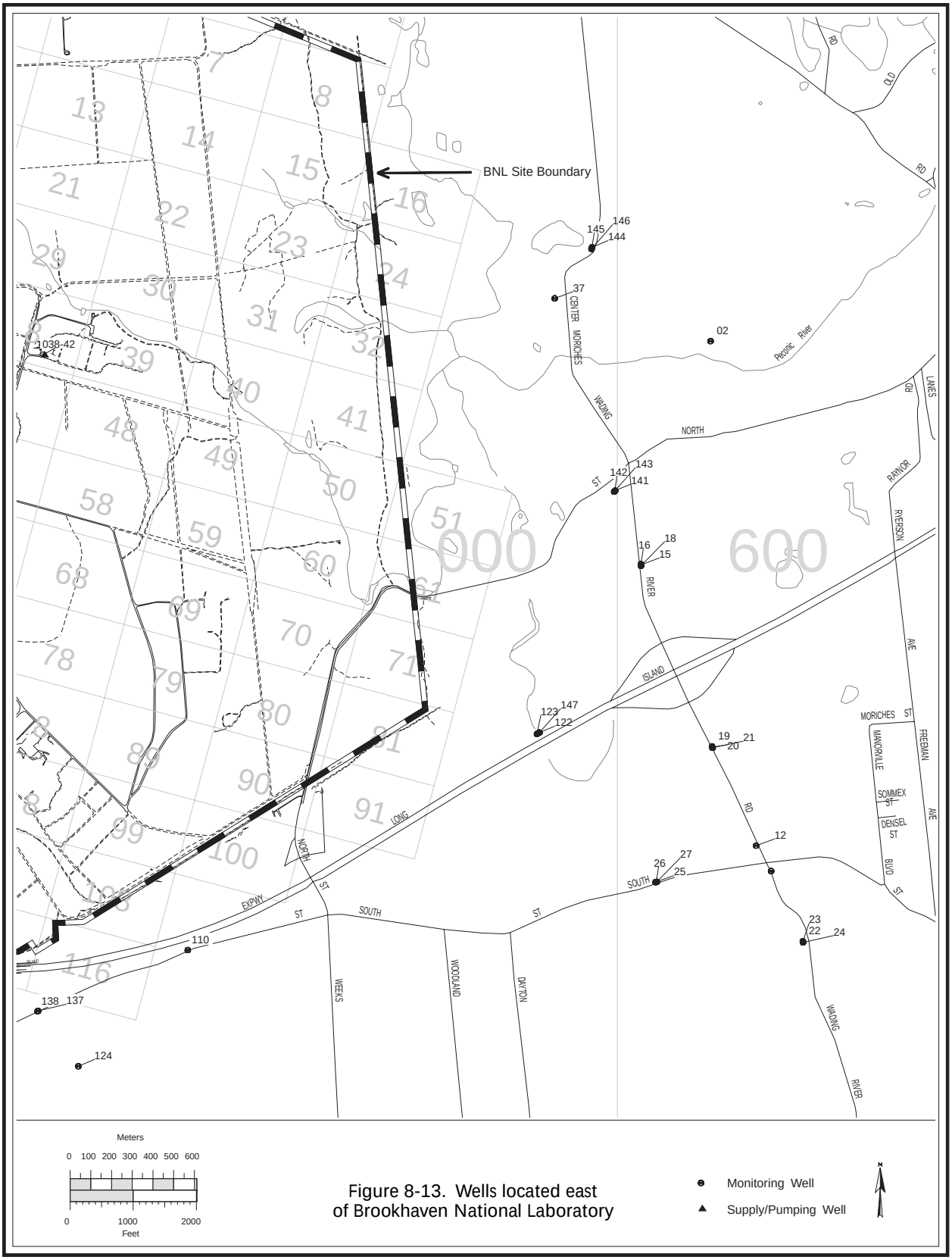


Figure 8-13. Wells located east of Brookhaven National Laboratory

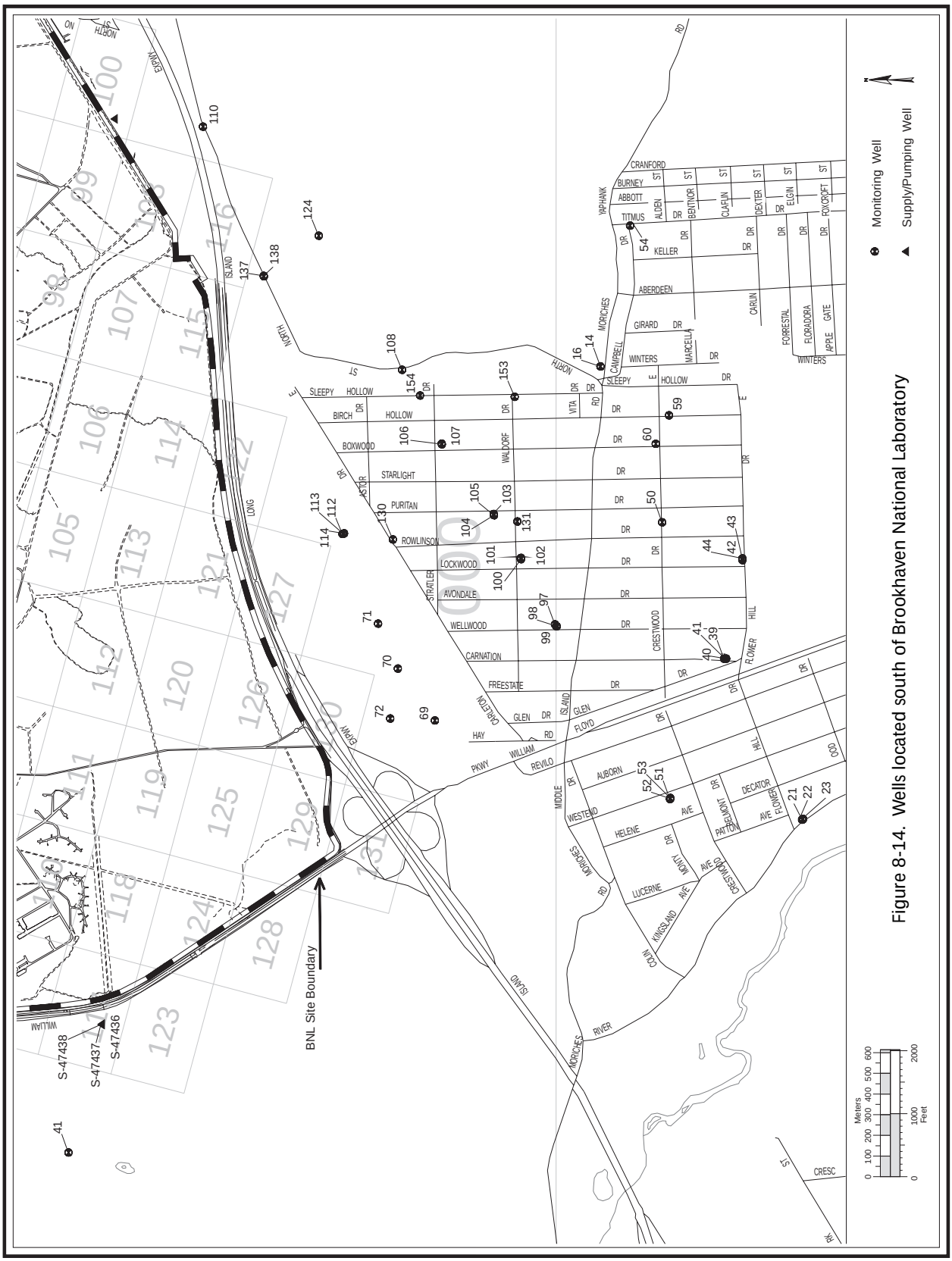


Figure 8-14. Wells located south of Brookhaven National Laboratory

Water obtained from Wells 4, 6 and 7 contains naturally occurring iron at concentrations which exceed drinking water guidelines. The water is treated at the WTP by a conventional lime softening process to precipitate the iron from solution. This water also contains elevated levels of VOCs, which must be treated to reduce their concentrations to below drinking water standards. To improve the efficiency of VOC removal, as well as to update WTP controls, modifications to the WTP were initiated in 1995. This project included the construction of dual 10-foot diameter by 35-foot tall air stripping towers, each with a rated capacity of 2,400 gallons per minute, for the removing of VOCs. The project also included construction of a new wetwell, which stores the iron-free water before air stripping, and a new clearwell, which stores the VOC treated water prior to site distribution. Although WTP improvements were completed in the summer of 1997, due to the build-up of iron scale within the screen zones of Wells 4 and 7, start-up of the facility was limited. Each of the wells was subsequently descaled and pump sections rebuilt to improve the yield. Consequently, the WTP and Wells 4, 6, and 7 were not sampled in 1997. The WTP is expected to be restarted in the summer of 1998.

In addition to the requirements of NYSDOH compliance monitoring, the ES&HS Division maintains a supplemental sampling and analysis program for the BNL potable water supply. During 1997, the S&EP Division monitored these wells for metals, water quality parameters, and VOCs. All analyses were conducted by the ES&HS Division ASL using EPA-approved methods. Tables 8-1, 8-2, and 8-3 summarize all the 1997 data.

The water-quality data show that nitrates, sulfates, and chlorides are well within the limits established in the NYS DWS (Part 5 NYS Sanitary Code). The pH values in these wells ranged from 5.9 – 7.2 and are typical of natural Long Island groundwater. To reduce the corrosivity of the groundwater Wells 10, 11, and 12 are equipped with metering pumps, which add sodium hydroxide to maintain the pH of the potable water effluent at approximately 8.

The majority of metals, including silver, cadmium, chromium, mercury, manganese and lead were not typically detected in the Laboratory's potable supply wells. Zinc and iron were detected at levels below their respective NYS DWS. Sodium occurred in all wells at ambient concentrations, which were well within NYS drinking water guidance values.

During the second or third month of each quarter, BNL collects samples which are analyzed onsite by the ES&HS ASL for ten organic compounds, consisting of the primary volatile halogenated aliphatic hydrocarbons and aromatic hydrocarbons detected in groundwater at the BNL site. These samples serve both as a quality control on the contractor laboratory, and as an additional source of organic data used in trend analysis of water quality. Water samples are collected from the well head before treatment. These data are summarized in Table 8-1. The data show that only TCA and chloroform were detected in the potable wells. The concentration of TCA in Well 11 exceeded the NYS DWS; however, this well was fitted with a carbon-adsorption treatment system during CY 1992 which reduced the concentration of TCA to levels well below the NYS DWS. The maximum concentration of TCA detected after the carbon filter was 2.7 µg/L. Chloroform was detected in several of the wells but only at trace levels. The remaining eight organic compounds were not detected in water samples collected during CY 1997.

Process Wells 9, 102, 103, and 105 were also sampled and analyzed during CY 1997. Wells 102 and 103 are used solely for supplying cooling water to the AGS, Well 9 supplies fresh water to the fish tanks housed in Building 463 (Biology Dept.), and Well 105 provides once-through cooling water for the Brookhaven Medical Research Reactor (BMRR). Tables 8-2 and 8-3 show that the concentrations of water-quality and inorganic elements are within ambient levels. Ambient groundwater quality in the western half of the BNL developed site is characterized by low pH and elevated concentrations of iron. Consequently, iron is present in all process wells at concentrations which exceed NYS AWQS. As in past years, VOCs continued to be detected in Biology Department process well 9, which is located within a portion of the defined Operable Unit III (OU III) VOC plume (see Section 8.1.2.1.3, below), contained concentrations of TCA and DCE which exceed the NYS DWS. This water is not used for drinking and the concentrations present do not interfere with the fish experiments conducted in Building 463.

Table 8-1
BNL Site Environmental Report for Calendar Year 1997
Potable Water and Process Supply Wells
Volatile Organic Compound Data [b]

Well Id. [a]		Chloroform ug/L	1,1 Dichloroethylene ug/L	1,1,1 - Trichloroethane ug/L
10 (FO)	N	5	5	5
	Minimum	<2.0 (trace)	<2.0	<2.0 (trace)
	Maximum	<2.0	<2.0	< 2.0
	Average	<2.0	<2.0	<2.0
11 (FP)	N	5	5	5
	Minimum	<2.0	<2.0 (trace)	3.0
	Maximum	<2.0	<2.0	6.2
	Average	<2.0	<2.0	5
12 (FQ)	N	5	5	5
	Minimum	<2.0 (trace)	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0
	Average	<2.0	<2.0	<2.0
9 (FM)	N	3	3	3
	Minimum	2.5	<2.0	12.1
	Maximum	3.7	5.4	17.5
	Average	2.9	3.3	14.7
102 (FI)	N	1	1	1
	Minimum	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0
	Average	<2.0	<2.0	<2.0
103 (FJ)	N	1	1	1
	Value	< 2.0	< 2.0	< 2.0
105 (FL)	N	5	5	5
	Minimum	<2.0	<2.0	<2.0
	Maximum	3	<2.0	2.2
	Average	2	<2.0	< 2.0
NYSDWS		100	5	5
Typical MDL		2	2	2

N: No. of samples
NYSDWS: New York State Drinking Water Standard
MDL: Minimum Detection Limit
(a): The location of potable and process wells is shown on Figure 6-11.
(b): Prefiltration

8.1.1.2 Radiological Analyses

Potable and process well water were sampled and analyzed for gross alpha and gross beta activity, tritium and strontium-90; the results are listed in Table 8-4. Nuclide-specific gamma spectroscopy was also performed, supplementing the requirements of the SDWA, which does not strictly require this analysis unless gross beta activity exceeds 50 pCi/L (1.9 Bq/L). In 1997, the total number of samples collected was increased from previous years. Collection frequency for potable wells was increased from four to eight times per year. The gross activity data for all potable well samples collected on August 19, 1997 were rejected and removed from the data set after a QA review indicated a uniform positive bias for all samples (see Chapter 10 for discussion).

Table 8-2
BNL Site Environmental Report for Calendar Year 1997
Potable Water and Process Supply Wells
Water Quality Data

Well Id. (a)		pH SU	Conductivity umhos/cm	Chlorides mg/L	Sulfates(c) mg/L	Nitrate as N (c) mg/L
10 (FO)	N	8	7	4	4	4
	Minimum	6.1	98	12.2	10.1	<1.0
	Maximum	6.8	116	13.8	10.9	< 1.0
	Average	NA	105	13	10.6	<1.0
11 (FP)	N	9	7	4	4	4
	Minimum	5.9	140	18.4	12.4	<1.0
	Maximum	6.5	149	19.7	13.4	<1.0
	Average	NA	144	19.3	13	<1.0
12 (FQ)	N	9	8	4	4	4
	Minimum	6.2	123	16.2	11	<1.0
	Maximum	6.5	129	16.7	11.9	<1.0
	Average	NA	125	16.5	11.5	<1.0
102 (FI)	N	2	2	2	2	2
	Minimum	6.2	130	20.4	8.6	<1.0
	Maximum	6.6	131	20.4	9	<1.0
	Average	NA	130	20.4	8.8	<1.0
103 (FJ)	N	1	1	1	1	1
	Value	6.4	135	20.1	8.7	< 1.0
9 (FM)	N	5	4	4	4	4
	Minimum	6.3	120	17.6	11.01	<1.0
	Maximum	7.2	126	18.5	11.5	<1.0
	Average	NA	124	18.2	11.3	<1.0
105 (FL)	N	5	4	4	4	4
	Minimum	6.4	182	28.3	13.4	< 1.0
	Maximum	7.1	194	32.3	14.8	< 1.0
	Average	NA	189	30.8	13.8	< 1.0
NYSDWS		(b)	(b)	250	250	10
Typical MDL		NA	10	4	4	1

N: No. of samples
NA: Not Applicable
MDL: Minimum Detection Limit
NYSDWS: New York State Drinking Water Standard
(a): The location of potable and process wells is shown on Figure 6-11.
(b): No standard specified.
(c): Holding times for nitrates and sulfates were typically exceeded.

Gross activity levels in the potable water wells were consistent with those of typical background environmental water samples. Note that the maximum gross activity data summarized in Table 8-4 is lower than the values reported to the County in 1997 as presented in Table 2-5. Several datum listed in Table 2-5 were biased high due to an analytical instrument error. Table 8-4 includes only those results which were validated. Neither tritium nor strontium-90 were observed above the MDL in any of these wells. No man-made gamma-emitting radionuclides were detected in any of the potable water samples, with the exception of one detection of manganese-54 in Well 10 at 0.23±0.16 pCi/L (9 ± 5 mBq/L). This result is near the detection limit of the analysis method, making its positive identification uncertain.

Table 8-3
BNL Site Environmental Report for Calendar Year 1997
Potable and Process Supply Wells
Metals Data

Well Id. (a)		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Na mg/L	Pb mg/L	Zn mg/L
10 (FO)	N	4	4	4	4	4	4	4	4	4	4
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	8.8	<0.002	<0.02
	Maximum	<0.025	< 0.0005	<0.005	< 0.05	0.11	<0.0002	<0.05	9.4	0.01	0.049
	Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.2	<0.002	< 0.02
11 (FP)	N	5	5	5	5	5	5	5	5	5	5
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	12.8	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	< 0.05	<0.075	<0.0002	<0.05	13.2	< 0.002	0.225
	Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	12.9	<0.002	0.055
12 (FQ)	N	5	5	5	5	5	5	5	5	5	5
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	13.1	<0.002	< 0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	0.11	<0.0002	<0.05	14	<0.002	0.1
	Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	13.7	<0.002	0.022
9 (FM)	N	5	5	5	5	5	5	5	5	5	5
	Minimum	<0.025	<0.0005	<0.005	<0.05	0.21	<0.0002	<0.05	10.2	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	0.89	<0.0002	<0.05	11.1	<0.002	0.095
	Average	<0.025	<0.0005	<0.005	<0.05	0.39	<0.0002	<0.05	10.9	<0.002	0.024
102 (FI)	N	2	2	2	2	2	2	2	2	2	2
	Minimum	<0.025	<0.0005	<0.005	<0.05	3.8	<0.0002	0.47	14	< 0.002	0.06
	Maximum	<0.025	<0.0005	<0.005	<0.05	3.9	<0.0002	0.48	14.4	0.022	0.1
	Average	<0.025	<0.0005	<0.005	<0.05	3.8	<0.0002	0.48	14.2	0.011	0.08
103 (FJ)	N	1	1	1	1	1	1	1	1	1	1
		<0.025	<0.0005	<0.005	<0.05	3.7	< 0.0002	0.46	14.65	< 0.002	0.03
105 (FL)	N	5	5	5	5	5	5	5	5	5	5
	Minimum	<0.025	<0.0005	<0.005	< 0.05	< 0.075	<0.0002	< 0.05	17.4	< 0.002	0.024
	Maximum	<0.025	0.0012	<0.005	0.11	20.8	<0.0002	0.07	18.8	0.24	4.8
	Average	<0.025	<0.0005	<0.005	0.05	4.7	<0.0002	0.05	18.1	0.05	1.3
NYSDWS		0.05	0.01	0.05	1.3	0.3	0.002	0.3	(b)	0.015	5
Typical MDL		0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1	0.002	0.02

N: No. of samples
NYSDWS: New York State Drinking Water Standard
MDL: Minimum Detection Limit
(a): The location of potable and process wells is shown on Figure 6-11.
(b): No standard specified.

Compliance with the Safe Drinking Water Act is based on the analysis results obtained from an annual composite of four quarterly samples or the average of the analyses of four quarterly samples. Compliance is demonstrated if annual average gross alpha activity is less than 15 pCi/L (0.6 Bq/L), gross beta activity is less than 50 pCi/L (1.9 Bq/L), strontium is less than 8 pCi/L (0.3 Bq/L), and tritium is less than 20,000 pCi/L (740 Bq/L). All detected radionuclides combined must not cause a person consuming the water to receive an effective dose equivalent greater than 4 mrem in a year. All of these criteria were satisfied. *Therefore, in CY 1997, the BNL portable water system was in full compliance with the radiological requirements of 40 CFR 141.*

Process wells 9, 102, and 105 showed radiological results throughout the year that were consistent with ambient environmental values.

Table 8-4
BNL Site Environmental Report for Calendar Year 1997
Potable and Process Well Gross Activity and Tritium Results

Well No.	Samples Collected		Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Tritium (pCi/L)	Sr-90 (pCi/L)
Process Wells						
102	2	Max.	< 1.4	2.1 ± 1.0	< 333	NS
		Avg.	0.1 ± 0.6	1.6 ± 1.0	120 ± 126	
103	1	Max.	3.3 ± 1.2	5.7 ± 2.4	< 534	NS
105	3	Max.	3.6 ± 1.2	2.7 ± 1.0	< 375	NS
		Avg.	1.3 ± 3.3	2.1 ± 1.2	-124 ± 863	
9	4	Max.	< 0.5	< 3.8	< 375.	NS
		Avg.	0.2 ± 0.4	0.9 ± 1.3	-74 ±1094	
Potable Wells						
10	7	Max.	1.2 ± 0.5	8.3 ± 0.5	< 375	< 1.3
		Avg.	0.1 ± 1.0	1.9 ± 5.5	37 ± 672	(c)
11	8	Max.	1.7 ± 1.0	< 3.8	373 ± 208*	< 1.2
		Avg.	0.3 ± 1.3	1.9 ± 2.5	-79 ± 934	(c)
12	7	Max.	< 1.4	1.6 ± 0.9	< 375	< 1.1
		Avg.	0.1 ± 0.8	1.2 ± 0.7	-103 ± 954	(c)
Drinking Water Standard			15 (a)	50 (b)	20,000	8

* MDL for this sample = 326 pCi/L.
NS = Not Sampled for this analyte
Notes:
(a) Excluding radon and uranium.
(b) Screening level above which analysis for individual radiouclides is required.
(c) All results for this analyte were below the detection limit. Highest detection limit shown as maximum.

Data from potable wells sampled on August 19, 1997 deleted from sample population following QA review. See Chapter 10 for discussion.

8.1.2 Environmental Restoration (CERCLA) Groundwater Monitoring

The BNL Environmental Restoration Division's Sitewide Groundwater Monitoring Program was established to integrate groundwater sampling, and database activities required for the various CERCLA projects managed by ERD. The mission of ERD's Program is to monitor the various contaminant plumes both on- and off-site, as well as the effects of remedial actions on them. The ES&HS Division is responsible for facility and regulatory compliance monitoring at BNL (see 8.1.3). The ES&HS Division and ERD programs are coordinated to ensure completeness, and to prevent duplication of effort in sampling and analyzing the groundwater.

The long-term groundwater monitoring projects coordinated under the Sitewide Groundwater Monitoring Program are designed to address the following issues:

1. Pre-Record of Decision (ROD) Monitoring: Addresses the short-term monitoring of plumes to track their movement following the Remedial Investigation characterization and prior to remediation;
2. Post-Record of Decision (ROD) Monitoring: Addresses the long-term monitoring of plumes to track their movement following the initiation of remediation systems, including:

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

b. Treatment System/Hydraulic Containment Effectiveness: Includes monitoring the active pump-and-treat systems to verify that they are capturing and removing contaminants.

3. Outpost Monitoring: Samples the wells located downgradient of the leading edge of contaminant plumes to give early warning of the arrival of the leading edge of the plume.

Sections 8.1.2.1 and 8.1.2.2 are overviews of significant CERCLA groundwater monitoring and remediation activities for CY 1997. Detailed analytical results for each sample obtained under the Sitewide Groundwater Program are provided in the "1997 ERD Sitewide Groundwater Monitoring Report" (BNL, 1998).

For each significant contaminant source area and plume described below, groundwater contaminant distribution maps and cross sections are provided. These maps depict the areal extent of contamination, and were created by selecting the highest contaminant concentration for a given well cluster observed during a selected sample period. Associated cross sections show the vertical distribution/extent of contamination, as well as the hydrogeology. The cross sections are generally oriented through along the highest contaminant concentration sections of each plume. The position for each line of the cross section is identified on the corresponding plume maps.

A review of the groundwater data indicates that in most areas there was little overall change in contaminant distribution during CY 1997 in any of the plumes. However, slight decreases in VOC concentrations were observed near the OU III southern boundary, groundwater extraction well area. CY 1997 was the first full year of active CERCLA groundwater remediation activities, and it is expected that significant changes in plume distributions will be observed in future years as these remediation systems remove the contaminants from the groundwater. The locations of all BNL groundwater monitoring wells are shown in Figures 8-1 through 8-14. All wells sampled during CY 1997 are listed in Appendix D.

8.1.2.1 Non-radiological Analyses

This section is an overview of non-radiological groundwater contamination issues across the BNL site, typically VOCs. The 1997 ERD Sitewide Groundwater Monitoring Report (BNL, 1998) gives detailed information on these plumes.

8.1.2.1.1 Site Background

Ambient (or background) groundwater quality for the BNL site is monitored through a network of 13 wells located in the northern portion of the site and in off-site areas to the north. The site background wells provide information on the chemical and radiological composition of groundwater that has not been impacted by activities at BNL. These background data are a valuable reference for comparison with groundwater quality data from areas that have been affected. This well network also provides early warning of contaminants originating from potential upgradient sources of contamination.

There were no significant detections of VOCs in background wells. The highest concentration was tetrachloroethylene (PCE) at 1.4 micrograms per liter (µg/L) in well 017-03, a deep Upper Glacial aquifer well located in the northwest corner of the site. In previous years, both VOCs and nitrates were found at concentrations slightly above NYS AWQS in several background wells.

8.1.2.1.2 Operable Unit I

Former Landfill, Animal/Chemical Pits and Glass Holes: The Former Landfill area initially was used by the United States Army during World Wars I and II, then BNL used the southeast corner of the landfill from 1947 through 1966 to dispose of construction and demolition debris, sewage sludge, chemical and low-level radioactive waste, used equipment, and animal carcasses. From

Animal Chemical Pits & Glass Holes

Former Landfill

1960 through 1966, Laboratory waste, glassware containing chemical and radioactive waste, and animal carcasses containing radioactive tracers were disposed of in shallow pits in an area directly east of the Former Landfill. From 1966 through 1981, the Laboratory continued to dispose of used glassware in shallow pits located directly north of these chemical/animal pits.

A network of seven monitoring wells is situated directly upgradient and downgradient of the Former Landfill. It was designed in accordance with post-closure operation and maintenance (O&M) requirements specified in 6 NYCRR Part 360, "Solid Waste Management Facilities." These requirements specify that the well network be monitored quarterly for a minimum of five years, upon which BNL may petition the NYSDEC to modify the frequency and types of analyses based on supporting data. The objective of this program is to monitor radiological and non-radiological contamination in the shallow Upper Glacial aquifer immediately downgradient of the landfill. The program was initiated following the capping of the Former Landfill in November 1996, and will verify whether the cap effectively prevents the continued leaching of contaminants from the landfill, and anticipated long-term improvements to groundwater quality occur. In addition to these seven wells, BNL established a separate well network to monitor the Animal/Chemical Pits and Glass Holes areas and the downgradient portions of the Former Landfill plume, and plumes originating from the Animal/Chemical Pits and Glass Holes areas. The downgradient portions of these plumes are currently being monitored as part of the OU I/IV Pre-ROD Monitoring Program.

The primary chemical contaminants observed in the Former Landfill - Animal/Chemical Pits and Glass Holes plume are carbon tetrachloride (CT), 1,1,1-trichloroethane (TCA), 1,1-dichloroethylene (DCE), trichloroethylene (TCE), and chloroform. All of these constituents are observed in wells extending from the source area to the southern site boundary at concentrations generally less than 20 µg/L total concentration VOCs (TVOCs). The New York State Ambient Water Quality Standards (NYS AWQS) for CT, TCA, DCE, and TCE is 5 µg/L, whereas the standard for chloroform is 7 µg/L. The same constituents are also found south of the site boundary, to just beyond Moriches Middle Island Road in North Shirley. Figure 8-15 depicts the extent of TVOC contamination (as defined by the 5 µg/L TVOC iso-concentration contour). The plume is approximately 3,500 feet at its maximum width. The higher concentration segment of the plume (>50 µg/L) is approximately 1,600 feet wide (Figure 8-15). The area of the plume showing the highest TVOC concentration is off-site. This area of the plume is composed primarily of CT, with a TVOC concentration of 825 µg/L observed in October 1997.

The distribution of VOC contamination with depth is shown on Figure 8-16. In general, VOCs are found in the shallow portions of the Upper Glacial aquifer in the vicinity of the Former Landfill, Animal/Chemical Pits and Glass Holes area. As the contamination migrates southward, it moves into the middle Upper Glacial at the site boundary, and the deep Upper Glacial aquifer off-site in North Shirley.

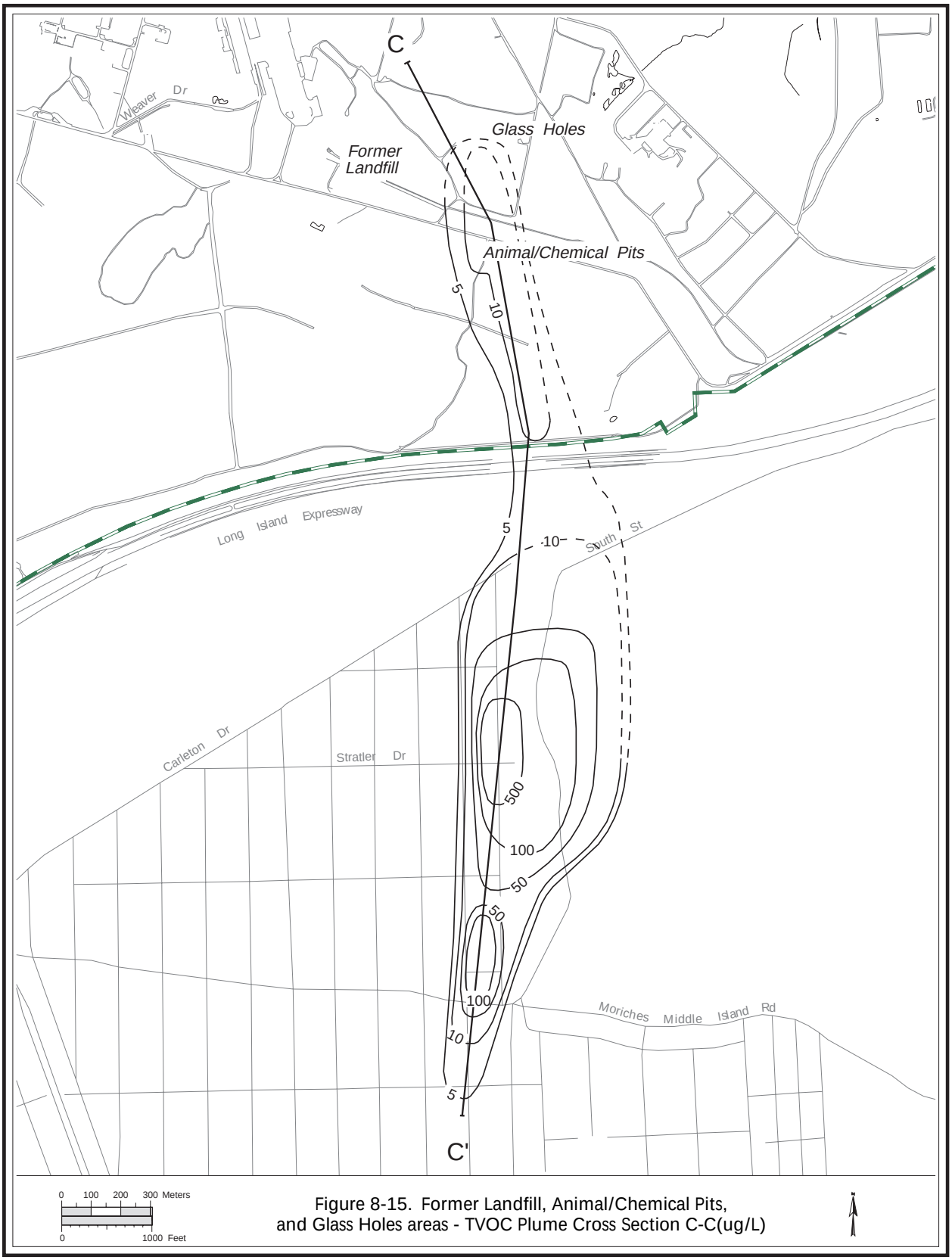


Figure 8-15. Former Landfill, Animal/Chemical Pits, and Glass Holes areas - TVOC Plume Cross Section C-C(ug/L)

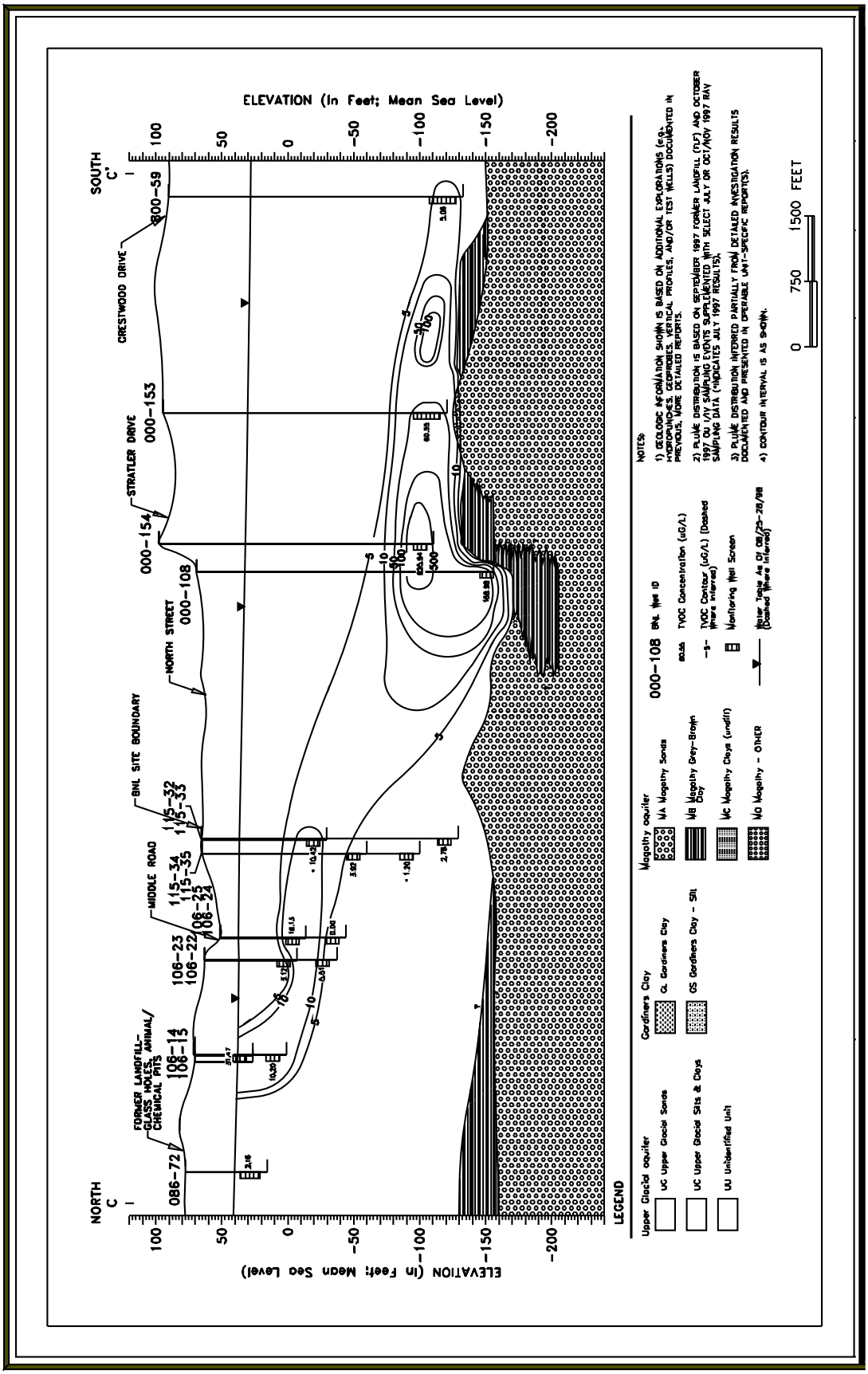


Figure 8-16. Former Landfill, Animal/Chemical Pits, and Glass Holes areas TVOC plume cross section C-C (ug/L)

Old Hazardous Waste Management Facility

Figure 8-17 shows the trend in VOC concentration for two key wells (000-108 and 000-154) located off-site in the high concentration portion of the plume. Data from well 000-108 indicates a general increase with time. The Former Landfill - Animal/Chemical Pits and Glass Holes plume characterization is ongoing, and additional monitoring wells will be installed during CY 1998.

Current Landfill Area: The "Current" Landfill operated from 1967 through 1990, when it was closed in accordance with the Long Island Landfill Law. It was used to dispose of putrescible garbage, sludge containing precipitated iron from the potable WTP, and anaerobic digester sludge from the STP. The latter contained low concentrations of radionuclides, and possibly metals and organic compounds. The Laboratory also disposed of limited quantities of laboratory wastes containing radioactive and chemical material at the landfill. As a result, the Current Landfill is a source of groundwater contamination. Permanent closure (i.e., capping) of this landfill was completed in November 1995 as part of the CERCLA Program.

The Current Landfill Post-Closure Monitoring Program consists of a network of 11 monitoring wells situated adjacent to the landfill in both upgradient and downgradient locations. These wells are monitored quarterly, and will be used to determine the cap's effectiveness in preventing the continued leaching of contaminants from the landfill, and to document the anticipated long-term improvements to groundwater quality. The monitoring well network was designed in accordance with post-closure O&M requirements specified in 6 NYCRR Part 360, "Solid Waste Management Facilities." These requirements specify that the well network be monitored quarterly for a minimum of five years, upon which BNL may petition the NYSDEC to modify the frequency and types of analyses based on supporting data.

During CY 1997, VOCs were consistently detected in wells located downgradient of the Current Landfill (see Figures 8-18 and 8-19), including chloroethane, benzene, and DCA. Chloroethane

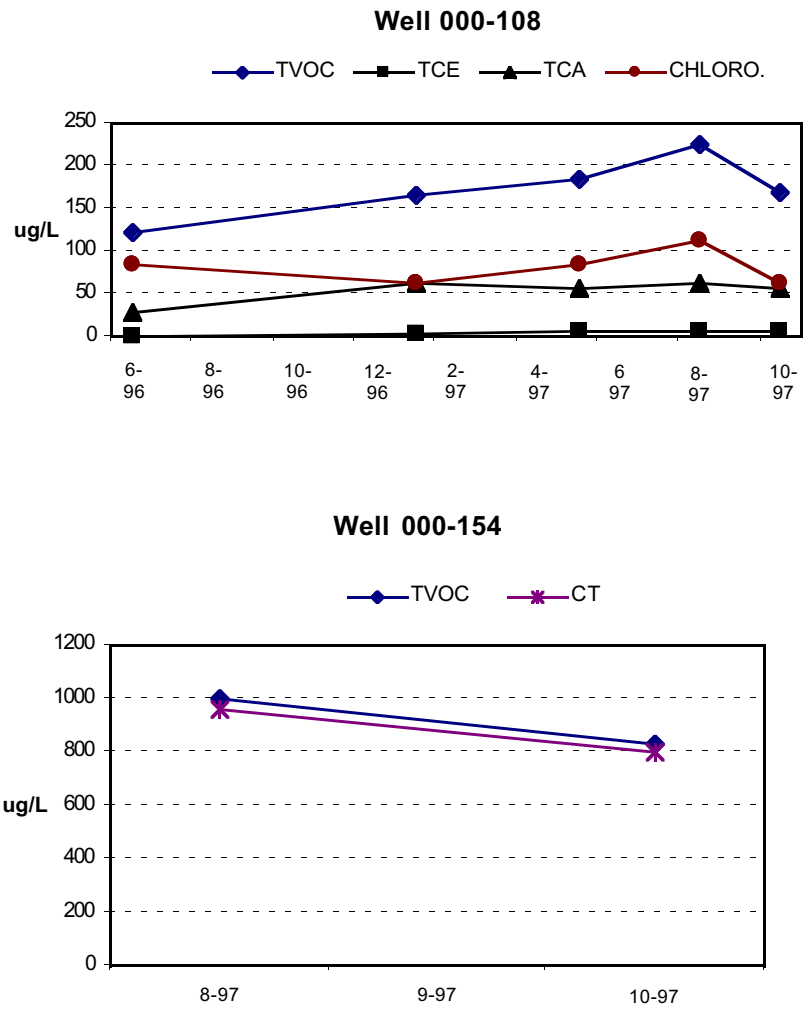


Figure 8-17. Time-vs.-VOC concentration trend plots for selected off-site wells in the Former Landfill Plume: well 000-108 located on North Street approximately 900 m south of Long Island Expressway; and well 000-154 located on Sleepy Hollow Drive approximately 900 m south of the Long Island Expressway.

was detected at concentrations exceeding the NYS AWQS of 5 µg/L in monitoring wells 087-11, 087-27, 087-23, 088-22, 088-23, 088-109, and 088-110, with a maximum concentration of 350 µg/L detected in well 088-22. Benzene was found in monitoring wells 087-11, 087-23, 088-22, 088-109, and 088-110 at concentrations exceeding the NYS AWQS of 0.7 µg/L, with a maximum concentration of 5 µg/L detected in well 087-11. DCA was detected in monitoring wells 088-109 and 088-22 at concentrations exceeding the NYS AWQS of 5 µg/L, with a maximum concentration of 81 µg/L detected in well 088-22. The only other VOC exceeding the NYS AWQS (of 5 µg/L) was toluene, which ranged from 1 µg/L to 130 µg/L.

HWMF Plume and (Downgradient) Current Landfill Plume (Removal Action V): Groundwater contamination originating from the HWMF and the downgradient section of the Current Landfill plume is being monitored under the Removal Action V (RA V) Program. As noted above, the Current Landfill was capped in November 1995. Until 1997, the HWMF was BNL's central RCRA receiving facility for processing, neutralizing, and storing hazardous and radioactive wastes before off-site disposal. As the result of past waste handling and storage practices, the soil and groundwater at the HWMF have become contaminated with both chemical and radionuclides at concentrations that exceed NYS AWQS.

The RA V monitoring program uses a network of 51 monitoring wells located in areas downgradient of the Current Landfill and HWMF. The RA V monitoring program is specifically designed to address the following issues on groundwater contamination and plume remediation:

- Monitoring of VOC and radiological contamination of groundwater in the shallow zone of the Upper Glacial aquifer at, and immediately adjacent to, the HWMF;
- Monitoring of VOC and radiological contaminant plumes located south of the Current Landfill and HWMF that have been commingled due to the effects of the former Spray Aeration Groundwater Remediation System, which was located to the south of the HWMF; and,
- Evaluating the effectiveness of the RA V groundwater pump-and-treat system that was initiated in December 1996 at the southern site boundary using wells EW-1 and EW-2. The monitoring program will characterize the effects of this treatment system on the contaminant plume, and provide data necessary to make decisions on the future operations of the system.

The RA V system is remediating groundwater contamination that originates from the Current Landfill and the former HWMF. Contaminant plumes from these two sources became commingled south of the HWMF due, at least partially, to the effects of the Former Spray Aeration System, which operated from 1984 to 1990. The primary chemical contaminants found in the Current Landfill/HWMF plume are chloroethane, TCA, and DCA (on-site) and TCE in off-site areas. The areal extent of VOC contamination is shown on Figure 8-18. The Current Landfill/HWMF plume (as defined by the 5 µg/L iso-concentration contour) extends from the Current Landfill and HWMF areas south to an area approximately 1,500 feet south of South Street (a distance of approximately 7,000 feet). The maximum width of the plume is about 1,700 feet wide. And the width of its higher concentration portions (>50 µg/L TVOCs) is about 600 feet. Two areas of the plume display TVOC concentrations of >200 µg/L; the first is immediately downgradient of the Current Landfill, and the second is off-site, south of the Long Island Expressway (Figure 8-18).

The vertical distribution of VOCs is shown on Figure 8-19. Chloroethane, TCA, and DCA are found in the shallow portions of the Upper Glacial aquifer near the source areas and in the deep Upper Glacial aquifer at the site boundary and off-site. TCA, DCE, TCE and chloroform are found in the middle to deep Upper Glacial aquifer off-site, south of North Street.

Figure 8-20 shows trends in VOC concentration for key wells located near the source areas, at the southern site boundary in the vicinity of the RA V Remediation Extraction wells, and off-site. The effects of the groundwater extraction system are reflected in declining VOC concentrations in monitoring wells located at the site boundary.

8.1.2.1.3 Operable Unit III

The monitoring well network established to monitor the OU III VOC and radionuclide source areas and resulting contaminant plumes is composed of approximately 90 monitoring wells positioned from the north-central portion of the site to the southern site boundary and off-site. The OU III groundwater-monitoring program is specifically designed to address the following groundwater contamination issues and plume remediation:

- Monitor VOC plumes with identified or suspected sources in the AGS Complex, Paint Shop, Building 96 area, and the Supply and Materiel area. These plumes extend from the

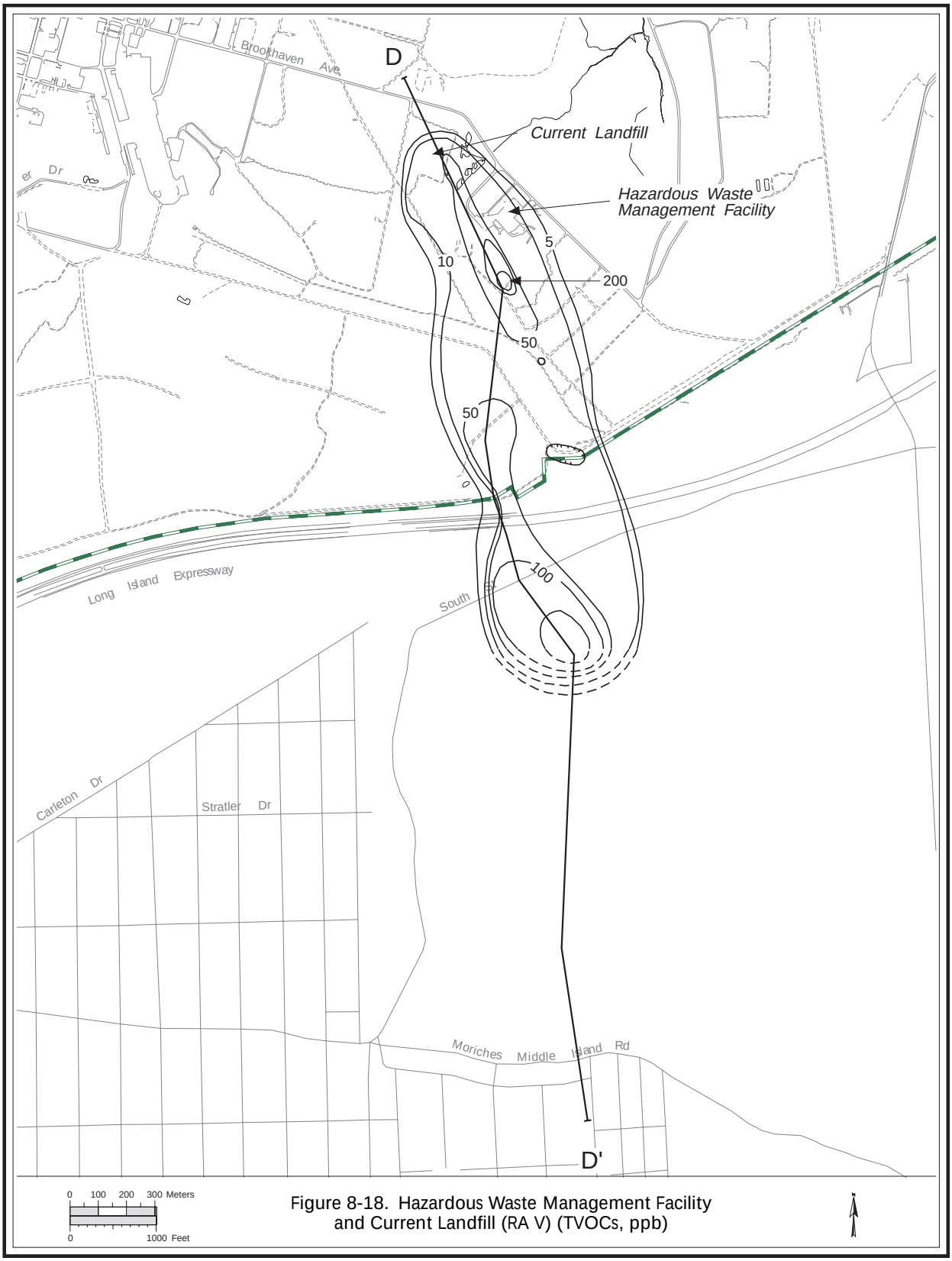


Figure 8-18. Hazardous Waste Management Facility and Current Landfill (RA V) (TVOCs, ppb)

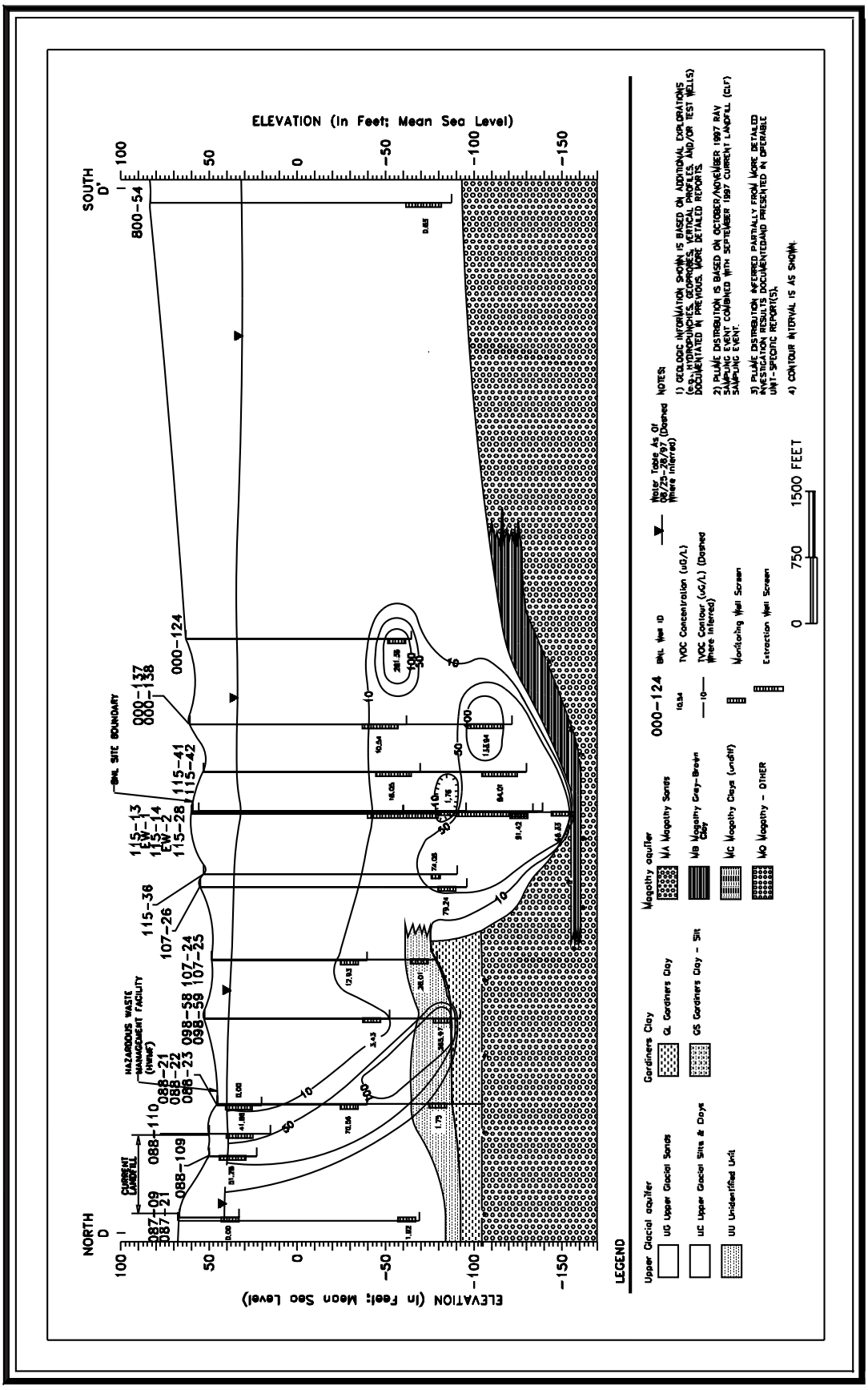


Figure 8-19. Current Landfill/HWM-TVOC Plume Cross Section D-D (ug/L)

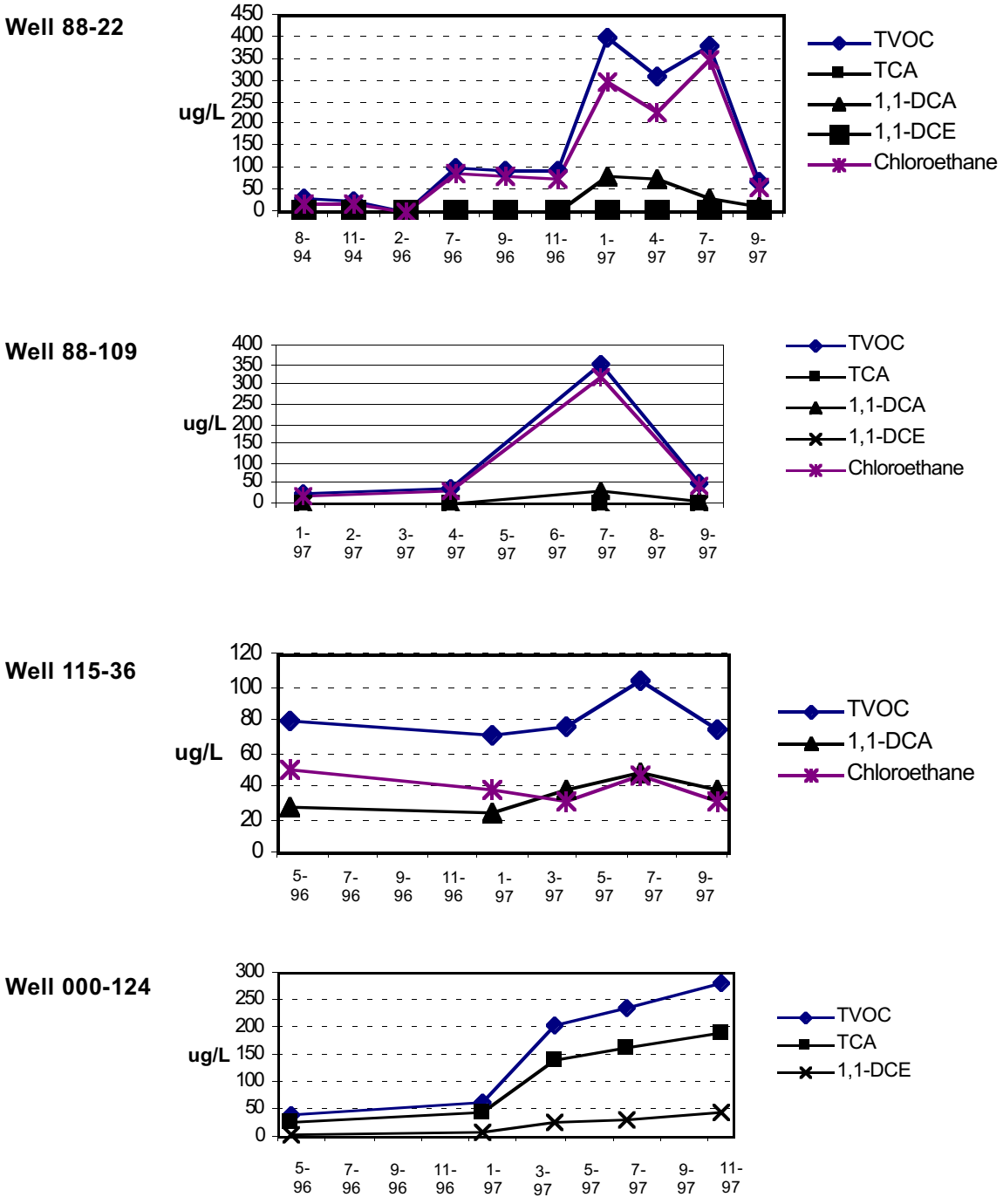


Figure 8-20. Time-vs. VOC concentration trend plots for selected wells in the Current Landfill/ HWMF TVOC plume: well 88-109 located directly downgradient of landfill; well 88-22 located 120m downgradient of landfill; well 115-36 located approximately 900m downgradient of landfill near the southern boundary; and well 000-124 located off-site approximately 500m south of the Long Island Expressway.

north-central portion of the site to south of the site boundary and then into North Shirley (Figures 8-21 and 8-22). The plumes become deeper as the distance from the source areas increases. Plumes at the southern site boundary and off-site are in the deep portion of the Upper Glacial aquifer and the upper portion of the Magothy aquifer;

- Evaluate the effectiveness of the OU III south boundary groundwater pump-and-treat system initiated in May 1997 (extraction wells EW-3 through EW-8). The monitoring program will characterize the effects of this pumping on the contaminant plume and provide data that are necessary for making decisions on the future operations of the extraction wells; and,
- Monitor "outpost" wells located to the south (downgradient) of the defined extent of the off-site VOC plume 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 are used to verify groundwater quality south of the BNL Apartment areas, and they would also provide an early warning of potential contaminant migration towards the SCWA well field.

The OU III "plume" is composed of multiple commingled plumes, some of which can be traced directly to their source area. Some identified sources that were evaluated during the OU III RI/FS include spill areas within the AGS Complex, former Building 96 area (a former vehicle maintenance area), and Building 208 located within the Supply and Materiel Facility area. Figure 8-21 depicts the OU III "TVOC" contamination plume. The primary OU III VOCs detected in on-site monitoring wells include CT, TCA, and PCE, whereas CT is the primary VOC in off-site wells. The OU III plume extends from the AGS Complex in the north-central part of the site southward to the vicinity of Flower Hill Drive in North Shirley (approximately 17,000 feet). The plume is about 5,000 feet wide at its maximum, as defined by the 5 µg/L isoconcentration contour on Figure 8-21. The width of the high concentration portion of the plume (i.e., >50 µg/L), which appears to have originated from the former Building 96 vehicle maintenance area, is approximately 1,800 feet at the site boundary. The area defined by the 5 µg/L isoconcentration line should not be interpreted to mean that there is continuous VOC contamination from the western 5 µg/L line eastward to the central core of the OU III plume. In actuality, the plume is comprised of low concentration VOC contamination occurring discontinuously in this area.

Figure 8-22 is a cross sectional view of the OU III plume. Some of the highest VOC concentrations are found near the former Building 96 vehicle maintenance area. This plume is composed primarily of PCE and lower levels of TCA, with TVOC concentrations ranging from 1,000 to slightly more than 5,000 µg/L. In general, PCE and TCA are observed in the shallow portions of the Upper Glacial aquifer in the central portion of OU III and in the deep Upper Glacial aquifer at the southern site boundary and off-site.

The plume from the Building 96 area appears to be traceable to the southern boundary, where TVOC concentrations of >500 µg/L have been detected. TVOC concentrations greater than 1,000 µg/L were detected in the vicinity of off-site well 000-130 located near Carleton Drive. However, in this case the primary contaminant of concern is CT. As depicted in Figure 8-22, CT contamination is also found in the upper portion of the Magothy aquifer; its extent there is not well defined, and additional characterization is necessary.

As depicted in Figure 8-23, VOC concentration trends in wells located near identified source areas in the central portion of the OU III area (e.g., wells 64-03, 65-03, 96-07 and 105-23) are showing either a fluctuating or slightly decreasing concentration. In Figure 8-24, VOC concentrations appear to be decreasing in wells located near the southern boundary extraction system (e.g., wells 121-10 and 121-14), which could be attributed to the actions of the OU III groundwater treatment system.

The OU III monitoring wells are also sampled and analyzed for radiological contaminants such as strontium-90 which has been found in the groundwater extending south from the WCF, Pile Fan Sump, and Brookhaven Graphite Research Reactor (BGRR) areas, and tritium from the HFBR (see Section 8.1.2.2).

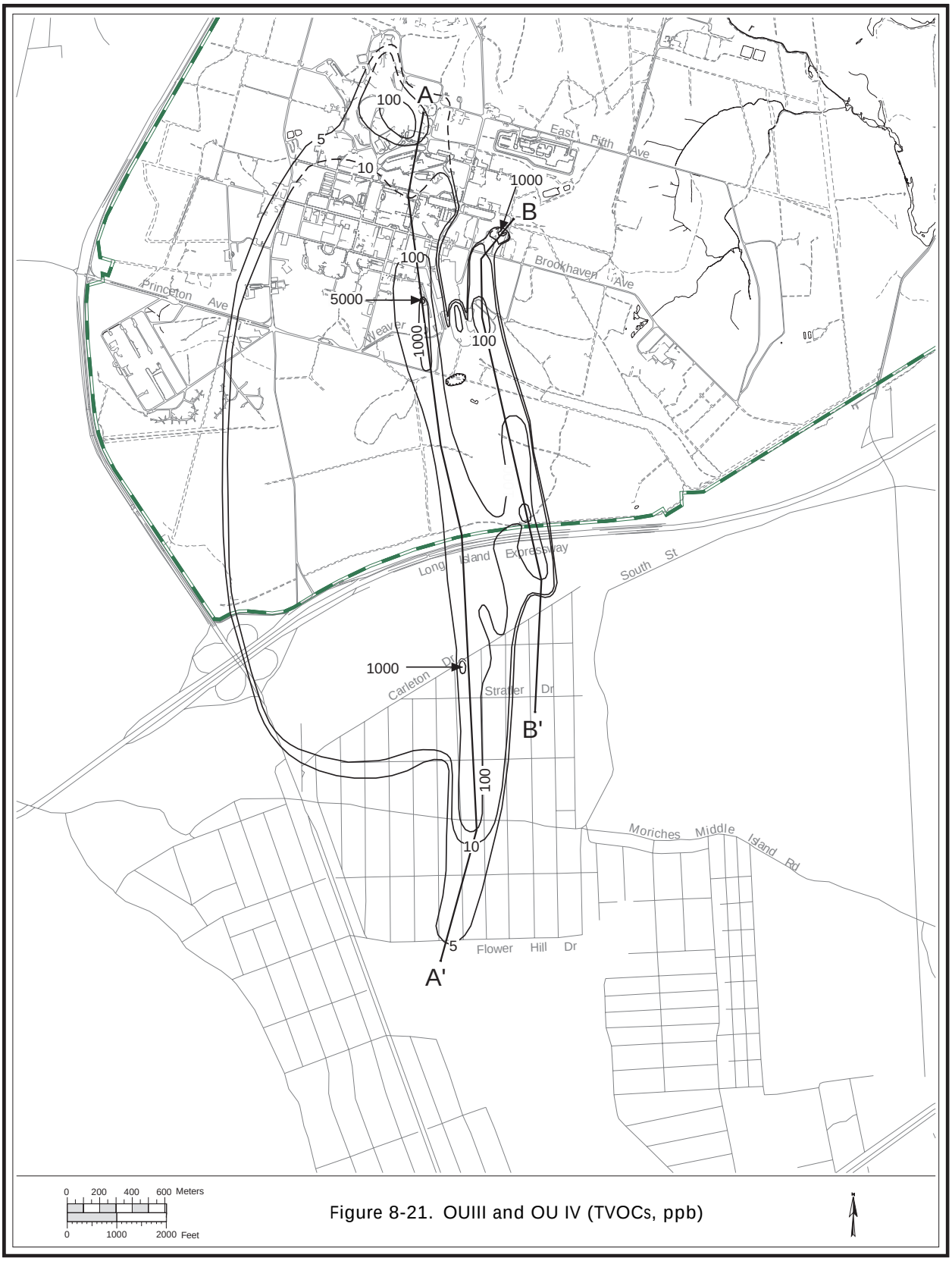


Figure 8-21. OUIII and OU IV (TVOCs, ppb)

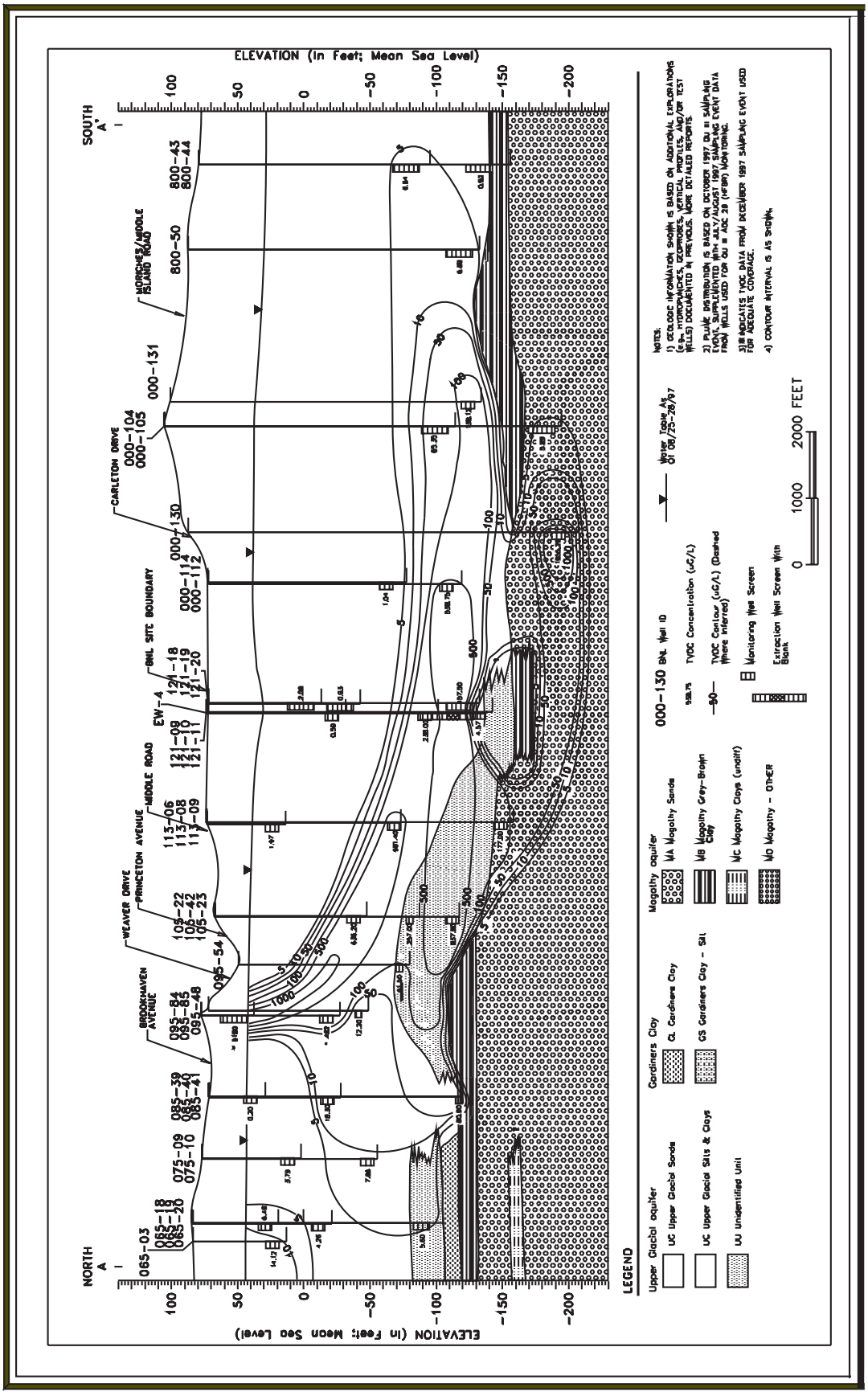


Figure 8-22. OU III TVOC Plume Cross Section A-A (ug/L)

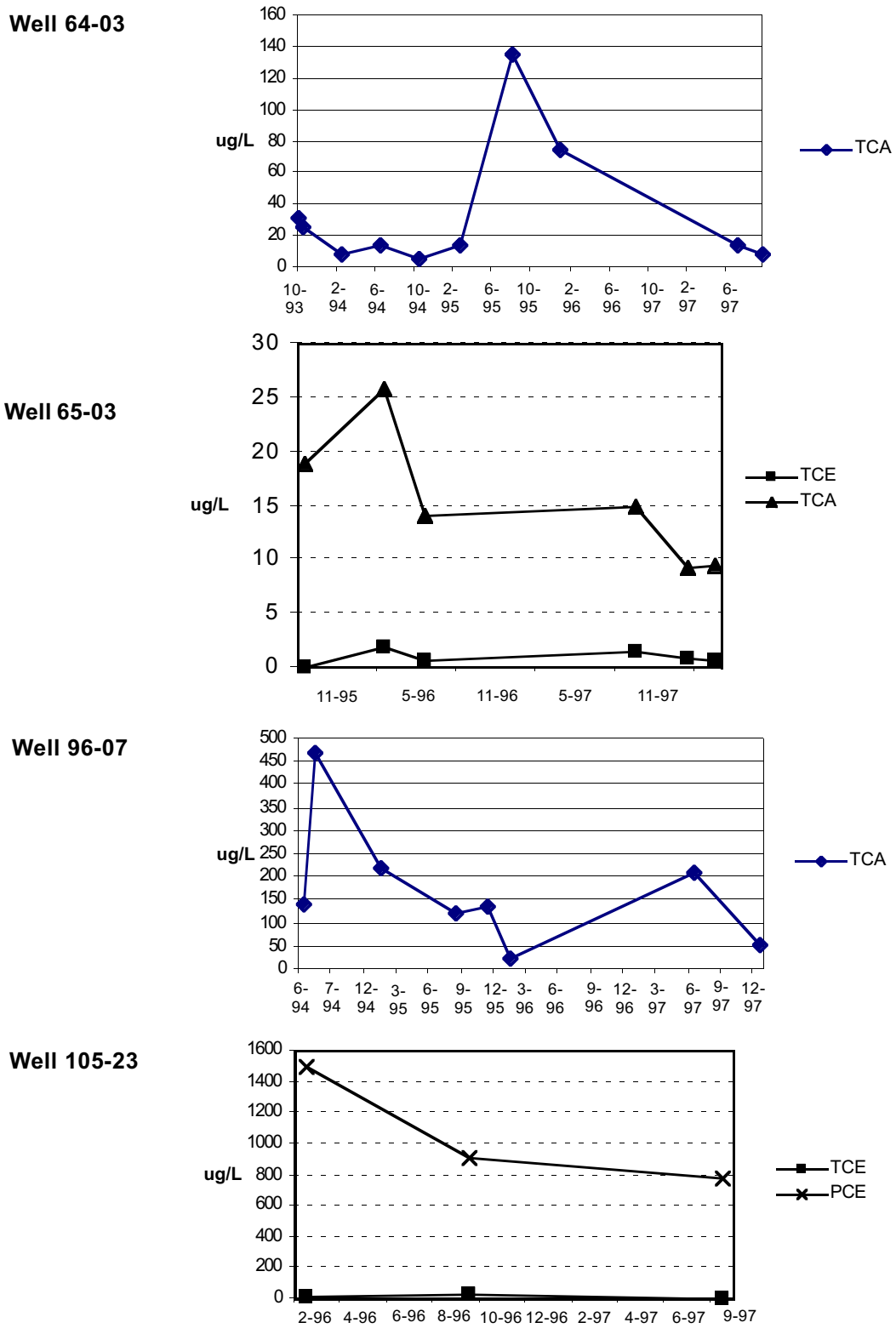


Figure 8-23. Time-vs.-VOC concentration trend plots for selected wells in the OU III Plume (Central Area): well 64-03 located within the AGS area; well 65-03 located downgradient of the AGS area; well 96-07 located downgradient of Supply and Materiel Building 208; and well 105-23 located near East Princeton Avenue.

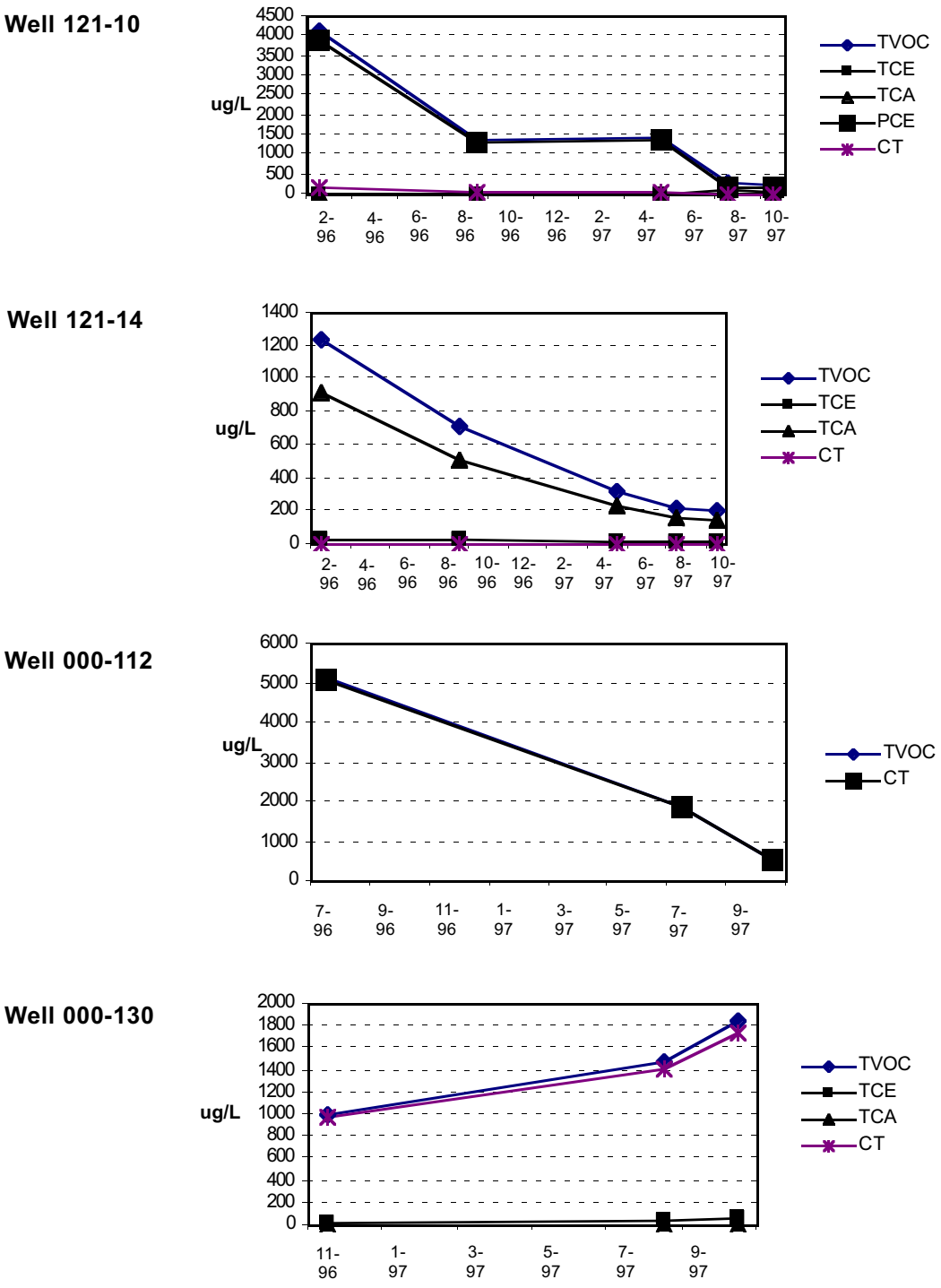


Figure 8-24. Time-vs.-VOC concentration trend plots for selected wells in the OU III Plume (south boundary and off-site): wells 121-10 and 121-14 located near the southern boundary; off-site well 000-112 located 400 m south of the Long Island Expressway in the Brookhaven Industrial Complex; and off-site well 000-108 located on Carleton Drive.

8.1.2.1.4 Operable Unit IV

In 1977, a mixture of 23,000 to 25,000 gallons of Number 6 fuel oil and mineral spirits was released from a ruptured pipe used to transfer the contents from an underground storage tank to above ground storage tanks at the BNL Central Steam Facility (CSF). In addition, several small spills of Number 6 fuel oil from the CSF fuel unloading area were documented between 1988 and 1993, and it is suspected that small volumes of solvents, such as PCE, have been released to the ground in the vicinity of the CSF.

Contamination originating from the Central Steam Facility area is currently monitored under two programs: the OU IV 1977 spill area cleanup program (AOC 5); and the OU I/VI Program which monitors the downgradient (south of Brookhaven Avenue) component of the OU IV plume.

1977 Spill Site (AOC 5): The OU IV AOC 5 Program consists of 18 wells located in close proximity to the source area. These wells are used to assess the effects of the OU IV Air Sparge/Soil Vapor Extraction Remediation System that was started in November 1997 to remediate soils and groundwater near the 1977 spill site. The primary contaminants found in groundwater near the 1977 spill site are toluene, ethylbenzene, xylenes (total), TCA, PCE, DCE, and TCE. Total VOC concentrations in some wells can be as much as 4,000 µg/L. The toluene, ethylbenzene, and xylene components of the plume are highly localized to the spill area and directly downgradient of it. Figure 8-21 shows the extent of OU IV VOC contamination.

Downgradient Portion of the OU IV Plume: The OU I/IV Groundwater Monitoring Program consists of 28 monitoring wells located 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. The wells are monitored quarterly.

The OU IV plume extends from the CSF/1977 Waste Oil Solvent Spill area in the north to an off-site area between the southern site boundary and Carleton Drive (a total distance of approximately 7,500 feet) (Figure 8-21). The plume is approximately 900 feet wide, as defined by the 5 µg/L isoconcentration contour. The higher concentration segment of the plume (>50 µg/L) is approximately 700 feet wide.

Figure 8-21 shows several areas of high VOC contamination (> 100 µg/L TVOC). Definition of these high concentration areas is based primarily upon data from temporary vertical profile wells rather than permanent monitoring wells. Additional permanent wells will be installed to provide long-term monitoring coverage of these high concentration portions of the plume. One of the areas containing the highest VOC concentrations is the 1977 Spill site, which consists primarily of ethylbenzene, toluene, and xylene, TCA, PCE, DCE, and TCE at concentrations ranging up to 4,000 µg/L TVOC. The highest VOC levels in the southern portion of the plume are found in wells located at the southern site boundary, consisting primarily of TCA, DCE and TCE up to 2,240 µg/L TVOC.

The vertical distribution of TVOC contamination is shown on Figure 8-25. In general, VOCs are present in the shallow sections of the Upper Glacial aquifer near the source area, and in the deep Upper Glacial aquifer and upper Magothy aquifer at the southern site boundary and just off-site respectively. Figure 8-26 depicts VOC concentration trends for southern boundary wells 122-04, 122-19 and 122-22.

8.1.2.1.5 Operable Unit V

The Sewage Treatment Plant processes sanitary sewage for BNL facilities. The treatment includes primary clarification to remove settleable solids and floatable materials, aerobic oxidation for secondary removal of biological matter and nitrification of ammonia, secondary clarification, sand filtration for final effluent polishing, and ultraviolet disinfection for bacterial control prior to discharge into the Peconic River. Approximately 15% of the water released to the filter beds is either lost to evaporation or to direct groundwater recharge; the remaining water is discharged to the Peconic River. This discharge is regulated under a NYSDEC SPDES permit. Past radiological

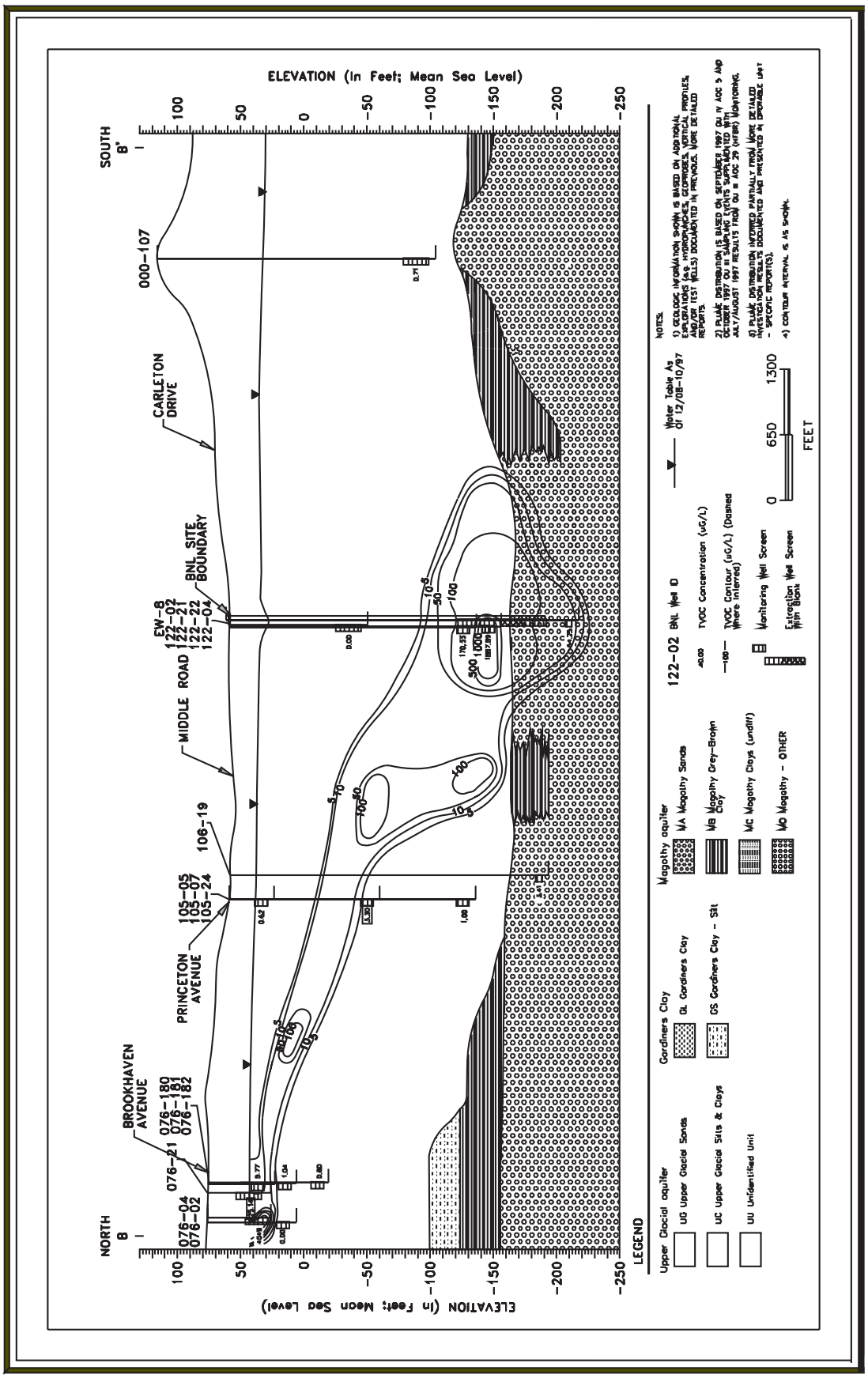


Figure 8-25: OU IV TVOC Plume Cross Section B-B' (ug/L)

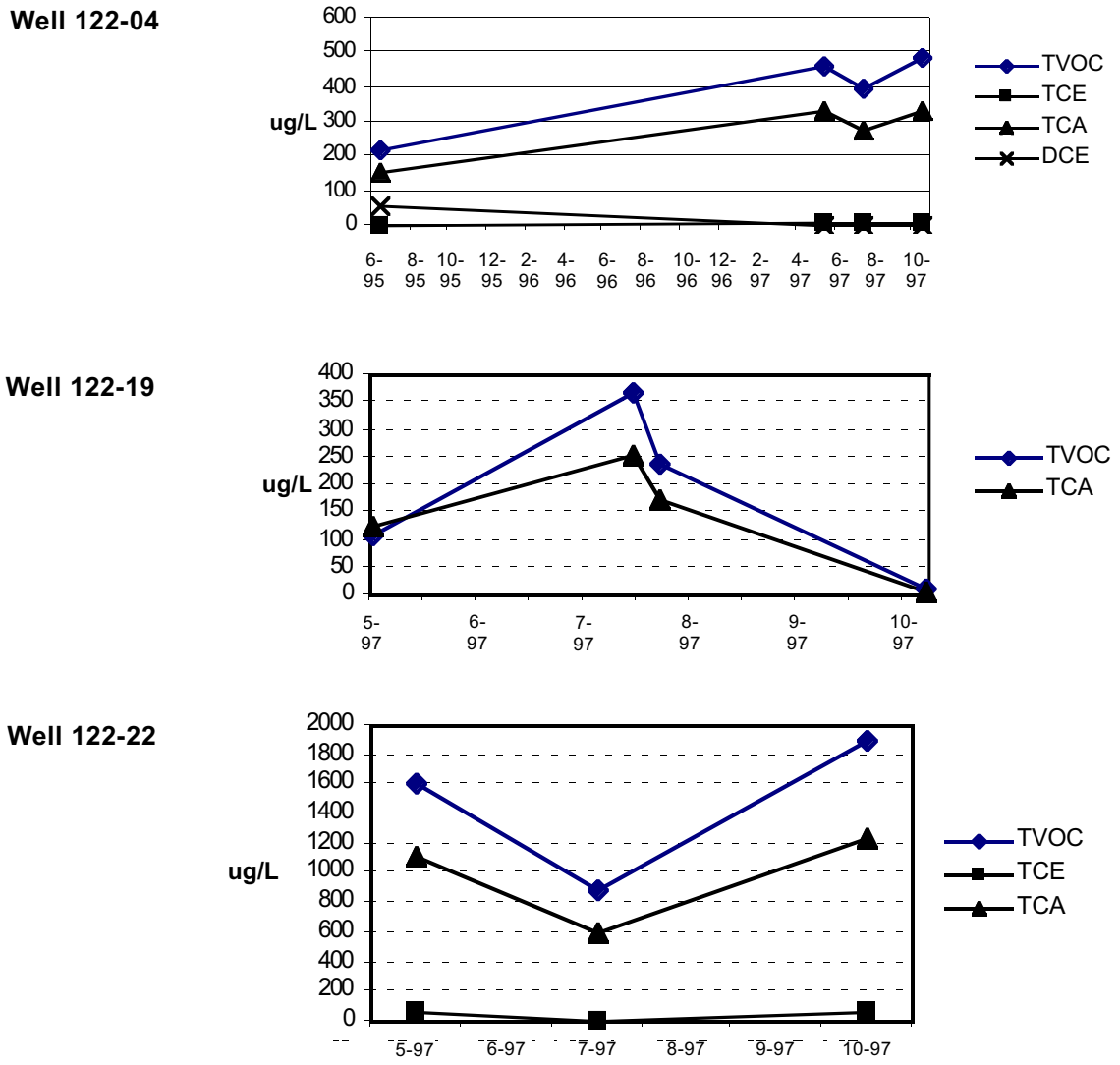


Figure 8-26. Time-vs.-VOC concentration trend plots for selected OU IV South Boundary Monitoring Wells

and chemical releases to the sanitary system contaminated soils, sediments and groundwater in the STP and Peconic River areas.

The OU V Pre-ROD Monitoring Program, started in March 1997, and uses 34 monitoring wells located downgradient of the Sewage Treatment Plant (STP). This monitoring program provides groundwater quality data for this area for the period between the completion of the RI/FS and the ROD. In particular, the wells monitor VOC and tritium contamination resulting from historical releases at the STP. These contaminants are currently being detected in wells located at the BNL eastern site boundary, and off-site between the site boundary and the Long Island Expressway (Figure 8-27). Monitoring of present groundwater quality at the STP is performed as part of the BNL Facility Surveillance Monitoring Program (see Section 8.1.3). In addition, a number of out-post wells are being monitored off-site; they are downgradient of the leading edge of the plume, and will detect any future migration of VOCs and tritium. The wells are monitored semi-annually.

The STP plume (defined by the 5 µg/L isoconcentration contour) extends from southeast of the STP on-site to the Long Island Expressway (LIE) off-site (approximately 6,000 feet) (Figure 8-27). It is approximately 2,000 feet wide. The STP plume primarily consists of TCE, with a maximum observed concentration of 21µg/L. Low concentrations of toluene (<4 µg/L) were also detected in several off-site wells. Several of the OU V wells were also analyzed for Target Analyte List (TAL) metals and pesticides/PCBs during 1997. None of these metals, including mercury and hexavalent chromium, were above NYS AWQS. Of the groundwater samples from off-site wells that were analyzed for pesticides/PCBs, the only detection was a trace amount (0.009 µg/L) of 4,4'-DDT in deep Upper Glacial aquifer well 600-21, an off-site well. The vertical distribution of VOCs is shown in Figure 8-28. Sampling results indicate that VOCs are present in the deep Upper Glacial aquifer near the southeastern site boundary and off-site in the vicinity of the LIE.

Figure 8-29 plots the concentration trend for monitoring wells showing the highest VOC concentrations on-site near the site boundary (e.g., wells 50-01 and 61-05) and at the downgradient fringe of the plume (well 000-122).

8.1.2.1.6 Operable Unit VI

Ethylene dibromide (EDB) was used as a fumigant in the biological agricultural fields located in the southeast portion of the site. Available records indicate that the application of EDB in this area took place in the 1970s. EDB is detected in several on-site and off-site monitoring wells at concentrations exceeding the NYS DWS of 0.05 µg/L.

The OU VI Pre-ROD groundwater monitoring program consists of 16 monitoring wells that extend from the Biology Fields southeast to the site boundary, and off-site (Figure 8-30). This program was initiated in June 1997, and will continue as outlined in the "Operable Unit VI ROD." The wells are currently monitored on a semi-annual basis.

EDB is the only contaminant of concern for the Biology Fields plume. Figure 8-30 shows the limits of EDB groundwater impacts (defined by a concentration of 0.01 µg/L). The plume extends from the Biology Fields to an area just south of South Street (a distance of approximately 5,000 feet). The width of the plume is approximately 1,000 feet. During CY 1997, the highest EDB concentration was found in off-site well 000-110, at a concentration of 1.48 µg/L. The vertical distribution of EDB is shown on Figure 8-31. The EDB is observed in the Shallow Glacial aquifer in the vicinity of the Biology Fields and in the deep Upper Glacial aquifer at the southern site boundary and off-site. Characterization of the off-site portion of the plume is ongoing, and additional monitoring wells will be installed during CY 1998.

Plots of EDB concentration trends for selected OU VI wells are shown on Figure 8-32. These wells are located near the source area (089-14), at the southern site boundary (100-13 and 100-14), and off-site (000-110). All of them displayed decreasing concentrations or EDB in CY 1997.

8.1.2.2 Radiological Analyses

This section gives an overview of significant radiological issues that are being addressed under the Environmental Restoration Program. The primary radiological contaminants of concern in groundwater include tritium and strontium-90. The following briefly summarizes the CY 1997 findings for each monitoring area.

8.1.2.2.1 Site Background

Radionuclides in the site background monitoring wells did not exceed either the NYS DWS or NYS AWQS. The maximum observed concentrations of gross alpha and gross beta activity were 1.5 pCi/L (0.06 Bq/L) and 3.8 pCi/L (0.14 Bq/L), respectively (see BNL, 1998). These radionuclide values are typical of ambient environmental values.

Figure 8-27. OU V TVOC Plume Map (ug/L)

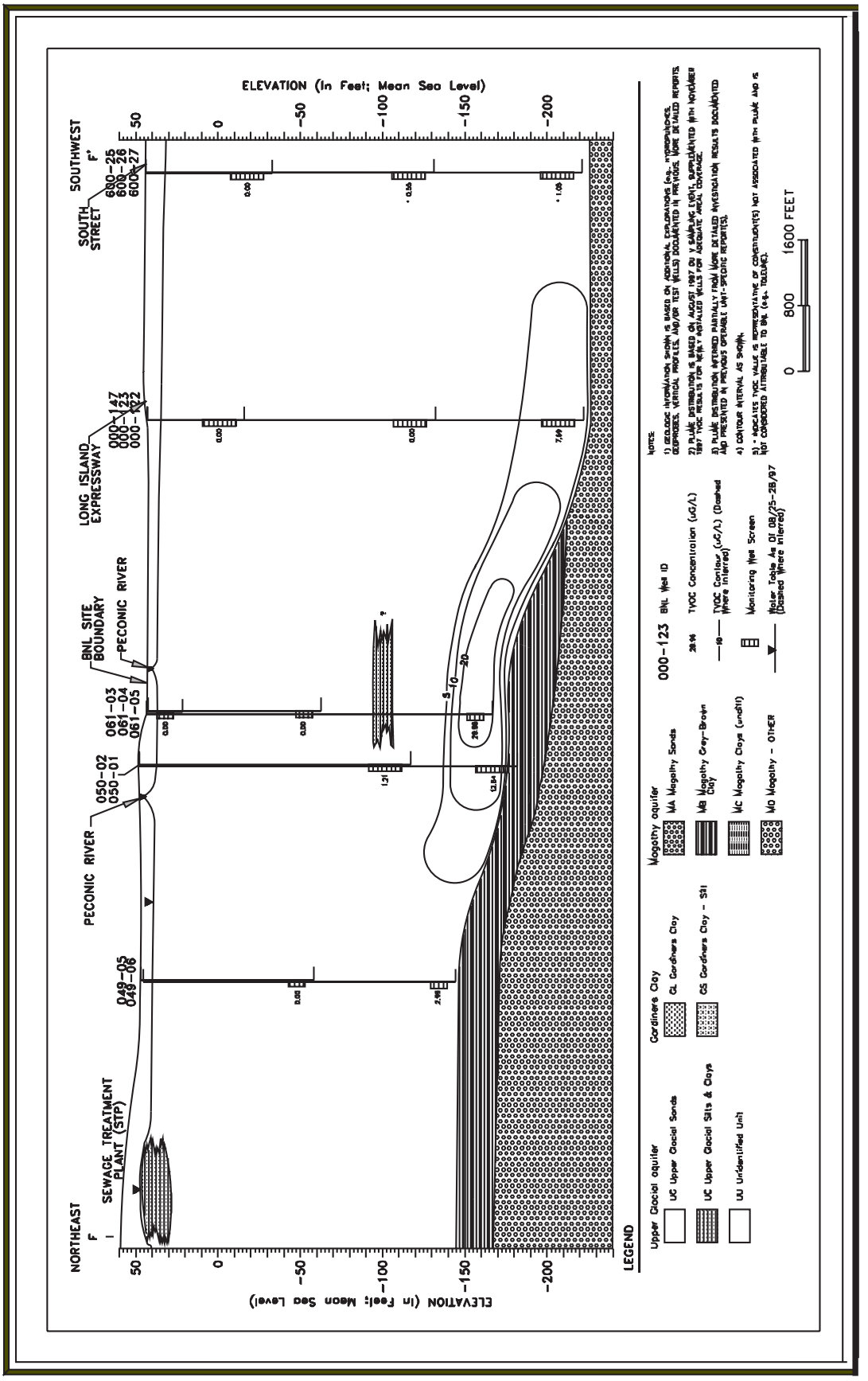
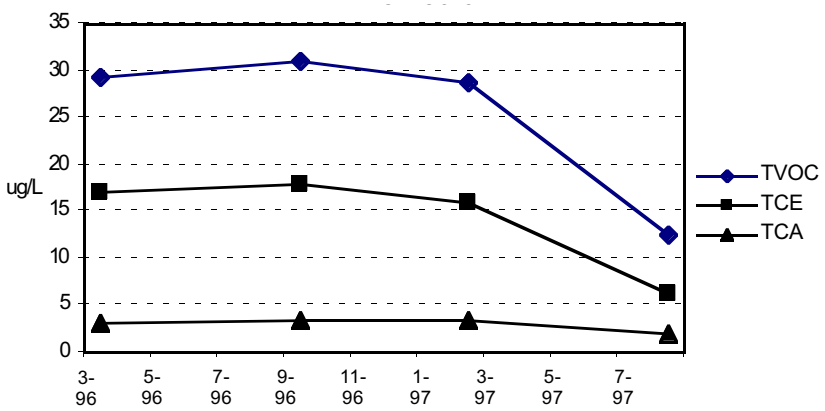
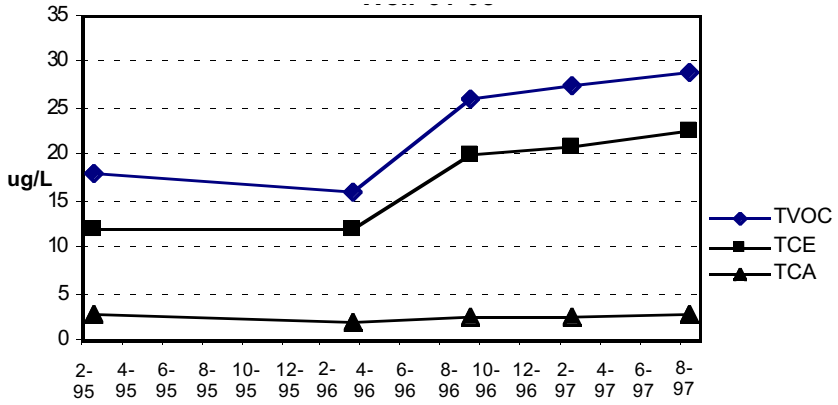


Figure 8-28. OU V TVOC Plume Cross Section F-F (ug/L)

Well 50-01



Well 61-05



Well 000-122

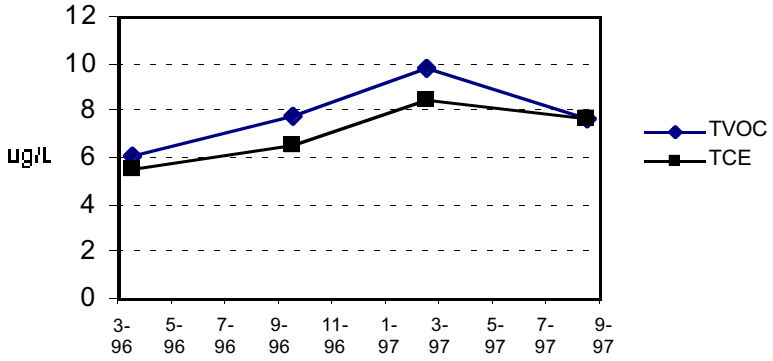


Figure 8-29. Time-vs.-VOC concentration trend plots for selected wells in the OU V Plume: Wells 50-01 and 61-05 located near the eastern boundary; and off-site well 000-122 located just north of the Long Island Expressway.

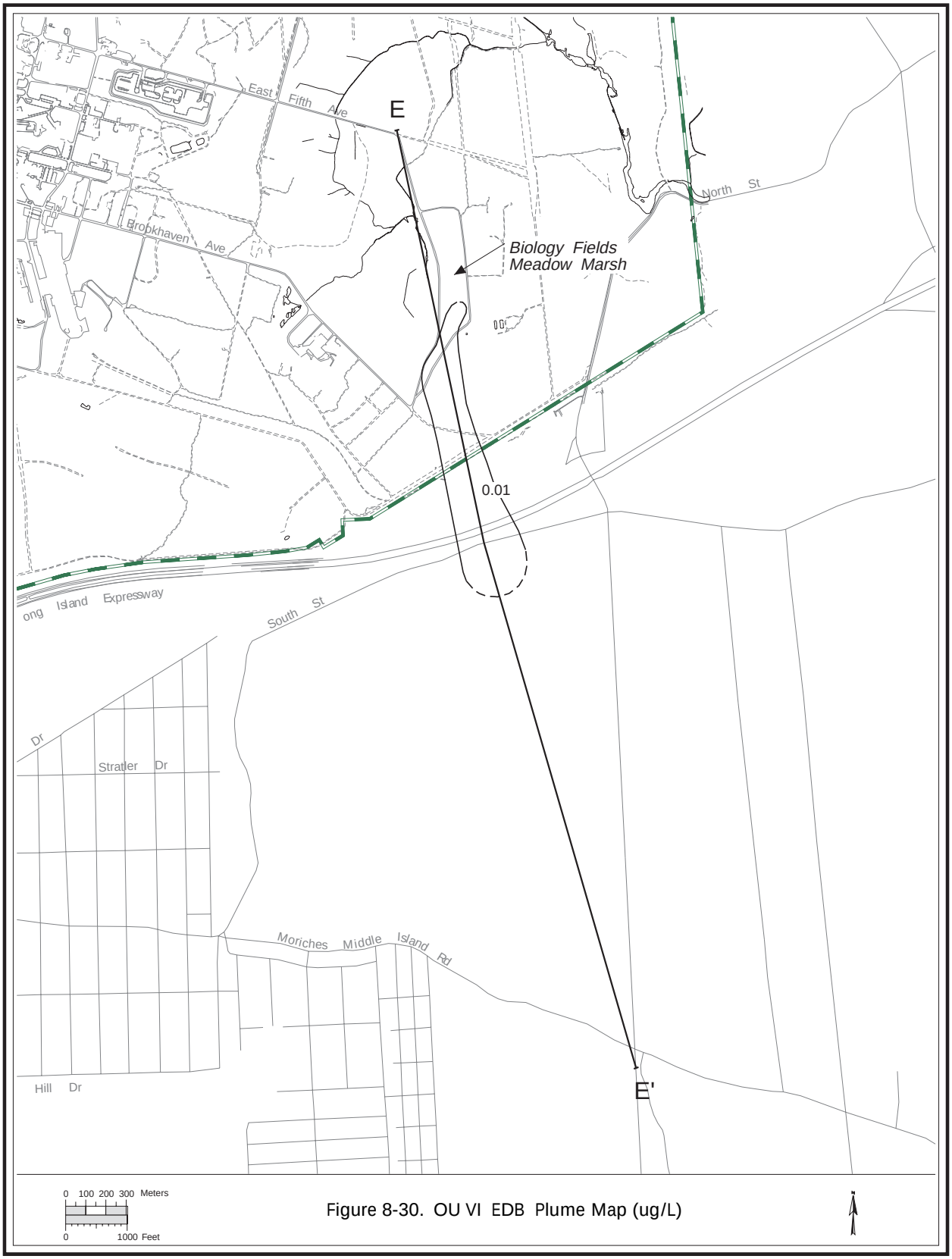


Figure 8-30. OU VI EDB Plume Map (ug/L)

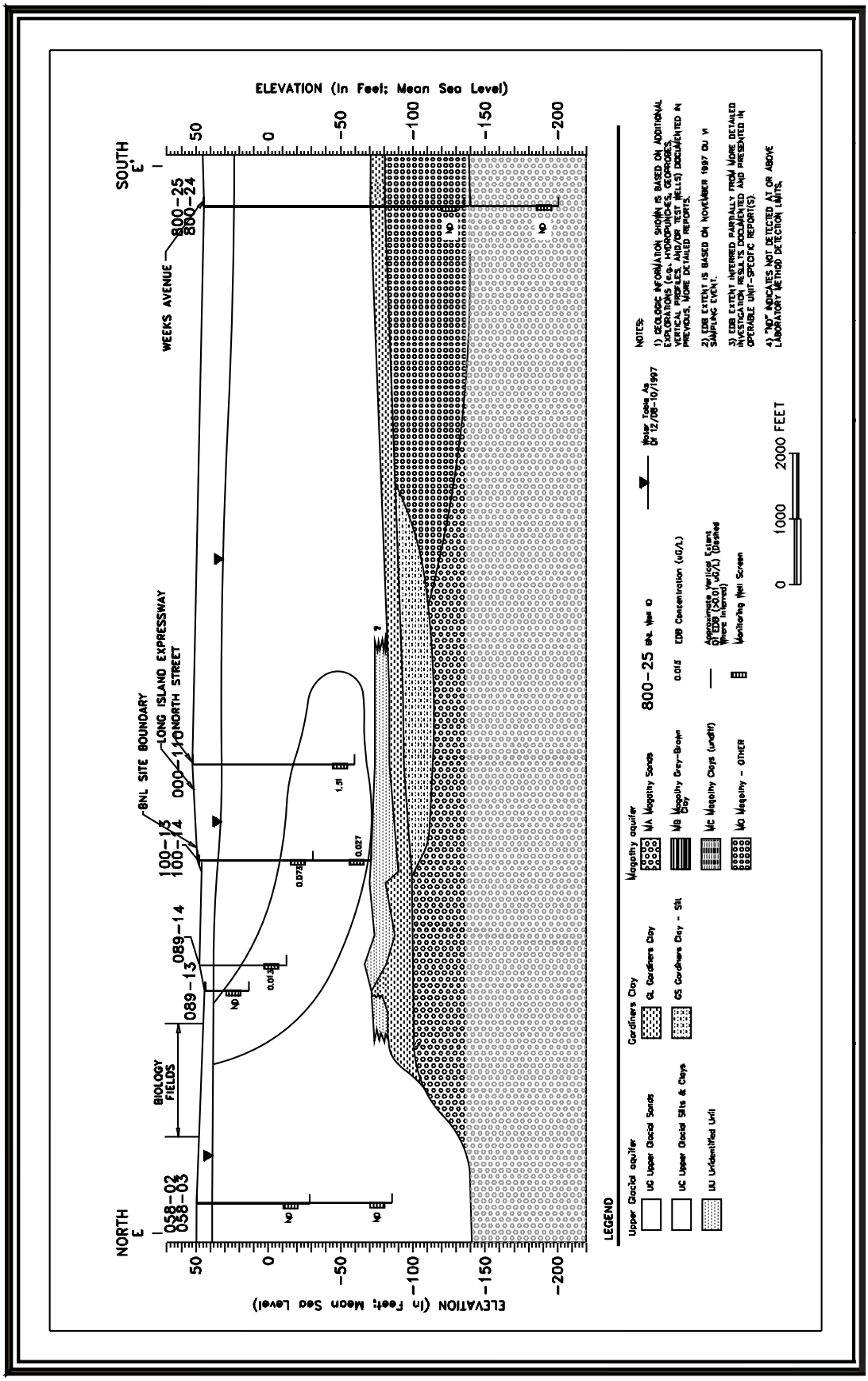


Figure 8-31. OU VI EDB Plume Cross Section E-E (ug/L)

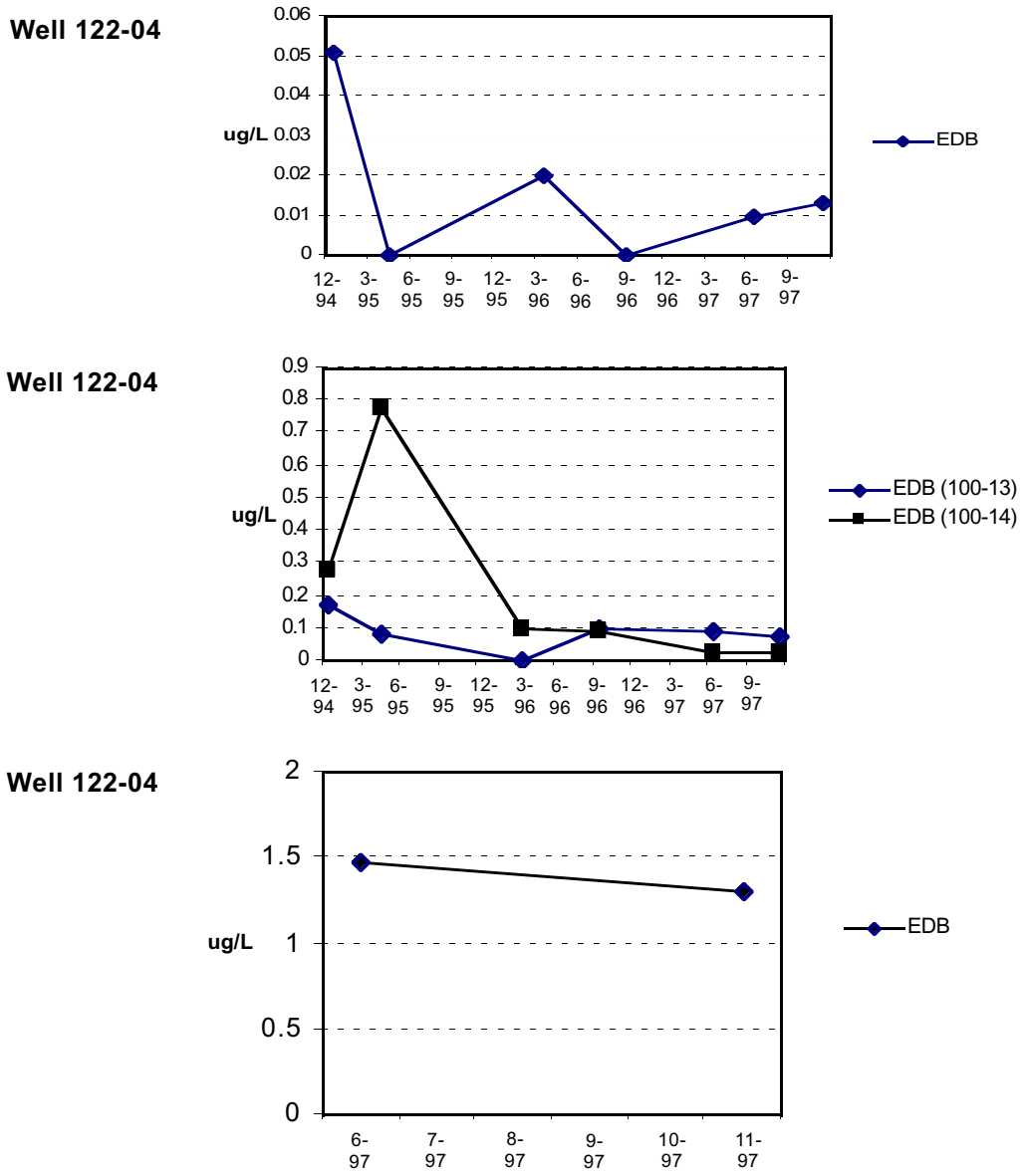


Figure 8-32. Time-vs.-EDB concentration trend plots for selected wells in the OU VI EDB Plume: Well 89-14 located immediately downgradient of the Biology Fields; well cluster 100-13/100-14 located at the southeastern boundary; and off-site well 000-110 located on South Street.

8.1.2.2.2 Operable Unit I

Hazardous Waste Management Facility/Current Landfill Areas: The Current Landfill, which was closed in 1990, received waste such as animal carcasses and protective clothing contaminated with low specific-activity radioactive material (CDM, 1996). The former HWMF was used to handle, process, and store radioactive materials since the late 1940s. Due to past waste handling methods and accidental spills, the soils and groundwater at the HWMF have become contaminated with radionuclides at concentrations exceeding NYS DWS or AWQS. Groundwater for the Current Landfill and HWMF is monitored as part of the RA V project.

During 1997, low-levels of tritium were detected in several of Current Landfill and RA V Monitoring Program wells (Figure 8-33). However, concentrations exceeding the 20,000 pCi/L (740 Bq/L) drinking water standard were only detected in HWMF well 88-26 at a maximum of 43,691 pCi/L (1,617 Bq/L). The maximum tritium concentration in off-site wells was found in well 000-137, at 2,384 pCi/L (88 Bq/L). A plot of trends in tritium concentration for well 88-26 is shown on Figure 8-34. A complete set of CY 1997 tritium results is provided in the 1997 ERD Sitewide Groundwater Monitoring Report (BNL, 1998). Additional characterization in off-site areas is planned for CY 1998.

During 1997, strontium-90 was also detected in three wells in the HWMF area at concentrations slightly exceeding the NYS DWS of 8 pCi/L. Specifically, strontium-90 was detected in wells 088-13 (8.4 pCi/L [0.31 Bq/L]), 088-26 (9.2 pCi/L [0.34 Bq/L]), and 98-30 (8.5 pCi/L [0.31Bq/L]).

Former Landfill, Animal/Chemical Pits and Glass Holes Area: The Former Landfill and the Animal/Chemical Pits and Glass Holes area received low-level radioactive wastes when they were used.

During 1997, strontium-90 was detected above drinking water standards in Former Landfill well 97-03 at a maximum concentration of 11.6 pCi/L (0.4 Bq/L), and in Animal/Chemical Pits and Glass Holes Area wells 106-16 and 106-13 at maximum concentrations of 769 pCi/L (28 Bq/L) and 36 pCi/L (1.3 Bq/L), respectively. Figure 8-35 plots the concentration trend for strontium-90. During CY 1997, several temporary wells were installed to determine the downgradient extent of the strontium-90 contamination. Low levels of strontium-90 (up to 1.5 pCi/L [0.06 Bq/L]) were detected in on-site temporary wells installed at a distance of approximately 1,500 feet from the source area. The installation of additional monitoring wells is planned for this area in CY 1998.

8.1.2.2.3 Operable Unit III

High Flux Beam Reactor (HFBR): The HFBR is a heavy water moderated and cooled research reactor used principally for basic experimental research requiring external neutron beams. The reactor began operation in October 1965, and was in service until the fall of 1996. In January 1997, tritium was detected at levels exceeding the drinking water standard in wells installed immediately downgradient of the facility. As a result of these findings, an extensive field investigation was conducted from January through December 1997 to characterize the nature and extent of the tritium contamination (see ITC, 1997). It was determined that leakage of tritiated water from the HFBR's spent fuel pool was the primary source of the tritium detected in the groundwater. The groundwater characterization aspects of this investigation consisted of the following:

- The collection and analysis of 231 groundwater samples collected from 45 Geoprobe™ wells located upgradient and downgradient of the HFBR. Analysis of the samples consisted of one or more of the following: tritium, gross alpha/beta activity, gamma spectroscopy, and strontium-90; and
- The collection of nearly 1,600 groundwater samples from 77 temporary wells installed downgradient of the HFBR for one or more of the following analyses: VOCs, tritium, gross alpha/beta activity, gamma spectroscopy and strontium-90.

Using the data collected from the temporary well samples, a permanent network of 88 existing and newly installed monitoring wells was developed for long-term surveillance of the HFBR tritium plume.

The HFBR tritium plume (defined by wells having tritium concentrations >1,000 pCi/L [37 Bq/L]) extends from the HFBR, approximately 3,800 feet south to a location on-site near East Princeton Road (Figure 8-36). Tritium concentrations up to 1.6 million pCi/L (59,200 Bq/L) were detected in wells directly downgradient of the HFBR. The leading edge of the portion of the plume, with concentrations exceeding the drinking water standard of 20,000 pCi/L (740 Bq/L) is located north of Weaver Drive (a distance of approximately 2,800 feet from the HFBR). The vertical distribution

of tritium contamination is shown on Figure 8- 37. Tritium is detected in the shallow Upper Glacial aquifer in the vicinity of the HFBR and in the deep Upper Glacial aquifer just to the north of Weaver Drive.

Waste Concentration Facility (WCF): Historically, the WCF (Building 811) was used to reduce the volume of liquid radioactive wastes by removing suspended solids and applying limited treatment. Currently, the facility is used primarily for the temporary storage and limited treatment of radioactive liquids prior to off-site treatment or disposal. All operational liquid storage vessels and transfer lines comply with Suffolk County Article 12 requirements. Past leakage from above ground waste storage tanks and transfer operations led to radiological groundwater contamination in the immediate area. During CY 1997, strontium-90 was detected at concentrations exceeding the 8 pCi/L drinking water standard in well 65-18, at a maximum observed concentration of 18.3 pCi/L (0.7 Bq/L).

Building 830 Area: In 1986, it was discovered that a waste transfer line between Building 830 and an underground storage tank had leaked. Approximately 900 gallons of liquid radioactive waste were lost (Miltenburger *et al.*, 1989). Soil contaminated by the leak was excavated and removed in 1988. During 1997, cobalt-60 (half-life = 5.2 years) was detected in temporary wells installed downgradient of the transfer line and underground storage tank. In a temporary well located directly downgradient of the tank, cobalt-60 was detected at a concentration of 242 pCi/L (8.9 Bq/L), which is slightly above the 200 pCi/L (7.4 Bq/L) drinking water standard (i.e., 4% of the DOE DCG). Low-levels of cobalt-60 were also detected in four wells downgradient of the transfer line, with concentrations ranging between 5.3 and 28 pCi/L (0.2 and 1.0 Bq/L). The underground storage tank and transfer line are scheduled to be removed during CY 1998.

Brookhaven Graphite Research Reactor Area: Starting in late 1996, BNL initiated an extensive effort to characterize the soil and groundwater in the vicinity of the BGRR. Water samples were obtained from several BGRR water and air handling systems that could impact groundwater resources. For example, sediment samples obtained from three nearby storm drains showed elevated gross alpha and beta activity, cesium-137, and strontium-90 (up to 41 pCi/g [1.5 Bq/g]). Standing water samples were also obtained from a vault that previously contained a tank, and the Pile Fan Sump (PFS). Although analytical results from the vault indicated only low-level contamination, samples obtained from the PFS showed high concentrations of strontium-90 (up to 2,270 pCi/L [84 Bq/L]), tritium (340,000 pCi/L [12,600 Bq/L]), and cesium-137 (2,458 pCi/L [91 Bq/L]).

During 1997, 45 temporary Geoprobe wells were installed downgradient of the BGRR and PFS areas to determine the extent of radionuclide contamination in groundwater (Figure 8-38). The results showed strontium-90 contamination exceeding drinking water standards in wells extending from the BGRR area to an area just south of Cornell Avenue (a distance of approximately 200 meters). Strontium-90 was detected at a concentration of 54 pCi/L (2 Bq/L) in a temporary well installed approximately 50 meters downgradient of the BGRR. Strontium-90 concentrations decrease to <37 pCi/L (<1.4 Bq/L) in wells located south of Cornell Avenue.

In the PFS area, strontium-90 and tritium were detected in temporary wells installed directly downgradient of the sump, at maximum concentrations of 565 pCi/L (21 Bq/L) and 14,700 pCi/L (544 Bq/L), respectively. However, strontium-90 and tritium also were detected in temporary wells installed approximately 20 meters north of the PFS, which may be related to upgradient source areas such as the Waste Concentration Facility. Strontium-90 was not detected in temporary wells installed approximately 170 meters south (downgradient of the PFS, near Cornell Avenue. Tritium was detected in several of these wells, however, at a maximum observed concentration of 4,660 pCi/L (172 Bq/L). The results from this study, and a complete evaluation of potential sources located within the BGRR and upgradient areas will be presented in the OU III RI Report that is expected to be finalized by the fall of 1998.

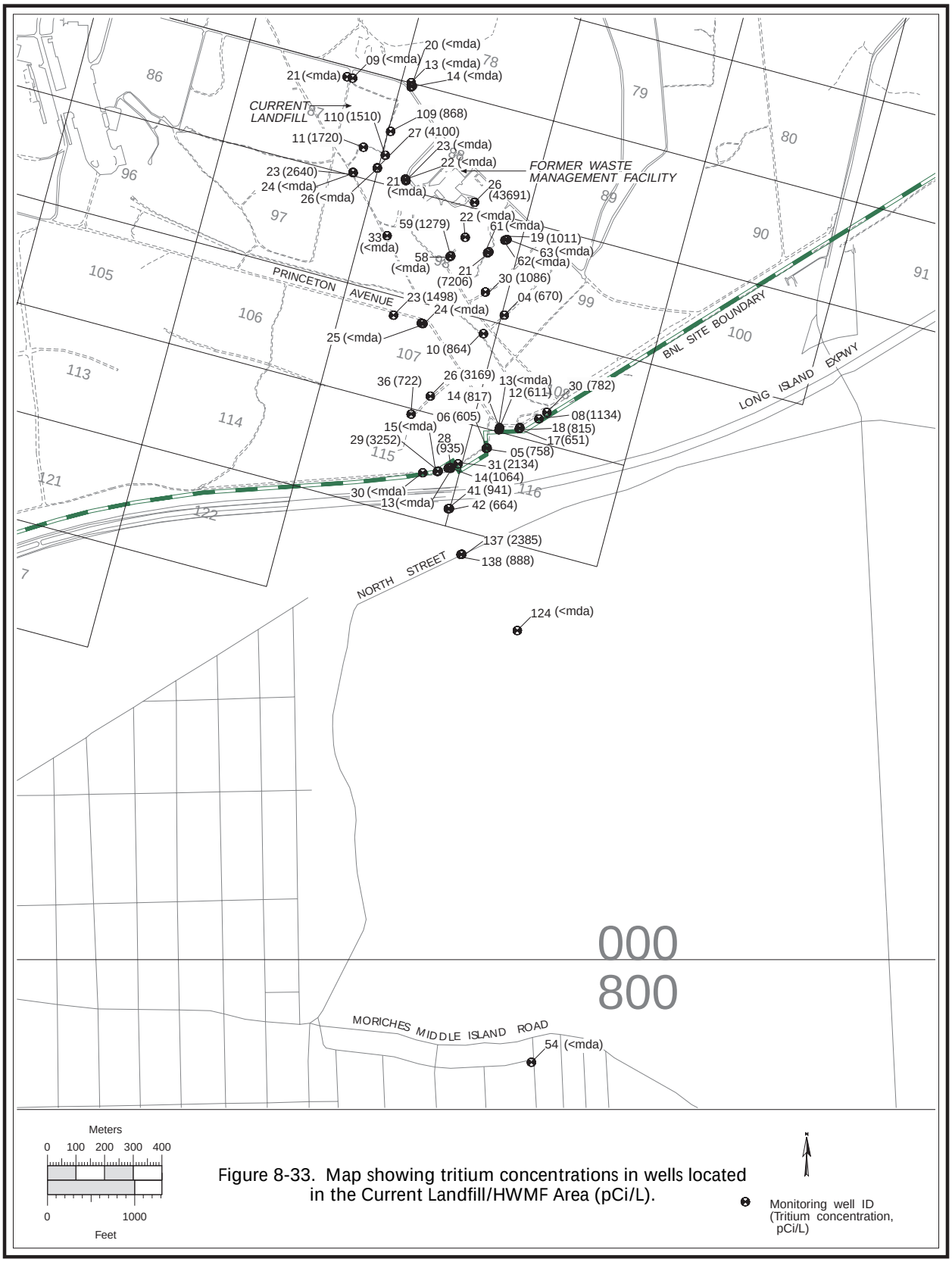


Figure 8-33. Map showing tritium concentrations in wells located in the Current Landfill/HWMF Area (pCi/L).

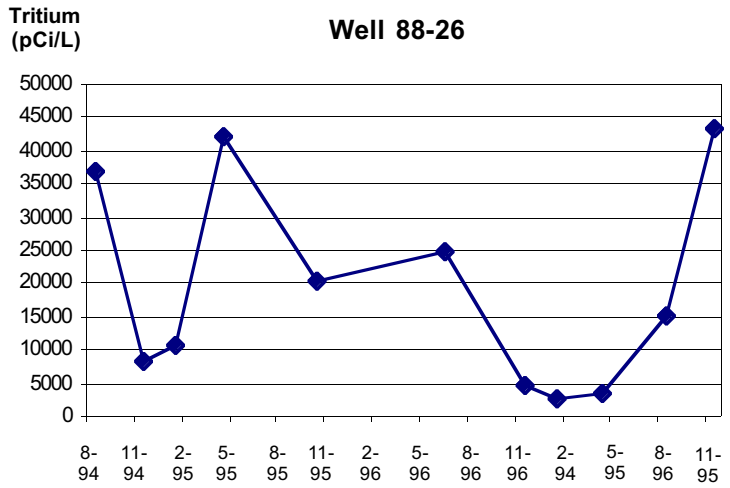


Figure 8-34. Time-vs.-tritium concentration trend plots for well 88-26 located in the HWMF area.

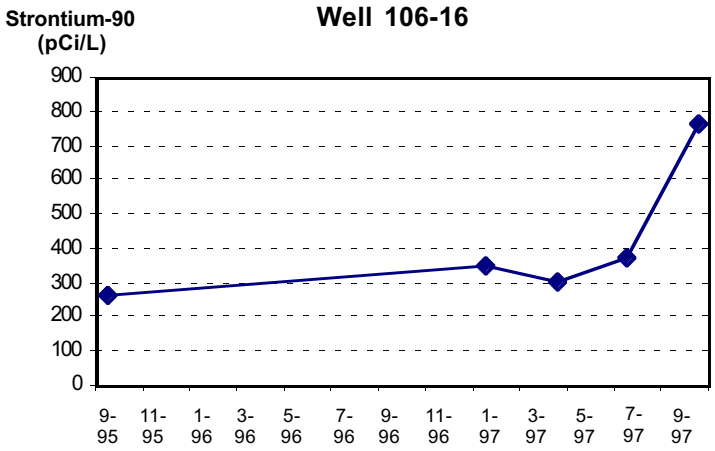


Figure 8-35. Time-vs.-strontium-90 concentration trend plots for well 106-16 located in Former Landfill area.

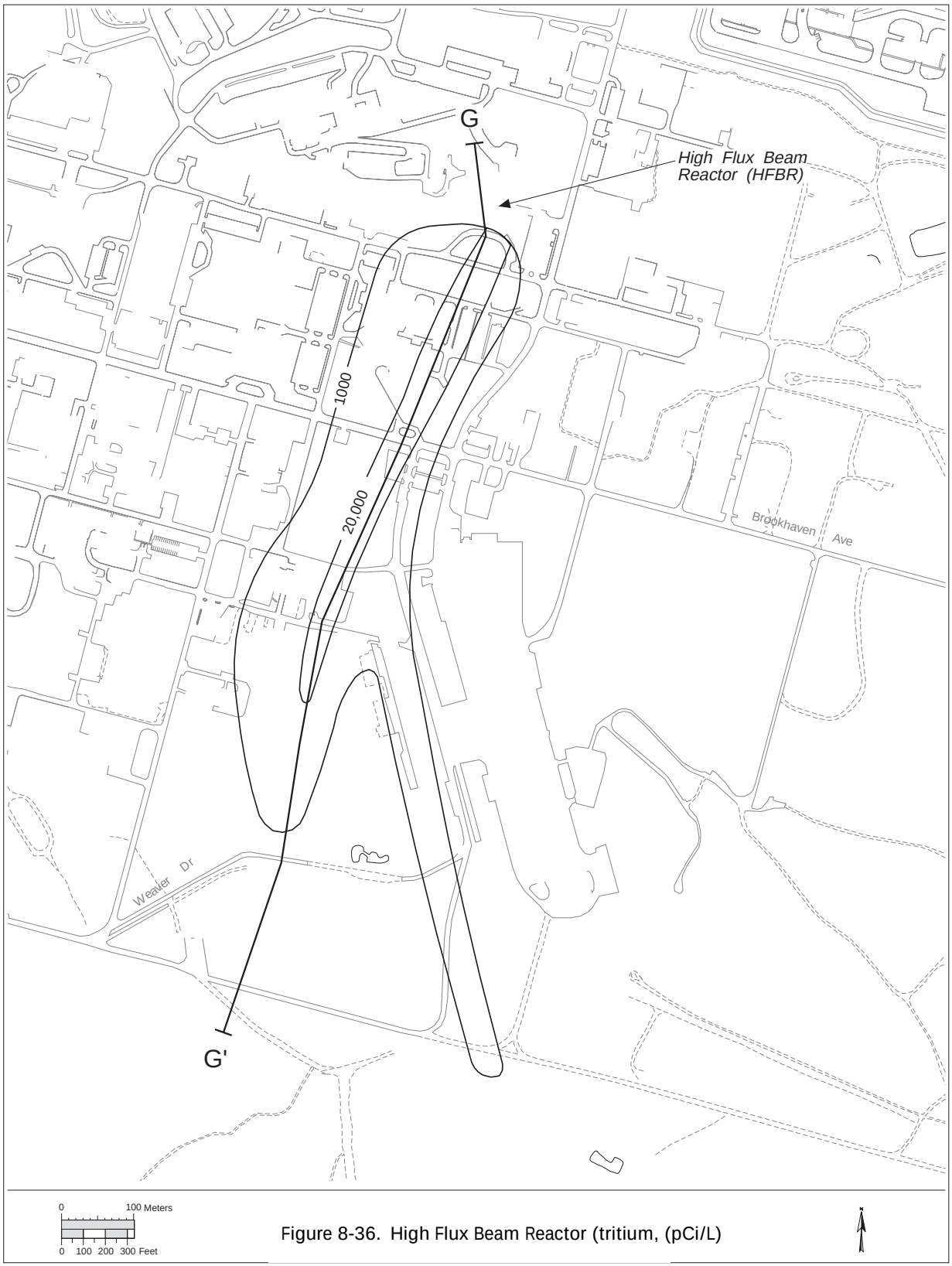


Figure 8-36. High Flux Beam Reactor (tritium, (pCi/L)

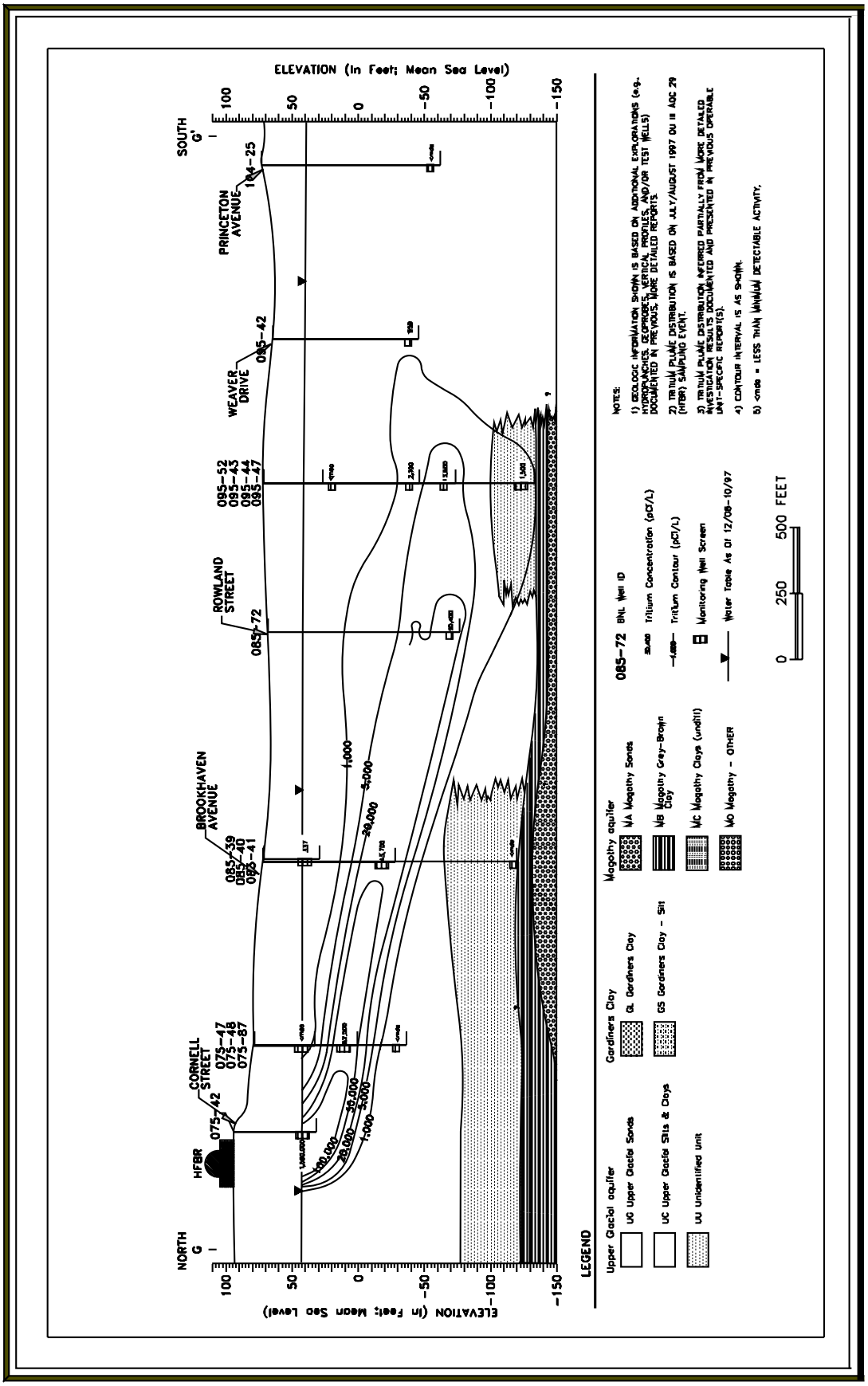


Figure 8-37. HFBR Tritium Plume Cross Section G-G (pCi/L)

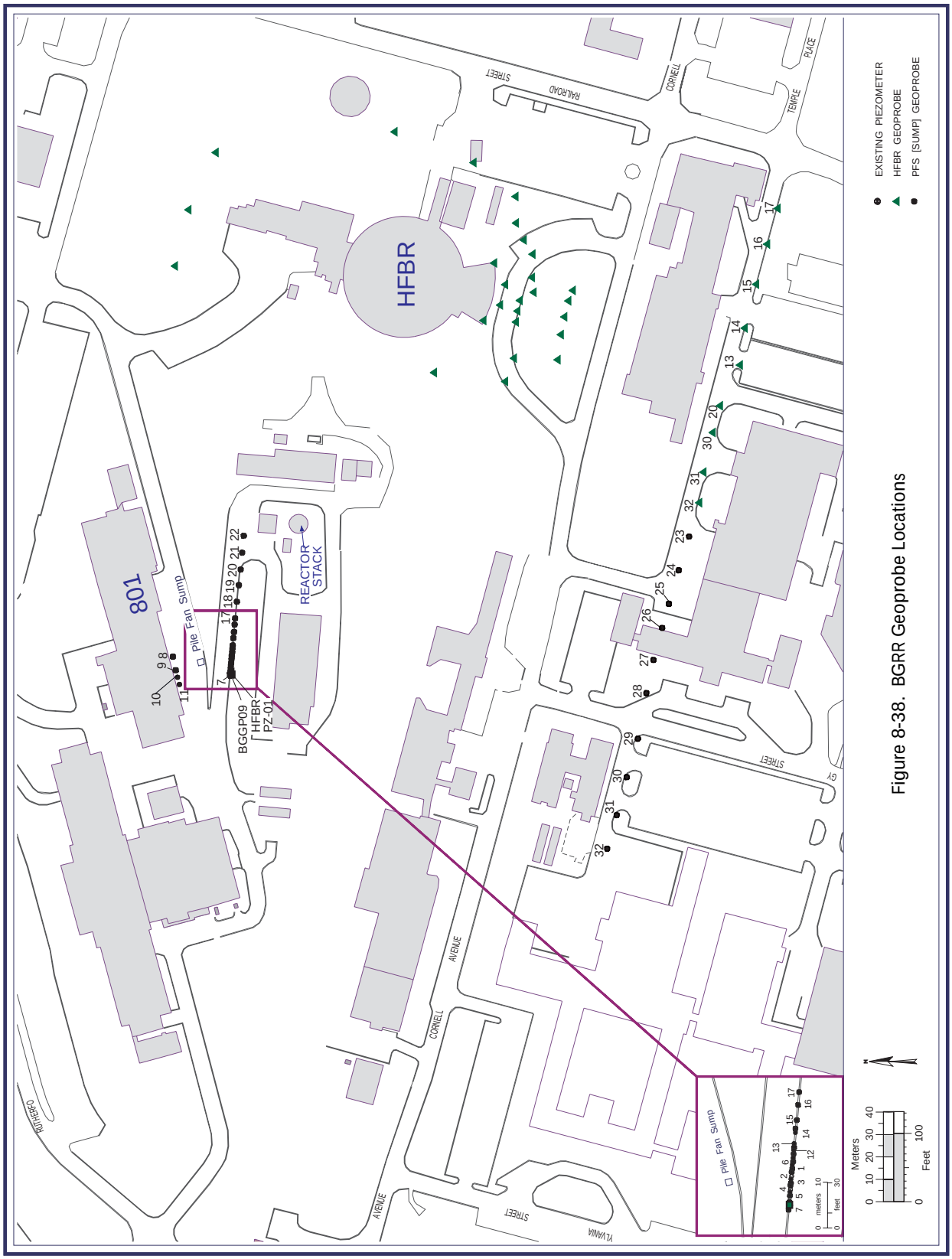


Figure 8-38. BGRR Geoprobe Locations

8.1.2.2.4 Operable Unit IV

Building 650 Sump Outfall: Building 650 was used as a decontamination facility to remove radioactive material from clothing and heavy equipment. Drainage from outdoor decontamination of heavy equipment was routed to a drain system, which emptied out into a natural depression (known as the Building 650 Sump Outfall) 800 feet to the northeast, adjacent to Recharge Basin HO.

Detectable levels of strontium-90 were historically observed in wells located directly downgradient of the Building 650 Sump Outfall. Figure 8-39 shows the radionuclide data for samples collected during August 1997. Strontium-90 was detected at concentrations exceeding the 8 pCi/L (0.3 Bq/L) drinking water standard in wells 76-13 (14.9 pCi/L [0.55 Bq/L]) and 76-169 (14.7 pCi/L [0.54 Bq/L]). Radium-226 was detected by gamma spectroscopy screening in monitoring wells 66-17 (41.4 pCi/L) and 76-167 (27.6 pCi/L) during CY 1997 sampling. These wells were re-sampled during early CY 1998 and analyzed specifically for isotopic radium-226. Radium-226 was not detected in either sample using this method. Monitoring wells 66-17 and 76-167 will continue to be monitored for radium-226.

8.1.2.2.5 Operable Unit V

Although tritium is routinely detected in several of the OU V Pre-ROD monitoring wells near the southeast site boundary, concentrations are well below the drinking water standard of 20,000 pCi/L (740 Bq/L). The tritium results from the August and November 1997 samples are shown on Figure 8-40. The highest level was in 50-02, at 3,320 pCi/L (123 Bq/L). Time-versus-concentration trends for wells 50-01 and 50-02 are shown on Figure 8-41. Tritium was not detected in any of the OU V Pre-ROD monitoring wells located off-site.

During the November 1997 sample period, elevated gross alpha (64 pCi/L [2.4 Bq/L]) and gross beta (54 pCi/L [2.0 Bq/L]) levels were detected in off-site well 000-143, which is screened in the upper Magothy aquifer. The water from this well was highly turbid due to the fine-grained sediments in which the well is screened. This well was sampled again in March 1998, and gross alpha and gross beta values were only 9 and 4 pCi/L (0.33 and 0.15 Bq/L), respectively. The initial elevated gross activity appears to be due to naturally occurring radionuclides due to the presence of suspended soil particles in the turbid sample water. To determine the contribution of suspended solids to the detection of gross alpha and gross beta, both filtered and unfiltered samples will be collected from this well during CY 1998.

8.1.2.3 CERCLA Groundwater Treatment Systems Operational in 1997

A primary mission of BNL's Environmental Restoration program is remediating soil and groundwater contamination and preventing additional contamination from migrating off the BNL site. To that end, four groundwater treatment systems are operating at BNL, and a fifth system will be installed in 1999. Figure 8-42 shows the locations of these four. The following is a brief description of the groundwater treatment systems that were operational during 1997 and a summary of their performance:

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 Medical Department complex (Figure 8-42) where air from a powerful blower separates the VOCs from the water. The removal efficiency is close to 100 percent (see Table 8-5). 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 600 gallons of water per minute.

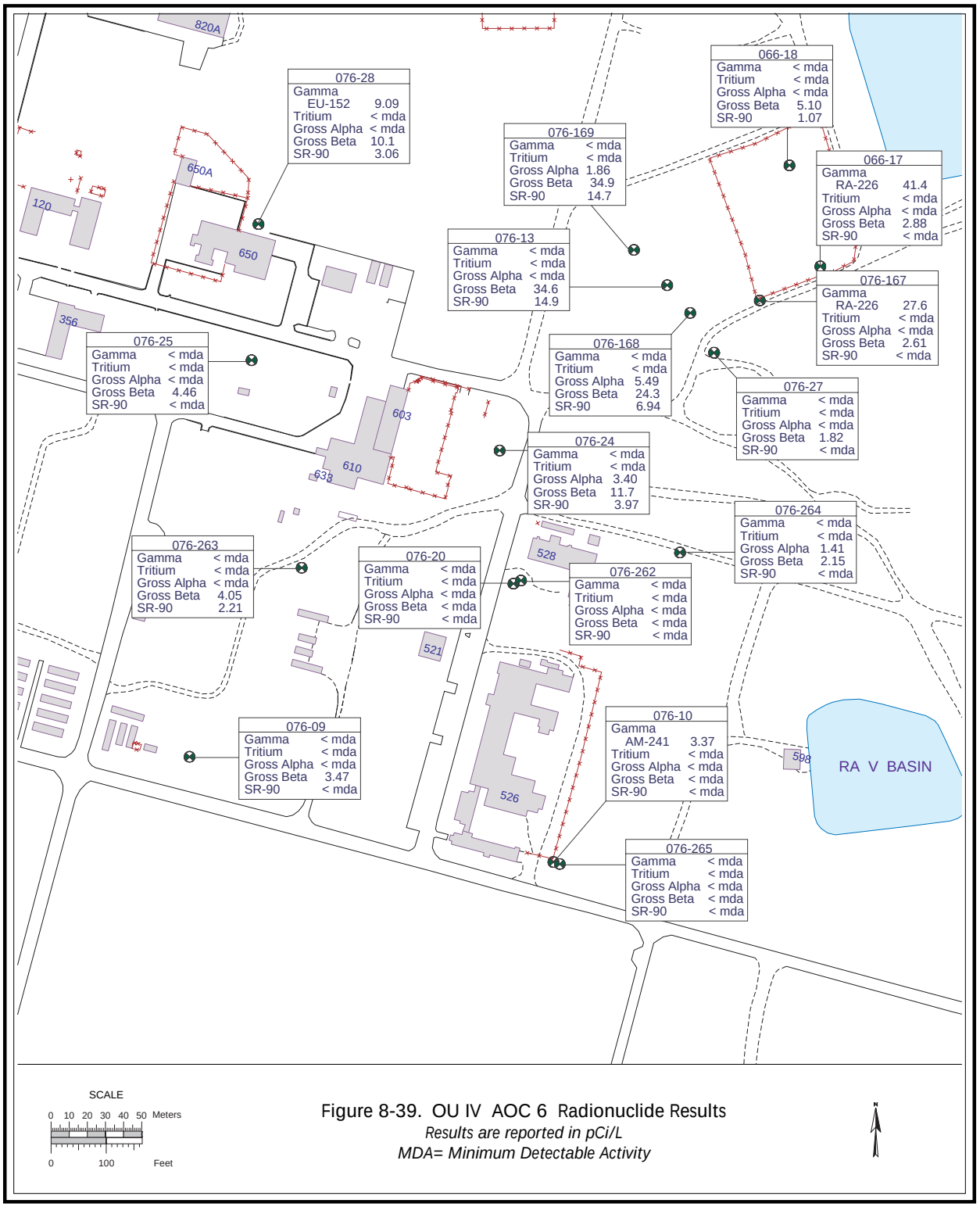


Figure 8-39. OU IV AOC 6 Radionuclide Results

Results are reported in pCi/L

MDA= Minimum Detectable Activity

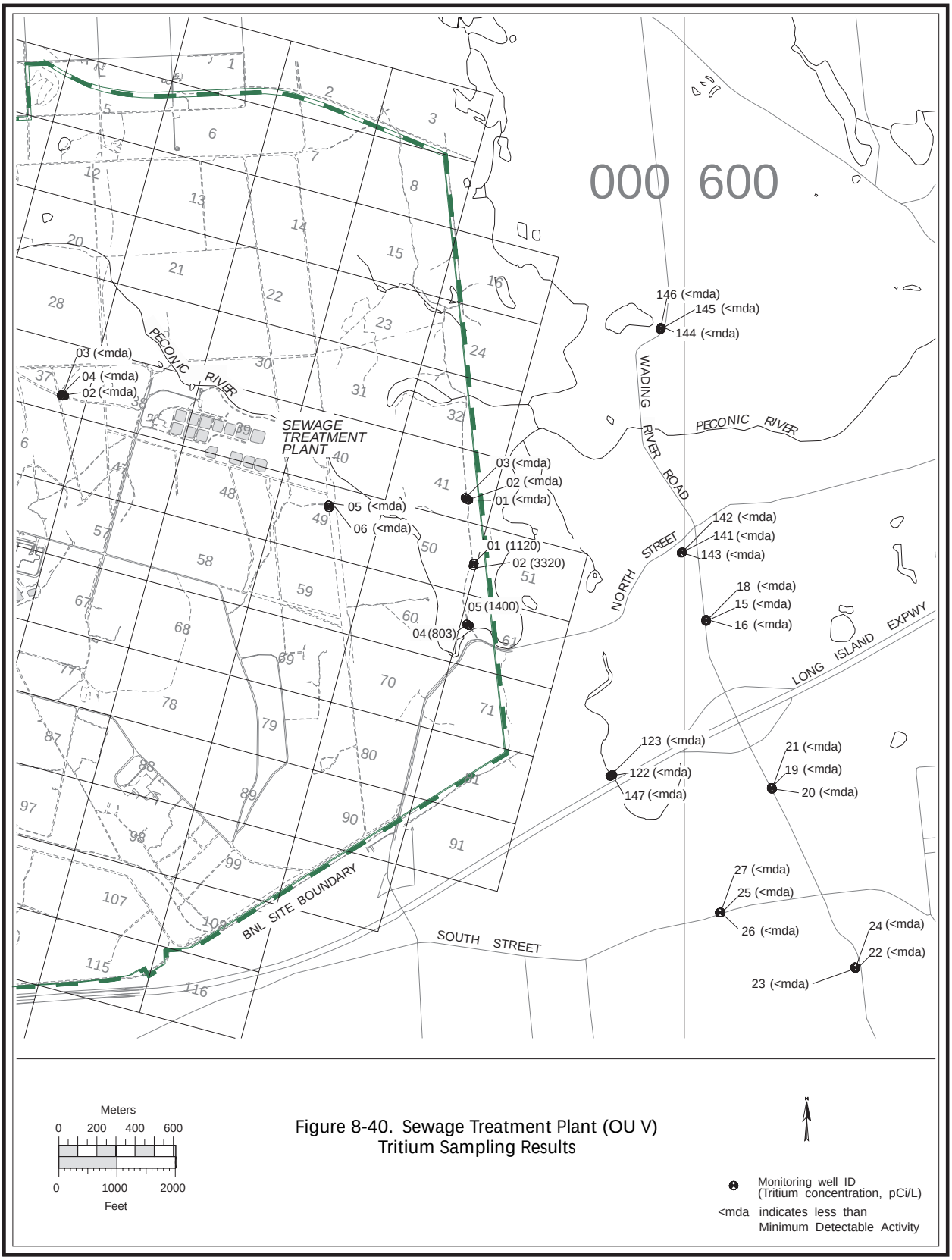


Figure 8-40. Sewage Treatment Plant (OU V)
Tritium Sampling Results

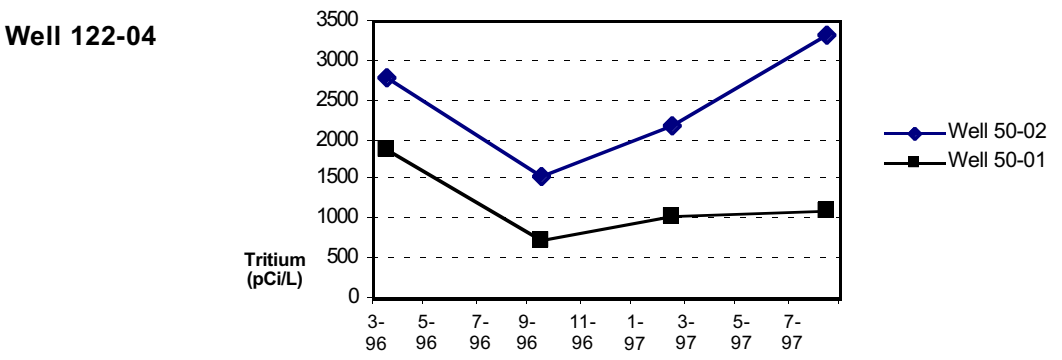


Figure 8-41. Time-vs.- tritium concentration trend plots for well cluster 50-01/50-02 located in the OU V Plume near the eastern site boundary.

Approximately 340 pounds of VOCs were removed from the groundwater during 1997, and 166,000,000 gallons of treated groundwater returned to the aquifer.

South Boundary Remediation System for OU I (RA 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 (Figure 8-42). This system processes more than 700 gallons of water per minute. Like the OU III treatment system, the RA V system removes close to 100 percent of the chemical contamination (Table 8-6). 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.

Approximately 120 pounds of VOCs were removed from the groundwater during 1997, and 340,000,000 gallons of treated groundwater returned to the aquifer.

Geoprobe Sampling

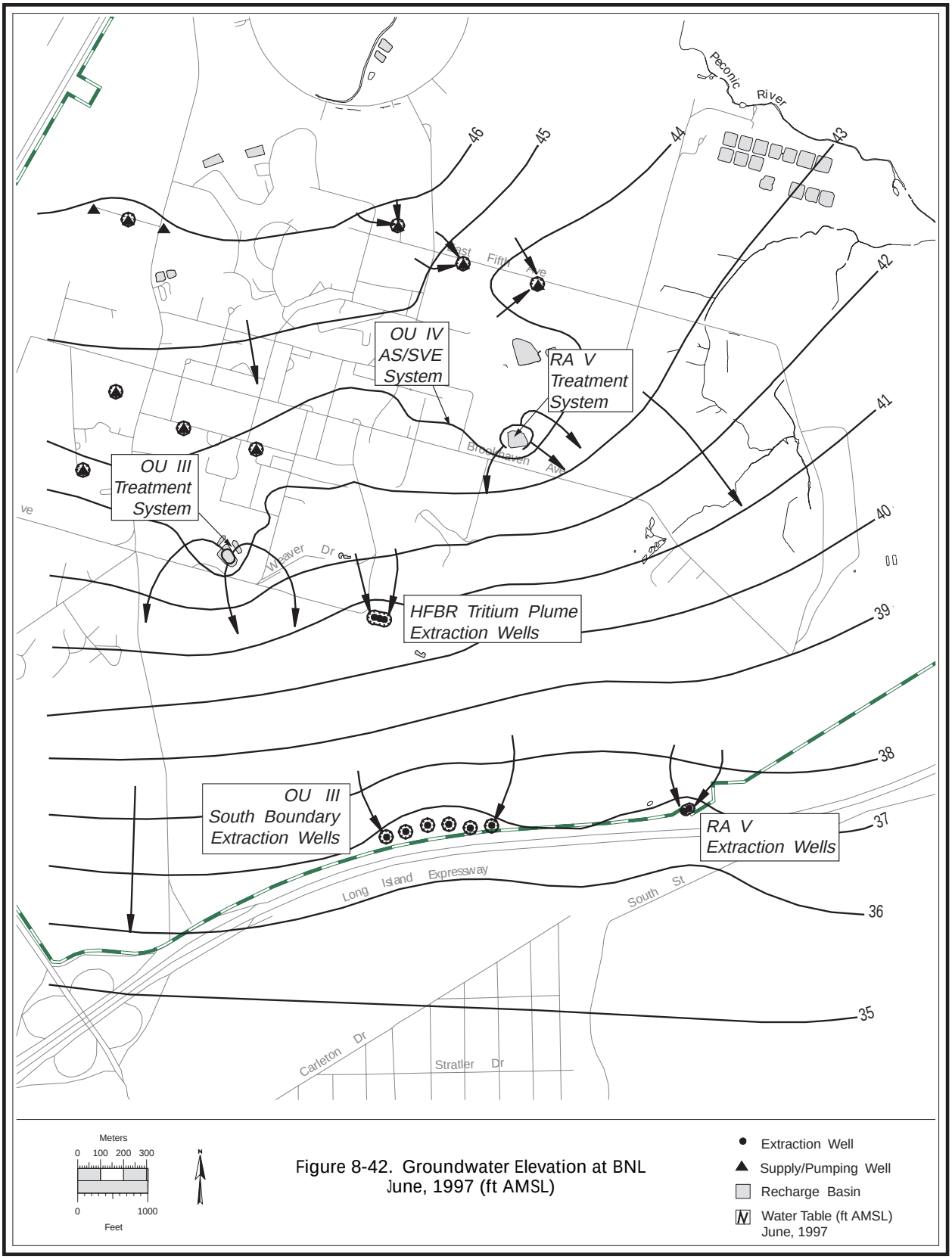


Figure 8-42. Groundwater Elevation at BNL June, 1997 (ft AMSL)

Table 8-5
BNL Site Environmental Report for Calendar Year 1997
OU III South Boundary Groundwater Remediation System
Comparision of Monthly Average Influent and Effluent VOC Concentrations

Month (lbs)	VOC Removal		Carbon Tetrachloride	1,1 - Dichloroethylene	Tetrachloroethylene	Trichloroethane	1,1,1- Trichloroethylene
			µg/L				
June	29	Influent	14	52	118	155	12
(n=7)		Effluent	<0.5	<0.5	<0.5	<0.5	<0.5
July	62	Influent	12	40	94	128	11
(n=4)		Effluent	<0.5	<0.5	<0.5	<0.5	<0.5
August	50	Influent	10	40	78	120	41
(n=4)		Effluent	<0.5	<0.5	<0.5	<0.5	<0.5
September	59	Influent	9	44	75	108	10
(n=5)		Effluent	<0.5	<0.5	<0.5	<0.5	<0.5
October	47	Influent	8	43	63	106	9
(n=4)		Effluent	<0.5	<0.5	<0.5	<0.5	<0.5
November	45	Influent	8	37	54	101	8
(n=4)		Effluent	<0.5	<0.5	<0.5	<0.5	<0.5
December	52	Influent	8	40	45	101	7
n=5)		Effluent	<0.5	<0.5	<0.5	<0.5	<0.5

HFBR Tritium Plume Remediation System (OU III): This groundwater pump and recharge system was constructed as an interim remedial action after discovering the HFBR tritium plume, and has operated since May 1997. Three groundwater extraction wells were installed approximately 3,500 feet south of the HFBR. The tritiated groundwater (generally <2,000 pCi/L) is pumped from the aquifer at a rate of about 120 gallons per minute and piped north to a treatment facility adjacent to the RA V treatment system (see Figure 8-42). Because the tritiated water also contains VOCs that originated from another source(s), the water is treated by passing it through a granular carbon filter to remove the VOCs before discharging the water 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.

During CY 1997, 63,000,000 gallons of water were treated by the granular activated carbon filters (to remove VOCs), and then recharged to the aquifer system.

Air Sparging/Soil Vapor Extraction System for OU IV: This remediation system, which has operated since November 1997, combines two technologies to remove VOC and Semi-VOC 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.

Table 8-6
BNL Site Environmental Report for Calendar Year 1997
Removal Action V Groundwater Remediation System
Comparison of Monthly Average Influent and Effluent VOC Concentrations [a]

Month	VOC Removal (lbs.)		Chloroethane	1,1 - Dichloroethane	Chloroform	1,1,1-Trichloroethane
			µg/L			
January (n=16)	17	Influent	14	49	2	6
		Effluent	<1	<1	<1	<1
February (n=18)	12	Influent	12	38	2	7
		Effluent	<1	<1	<1	<1
March (n=1)	14	Influent	11	34	<1	7
		Effluent	<1	<1	<1	<1
April (n=0)	15	Influent	-	-	-	-
		Effluent	-	-	-	-
May (n=5)	10	Influent	3	20	<1	5
		Effluent	<1	<1	<1	<1
June (n=4)	17	Influent	3	13	44	4
		Effluent	<1	<1	<1	<1
July (n=4)	10	Influent	4	18	1	5
		Effluent	<1	<1	<1	<1
August (n=4)	6	Influent	3	16	<1	4
		Effluent	<1	<1	<1	<1
September (n=4)	5	Influent	3	14	<1	4
		Effluent	<1	<1	<1	<1
October (n=4)	8	Influent	3	13	<1	3
		Effluent	<1	<1	<1	<1
November (n=1)	4	Influent	2	11	<1	2
		Effluent	<1	<1	<1	<1
December (n=1)	2	Influent	2	9	<1	3
		Effluent	<1	<1	<1	<1

(a): Other compounds detected (typically <3 µg/L).

Approximately 12 pounds of contaminants were removed from the soil and groundwater through the treatment of 1,300,000,000 cubic feet of air collected in the soil vapor extraction system.

Off-site Groundwater Treatment System for OU III: A fifth groundwater remediation system is expected to be operational in the spring of 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 will consists of a series of innovative "in-well sparging" wells that use the same air stripping treatment concept as the OU III south boundary systems, but all treatment and recharge occur within

the same well. Within each well, contaminated water will be pumped from a deep well screen to a treatment section located near the top of the well where VOCs will be stripped from the water. The treated water will then be routed to shallow screened section of the same well where it will re-enter the aquifer, and the VOC vapors will be captured by a granular carbon filter.

8.1.3 Facility Surveillance (NON-CERCLA) Groundwater Monitoring

Groundwater monitoring is an integral part of BNL's Environmental Monitoring Program which is conducted to fulfill DOE Orders and NYS permits. This program includes monitoring at active waste processing and temporary storage facilities to comply with RCRA, waste-treatment facilities, operational monitoring around accelerators, and in other areas of known or suspected soil and groundwater contamination. During 1997,105 surveillance wells were monitored during nearly 400 individual sampling events. The locations of all BNL groundwater monitoring wells are presented in Figures 8-1 through 8-14. All wells sampled during CY 1997 are listed in Appendix D.

Most groundwater monitoring wells on the site are two to four inches in diameter, and typically constructed of PVC material. A few wells are constructed of stainless steel materials. The majority of the wells used for the groundwater monitoring program were installed after the mid-1980s, following the appropriate RCRA and CERCLA protocols. Groundwater samples are collected following documented sampling procedures based on EPA guidelines (EPA, 1987). The analytical techniques used are described in this report (see Appendix C), and in the BNL Site Environmental Monitoring Plan (Naidu et al., 1997). Comparing analytical data from the surveillance wells to NYS DOH and DOE reference levels provides a way to evaluate the potential impact of radiological and non-radiological levels of contamination. The groundwater resources underlying the BNL site are designated as Class GA fresh groundwater by NYS. Non-radiological data for groundwater samples collected from surveillance wells (which are not used for drinking water supply) are usually compared to NYS DEC Ambient Water Quality Standards (6NYCRR 703.5). Radiological data are compared to NYS DWS for tritium, gross beta, and strontium-90), NYS AWQS for gross alpha and radium-226/228, and DOE DCGs for other beta/gamma-emitting radionuclides.

8.1.3.1 Non-Radiological Analyses

8.1.3.1.1 Research Facilities

***Alternating Gradient Synchrotron/LINAC and BLIP Areas*:** In the AGS experimental areas, surface spills and discharges to cesspools and recharge basins have contaminated the soils and groundwater with VOCs. Also, several documented spills have occurred in the AGS Bubble Chamber area, which was used as a storage area for drums and liquid-filled scintillation counters.

The surveillance well network for the AGS/LINAC and BLIP areas consists of 19 shallow to deep Upper Glacial aquifer wells which primarily monitor groundwater near and downgradient of the AGS Bubble Chamber spill areas and the AGS and AGS Booster facilities (Figure 8-4). During 1997, groundwater samples were collected from 14 of the AGS/LINAC and BLIP area surveillance wells, and analyzed for water quality, VOCs, and metals. The pH of the groundwater samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.1. Other water quality parameters were below the applicable NYS AWQS. Samples from seven wells showed metals concentrations above NYS AWQS. Elevated levels of iron were detected in two wells (up to 1.6 mg/L), sodium in five wells (up to 38 mg/L), and zinc in one well (1.7 mg/L). Elevated iron and zinc detected in two of the wells, 54-01 and 54-02, is likely due to degradation of the wells' carbon steel casings. VOC analysis of groundwater samples collected from the AGS/LINAC and BLIP area show TCA, TCE, and DCE at concentrations that exceeded NYS AWQS. Levels of TCA that exceeded standards were detected in wells 54-07 and 64-03 at maximum concentrations of 471 µg/L and 18 µg/L, respectively. TCE and DCE were also detected in Well 54-07, at maximum concentrations of 25.9 µg/L and 15.5 µg/L, respectively. The VOCs in Well 64-03 may have originated from cesspools associated with Buildings 914 and 919, whereas the VOCs in

well 54-07 may have originated from the Bubble Chamber spill areas. The contents of the Building 914/919 cesspools were characterized under the IAG (Cesspools EE/CA); they contained VOCs at levels above NYS Soil Cleanup Guidelines. No VOCs were detected in the LINAC and BLIP area wells. The full extent of groundwater contamination downgradient of the AGS/LINAC and BLIP areas is being examined as part of the BNL CERCLA Program (see section 8.1.2.1.3).

8.1.3.1.2 Support Facilities

Sewage Treatment Plant / Peconic River Area: The Sewage Treatment Plant processes sanitary sewage for BNL facilities. The discharge is regulated under a NYSDEC SPDES permit.

The surveillance well network at the STP and Peconic River areas consists of over 50 shallow to deep Upper Glacial aquifer wells (Figures 8-5, 8-6 and 8-13). Twenty-one of the wells are located off-site, and are currently monitored as part of the OU V Pre-ROD monitoring program (see Section 8.1.2). As part of the BNL Facility Surveillance Program for the STP, groundwater samples from 13 of these wells were analyzed for water quality, VOCs, and metals (Tables 8-7, 8-8 and 8-9). In most wells, the pH of groundwater was typically below the NYS AWQS of 6.5 - 8.5, with a median pH of 5.6. Most other water quality parameters were within the applicable NYS AWQS. Although detectable levels of nitrates (NO_3) were found in five shallow wells located near the STP filter beds, only one well (38-02) had concentrations that were slightly above the NYS AWQS of 10 mg/L, with a maximum observed concentration of 12 mg/L. Iron exceeded NYS AWQS of 0.3 mg/L in four wells, with maximum concentrations ranging from 0.39 mg/L to 1.4 mg/L. Four wells had sodium concentrations above the NYS AWQS of 20 mg/L, with maximum concentrations ranging from 22.9 mg/L to 32.5 mg/L. Although trace amounts of chloroform were detected (maximum concentration of 2 µg/L), no VOCs were detected above NYS AWQS in any of the STP area wells. However, TCE at levels exceeding NYS AWQS are observed in wells located to the east of BNL, that are monitored under the OU V Pre-ROD Monitoring Program (see Section 8.1.2.1.5).

***BNL Shotgun Range*:** In the north central portion of the site (north of the new Waste Management Facility), BNL maintains a recreational shotgun range. There is concern that the deposition of lead shot used at the range has, or will, degrade soil and groundwater quality. Furthermore, the shotgun range lies within the zone of contribution for BNL potable supply wells 11 and 12, south of the shotgun range. Routine sampling of them has not revealed elevated lead concentrations (see Section 8.1.1.2). Groundwater quality in the shotgun range area is currently evaluated from four shallow Upper Glacial aquifer wells. During 1997, a composite soil sample was also collected. It contained lead at a concentration of 96 mg/kg, which is below the SCDHS soil cleanup criteria of 400 mg/kg.

During 1997, two rounds of groundwater samples from four wells located in the shotgun range area were collected and analyzed for metals and water quality. The pH of groundwater was below the NYS AWQS of 6.5 - 8.5, with a median pH of 5.6. Other water quality parameters were below the applicable NYS AWQS. All metals, including lead, were also below NYS AWQS.

***Water Treatment Plant Area*:** At the direction of the NYSDEC, five groundwater surveillance wells were installed at the WTP in 1993 to assess potential leaching of iron from the plant's recharge basins into the groundwater. Naturally high levels of iron in groundwater are removed at the WTP, and the precipitated iron is discharged to the recharge basins.

During 1997, two rounds of groundwater samples were collected from these five wells, and analyzed for water quality and metals. The pH of the groundwater from two upgradient wells was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.1, whereas it was within limits in three wells directly downgradient of the basins, with a median pH of 7.0. Other water quality parameters were below the applicable NYS AWQS. Most metals concentrations (including iron) were below the applicable NYS AWQS. However, sodium was detect-

ed slightly above the NYS AWQS of 20 mg/L in one well (73-01), with a maximum concentration of 26 mg/L.

***Building 423 (Motor Pool) Area*:** Building 423 serves as the site motor pool, where BNL's fleet vehicles are repaired and refueled. Gasoline is stored in two 8,000 gallon-capacity underground storage tanks (USTs), and waste oil is stored in one 500 gallon-capacity UST. Although the USTs and associated distribution lines meet SC Article 12 requirements for secondary containment, leak detection, and high level alarms, BNL initiated a groundwater monitoring program in 1996 to ensure that potential leakage will be detected if a tank alarm system failed.

During 1997, three rounds of groundwater samples were collected from the two surveillance wells and analyzed for VOCs, and checked for floating petroleum product. TCA was detected at concentrations exceeding NYS AWQS in well 102-06, with a maximum observed concentration of 8 µg/L. The fuel additive MTBE was also detected in Well 102-06 at a maximum concentration of 7.4 µg/L, which is well below the NYS DWS of 50 µg/L. No floating product was observed.

On-Site Service Station: Building 630 is a commercial automobile repair and gasoline station for the BNL site. Gasoline is stored in two 8,000 gallon capacity and one 6,000 gallon capacity underground storage tanks (USTs), and waste oil is stored in one 500 gallon capacity UST. Although the USTs and associated distribution lines meet SC Article 12 requirements for secondary containment, leak detection, and high level alarms, BNL initiated a groundwater monitoring program in 1996 to ensure that potential leakage will be detected if a tank alarm system failed.

During 1997, three rounds of groundwater samples were collected from the two surveillance wells and analyzed for VOCs, and checked for floating petroleum product. PCE and carbon tetrachloride were detected at concentrations exceeding NYS AWQS. PCE was detected in both well 85-16 and well 85-17, at maximum observed concentrations of 12.1 µg/L and 11 µg/L, respectively. Carbon tetrachloride was found in one sample from well 85-17 at a concentration of 6.5 µg/L. The fuel additive MTBE was also detected in Well 85-17 at a maximum concentration of 18.6 µg/L, which is well below the NYSDWS of 50 µg/L. No floating product was observed.

***Former Chemistry Department Area*:** The Former Chemistry Department complex was located on Rochester Street and Bell Avenue. In the 1950s, the Chemistry Department conducted a long-term solar neutrino study using a 1,000 gallon-capacity tank installed underground south of Bell Avenue. This tank was filled with 1,000 gallons of carbon tetrachloride. Available records indicate that the carbon tetrachloride was removed from the tank, and that air was blown through it to remove residual traces of the solvent. During CY 1998, BNL will locate and remove the tank, and install additional wells to further evaluate groundwater quality downgradient of the tank.

Groundwater quality downgradient of the Former Chemistry Department complex is presently monitored by a single shallow Upper Glacial aquifer well (Figure 8-7). During 1997, the well (85-06) was sampled for VOCs. Carbon tetrachloride and chloroform were detected above NYS AWQS at maximum concentrations of 20 µg/L and 9 µg/L, respectively.

***Major Petroleum Facility (MPF) Area*:** The CSF supplies steam for heating to all major facilities of the Laboratory through an underground distribution system. The MPF is the holding area for most fuels used at the CSF. Five shallow wells monitoring the MPF were installed as part of the licensing requirements for this facility, and are screened across the water table so that free products (i.e., oil floating on top of the groundwater) can be detected. The surveillance wells at the CSF were installed primarily to monitor ground-water contamination resulting from a 1977 leak of approximately 23,000 gallons of Alternative Liquid Fuel (a fuel oil/spent solvent mixture). The CSF/MPF area has been the subject of an RI/FS (OU IV), and has been undergoing active soil and groundwater remediation since the winter of 1997 (see Sections 8.1.2.1.4 and 8.1.2.3).

The surveillance well network at the CSF and MPF area consists of 30 shallow to deep Upper Glacial aquifer wells (Figures 8-5 through 8-8). During 1997, 23 wells were monitored for water quality, metals, and VOCs. The five MPF wells were also sampled monthly for floating petroleum

Table 8-7
BNL Site Environmental Report for Calendar Year 1997
Sewage Treatment Plant/Peconic River Area
Groundwater Surveillance Wells, Water Quality Data

Well	No. of Samples	pH (SU) Range		Chlorides (mg/L)	Sulfates (a) (mg/L)	Nitrate (NO3) (a) (mg/L)
38-01	4	4.8 - 5.4	Max.	6.416	<1.0	
			Avg.	5.1	14.5	<1.0
38-02	3	5.4 - 5.9	Max.	22.1	20.4	12.0
			Avg.	11.9	14.5	7.1
38-03	4	5.1 -5.8	Max.	14.7	17.6	3.3
			Avg.	10.0	14.8	<1.0
38-05	4	5.5 - 6.3	Max.	11.3	14.6	3.5
			Avg.	10.2	12.3	3.2
38-06	4	5.2 - 5.7	Max.	5.0	10.0	<1.0
			Avg.	4.7	8.6	<1.0
39-05	4	5.4 - 5.7	Max.	21.3	9.3	<1.0
			Avg.	16.6	6.6	<1.0
39-06	4	5.8 - 6.4	Max.	47.1	31.3	1.1
			Avg.	35.1	12.8	<1.0
39-07	4	5.7 - 6.2	Max.	37.9	13.3	6.2
			Avg.	21.9	11.3	3.7
39-08	4	5.4 - 6.1	Max.	39.3	16.9	5.3
			Avg.	31.3	14.9	4.2
39-09	4	4.9 - 5.1	Max.	10.2	8.7	<1.0
			Avg.	9.5	7.7	<1.0
39-10	4	6.4 - 6.7	Max.	8.2	8.6	<1.0
			Avg.	6.3	6.5	<1.0
60-01	4	4.8 - 5.5	Max.	10.9	13.0	<1.0
			Avg.	8.0	9.6	<1.0
61-03	3	4.7 - 5.1	Max.	13.2	12.7	<1.0
			Avg.	11.6	12.1	<1.0
NYS AWQS		6.5 - 8.5		250	250	10
Typical MDL				4	4	1

a): Holding times for sulfates and nitrates were usually exceeded.

products, and twice per year for polynuclear aromatics and base-neutral extractable compounds (EPA Method 625), in accordance with the NYSDEC license (see Section 2.3.4). The pH was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.0. Other water quality parameters were below the applicable NYS AWQS. All metal concentrations were below the applicable NYS AWQS. In the five wells monitoring the MPF, VOCs were above NYS AWQS, in upgradient Well 76-25 with TCA at a maximum concentration of 8.2 µg/L, and PCE was detected in well 76-19 at a maximum concentration of 9.9 µg/L. The TCA detected in well 76-25 is likely to have originated from releases in the Building 650 area, whereas the PCE in well 76-19 is likely to have originated historical spills at the MPF. No benzene/ethylbenzene/toluene/xylene (BETX) or other hydrocarbon-related compounds were detected in the MPF wells. As in previous years, no floating petroleum products were observed during 1997.

Table 8-8
BNL Site Environmental Report for Calendar Year 1997
Sewage Treatment Plant/Peconic River Area
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			mg/L								
38-01	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	3.4	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	3.3	<0.002	<0.02
38-02	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	2.3	<0.002	0.06
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	14.47	<0.002	0.03
38-03	3	Max.	<0.025	0.002	<0.005	<0.05	0.392	<0.0002	8.6	<0.002	0.67
		Avg.	<0.025	0.002	<0.005	<0.05	0.185	<0.0002	7.1	<0.002	0.48
38-05	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.8	<0.002	0.18
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.4	<0.002	0.06
38-06	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.8	<0.002	0.12
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.3	<0.002	0.05
39-05	3	Max.	<0.025	<0.0005	<0.005	<0.05	0.775	<0.0002	15.10	<0.002	0.05
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.594	<0.0002	10.00	<0.002	<0.02
39-06	3	Max.	<0.025	<0.0005	<0.005	<0.05	1.378	<0.0002	26.10	<0.002	1.38
		Avg.	<0.025	<0.0005	<0.005	<0.05	1.367	<0.0002	21.10	<0.002	0.47
39-07	3	Max.	<0.025	<0.0005	<0.005	<0.05	0.615	<0.0002	25.9	<0.002	0.06
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.365	<0.0002	17.6	<0.002	<0.02
39-08	3	Max.	<0.025	<0.0005	<0.005	<0.05	0.122	<0.0002	32.5	<0.002	0.17
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	29.3	<0.002	0.06
39-09	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	6.5	<0.002	0.06
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	6.1	<0.002	0.03
39-10	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.6	<0.002	0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.6	<0.002	<0.02
60-01	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.5	<0.002	0.03
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.0	<0.002	<0.02
61-03	2	Max.	<0.025	<0.0005	<0.005	<0.05	0.142	<0.0002	8.9	<0.002	0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	8.8	<0.002	<0.02
NYS AWQS			0.05	0.01	0.05	0.2	0.3	0.002	20	0.025	0.3
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

New Waste Management Facility: In CY 1997, BNL began operating a new Waste Management Facility (WMF) located close to the geographic center of the site. The new facility is designed to safely handle, repackage, and temporarily store BNL derived hazardous and radioactive waste prior to shipment to an off-site disposal or treatment facility. The new WMF is designed and operated in a manner that meets all applicable federal, state and local environmental protection requirements; never the less, BNL established a groundwater monitoring program as a secondary means of verifying the effectiveness of the engineering and operational controls.

The new WMF is monitored by eight shallow Upper Glacial aquifer wells. During 1997, three rounds of groundwater samples were collected and analyzed for VOCs, metals and water quality. The pH of groundwater was slightly below the NYS AWQS of 6.5 - 8.5, with a median pH of 6.2. All other water quality parameters were below the applicable NYS AWQS. Except for sodium, metal concentrations were also found to be below NYS AWQS. Sodium routinely exceeded the 20 mg/L AWQS in well 55-03, with a maximum observed concentration of 38 mg/L. All VOCs were below applicable NYS AWQS.

8.1.3.2 Radiological Analyses

8.1.3.2.1 Research Facilities

Alternating Gradient Synchrotron (AGS) Area: Wells in the vicinity of the AGS are positioned in Grids 54, 64, and 65 (see Figure 8-4). Man-made (or anthropogenic) radionuclides have been detected in groundwater downgradient of the Brookhaven Linac Isotope Producer (BLIP) and AGS facilities. These radionuclides have been produced through activation and/or spallation processes in soil constituents by secondary radiation generated by beam/target interactions. The radiological data are presented in Table 8-9. Except for well 54-01, which showed two highly divergent gross beta values in 1997, all gross activity concentrations in wells in this part of the site were typical of nominal environmental levels. The high gross beta value of 34 pCi/L (1.3 Bq/L) in the 54-01 well sample may be falsely elevated due to analytical instrument problems (see Chapter 10 for details).

Well 64-02 continued to show low levels of tritium, consistent with values observed since this well's installation in 1994. The maximum observed concentration was 2,470 pCi/L (91 Bq/L). Samples from this well also continued to show sodium-22 (half-life = 2.6 years), at a maximum concentration of 21 pCi/L (0.8 Bq/L). A more extensive investigation of possible radionuclides in groundwater downgradient of the BLIP facility is scheduled for CY 1998.

Brookhaven Medical Research Reactor (BMRR): The BMRR's primary cooling water system consists of a recirculating loop containing 2,550 gallons of water. The tritium concentration in the primary water is approximately 465 mCi/L (17 MBq/L). However, unlike the High Flux Beam Reactor, the BMRR has neither a spent fuel storage canal nor an imbedded pressurized piping system, which could provide a route of environmental release for radioactive liquids.

Potential environmental vulnerabilities at the BMRR were initially evaluated during the HFBR Tritium Remediation Project, and later as part of the BNL Facility Review Project. Low levels of tritium (2,450 pCi/L [91 Bq/L]) were detected in a groundwater sample collected in January 1997 from a shallow Upper Glacial aquifer-monitoring well (94-01), located 400 feet south of the BMRR. Therefore, BNL installed two shallow monitoring wells directly downgradient of the BMRR. Subsequent sampling of the new wells revealed tritium concentrations of up to 11,400 pCi/L (422 Bq/L). Twenty-five temporary Geoprobe™ wells were then installed to identify the source and determine the extent of the tritium contamination (Paquette, 1997). The highest tritium levels were found in temporary wells installed within 50 feet of the BMRR, where a maximum concentration of 11,800 pCi/L (437 Bq/L) was detected. A plume of tritiated groundwater was traced from the BMRR to approximately 400 feet south (downgradient), where a maximum concentration of 3,800 pCi/L (141 Bq/L) was detected. The tritium is believed to have originated from the

Table 8-9
BNL Site Environmental Report for Calendar Year 1997
Radiological Data for Groundwater Wells near AGS, BLIP and LINAC Areas

Well ID	N		Gross Alpha	Gross Beta	Tritium	Na-22
			(pCi/L)			
044-02	3	Max.	2.4 ± 1.2	6.9 ± 2.5	< 372	ND
		Avg.	1.2 ± 3.4	3.7 ± 8.8	-134 ± 376	
053-01	4	Max.	4.8 ± 1.3	5.2 ± 2.3	402 ± 212	ND
		Avg.	1.7 ± 5.5	2.3 ± 5.0	107 ± 550	
054-01	3	Max.	< 1.4	4.0 1.2	< 372	ND
		Avg.	0.7 ± 0.7	3.7 ± 0.9	-72 ± 377	
054-02	3	Max.	3.5 ± 1.2	8.1 ± 2.5	673 ± 233	ND
		Avg.	1.0 ± 4.3	4.6 ± 6.1	491 ± 570	
054-03	2	Max.	< 1.2	< 3.8	< 324	ND
		Avg.	0.6 ± 1.4	0.4 ± 2.3	39 ± 235	
054-05	3	Max.	5.9 ± 1.5	9.0 ± 2.5	< 372	ND
		Avg.	2.0 ± 6.7	4.8 ± 8.0	-95 ± 279	
054-06	3	Max.	4.0 ± 1.2	6.0 ± 2.4	< 372	0.14 ± 0.003
		Avg.	2.0 ± 4.4	4.4 ± 2.9	92 ± 408	(a)
054-07	3	Max.	2.3 ± 1.0	15.1± 2.7	717 ± 234	1.43 ± 0.03
		Avg.	0.3 ± 3.3	8.3± 13.7	397 ± 657	0.94 ± 0.85
054-08	3	Max.	3.0 ± 1.1	12.0± 2.6	993 ± 215	ND
		Avg.	1.7 ± 2.6	7.7± 11.2	662 ± 719	
54-10	2	Max.	2.4 ± 1.0	33.7± 3.4	494 ± 216	0.30 ± 0.01
		Avg.	2.1 ± 0.8	20.6± 36.9	225 ±761	(a)
064-01	3	Max.	3.5 ± 1.2	4.7± 2.4	< 291	ND
		Avg.	1.5 ± 3.5	4.4± 0.4	25 ± 303	
064-02	5	Max.	1.8 ± 1.0	8.4± 1.4	2,470 ± 379	21.0 ± 0.42
		Avg.	0.2 ± 1.9	4.9± 7.0	1,337 ± 2,131	7.80 ± 0.85
064-03	3	Max.	2.3 ± 1.1	7.4± 2.4	< 291	3.60 ± 0.07
		Avg.	0.7 ± 2.8	4.6± 5.1	35 ± 576	2.04 ± 2.75

N = No. of samples collected.
ND = Not Detected.
Notes:
(a) This nuclide detected only once.
Maximum values reported with 2σ (95%) confidence interval.
Average values calculated as arithmetic mean of individual measurements ±2 standard errors of the mean.

historical discharge of primary cooling water to a basement floor drain and sump system that may have leaked. The last such discharge from this system occurred in 1987, and the floor drains are scheduled to be permanently sealed in CY 1999 to prevent any future releases to the underlying soils.

8.1.3.2.2 Support Facilities

Sewage Treatment Plant / Peconic River Area: For groundwater in the area surrounding the STP, gross alpha activity values were typical of ambient groundwater values while gross beta activities were elevated in Wells 38-03 and 39-08 with a maximum recorded value of 61 pCi/L (2.3 Bq/L) (Table 8-10). These wells showed elevated gross beta concentrations in 1996 also. Tritium was present at up to 3,630 pCi/L (134 Bq/L)(Figure 8-43). Though cesium-137 has been detected in groundwater in this area in the past, no significant concentrations were observed in samples collected in 1997. The only well which showed cesium-137 was 39-09 at 0.21 ± 0.14 pCi/L (8 ± 5 mBq/L), a concentration which is at the limit of detection and, therefore, questionable as a valid result. The drinking water standard for cesium-137 is 120 pCi/L (4.4 Bq/L). No other anthropogenic radionuclides were detected in groundwater in this area.

New Waste Management Facility (WMF): The new WMF is monitored by eight shallow Upper Glacial aquifer wells. During 1997, three rounds of groundwater samples were collected for radiological analysis (Table 8-11). With one exception, gross activity levels in these samples were typical of ambient background levels. Well 56-01 showed slightly elevated gross beta activity, with a maximum value of 12.8 pCi/L (0.47 Bq/L), due to cobalt-60 (half-life = 5.2 years), which was detected in two of the three samples collected from this well in 1997. The maximum concentration of cobalt-60 observed was 4.4 pCi/L (0.16 Bq/L). The drinking water standard for this radionuclide is 200 pCi/L (7.4 Bq/L). This material is not related to the WMF. The likely sources of the cobalt are (1) past leakage from nearby underground sanitary lines (which at one time transported liquid wastes containing this nuclide from Building 811 to the STP) or (2) the underground storage tank leak which occurred at Building 830 in 1988. Though the Building 830 tank is downgradient of well 56-21, contaminants from the 1988 release are within the hydraulic zone of influence/capture created by pumps at Wells No. 11 and 12.

While results indicated maximum tritium concentrations above the minimum detection limit (MDL) at wells 55-03 and 66-07, these values were extremely close to the MDL of 254 pCi/L (9.4 Bq/L). When the 95% confidence intervals are considered, these two values are not statistically different from the MDL and do not, therefore, represent clear detections. The annual average value for each well, which includes all three-sample results, was less than the typical MDL for this analysis.

8.1.4 Surveillance of Private Supply Wells

8.1.4.1 Radiological Analyses

1995-1996 Surveillance Program: Between September 1995 and May 1996, the SCDHS sampled approximately 550 residential wells from the area shown in Figure 8-44. Approximately 550 samples were collected for tritium analysis, 220 samples were collected for gross alpha and gross beta activity, and 100 wells sampled for strontium-90.

Detectable levels of tritium were found in thirteen of the private wells, all at levels significantly below the Safe Drinking Water Act (SDWA) standard of 20,000 pCi/L (740 Bq/L). The concentrations in those wells ranged from 410 pCi/L (15 Bq/L) to a maximum of 3,930 pCi/L (145 Bq/L), or 2% to 20% of the drinking water standard. Figure 8-45 summarizes these results.

Gross alpha, gross beta, and strontium-90 concentrations above the minimum detection limit were found in several private well samples. Figure 8-46 illustrates the results of these tests. No private well sampled during this period showed gross alpha, gross beta, or strontium-90 concentrations that exceed or approach the drinking water standards of 15 pCi/L (0.6 Bq/L), 50 pCi/L (1.9 Bq/L), and 8 pCi/L (0.3 Bq/L), respectively.

1997 Surveillance Program: In 1997 the SCDHS sampled water from approximately 100 residential wells to the east of BNL for tritium, gross alpha and gross beta activity.

Table 8-10
BNL Site Environmental Report for Calendar Year 1997
Gross Activity and Tritium Results at STP and Peconic River Area

Well ID		Gross Alpha	Gross Beta	Tritium
		(pCi/L)		
038-01	N	3	3	3
	Max.	2.8 ± 1.2	4.7 ± 2.3	2,040 ± 329
	Avg.	1.5 ± 2.5	2.7 ± 3.5	879 ±2,017
038-02	N	3	3	3
	Max.	2.7 ± 1.2	6.4 ± 2.5	2,850 ± 363
	Avg.	1.0 ± 2.9	4.8 ± 3.3	1,244 ±2,818
038-03	N	3	3	3
	Max.	4.2 ± 1.3	25.5 ± 3.1	1,170 ± 285
	Avg.	2.1 ± 3.7	23.1 ± 6.6	631 ± 958
038-05	N	3	3	3
	Max.	9.9 ± 1.7	12.6 ± 2.7	2,070 ± 331
	Avg.	3.3 ± 11.4	4.5 ± 14.2	1,560 ± 893
038-06	N	3	3	3
	Max.	3.2 ± 1.3	4.1 ± 2.4	2,020 ± 329
	Avg.	1.3 ± 3.3	1.3 ± 5.3	921 ±1,945
039-05	N	3	3	4
	Max.	3.7 ± 1.4	9.1 ± 2.6	3,630 ± 394
	Avg.	1.9 ± 3.2	4.4 ± 8.3	1,666 ±2,785
039-07	N	3	3	3
	Max.	1.7 ± 1.1	5.2 ± 2.4	1,910 ± 321
	Avg.	0.8 ± 1.7	2.9 ± 4.4	1,108 ±1,432
039-08	N	3	3	3
	Max.	4.9 ± 1.3	60.7 ± 4.1	1,580 ± 308
	Avg.	4.6 ± 0.9	27.6 ± 58.3	998 ±1,019
039-09	N	3	3	3
	Max.	10.1 ± 1.8	14.4 ± 2.8	< 306
	Avg.	5.7 ± 9.5	7.7 ± 12.2	-113 ± 896
039-10	N	3	3	3
	Max.	1.1 ± 0.9	6.5 ± 4.3	< 333
	Avg.	0.4 ± 2.1	3.8 ± 5.3	-73 ± 480
060-01	N	3	3	5
	Max.	2.9 ± 1.2	11.2 ± 4.7	1,990 ± 328
	Avg.	1.6 ± 2.5	8.0 ± 7.6	479 ±1,707
061-03	N	2	2	4
	Max.	4.0 ± 1.3	5.4 ± 2.4	< 316
	Avg.	2.6 ± 3.8	4.2 ± 3.3	-9 ± 124
Drinking Water Standard		15	50	20,000

1. Maximum values reported with 2σ (95%) confidence interval.
2. Average values calculated as arithmetic mean of individual measurements ±2 standard errors of the mean.
N = Number of samples collected.

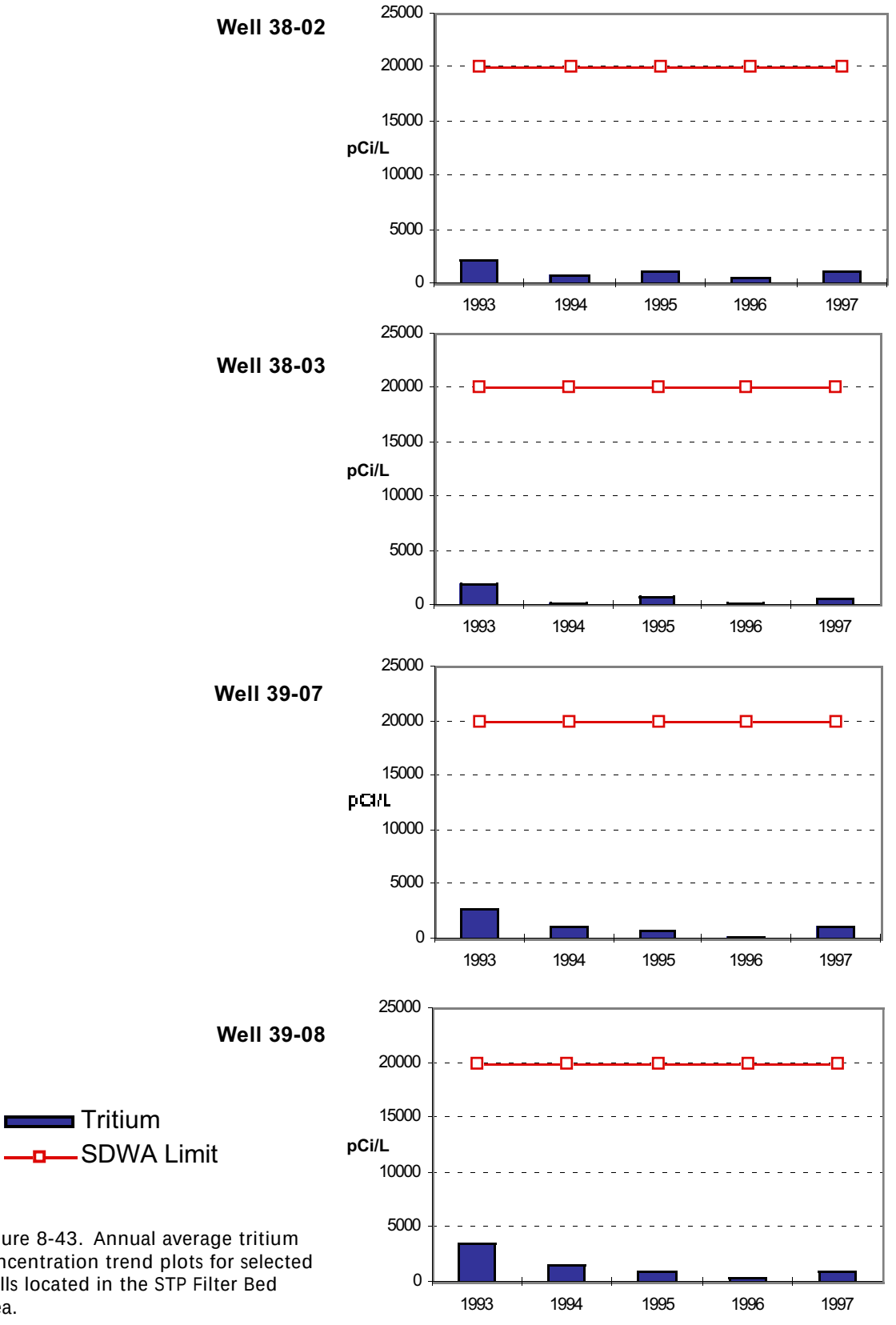


Figure 8-43. Annual average tritium concentration trend plots for selected wells located in the STP Filter Bed area.

Table 8-11
BNL Site Environmental Report for Calendar Year 1997
Gross Activity and Tritium Results at New Waste Management Facility

Well ID	N		Gross Alpha	Gross Beta (pCi/L)	Tritium
055-03	3	Max.	3.4 ± 1.2	4.2 ± 2.3	384 ±179 (MDL: 254)
		Avg.	1.6 ± 3.6	3.5 ± 1.3	192 ± 338
066-07	3	Max.	3.2 ± 1.2	5.4 ± 2.4	294 ±174 (MDL: 254)
		Avg.	1.8 ± 3.0	2.9 ± 4.6	117 ± 502
055-10	2	Max.	3.2 ± 1.0	4.5 ± 2.2	< 283
		Avg.	1.5 ± 4.8	3.1 ± 3.9	107 ± 389
056-21 (a)	2	Max.	4.3 ± 1.4	12.8 ± 2.7	< 316
		Avg.	2.5 ± 5.1	8.5 ± 12.0	213 ± 116
056-22	3	Max.	0.7 ± 1.0	4.0 ± 2.4	< 303
		Avg.	0.3 ± 1.0	3.1 ± 1.8	65 ± 128
056-23	4	Max.	2.0 ± 1.2	6.0 ± 2.2	< 316
		Avg.	0.9 ± 1.4	3.7 ± 5.0	-57 ± 335
066-83	3	Max.	1.8 ± 0.8	7.7 ± 2.3	< 316
		Avg.	1.3 ± 1.3	5.1 ± 7.3	10 ± 183

Maximum values reported with 2σ (95%) confidence interval.
Average values calculated as arithmetic mean of individual measurements ±2 standard errors of the mean.
N = Number of samples collected.
Notes:
(a) Co-60 detected in well 056-21 in May 28 and August 26 samples at 2.5 and 4.4 pCi/L, respectively.

Gross alpha concentrations in the wells ranged from 1 to 3 pCi/L (0.04 to 0.1 Bq/L); a range typical of ambient environmental levels. Gross beta concentrations were also nominal, ranging from 2 to 6 pCi/L (0.07 to 0.2 Bq/L). Figure 8-47 summarizes the results. No private well sampled during this period showed gross alpha or gross beta concentrations that exceeded or approached their respective drinking water standards of 15 pCi/L (0.6 Bq/L) and 50 pCi (1.9 Bq/L).

Detectable levels of tritium were found in eight private wells, all at levels significantly below the drinking water standard of 20,000 pCi/L (740 Bq/L). The concentration ranged from 800 to 2,201 pCi/L (30 to 81 Bq/L), or 4% to 11% of the drinking water standard. Figure 8-48 summarizes these results.

8.1.4.2 Non-Radiological Analyses

1995-1996 Surveillance Program: Approximately 550 residential wells were sampled for VOCs during September 1995 through May 1996. There were detectable levels of TCE, TCA, DCE, and chloroform in several of the wells. The concentrations fell above the Maximum Contaminant Levels (MCLs) of 5 µg/L in two wells for TCE; five wells for TCA; and one well for DCE. Figure 8-49 summarizes these results.

The solvent TCA was detected in one residential well at 180 µg/L. It is likely to have originated from a previously identified source in the Brookhaven Industrial Park as described in Geraghty and Miller (1992) and SCDHS (1990).

1997 Surveillance Program: Approximately 100 residential wells were sampled for VOCs during September 1997. TCE, TCA, DCE, MTBE, and chloroform were detected in several wells. The observed concentrations fell above the MCL of 5 µg/L in one well for TCE. All other concentrations were below NYS DWS, including wells sampled for MTBE (NYS DW 50 µg/L). Figure 8-50 summarizes these results.

Low concentrations of tetrachloroethylene, xylene, trimethylbenzene, methylethylbenzene, and napthalene were detected in one residential well, but were significantly below the drinking water standards established for these contaminants.

8.1.5 Surveillance of SCWA Municipal Supply Wells

In 1996, the Suffolk County Water Authority (SCWA) began monitoring the supply wells in the vicinity of BNL for radionuclides. Samples were obtained from the William Floyd well field located to the southwest of BNL, the Lambert Avenue well field to the south, and the Country Club Drive well field to the southeast. The locations of these public water supply well fields are illustrated in Figure 8-51. The SCWA used Core Laboratories of Casper, Wyoming to perform these analyses. Core Laboratories is a commercial analytical laboratory that is certified by the NYSDOH to perform these analyses. The SCWA also sent duplicate (or quality assurance) samples to a second analytical laboratory, IEA of Cary, South Carolina.

The samples were analyzed for gross alpha and gross beta activity, tritium, and gamma-emitting radionuclides. Table 8-12 provides the analytical results for CY 1997. No elevated gross activity was detected in any sample, nor were any man-made gamma-emitting radionuclides detected. Though tritium was above the minimum detection limit in some cases, all values were below 1,000 pCi/L (37 Bq/L). Regarding these results, the SCWA determined that that public water supply is unaffected by BNL operations, and that it is safe to drink. This finding is further corroborated by the Suffolk County Department of Health Services (SCDHS) who state that:

> *"Although the results of the test indicates the finding of tritium in the sample, any level which is reported below 1,000 pCi/L is not considered significant due to the presence of naturally-occurring tritium and the inherent lack of accuracy and precision in analyzing very low levels of tritium"* (SCDHS, 1997).

In 1997, the SCWA also monitored these supply wells on a monthly basis for VOCs and the pesticide EDB. None of these contaminants were detected.

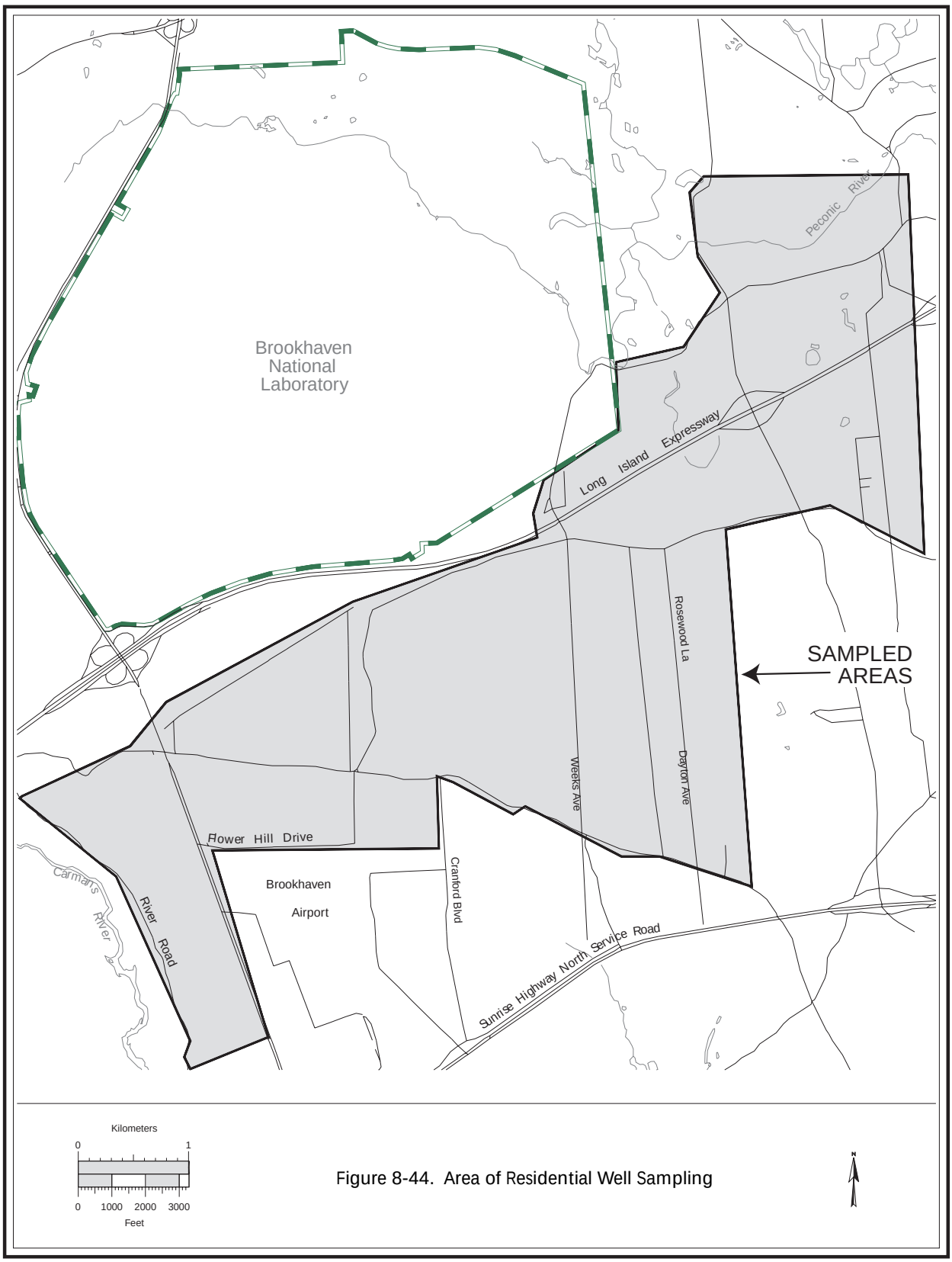


Figure 8-44. Area of Residential Well Sampling

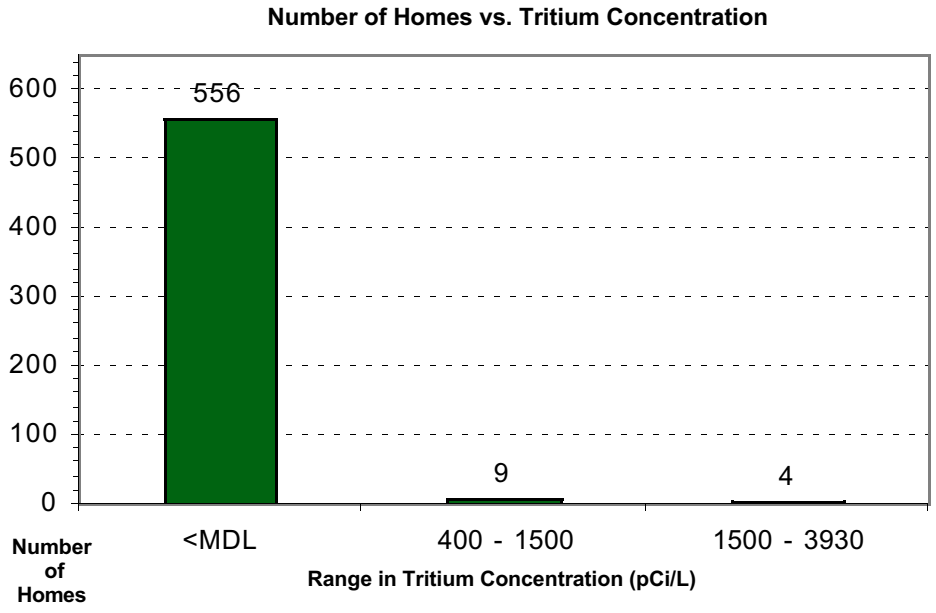


Figure 8-45. Private supply well sampling program for CY 1995 and CY 1996 - Tritium Data

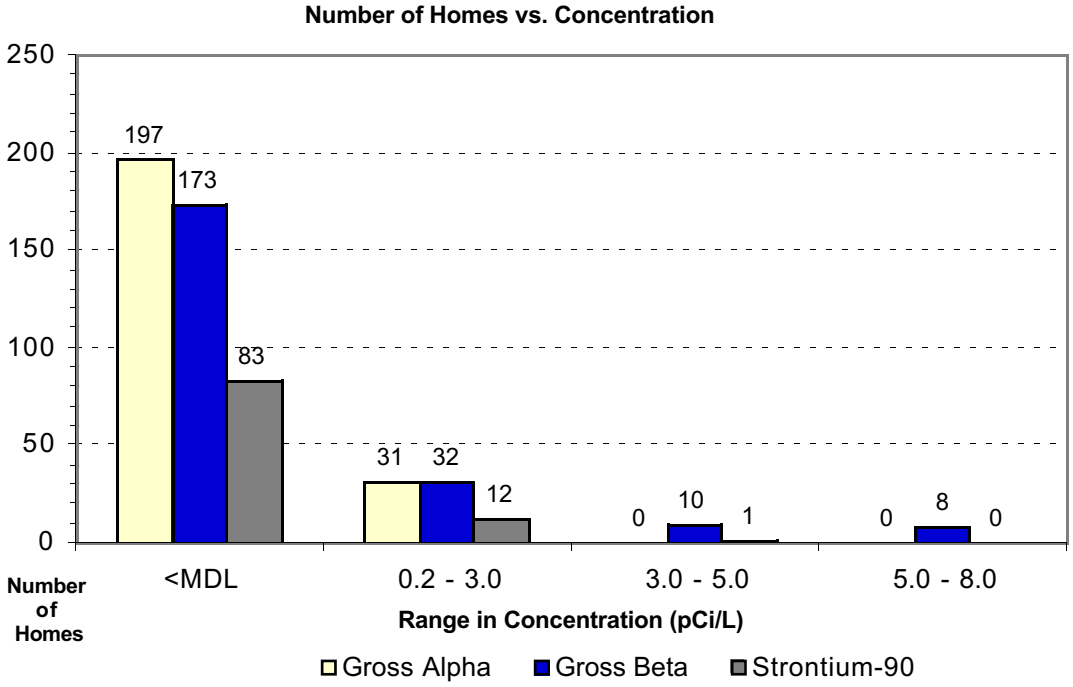


Figure 8-46. Private supply well sampling program for CY 1995 and CY 1996 - Strontium-90, Gross Alpha and Gross Beta Data

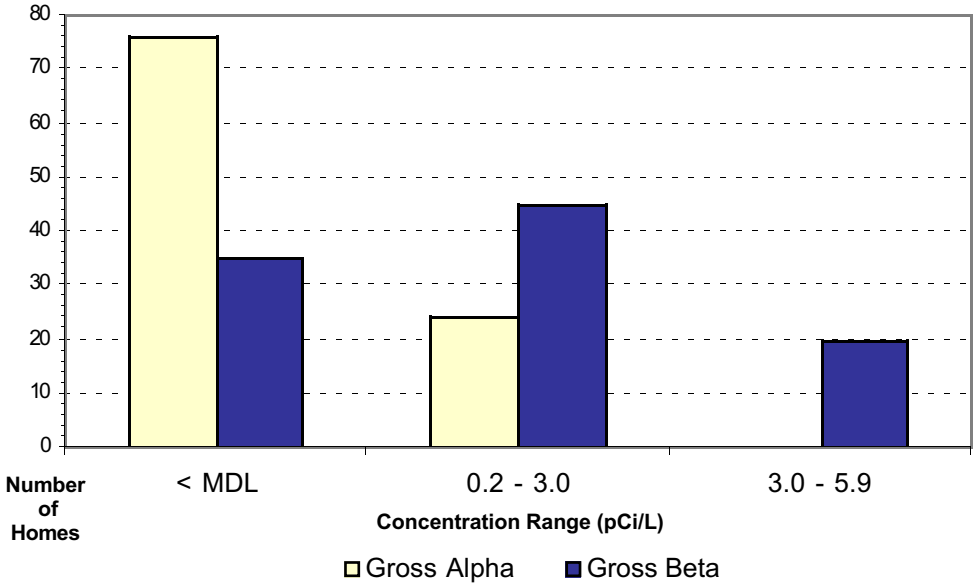


Figure 8-47. Gross activity in private wells sampled in 1997 (number of homes vs. concentration

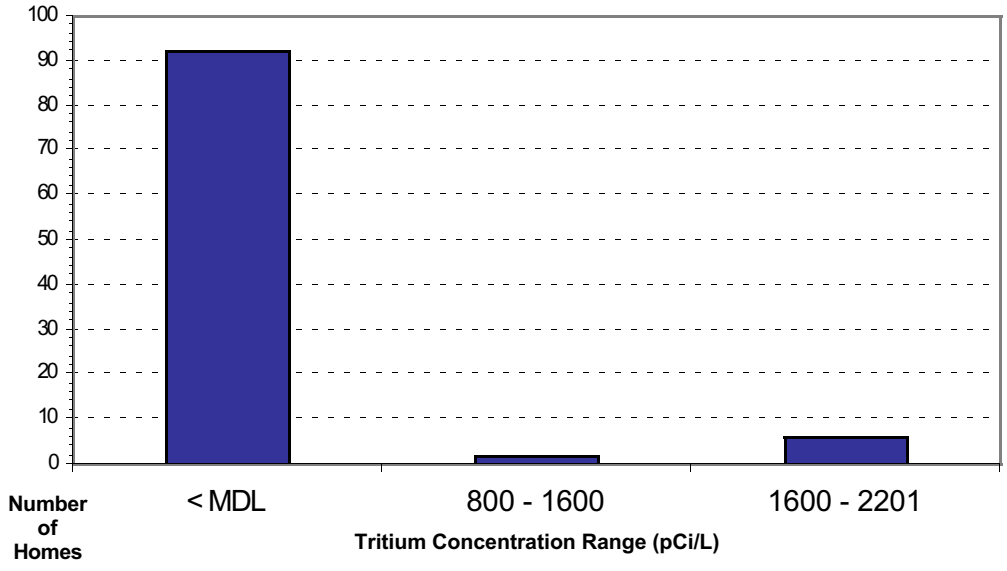


Figure 8-48. Tritium in private wells sampled in 1997 (number of homes vs. concentrations)

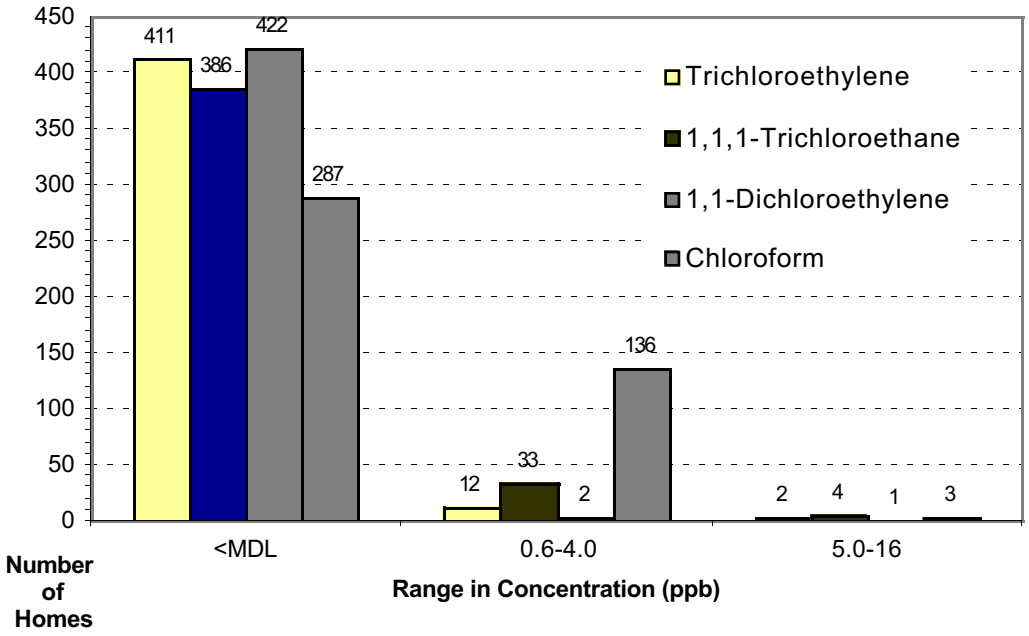


Figure 8-49. Private supply well sampling program for CY 1995 and CY 1996 - VOC Data

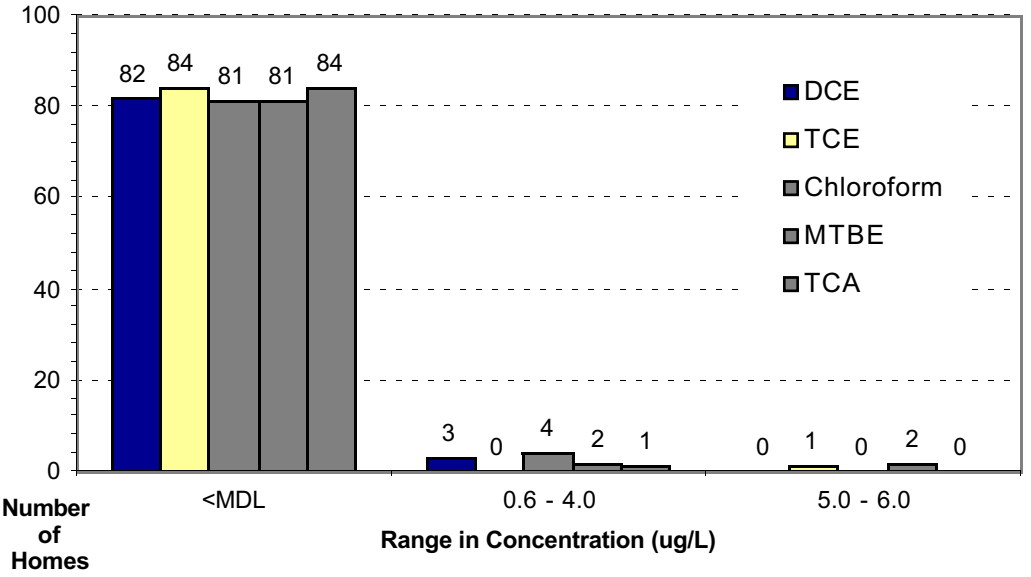


Figure 8-50. Private Supply Well Sampling program for CY 1997- VOC Data

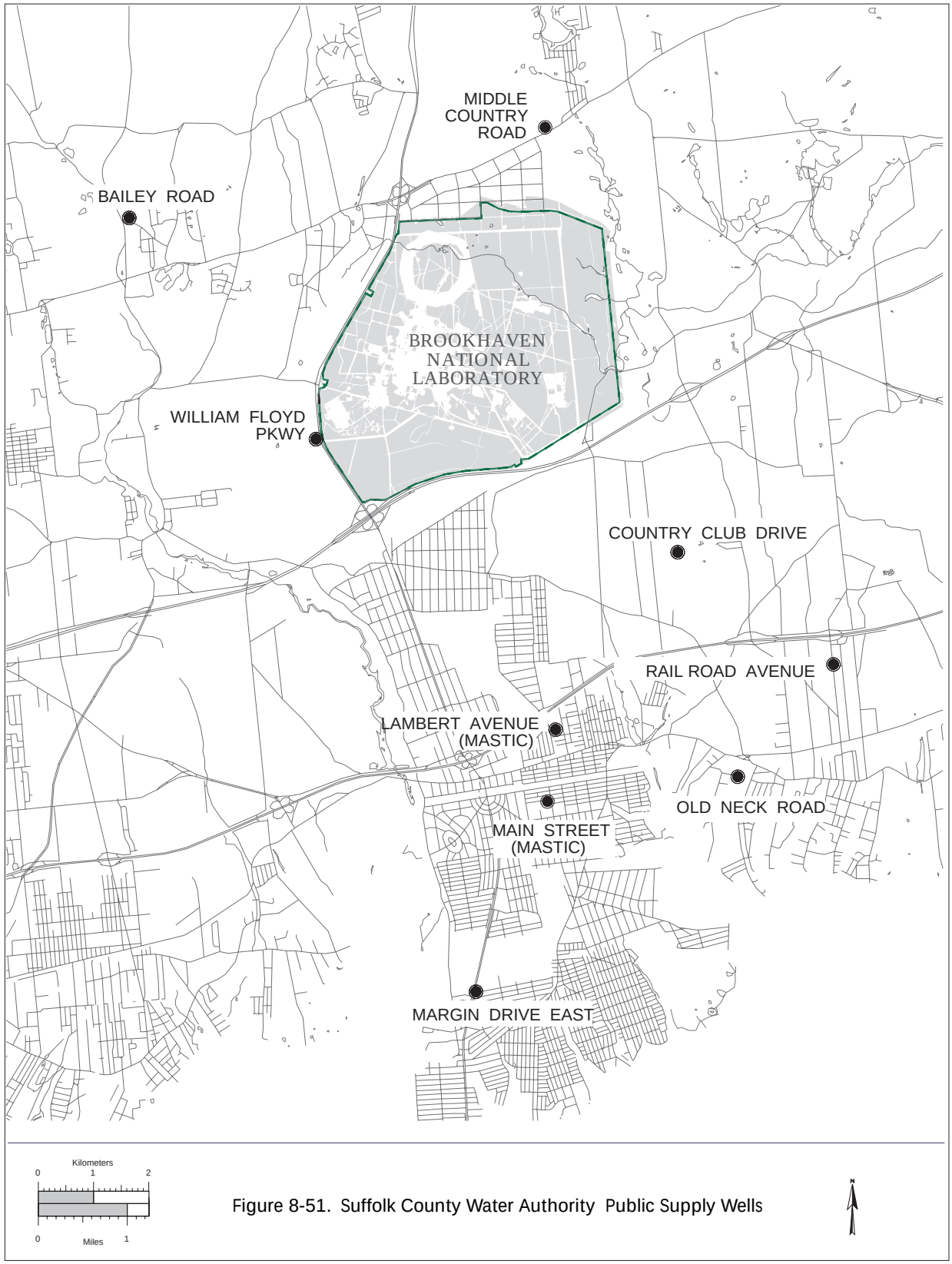


Figure 8-51. Suffolk County Water Authority Public Supply Wells

Table 8-12
BNL Site Environmental Report for Calendar Year 1997
SCWA Supply Well Radiological Analysis Data

Well	Depth (ft.)	Sample Date	Gross Alpha	Gross Beta	Tritium	Gamma-Emitters
			(pCi/L)			
William Floyd Well Field						
1	165	19-Mar-97	<0.8	<0.9	<200	ND
		16-Apr-97	0.6	0.8	<141	ND
		28-May-97	<0.5	1.6	<68.8	ND
		10-Jun-97	<0.6	<0.8	<71.6	ND
		4-Sep-97	<0.5	<0.6	93.2	ND
		23-Oct-97	<0.6	<0.7	200*	ND
2	179	19-Mar-97	<0.9	1.1	<200	ND
		16-Apr-97	1	2.4	<141	ND
		28-May-97	<0.8	12.9	90.1*	ND
		10-Jun-97	1.1	<1.1	<71.2	ND
		29-Jul-97	<0.6	2.9	129*	ND
		4-Sep-97	<0.7	2.2	86.1*	ND
		23-Oct-97	<0.9	1.5	211*	ND
3	268	19-Mar-97	1.0	1.4	<200	ND
		16-Apr-97	<1.0	1.7	153*	ND
		28-May-97	0.9	0.9	<68.7	ND
		10-Jun-97	<0.8	<1.1	<71.3	ND
		4-Sep-97	<0.5	1.3	<56.0	ND
		23-Oct-97	<0.8	2.6	217*	ND
Lambert Ave. Well Field						
1	308	19-Mar-97	<0.7	<0.9	<200	ND
		28-May-97	<0.5	1.3	<200	ND
		5-Sep-97	<0.5	0.7	<56.1	ND
		23-Oct-97	0.7	<0.8	67.6	ND
2	318	19-Mar-97	<0.7	<0.9	<200	ND
		28-May-97	<0.5	<0.7	<69.7	ND
		5-Sep-97	<0.6	1.7	<55.9	ND
		23-Oct-97	0.8	<0.7	<67.8	ND
Country Club Dr. Well Field						
1	157	19-Mar-97	<0.7	1.4	<200	ND
		29-MAY-97	<1.2	<1.7	<72.7	ND
		4-Sep-97	<0.5	0.8	91.8*	ND
		23-Oct-97	<0.8	1.4	255*	ND
2	163	19-Mar-97	<1.3	1.6	<200	ND
		30-May-97	<3.1	<2.0	<72.3	ND
		4-Sep-97	<0.8	<2.0	80.0*	ND
		23-Oct-97	<1.2	1.8	<67.7	ND
3	168	4-Sep-97	<0.7	0.9	66.3*	ND
		23-Oct-97	<1.6	3.4	78.8*	ND
Drinking Water Standard			15	50	20,000	N/A

* Although the result of the test indicates the finding of tritium in the sample, any level which is reported below 1,000 pCi/L is not considered significant due to the presence of naturally occurring tritium and the inherent lack of accuracy and precision in analyzing very low levels of tritium. (SCDHS statement)
ND =Not Detected.