
# Groundwater Protection

The Brookhaven National Laboratory Groundwater Protection Management Program is made up of four elements: prevention, monitoring, restoration, and communication. In addition to implementing aggressive pollution prevention measures to protect groundwater resources, BNL has established an extensive groundwater monitoring well network to verify that prevention and restoration activities are effective. In 1999, BNL collected groundwater samples from 589 monitoring wells during 2,122 individual sampling events. Six significant volatile organic compound plumes and eight radionuclide plumes were tracked and evaluated. During 1999, five onsite and one offsite groundwater remediation systems removed approximately 634 pounds of volatile organic compounds and returned approximately 757 million gallons of treated water to the Upper Glacial aquifer.

## 7.1 THE BNL GROUNDWATER PROTECTION MANAGEMENT PROGRAM

DOE Order 5400.1 (1988), *General Environmental Protection Program,* requires development and implementation of a groundwater protection program. The primary goal of the BNL Groundwater Protection Management Program is to ensure that plans for groundwater protection, management, monitoring and restoration are fully defined, integrated and managed in a cost-effective manner that is consistent with federal, state and local regulations. The BNL Groundwater Protection Program includes policy, strategy, requirements and regulations applicable to groundwater protection (Paquette *et al.* 1998). As shown in Figure 7-1, the BNL Groundwater Protection Program consists of four interconnecting elements: (1) preventing pollution of the groundwater, (2) monitoring the effectiveness of engineered/administrative controls at operating facilities and groundwater treatment systems, (3) restoration of the environment by cleaning up contaminated soil and groundwater, and (4) communicating with interested parties on groundwater protection issues.


**Figure 7-1. BNL's Groundwater Protection Program.**

*Prevention*

BNL has initiated a three-phased project to: (1) identify past or current activities with the potential to affect environmental quality, (2) conduct a Laboratory-wide review of all experiments and industrial-type operations to determine the potential impacts of those activities on the environment and to integrate pollution prevention/waste minimization, resource conservation, and compliance into planning, decision-making and implementation, and (3) develop and implement an Environmental Management System. These activities are designed to prevent further pollution of the sole source aquifer underlying the BNL site, and are described in Chapter 2. In addition, as described in Chapter 3, efforts are being made to achieve or maintain compliance with regulatory requirements and to implement best management practices designed to protect groundwater. Examples include upgrading underground storage tanks, closing cesspools, adding engineered controls (e.g., barriers to prevent rainwater infiltration that could move contaminants out of the soil and into groundwater), and administrative controls (i.e., reducing the toxicity and volume of chemicals in use or storage).

*Monitoring*

BNL has an extensive groundwater-monitoring network designed to evaluate groundwater contamination from historical and current operations. Groundwater monitoring is a means of verifying that protection and restoration efforts are working. Groundwater monitoring is being conducted under two programs - the Environmental Monitoring Program designed to satisfy DOE and New York State monitoring requirements for active research and support facilities, and the Environmental Restoration (ER) program for monitoring related to BNL's obligations under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). These programs are coordinated to ensure completeness and to prevent any duplication of effort in the installation and abandonment of wells, and the sampling and analysis of groundwater. Furthermore, data quality objectives; plans and procedures; sampling and analysis; quality assurance; data management; and well installation; maintenance and abandonment programs are being integrated to optimize the groundwater monitoring system and to ensure that water quality data are available for review and interpretation in a timely manner. In 1999, there were no major changes to BNL's groundwater monitoring program in terms of number of wells sampled, frequency of sampling or specific analytes tested.

*Restoration*

BNL was added to the National Priorities List in 1989 (see Chapter 2 for a discussion of the BNL's ER program). Twenty-nine Areas of Concern (AOC) have been grouped into six Operable Units (OU). Remedial Investigation/ Feasibility Studies have been conducted for each OU. A primary goal of the ER program is remediating soil and groundwater contamination, and preventing additional groundwater contamination from migrating offsite. To that end, contaminant sources (e.g., contaminated soil, underground tanks) are being removed or remediated to prevent further contamination of groundwater. All remediation work is carried out under the Interagency Agreement (IAG) between the U.S. Environmental Protection Agency (EPA), New York State Department of Environmental Conservation (NYSDEC) and DOE.

*Communication*

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

### 7.2 GROUNDWATER MONITORING

Groundwater monitoring program elements include: installing monitoring wells; planning and scheduling; quality assurance; sample collection; sample analysis; data verification, validation and interpretation; and reporting. Monitoring wells are generally used to monitor specific facilities where degradation of the groundwater is known or suspected to have occurred, to fulfill regulatory permit requirements, to assess the quality of groundwater entering or leaving the BNL site, and to ensure that corrective measures designed to protect and restore groundwater are, in fact, working.

The groundwater beneath the BNL site is considered by New York State as Class GA groundwater. Class GA groundwater is defined as a source of potable water supply and suitable for drinking. As such, federal drinking water standards, New York State Drinking Water Standards (NYS DWS), and NYS Ambient Water Quality Standards (NYS AWQS) for Class GA groundwater have been used as groundwater protection and remediation goals. The BNL groundwater surveillance program uses monitoring wells (which are not utilized for drinking water supply) to monitor research and support facilities where there is a potential for environmental impact, and areas where past waste handling practices or accidental spills have already degraded groundwater quality. BNL evaluates the potential impact of radiological and non-radiological levels of contamination by comparing analytical results to New York State and DOE reference levels and background water quality levels. Non-radiological analytical results from groundwater samples collected from surveillance wells are usually compared to NYSDEC AWQS. Radiological data are compared to NYS DWS (for tritium, gross beta, and Sr-90), NYS AWQS (for gross alpha and radium-226/228), and Safe Drinking Water Act (SDWA)/DOE Derived Concentration Guides (for determining the 4 mrem dose for other beta/gamma-emitting radionuclides). Contaminant concentrations that are below these standards are also compared to background values to evaluate the potential effects of facility operations. The detection of low concentrations of facility-specific volatile organic compounds (VOCs) or radionuclides may provide important early indications of a contaminant release and allow for the timely investigation into the identification and remediation of the source.

Groundwater quality at BNL is routinely monitored through a network of approximately 460 onsite and 115 offsite surveillance wells (see Figures 7-2 and 7-3). In addition to groundwater quality assessments, water levels are routinely measured in over 650 onsite and offsite wells to assess variations in directions and velocities of groundwater flow. Groundwater flow directions in the vicinity of BNL are shown on Figure 7-4.

Active and inactive facilities that have groundwater monitoring programs include the following: the Sewage Treatment Plant/Peconic River area, Biology Agricultural Fields, Former Hazardous Waste Management Facility (HWMF), new Waste Management Facility (WMF), two former landfill areas, Central Steam Facility/ Major Petroleum Facility (CSF/MPF), Alternating Gradient Synchrotron (AGS), Waste Concentration Facility (WCF), Supply and Material, and several other smaller facilities. As the result of detailed groundwater investigations conducted


**Figure 7-2. Sampling a Groundwater Monitoring Well.**

over the past fifteen years, six significant VOC plumes and six radionuclide plumes have been identified (Figures 7-5 and 7-6).

### 7.3 SUPPLEMENTAL MONITORING PROGRAM FOR POTABLE AND PROCESS SUPPLY WELLS

Groundwater quality is also routinely monitored at all active potable supply wells and process supply wells. Because of the proximity of BNL's potable supply wells to known or suspected groundwater contamination plumes and source areas, BNL conducts a supplemental potable supply well monitoring program that exceeds the monitoring required by the SDWA (see Chapter 3 for more details). This program also evaluates the quality of water obtained from process supply wells that is used to provide water for non-potable uses (secondary cooling water and biological experiments). In 1999 samples were collected and analyzed for radionuclides (e.g., gross alpha, gross beta, gamma, Sr-90, and tritium), and VOCs (consisting of the volatile halogenated aliphatic hydrocarbons and aromatic hydrocarbons). These samples serve both as a quality control on contractor laboratory analyses of compliance samples and as an additional source of data used in evaluating groundwater quality.

The BNL supply well 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 supply wells are screened entirely within the Upper Glacial aquifer (Figure 7-7). In 1999, process wells 101, 102, and 103 were not used since the AGS used domestic water for cooling purposes. Well 9 supplied process water to a facility where biological research on fish is conducted. Secondary cooling water for the Brookhaven Medical Research Reactor was supplied exclusively from Well 105.

In 1999, with the exception of a single detection of 1,1,1-trichloroethane in Well 9, all VOC analytes were less than the ambient water quality standards. Well 9 has historically exhibited concentrations above this standard and is located within a known plume of 1,1,1-trichloroethane. This plume is monitored as part of the Environmental Restoration program — Operable Unit III. All radiological analytes were well within drinking water standards.

#### 7.3.1 NONRADIOLOGICAL RESULTS

Samples collected from supply Wells 9, 10, 12 and 105 were analyzed for VOCs followed EPA Standard Method 624. This method analyzes for 37 organic compounds, including halogenated and aromatic hydrocarbons. The only parameters detected above minimum detection limits (MDL) were chloroform, 1,1,1-trichloroethane, and dichloroethylene. The chemical 1,1,1-trichloroethane was detected in Well 9 at 7.2

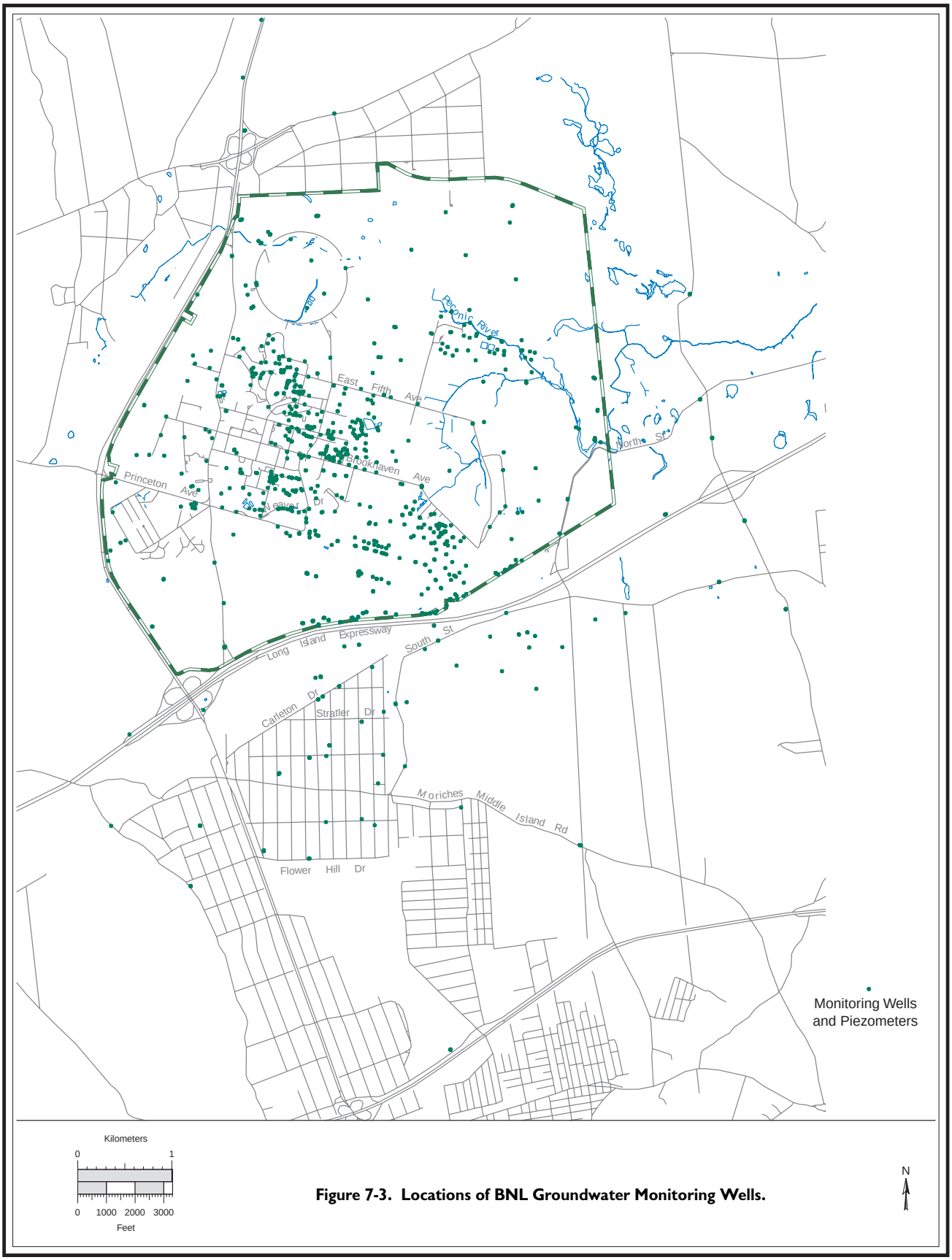


**Figure 7-3. Locations of BNL Groundwater Monitoring Wells.**

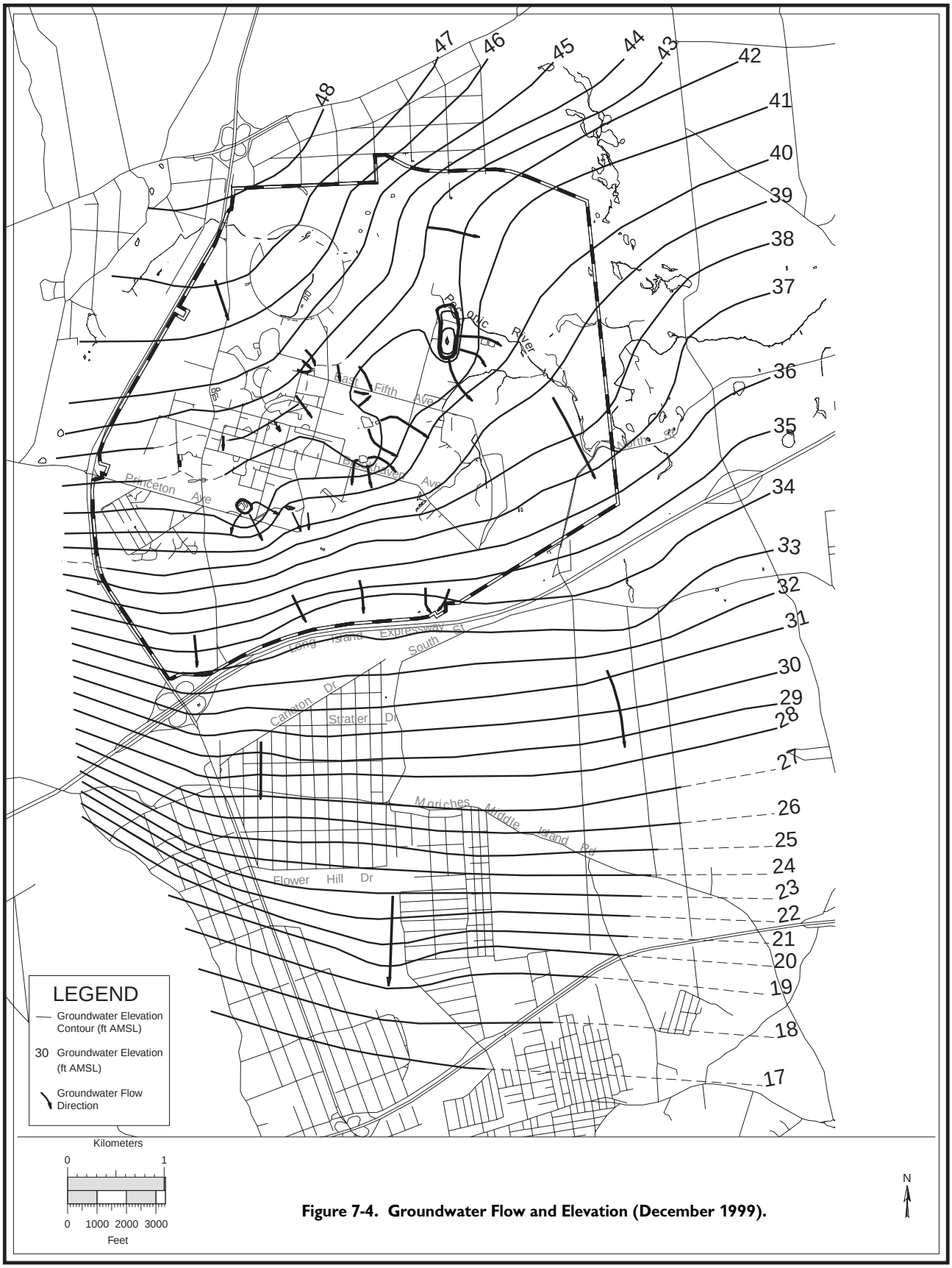


**Figure 7-4. Groundwater Flow and Elevation (December 1999).**

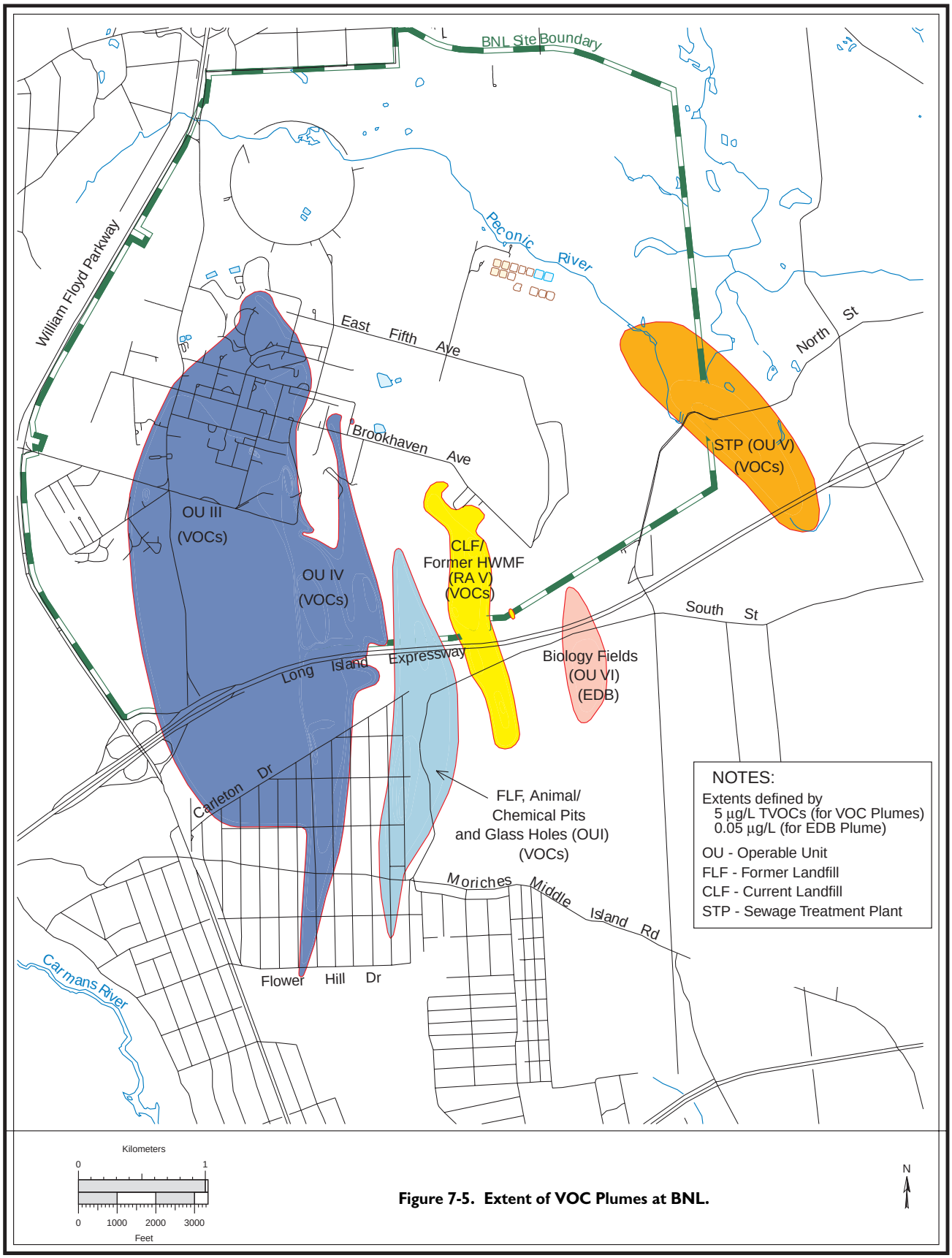


**Figure 7-5. Extent of VOC Plumes at BNL.**

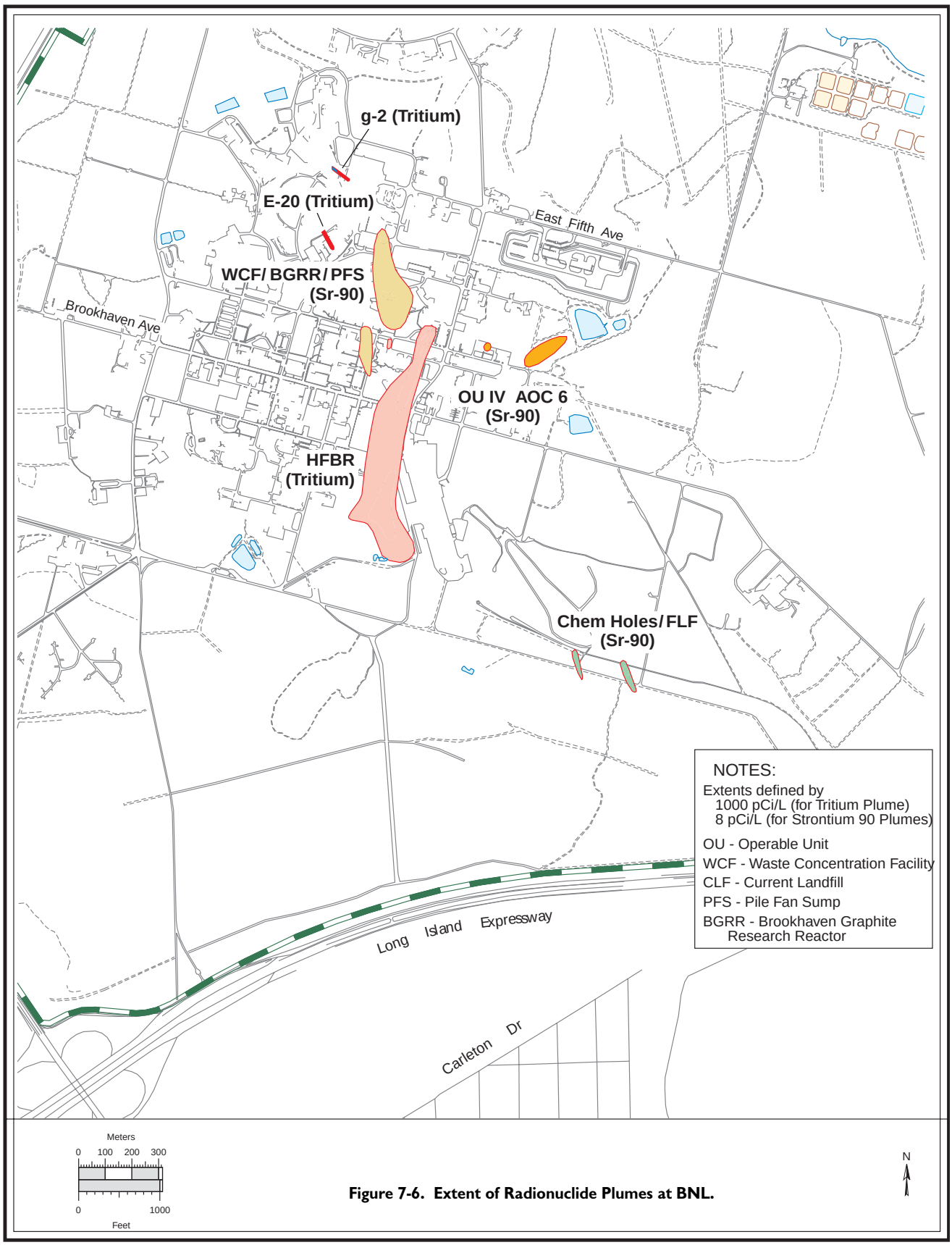


**Figure 7-6. Extent of Radionuclide Plumes at BNL.**

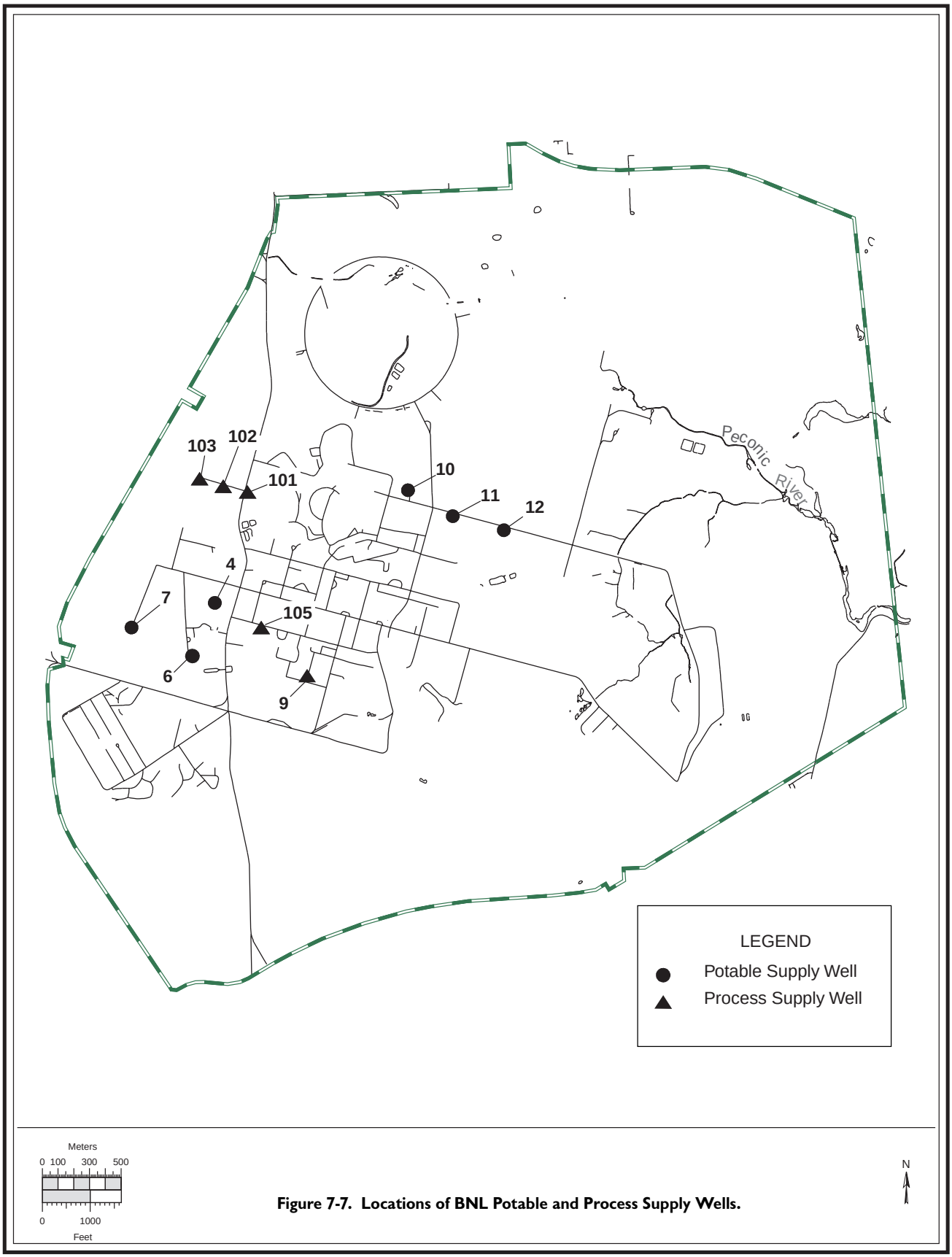


**Figure 7-7. Locations of BNL Potable and Process Supply Wells.**

micrograms per liter (µg/L), which exceeds the ambient water quality standard of 5 µg/L. Well 9 is located within a known area of contamination and is included in the Operable Unit III study area. This concentration of 1,1,1-trichloroethane does not interfere with the fish experimentation for which the water is used.

Chloroform was found in most wells, with concentrations ranging from trace levels (i.e., < 2 µg/L) to a maximum of 4 µg/L. All chloroform concentrations were equal to or below the ambient water quality standard of 7 µg/L and well below the drinking water standard of 100 µg/L.

Dichloroethylene was detected in Well 9 at a maximum concentration of 2.9 µg/L, which is less than the drinking water standard of 5 µg/L.

#### 7.3.2 RADIOLOGICAL RESULTS

Potable and process well water was sampled and analyzed for gross alpha and gross beta activity, tritium, and Sr-90; the results are listed in Table 7-1. 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. In response to employee concerns regarding the radiological content of the BNL potable water system, the total number of samples collected in 1999 was increased from previous years, to a maximum of ten times for Well 12. This well was in operation for the entire year and provided the majority of the drinking water for the site. Wells 4, 6, 7, 10, and 11 are less frequently used; consequently, they were sampled less frequently.

Average gross activity and tritium levels in the potable water wells were consistent with those of typical background water samples. Neither Sr-90 nor any man-made gamma-emitting radionuclides were observed above the minimum detection limit in any of the potable wells sampled. Throughout the year, process Wells 9 and 105 also showed radiological results that were consistent with background environmental values.

Compliance with the SDWA is based on the analytical results obtained from an annual composite of four quarterly samples or the average of the analyses of four quarterly samples. Compliance is demonstrated if

- the annual average gross alpha activity is less than 15 pCi/L,
- gross beta activity is less than 50 pCi/L,
- strontium concentrations are less than 8 pCi/L,
- tritium concentrations are less than 20,000 pCi/L, and
- the total effective dose equivalent for all detected radionuclides combined is less than 4 mrem in a year.

During 1999, all of these criteria were satisfied, and therefore, the BNL potable water system was in full compliance with the radiological requirements of 40 CFR 141.

### 7.4 ENVIRONMENTAL RESTORATION (ER) GROUNDWATER MONITORING PROGRAM

The mission of the ER groundwater monitoring program is to monitor the various contaminant plumes located onsite and offsite, as well as to monitor the progress that the groundwater treatment systems are making on plume remediation. The long-term groundwater monitoring projects coordinated under the ER monitoring program are designed to address the following issues:

1. Pre-Record of Decision (pre-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 (post-ROD) Monitoring: Addresses the long-term monitoring of plumes to track their movement following the initiation of remediation systems. This monitoring includes

- Source Removal Effectiveness: The monitoring of wells installed to verify that remediation projects, such as the capping of previously used landfills, are performing to specifications,
- Treatment System Performance: The monitoring of active pump-and-treat systems to verify that they are effectively capturing and removing contaminants, as well as the monitoring of plumes undergoing passive remediation (i.e., natural attenuation) to verify that natural processes are effective in reducing contaminant concentrations, and
- Outpost (Sentinel Well) Detection Monitoring: The monitoring of wells located between the leading edge of contaminant plumes and a potential receptor, to give early warning of the arrival of the leading edge of the plume and trigger contingency remedial actions.

The groundwater monitoring information described below provides an overview of ER groundwater monitoring and remediation activities for 1999. During this period, a total of 505 groundwater surveillance wells were moni-

**Table 7-1. Potable and Process Well Radiological Analytical Results for 1999.**

| Well ID* | | Gross Alpha (pCi/L) | Gross Beta (pCi/L) | Tritium (pCi/L) | Sr-90 (pCi/L) |
|---|---|---|---|---|---|
| **Potable Wells** | | | | | |
| 4 (FD) | N | 6 | 6 | 7 | 2 |
| | Max. | 1.8 ± 0.6 | 7.9 ± 1.6 | < 339 | < 0.41 |
| | Avg. | 0.4 ± 0.7 | 2.3 ± 2.1 | 54 ± 116 | 0.14 ± 0.34 |
| 6 (FF) | N | 7 | 7 | 8 | 2 |
| | Max. | 1.5 ± 0.6 | 7.9 ± 1.5 | 348 ± 210 | 2.74 ± 0.49 |
| | Avg. | 0.4 ± 0.5 | 2.3 ± 2.0 | 53 ± 108 | 1.42 ± 1.83 |
| 7 (FG) | N | 6 | 6 | 6 | 2 |
| | Max. | < 0.8 | 52.9 ± 2.6 | < 339 | < 0.411 |
| | Avg. | 0.1 ± 0.3 | 9.7 ± 15.5 | 20 ± 124 | -0.006 ± 0.005 |
| 10 (FO) | N | 8 | 8 | 9 | 2 |
| | Max. | 2.3 ± 0.7 | 6.2 ± 1.5 | < 316 | < 0.37 |
| | Avg. | 0.5 ± 0.6 | 2.3 ± 1.2 | 88 ± 97 | 0.07 ± 0.06 |
| 11 (FP) | N | 9 | 9 | 11 | 3 |
| | Max. | 2.1 ± 0.7 | 6.3 ± 1.5 | < 331 | < 0.38 |
| | Avg. | 0.2 ± 0.6 | 2.6 ± 1.6 | 20 ± 71 | 0.11 ± 0.31 |
| 12 (FQ) | N | 10 | 10 | 12 | 2 |
| | Max. | 1.2 ± 0.6 | 7.8 ± 1.6 | < 316 | < 0.51 |
| | Avg. | -0.1 ± 0.4 | 1.8 ± 1.6 | 41 ± 75 | 0.14 ± 0.16 |
| Tap Water | N | 243 | 243 | 243 | NS |
| Bldg. 490 (FN) | Max. | 11.7 ± 3.5 | 11.4 ± 5.7 | 451 ± 197 | |
| | Avg. | 1.9 ± 0.2 | 3.7 ± 0.3 | -20 ± 16 | |
| **Process Wells** | | | | | |
| 105 (FL) | N | 1 | 1 | 2 | NS |
| | Max. | 6.0 | -0.8 | < 316 | |
| | Avg. | 6.0 | -0.8 | 29 ± 154 | |
| 9 (FM) | N | 1 | 1 | 2 | NS |
| | Max. | -1.0 | -1.1 | < 316 | |
| | Avg. | -1.0 | -1.1 | 0 ± 87 | |
| **SDWA Limit** | | 15[(a)] | 50[(b)] | 20,000 | 8 |

Notes:
All values shown with 95% confidence interval.
No anthropogenic gamma-emitting radionuclides were detected in samples collected from these wells in 1999.
N=Number of samples collected.
NS=Not sampled for this analyte.
SDWA=Safe Drinking Water Act
* Historic ID shown in parentheses.
[(a)] Excluding radon and uranium.
[(b)] Screening level above which analysis for individual radionuclides is required.

tored during approximately 1,800 individual sampling events. All wells sampled during 1999 are listed in Appendix E. Detailed analytical results for each sample obtained under the ER program are provided in the *1999 BNL Groundwater Monitoring Report* (Dorsch *et al.* 2000). Detailed information about the performance of the remediation systems and recommendations for potential adjustments to the systems are presented in the Operational Reports for the individual systems briefly described below.

Maps showing the main VOC and radionuclide plumes are provided as Figures 7-5 and 7-6. For each significant contaminant source area and plume described below, specific groundwater contaminant distribution maps are provided. These maps depict the areal extent of contamination, and were created by selecting the highest contaminant concentration observed for a given set of wells during a selected sampling period. Associated cross sections showing the vertical distribution/extent of contamination, as well as the hydrogeology are described in the *1999 BNL Groundwater Monitoring Report*. Because significant changes in contaminant concentrations are typically not observed during the course of the year, a single representative monitoring period (i.e., one quarterly sampling period) was chosen for each plume.

### 7.4.1 BACKGROUND MONITORING

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 offsite areas to the north. The site background wells provide information on the chemical and radiological composition of groundwater that has not been affected 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 can also provide warning of any contaminants originating from potential sources of contamination that may be located upgradient of the BNL site.

There were no significant detections of VOCs in background wells. The highest concentration detected was chloroform at 2.1 µg/L in Well 000-120, which is a shallow Upper Glacial aquifer well, located immediately north of the northwest corner of the site. The ambient water quality standard for chloroform is 7 µg/L. Historically, low concentrations of VOCs have been detected in background Wells 017-03, 017-04, 018-03 and 018-04. All radionuclide concentrations were consistent with ambient (natural) levels.

### 7.4.2 OPERABLE UNIT (OU) I

#### 7.4.2.1 FORMER LANDFILL, ANIMAL/CHEMICAL PITS AND GLASS HOLES

The Former Landfill area was initially used by the U.S. Army during World Wars I and II. Then BNL used the southeast corner of the landfill from 1947 through 1966 for disposal of construction and demolition debris, sewage sludge, chemical and low-level radioactive waste, used equipment, and animal carcasses. From 1960 through 1966, BNL 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, BNL disposed of used glassware in shallow pits located directly north of these chemical/animal pits.

A network of eight monitoring wells is used to monitor the Former Landfill area. The monitoring program for the Former Landfill is designed in accordance with post-closure operation and maintenance 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, after which time BNL may petition NYSDEC to modify the frequency and types of analyses based on supporting data. The objective of this program is to monitor radiological and nonradiological 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, to verify whether the cap effectively prevents the continued leaching of contaminants from the landfill and document anticipated long-term improvements to groundwater quality. In addition to these wells, BNL established a separate network of 24 wells to monitor the Animal/Chemical Pits and Glass Holes areas, and the downgradient portions of the Former Landfill plume. The downgradient portions of these plumes are currently being monitored as part of the OU I/IV Pre-ROD Monitoring Program.

*Volatile Organic Compounds*

The areal extent of VOC contamination from the Former Landfill - Animal/Chemical Pits and Glass Holes area is shown on Figure 7-8. The primary chemical contaminants observed in the Former Landfill - Animal/Chemical Pits and Glass Holes plume are carbon tetrachloride (CT), 1,1,1-trichlorethane (TCA), 1,1-dichlroethylene (DCE), trichlorethylene (TCE), tetrachloroethylene (PCE) and chloroform. These individual constituents were observed in wells extending from the Former Landfill source areas to the southern site boundary at concentrations generally less than 50 µg/L. (Note: the NYS AWQS for most of these VOCs is 5 µg/L; the standard for chloroform is 7 µg/L.) The same constituents also appear in the segment of the plume located south of the southern site boundary. The plume is approximately 9,700 feet in length from the Former Landfill source areas to just south of Crestwood Drive, and approximately 1,600 feet at its maximum width, as defined by areas having Total Volatile Organic Compound (TVOC) concentrations greater than 5 µg/L. (Note: A TVOC concentration is the sum of all individual VOC concentrations detected in a given sample.) The segment of the plume with >50 µg/L concentrations is approximately 700 feet wide. The area of the plume showing the

highest TVOC concentration is located offsite near Sleepy Hollow Drive. This segment of the plume is comprised primarily of CT, with a maximum TVOC concentration of 397 µg/L detected in Well 000-154 in November 1999. In general, VOCs are found in the shallow Glacial aquifer in the vicinity of the Former Landfill, Animal/Chemical Pits and Glass Holes area, in the middle Upper Glacial aquifer at the southern site boundary, and in the deep Upper Glacial aquifer south of BNL. For a more detailed discussion on the vertical distribution of VOC contamination, see the 1999 BNL Groundwater Monitoring Report (Dorsch *et al.* 2000).

Wells 106-25 (located onsite in the Middle Road area) and 115-32 (located at the site boundary) displayed declining TVOC concentrations in 1999, following increasing trends during 1998 (see Figure 7-8). In both wells, the decline in VOC concentrations is probably due to the migration of high concentration "slugs" of PCE past these wells. Offsite Well 000-154 (located in the high concentration segment of the plume) displayed fluctuating TVOC concentrations in 1999 after showing a steady decline in 1998. A similar trend has been observed for offsite Well 000-108.

A comparison of the TVOC plume distribution from 1997 through 1999 is shown on Figure 7-9. Comparison of the groundwater data indicates that the capping of the Former Landfill in November 1996 and the excavation of the Chemical/Animal Pits and Glass Holes in September 1997 have contributed to the decline of TVOC concentrations to below 5 µg/L in shallow wells located near the source areas. Since 1997, TVOC concentrations greater than 500 µg/L that were observed in the vicinity of Stratler Drive, Shirley, have declined. Although part of this decline is due to natural degradation and dispersion of the plume with time, the high TVOC concentration portion of the plume has probably migrated south of Well 000-154. Monitoring Wells 000-153 and 800-63 have been positioned to detect this high contamination zone as it continues to move south.

*Radionuclides*

Strontium-90 (Sr-90) has been routinely detected in groundwater in the Former Landfill, Animal/Chemical Pits and Glass Holes areas at concentrations above the drinking water standard of 8 pCi/L (specifically in Wells 106-16, 106-13, 097-03 and 097-64). There are two Sr-90 plumes (as defined by the 8 pCi/L standard) that are located close to the source areas. One plume originates from the Former Landfill and the second originates from the Animal/Chemical Pits area (Figure 7-10). Well 106-16, located immediately downgradient of the Animal/Chemical pits area, showed a maximum concentration of 2,540 pCi/L in November 1999. Historical trends in Sr-90 concentration for wells 097-64, 106-16, and 106-50 are presented in Figure 7-10. The leading edge of the Animal/Chemical Pits Sr-90 plume has migrated towards Well 106-50 (located approximately 450 feet downgradient) as evidenced by increasing Sr-90 concentrations in this well through 1999.

#### 7.4.2.2 CURRENT LANDFILL

The Current Landfill operated from 1967 through 1990. It was used for disposal of putrescible waste, sludge containing precipitated iron from the Water Treatment Plant, and anaerobic digester sludge from the Sewage Treatment Plant. The latter contained low concentrations of radionuclides, and possibly metals and organic compounds. BNL 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 (capping) of this landfill was completed in November 1995 as part of the ER program.

The Current Landfill post-closure groundwater 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 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 New York State specified landfill post-closure O&M requirements.

*Volatile Organic Compounds*

Although VOCs continue to be routinely detected in wells located immediately downgradient of the landfill, their concentrations continued to decrease in response to the capping of the landfill. The highest TVOC concentration observed during 1999 was 65 µg/L, detected in Well 087-23. Well 087-23 is a

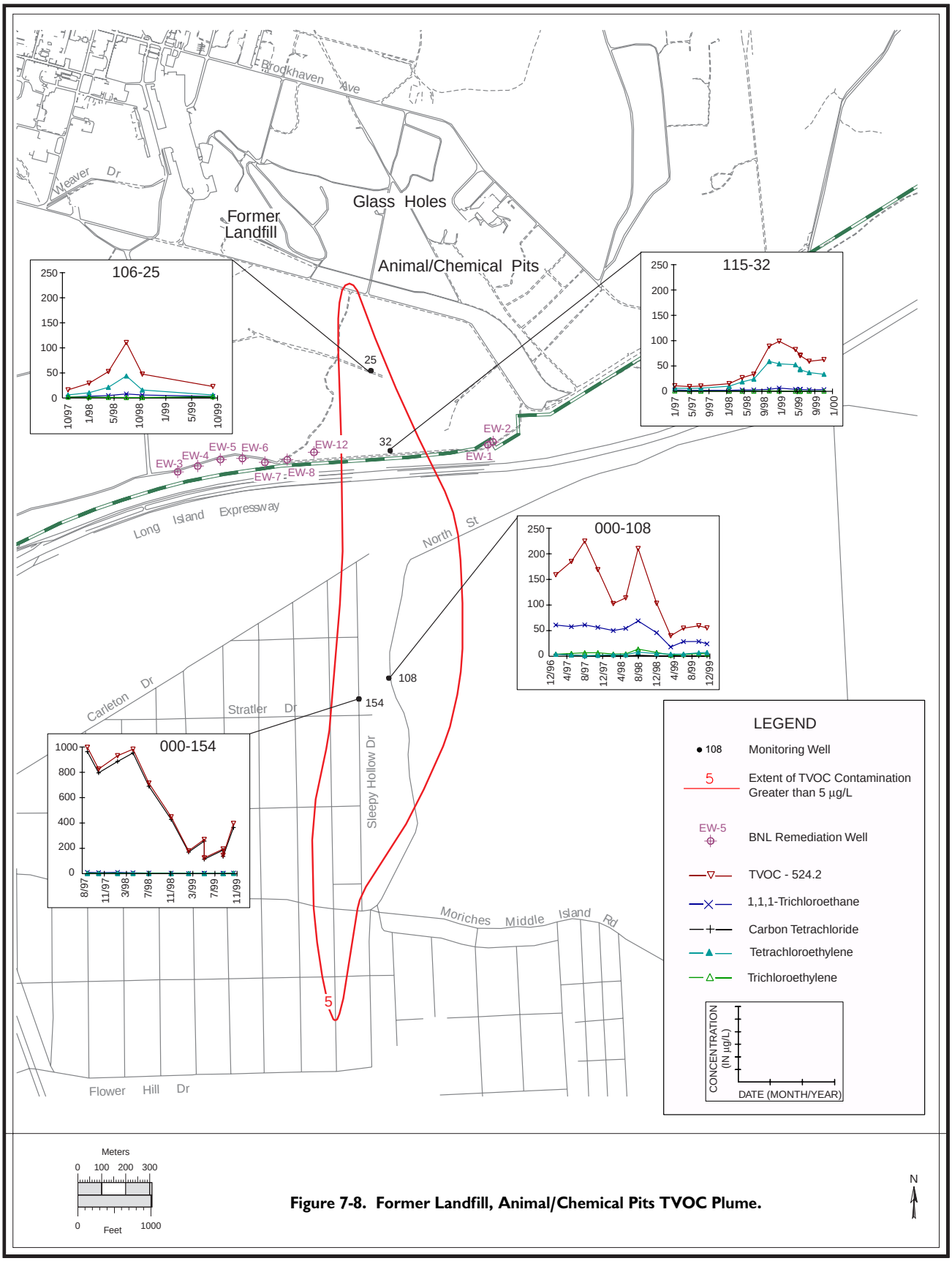


**Figure 7-8. Former Landfill, Animal/Chemical Pits TVOC Plume.**

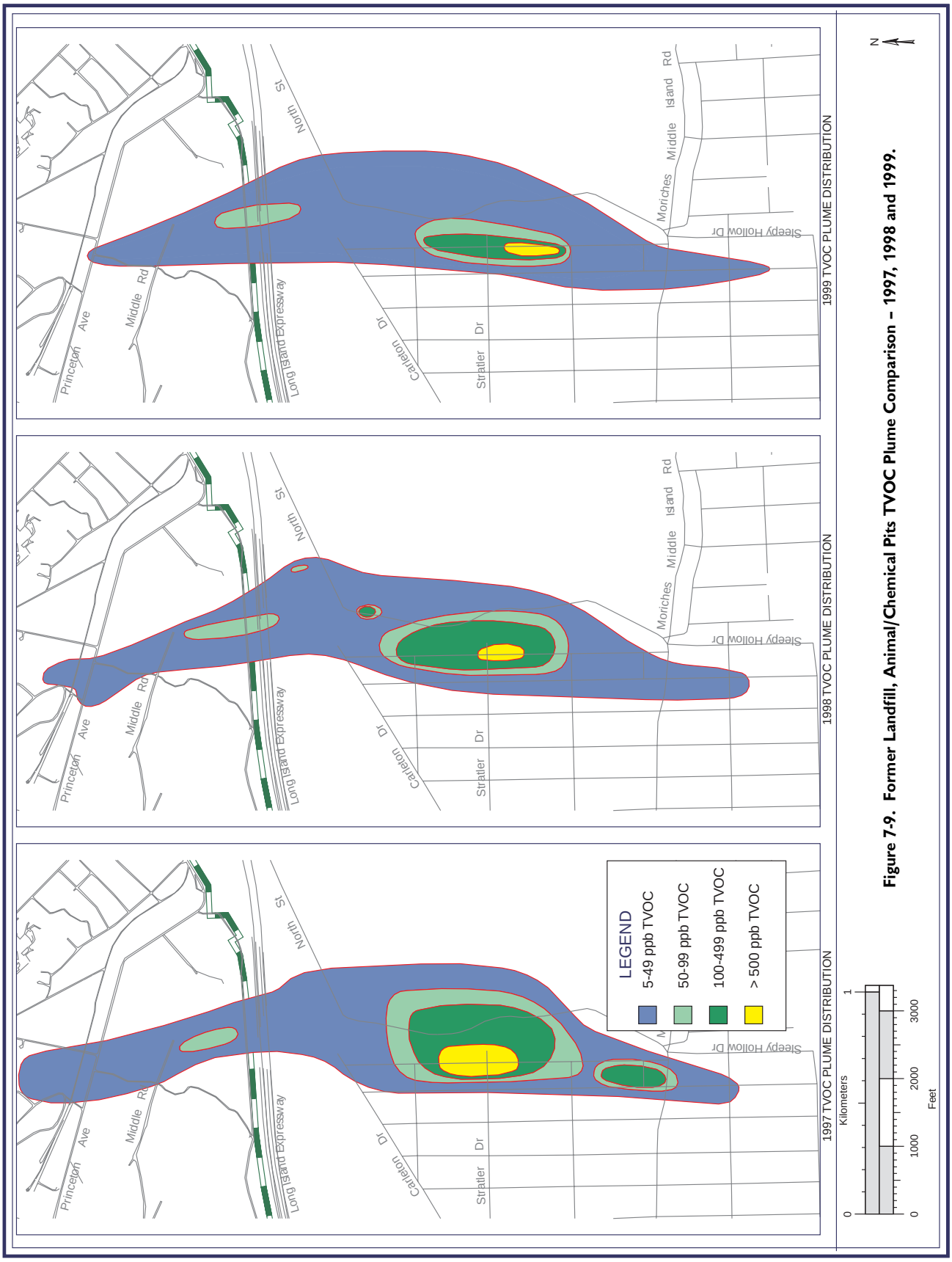


**Figure 7-9. Former Landfill, Animal/Chemical Pits TVOC Plume Comparison – 1997, 1998 and 1999.**

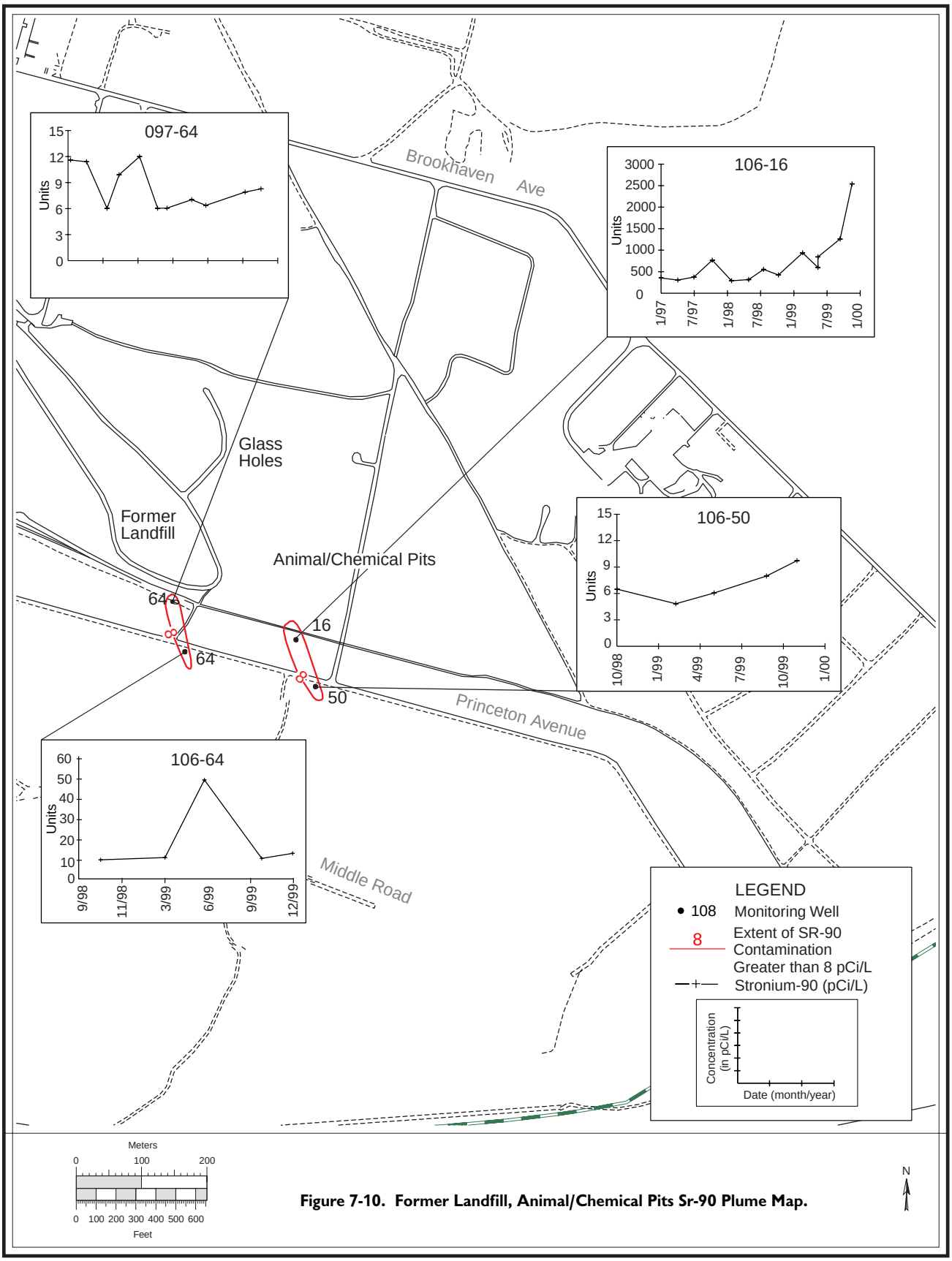


**Figure 7-10. Former Landfill, Animal/Chemical Pits Sr-90 Plume Map.**

shallow water table well located just south of the southwest corner of the landfill. Concentrations in downgradient Wells 088-22 and 088-109, which exhibited TVOC concentrations of greater then 500 µg/L during 1998, were non-detect and 35 µg/L respectively during 1999.

A detailed discussion of the groundwater monitoring results for the Current Landfill area are included in the *1999 Environmental Monitoring Report - Current and Former Landfill Areas* (BNL 2000a).

*Radionuclides*

As in previous years, low levels of tritium and Sr-90 were detected in Current Landfill monitoring wells during 1999, but at concentrations well below their applicable drinking water standards. The highest tritium value was 2,325 pCi/L in Well 088-110, whereas the highest Sr-90 value was 2.2 pCi/L detected in Well 088-21.

#### 7.4.2.3 FORMER HAZARDOUS WASTE MANAGEMENT FACILITY (HWMF) AND DOWNGRADIENT SECTION OF CURRENT LANDFILL PLUME

Groundwater contamination originating from the former HWMF and the downgradient section of the Current Landfill plume is being monitored under the Removal Action V (RA V) program. Until 1997, the former HWMF was BNL's central Resource Conservation and Recovery Act receiving facility for processing, neutralizing, and storing hazardous and radioactive wastes before offsite disposal. As the result of past waste handling and storage practices, groundwater at the former HWMF are contaminated with both chemicals and radionuclides at concentrations that exceed NYS AWQS or DWS.

The Current Landfill and former HWMF plumes become commingled south of the HWMF due, at least partially, to historical pumping and recharge effects of the former Spray Aeration System, which operated from 1985 to 1990. The Spray Aeration System was designed to treat VOC-contaminated groundwater originating from the HWMF. The Current Landfill/HWMF plume is currently being remediated using a groundwater extraction and treatment system consisting of two wells screened in the deep portion of the Upper Glacial aquifer at the site boundary (the RA V Treatment System is described in Section 7.4.7). This system provides hydraulic containment of those onsite portions of the plume that have TVOC concentrations greater than 50 µg/L.

The RA V monitoring program uses a network of 54 monitoring wells located in areas downgradient of the Current Landfill and HWMF. This monitoring program is specifically designed to

- Monitor the VOC and radiological contamination of groundwater in the shallow zone of the Upper Glacial aquifer at, and immediately adjacent to, the HWMF,
- Monitor the VOC and radiological contaminant plumes located south of the Current Landfill and HWMF that have been commingled south of the HWMF, and
- Evaluate the effectiveness of the RA V groundwater pump-and-treat system that was initiated in December 1996 at the southern site boundary (extraction wells EW-1 and EW-2). The monitoring program provides information necessary to characterize the effects of this treatment system on the contaminant plume, and provide the data necessary to make decisions on the future operations of the system.

For a detailed description of the remediation system and its effects on the VOC plume, readers are referred to the *RA V Groundwater Treatment Annual Operations Report 1999* (BNL 2000b). A detailed discussion of the groundwater monitoring results for the Current Landfill/HWMF area is included in the *1999 BNL Groundwater Monitoring Report* (Dorsch *et al*. 2000).

*Volatile Organic Compounds*

TVOC concentration distributions for the Current Landfill/HWMF plume are shown in Figure 7-11. The primary VOCs found onsite include chloroethane, TCA , and DCA; whereas TCA, DCE, TCE, and chloroform are found in the offsite portion of the plume. The Current Landfill/HWMF plume, as defined by TVOC concentrations greater than 5 µg/L, extends from the Current Landfill south to an area south of North Street, a distance of approximately 7,150 feet. The plume is approximately 1,100 feet wide at its maximum (as defined by concentrations >5 µg/L). The higher concentration portion of the plume (i.e., where concentrations are >50 µg/L) is approximately 800 feet wide. Chloroethane, TCA, and DCA are detected in the shallow Upper Glacial aquifer near the source areas, and in the deep Upper Glacial aquifer at the site boundary and offsite. TCA, DCE, TCE, and chloroform are found in the middle to deep

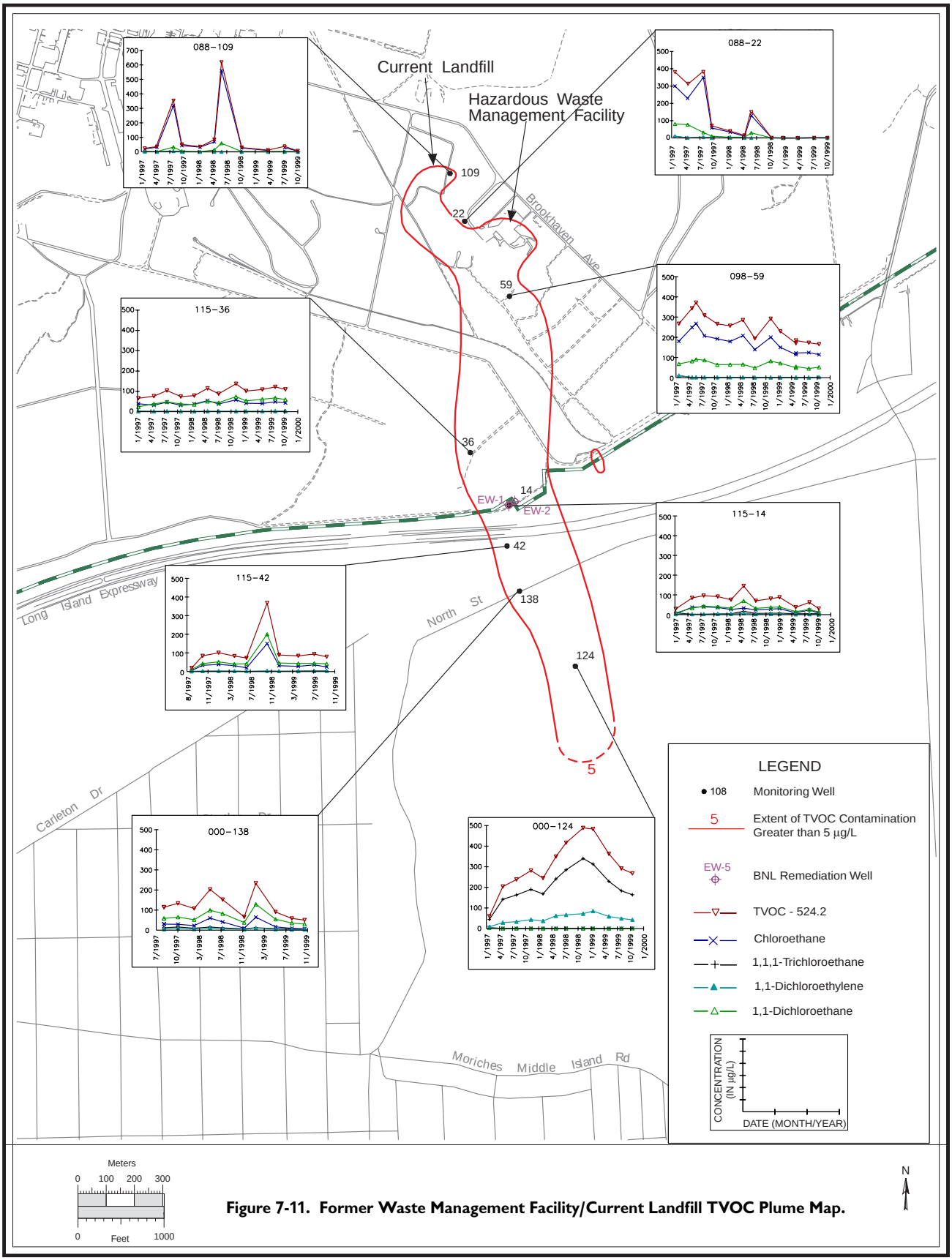


**Figure 7-11. Former Waste Management Facility/Current Landfill TVOC Plume Map.**

Upper Glacial aquifer offsite south of North Street. Cross sectional views of the plume are presented in the *1999 BNL Groundwater Monitoring Report* (Dorsch *et al*. 2000).

Time-vs.-VOC concentration trend plots for key wells within the Current Landfill/HWMF plume are provided on Figure 7-11. TVOC concentrations in Current Landfill Wells 088-109 and 088-22 continued to display decreasing levels. Wells 098-59 and 115-36 (located between the source areas and the site boundary) displayed slightly decreasing TVOC concentrations during 1999. Well 115-14, located close to the extraction system has maintained a low, and steady TVOC concentration. TVOC concentrations trended downward in 1999 for offsite wells 115-42, 000-124, and 000-138.

There have been several distinct changes in the distribution of the plume from 1997 through 1999 as shown on Figure 7-12. In general, the width of the plume has significantly decreased. The onsite reduction in plume width can be attributed to the effects of the pump-and-treat system located at the site boundary (for additional details on this system, refer to the *RA V Groundwater Treatment Annual Operations Report* (2000b). The apparent reduction of plume width in offsite areas is the result of improved definition of the plume using temporary wells installed during 1998. Hydraulic control of the plume at the site boundary has been achieved as evidenced by the groundwater flow patterns in this area, and the decrease in contaminant concentrations in Well 000-138 located downgradient of the extraction wells. The decrease in high concentrations immediately south of the former HWMF and offsite south of North Street may be a function of those portions of the plume having migrated to a position in between monitoring locations. The downgradient extent of the Current Landfill/HWMF plume is estimated based on temporary well data obtained during the 1998 groundwater characterization effort in conjunction with knowledge of the groundwater flow system through groundwater modeling and mapping efforts.

*Radionuclides*

During 1999, tritium was detected in several wells, but at concentrations below the drinking water standard of 20,000 pCi/L. The maximum observed tritium concentration was 4,331 pCi/L in a sample from Well 115-29 located near the south boundary extraction system. With the exception of Well 115-29, most of the Current Landfill/HWMF wells displayed decreasing tritium concentration trends during 1999. Although tritium concentrations in Well 088-26 (located inside the HWMF) have historically exceeded the 20,000 pCi/L drinking water standard, the maximum observed concentration during 1999 was only 2,183 pCi/L.

Although Sr-90 was detected in a number of wells located within or immediately downgradient of the HWMF, all concentrations were below the drinking water standard of 8 pCi/L. The highest Sr-90 concentration (6.3 pCi/L) was detected in Well 088-26 (located within the HWMF area). Additional groundwater characterization work is planned for CY 2000 to confirm the extent of Sr-90 contamination in the HWMF area. There were no gross alpha/beta results or gamma-emitting radionuclides detected above standards and/or screening levels during 1999.

### 7.4.3 OPERABLE UNIT (OU) III

The monitoring well network established to monitor the OU III VOC and radionuclide source areas and resulting contaminant plumes is composed of approximately 180 monitoring wells positioned from the north-central portion of the site to the southern site boundary and offsite. The OU III groundwater-monitoring program is specifically designed to address the following groundwater contamination and plume remediation issues:

- Monitor VOC plumes with identified or suspected sources in the AGS Complex, Paint Shop, former Carbon Tetrachloride (CT) Underground Storage Tank area, former Building 96 area, and the Supply and Materiel area.
- Monitor the tritium plume associated with the High Flux Beam Reactor (HFBR) and Sr-90 plumes associated with the Waste Concentration Facility and the formerly operated Brookhaven Graphite Research Reactor (BGRR).
- Evaluate the effectiveness of the OU III south boundary groundwater pump-and-treat system initiated in June 1997 (extraction wells EW-3 through EW-8). This monitoring program characterizes the effects of the pumping on the contaminant plume, and provides the data necessary for making decisions on the future operations of the extraction wells.


**Figure 7-12. Former Waste Management Facility/Current Landfill TVOC Plume Comparison – 1997, 1998 and 1999.**

- Monitor the offsite segment of the plume and "outpost" wells located to the south (downgradient) of the defined extent of the offsite VOC plume to provide data on future downgradient migration of the plume. Outpost wells are also situated in the southwestern portion of BNL, directly upgradient of the Suffolk County Water Authority's Parr Village Well Field located near the 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 if contaminants from BNL were to migrate toward the Suffolk County Water Authority wells.

*Volatile Organic Compounds*

Figure 7-13 shows the areal extent of the OU III VOC plume and the OU IV VOC plume. The two plumes are so close to each other that it is difficult to represent them as distinct, separate plumes. The OU III VOC plume extends from the AGS Complex area in the central part of the site south to the vicinity of Flower Hill Drive in North Shirley, a distance of approximately 17,600 feet (Figure 7-13). The plume is approximately 5,000 feet at its maximum width, as defined by TVOC concentrations >5 µg/L. The higher concentration portion of the plume (i.e., containing concentrations >50 µg/L) is approximately 1,900 feet wide near the BNL southern boundary.

The OU III VOC plume is actually comprised of multiple commingled plumes originating from several sources. To determine the extent of VOC contamination, monitoring well data from 11 separate ER and Environmental Surveillance (ES) monitoring programs were evaluated. These monitoring programs include the OU III Central area, Southern Boundary area, Carbon Tetrachloride Plume, former Building 96 area, AS-Industrial Park area, Offsite Program, select downgradient wells from the HFBR Tritium Monitoring Program, Alternating Gradient Synchrotron Complex area, and the Motor Pool and Service Station areas. The primary VOCs detected in onsite monitoring wells include CT, TCA, and PCE; whereas CT and PCE are the primary VOCs detected in offsite groundwater. In general, PCE, TCA, and CT are observed in the shallow portions of the Upper Glacial aquifer in the central portion of BNL and in the deep Upper Glacial aquifer at the southern boundary and offsite areas. Samples from deep wells located near the offsite Industrial Park indicate that there is CT contamination in the Upper Magothy aquifer.

During 1999, wells displaying the highest VOC concentrations (i.e., greater than 1,000 µg/L) include the former Building 96 area, the former CT underground storage tank area (Figure 7-14), areas near the South Boundary Treatment System, and the offsite Industrial Park Treatment System area. Trend plots showing changes in VOC concentrations for key OU III monitoring wells are presented on Figures 7-15 and 7-16. A comparison of the OU III plume distribution from 1997 through 1999 is provided on Figure 7-17.

The VOC plume in the former Building 96 area consists primarily of PCE, and lower concentrations of TCA, with TVOC concentrations up to 4,390 µg/L. During 1999, design work was initiated for an in-well air sparging system to remediate the Building 96 source area. This groundwater treatment system is expected to be operational in CY 2000.

In April 1998, an inactive underground storage tank used for the storage of CT was excavated and removed. Although groundwater samples collected from a nearby well had shown low-level concentrations of CT since 1995, samples collected in June 1998 revealed levels approaching 100,000 µg/L. The ambient water quality standard for CT is 5 µg/L. It is now apparent that the increase in contaminant concentration was probably due to the spillage of residual CT during removal of the underground storage tank. Since 1998, the leading edge of the CT plume has migrated approximately 300 feet downgradient from the former underground storage tank area (see Figure 7-14). The highest CT concentrations (up to 7,290 µg/L) were detected in Well 085-161 located approximately 100 feet downgradient of the former underground storage tank area. Concentrations drop to 375 µg/L in Well 085-17. Figure 7-14 provides time-vs.-carbon tetrachloride trend plots for the wells in this area. The effects of the pump-and-treat system on the source area are apparent in the sharp decline in VOC concentrations at Well 085-98 (see Section 7.4.7 for a description of the treatment system). Additional monitoring wells will be installed in CY 2000 to address the leading edge of this plume.

TVOC concentrations greater than 1,000 µg/L extend from the Middle Road to the

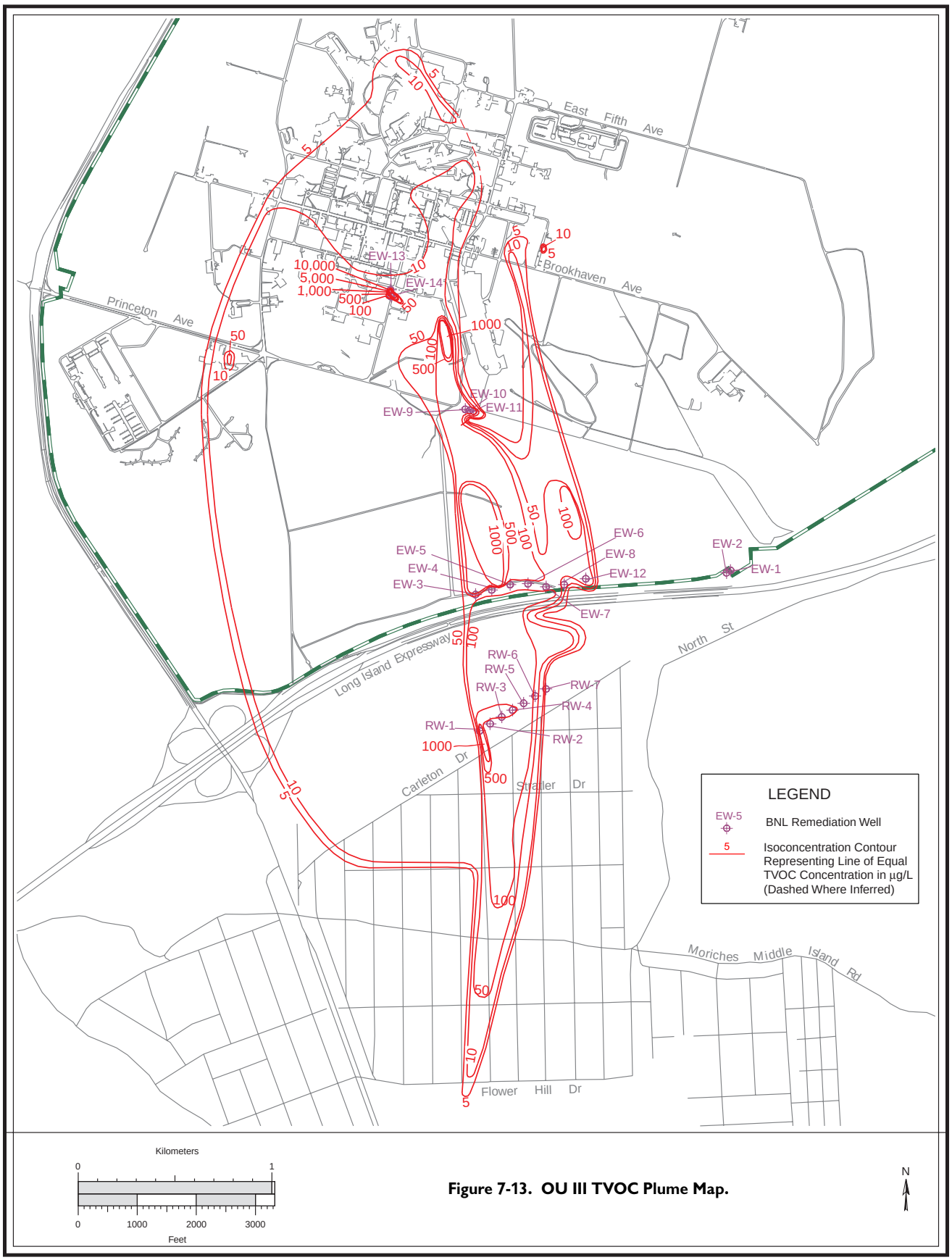


**Figure 7-13. OU III TVOC Plume Map.**

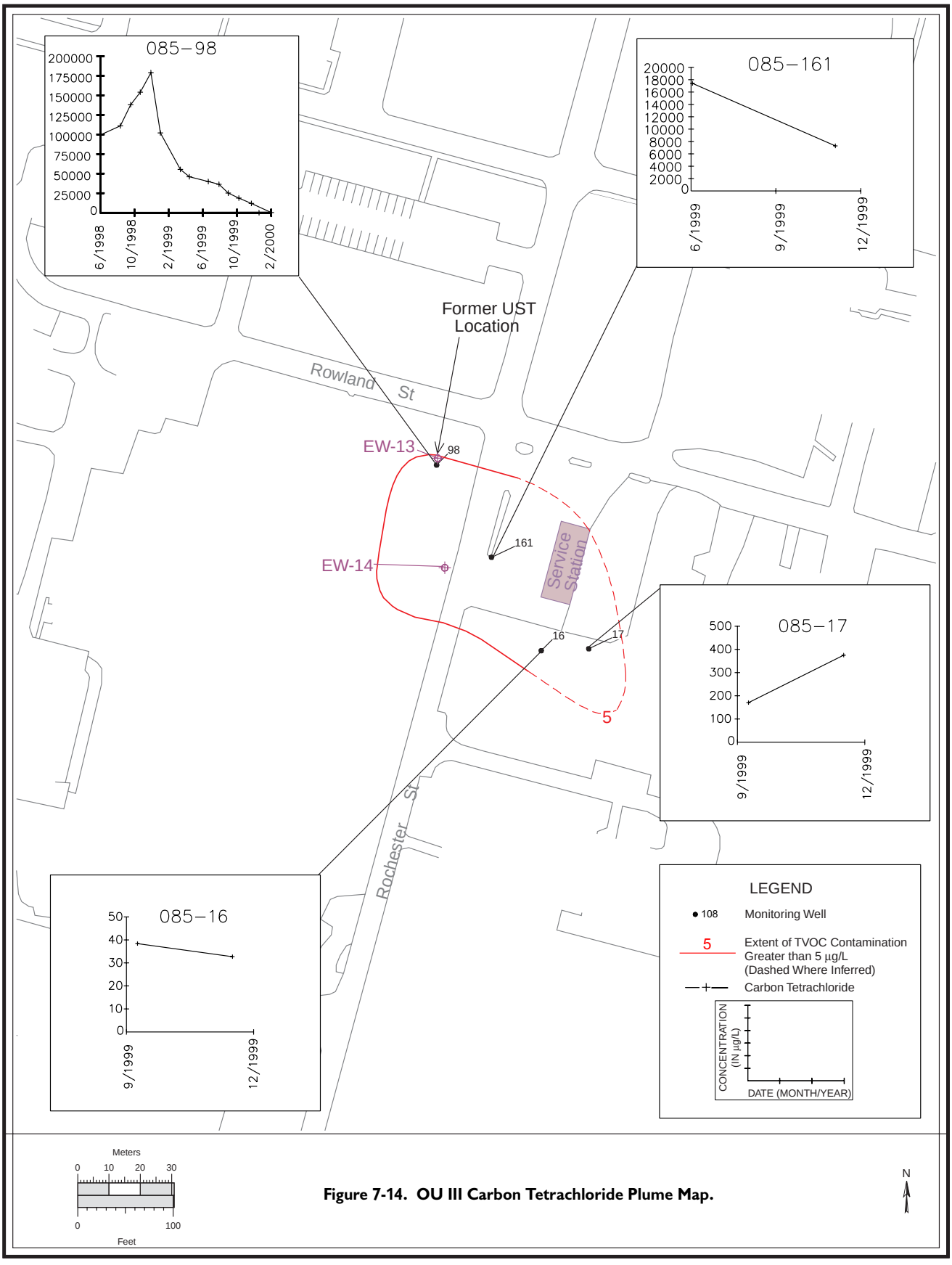


**Figure 7-14. OU III Carbon Tetrachloride Plume Map.**

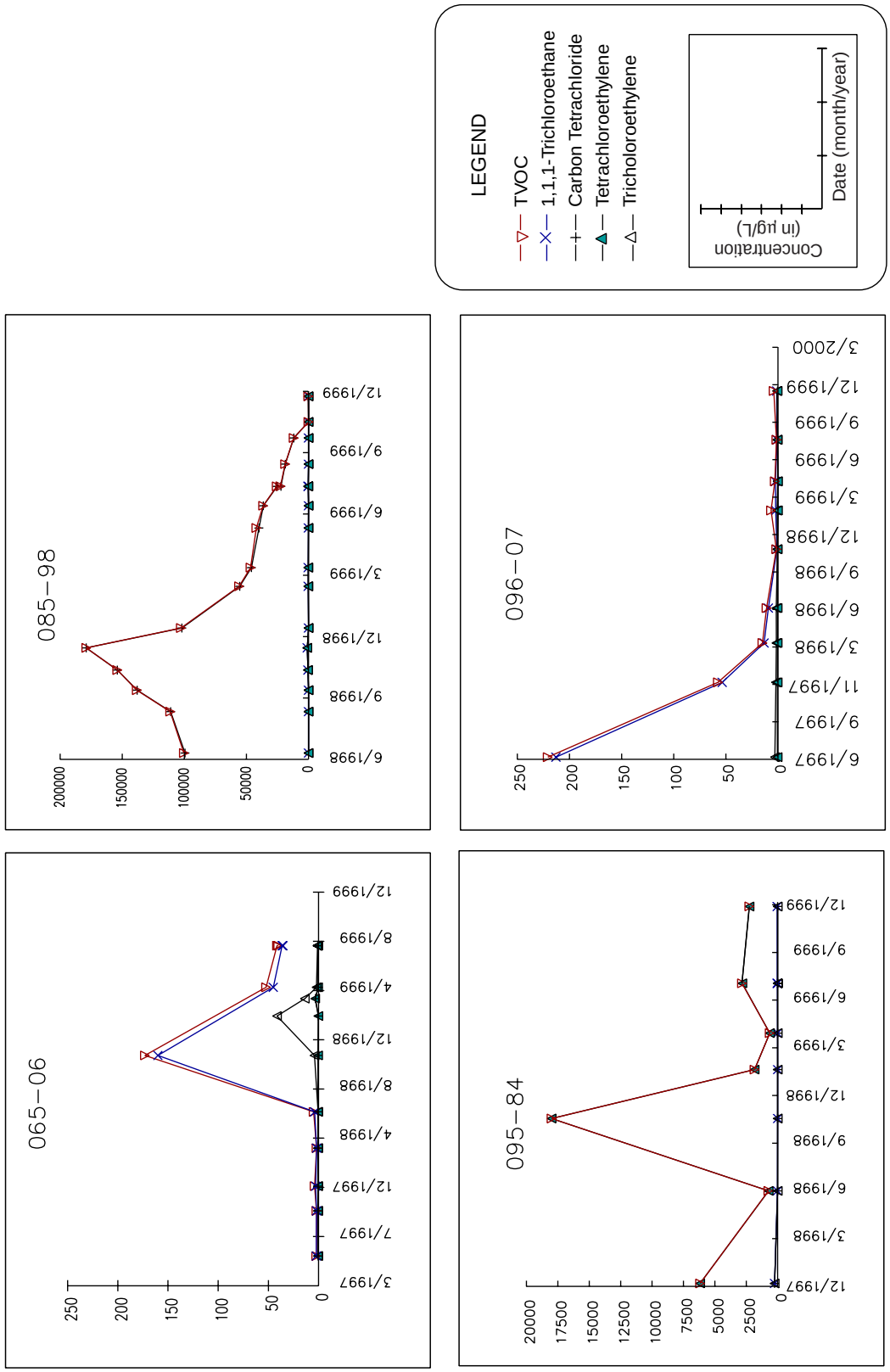


**Figure 7-15. Time-vs.-VOC concentration trend plots for key wells in the OU III plume (central area): Well 065-06 located downgradient of the AGS area; Well 085-98 located downgradient of the carbon tetrachloride spill area; Well 095-84 located in the former Building 96 area; and Well 096-07 located downgradient of the Supply and Materiel Building 208.**

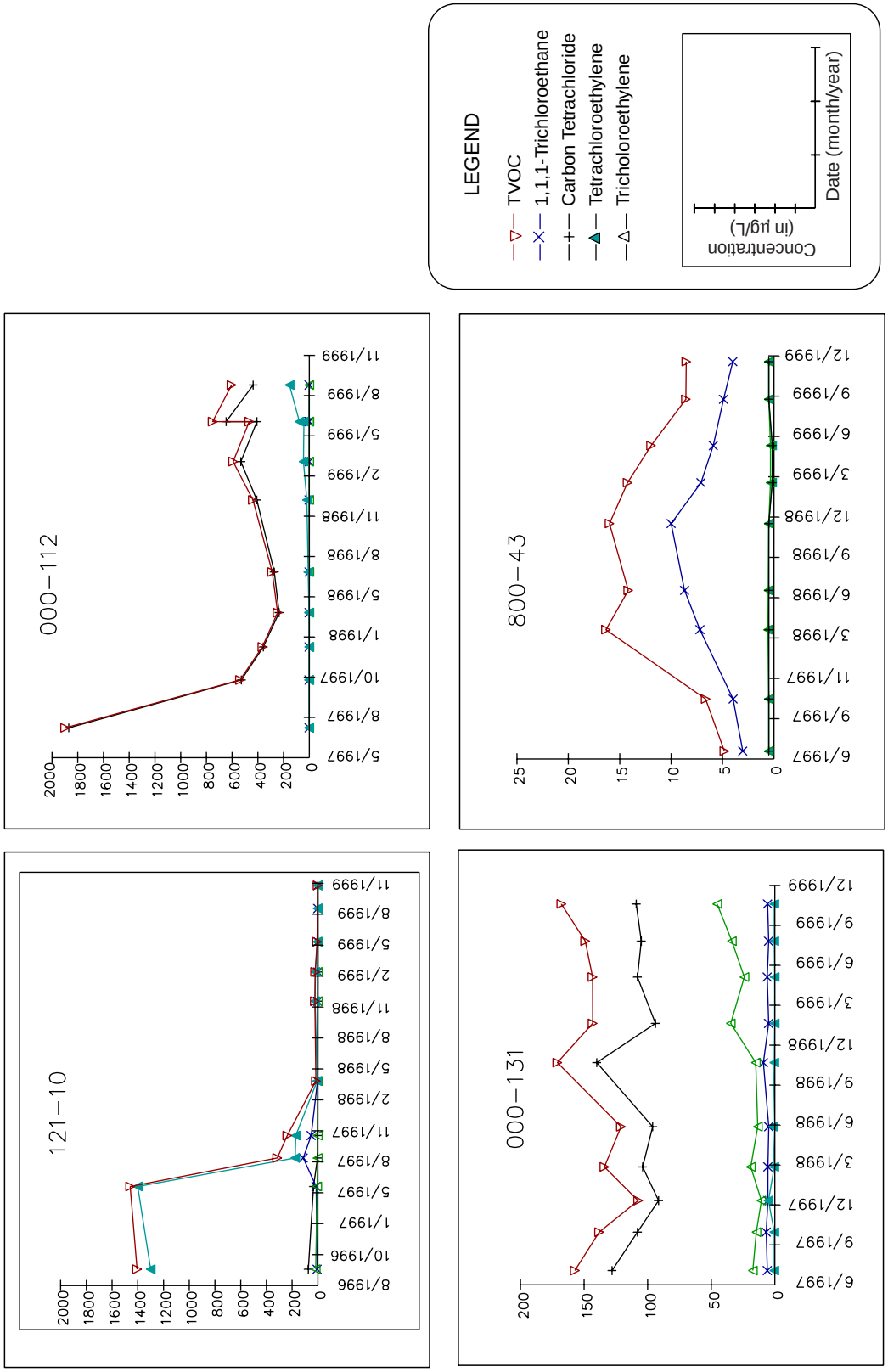


**Figure 7-16. Time-vs.-VOC concentration trend plots for key wells in the OU III plume (southern boundary and offsite areas): Well 121-10 located at the BNL southern boundary; Well 000-112 located offsite near the Brookhaven Industrial Park; Well 000-131 located on Waldorf Drive; and Well 800-43 located near Flower Hill Drive near leading edge of the OU III plume.**

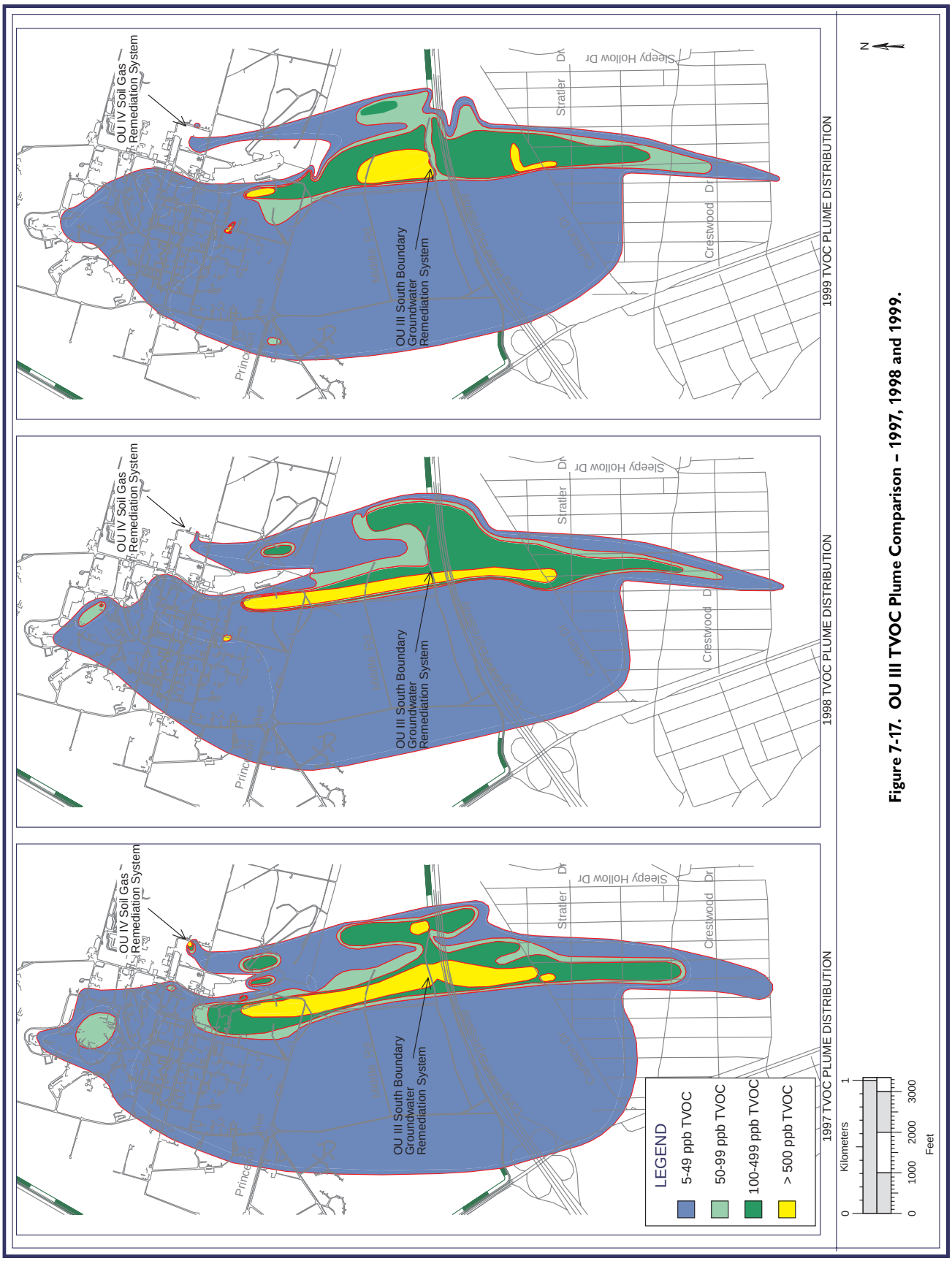


**Figure 7-17. OU III TVOC Plume Comparison – 1997, 1998 and 1999.**

South Boundary Treatment System area. Concentrations ranged from 1,044 µg/L in wells located near the Middle Road (i.e., Wells 113-08 and 113-11) to 1,213 µg/L in Well 121-13, which is located immediately upgradient of the southern boundary extraction system. Wells located south of the southern boundary extraction system have continued to display either reductions in concentrations or are maintaining already low concentrations (<200 µg/L). These low concentrations can be attributed to the positive effects of the extraction system. A seventh extraction well (EW-12) was installed during 1999 to provide better hydraulic control of the eastern portion of the plume, which consists of contaminants originating from the OU IV source area (See Figure 7-26). The *CY 1999 OU III Pump-and-Treat System Annual Report* (BNL 2000c) contains detailed information on system operations and progress on the remediation effort.

A TVOC plume with concentrations greater than 1,000 µg/L extends from the offsite Industrial Park area to Carleton Drive in North Shirley. This plume, which consists primarily of CT, is located in the upper portion of the Magothy aquifer. The highest CT concentrations were found in samples from Wells 000-249 and 000-130, with maximum concentrations of 1,011 µg/L and 5,485 µg/L, respectively. A groundwater treatment system, consisting of seven in-well air stripping treatment wells, was installed in the industrial park located south of BNL in 1999. The purpose of the in-well air stripping wells is to treat VOC contamination located in the deep Upper Glacial aquifer. Thirty-six monitoring wells were also installed in this area to monitor the effects of the system (i.e., hydraulic control and changes in VOC concentrations). The OU III Off Site Removal Action groundwater treatment system went into operation on September 29, 1999. Details on the system start-up and technology can be found in the report *OU III Off site Removal Action System Start-Up Report* (BNL 2000d). Additional characterization to define the extent of CT contamination in the Magothy aquifer is planned in CY 2000.

Compared to previous years, VOC concentrations increased in HFBR Tritium Plume extraction well EW-9 (located on Princeton Avenue), with annual average TVOC concentrations increasing from 79 µg/L in 1998 to 298 µg/L in 1999. This increase can be attributed to slight changes in groundwater flow directions caused by site-wide pumping and recharge effects, and the continued operation of the extraction wells. These combined effects have apparently shifted higher concentration portions of the OU III plume (originating from the former Building 96 area) to the east. Details on the treatment of VOC contamination can be found in the *Tritium Pump and Recharge System Annual Evaluation Report* (BNL 2000e).

#### 7.4.3.1 HFBR TRITIUM PLUME

Following the January 1997 discovery of tritium in wells south of the HFBR, it was determined that the HFBR's spent fuel pool was leaking tritiated water at a rate of approximately six to nine gallons per day. To prevent additional release of tritiated water, the HFBR's spent-fuel pool was completely emptied in December 1997. An extensive groundwater investigation has demonstrated that the tritium plume remains completely onsite, and an interim remediation system was designed to control the leading edge of the plume.

During 1999, additional groundwater characterization work was conducted to provide an updated picture of the high concentration portion of the plume located immediately downgradient of the HFBR, and to enhance the downgradient monitoring well network. Figure 7-18 shows the HFBR tritium plume. The plume (defined by tritium concentrations greater than 1,000 pCi/L) extends from the HFBR to a location immediately north of Weaver Drive, a distance of approximately 3,000 feet. (Note: The drinking water standard for tritium is 20,000 pCi/L.) The plume is approximately 600 feet wide at its maximum. Tritium is detected in the shallow Upper Glacial aquifer near the HFBR source area, and in the deep Upper Glacial aquifer just to the north of Weaver Drive.

There are two areas of the tritium plume with concentrations greater than 20,000 pCi/L. One segment extends from the HFBR to Brookhaven Avenue, and the second smaller area is located between Weaver Drive and Rowland Street. The area of the plume containing the highest concentrations continues to be located in a narrow band extending from the HFBR south to the vicinity of Brookhaven Avenue (see Figure 7-18). Concentrations greater than 500,000 pCi/L were found from the HFBR south to a point just north of Temple Place. The highest tritium concentration was

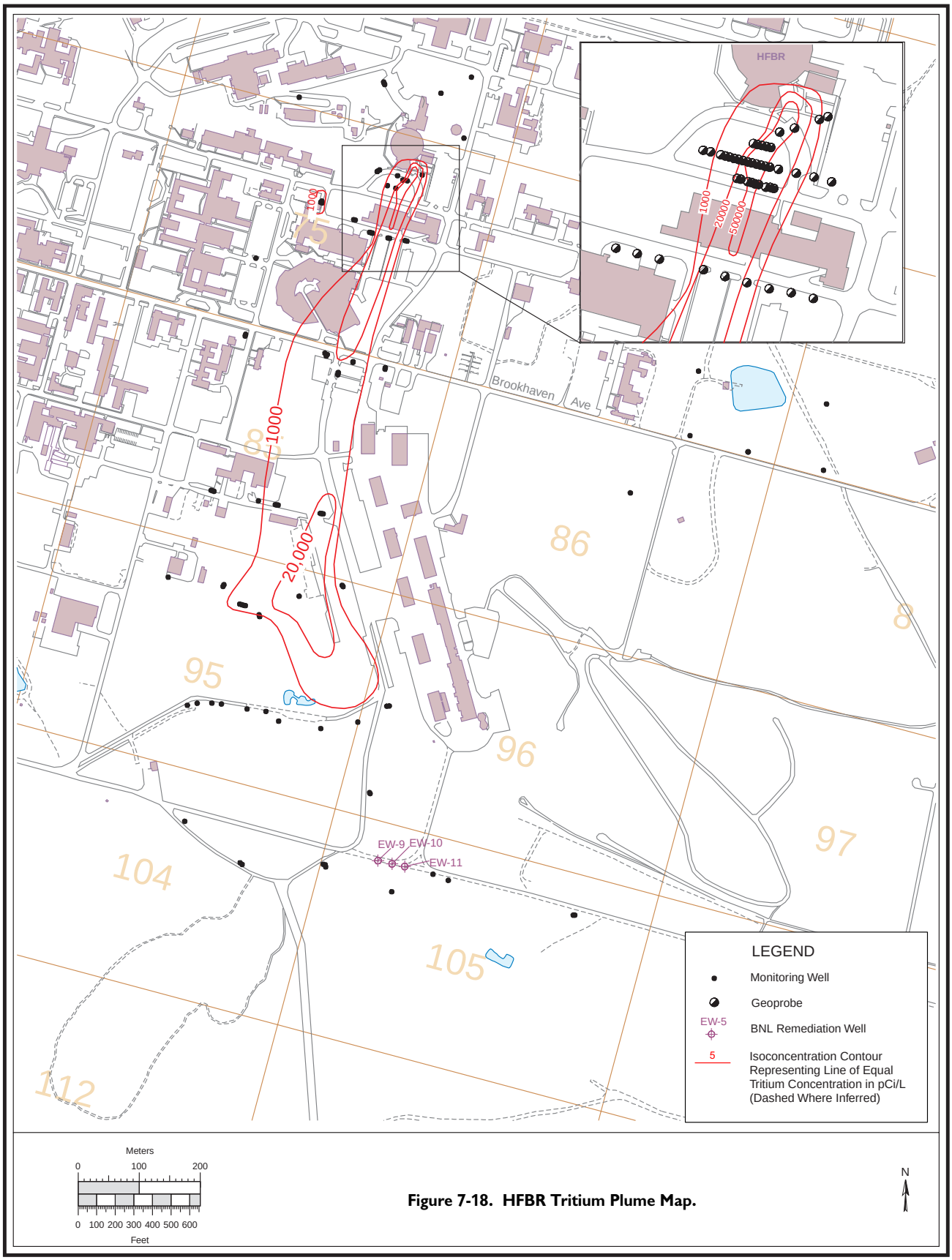


**Figure 7-18. HFBR Tritium Plume Map.**

5,034,561 pCi/L, detected in a temporary well installed approximately 150 feet south of the HFBR (north of Cornell Avenue). The second area where tritium concentrations exceeded 20,000 pCi/L is located south of Rowland Street and centered on Wells 085-78 (maximum concentration of 63,261 pCi/L) and Well 095-48 (maximum concentration of 51,898 pCi/L). It appears that the remediation system has had a positive effect on further reducing the low level tritium concentrations previously detected in the area south of Weaver Drive. There has been no significant downgradient migration of tritium between 1997 and 1999; and Well 105-44, which is located immediately downgradient of the tritium pump and treat system, showed a significant decline in tritium concentration during 1999.

Historical tritium trends are presented in Figure 7-19. Data collected during 1999 indicate that the tritium plume has shifted to the east in response to artificial influences on the groundwater flow field (i.e., influence caused by supply well pumping and water recharge). This eastward shift is discernable when comparing tritium concentration trends from 1997 through 1999. Wells that were initially located within the plume either showed continual concentration declines or remained at or just above detection limits (Wells 075-11, 075-12, 075-43, 075-45, 075-44, 075-85, 085-71, 085-72, and 095-44). However, tritium concentrations have increased in wells that were located to the east of the high concentration portions of the plume in 1997 (Wells 085-67, 085-78, and 095-48). Figure 7-20 shows a comparison of the 1997 and 1999 plume distribution. A detailed analysis of the flow conditions in this area of the site was performed as part of the *Monitored Natural Attenuation (MNA) Work Plan for the HFBR Tritium Plume* (BNL 1999a).

#### 7.4.3.2 WASTE CONCENTRATION FACILITY (WCF) AND BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)/ PILE FAN SUMP AREAS

Historical waste handling operations at the WCF, and operations at the former BGRR and its associated Pile Fan Sump, resulted in the release of Sr-90 to the groundwater below these facilities. Following an extensive characterization effort in 1997 utilizing temporary wells, a permanent monitoring-well network was installed in the spring of 1999. The newly installed wells supplemented available existing wells monitored under the OU III (AOC 29 HFBR) program and wells previously installed under the OU III Remedial Investigation. The distribution of Sr-90 contamination in these source areas is shown on Figure 7-21.

Two separate and distinct areas of Sr-90 contamination are recognized. The more significant of the two areas can be traced from the WCF area south to the area just north of Cornell Avenue, a distance of approximately 1,300 feet. The width of this plume, as defined by Sr-90 concentrations that exceed the 8 pCi/L drinking water standard, is approximately 400 feet. The vertical extent of contamination is confined to the shallow and middle portion of the Upper Glacial aquifer. The highest concentration associated with the WCF plume is in shallow Well 065-175, at a concentration of 361 pCi/L. It is noted that a portion of this plume is composed of Sr-90 that was released in the Building 801 and nearby Pile Fan Sump area. This contamination is detected in shallow Upper Glacial aquifer wells located directly downgradient of the Building 801/Pile Fan Sump area. The highest concentration associated with the Building 801/Pile Fan Sump portion of the plume is in shallow Well 065-172, at a concentration of 49 pCi/L.

The second area of Sr-90 contamination is located approximately 400 feet south of the BGRR near Cornell Avenue. This plume, defined by Sr-90 concentrations greater than 8 pCi/L, extends approximately 550 feet to an area just north of Brookhaven Avenue and is less than 200 feet wide. The highest concentration associated with the BGRR plume was detected in Well 075-202, at a concentration of 42.9 pCi/L.

### 7.4.4 OPERABLE UNIT (OU) IV

The Operable Unit IV area contains two significant source areas: the 1977 fuel oil/ solvent spill site (AOC 5) and the Building 650 Sump and Sump Outfall area (AOC 6).

#### 7.4.4.1 1977 OIL-SOLVENT SPILL SITE (AOC5)

In 1977, approximately 25,000 gallons of a mixture 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 aboveground storage tanks at the 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

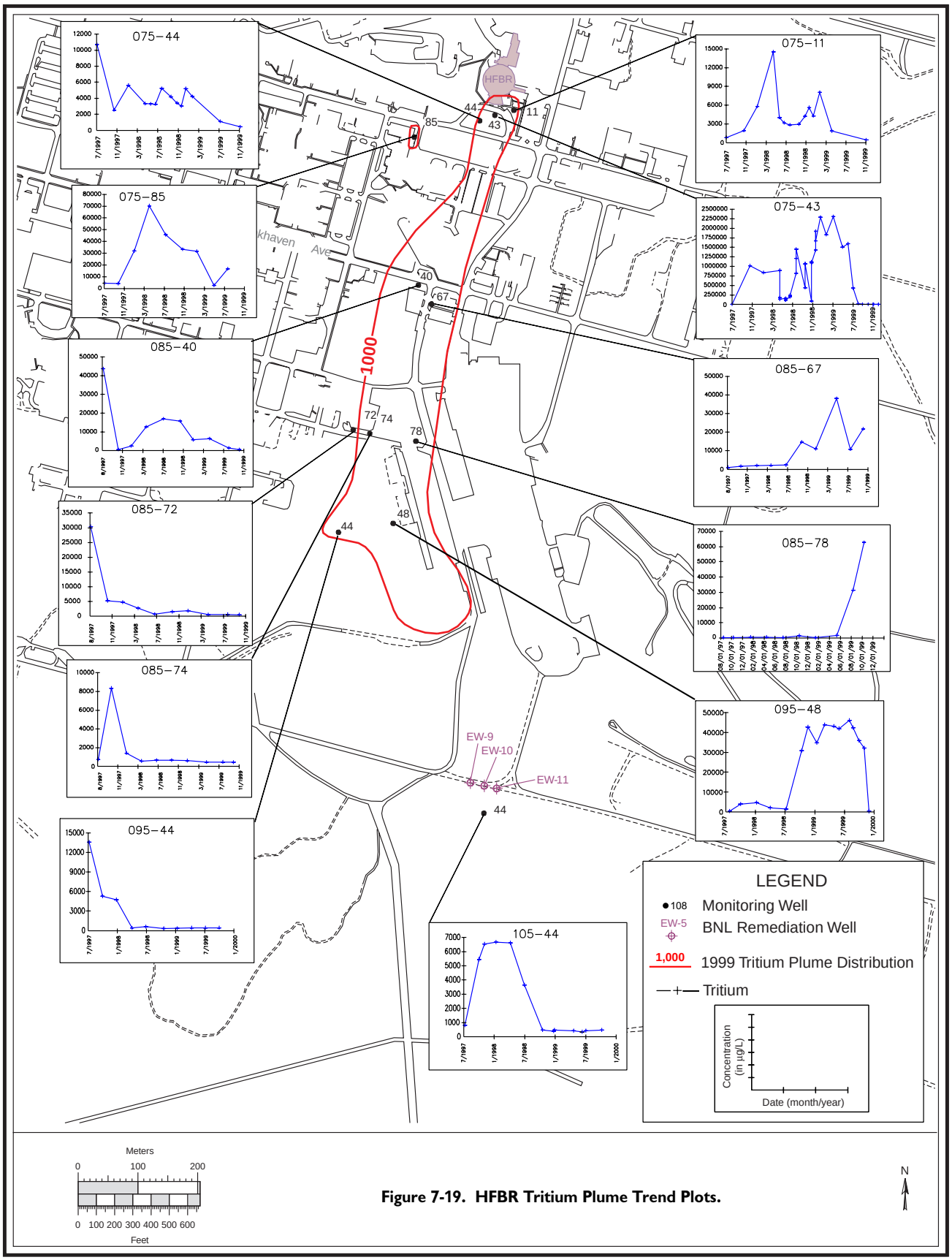


**Figure 7-19. HFBR Tritium Plume Trend Plots.**


**Figure 7-20. HFBR Tritium Plume Comparison – 1997 and 1999.**

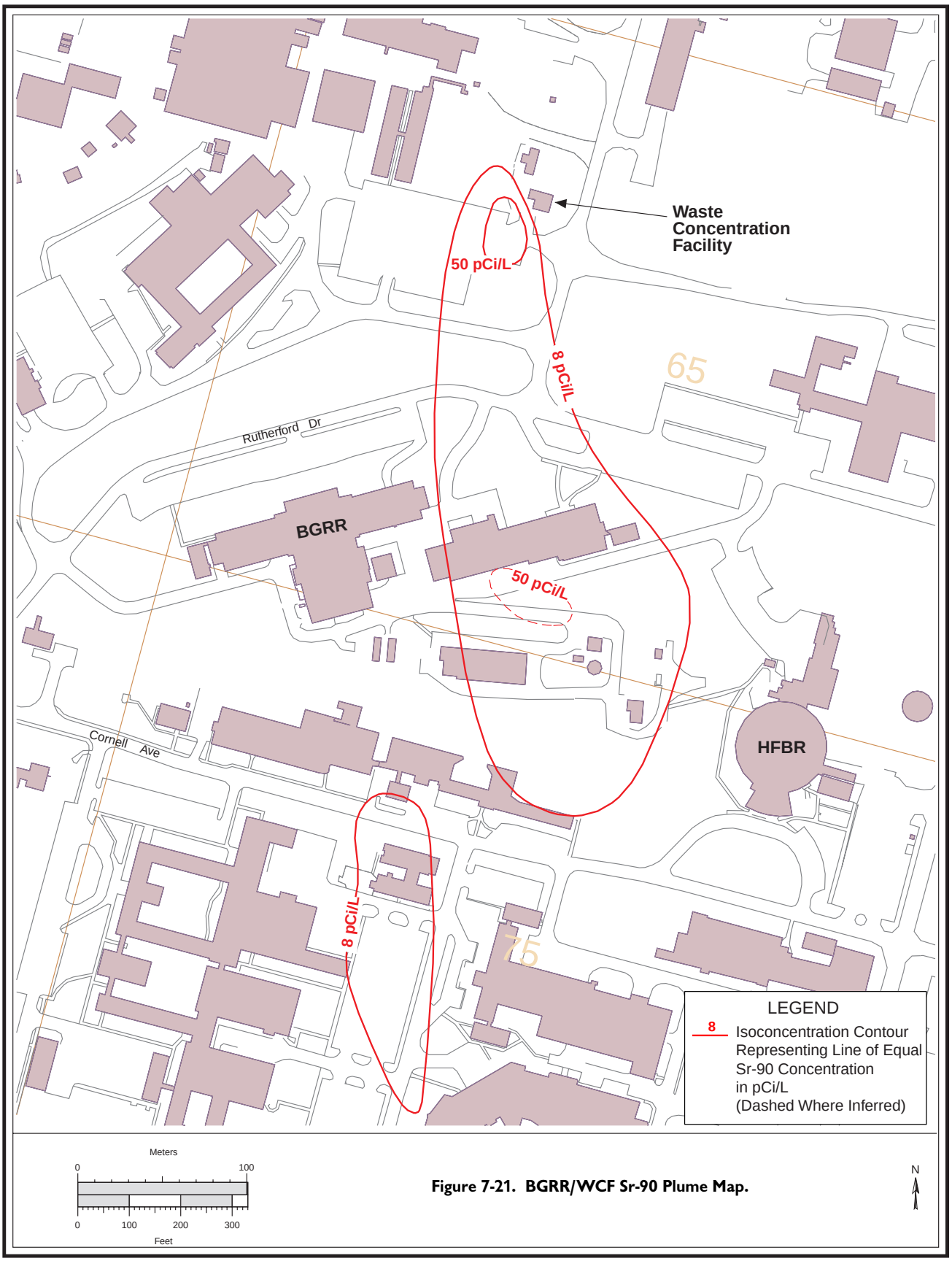


**Figure 7-21. BGRR/WCF Sr-90 Plume Map.**

small volumes of solvents, such as PCE, have been released to the ground in the vicinity of the CSF. Eighteen wells are used to monitor this area. VOC contamination originating from the CSF area is currently monitored under two programs: the OU IV 1977 spill area cleanup program (AOC 5) and the OU I/IV program which monitors the downgradient (south of Brookhaven Avenue) component of the OU IV plume.

The areal extent of OU IV VOC contamination is shown in Figure 7-13. The OU IV plume, as defined by TVOC concentrations greater than 5 µg/L, extends from the 1977 Waste Oil Solvent Spill area in the north to an off site area between the southern site boundary and Carleton Drive, a distance of approximately 6,200 feet. The plume is approximately 1,000 feet wide. The width of the higher concentration segments of the plume (i.e., having TVOC concentrations >50 µg/L) is approximately 700 feet. In general, VOCs are present in the Shallow Glacial aquifer near the 1977 spill area and in the Deep Glacial aquifer at the southern site boundary and offsite areas.

The OU IV plume is composed of the solvents TCA, PCE, DCE, and TCE, and oil products (consisting of toluene, ethylbenzene, and xylene). Although the main source area appears to be in the vicinity of the 1977 spill, the detection of low levels of TCA and PCE in several upgradient wells indicates that some of the contamination originates from historical spills that occurred in the nearby CSF and Building 650 areas. Whereas TCA, PCE, DEC, and TCE have migrated considerable distances, the presence of toluene, ethylbenzene and xylene is highly localized to the source area. An air sparging/soil vapor extraction system (AS/SVE) has been in operation since November 1997 to remediate VOC and semi-VOC contamination of soils and groundwater near the spill site (see section 7.4.7). Compared to pre-November 1997 VOC concentration data (when TVOC concentrations were typically >1,000 µg/L), the highest TVOC concentration during 1999 was 13 µg/L detected in well 076-08. Therefore, the AS/SVE remediation system has been highly effective in reducing VOC concentrations within the source area.

In the downgradient portion of the OU IV plume, the highest VOC concentrations during 1999 were found in the area between Princeton Avenue and the southern site boundary. The plume in this area is composed primarily of TCA, DCE, and TCE, with TVOC concentrations up to 298 µg/L. In addition, during the fourth quarter of 1999, VOCs were detected in the upper Magothy aquifer in Wells 122-05 and 122-24 at 99 µg/L and 87 µg/L, respectively. Additional characterization of contamination within the upper Magothy aquifer will be conducted during CY 2000.

Figure 7-22 contains time-vs.-VOC concentration trend plots for select wells in the OU IV plume. The reduction in VOC concentrations in the 1977 spill area since November 1997 start up of the AS/SVE system can be clearly seen in source area Well 076-04. Well 096-07 (Supply and Materiel area) and Well 105-06 (Princeton Avenue) have also shown marked VOC concentration reductions since 1997. These concentration reductions can be attributed to either the migration of contaminant "slugs" downgradient and beyond these wells or the change in the groundwater flow field in the area and the resulting eastward shift of the plume. Operation of the OU III Southern Boundary treatment system has resulted in a significant lowering of TVOC concentrations. A seventh extraction well, EW-12 was installed during 1999 to enhance the existing pump-and-treat system and provides hydraulic control for the OU IV plume (see Figure 7-28). Pumping of EW-12 started in late December 1999. The *CY 1999 OU III Pump-and-Treat System Annual Report* (BNL 2000c) contains detailed information on system operations and remediation progress.

The changes in the OU IV plume distribution from 1997 through 1999 are shown on Figure 7-17, which depicts the combined OU III and OU IV plumes. The higher concentration segments of the plume have undergone reductions as a result of remediation both at the source area and the site boundary.

#### 7.4.4.2 BUILDING 650 AND 650 SUMP OUTFALL AREAS (AOC 6)

In the Building 650 area, Sr-90 concentrations in Well 076-28 showed an increase to levels above the 8 pCi/L drinking water standard for the first time in its monitoring history (Figure 7-23), with a maximum Sr-90 concentration of 14.9 pCi/L. Previous Sr-90 concentrations detected in this well had ranged up to 5 pCi/L. Well 76-28 is located adjacent to the Building 650 sump/decontamination pad and downgradient of a former underground storage

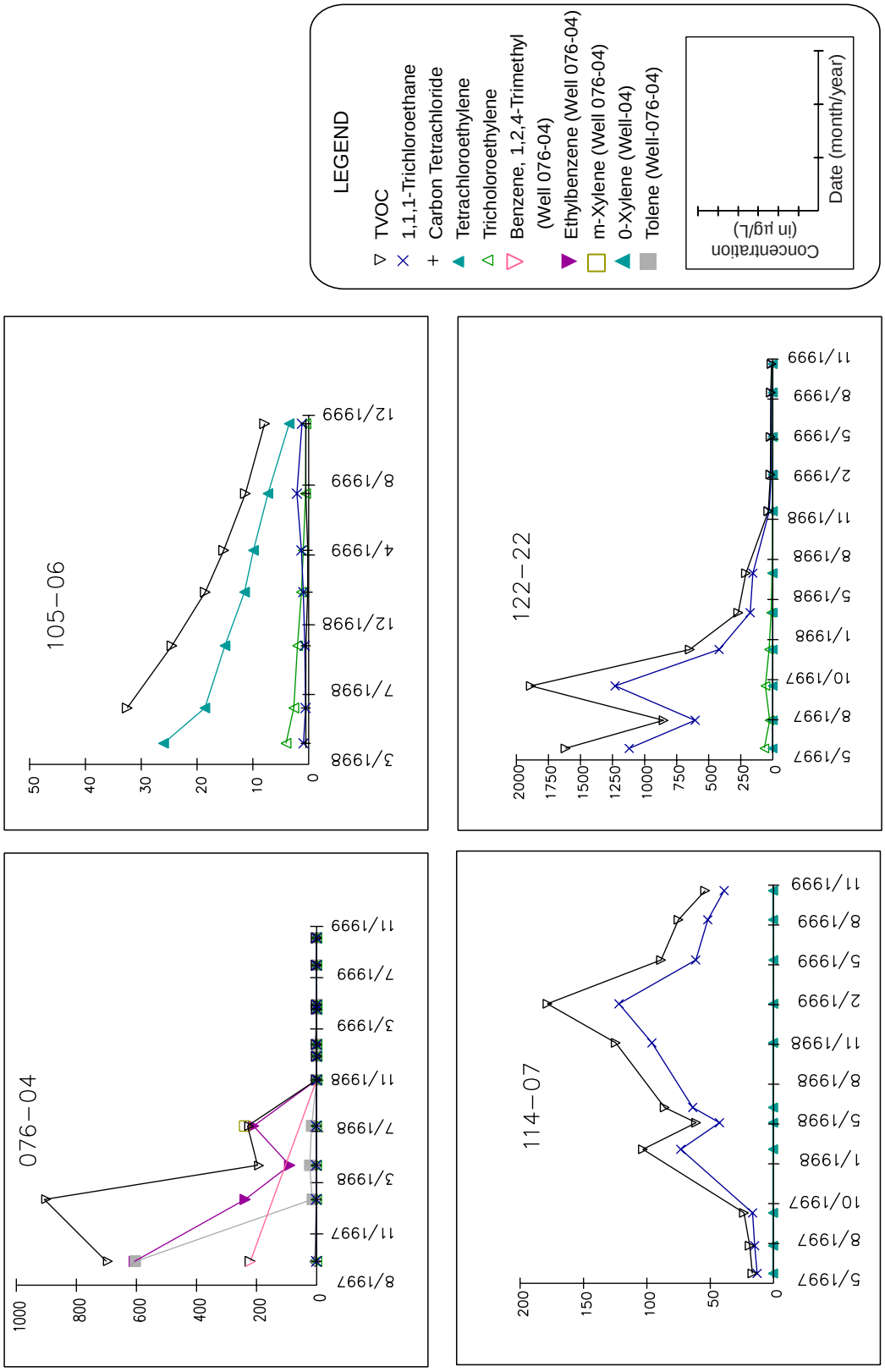


**Figure 7-22. Time-vs.-VOC Concentration Trend Plots for Key Wells in the OU IV VOC Plume. Well 076-04 located near the 1977 oil/solvent spill area; Well 105-06 located on eastern Princeton Avenue; Well, 114-07 and 122-22 located along the BNL southern boundary.**

tank area. The Sr-90 detected in Well 076-28 probably originates from contaminated soils associated with decontamination pad and storage tank operations. Strontium-90 was not detectable in samples from three wells located downgradient of Building 650 (Wells 076-25, 076-317, and 076-373), nor in upgradient Well 076-314.

Soil and groundwater contamination at the Building 650 Sump Outfall is due to the historical discharge of radionuclides to the Building 650 sump. Historically, Sr-90 has been detected at concentrations above the 8 pCi/L drinking water standard in a number of the wells located downgradient of the outfall. Figure 7-23 shows the areal extent of the Sr-90 plume, as well as time-vs.-Sr-90 concentration trend plots for key wells in this area. Compared to its 1998 position, little movement of the Sr-90 plume was evident in 1999. During 1999, Sr-90 concentrations exceeded the drinking water standard in three wells located within 500 feet of the Outfall, with the highest concentration observed in Well 076-13 at a concentration of 60 pCi/L. Wells 076-28, 076-13 and 076-263 showed declining Sr-90 trends during 1999. In late 1999, additional wells were installed downgradient of the previously defined extent of contamination to allow for future evaluation of Sr-90 plume migration. (Note: Although the new wells were not sampled until February 2000, the resulting analytical data were utilized for purposes of constructing the plume distribution map presented on Figure 7-23.)

### 7.4.5 OPERABLE UNIT (OU) V, EASTERN PLUME

The OU V monitoring program uses 34 monitoring wells located downgradient of the Sewage Treatment Plant (STP). These wells monitor VOC and tritium contamination resulting from historical releases at the STP. Surveillance of present groundwater quality at the STP is performed as part of the BNL Environmental Surveillance (ES) program (see section 7.5).

*Volatile Organic Compounds, Metals and Pesticides*

The areal extent of VOC contamination is shown on Figure 7-24. It is noted that historical temporary well data were used to supplement the definition of the extent of VOC contamination. The primary chemical contaminants found in the OU V Eastern VOC plume are TCE and TCA. The ambient water quality standard for these both of these compounds is 5 µg/L. The Eastern VOC plume, defined by TVOC concentrations greater than 5 µg/L, extends from a location southeast of the STP to the Long Island Expressway offsite, a distance of approximately 5,300 feet. The plume is approximately 1,100 feet wide. During 1999, the highest TVOC concentration was 22 µg/L, detected in Well 061-05 located at the site boundary near North Street. The plume degrades to less than 13 µg/L (TVOC) near the Long Island Expressway. Vertically, the VOCs are restricted to the deep portions of the Upper Glacial aquifer.

Samples from key OU V wells were analyzed for Target Analyte List (TAL) Metals, and samples from offsite wells were analyzed for pesticides/PCBs. All of the inorganic contaminants of concern initially identified during the OU V Remedial Investigation/Feasibility Study, including mercury and hexavalent chromium, were not detected during 1999. Although trace amounts of the pesticides 4,4''-DDD and 4,4''-DDT were detected in several offsite wells during 1998, all samples collected during 1999 were non-detect for these compounds.

Time-vs.-VOC concentration trend plots for key OU V wells are also provided on Figure 7-24. Monitoring Wells 049-06, 050-01, and 061-05 all showed decreasing trends in VOC concentrations during 1999. Well 000-122 (located near the leading edge of the plume) showed a very slight increase in VOC concentrations. VOC concentrations in Well 049-06, located near the interpreted trailing edge of the plume during 1998, dropped to below the 5 µg/L in 1999. The changes in plume distribution from 1997 through 1999 are presented on Figure 7-25. The higher concentration middle portion of the plume (i.e., with TVOC concentrations >20 µg/L) during 1998 has probably migrated south of well 061-05 and is presently situated in between available monitoring points.

*Radionuclides*

Detectable levels of tritium were found in a number of wells located near the BNL's southeastern site boundary and several offsite wells. However, the concentrations were well below the drinking water standard of 20,000 pCi/L. In wells located near the southeastern site boundary, the maximum tritium concentration was detected in Well 50-02, at a concentration of 2,175 pCi/L. In offsite wells monitored

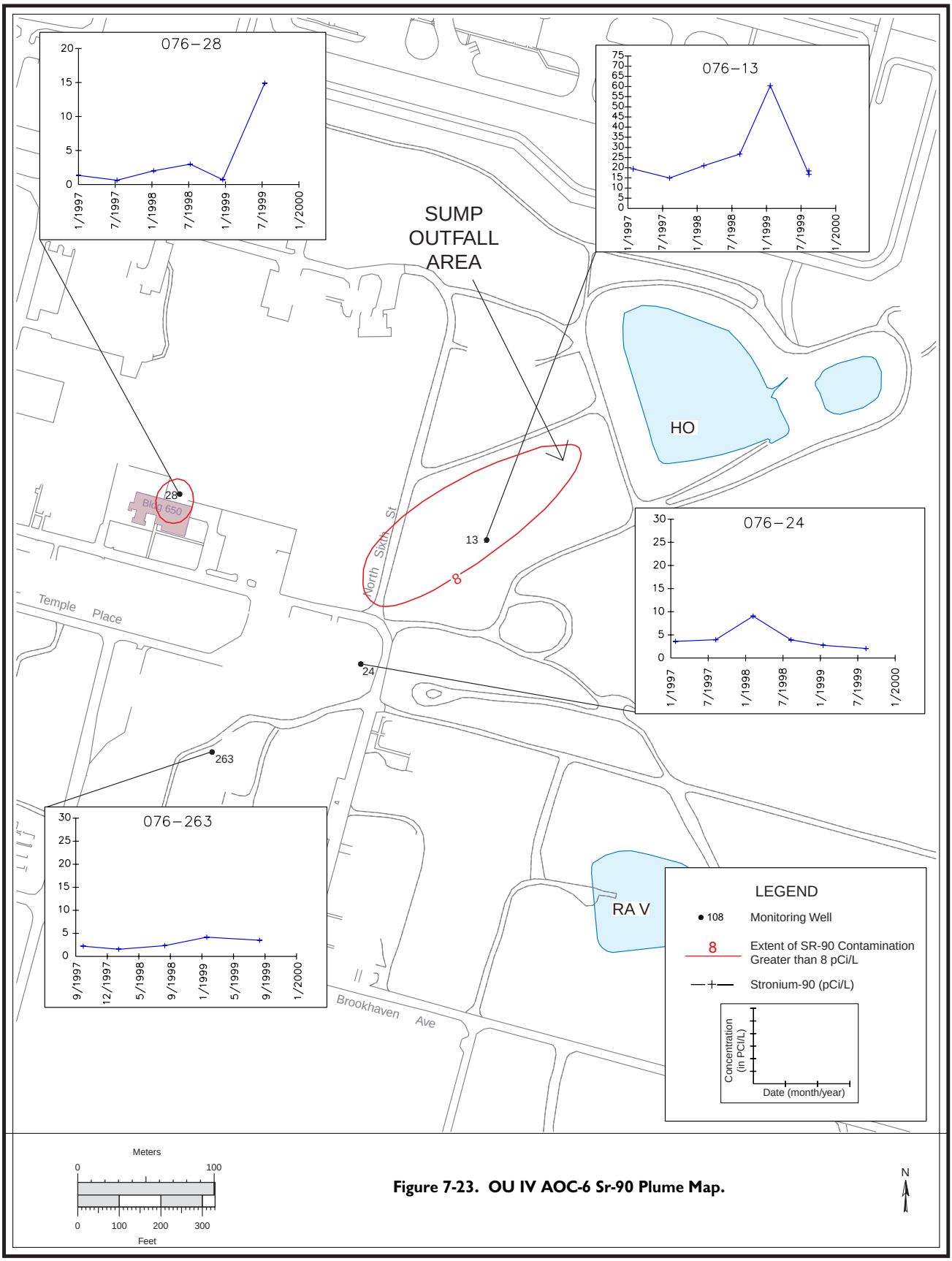


**Figure 7-23. OU IV AOC-6 Sr-90 Plume Map.**

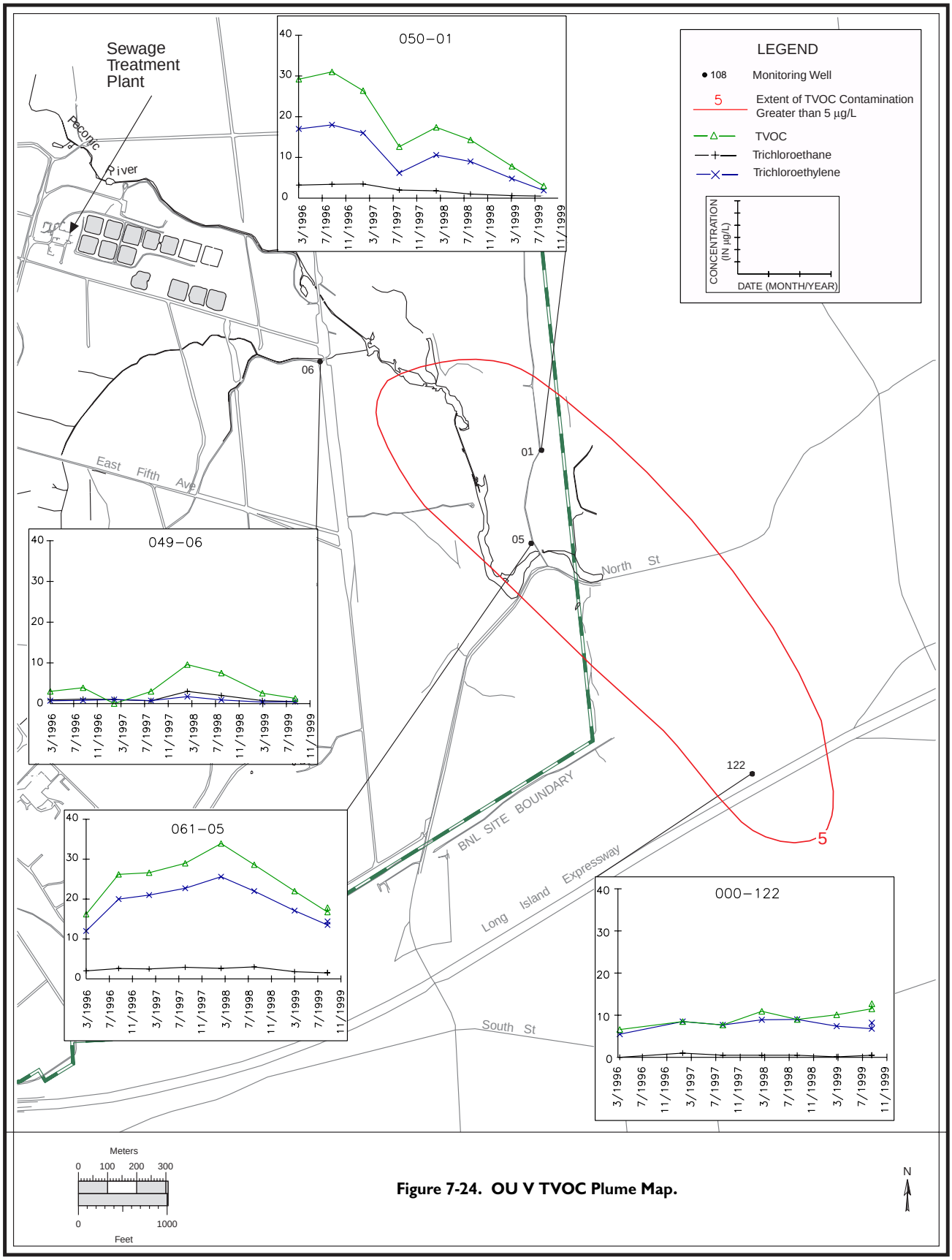


**Figure 7-24. OU V TVOC Plume Map.**

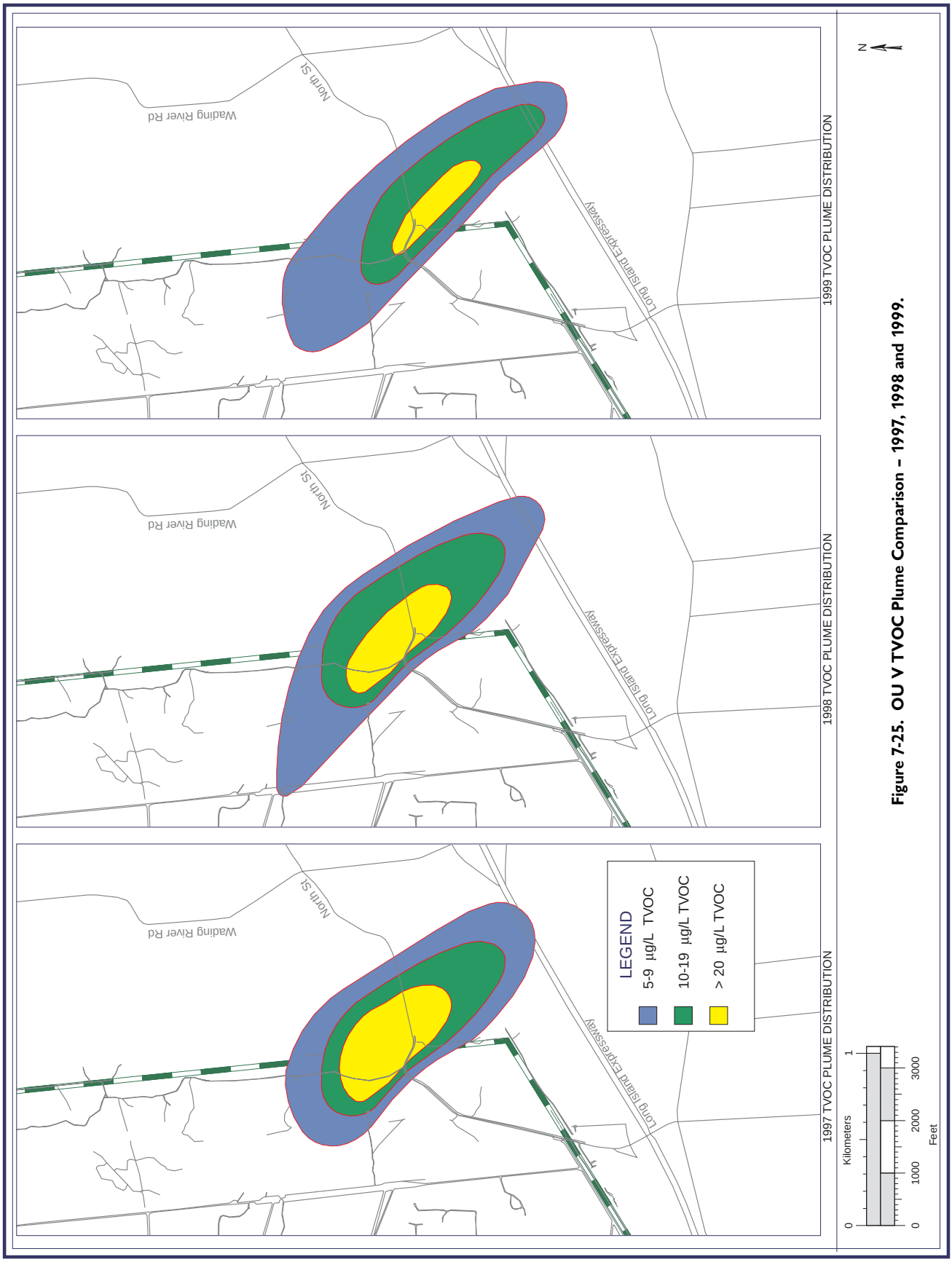


**Figure 7-25. OU V TVOC Plume Comparison – 1997, 1998 and 1999.**

during 1999, tritium was either non-detectable or just slightly above detection limits. (Note: the typical detection limit for tritium is 400 pCi/L.) The maximum offsite tritium concentration was 979 pCi/L, detected in Well 000-122 located near the Long Island Expressway. A detailed discussion on the distribution of tritium within the OU V plume is provided in the *1999 Groundwater Monitoring Report* (Dorsch *et al.* 2000).

#### 7.4.6 OPERABLE UNIT (OU) VI, BIOLOGY FIELDS

Ethylene dibromide (EDB) was used as a fumigant in the BNL Biology Department's 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. As the result of these historical releases of EDB, a contaminant plume (as defined by concentrations greater than the 0.05 µg/L drinking water standard for EDB) extends approximately 3,500 feet, from near BNL's southeastern site boundary to an area south of the Long Island Expressway (see Figure 7-26). EDB is the only contaminant of concern for the Biology Fields plume. The width of the plume is approximately 1,100 feet. During 1999, the off site portion of the EDB plume was further defined by using temporary vertical profile wells and new permanent monitoring wells.

During 1999, the highest EDB concentration was found in offsite Well 000-175 (located south of North Street) at 4.2 µg/L. Vertically, EDB is found in the deep Upper Glacial aquifer at the southern site boundary and in offsite areas. EDB concentration trends for representative wells are also shown on Figure 7-26. Offsite Wells 000-110, 000-175, and 000-209 all showed increasing EDB concentration trends through September and a return to lower concentrations by December. Figure 7-27 shows a comparison of the EDB plume from 1997 through 1999. The important changes in the plume are the downgradient migration of both the trailing edge of the plume and the area of highest EDB concentrations. The 1998 and 1999 plume boundaries depicted on Figure 7-27 are based on a significantly greater coverage of offsite wells that were installed in 1998 and 1999.

#### 7.4.7 GROUNDWATER TREATMENT SYSTEMS

The primary mission of BNL's ER Program is remediating soil and groundwater contamination, and preventing additional contamination from migrating off the BNL site. To that end, six groundwater treatment systems are presently operating at BNL, and a seventh system will be operational in 2000. Figure 7-28 shows the locations of these treatment systems. The following is a brief description of the groundwater treatment systems that were operational during 1999 along with a summary of their performance. Table 7-2 provides a summary of pounds of VOCs removed and gallons of water treated since the first treatment system became operational in 1997.

*OU III South Boundary Remediation System*

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, where air from a powerful blower separates the VOCs from the water. The removal efficiency is close to 100 percent. No VOCs were detected above the minimum detection limit (typically 0.5 µg/L) in treated water samples. 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. During 1999, approximately 327 pounds of VOCs were removed from the groundwater, and 336,300,000 gallons of treated groundwater were returned to the aquifer.

*OU III Offsite Groundwater Treatment System*

The OU III Offsite groundwater remediation system became operational in the summer of 1999. The system was 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 consists of a series of innovative "in-well stripping" wells that use the same air stripping treatment concept as the OU III South Boundary Remediation System, but all treatment and recharge occurs within the well. Within each well, contaminated water is pumped from a deep well screen to a treatment system located near the top of the well, where VOCs are stripped from the water. The treated

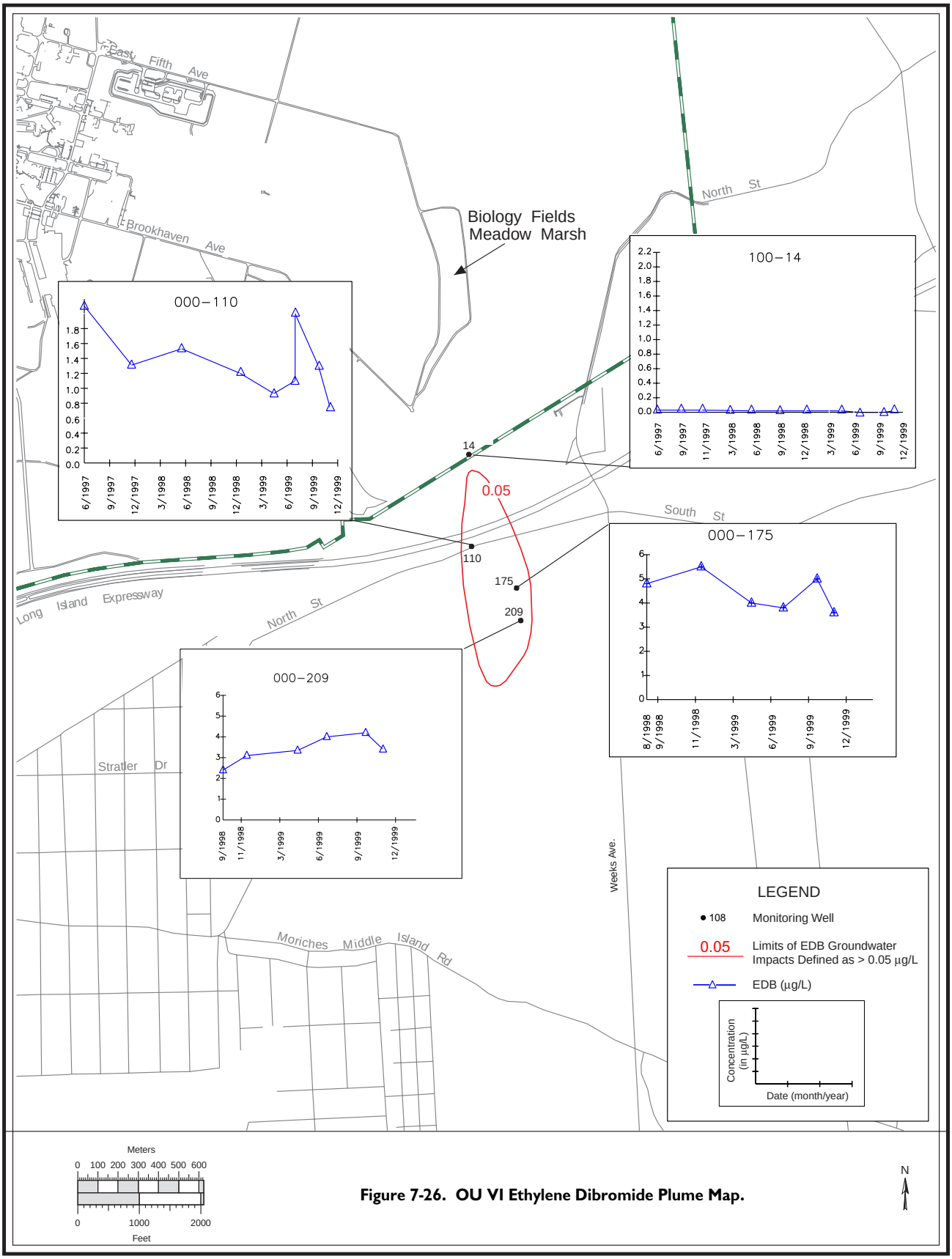


**Figure 7-26. OU VI Ethylene Dibromide Plume Map.**


**Figure 7-27. OU VI EDB Plume Comparison – 1997, 1998, and 1999.**

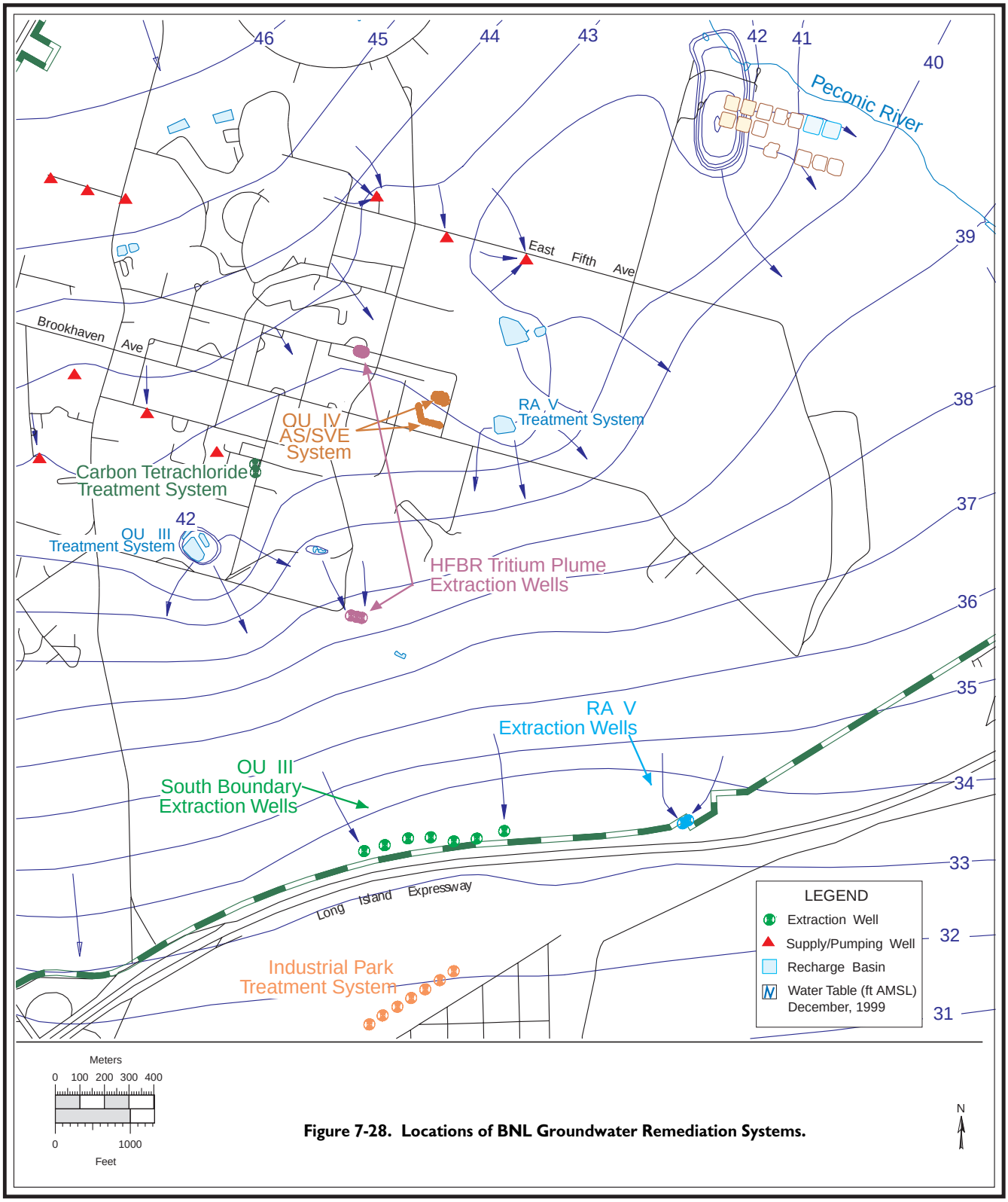


**Figure 7-28. Locations of BNL Groundwater Remediation Systems.**

**Table 7-2. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 1999.**

| Remediation System | 1997 | | 1998 | | 1999 | |
|---|---|---|---|---|---|---|
| | Water Treated (gals.) | VOCs Removed (lbs.) | Water Treated (gals.) | VOCs Removed (lbs.) | Water Treated (gals.) | VOCs Removed (lbs.) |
| OU III South Boundary | 166,000,000 | 340 | 335,000,000 | 405 | 336,300,400 | 354 |
| OU III Off-site | (a) | — | (a) | — | 35,300,000 | 63 |
| Carbon Tetrachloride | (a) | — | (a) | — | 6,900,000 | 112 |
| RA V | 340,000,000 | 120 | 342,000,000 | 46 | 314,000,000 | 29 |
| HFBR Tritium Plume | 63,000,000 | 16 | 63,000,000 | 20 | 64,000,000 | 68 |
| OU IV AS/SVE | (b) | 12 | (b) | 19 | (b) | 8 |
| **Total** | 569,000,000 | 488 | 740,000,000 | 490 | 756,500,000 | 634 |

Notes:
(a) Treatment system not installed/operational during this time.
(b) Air Sparging/Soil Vapor Extraction system performance measured by pounds of VOC removed per cubic foot of air treated.

water is then routed to a shallower screened section of the same well where it re-enters the aquifer. The VOC vapors are captured by a granular carbon filter. During 1999, approximately 63 pounds of VOCs were removed from 35,300,000 gallons of groundwater.

*OU I (RA V) South Boundary Remediation System*

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. This system processes more than 700 gallons of water per minute. Like the OU III South Boundary Remediation System, the RA V system removes close to 100 percent of the chemical contamination. No VOCs were detected above the MDL in treated water samples. 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. During 1999, approximately 29 pounds of VOCs were removed from the groundwater, and 314,000,000 gallons of treated groundwater were returned to the aquifer.

*OU III Carbon Tetrachloride Treatment System*

A groundwater remediation system consisting of two extraction wells screened in the shallow Upper Glacial Aquifer began operations on October 6, 1999 to address the carbon tetrachloride released during the removal of an underground storage tank in early 1998. Groundwater extracted from this area is treated with carbon filtration and recharged back into the aquifer through an unlined drainage swale to Recharge Basin HS located south of Princeton Avenue. Details on this groundwater treatment system can be found in the *OU III Carbon Tetrachloride Pump and Treat System Start-Up Report* (BNL 2000c). During 1999, approximately 112 pounds of VOCs were removed, and 6,900,000 gallons of treated water were recharged to the Upper Glacial aquifer.

*OU III HFBR Tritium Plume Remediation System*

This groundwater pump and recharge system was constructed as an interim remedial action after the HFBR tritium plume was discovered, and has operated since May 1997. Three groundwater extraction wells were installed approximately 3,500 feet south of the HFBR. Groundwater is pumped from the aquifer at a rate of about 50 gallons per minute and piped north to a treatment facility adjacent to the RA V treatment system. Because the water also contains VOCs that originate from another sources (possibly the former Building 96 area), 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. No VOCs were detected above the minimum detection limit in treated water samples; and tritium was not detected in samples collected at the influent to the treatment system (i.e., concentrations <500 pCi/L). This interim remediation system is designed to prevent the further southward migration of the HFBR tritium plume while long-term remediation options are evaluated and implemented. During 1999, the granular activated carbon filters removed approximately 68 pounds of VOCs, and 64,000,000 gallons of treated water were recharged to the aquifer system.

*OU IV Air Sparging/Soil Vapor Extraction System*

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 that forces pressurized air into the groundwater to "bubble" or strip the 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. During 1999, approximately eight pounds of contaminants were removed from the soil and groundwater.

## 7.5 ENVIRONMENTAL SURVEILLANCE (ES) PROGRAM (NON-CERCLA)

BNL's Environmental Surveillance (ES) Program includes groundwater monitoring at active research facilities (i.e., research reactor areas, accelerator beam stop and target areas, greenhouse areas) and support facilities (i.e., fuel storage facilities and water treatment facilities). In September 1998, BNL finalized a *Groundwater Monitoring Improvements Plan* (Paquette 1998) that identified active research and support facilities requiring improved groundwater monitoring programs. As a result of this evaluation, 84 new, permanent groundwater monitoring wells were installed on a prioritized basis during 1999 and early 2000. During 1999, 93 groundwater surveillance wells were monitored during 318 individual sampling events. All wells sampled during 1999 are listed in Appendix E. Results for these programs are summarized below. For detailed descriptions and maps related to the ES monitoring programs, refer to the *1999 BNL Groundwater Monitoring Report* (Dorsch *et al*. 2000).

### 7.5.1 RESEARCH FACILITIES

#### 7.5.1.1 ALTERNATING GRADIENT SYNCHROTRON (AGS) COMPLEX

Activated soils have been created near a number of AGS experimental areas as the result of secondary particles (primarily neutrons) produced at beam targets and beam stops. Radionuclides, such as tritium and sodium-22, have been produced by the interaction of these secondary particles with the soils that surround these experimental areas. Furthermore, historical surface spills and discharges of solvents to cesspools and recharge basins near the AGS have contaminated soils and groundwater with VOCs. VOC contamination is monitored under the ER program's OU III Central Areas Project (see section 7.4.3).

During 1999, 32 groundwater monitoring wells were used to evaluate groundwater quality near potential soil activation areas located within the AGS Complex (e.g., Building 912, AGS Booster Beam Stop, 914 Transfer Tunnel, g-2 experimental area, E-20 Catcher, former U-Line Target, and the new J-10 Beam Stop). Twenty-four of these wells were installed as part of the Groundwater Monitoring Improvements project. The enhanced groundwater monitoring program detected two tritium plumes that originated from the g-2 experimental area and the former E-20 Catcher region of the AGS Ring.

New monitoring wells installed approximately 250 feet downgradient of the g-2 experimental area detected the presence of a tritium and sodium-22 plume originating from activated soil shielding. A sample from the new g-2 area Well 054-067 collected in October 1999 had a tritium concentration of 41,700 pCi/L (approximately twice the drinking water standard of 20,000 pCi/L). Sodium-22 was not detected in the sample. In November 1999, BNL installed 18 temporary wells to determine the extent of the contamination and verify the location of the source (Figure 7-29). A sample from temporary Well 054-116, located approximately 70 feet downgradient of an area where the soil-shield was activated, had a tritium concentration of 1,800,000 pCi/L. Tritium concentrations in temporary Well 054-111 located approximately 120 feet downgradient of the soil activation area, were approximately 1,500,000 pCi/L. Results from samples collected from temporary wells installed near permanent Well 054-67 showed tritium concentrations up to 33,000 pCi/L. Tritium was not detected in three temporary wells installed directly upgradient of the g-2 soil-shield activation area. The highest level of sodium-22 was detected in Well 054-116, at a concentration of 60 pCi/L (or 15% of the 400 pCi/L drinking water standard). In December 1999, an impermeable cap was installed over the g-2 soil activation area to prevent rainwater infiltration and the continued leaching the

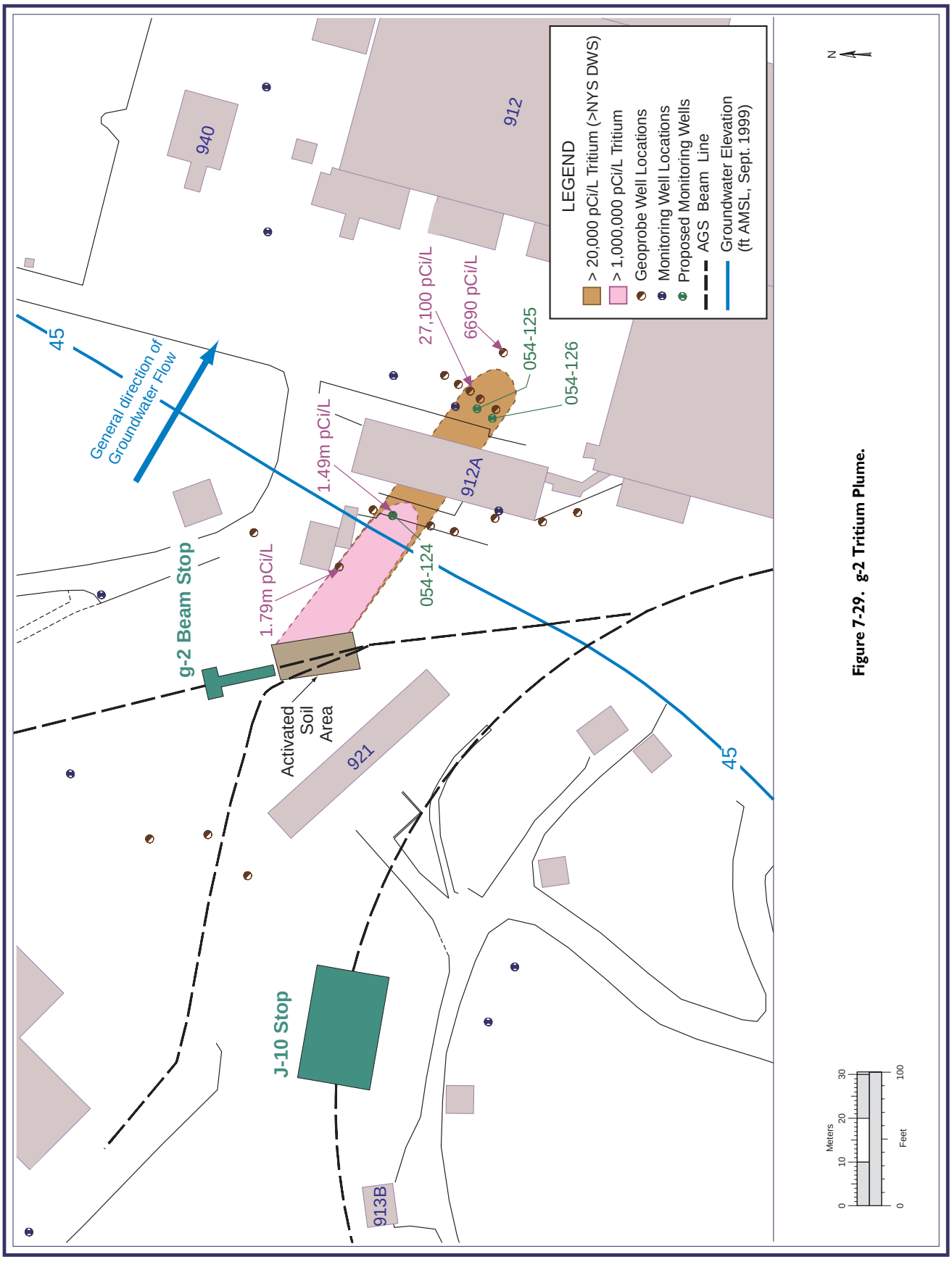


**Figure 7-29. g-2 Tritium Plume.**

radionuclides out of the soils and into groundwater.

A new well (064-65) installed approximately 100 feet downgradient of the former E-20 Catcher area of the AGS detected a narrow plume of tritium and sodium-22 originating from activated soil used as shielding near the former beam catcher. During 1999, tritium and sodium-22 were detected in Well 064-56 at maximum concentrations of 5,800 pCi/L and 219 pCi/L, respectively. To further evaluate the extent of contamination, four Geoprobe wells were installed in January 2000. The highest levels of tritium and sodium-22 were found in Geoprobe Well 064-065 with concentrations of 40,400 pCi/L and 704 pCi/L, respectively. This well was installed approximately 12 feet southwest of permanent Well 064-56. These data indicate that at a distance of approximately 100 feet downgradient of the E-20 Catcher, the zone of elevated tritium and sodium-22 is estimated to be approximately 20 to 30 feet wide and situated within 10 feet of the water table (approximately 30 to 40 feet below land surface). During CY 2000, BNL will install an impermeable cap over the E-20 Catcher soil activation area to prevent rainwater infiltration and the continued leaching the radionuclides out of the soils and into groundwater.

Low levels of tritium and sodium-22 were also detected in new shallow wells installed downgradient of Building 912 (the AGS's main experimental hall) and the former U-Line Target area. In wells located downgradient of Building 912, tritium concentrations ranged from non-detectable to 2,120 pCi/L and sodium-22 concentrations ranged from non-detectable to 32.6 pCi/L. In Well 054-69, located approximately 500 feet downgradient of the former U-Line Target area, tritium and sodium-22 were detected at maximum concentrations of 1,130 pCi/L and 38.3 pCi/L, respectively.

#### 7.5.1.2 BROOKHAVEN LINAC ISOTOPE PRODUCER (BLIP)

The BLIP facility is located at the southern end of the Linear Accelerator (LINAC). When the BLIP is operating, the LINAC delivers a beam of protons that impinges on a series of eight targets located within the BLIP target vessel. During irradiation, activation of the soils immediately outside of the vessel occurs due to the creation of secondary particles produced at the target. In February 1998, elevated levels of tritium and sodium-22 were detected in wells located downgradient of BLIP. Maximum tritium and sodium-22 concentrations (52,000 pCi/L and 151 pCi/L, respectively) were detected in temporary wells installed approximately 20 feet downgradient of BLIP. To prevent rainwater from infiltrating the activated soils below the building, the BLIP building's roof drains were redirected away from the building, paved areas were resealed, and an extensive gunnite (cement) cap was installed on three sides of the building.

Results from six new groundwater monitoring wells installed in 1999 indicate that the corrective actions noted above have been highly effective in preventing rainwater infiltration through the contaminated soils. Maximum tritium and sodium-22 concentrations in new permanent wells located 20 feet downgradient of the BLIP facility were only 2,450 pCi/L and 14 pCi/L, respectively. Remnants of the higher concentration plume initially observed in 1998 were detected in Well 064-50, which is located approximately 100 feet downgradient of BLIP. A sample collected from Well 064-50 in March 1999 had tritium and sodium-22 concentrations of 18,700 pCi/L and 72 pCi/L, respectively. However, subsequent samples from Well 064-50 had tritium and sodium-22 concentrations of less than 1,000 pCi/L and 40 pCi/L, respectively. These results indicate that the corrective actions taken in 1998 (e.g., connecting roof drains, sealing paved areas, and construction of a cement cap) have been effective in preventing rainwater from infiltrating the activated soils, and washing out the tritium and sodium-22 from the soils and into the groundwater.

#### 7.5.1.3 RELATIVISTIC HEAVY ION COLLIDER (RHIC)

Within the RHIC facility, there are two areas where radionuclides may be produced in the soils outside of the collider tunnel. The first area contains two beam stops that are located at the 10 o'clock position of the ring, and the second contains two collimators that are located at the 8 o'clock region. When RHIC becomes operational, secondary particles created at the internal beam stop and collimator areas will have the potential to activate the soils immediately surrounding those areas.

*Metals and Water Quality Parameters*

During 1999, quarterly groundwater samples were collected from twelve new RHIC monitoring wells to evaluate pre-operational metals and water quality parameter concentra-

tions. Metals analyses of the groundwater samples indicate the presence of naturally occurring aluminum, iron and manganese at concentrations that exceed New York State ambient water quality standards. Most of these elevated concentrations were observed in samples collected from RHIC beam stop area wells (Wells 025-03, 025-05, 025-06, and 025-08). These metals originate from naturally occurring clay minerals that are prevalent in the near-surface soils located near the Peconic River. Analysis of samples for water quality parameters (e.g., chlorides, sulfates and nitrates) indicate that all concentrations are below ambient water quality standards.

*Radionuclides*

During 1999, groundwater samples were collected to evaluate pre-operational radionuclide concentrations. Analytical results indicate that all radionuclide concentrations are below applicable drinking water standards and are consistent with background levels. Slightly elevated gross beta concentrations (up to 26.5 pCi/L) were detected in samples from Well 025-05, which is located downgradient of RHIC's southern beam stop. The elevated gross beta values are probably due to potassium-40, which was also detected at concentrations up to 26.7 pCi/L. The potassium-40 found in the water samples is likely to have originated from naturally occurring clay minerals that are prevalent in the near-surface soils adjacent to the Peconic River.

#### 7.5.1.4 BROOKHAVEN MEDICAL RESEARCH REACTOR (BMRR)

During a 1997 investigation to evaluate groundwater quality near the BMRR, a tritium plume with a maximum concentration of approximately one-half the 20,000-pCi/L drinking water standard was identified. The maximum tritium concentration during 1997 was 11,800 pCi/L in wells installed directly downgradient (within 30 feet) of the facility. The tritium is believed to have originated from the historical discharge of small amounts of BMRR primary cooling water to a basement floor drain and sump system that may have leaked. Although the last discharge of primary cooling water to the floor drain system occurred in 1987, the floor drains continued to be used for secondary (non-radioactive) cooling water until 1997. The infiltration of this water may have promoted the movement of residual tritium from the soils surrounding the floor drain piping system to the groundwater. The floor drains were permanently sealed in 1998 to prevent any accidental future releases to the underlying soils.

During 1999, groundwater samples were collected from one upgradient and three downgradient wells on a quarterly basis. As in previous years, tritium concentrations continued to be below the drinking water standard of 20,000 pCi/L. Detectable levels of tritium were observed in all three downgradient wells, with the maximum value of 17,100 pCi/L in Well 084-27. A slightly elevated gross beta concentration of 26.3 pCi/L was detected in the December 1999 sample from downgradient Well 084-27. The elevated gross beta values are probably due to potassium-40, which was also detected at a concentration of 25.4 pCi/L. The potassium-40 that was detected in the water sample is likely to have originated from naturally occurring clay minerals.

### 7.5.2 SUPPORT FACILITIES

#### 7.5.2.1 SEWAGE TREATMENT PLANT (STP) AREA

As described in Chapters 1 and 3, the STP processes sanitary sewage for BNL facilities. Approximately 15 percent of the water released to the STP's filter beds is lost either to evaporation or to direct groundwater recharge; the remaining water is discharged to the Peconic River. Past radiological and chemical releases to the sanitary system contaminated soils, sediments, and groundwater in the STP and Peconic River areas. During 1999, the STP groundwater monitoring program used 12 shallow Upper Glacial aquifer wells to evaluate groundwater quality near the plant's filter beds and along the Peconic River from the STP discharge point to the site boundary.

*Volatile Organic Compounds, Metals and Water Quality Parameters*

As noted earlier, groundwater quality impacts resulting from historical STP discharges are currently being monitored as part of the OU V monitoring program using wells that are located at the site boundary and offsite areas (see Section 7.4.5). The STP facility monitoring program on the other hand, is designed to evaluate whether current operations are impacting groundwater quality. The 12 wells used under this program are situated close to the

STP's sand filter beds and along the Peconic River. During 1999, groundwater samples were analyzed for water quality, VOCs, and metals. In all groundwater samples, water quality parameters (i.e., chlorides, sulfates and nitrate) were within the applicable New York State ambient water quality standards. Iron levels exceeded ambient water quality standard of 0.3 mg/L in three wells (038-01, 038-03, and 039-06), with maximum concentrations ranging from 0.32 mg/L to 1.8 mg/L. Three wells (039-06, 039-07, and 039-08) had sodium concentrations above the NYS AWQS of 20 mg/L, with maximum concentrations ranging from 20.1 mg/L to 33.1 mg/L. A sample from one well (038-03) had a zinc value of 0.54 mg/L, which exceeded the ambient water quality standard of 0.3 mg/L. Whereas the elevated iron and zinc concentrations may be due to naturally occurring sediments surrounding the wells, the sodium levels are likely due to road salting operations. No VOCs were detected above NYS AWQS in any of the STP area wells.

*Radionuclides*

For groundwater in the area surrounding the STP, gross alpha and gross beta activity values were below drinking water standards, and were typical of background values. However, gross beta activities were slightly elevated in Well 038-03 (located near the filter beds) with a maximum recorded value of 41.7 pCi/L. Because these wells are screened near shallow clay deposits, the slightly elevated gross beta values are likely due to naturally occurring potassium-40 from clay minerals introduced into the samples during collection. Monitoring results indicated a tritium concentration of 356 pCi/L in one sampled from filter bed area Well 039-08. However, this value is extremely close to the minimum detection limit (for that analysis) of 327 pCi/L. When the 95 percent confidence intervals are considered, these two values are not statistically different from the MDL and do not, therefore, represent a clear detection of tritium. No other man-made radionuclides were detected in groundwater in this area.

#### 7.5.2.2 WATER TREATMENT PLANT (WTP)

At the direction of the NYSDEC, five shallow Upper Glacial aquifer 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 the groundwater pumped for potable and process supply are removed at the WTP, and the precipitated iron is discharged to the recharge basins.

*Metals and Water Quality Parameters*

During 1999, one set of groundwater samples was collected from the five WTP area wells, and analyzed for water quality and metals. As in previous years, all water quality parameters (i.e., chlorides, sulfates, and nitrate) and most metals concentrations, including iron, were below the applicable NYS AWQS. Sodium was detected at a concentration of 26.9 mg/L in the sample collected from Well 063-01 (the NYS AWQS for sodium is 20 mg/L).

#### 7.5.2.3 BUILDING 423 (MOTOR POOL)

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, and waste oil is stored in one, 500-gallon capacity underground storage tank. Although the underground storage tanks and associated distribution lines meet Suffolk County 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 would be detected if a tank alarm system failed. Following the discovery of a hydraulic oil spill in Building 423 and a historical oil spill immediately south of the nearby Site Maintenance Facility Building 326, BNL entered into a spill response (stipulation) agreement with NYSDEC. As part of this agreement, BNL installed six new groundwater surveillance wells in early 1999.

During 1999, groundwater samples were analyzed for VOCs and semi-VOCs on a quarterly basis, and the wells were checked monthly for floating petroleum product. None of the target compounds associated with gasoline or oil spills were detected in the samples, and no floating product was observed. However, the solvent TCA was detected at concentrations above New York State ambient water quality standard of 5 µg/L in all four wells located downgradient of Building 326 (see Figure 7-30). The maximum TCA concentration was detected in Well 102-10 at 50 µg/L. TCA was not detected in the upgradient well. The presence of TCA in these samples is the result of historical solvent spillage in the Motor Pool and Site

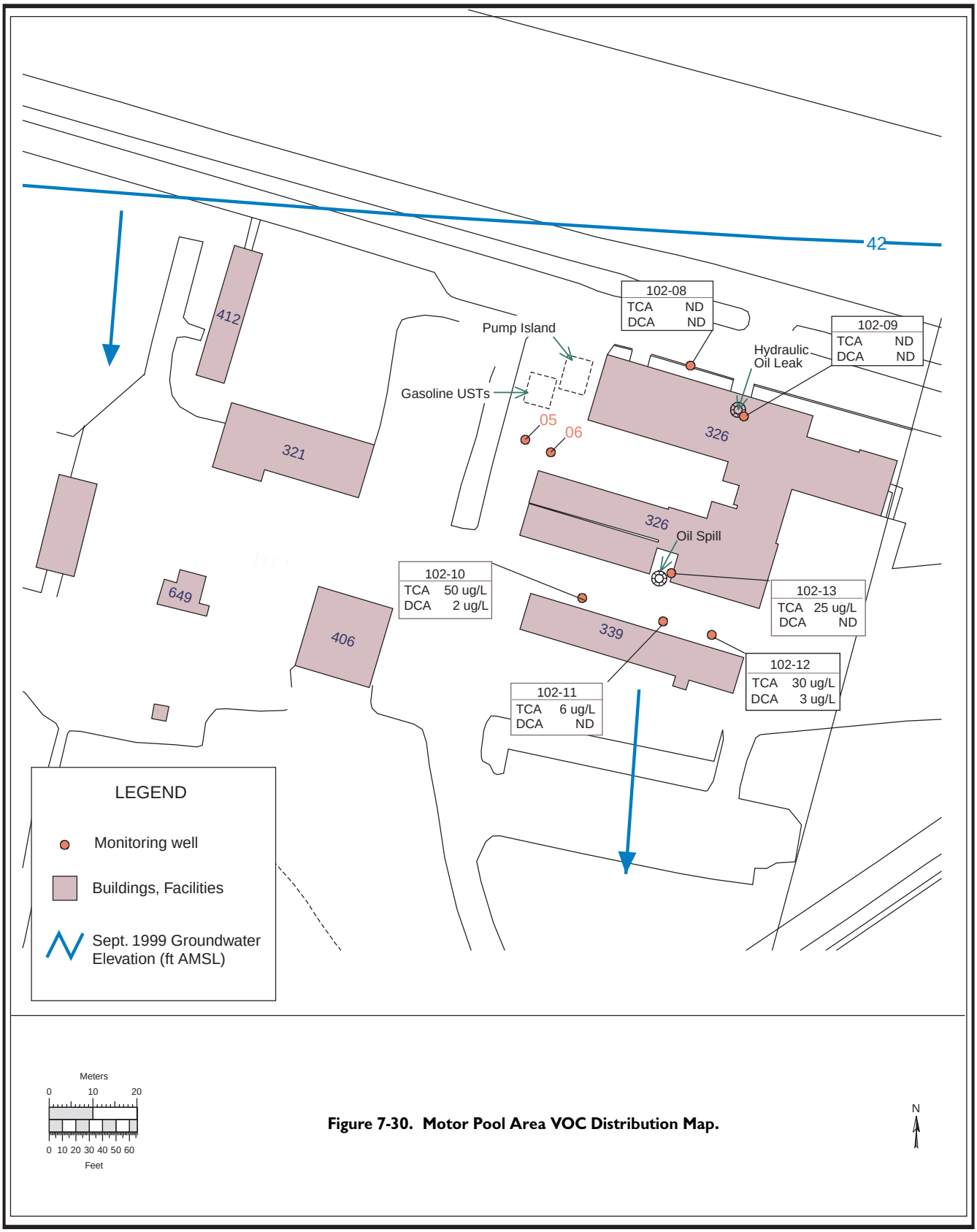


**Figure 7-30. Motor Pool Area VOC Distribution Map.**

Maintenance area, and is not associated with current operations.

#### 7.5.2.4 ONSITE 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, and waste oil is stored in one 500-gallon capacity underground storage tank. Although the storage tanks and associated distribution lines meet Suffolk County 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 would be detected if a tank alarm system failed.

During 1999, groundwater samples were collected from the two shallow Upper Glacial aquifer surveillance wells (085-16 and 085-17) and analyzed for VOCs. The wells were also checked for floating petroleum product. Carbon tetrachloride was detected at concentrations exceeding NYS AWQS in both wells, with a maximum concentration of 503 µg/L detected in Well 085-17. PCE was also detected in Well 085-17, at a maximum concentration of 5.1 µg/L. The fuel additive MTBE was not detected in either of the wells, and no floating product was observed. Whereas the PCE is likely associated with historical degreasing operations at the service station, the substantial increase in carbon tetrachloride concentrations compared to previous years (with levels <10 µg/L), is due to the advancement of a carbon tetrachloride plume originating from an underground storage tank that was located approximately 280 feet upgradient of Well 085-17 (see section 7.4.3).

#### 7.5.2.5 MAJOR PETROLEUM FACILITY (MPF)

The Central Steam Facility 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 Central Steam Facility. Five shallow Upper Glacial aquifer 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 product (i.e., oil floating on top of the groundwater) could be detected. The surveillance wells at the CSF were installed primarily to monitor groundwater 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 Remedial Investigation/Feasibility Study, and has been undergoing active soil and groundwater remediation since the winter of 1997 (see Section 7.4.4.1).

In accordance with the NYSDEC operating license, the five MPF wells were sampled monthly in 1999 for floating petroleum products, and semiannually for polynuclear aromatics and base-neutral extractable compounds (EPA Method 625). As in previous years, no fuel oil-related compounds were detected, and no floating petroleum products were observed.

#### 7.5.2.6 NEW WASTE MANAGEMENT FACILITY (WMF)

In 1997, BNL began operating a new WMF. The new WMF is designed and operated in a manner that meets all applicable federal, state and local environmental protection requirements. Nevertheless, BNL established a groundwater monitoring program as a secondary means of verifying the effectiveness of the facility's administrative and engineered controls. The new WMF is monitored by eight shallow Upper Glacial aquifer wells. During 1999, groundwater samples were collected quarterly and analyzed for VOCs, radioactivity, metals, and water quality.

*Volatile Organic Compounds, Metals and Water Quality Parameters*

In 1999, all water quality and most metals concentrations were below the applicable NYS AWQS. Sodium was detected at concentrations above the NYS AWQS of 20 mg/L in upgradient Wells 055-10 and 066-07 (26.9 mg/L and 21.6 mg/L, respectively). Silver was detected above the NYS AWQS of 0.01 mg/L in one sample from downgradient Well 056-23, with a concentration of 0.1 mg/L. Although low levels of chloroform and TCA (up to 2.3 µg/L and 3.8 µg/L, respectively) were detected in a number of the WMF wells, all VOC concentrations were below applicable NYS AWQS. It is believed that the trace amounts of TCA are due to historical releases in upgradient areas, whereas the chloroform is likely to be related to the use of water treatment chemicals in the potable and process water that is routinely discharged to nearby Recharge Basin HO.

*Radionuclides*

With one exception, in 1999 gross activity levels in these samples were typical of ambient (background) levels. Slightly elevated gross beta concentrations were observed in upgradient Well 066-07 and downgradient Well 056-21, at maximum concentrations of 21.3 pCi/L and 19.2 pCi/L, respectively. Low levels of cobalt-60 were detected in samples collected from Well 066-07, with a maximum concentration of 8.8 pCi/L (the drinking water standard for cobalt-60 is 200 pCi/L). The source of the cobalt-60 is an underground storage tank leak that occurred at Building 830 in 1988. Monitoring results indicated a tritium concentration of 334 pCi/L in one sampled from upgradient Well 066-07. However, this value is extremely close to the minimum detection limit of 306 pCi/L. When the 95 percent confidence intervals are considered, this value is not statistically different from the minimum detection limit and does not, therefore, represent a clear detection of tritium.

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